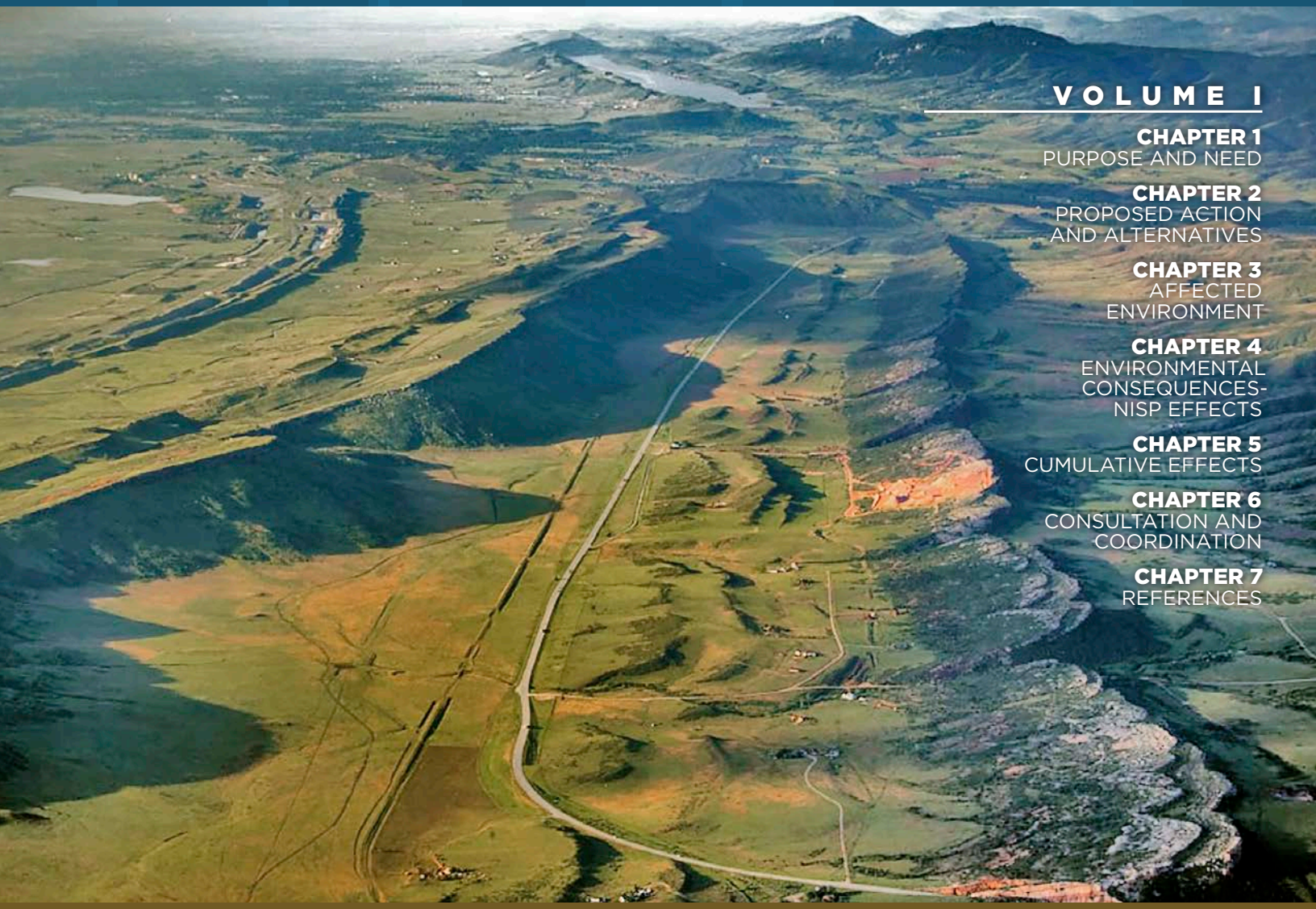
SUPPLEMENTAL DRAFT ENVIRONMENTAL IMPACT STATEMENT

NORTHERN INTEGRATED SUPPLY PROJECT

JUNE 2015



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US Army Corps of Engineers®

OMAHA DISTRICT
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SUPPLEMENTAL DRAFT ENVIRONMENTAL IMPACT STATEMENT

NORTHERN INTEGRATED SUPPLY PROJECT

Applicant:
Northern Colorado Water Conservancy District

U.S. Army Corps of Engineers
Omaha District
1616 Capitol Avenue, Suite 9000
Omaha, Nebraska

June 2015

_____
Martha S. Chieply, Chief
REGULATORY BRANCH
ARMY CORPS OF ENGINEERS, OMAHA DISTRICT

_____
Date

US Army Corps of Engineers®

This Supplemental Draft Environmental Impact Statement was prepared by ERO Resources Corporation, an environmental consulting firm, with the guidance, participation, and independent evaluation of the U.S. Army Corps of Engineers (Corps). The Corps, in accordance with 40 CFR 1506.5(a) and (c), is in agreement with the findings of the analysis, and approves and takes responsibility for the scope and content of this document.

COVER SHEET
SUPPLEMENTAL DRAFT ENVIRONMENTAL IMPACT STATEMENT
NORTHERN INTEGRATED SUPPLY PROJECT

Lead Agency: Department of the Army
Corps of Engineers, Omaha District

Cooperating Agencies: U.S. Bureau of Reclamation
Colorado Department of Transportation
Colorado Department of Public Health and Environment
Colorado Department of Natural Resources
Larimer County
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service

Jurisdictions in Colorado That Could Be Directly Affected: Boulder, Larimer, Morgan, and Weld Counties

Abstract: The Northern Integrated Supply Project Supplemental Draft Environmental Impact Statement (SDEIS) evaluates the effects of constructing and operating the proposed Northern Integrated Supply Project (NISP) located in Larimer and Weld Counties in northeastern Colorado. The U.S. Army Corps of Engineers (Corps), Bureau of Reclamation, and Colorado Department of Transportation will use this information to determine whether to approve permits and contracts necessary for construction and operation of NISP. As proposed by the Northern Colorado Water Conservancy District (District), NISP would consist of a proposed Glade Reservoir with a capacity of approximately 170,000 acre-feet (AF). Associated with Glade Reservoir would be a forebay, pump station, and diversion structure and canal upgrade to convey water diverted from the Cache la Poudre River to the proposed reservoir. A pipeline connecting the proposed Glade Reservoir to the existing Horsetooth Reservoir may also be constructed in the future. Glade Reservoir would inundate a section of U.S. 287 and require the relocation of the highway. The proposed Project also would include a proposed Galeton Reservoir with a capacity of about 45,624 AF. Associated with Galeton Reservoir would be a forebay, pump station, and pipeline to deliver water diverted from the South Platte River to Galeton Reservoir. Water exchanges between the Galeton Reservoir and Glade Reservoir diversion locations are proposed.

The proposed Project is a collaborative effort among 15 water providers (Participants) facilitated and coordinated by the District. The proposed Project would provide approximately 40,000 AF of new reliable water supply, which would meet a portion of the Participants' estimated current and future water supply needs.

The SDEIS evaluates four alternatives for NISP: 1) No Action; 2) District's Preferred Alternative (Proposed Action) Glade Reservoir at 170,000 AF and Galeton Reservoir at 45,624 AF; 3) Cactus Hill Reservoir at 190,000 AF and Galeton Reservoir at 45,624 AF; and 4) Cactus Hill Reservoir at 190,000 AF and Galeton Reservoir at 45,624 AF with multiple diversions. The District has submitted a Department of the Army permit application to the Corps for the Proposed Action.

Reviewers should provide the Corps with their comments during the review period for the SDEIS. This will enable the Corps and cooperating agencies to analyze and respond to comments at one time and use the information acquired in the preparation of the Final Environmental Impact Statement. Comments on the SDEIS should be specific and should address the adequacy of the statement and the merits of the alternatives discussed (40 CFR 1503.3). The Corps will conduct a public hearing on the SDEIS.

EIS Contact for Comments and Additional Information:

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Date Comments Must Be Received By: August 4, 2015

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Appendices

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Acronyms and Abbreviations

°C	Degrees Celsius
°F	Degrees Fahrenheit
µg	microgram
µg/m^3	microgram per cubic meter
µS/cm	microSiemens per centimeter
1-D	1-dimensional data collection
2-D	2-dimensional data collection
Ac	Acute
ADT	Average daily traffic
AF	Acre-feet
AFM	Acre-foot per month
AFY	Acre-feet per year
APCD	Air Pollution Control Division
APE	Area of Potential Effect
AQCC	Air Quality Control Commission
AWRPC	Average annual water requirements per capita
BA	Biological Assessment
BGEPA	Bald and Golden Eagle Protection Act
bgs	Below ground surface
BLM	Bureau of Land Management
BMPs	Best management practices
CAA	Clean Air Act
CBGWS	Colorado Basic Ground Water Standards
CBP	Colorado butterfly plant
C-BT	Colorado-Big Thompson Project
CDNR	Colorado Department of Natural Resources
CDOT	Colorado Department of Transportation
CDOW	Colorado Division of Wildlife
CDP	Census Designated Place
CDPHE	Colorado Department of Public Health and Environment
CDPS	Colorado Discharge Permit System
CDSS	Colorado's Decision Support System
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	Cubic feet per second
Ch	Chronic
CNHP	Colorado Natural Heritage Program
CO	Carbon monoxide
COGCC	Colorado Oil and Gas Conservation Commission
Corps	U.S. Army Corps of Engineers
CPA	Cooperative planning area
CPW	Colorado Parks and Wildlife
CR	County Road
CRP	Conservation Reserve Program

CRS	Colorado Revised Statute
CSU	Colorado State University
CTM	Critical thermal maxima
CTP	Common Technical Platform
CU	Consumptive use
CWA	Clean Water Act
CWCB	Colorado Water Conservation Board
CWCWD	Central Weld County Water District
dB	Decibel scale
dBA	A-weighted levels
Dbh	Diameter at breast height
DDM	Data delivery mile
DEIS	Draft Environmental Impact Statement
dis	dissolved
District	Northern Colorado Water Conservancy District
DM	Daily maximum
DO	Dissolved oxygen
DRCOG	Denver Regional Council of Governments
DUWS	Direct use water supply
DWR	Colorado Division of Water Resources
EAB	Emerald ash borer
EIS	Environmental Impact Statement
ELC	Environmental Learning Center
EOM	End of month
EPA	U.S. Environmental Protection Agency
EPT	Ephemeroptera, Plecoptera, and Trichoptera (mayflies, stoneflies, and caddisflies)
ESA	Endangered Species Act
FACWet	Functional Assessment of Colorado Wetlands
FCLWD	Fort Collins-Loveland Water District
FCWTF	Fort Collins Water Treatment Facility
Fed. Reg.	Federal Register
FEIS	Final Environmental Impact Statement
FERC	Federal Energy Regulatory Commission
FHWA	Federal Highways Administration
FPPA	Farmland Protection Policy Act
FTA	Federal Transit Administration
FUDS	Former Used Defense Site
GHG	Greenhouse gases
GIS	Geographic information system
GMA	Growth Management Area
GMU	Game Management Unit
gpcd	Gallons per capita per day
gpm	Gallons per minute
GVWR	Gross vehicle weight rating
Hansen Canal	Charles Hansen Supply Canal

HGM	Hydrogeomorphic Method
HRA	Healthy Rivers Alternative
HSWSPs	Halligan and Seaman Water Supply Projects
IFIM	Instream Flow Incremental Methodology
IGA	Intergovernmental Agreement
IMPROVE	Interagency Monitoring of Protected Visual Environments
IY	Irrigation year
JD	Jurisdictional determination
LA	Weighted sound level
LCC	Larimer County Canal
LCDHE	Larimer County Department of Health and Environment
LCR	Larimer County Road
Ldn	Day-night average sound limit
LEDPA	Least environmentally damaging practicable alternative
Leq	Equivalent sound level
LHWD	Lefthand Water District
LOS	Level of service
LTWD	Little Thompson Water District
M&E	Monitoring and Evaluation
M&I	Municipal and industrial
MBTA	Migratory Bird Treaty Act
MCQWD	Morgan County Quality Water District
MDL	Method detection limit
mg	Million gallons
mgd	Million gallons per day
mg/kg	Milligrams per kilogram
mg/L	milligrams per liter
MGWR	Manufacture's gross vehicle weight rating
MHI	Median household income
MMI	Macroinvertebrate multimetric index (see glossary)
MOA	Memorandum of Agreement
MPB	Mountain pine beetle
MWAT	Maximum weekly average temperature
MWhrs	mega-watt hours
NAAQS	National Ambient Air Quality Standards
NAIP	National Agriculture Imagery Program
NAWQA	National Water Quality Assessment Program
NDIS	Colorado Natural Diversity Information Source
NEPA	National Environmental Policy Act
NFRMPO	North Front Range Metropolitan Planning Organization
NFRTAQPC	North Front Range Transportation and Air Planning Council
NHPA	National Historic Preservation Act
NHS	National Highway System
NISP or Project	Northern Integrated Supply Project
NO_x	Oxides of nitrogen
NPIC	North Poudre Irrigation Company

NPS	National Park Service
NRCS	Natural Resource Conservation Service
NRHP	National Register of Historic Places
NWCWD	North Weld County Water District
NWI	National Wetland Inventory
NZMS	New Zealand mudsnails
O&M	Operations and maintenance
ORV	Outstanding Remarkable Value
PA	Programmatic Agreement
Participants	The 15 communities and domestic water districts located throughout the Northern Colorado Water Conservancy District participating in NISP: Central Weld County Water District, City of Dacono, Town of Eaton, Town of Erie, City of Evans, Town of Firestone, Fort Collins-Loveland Water District, City of Fort Lupton, City of Fort Morgan, Town of Frederick, City of Lafayette, Lefthand Water District, Morgan County Quality Water District, Town of Severance, and the Town of Windsor
PBN	Poudre Basin Network
PEM	Palustrine emergent wetland
PFYC	Probable Fossil Yield Classification system
PHABSIM	Physical Habitat Simulation
Phase II report	Phase II Alternative Evaluation Report
PM_{10}	Particulate Matters less than 10 micron
PMF	Probable maximum flood
Poudre	Cache la Poudre River
ppb	Parts per billion
ppm	Parts per million
Preble's	Preble's meadow jumping mouse
Project	Northern Integrated Supply Project or NISP
Proposed Action	District's preferred configuration of the Project (Alternative 2)
PSS	Palustrine scrub-shrub wetland
QA/QC	Quality Assurance/Quality Control
Reclamation	U.S. Bureau of Reclamation
RFFAs	Reasonably foreseeable future actions
RL	Reporting limit
ROD	Record of decision
ROW	Right-of-way
RTP	Regional Transportation Program
RWSP	Regional Water Supply Project
SB40	Senate Bill 40
SCFP	Soldier Canyon Filter Plant
SDEIS	Supplemental Draft Environmental Impact Statement
SDO	State Demography Office
SDWA	Safe Drinking Water Act
SEL	Sound exposure level
SEO	Colorado State Engineers Office
SH	State Highway

SHPO	State Historic Preservation Office
SIP	State Implementation Plan
SO_2	Sulphur dioxide
SPWCP	South Platte Water Conservation Project
SQG	Small quantity generator
SSCV	Shallow slow moving current
STIP	Statewide Transportation Improvement Program
Subdistrict	Municipal Subdistrict of the Northern Colorado Water Conservancy District
SVP	Society of Vertebrate Paleontology
SWA	State Wildlife Area
SWMP	Stormwater Management Plan
SWSI	State Water Supply Initiative
SWSP	Southern Water Supply Project
TCE	Trichloroethene
TDS	Total dissolved solids
TIN	Total inorganic nitrogen
TIP	Transportation Improvement Program
TMDL	Total maximum daily load
TNM	Traffic Noise Model
TOC	Total organic carbon
TP	Total phosphorous
TPR	Transportation Planning Region
Trec	Total recoverable
U.S.	United States
UFRTPR	Upper Front Range Transportation Planning
ULTO	Ute ladies'-tresses orchid
USC	United States Code
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Service
VOCs	Volatile organic compounds
vpd	Vehicles per day
WCR	Weld County Road
WEG	Wind erodibility group
WGFP	Windy Gap Firming Project
WNV	West Nile Virus
WQCC	Colorado Water Quality Control Commission
WQCD	Water Quality Control Division
WSSC	Water Supply and Storage Company
WTP	Water treatment plant
WUA	Weighted useable area
WWTP	Wastewater treatment plant
WY	water year
Wyco	Wyco Power and Water, Inc.

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SUMMARY

SUMMARY

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S.1 INTRODUCTION

The U.S. Army Corps of Engineers (Corps) has issued a Supplemental Draft Environmental Impact Statement (SDEIS) to disclose direct, indirect, and cumulative effects of the Northern Integrated Supply Project (NISP or Project). The proposed Project is a regional water supply project designed to serve the current and a portion of the future water needs of 15 towns and water districts in Boulder, Larimer, Morgan, and Weld Counties within the Northern Colorado Water Conservancy District (District). Construction of the proposed Project would involve the discharge of fill material into jurisdictional waters of the United States, thereby requiring a Clean Water Act Section 404 permit from the Corps. The District, acting by and through the Northern Integrated Supply Project Water Activity Enterprise, notified the Corps that it will seek a Section 404 permit for the District's Preferred Alternative (Proposed Action).

The Corps published a Draft Environmental Impact Statement (DEIS) for NISP on April 30, 2008 for public comment. Substantial comments were received during three public hearings held for the DEIS as well as during the comment period. The Corps determined that additional analysis was required and that the purposes of the National Environmental Policy Act (NEPA) would be furthered through the issuance of a SDEIS. As a SDEIS, this document does not repeat information in the DEIS.

The Town of Berthoud withdrew as a Participant in NISP in April 2008 as the DEIS was being released to the public. Frederick requested the project yield previously allocated to Berthoud. In the DEIS, the NISP yield requests for the Town of Frederick, Town of Firestone, and City of Dacono were combined with the yield request for Central Weld County Water District that serves these communities. In the SDEIS, these Participants are discussed individually.

The public and federal and state agencies provided about 675 letters, emails, and oral statements on the DEIS. The Corps has taken these comments into consideration during the preparation of this SDEIS. The Corps' new alternatives, studies, data collection, modeling, and analyses (Table S-1) were in response to comments on the NISP DEIS. In 2009, the Corps decided that a common technical platform (CTP) would be developed for several key resources potentially affected by the proposed NISP and Halligan-Seaman Water Supply Projects (HSWSPs) (hereafter collectively referred to as the Projects). The CTP involves development of common

Halligan-Seaman Water Supply Projects (HSWSPs)

During the final stages of developing the NISP SDEIS, the Cities of Fort Collins and Greeley requested that separate EISs be prepared for their proposed water supply projects, the enlargement of Halligan Reservoir and the enlargement of Seaman Reservoir, respectively. The Corps concurred with this request and published a Notice of Intent to separate the EISs on February 4, 2015. The two projects have independent utility and require separate authorizations by the Corps. The NISP SDEIS refers to these projects as the HSWSPs; however, they are two separate projects that are now being analyzed in two EISs. The CTP hydrology modeling (Run 5 series), which includes the proposed Halligan and Seaman Reservoir enlargements, is still valid since the proposed actions for these projects have not changed. The Corps will continue to use the CTP for analysis of flow related effects for the two projects since the purpose of the CTP is to ensure a consistent approach is used between these projects and NISP.

protocols by which data are collected, the use of a common analytical approach, and the sharing of data between the NISP and HSWSPs EISs. The majority of the CTP information was developed for the mainstem of the Poudre River from the Canyon Gage to the confluence with the South Platte River. The following resources and analyses were prepared as part of the CTP for NISP and HSWSPs:

- Current Conditions, Future Conditions, and Cumulative Effects hydrologic modeling
- River morphology and sediment transport current conditions
- Aquatic biological resources current conditions
- Surface water quality current conditions
- Riparian and wetland resources current conditions

Table S-1. Post-DEIS studies, data collection, modeling, and revisions to the DEIS.

Resource/Topic	New Studies/Revisions	SDEIS Chapter, Section, or Appendix
Participants' Water Supply and Future Needs	Existing water supplies for the NISP Participants were updated through 2010. Estimated future water supply needs of the NISP Participants were updated through 2060.	Chapter 1, Sections 1.1 and 1.1.8
Water Conservation	NISP Participants' water conservation programs and plans were updated through 2010. A future conservation scenario was developed to further examine project need.	Chapter 1, Section 1.2.7
No Action Alternative	A new No Action Alternative for NISP was developed.	Chapter 2, Section 2.4
Elimination of Action Alternative	Alternative 4 – Glade Reservoir and SPWCP with Agricultural Transfers and Subalternative 4.2 evaluated in detail in the DEIS were not carried forward for detailed evaluation in the SDEIS. The new No Action Alternative for the SDEIS addresses the alternative of agricultural transfers and provides a reasonable range of alternatives for evaluation in the SDEIS.	Chapter 2, Section 2.2.6.2
Modification of Alternative Screening Criteria	The Corps eliminated timeliness in the purpose and need screening category and reevaluated the alternatives for the land use criterion in the practicable screening category. Previously eliminated concepts and elements were reevaluated.	Chapter 2, Sections 2.2.2, 2.2.3, and 2.2.4
Evaluation of Submitted NISP Alternatives	Two NISP alternatives, the Healthy Rivers Alternative and A Better Future for the Poudre River were considered but eliminated from detailed evaluation in the SDEIS.	Chapter 2, Section 2.2.5
New Action Alternative	A new action alternative that includes the proposed Cactus Hill Reservoir and SPWCP with diversions from the Poudre River near the Larimer-Weld Canal and New Cache Canal diversions was analyzed in detail.	Chapter 2, Section 2.7
Preferred Realignment of U.S. 287	CDOT selected the western alignment as their preferred alternative for the realignment of U.S. 287 associated with the District's Preferred Alternative. The northern alignment is eliminated from detailed analysis in the SDEIS.	Chapter 2, Section 2.2.6.2
Hydrology	New Poudre River modeling using a CTP for the NISP and HSWSPs EISs.	Chapter 3, Section 3.2

Resource/Topic	New Studies/Revisions	SDEIS Chapter, Section, or Appendix
Aquatic Biological Resources	In coordination with the USGS, established six representative 2-D hydraulic and aquatic habitat sites on the mainstem of the Poudre River (Poudre River study sites) to assess aquatic habitat with changes in flows. These sites involved detailed topographic survey and aquatic habitat mapping. In coordination with the Colorado Parks and Wildlife (CPW), developed site-specific habitat suitability curves for habitat utilization by Poudre River fish in different segments of the Poudre River based on more than 2,000 Poudre River observation points. Effects to aquatic habitat were reevaluated using new Poudre River CTP hydrology, 2-D modeling, and habitat suitability curves. New technical reports were prepared using 2-D modeling and the CTP hydrology.	Chapter 3, Section 3.12; Chapter 4, Section 4.12; Chapter 5, Section 5.12
Stream Morphology and Sediment Transport	An expanded review of historical aerial photography was undertaken to better define Poudre River channel and floodplain trends. A review of historical floodplain encroachment was undertaken to better define the trends of floodplain impacts. The reaches of the Poudre River used for the DEIS were reviewed and further subdivided to more accurately describe past trends and potential impacts on different segments of the Poudre River. The Poudre River segments were classified using the Rosgen classification (Level I/II). New technical reports were prepared using new and revised information and the CTP hydrology.	Chapter 3, Section 3.4; Chapter 4, Section 4.4; Chapter 5, Section 5.4

Resource/Topic	New Studies/Revisions	SDEIS Chapter, Section, or Appendix
Water Quality	Effects to water quality in the Poudre and South Platte Rivers were reevaluated using new CTP hydrology and new water quality data. Review of new water quality regulations. Review of Hoffman 2012 report regarding potential effects to crop production with increasing canal water salinity. Review of new information on emerging contaminants in the Poudre River. Additional surface water quality data for numerous parameters were collected at 17 sites on the Poudre River and one location on the South Platte River near Kersey. Ground water quality was sampled at two springs tributary to the Poudre River. Water quality effects on Horsetooth Reservoir were evaluated using a two dimensional hydrodynamic water quality model. Soil and water quality water data were collected and historical data were reviewed at the proposed Glade, Cactus Hill and Galeton reservoir sites to assist in estimating water quality of the reservoirs, to evaluate effects of using Galeton water by irrigators, and to determine potential selenium and salinity contributions to the South Platte River from Galeton Reservoir. Water quality data for existing reservoirs comparable to potential new reservoirs (Glade, Galeton, and Cactus Hill) were used to estimate likely water quality in new reservoirs. New hydrologic data and anticipated reservoir operations for Glade, Cactus Hill, and Galeton Reservoirs were used to predict reservoir water quality using mass balance models developed for each reservoir. Information was collected on existing water treatment plant operation for entities using Horsetooth Reservoir as a domestic water source to analyze effects to those water treatment plants. New water quality technical reports were prepared using new data and CTP hydrology to assess potential impacts to temperature, dissolved oxygen, and nutrient and metal concentrations in the Poudre and South Platte Rivers, New reports also evaluated potential effects to existing and new reservoirs, water treatment plants, wastewater treatment plants, and irrigation water quality.	Chapter 3, Section 3.3; Chapter 4, Section 4.3; Chapter 5, Section 5.3
Ground Water	28 ground water monitoring wells and six river staff gages were installed and monitored at the six Poudre River study sites to determine ground water-surface water relationships. Ground water quality was sampled at the monitoring wells. At least one monitoring well at each 2-D hydraulic site was tested to determine hydraulic conductivity of the river alluvium.	Chapter 3, Section 3.5; Chapter 4, Section 4.5; See Figures 3-26 and 3-27

Resource/Topic	New Studies/Revisions	SDEIS Chapter, Section, or Appendix
Riparian and Wetland Areas	Wetland and riparian vegetation was mapped at each of the six Poudre River study sites to develop relationships between vegetation, ground water, and streamflows. Wetland and riparian resources mapping by CPW was reviewed and revised for the Poudre River corridor from the canyon mouth to the confluence with the South Platte River to determine the distribution of wetland and riparian resources. Data on tree recruitment were collected at each of the six Poudre River study sites. Data on the distribution of size classes of trees were collected along four 100-foot-wide belt transects at each Poudre River study site. Wetland functions were assessed at each of the Poudre River study sites using the Functional Assessment of Colorado Wetlands (FACWet) Method. The presence and distribution of noxious weeds were recorded and discussed for each of the Poudre River study sites. Historical aerial photos were reviewed to assess changes in land use and distribution of riparian communities along the Poudre River. The new CTP hydrology, 2-D modeling, information on ground water-streamflow relationships, and woody vegetation recruitment were used to reevaluate effects to mainstem Poudre River wetland and riparian resources associated with changes in Poudre River flows, and prepare new technical reports. An assessment of amount of wetlands associated with irrigation in the region was redone as a CTP study. Post-flood reviews of the Poudre River mainstem were conducted in 2010, 2011 and 2013.	Chapter 3, Section 3.9; Chapter 4, Section 4.9; Chapter 5, Section 5.9
Hazardous Materials	Monitoring of the ground water wells occurred at the former Atlas missile site near the proposed Glade Reservoir forebay to collect temporal data on the distribution and concentration of the trichloroethylene in ground water, and a new technical memo was prepared. Changes in Poudre River flows and hydraulics were evaluated to determine if reduced flows would affect a site along the Poudre River in Fort Collins contaminated by coal tar. An assessment of oil and gas development at the proposed Galeton Reservoir site was completed.	Chapter 3, Section 3.21; Chapter 4, Section 4.21
Costs/Financial Impacts	Construction costs for Glade Reservoir, Galeton Reservoir, and Cactus Hill Reservoir, and associated facilities were updated to 2010 dollars. Updated financial models were developed for the Participants to examine effects of the alternatives on water affordability.	Chapter 2, Section 2.9.1, Chapter 3, Section 3.20; Chapter 4, Section 4.20
Operations	An operations plan for the District's Preferred Alternative was developed.	Chapter 2, Section 2.5.1
Mitigation	The mitigation plan in the DEIS presented a range of potential mitigation measures. The mitigation plan has been revised and presents what is proposed by the District.	Appendix F

CTP information also was developed for wetlands associated with irrigated lands in the region to help estimate the effects of transferring irrigation water to municipal uses for the Projects' EIS alternatives. In addition, a history of the Poudre River was developed to provide a context for the proposed Project's potential effects on the Poudre River.

The CTP provides common information for the NISP and HSWSPs EIS teams and reviewers of the EISs for key resources that are potentially affected by the proposed projects. A strength of the CTP is that it brought together parties responsible for preparation of the EISs to reach consensus on a common approach, and then to work together toward development of the CTP. For example, the CTP current conditions hydrology took more than 3 years to develop and involved numerous reviews and inputs from the Corps, Division 1 Water Commissioner, hydrologists and water resource engineers for the EIS teams' third-party contractors, the District, and the cities of Fort Collins and Greeley.

The following changes to the proposed NISP facilities and operations have also been made since the DEIS was issued:

- **Galeton Reservoir** – Sized at 40,000 AF in the DEIS is now proposed to be expanded to 45,624 AF (maximum volume under the 1992 priority storage right). The high water elevation of Galeton Reservoir would change from 4,869 feet to 4,872 feet.
- **SPWCP Pumping Rate** – The maximum proposed pumping rate from the South Platte River for the SPWCP increased from 150 cfs to 200 cfs.
- **Pleasant Valley Pipeline** – The Fort Collins-Loveland Water District would use its own capacity in the Pleasant Valley Pipeline to receive its water by direct connection from Glade Reservoir.
- **Curtailment of Winter Diversions from the Poudre River** – NISP would not divert from the Poudre River when flows at the Watson Lake Fish Hatchery diversion weir are less than 50 cfs or the flows at the Fort Collins Boat Chute are less than 30 cfs.
- **Winter Flow Augmentation –** The District proposes to integrate a flow augmentation program with the operation of its Preferred Alternative to maintain a minimum of 10 cfs in the Poudre River on the downstream side of the Larimer-Weld Canal headgate. Augmentation flows would be released upstream of the Larimer County Canal headgate and re-diverted at the Timnath Reservoir inlet. Releases would be made from a 3,600-AF pool in Glade Reservoir from November 1 through April 30 and again September 1 through September 30 if water was available in September.
- **Cactus Hill Reservoir Size** – Cactus Hill Reservoir has been expanded from 180,000 AF as presented in the DEIS to 190,000 AF for Alternatives 3 and 4. The expansion of Cactus Hill Reservoir is in response to the new CTP hydrology modeling and its increased evaporation estimates for Cactus Hill Reservoir. The 190,000-AF size is estimated to provide the same yield as that estimated in the DEIS.

S.1.1 Major Issues Addressed by the SDEIS

The following sections summarize major issues addressed by the SDEIS. These issues are presented in greater detail in specific resource sections of Chapters 3 and 4 and in technical reports and memoranda prepared in support of the SDEIS.

S.1.1.1 Hydrology Modeling

New CTP hydrology modeling was prepared for the NISP and HSWSPs EISs (CDM Smith and DiNatale 2013). Previously, a Poudre River Basin MODSIM network was developed and used for hydrologic analyses associated with the NISP DEIS. Simultaneously in the mid-2000s, development of a different version of the Poudre Basin Network (PBN) model was underway for use in the NEPA process for the proposed HSWSPs. The CTP included the development of a modeling tool that 1) could be used for both EISs and 2) provided a common baseline for the analysis of hydrologic impacts associated with project implementation and reasonably foreseeable future actions (RFFAs). The final CTP version of the PBN represents a collaborative effort of the Project Applicants (District, Fort Collins, and Greeley), the Corps, and the third-party contractors with final determination and verification of model inputs and assumptions by the Corps and third-party contractors.

The following differences between the NISP DEIS model and the original HSWSPs PBN were addressed as part of the CTP effort:

- **Definition of "current" and "future" conditions** – The NISP DEIS modeling defined current conditions as 2005 and future conditions as 2020. For the CTP, the Current Conditions hydrology baseline was defined as river conditions in 2010. Future Conditions hydrology is based on demand projections and anticipated operational changes in 2050.
- **Study period for hydrology** – Based on public comments, the original 1950-1999 monthly model study period was extended through 2005 to include the drought of the early 2000s. The CTP process also provides a daily disaggregation of the monthly model results for 1980-2005.
- **Colorado-Big Thompson (C-BT) Project deliveries to Poudre River** – Allocations of C-BT water to Poudre Basin users were revised for current and future conditions using a C-BT Projection Tool developed by the District.
- **Agricultural Demands** – Modeled demands were adjusted to better reflect highs and lows in the historical streamflow record.
- **Representation of Fort Collins' South Side Ditch (SSD) Water Rights and Exchanges** – The participation of Fort Collins and integration of the Fort Collins System Model into the CTP process allowed for more detailed simulation of SSD operations than what was included in the NISP DEIS modeling.
- **Fish Hatchery and Recreational Flow Rates** – Water rights decrees and stipulations for the Watson Lake Fish Hatchery, Fort Collins Boat Chute, and the Fort Collins Environmental Learning Center were reviewed, and the CTP model was revised to better simulate minimum flow targets at these locations.
- **Winter Flow Augmentation** – As described previously, the District proposes to integrate a winter flow augmentation program with the operation of its Preferred Alternative to maintain a minimum of 10 cfs in about a 12-mile portion of Poudre River. The modeling for the District's Preferred Alternative includes the flow augmentation program.

Other model changes made as part of the CTP process include revisions to South Platte River flows above the Poudre River confluence to reflect 2010 and 2050 conditions and modifications to reservoir net evaporation factors, winter out-of-priority storage operations, and the naturalized flow time series. Each of these topics is addressed in greater detail in Appendix A of the NISP/HSWSPs Common Technical Platform Model Review Report (CDM 2011a).

S.1.1.2 Aquatic Resources

The evaluation of aquatic resources for the DEIS and SDEIS focuses on fish and benthic macroinvertebrates and their habitat in the Poudre River. An important step in the evaluation is modeling changes in habitat availability for fish with changes in flow that could result from the Project and its alternatives. The Physical Habitat Simulation (PHABSIM) model of the Instream Flow Incremental Methodology (IFIM) was used in both the DEIS and SDEIS to model changes in habitat. For the DEIS, existing PHABSIM information was used from several sources from data collected with a 1-D (one dimensional data collected at transects across the river) method. The 1-D data collection method was the accepted method in the 1980s and 1990s but is being replaced in some cases with 2-D methods (two-dimensional data collection that maps the entire stream bottom at a site). The 1-D PHABSIM data in the DEIS were not available for all sections of the river in the study area, did not model habitat for all species of interest, and was considered lower quality data than the 2-D PHABSIM information available for sites on the North Fork Poudre River for the HSWSPs EIS. Therefore, the Corps decided to model fish habitat availability for the SDEIS using data collected with the 2-D method necessitating the collection of supplemental data.

Six 2-D hydraulic and aquatic habitat sites were established in 2009, in coordination with the U.S. Geologic Survey (USGS), to represent habitat in the Poudre River downstream of the canyon mouth to the confluence with the South Platte River. These sites are representative of the six segments of the Poudre River where they are located because they have a range of channel forms and floodplain widths, diversity of aquatic habitat, and diversity of wetland and riparian communities that characterize their respective segments. Substantial information was collected at the six 2-D hydraulic modeling sites over lengths of the river from about 4,000 to 6,000 linear feet at each site from spring through fall 2009. Data collection included hydraulic parameters such as stream width, stream depth, and water velocity as well as parameters that are important to fish and other aquatic organisms including cover and substrate composition. This data collection and habitat modeling information is much more intensive and extensive than the information available for the DEIS and allowed a more in-depth evaluation of impacts in the SDEIS.

Although many studies using PHABSIM incorporate generic fish habitat use information in the habitat modeling, site-specific fish habitat use information was collected in 2009 as another component of PHABSIM modeling for the SDEIS. The habitat used by different fish species in the Poudre River was documented and the information was used to construct habitat suitability curves for the 2-D PHABSIM modeling for the SDEIS. Habitat suitability curves were constructed, in coordination with CPW, for several fish species native to the river in the study

area that use a variety of different habitats, such as small minnow species and larger sucker species. The suitability curves further tailor the habitat evaluation in the SDEIS to conditions that actually occur in the Poudre River.

The 2-D hydraulic information was also used to evaluate channel dynamics and sediment transport in the SDEIS in more detail. Changes to stream morphology and sediment transport can also have an important effect on aquatic biological resources. The new stream morphology information was also used in the evaluation of the project effects on fish and aquatic organisms.

S.1.1.3 Water Quality

The water quality assessment was revised in coordination with the Colorado Department of Public Health and Environment (CDPHE), Water Quality Control Division (WQCD) and EPA based on revised hydrology and additional surface water and ground water data collection and analysis. New information available for the SDEIS includes recent water quality data collected at numerous locations along the Poudre River, from discharges into the river, from ground water wells adjacent to the river, and from agricultural diversion ditches. Streamflows, temperature data, and other information were also collected for estimating impacts to the temperature of the Poudre River. Major water quality issues addressed in the SDEIS are listed in Table S-2.

Table S-2. Water quality issues addressed in the SDEIS.

Issues	Data Collection and Analysis Completed
Impacts to Poudre River and South Platte River stream temperature	Collection of additional stream temperature data for use in revised qualitative analysis and for use with future temperature modeling.
Impacts to Poudre River and South Platte River parameters of concern including those currently on the 303(d) list or that are approaching water quality standards	Collection of additional recent water quality data from all available sources and locations on the Poudre and South Platte Rivers in the study area. Evaluation of flow/concentration relationship and longitudinal changes in water quality to evaluate potential water quality effects for alternative diversions particularly at low flows.
Impacts to Poudre River and South Platte River dissolved oxygen	Collection of available dissolved oxygen data to assess potential impacts from changes in flow.
Potential impacts to Horsetooth Reservoir under Alternative 2 and for water treatment plant intakes at the reservoir	Acquisition of new water quality data for Horsetooth Reservoir from the City of Fort Collins and other sources of data to evaluate potential water quality effects of changes in reservoir operations using a two dimensional hydrodynamic water quality model.
Ground water contribution to Poudre River stream temperature and quality.	Collection of ground water quality data at multiple sites along the Poudre River.
Potential impacts to water quality in new reservoirs (Glade, Galeton, and Cactus Hill)	Mass balance modeling to predict new reservoir water quality based on reservoir operations, input sources, and site conditions. Collection of data from existing reservoirs of similar size and operations to provide a relative indication of new reservoir water quality.

S.1.1.4 Hazardous Materials

In response to comments on the DEIS, additional ground water monitoring was conducted in 2008 and 2009 at the Glade Reservoir site to gain additional temporal data for the trichloroethene plume relative to the 2003/2004 characterization sampling period and to determine if trichloroethene concentrations fluctuated seasonally. Information was also collected to allow

estimates in trends of trichloroethene concentrations and the size of the plume. A new technical memo addressing the trichloroethene plume was prepared.

The potential for changes in Poudre River flows to affect a site contaminated by coal tar next to the Poudre River in Fort Collins was assessed for the SDEIS.

Subsequent to the release of the DEIS, oil and natural gas wells have been drilled and are operating at the proposed Galeton Reservoir and Cactus Hill sites. The potential effects of the wells, drilling, and enhanced production (hydraulic fracturing) are assessed for the SDEIS.

S.1.1.5 Stream Morphology and Sediment Transport

The information used in the DEIS, supplemented by the collection of additional field data and pertinent literature and data sources, supported a more detailed investigation of the geomorphic and sediment transport characteristics of the Poudre River. In response to the DEIS comments, the SDEIS includes an assessment related to flushing flows, potential changes in riffle-pool sequences, deposition processes related to bed sediments, and the potential for threshold responses when assessing the long-term and cumulative impacts of proposed project alternatives. Furthermore, the work supporting the SDEIS was formulated to be consistent with the corresponding assessment for the HSWSPs EIS.

The assessment for the SDEIS describes the river in terms of: (a) the morphologic parameters related to the river corridor and the evolution of these parameters through time; and (b) the ability, or inability, of the river to move its sediment load through the corridor and the resulting geomorphic changes manifested by the potential for deposition or scour of material within the channel. The assessment includes:

- Evaluation of hydrologic conditions related to flood frequency and flow duration
- Analyses of channel hydraulic conditions through a range of flows
- Evaluation of trends related to geomorphic parameters and characterization of various reaches of the river
- Analyses related to stability of the channel bed
- Spells analyses related to duration, and frequency of selected flows pertaining to channel-forming discharges and riparian terraces
- Evaluation of cumulative stream power and sediment transport potential
- Analysis of the potential for aggradation or degradation

As part of the work completed for the SDEIS, a 2-D hydraulic model was formulated to support the evaluation of riffle-pool sequences and deposition processes related to bed sediments with respect to the geomorphic and sediment transport conditions within the river channel. The results of the 2-D hydraulic modeling also provided data in support of other resource specialists in the fields of aquatic habitat, water quality, and riparian vegetation.

S.1.1.6 Alluvial Ground Water – Surface Water Relationships

In 2009, ground water monitoring wells and stream crest gages were installed and monitored at each of the six 2-D hydraulic sites (Poudre River study sites) to determine ground water-surface water relationships to help respond to comments on the DEIS on the effect that changes in Poudre River flows would have on ground water levels along the Poudre River. Concern was also expressed that considerable regional ground water recharge may be occurring at the mountain front-valley transition zone, which could be adversely affected by diversions from the Poudre River by NISP. The monitoring of ground water levels, river stage, and ground water quality provided additional information to address ground water in greater detail in the SDEIS.

S.1.1.7 Riparian and Wetland Areas

Riparian and wetland areas associated with the mainstem of the Poudre River were assessed to determine the current distribution and quality of the resources and how changes in Poudre River flows might affect the resources. Additional studies for the SDEIS were undertaken to address comments on the DEIS. In 2009 and 2010, field studies were conducted to collect information on:

- Nonnative species
- Recruitment of woody riparian vegetation
- Size class distribution of riparian trees
- Wetland functional assessment
- Ground water – river stage/flow relationships

Additionally, wetland and riparian resources along the mainstem of the Poudre River were mapped using CPW riparian mapping and were reviewed for accuracy. Historical and recent aerial photography was reviewed to determine changes in the distribution of woody riparian vegetation at selected sites. The elevations of water bodies within the floodplain were determined relative to water surface elevations at a nearby location on the Poudre River to determine potential relationships between the river and riparian water bodies.

The effect of the transfer of irrigation water from agricultural lands in portions of Larimer and Weld Counties on wetlands in the No Action Alternative was assessed using a method developed for the SDEIS.

S.1.2 Organization of the SDEIS

The SDEIS provides new information that was not presented in the DEIS. Sections of the DEIS that did not change are referenced in the respective sections of the SDEIS. The Corps prepared this SDEIS because new information was gathered for several resources relevant to environmental concerns and bears on the Project or its impacts.

S.1.2.1 Contents of SDEIS

This SDEIS contains seven chapters. Chapter 1 describes the project purpose and need as defined by the Corps, USDI Bureau of Reclamation (Reclamation), and the District and provides a Project overview and background. Chapter 2 describes the District's Preferred Alternative and revisions since the DEIS to other alternatives considered as part of this SDEIS. Since issuance of the DEIS, the District developed a new No Action Alternative and the Corps developed a new action alternative, replacing Alternative 4 that was analyzed in detail in the DEIS. The Corps modified the screening criteria and reevaluated some previously eliminated alternatives. Additional alternatives suggested in comments on the DEIS were also considered and reviewed. Chapter 3 includes an updated description of the affected environment for sections that changed since the DEIS for water resources, water rights, geology, soils, vegetation, noxious weeds, wetlands and other waters, riparian resources, wildlife, fish and other aquatic life, species of concern, recreation, cultural resources, aesthetics and visual resources, traffic and transportation, land use, socioeconomic resources, hazardous sites, noise, air quality, and energy use. When the description of the affected environment has not changed since the DEIS, the appropriate DEIS section is referenced in the SDEIS section. Chapter 4 discloses new and revised potential environmental consequences (direct and indirect effects) of the District's Preferred Alternative and the other alternatives analyzed in detail in this SDEIS based on changes since the DEIS. Chapter 5 contains an analysis of the cumulative effects of the alternatives. Chapter 6 summarizes public participation and agency consultation and coordination. Chapter 7 is the reference list for the SDEIS. Appendix A Stream Flow and Stage Data in the DEIS has been replaced by information in corresponding technical reports and is so noted in the SDEIS. Appendix B Biological Assessment and Opinion and Appendix C Draft Programmatic Agreement remain unchanged from the DEIS and are referenced in the SDEIS. Appendix D presents the Corps' preliminary Section 404(b)(1) analysis for the alternatives and replaces Appendix D from the DEIS. Appendix E Poudre River Stream Morphology Reaches has been updated and is provided in the SDEIS. Appendix F, the District's Proposed Conceptual Mitigation Plan, is new for the SDEIS and replaces Chapter 5 of the DEIS.

S.1.2.2 Planned Activities After SDEIS Issuance

Before FEIS issuance, the Corps anticipates the District will complete the following activities:

- Coordinate with CPW to develop a mitigation plan that addresses impacts to fish and wildlife resources. The state fish and wildlife mitigation plan will be available for public review and comment and the Colorado Wildlife Commission will hold hearings on the mitigation plan.
- Describe planned road improvements, if needed to accommodate project-related traffic.
- Determine the method to return water to Glade Reservoir that was released from Glade Reservoir for streamflow augmentation.
- Refine all conveyance alignments.
- Develop a more comprehensive mitigation plan (see Section S.9, Mitigation).

Before FEIS issuance, or issuance of a Record of Decision as noted, the Corps anticipates completing the following activities:

- Update the description and potential effect of oil and gas well drilling activities at the Galeton Reservoir site.
- Update the effect of the NISP alternatives, including conveyance, on land use, growth, regional plans, and ownership.
- Complete an approved jurisdictional determination to determine the extent of jurisdictional waters of the U.S. within the study areas of the action alternatives.
- Finalize the effect analysis of the NISP action alternatives, including conveyance, on jurisdictional waters of the U.S.
- Prepare a Supplemental Biological Assessment that addresses changes to the District's Preferred Alternative that could have effects on federally listed threatened or endangered species and their designated critical habitat and reinitiate consultation with the U.S. Fish and Wildlife Service (USFWS) under Section 7 of the ESA. These actions will take place prior to issuance of the FEIS or a Record of Decision.
- Review the USFWS's Fish and Wildlife Coordination Act report, which will be prepared after the District has an approved state fish and wildlife mitigation plan.
- Incorporate appropriate mitigation measures from an approved state fish and wildlife mitigation plan in the FEIS.
- Complete Phase II water quality and stream temperature modeling in coordination with the WQCD and the EPA using WQCD protocols.
- Perform additional hydrological assessments at the proposed Galeton Reservoir site to determine if fluctuating reservoir levels at Galeton Reservoir have the potential to mobilize any future contaminant plumes from oil and gas development in the area.
- Update traffic volumes and impact assessment for roadways that could be affected by the NISP components.
- Assess carbon dioxide emissions associated with construction of all alternatives, following Council on Environmental Quality (CEQ) guidance, if finalized before the FEIS. The CEQ issued draft proposed guidance addressing GHG emissions in NEPA documents on December 24, 2014, with public comments due on February 23, 2015.
- Finalize a Programmatic Agreement regarding cultural resources management with the Colorado State Historical Preservation Officer (Appendix C of the DEIS).
- Respond to substantive comments on the SDEIS.

S.2 COOPERATING AGENCIES (EIS CHAPTER 1)

The Corps requested that six agencies and one local government with statutory authority or special expertise with an environmental issue participate in the EIS process as cooperating agencies (40 CFR 1501.6 and 1508.5): Reclamation, USFWS, U.S. Environmental Protection Agency (EPA), Colorado Department of Transportation (CDOT), Colorado Department of Natural Resources (CDNR), Colorado Department of Public Health and Environment (CDPHE) and Larimer County. Reclamation is a cooperating agency because the District would need a

Reclamation contract and special use permit to facilitate water delivery to the Participants for one option under its Preferred Alternative. Reclamation will initiate their ROD and contract negotiation process subsequent to issuance of the Corps' ROD and 404 permit if the Reclamation Action Option for the District's Preferred Alternative was permitted by the Corps. Reclamation will make a decision about issuance of a special use permit for the connection of the Glade to Horsetooth Pipeline in a ROD addressing contracting actions, or a separate decision if it was determined the pipeline would be needed.

The District's Preferred Alternative includes realignment of a segment of U.S. 287 at the proposed Glade Reservoir site. CDOT was responsible for selection of the preferred alignment of U.S. 287.

The EPA is a cooperating agency on issues for which the agency has special expertise. The USFWS is responsible for consultation with the Corps and the District under the Endangered Species Act (ESA) and the Fish and Wildlife Coordination Act. In the DEIS, Larimer County was a cooperating agency due to their statutory requirements to allow a decision to be rendered by the Larimer County Planning Commission for Location and Extent Review (CRS 30-28-110) for project components located in Larimer County. Subsequent to the DEIS, Larimer County initiated the process of adopting 1041 regulations for domestic water supply storage reservoirs. If the Corps permitted Alternative 2, the construction of Glade Reservoir may require a 1041 permit from Larimer County or alternatively, the County and the District may enter into an intergovernmental agreement that would specify the permitting process required by the County for Glade Reservoir and associated facilities located in Larimer County. Other authorizations by Larimer County could include approval of site plans and building permits.

After the Draft EIS was published, the CDNR became a cooperating agency to facilitate Federal and State coordination under the Fish and Wildlife Coordination Act and development of a State Fish and Wildlife Mitigation Plan pursuant to the requirements of Colorado Revised Statutes (CRS) 37-60-122.2. The CDPHE became a limited-scope cooperating agency due to their statutory authority under Section 401 of the Clean Water Act and their special expertise related to water quality issues, with their scope limited to addressing water quality assessment methodology and water quality impact analyses.

Additionally, implementation of any of the alternatives will require compliance with applicable state and local regulatory agency reviews, approvals, and permitting requirements.

S.3 PUBLIC AND AGENCY PARTICIPATION (EIS CHAPTER 1)

The NISP EIS process began on August 20, 2004 when the Corps published a Notice of Intent to prepare an EIS in the Federal Register. The following are key dates in the NISP EIS process:

Date	Action
August 20, 2004	Notice of Intent (69 Fed. Reg. 51640)
September 21, 2004	Agency scoping meeting
September 20, 21, and 22, 2004	Public scoping meetings
March 30, 2005	Additional public scoping meeting for proposed U.S. 287 realignment
January and February 2008	Preliminary DEIS reviewed by cooperating agencies
April 30, 2008	DEIS released for review and comment
June 16, 17, and 19, 2008	Public hearings on DEIS
September 13, 2008	End of public comment period for DEIS
February 17, 2009	Corps announces preparation of a SDEIS (74 Fed. Reg. 7406)
February 2009	Corps decides to develop a CTP for specific resources that could be affected by NISP and the HSWSPs

S.4 PURPOSE AND NEED (EIS CHAPTER 1)

S.4.1 Purpose and Need Statement

The Corps and District jointly developed the purpose and need statement as follows:

> *To provide the Project Participants with approximately 40,000 acre-feet of new reliable municipal water supply annually through a regional project coordinated by the District, which will meet a portion of the Participants' current and reasonably projected future additional water supply needs.*

The District reevaluated the NISP Participant demands in 2011. The Corps reviewed these 2011 demand projections in connection with the validity of the need and found that 40,000 AF of firm annual yield is still valid for NISP. The need for the project and the Corps' independent review of the 2011 demand projections are discussed in Section 1.2 of this SDEIS.

The Corps determined that "regional project" is an appropriate screening criterion for the alternatives screening process for NISP. The District is the permit applicant, not the 15 individual NISP Participants. As discussed in Section 1.1.2 of the DEIS, NISP would be constructed and owned by the District if the Corps issued a permit. While the District would retain ownership and operational responsibility of the project, the Participants would own a perpetual contract right to a defined portion of the project facilities and a defined portion of the water diverted by the project. The District is a regional water supply entity with responsibilities for water supply planning and management for the region and what it is proposing is a regional water supply project to meet the water supply needs of 15 Participants providing water to an area of about 945 square miles.

S.4.2 Basic Project Purpose

The Corps will evaluate the District's 404 permit application in accordance with EPA's Guidelines for Specification of Disposal Sites for Dredged or Fill Material ("404(b)(1) Guidelines"), 40 CFR 230. The basic project purpose is examined by the Corps to determine if

the project is water-dependent. A project is water dependent if it requires access or proximity to, or siting within, a special aquatic site in order to fulfill its basic purpose. The Corps determined that the basic project purpose for the NISP is to provide water. Because supplying water, whether for municipal, industrial or agricultural uses, does not fundamentally require access or proximity to, or siting within, a special aquatic site to meet this basic project purpose, the 404(b)(1) Guidelines stipulate that practicable alternatives (1) are presumed to exist and (2) that do not involve a discharge into a special aquatic site are presumed to be less environmentally damaging than the Preferred Alternative, unless clearly demonstrated otherwise. The District's Preferred Alternative is not "water dependent" for the purposes of the 404(b)(1) Guidelines and the rebuttable presumptions apply.

S.4.3 Overall Project Purpose

Determination of the overall project purpose is the Corps' responsibility. The Corps defines the overall project purpose in light of an applicant's stated objectives as well as the public's perspective (33 CFR 325 Appendix B, Section 9(b)(4)). The NISP overall project purpose is synonymous with the purpose and need statement for NISP. The Corps uses the overall project purpose to evaluate whether less environmentally damaging practicable alternatives are available and to help make a decision whether to issue or deny a Section 404 permit. The evaluation of alternatives under the 404(b)(1) Guidelines applies to all jurisdictional waters of the United States, not just special aquatic sites.

S.5 ALTERNATIVES ANALYSIS (EIS CHAPTER 2)

Regulations implementing NEPA require that an EIS "rigorously explore and objectively evaluate all reasonable alternatives," including the No Action Alternative (40 CFR 1502.14((a) and (d)). Reasonable alternatives, as defined by the CEQ, are "those that are practical or feasible from the technical and economic standpoint and using common sense, rather than simply desirable from the standpoint of the applicant." In contrast to reasonable alternatives under NEPA, the 404(b)(1) Guidelines define practicable alternatives as "available and capable of being done after taking into consideration cost, existing technology, and logistics in light of the overall project purposes" (40 CFR 231.10(a)). These guidelines are the substantive environmental standards by which all Section 404 Permit applications are evaluated. By integrating the alternatives analysis for actions subject to NEPA and the 404(b)(1) Guidelines early in the process, the Corps ensured that the range of alternatives carried forward for detailed analysis in the EIS process met the Purpose and Need, and were practicable and reasonable.

S.5.1 Screening

S.5.1.1 Change in Screening Criteria and Re-evaluation of Some Alternatives

The alternative screening process for NISP was conducted in accordance with both NEPA and the 404(b)(1) Guidelines. The identification, verification, evaluation, and screening of all known alternatives were conducted by the Corps, with review and input from the cooperating agencies. Section 2.1.2, Alternative Screening, of the DEIS describes the screening process to develop alternatives for the DEIS. To ensure the alternatives analysis met the requirements of the 404(b)(1) Guidelines, the Corps reviewed the screening criteria used in the 2007 NISP EIS Alternatives Evaluation Report (HDR 2007a).

For the SDEIS, the Corps eliminated timeliness in the purpose and need screening category and reevaluated the alternatives for the land use criterion in the practicable screening category. The screening criteria described in Volume II of the NISP EIS Alternatives Evaluation Report (HDR 2007a) included land use considerations in the logistics criterion. For the SDEIS, the Corps reconsidered the rationale for the land use screening criterion and determined that all factors except local open space (e.g., city or local open space) remain valid. The Corps determined sites currently managed for local open space would be available for NISP purposes due to general limited ecological function in comparison to other nationally recognized natural areas and the applicant could condemn such land. The Corps determined local open space could reasonably be obtained, utilized, expanded, or managed in order to fulfill the basic project purpose (40 CFR 230.10(a)(2)). For the above reasons, the Corps no longer considers local open space an appropriate screening criterion for NISP.

In the NISP EIS Alternatives Evaluation Report Volume II (HDR 2007a), the Corps considered a concept of supplying water for NISP through the development of, or participation in, other projects that are proposed to bring water across the Continental Divide or other mountain ranges to the Front Range of Colorado. Projects evaluated included the Colorado River Return Project, the Yampa River Project, and the Green River Pipeline Project. These concepts were eliminated in whole or in part for the DEIS because of the timeliness criterion. The reevaluation of the Colorado, Yampa, and Green river projects without timeliness as a criterion for the SDEIS is discussed in more detail in the addendum to the NISP EIS Alternatives Evaluation Report (ERO 2014a).

The Corps determined the issues of reliability and logistics are still appropriate reasons for eliminating the Colorado River Return Project as a water supply concept from detailed analysis in the EIS.

In 2011, the BLM revised the Little Snake Resource Management Plan and identified three segments of the Yampa River totaling 22 miles as eligible and suitable for inclusion in the National Wild and Scenic Rivers System. The Corps eliminated the Yampa River Project from detailed analysis because it would affect the free-flowing characteristics of the eligible and suitable Yampa River segments, result in depletive effects to the expected higher quality functions of the Yampa River that support its listing in contrast to the effects on aquatic

resources in the Colorado Front Range, and other reasonable water supply alternatives were available to avoid such effects.

The Million Conservation Resource Group proposed the Regional Watershed Supply Project (RWSP) in 2009 that embodied the Green River Pipeline Project concept. The Corps notified interested parties in 2011 that it has withdrawn the Section 404 permit application for the proposed RWSP and terminated the process to develop a Draft Environmental Impact Statement. In September 2011, Wyco Power and Water, Inc. (Wyco) filed a preliminary permit application to study the RWSP with the Federal Energy Regulatory Commission (FERC). FERC dismissed Wyco's application in 2012 as premature. The Corps concluded that the Green River concept and the water it provides is integral to the plans of those entities participating in developing the concept. The Corps also determined that the concept offers no identifiable environmental advantages, including effects to waters of the U.S., over the concepts evaluated in detail based on the initial resource concerns identified during the scoping process associated with the RWSP. For these reasons, the concept is eliminated from detailed analysis.

S.5.1.2 Healthy Rivers Alternative

During the 2008 public comment period on the DEIS, the Save the Poudre Coalition submitted the "Healthy Rivers Alternative" to the Corps as an alternative to NISP. The NISP need of 40,000 acre-feet per year (AFY) of annual firm yield has not changed since the DEIS was issued. The Healthy Rivers Alternative report proposed a lower need of 35,000 AFY based on Save the Poudre's analysis of the NISP Participants' future water demands and proposed reduction of system losses, and the options proposed in the Healthy Rivers Alternative to meet this lower demand.

As defined by Save the Poudre, the Healthy Rivers Alternative would not meet the NISP need of 40,000 AFY. The Corps determined the water supply concepts and elements used in the development of the Healthy Rivers Alternative may constitute viable components of an alternative. The Corps evaluated these individual components using the NISP alternative screening criteria. The Healthy Rivers Alternative describes four agricultural water transfer concepts that could potentially provide additional water supply to the NISP Participants:

- Rotational fallowing
- Use of Colorado-Big Thompson Project (C-BT) units
- Traditional agricultural transfers where a water provider purchases agricultural water rights and transfers the water to municipal use, and the associated farmlands are permanently removed from irrigated agricultural production
- Development displaced water where agricultural water is transferred to municipal use in a similar manner as traditional agricultural transfers, but is limited to transfers from irrigated land being developed for municipal use

Rotational fallowing was a component of several agricultural to municipal water right transfers considered in the DEIS. Since the DEIS was issued, new information has become available about rotational fallowing. The State of Colorado has sponsored studies and pilot projects that

involve rotational fallowing and other transfer methods that do not result in permanent dry-up. The review of new information regarding the rotational fallowing concept found that the NISP firm yield criterion could be met if NISP were able to acquire ownership of the water rights, but would fail the firm yield criterion if ownership was left with the agricultural users because the perpetuity of the supply would last only as long as the initial lease. There are currently no large-scale rotational fallowing programs in Colorado, and the most significant pilot project, the Super Ditch in the Arkansas Basin, has not shown a proven ability to deliver a firm water supply. As a result, the rotational fallowing concept has not progressed to the point of being considered a proven technology. Therefore, the scenarios evaluated in the DEIS and for the SDEIS involving rotational fallowing would fail the NISP proven technology and firm yield screening criteria, if irrigators retained ownership of the water rights.

The NISP firm yield screening criteria include providing at least 12,000 AFY of firm yield of the full 40,000 AFY firm yield requirement for a component of an alternative to be considered potentially feasible. To meet the firm yield screening criteria of 12,000 AF, 20,000 to 24,000 C-BT units would be required, assuming a quota of 0.6 or 0.5, respectively. Given the strong competition for C-BT units from non-NISP entities, diminishing C-BT availability, and the municipal caps in place by the District, it is not likely that NISP Participants would be able to acquire 20,000 to 24,000 of the remaining 28,000 C-BT units available for transfer to municipal ownership. It is more likely that NISP Participants would be able to continue to acquire smaller amounts of C-BT to augment their overall supply portfolio. Therefore, acquisition of additional C-BT water failed the firm yield criterion.

Traditional agricultural transfers were previously evaluated as a partial supply for NISP as part of Alternative 4 in the DEIS. Additionally, the water source for the revised No Action Alternative is comprised primarily of agricultural transfers from three large ditch companies in the Poudre and Big Thompson Basins and includes pro-rata use of storage within the existing agricultural reservoirs. The traditional agricultural transfers concept as proposed in the Healthy Rivers Alternative does not differ fundamentally from the Corps' previous analyses.

A sub-category of agricultural water transfers is referred to as development displaced water. Development displaced water is agricultural water transferred to municipal use in a similar manner as traditional agricultural transfers, but is limited to transfers from irrigated land being developed for municipal use. Based on 2060 population projections, the NISP Participants were estimated to develop onto 25,000 irrigated acres. Using estimates of consumptive use and farm efficiency from the State's consumptive use model, 36,600 AFY of water is delivered to farm headgates on these 25,000 acres. Use of the farm headgate delivery by municipalities is possible provided return flow obligations are met (e.g., by wastewater effluent and releases from gravel pits or other storage). The transferable consumptive use is 25,600 AFY. NISP Participants would face several challenges in acquiring development displaced water due to several factors, including potential ownership of the water rights (or shares in ditch companies) by other municipalities (e.g., purchase and lease-back programs already in place by others), water quality concerns, and lack of adequate infrastructure to deliver water to the potable water system. Assuming these challenges could be overcome, development displaced water satisfies the firm yield criterion for a partial supply.

The nature of development displaced water is a local water supply. Water is derived from lands within the NISP Participant future planning areas and will likely be integrated into local water systems and used for meeting a portion of the Participants' future water needs, provided other legal and logistical challenges can be overcome. Acquisition of development displaced water by individual Participants does not constitute a regional project and therefore fails the regional project criterion. For the preceding reasons, the Corps eliminated the "Healthy Rivers Alternative" from detailed analysis.

S.5.1.3 A Better Future for the Poudre River Alternative

In 2012, after the end of the DEIS comment period, Western Resource Advocates submitted to the Corps an alternative to the NISP; it was called "A Better Future for the Poudre River". Western Resource Advocates developed the alternative to incorporate more current Colorado State Demography Office population projections, revised NISP Participant demands and supplies, data from the Colorado 2010 Statewide Water Supply Initiative, and other recent reports. The Better Future Alternative relied on water from growth onto agricultural lands, conservation, reuse, and cooperative agreements with agriculture. Based on Colorado State Demography Office population estimates, recent NISP Participant per capita water use, and applying passive conservation savings, the Western Resource Advocates calculated that water requirements for NISP Participants would total 72,100 AF in 2030 and 109,100 AF in 2060, 27,000 AF and 34,300 AF less than current NISP projections for 2030 and 2060, respectively. The Corps concluded the NISP need of supplying 40,000 AF of water is supported by the anticipated population growth in the Participant's service areas (see Chapter 1). The Corps also developed a Conservation Scenario as one of three demand projections (see Section 1.2.8 in Chapter 1). The Conservation Scenario assumes that the combination of passive and active conservation would reduce total water requirements for the Participants by 35,252 AF by 2060. Western Resource Advocates' suggested supplies of traditional agricultural transfers from urban growth onto previously irrigated lands and agricultural-urban cooperation were components to the previously discussed Healthy Rivers Alternative. Western Resource Advocates' suggested supply of 4,900 AF by 2030 from reuse was a minor component to the alternative's total supply. Existing reuse by the Participants was considered as a component of their existing supplies; any future reuse would contribute to meeting future 2060 water demands not met by NISP. For the preceding reasons and the reasons discussed in the previous section on the Healthy Rivers Alternative (Section S.5.1.2), the Corps eliminated the "A Better Future for the Poudre River" alternative from detailed analysis.

S.5.2 Alternatives Analyzed in Detail

Following alternative screening, the Corps then combined the retained concepts and elements to develop a reasonable range of alternatives. The key characteristics that differentiate the NISP alternatives from each other are presented in Table S-3. The alternatives developed for detailed analysis reflect the combined retained concepts and elements. The four alternatives analyzed in detail in this SDEIS are:

- No Action Alternative (Alternative 1) — Cactus Hill Reservoir (120,000 AF) and Agricultural Water Transfer
- Alternative 2 — Glade Reservoir (170,000 AF) and the South Platte Water Conservation Project (SPWCP) (District's Preferred Alternative)
- Alternative 3 — Cactus Hill Reservoir (190,000 AF), Poudre Valley Canal Diversion, and the SPWCP
- Alternative 4 — Cactus Hill Reservoir (190,000 AF), Multiple Diversion Locations, and the SPWCP

For the SDEIS, the No Action Alternative considers what the Participants would do to meet their need of 40,000 AFY of new firm yield if the Corps did not issue a Section 404 permit to the District for construction of NISP. In 2010, the Participants identified a new No Action Alternative (MWH 2010) for the SDEIS that assumes the Participants would collectively pursue a regional project, independent of the District, in the event of a permit denial for the proposed NISP. The No Action Alternative presented in the SDEIS would deliver water to the Participants by transferring agricultural water supplies from the Poudre River and Big Thompson River Basins, using a pro rata amount of existing storage in those systems, and constructing a new reservoir at the Cactus Hill Reservoir site. Key components of the No Action Alternative are:

- Transfer of water from 64,200 acres of irrigated land in the Larimer-Weld, New Cache, and Home Supply irrigation systems to municipal use
- Storage of water in the existing Big Windsor Reservoir, Lonetree Reservoir, and a new 120,000-AF Cactus Hill Reservoir
- Construction of two new regional water treatment plants
- Construction of 121 miles of water pipelines and nine pumping stations
- Realignment of three, two-lane Weld County roads totaling 10.3 miles
- Realignment of 6.8 miles of a 230-kV electric transmission line owned by Platte River Power Authority

The District's Preferred Alternative would deliver water to the Participants by using existing water rights, constructing a new reservoir at the Glade Reservoir site, and developing the SPWCP. Key components of the District's Preferred Alternative are:

- Diversion from the Poudre River at the Poudre Valley Canal for the District's Grey Mountain water right, SPWCP exchanges with the Larimer-Weld Canal and New Cache Canal, and reservoir exchanges with Terry Lake, Big Windsor Reservoir, and Timnath Reservoir
- Storage of water diverted from the Poudre River in a new 170,000 AF Glade Reservoir
- Augmenting flows in the Poudre River by releases from a designated 3,600-AF pool in Glade Reservoir with a target of maintaining a 10-cfs flow below the Larimer-Weld Canal headgate in November 1 through April 30 and September 1 through September 30
- Construction of the SPWCP, which includes a new South Platte River diversion and storage in a the new 45,624 AF Galeton Reservoir

- Construction of new pumping stations and water pipelines, the length of which would depend on whether Reclamation issued a contract and special use permit
- Realignment of 7 miles of U.S. 287 near Laporte, Colorado
- Realignment of four electrical transmission line structures totaling 0.6 mile of a 69-kV line owned by Poudre Valley REA

Table S-3. Major characteristics of alternatives.

Characteristic	Alternative 1	Alternative 2 Reclamation Action Option	Alternative 2 No Reclamation Action Option	Alternative 3	Alternative 4
Water Supply Source	Acquisition and transfer of irrigated agricultural water rights and minor new junior water rights on the Big Thompson and Poudre Rivers	Existing water rights on the Poudre and South Platte Rivers		Same as Alternative 2	Same as Alternative 2
Diversion Location	Historical diversion locations for the transferred agricultural water rights and exchanges to the Poudre Valley Canal when feasible	Diversions from the Poudre River at the Poudre Valley Canal SPWCP diversion on the South Platte River		Same as Alternative 2	Diversions from the Poudre River at the Poudre Valley Canal and New Cache Canal headgate SPWCP diversion on the South Platte River
New Reservoirs	Cactus Hill at 120,000 AF	Glade at 170,000 AF Galeton at 45,624 AF		Cactus Hill at 190,000 AF Galeton at 45,624 AF	Same as Alternative 3
Road Relocation	Weld County Roads (WCRs) 15, 19, and 90 affected by Cactus Hill Reservoir; WCR 15 would be realigned about 1 mile east	7-mile portion of U.S. 287		WCR 15, 19 and 90 affected by Cactus Hill Reservoir; WCR 15 would be realigned about 1 mile east	Same as Alternative 3
Winter Flow Augmentation	None, not feasible with Cactus Hill Reservoir	A pool of 3,600 AF would be designated from the existing storage in Glade Reservoir for release to the Poudre River at a rate up to 10 cfs from November 1 through April 30, and from September 1-September 30		None, not feasible with Cactus Hill Reservoir	None, not feasible with Cactus Hill Reservoir

†Flows in the 1.48-mile river reach between the Poudre Valley Canal and the Hansen Supply Canal would be greater (average of 8,200 AFY) than the No Reclamation Action Option and due to exchanges with C-BT, there would be an average reduction of 7,700 AFY in releases to the Poudre River at the Hansen Supply Canal.

Alternative 3 is similar to the District's Preferred Alternative except that water diverted from the Poudre River would be stored in the proposed Cactus Hill Reservoir instead of the proposed Glade Reservoir. Key components of Alternative 3 are:

- Diversion from the Poudre River at the Poudre Valley Canal for the District's Grey Mountain water right, SPWCP exchanges with the Larimer-Weld Canal and New Cache Canal, and reservoir exchanges with Terry Lake, Big Windsor Reservoir, and Timnath Reservoir
- Storage of water in a new 190,000 AF Cactus Hill Reservoir
- Construction of the SPWCP
- Construction of new pumping stations and water pipelines
- Realignment of three, two-lane Weld County roads totaling 10.3 miles
- Realignment of 6.8 miles of a 230–kV Platte River Power Authority transmission line

Alternative 4 is a new alternative developed for the SDEIS in response to comments on the DEIS requesting that alternatives be considered that would divert water from the Poudre River farther downstream than the Poudre Valley Canal, with storage of the water in a plains reservoir. Relative to the other action alternatives, Alternative 4 would allow more water to remain in the Poudre River between the Poudre Valley Canal and the New Cache Canal before it was diverted for exchanges. As modeled for SDEIS analyses, direct flow exchange water from Larimer-Weld Canal would be diverted or reexchanged at or near the Poudre Valley Canal as it would be in Alternatives 2 and 3. New Cache Canal direct flow exchange water would continue to flow downstream in the Poudre River channel about 23 miles to its current diversion location at the New Cache Canal headgate east of Fort Collins and I-25. This water would then be taken through a turnout from the New Cache Canal and routed by pump station and pipeline to storage in Cactus Hill Reservoir. The use of the New Cache Canal would be similar to the No Action Alternative (Alternative 1). Key components of Alternative 4 are:

- Diversion from the Poudre River at the Poudre Valley Canal for the District's Grey Mountain water right supply, SPWCP exchanges with the Larimer-Weld Canal, and reservoir exchanges with Terry Lake, Big Windsor Reservoir, and Timnath Reservoir.
- Diversion from the Poudre River at the New Cache Canal for the New Cache exchange water from the SPWCP
- Storage of water diverted from the Poudre River in a new 190,000 AF Cactus Hill Reservoir
- Construction of the SPWCP infrastructure which includes the new 45,624 AF Galeton Reservoir
- Construction of new pumping stations and water pipelines
- Realignment of three, two-lane Weld County roads totaling 10.3 miles
- Realignment of 6.8 miles of a 230-kV Platte River Power Authority transmission line

S.6 AFFECTED ENVIRONMENT (CHAPTER 3)

The affected environment associated with the action and No Action Alternatives consists of flow-based resources potentially affected by diversions or storage of water and land-based resources adjacent to proposed or realigned infrastructure, such as new reservoirs, new pipelines and realigned roads or transmission lines. Flow-based resources are rivers from which water would be diverted, such as the Poudre River and the South Platte River, canals that would be used in the operation of one or more of the alternatives, such as Larimer-Weld Canal, New Cache Canal and Home Supply Ditch, and reservoirs that would be used in the operation of one or more of the alternatives, such as Carter Lake and Horsetooth, Flatiron, Terry Lake, Big Windsor, and Timnath Reservoirs. Flow-based resources also include the aquatic life, wetlands and riparian resources associated with these surface water resources, the morphology and sediment transport of the Poudre River and the South Platte River, and alluvial ground water adjacent to surface water resources and proposed reservoir sites.

The primary water supply source for the No Action Alternative would consist of 45,200 AFY of permanently transferred historical consumptive use associated with agricultural water rights within the Poudre River and Big Thompson River Basins (estimated to equal 64,200 acres of fallowed agricultural land). Historical return flows associated with these agricultural water rights would remain at the headgates for maintenance of ditch losses and return flows. It is assumed that historical diversion locations and amounts would be maintained for water right transfers within the Big Thompson Basin and thus no streamflow impacts are predicted as a direct result of these transfers.

In response to comments on the DEIS requesting additional information about Poudre River resources, the mainstem was divided into six representative segments (Table S-4, Figure S-1) to collect baseline data on aquatic resources, ground water, water quality, stream morphology, and wetland and riparian vegetation. Segment selection was determined based on discussions between the Corps, USGS, and NISP third-party contractors. Within each segment, study sites considered representative of the aquatic biological resources, riparian vegetation, wetlands, and river geomorphology were selected for intensive data collection, and these are referred to as the Poudre River study sites throughout this document. Although the 2013 flood on the mainstem may have altered some of the aquatic and vegetation communities and land forms within the representative segments, the Poudre River study sites remain a representative sample of the conditions along the river developed in response to cycles of flooding and other forces that alter the river and the riparian environment.

Figure S-1. NISP Alternatives Study Area.

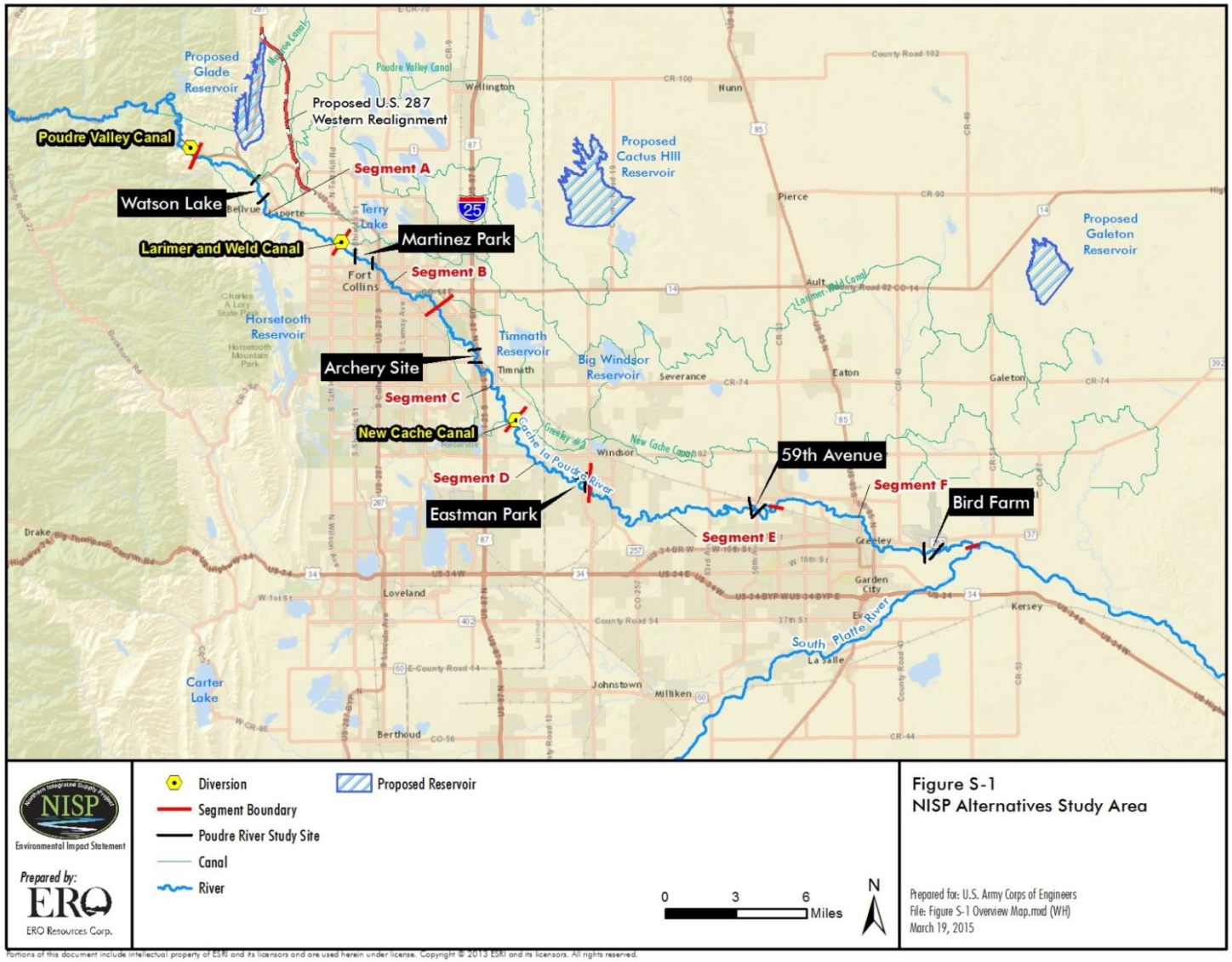


Table S-4. Poudre River study segments.

Segment	Reach	Representative Poudre River Study Site
A	From the mouth of Poudre Canyon to the Larimer-Weld Canal	Watson Lake
B	Larimer-Weld Canal to Spring Creek in Fort Collins	Martinez Park
C	Spring Creek to the New Cache Canal Diversion; this segment continues through Fort Collins and crosses under I-25	Archery Site
D	New Cache Canal to County Road 17, near of the Town of Windsor; this segment runs through the Town of Timnath	Eastman Park
E	County Road 17 to the 59th Ave. Railroad Bridge upstream of Greeley; this segment contains the Town of Windsor	59th Avenue
F	The 59th Avenue Railroad Bridge upstream of Greeley to the South Platte River; this segment is adjacent to and downstream of the City of Greeley	Bird Farm

S.6.1 Surface Water Hydrology, Surface Water Quality and Stream Morphology

S.6.1.1 Poudre River

The Poudre River study area for the flow-related resources is from the canyon mouth (approximate downstream limit of the Poudre Canyon where the river transitions from the confinement of the canyon to an unconfined alluvial channel) to the confluence with the South Platte River (Figure S-1). The study area largely coincides with the Cache la Poudre River National Heritage Area and is downstream of the Wild and Scenic River designated reaches. National Heritage Areas are designated by Congress as places where natural, cultural, and historic resources combine to form a cohesive, nationally important landscape.

In the upper Poudre River watershed, the majority of the river flow is from snowmelt, with additional input from overland storm runoff during summer and some ground water inflow. Average annual peak flows (related to seasonal snow melt and not rain events) are highest at the canyon mouth (2,552 cfs at Canyon Gage), lowest at the Boxelder Gage (1,571 cfs) downstream of Fort Collins, and then increase slightly in the lower reaches of the river (1,856 cfs at Greeley Gage) primarily due to return flows and ground water discharge. Natural flows are augmented by nine transbasin diversions that deliver water into the upper Poudre River.

The Poudre River has 21 major diversions at multiple locations primarily for municipal water supply and agricultural use. These diversions occasionally result in dry-up points along the river that occur during winter and summer. At least 12 dry-up points were identified between the Greeley Filters Pipeline intake and the Ogilvy Ditch headgate based on discussions with Water Commissioners and reviews of historical data, although several are reported to occur only in the driest of years, such as 2002. The river is recharged downstream of the dry-up points by surface water discharges and/or by ground water inflows. Water is returned to the river through a variety of point and nonpoint discharges.

Historically, pollution has been present in the Poudre River for at least 50 years. Primary sources of anthropogenic input to the Poudre River that affect water quality are wastewater treatment plant discharges, stormwater drains and runoff from urban areas, and return flow from irrigated agriculture. Tributary inflows to the Poudre River downstream of the canyon are minimal except during storm events. Seven permitted wastewater treatment plants currently discharge to the Poudre River in the study area. Poudre River water quality was generally the poorest between Boxelder Creek and Greeley.

Temperature in the Poudre River generally increases from upstream to downstream as cooler mountain waters and snowmelt reach the plains and is warmed by greater solar radiation. Temperatures are also affected by changes in flow rates from diversions, and contributions from waste water treatment plants (WWTP) outfalls, tributaries, and ground water return flows. During higher flows, total metals, total organic carbon, and turbidity concentrations tend to be higher than during lower flows. During lower flows, total dissolved solids, sulfate, chlorophyll *a*, nutrient concentrations, and river temperature tend to be higher than during higher flows. Elevated total metal concentrations were generally associated with elevated turbidity, but at some downstream locations were also due to elevated dissolved metal concentrations as a result of ground water discharge to the river from local bedrock formations. Some of the natural contaminants to the river, such as selenium, are exacerbated by human activities, such as runoff from agricultural fields.

Reductions in streamflow have been greatest in the vicinity of Fort Collins; changes in the Poudre River channel associated with reductions in streamflow have been greater downstream of I-25. River morphology from the canyon mouth to around I-25 is flood-dominated. At most cross sections upstream of I-25, bankfull discharge rarely occurs. River morphology downstream of I-25 tends to be deposition-dominated. Channel size and capacity are reduced in the downstream direction except for the Greeley Channelized Reach, which has an artificially high hydraulic depth and high bankfull discharge. Downstream of I-25, the river channel has contracted to as little as 15 feet wide at some riffles. It takes substantially less flow to flood the lower reaches of the Poudre River (except for the Greeley Channelized Reach) as was observed during recent high flows in 2011, 2013, and 2014.

The Poudre River upstream of I-25 appears to be sediment supply-limited and downstream of I-25 appears to be sediment transport-limited. A transport-limited system is more sensitive to changes in hydrology because its behavior is controlled by the hydraulics of the system rather than by sediment supply. This has led to channel narrowing downstream of I-25, and in some sections the riffle-pool complexes of the river are changing with the filling of pools with sediment.

Coarser cobble and gravel river substrate is more common upstream of I-25 and a substrate of silt and sand is more common downstream of I-25. Sands and gravels that have moved through the upstream reaches are in greater supply relative to the more limited transport capacity of the river. No continuous armor layer is present downstream of I-25.

S.6.1.2 South Platte River

The lower South Platte River study area extends from the South Platte River-Poudre River confluence downstream to the Kersey Gage. Peak runoff occurs primarily in May through early July. Total annual flow volumes vary considerably from year-to-year due to variability in snowpack, and precipitation events. Streamflow in the lower South Platte Basin during the spring and early summer is reliant on snowmelt runoff from headwaters watersheds, and during the remainder of the year is reliant on return flows from upstream use of native water and C-BT water. Occasional heavy precipitation events in the watershed results in associated peak flows from spring through early fall.

The South Platte River serves as the principal source of water for eastern Colorado and is diverted extensively for agricultural use. In general, water quality is poor at the Kersey Gage as a result of upstream discharges and diversions.

Within the South Platte River Basin primary sources of anthropogenic water pollutants are urban stormwater, wastewater treatment plan discharges, and runoff or subsurface flows from agricultural fields. Agricultural runoff to the Poudre and South Platte Rivers is a combination of nonpoint source discharges from fields and discharges from ditches and pipelines. Another source of pollution is water that percolates into ground water from farm fields and then flows into the streams. Agriculture contributes nutrients, suspended sediments, pesticides, and other pollutants to South Platte River Basin streams. Marine shale deposits along the Front Range are a natural source of salts to the South Platte River (e.g., sulfate, sodium, calcium, and selenium).

Stream morphology of the South Platte River is described in Section 3.4.1 of the DEIS. More detailed information can be found in the South Platte River Stream Morphology Report (ERO 2008a).

S.6.2 Aquatic Resources

Coldwater fishes (species that require cold temperatures throughout the year) still present in the Poudre River study area are the nonnative brown trout, rainbow trout, and mountain whitefish. The native greenback cutthroat trout is also a coldwater fish but no longer is present in the study area. The remaining species in the study area have varying preferences for water temperatures but are considered warmwater species based on their tolerance for seasonally warmer water temperatures in the summer. A few native species, such as longnose dace, longnose sucker, and white sucker, are considered warmwater species but have wide temperature tolerances and are commonly found with trout in coldwater sections of streams and rivers as well as in warmwater sections.

The loss of several native species over the last century indicates that some environmental thresholds have already been crossed. The native greenback cutthroat trout, a federal and state threatened species, has long ago been replaced by nonnative brown and rainbow trout in the coldwater sections of the Poudre River. Hornyhead chub, quillback, and northern redbelly dace have not been collected from the Poudre River since 1914. This could be a result of early flow manipulation, channelization, changes in water quality, or some combination of these factors.

Native fishes and nonnative game fishes in the mainstem are affected by channelization and fragmentation. These channel modifications may be partially responsible for the extirpation of some native species from the system.

Nonnative fish are much less prevalent in the South Platte River than they are in the lower sections of the Poudre River. The relatively small number of nonnative species may be partially attributable to the fluctuating flow conditions on the South Platte River, which may discourage species that are not adapted to this flow regime. In 2002, native sand shiners, fathead minnows, and bigmouth shiners were most common. In 2004, these three species were still abundant, but nonnative mosquitofish were also present in large numbers.

S.6.3 Soils

Prime Farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is also available for these uses. In general, prime farmlands have an adequate and dependable water supply from precipitation or irrigation, a favorable climate and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content, and few or no rocks. Many of the soils irrigated for agriculture in the NISP study areas are Prime Farmland soils.

S.6.4 Wetlands, Riparian Resources, and Other Waters

Wetlands are "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas" (33 CFR 328.3(b)). Other waters include surface water features such as streams, ditches, and ponds. Wetlands and other waters that meet the definition of "waters of the United States", currently the subject of proposed federal rulemaking, are under the jurisdiction of the Corps under Section 404 of the Clean Water Act (CWA). Riparian areas are a transitional habitat between terrestrial and aquatic ecosystems found immediately adjacent to rivers, streams, and sometimes lakes. Riparian areas differ from wetlands in that they are generally linear, more terrestrial, are often dependent on a natural disturbance regime, and do not include the instream environment.

Types of wetlands that occur in the study areas include: palustrine persistent emergent (PEM) wetlands dominated by grasses, sedges, and rushes; and palustrine scrub-shrub wetlands (PSS) dominated by willows and other shrubs. Some wetlands contain more than one type of wetland; in those cases, the dominant wetland type was used. Some wetlands may include scattered deciduous trees such as cottonwood and willow.

Wetland functional assessments were based on hydrogeomorphic (HGM) classes using the FACWet Method. HGM classes are riverine (associated with a stream channel, floodplain, or terrace), lacustrine fringe (topographic depression with permanent water greater than 2 meters deep), depressional (topographic depression without permanent water greater than 2 meters deep), and slope (located on a topographic slope with ground water as primary water source).

Using the FACWet method, a composite functional capacity index score ranging from 1.0 (reference standard) to below 0.60 (nonfunctioning) are derived for each wetland or group of wetlands.

S.6.4.1 Proposed Reservoir Sites

S.6.4.1.1 Glade Reservoir

Within the Glade Reservoir study area, including the U.S. 287 realignment study area, all of the wetlands were classified as PEM or PSS. Hydrogeomorphic types include depressional and riverine wetlands. The FACWet composite functional capacity index score ranged from 0.69 (functioning impaired) to 0.93 (reference standard). The composite functional capacity index scores of wetlands in the U.S. 287 realignment study area ranged from 0.76 (functioning) to 0.94 (reference standard). Of the 22 wetlands in the Glade Reservoir site and the U.S. 287 realignment study area, five wetlands had composite functional capacity index scores ranked as the reference standard with scores of 0.93 or 0.94. Six wetlands ranked as highly functioning with four wetlands with a score of 0.80, one with a score of 0.85, and one with a score of 0.89. Ten wetlands ranked as functioning with four wetlands with a score of 0.71 and six wetlands with a score of 0.79. One wetland ranked as functioning impaired with a score of 0.69. Mesic mixed shrublands and mesic native shrublands occur along creeks in the study area. The mesic mixed woodlands are dominated by cottonwoods and other trees and shrubs

S.6.4.1.2 Galeton Reservoir

Nine wetlands in the Galeton Reservoir study area were classified as PEM. HGM types included depressional and riverine wetlands. The wetlands all had a FACWet composite functional capacity index score of 0.82 (functioning).

S.6.4.1.3 Cactus Hill Reservoir

Within the Cactus Hill Reservoir study area, three wetlands classified as PEM occur. The only HGM type observed was depressional. FACWet composite functional capacity index scores were 0.67 and 0.69 (functioning impaired) and 0.70 (functioning) for the three wetlands.

S.6.4.2 Poudre River

The Poudre River corridor from the mouth of the canyon to the confluence with the South Platte River has diverse wetland, riparian, and upland communities interspersed throughout the floodplain. Cottonwood woodlands occur as narrow bands along the banks or as large stands with a grassy understory. Upstream of Fort Collins, narrowleaf cottonwoods are the dominant species of the woodlands and plains cottonwood are dominant through Fort Collins to the confluence with the South Platte River. Peachleaf willow, crack willow, box elder, and green ash are commonly found in the cottonwood woodlands. Sandbar willow, the most common riparian shrubland, most often occurs on sandbars along the banks. Reed canarygrass forms dense stands along the banks, often forming an understory in the sandbar willow stands. Typically, reed canarygrass and sandbar willow are wetlands with a fairly wide range of ground water depths that provide supportive wetland hydrology. Wetlands dominated by sedges and

mesic grasses occur along the river's edge, along the banks of tributaries and ditches, and throughout the floodplain in areas with shallow ground water. Upland grasslands interspersed between the stands of cottonwood are often dominated by smooth brome.

Within the Poudre River study sites, wetlands were classified as PEM and PSS. HGM types included depressional wetlands throughout the floodplain and riverine wetlands along the banks. FACWet composite functional capacity index scores for depressional wetlands ranked as functioning, but scores were lower at the four upstream Poudre River study sites (0.72 for 3.4 acres of wetlands at Watson Lake, 0.70 for 5.0 acres of wetlands at Martinez Park, 0.72 for 3.9 acres of wetlands at Archery Site, and 0.73 for 0.2 acres of wetlands at Eastman Park) and higher for the downstream sites (0.76 for 2.5 acres of wetlands at 59th Avenue and 0.77 for 8.5 acres of wetlands at Bird Farm). Riverine wetlands at Watson Lake (3.3 acres), Eastman Park (4.1 acres), and 59th Avenue (1.9 acres) had a composite functional capacity index score of 0.70. Martinez Park riverine wetlands (3.7 acres) had a score of 0.71 and Bird Farm riverine wetlands (4.3 acres) had a score of 0.73. The 2.8 acres of wetlands at Archery Site were functioning impaired with a score of 0.69. Sites that scored lower were typically within municipal areas or had more disturbances to the wetlands and surrounding area.

Past disturbances such as gravel mining, channelization, levee construction, development, and changes in hydrology have impacted the extent of the riparian corridor. The combination of flood flows that are no longer effective in establishing new stands of plains cottonwood, extensive stands of smooth brome and reed canarygrass that compete with cottonwood seedlings and nonnative woody vegetation that is establishing at rates equal to or greater than plains cottonwood, establish a trajectory for a future Poudre River riparian corridor that will likely be very different from the past and current riparian corridor. As the stands of plains cottonwoods mature and die, they will not likely be readily replaced at current densities and distribution, and the woody vegetation that replaces the plains cottonwoods will likely be a mix of cottonwoods and nonnative woody vegetation (e.g., green ash).

S.6.4.3 South Platte River

Herbaceous wetlands dominated by cattails, sedges, rushes, and grasses occur throughout the South Platte River floodplain below the confluence with the Poudre River to the Kersey Gage. On the south side of the South Platte River, some herbaceous wetlands are associated with an abandoned side channel that has areas of open water. Smaller areas of herbaceous wetlands border the north banks of the South Platte River or are associated with a tributary. Bare sand bars likely become colonized by sandbar willow periodically. Functional assessments were not conducted for South Platte River wetlands.

The riparian associations are similar to those on the Poudre River with plains cottonwood associations dominating the floodplain. Upland grasslands are interspersed between the stands of cottonwood. Other species likely associated with the cottonwood include peachleaf willow, crack willow, and green ash with a high cover of smooth brome in the understory.

S.6.5 Wildlife

Mule deer winter range is found in many of the study areas; severe winter range is found in a narrow band along the Front Range. Mule deer winter concentration areas occur in the westernmost study areas, such as the Glade and Cactus Hill Reservoir sites. White-tailed deer winter range is found between Fort Collins and the Glade Reservoir site, surrounding the Cactus Hill Reservoir site, and along the Poudre River. Pronghorn severe winter range is located at the Glade and Galeton Reservoir sites, with winter range found at the Cactus Hill and Galeton Reservoir sites. Elk winter range is found in the foothills in the western portion of the Glade Reservoir site. Elk severe winter range and elk winter concentration areas occur in the northwestern portion of the Glade Reservoir site and coincide with a portion of the western arm of proposed Glade Reservoir.

S.6.6 Hazardous Materials

The proposed Glade forebay would be located near the Atlas "E" Missile Site 13. A trichloroethene release occurred from operations at the facility. The Corps, Omaha District, Environmental Remediation Branch investigated the contaminated ground water plume from 1999 to 2004 to define the vertical and horizontal extent of the plume. In response to comments on the DEIS, additional monitoring was performed for the SDEIS. By the end of 2009, only one well had trichloroethene concentrations above the Colorado ground water standard. The plume is smaller than it was when originally investigated in 1999 and no detectable trichloroethene currently is within the footprint of the proposed forebay. As the contaminant mass continues to naturally attenuate, the plume will continue to decrease in size.

S.7 DIRECT AND INDIRECT EFFECTS (EIS CHAPTER 4)

Many of the effects associated with the alternatives are predicted to be similar. Differences in facilities, source water supply, diversion amounts, diversion locations and other characteristics would result in some differences in predicted effects that can be used to differentiate the alternatives as discussed below. This summary focuses on the effects that can be used to differentiate the alternatives; therefore not all sections of the SDEIS are summarized. All of the direct and indirect effects for the alternatives are summarized at the end of Chapter 4. Some flow-related resources are on a trajectory that is predicted to continue with or without implementation of any of the NISP alternatives. The NISP alternatives may accelerate or reinforce the trajectory in a similar manner or to a similar degree. For flow-based resources, the No Action Alternative was not evaluated by comparison to 2010 current conditions hydrology. Based on uncertainty regarding the Participants' response and timing of actions if the NISP permit is denied and uncertainty of the availability of future water supplies, the Corps determined that the No Action Alternative would be evaluated based on a comparison to 2050 Future Conditions hydrology, as described in Sections 1.8 and 4.1.2. With Future Conditions as a baseline, the maximum anticipated effect is disclosed, which will inform the decision-maker and the public of what may happen if the Corps denied the permit. In the following discussion,

Alternative 2 refers to both the Reclamation Action Option and No Reclamation Action Option unless otherwise noted.

The CTP hydrologic modeling was used to predict the flow changes associated with the NISP alternatives on the flow-related resources. The following terms are used to describe the hydrologic model runs when discussing predicted effects for the flow-related resources:

- Current Conditions (2010 flows = Run 1)
- Current Conditions Effects (2010 flows with NISP alternatives = Run Series 3)
- Future Conditions Effects (2050 flows with RFFAs + NISP alternatives = Run Series 4)
- Cumulative Effects (2050 flows with RFFAs + HSWSPs Proposed Actions + NISP alternatives = Run Series 5)
- Alternative 1 Effects (2050 flows with RFFAs + No Action Alternative = Run 9a)

S.7.1 Surface Water

Most of the flow-reducing changes associated with each of the proposed NISP action alternatives would be concentrated in the reach from the Poudre Valley Canal headgate to the New Cache Canal headgate, a distance of about 23 miles, including the segment of the Poudre River traversing Fort Collins. In this reach, modeled changes in streamflow are attributable to use of the Grey Mountain right in combination with one or more of the SPWCP direct flow and reservoir exchanges. Downstream of New Cache Canal on the Poudre River, modeled changes in streamflow are limited to diversions under the Grey Mountain right, which are predicted to have very little effect on daily median flows outside of April through June due to the junior (1980) priority of the water right.

In all alternatives, most diversion from the Poudre River would occur in May and June (Figure S-2 and Figure S-3). In the Reclamation Action Option of Alternative 2, 82% of average annual Poudre River diversions would occur during the months of May and June; 74% of the average annual Poudre River diversions would occur during the same 2 months under the No Reclamation Action Option of Alternative 2. The percentage of average annual diversions during May and June would be 72% under Alternatives 3 and 4.

Figure S-2. Effects on Current Conditions Median Daily Flow at Canyon Gage, IY 1980-2005.

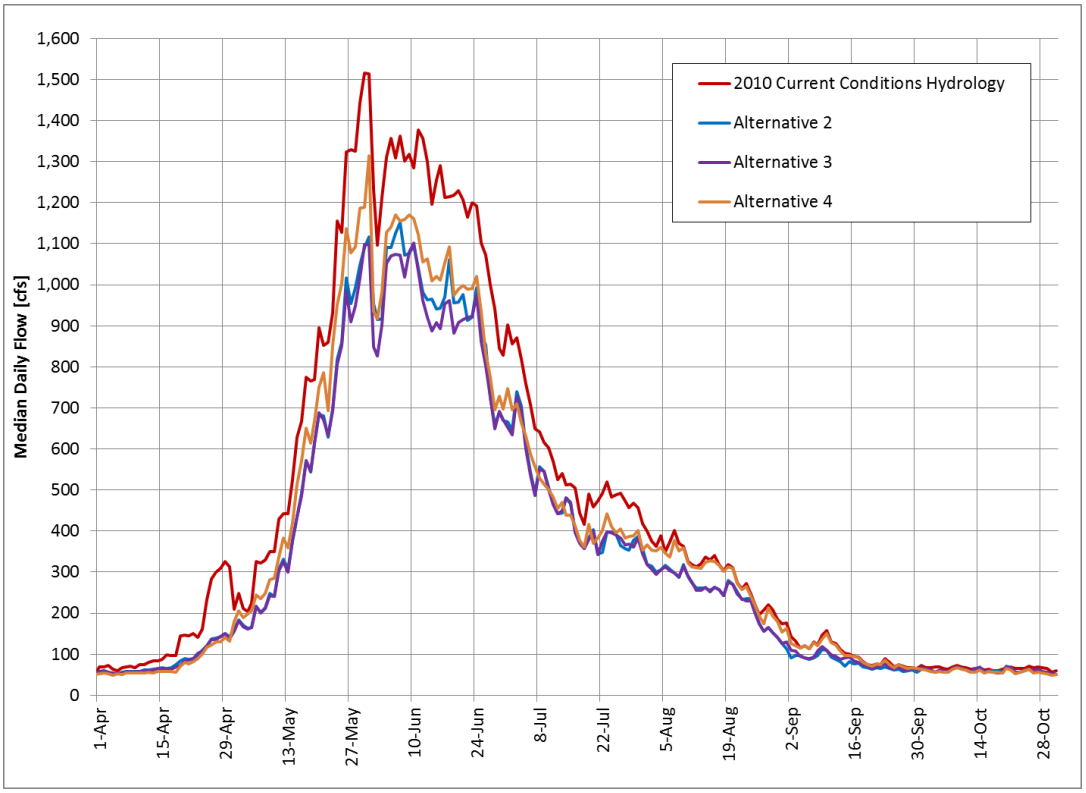
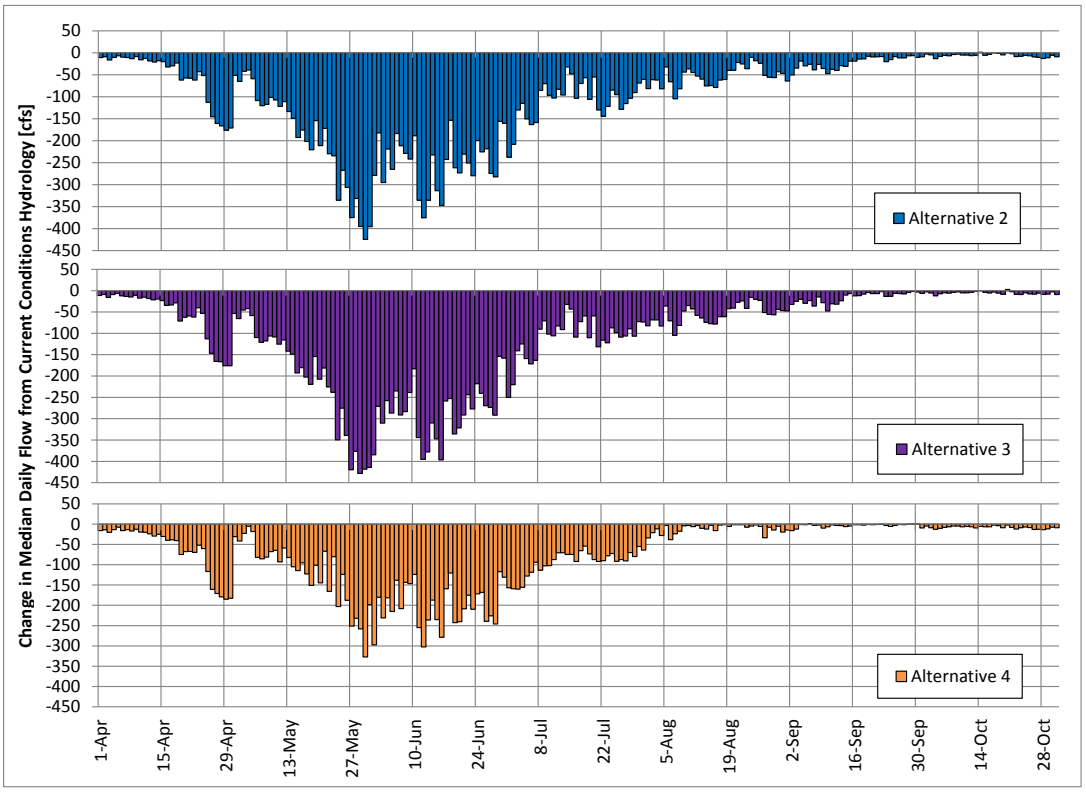


Figure S-3. Change in Median Daily Flow from Current Conditions at Canyon Gage, IY 1980-2005.



Alternative 2 Reclamation Action Option would require total average annual diversions of 63,500 AFY, 35,100 AFY of which would be from the Poudre River and the rest from the South Platte River. The No Reclamation Action Option would require physical diversions of 8,200 AFY more from the Poudre River than the Reclamation Action Option (Table S-5), but due to proposed operational changes to C-BT Project facilities associated with the Reclamation Action Option, net streamflow changes below the Hansen Supply Canal for the Reclamation Action Option would be nearly identical to the No Reclamation Action Option. This issue is discussed in more detail in Section 4.2.3.4.1 of Chapter 4. Compared to Glade Reservoir in Alternative 2, Cactus Hill Reservoir in Alternatives 3 and 4 would be larger, wider and shallower. In addition, the plains location of Cactus Hill Reservoir would require delivery of water through nearly 30 miles of the Poudre Valley Canal. Compared to Alternative 2, the resulting combination of increased evaporation and transit losses would require more water to be diverted to Cactus Hill Reservoir from the Poudre River in order to meet the Participants' water supply needs. Total average annual diversions would be 79,200 AFY in Alternative 3 (49,200 AFY from the Poudre River) and 80,800 AFY (48,800 AFY from the Poudre River) in Alternative 4 (Table S-5). The increased diversions would result in larger changes in modeled streamflows at the evaluated locations on the Poudre River and South Platte River.

Table S-5. Average annual diversion amounts under Current Conditions Effects by alternative.

River Location Canal	Alternative 1 (AFY)	Alternative 2		Alternative 3 (AFY)	Alternative 4 (AFY)
		Reclamation Action Option (AFY)	No Reclamation Action Option (AFY)		
Poudre River (see footnote)		**35,100†**	**43,300**	**49,200**	**48,800**
Location					
Poudre Valley Canal		35,100†	43,300	49,200	37,800
Larimer-Weld Canal	**Not evaluated**	0	0	0	0
New Cache Canal		0	0	0	11,000
South Platte River		**28,400**	**28,400**	**30,000**	**32,000**
Big Thompson River		**0**	**0**	**0**	**0**

†Flows in the 1.48-mile river reach between the Poudre Valley Canal and the Hansen Supply Canal would be greater (average of 8,200 AFY) than the No Reclamation Action Option due to exchanges with C-BT and the associated bypass of divertible flows by NISP. The combination of bypassed diversions, releases from Glade Reservoir, and reduced releases from the Hansen Supply Canal would be such that the streamflow effects of the Reclamation Action Option below the Hansen Supply Canal would be nearly identical to the No Reclamation Action Option, i.e., the net effect of both Alternative 2 options downstream of the Hansen Supply Canal would be a streamflow reduction of 43,300 AFY.

Alternative 4 would divert SPWCP exchange water from the New Cache Canal at the historical point of diversion (the New Cache headgate, located east of I-25) rather than diverting this water upstream at the Poudre Valley Canal headgate, as would be done under Alternatives 2 and 3. The resultant effect on streamflows would be less dewatering of the reach from the Hansen Supply Canal to the New Cache headgate (about 22 miles, including through Fort Collins) relative to Alternatives 2 and 3 (Figure S-4 and Figure S-5). From the Poudre Valley Canal headgate to the Larimer-Weld Canal headgate, there would still be reductions in flow associated with Grey Mountain diversions and the SPWCP exchanges with Larimer-Weld Canal, Terry Lake, and Big Windsor. Below the Larimer-Weld Canal headgate, streamflows would be

reduced due to Grey Mountain diversions and the SPWCP exchange with Timnath Reservoir. Downstream of the New Cache Canal headgate, the only differences between Alternatives 3 and 4 would be associated with the comparative amounts of Grey Mountain diversions. At the Kersey Gage, model results for Alternatives 3 and 4 show similar combined volumes of Grey Mountain diversions on the Poudre River and SPWCP diversions from the South Platte River.

The modeled changes to median daily flows at the Kersey Gage are similar for all action alternatives, reflecting both the Grey Mountain and South Platte River diversions that are similar in frequency and magnitude. Alternative 2 flows would be greater than the other alternatives in some months (December-February, June), consistent with Alternative 2 modeling showing the lowest average diversions (both Grey Mountain on the Poudre River and SPWCP water rights on the South Platte River).

For all action alternatives, Grey Mountain diversions from the Poudre River generally would be limited to the peak runoff months (May-June of wet years). The occurrence of modeled flow changes at the Kersey Gage illustrates that in-priority diversions from the South Platte River for storage in Galeton Reservoir could happen in any month, including through the winter. The relative changes in flow at the Kersey Gage would be much less than on the Poudre River as a percentage of the 2010 current conditions hydrology flows because the magnitude of flow on the South Platte River is much greater than on the tributary Poudre River.

Both the Reclamation Action Option and the No Reclamation Action Option for Alternative 2 would include a winter flow augmentation program. A pool of 3,600 AF would be designated in Glade Reservoir each year for release to the Poudre River during historical low flow periods between November 1 and April 30, and from September 1 to September 30 (if any of the designated 3,600 AF were available at the end of April). Winter flow in the Poudre River is typically low (Figure S-6). The flow augmentation program would minimize some indirect project effects and improve winter and September streamflows through Fort Collins by providing a flow of 10 cfs below the Larimer-Weld Canal headgate (upstream of Martinez Park) (Figure S-7). The reach affected by flow augmentation would extend from upstream of the Larimer County Canal headgate near Laporte to the Timnath Inlet Canal headgate located on the east side of Fort Collins, a distance of about 12 river miles. The release and recapture of the augmentation flows is allowed by the District's water rights decrees proposed to be used for NISP. The exact method to return the water to Glade Reservoir will be determined between the SDEIS and the FEIS, but possible options include water exchanges. Curtailment of streamflow augmentation releases may be required under extreme drought conditions when reservoir levels are low.

Figure S-4. Effects on Current Conditions Median Daily Flow at Lincoln Street Gage, IY 1980-2005.

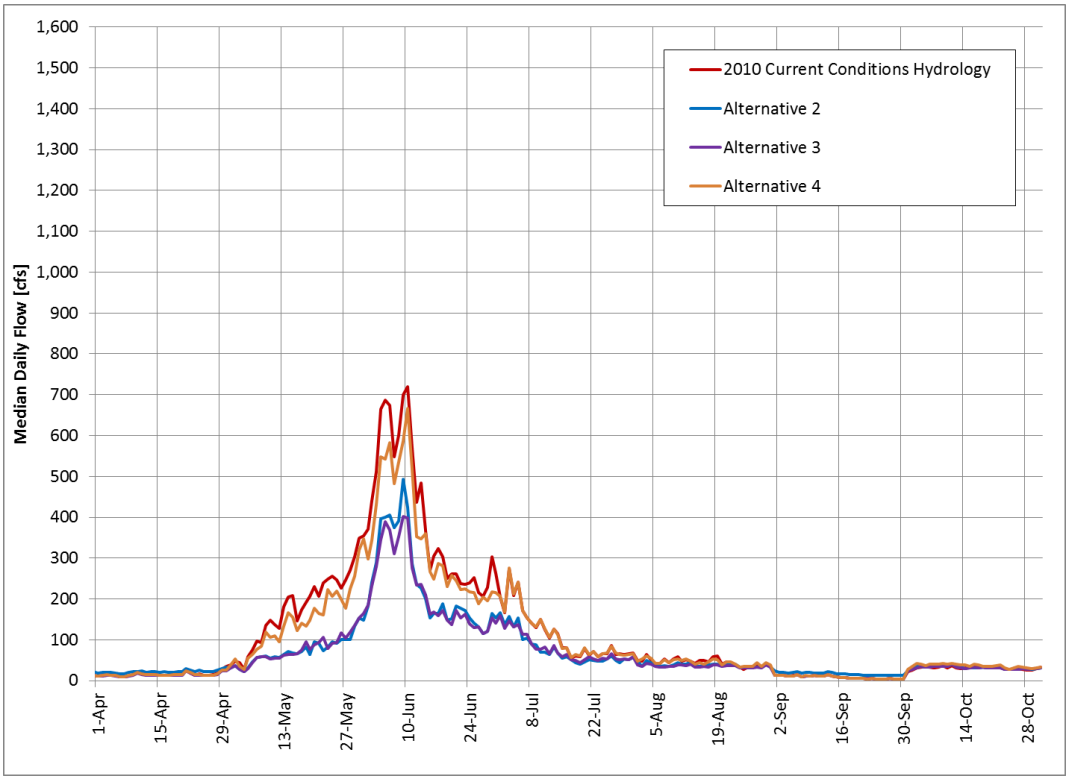


Figure S-5. Change in Median Daily Flow from Current Conditions at Lincoln Street Gage, IY 1980-2005.

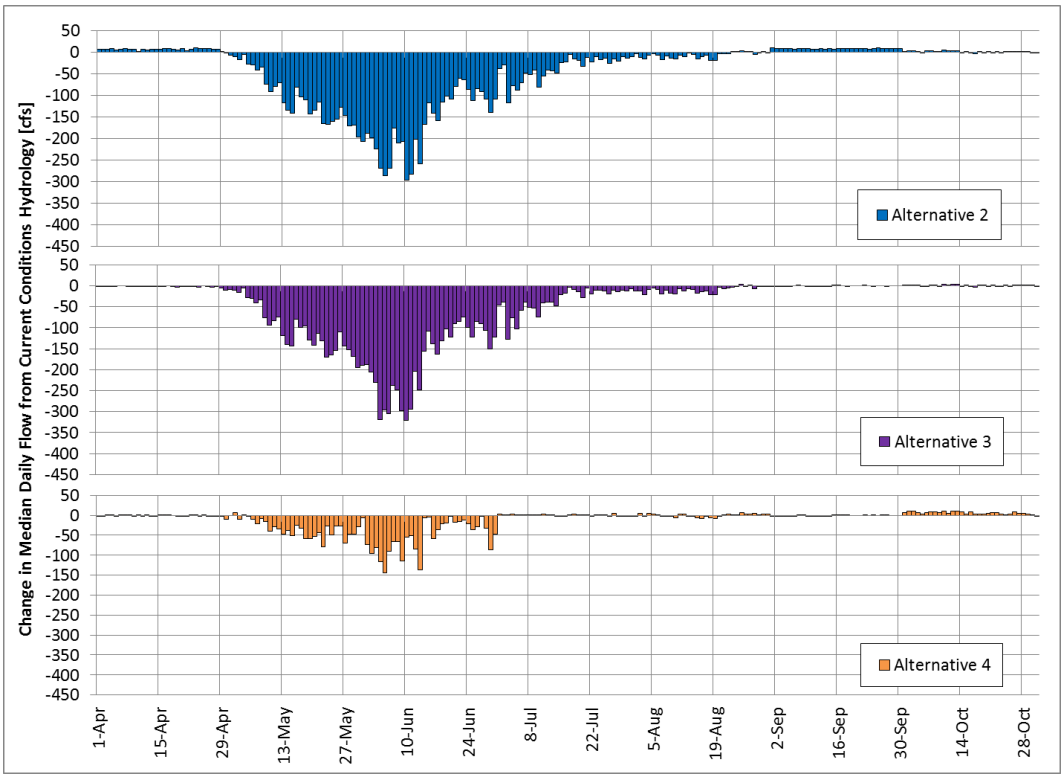


Figure S-6. Median Daily Flow at Lincoln Street Gage during Alternative 2 Flow Augmentation Periods, IY 1980-2005.

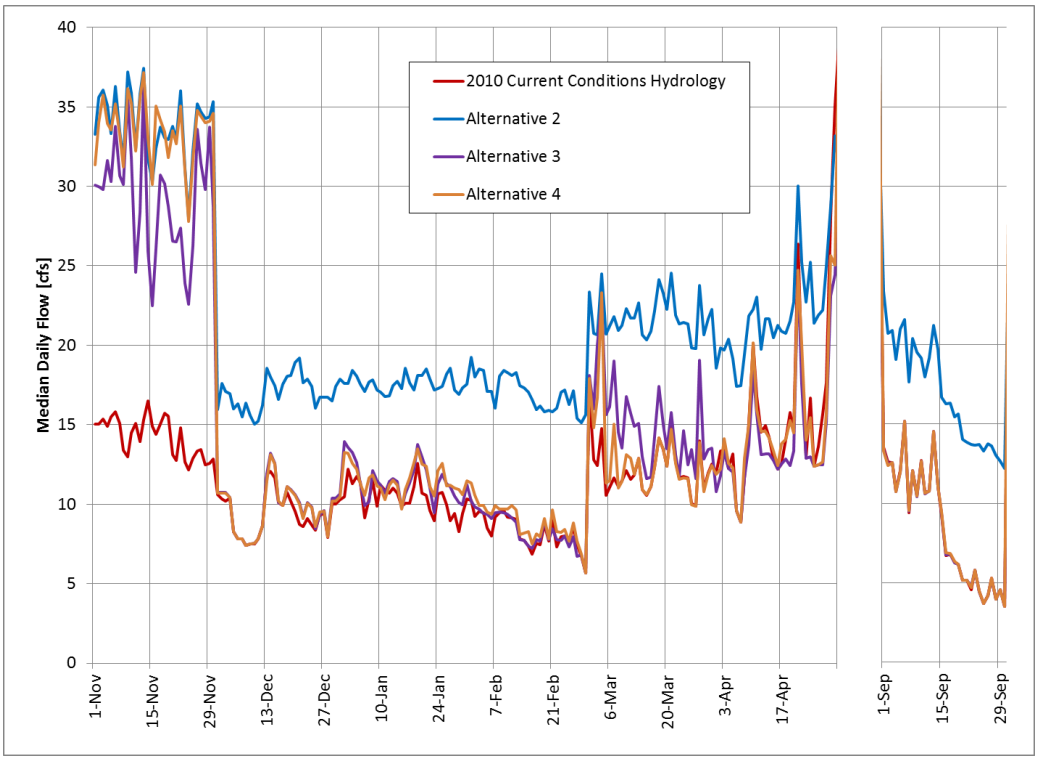
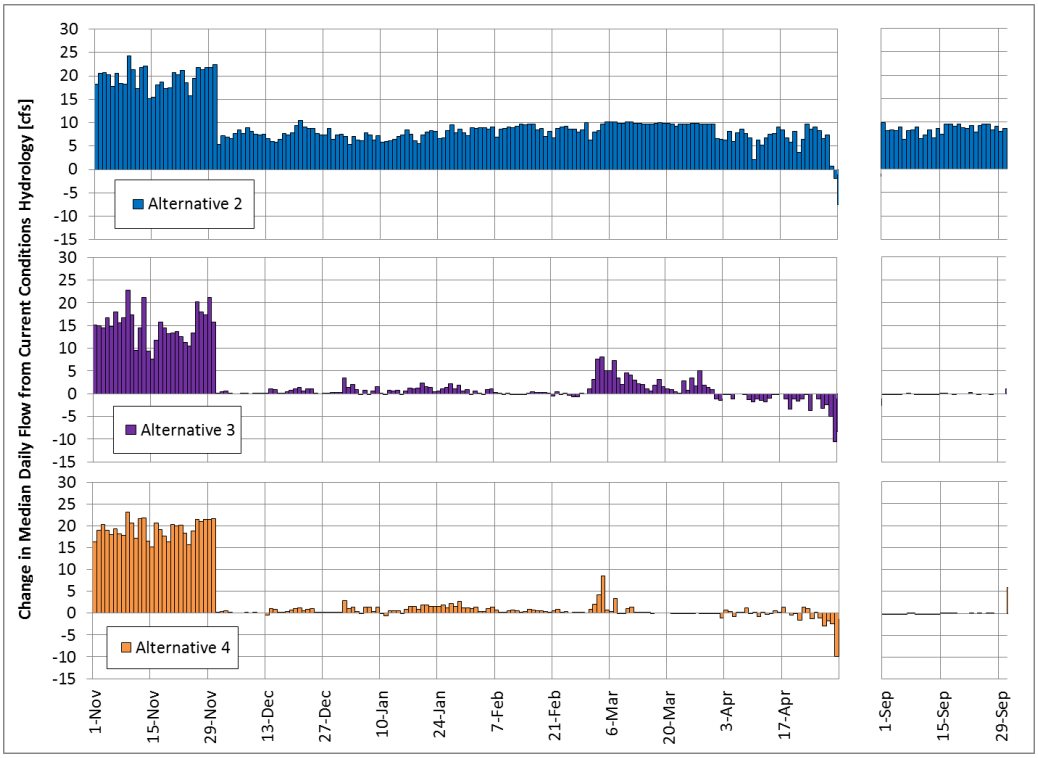


Figure S-7. Change in Median Daily Flow at Lincoln Street Gage during Alternative 2 Flow Augmentation Periods, IY 1980-2005.



S.7.2 Surface Water Quality

The results presented in the SDEIS reflect the first of two phases of water quality analysis. The first phase includes a qualitative assessment of likely changes in water quality for multiple locations under each of the alternatives. The intent of the first phase of analysis was to determine which water quality constituents and locations are most likely to be affected by hydrologic changes. Results of this first phase of analysis will then be used to determine which parameters can be quantitatively modeled at those locations most likely to be sensitive to hydrologic changes. Phase II water quality modeling will be conducted for the FEIS in coordination with the WQCD and the EPA using WQCD protocols to satisfy 401 certification requirements. Results of Phase II water quality modeling will be presented in the FEIS.

Among the action alternatives, the effects on water quality when compared to current conditions hydrology are similar. However, there are relative differences in water quality impact based on the volume, timing, and location of diversions. Generally, Alternative 2 would have fewer anticipated impacts because overall diversions would be less than Alternatives 3 and 4, and the augmentation releases from Glade Reservoir would have a beneficial effect in some months. The potential for the alternatives to result in increased instances of water quality standards being exceeded is summarized in Table S-6; only medium to high potential are shown. Other constituents would have a low potential for standard exceedance. A medium rating indicates that current water quality is approaching the standard and changes in flow associated with the alternative could result in standard exceedances. Parameters with a high rating are likely to continue exceeding the standard and the alternative could contribute to a greater magnitude and/or frequency of standard exceedance. The 404(b)(1) Guidelines at 40 CFR 230.10(b) specify that no discharge of dredged or fill material may be permitted if it will cause or contribute to violations of any applicable State water quality standard. Therefore, in order for the proposed Project to be permitted, the District must propose measures to avoid causes or contributions specifically attributable to the Project that would result in standard violations. The disclosure of potential effects to water quality is based on the evaluation of effects without consideration of the avoidance measures proposed by the District (Appendix F).

Table S-6. Potential for exceedance of water quality standards.

Parameter	Alternative 2	Alternative 3	Alternative 4
Poudre River above Lincoln Street in Fort Collins (Segment 10)			
Copper	Medium	Medium	Medium
Dissolved Manganese	Medium	Medium	Medium
Poudre River from Lincoln Street to below Boxelder Creek (Segment 11)			
Total Phosphorus	Medium	Medium	Medium
Selenium	High*	High	High
Poudre River from below Boxelder Creek the South Platte River (Segment 12)			
Total Recoverable Iron	High*	High*	High*
Ammonia	High*	High*	High*
Total Phosphorus	High*	High*	High*
Selenium	High*	High*	High*
Segment 1b of the South Platte River			
Total Recoverable Iron	High*	High*	High*
Dissolved Manganese	Medium	Medium	Medium
Ammonia	Medium	Medium	Medium
Total Phosphorus	High*	High*	High*
Sulfate	High*	High*	High*

*Water Quality Standard already being exceeded under current conditions.

The only parameters with "high" potential for exceeding water quality standards under any of the alternatives are those parameters that are already exceeding standards in Segment 11 of the Poudre River (from Shields Street in Fort Collins to a point immediately above the confluence with Boxelder Creek), Segment 12 of the Poudre River (from a point immediately above the confluence with Boxelder Creek to the confluence with the South Platte River), and Segment 1b of the South Platte River (from the Poudre River confluence to the Kersey Gage and downstream about 24 miles to the Weld/Morgan County line).

All action alternatives would have the potential to cause further exceedances of temperature standards in some locations and some years. Due to increased diversions at the Poudre Valley Canal, adverse effects on stream temperature are possible in sensitive reaches of Segment 10 (from the Monroe Canal/North Poudre Supply Canal diversion to Shields Street in Fort Collins) and Segment 11, potentially including key months of July and August. Generally, the anticipated adverse effects on stream temperature for Alternative 2 are expected to be less than those for Alternative 3 and greater than those for Alternative 4. The streamflow augmentation program included in Alternative 2 would increase flow rates in parts of Segments 10 and 11 (from 0.37 miles upstream of the Larimer County Canal to the Timnath Inlet headgate) to values greater than those in current conditions, providing a net temperature benefit in this reach in March and September.

Alternative 2 diversions at the Poudre Valley Canal could exacerbate occasionally observed dissolved oxygen issues in July and August in Segment 11. Augmentation flows under

Alternative 2 would likely provide a dissolved oxygen benefit during times of low flow from November through April and in September. Planned aeration of releases from Glade Reservoir under Alternative 2 should also help maintain dissolved oxygen concentrations within standards. Effects of Alternative 3 on dissolved oxygen would generally be similar to, but greater than those identified for Alternative 2, due to greater flow diversions at the Poudre Valley Canal and the lack of streamflow augmentation. Any adverse effects would be primarily in Segment 11. Adverse effects from Alternative 4 on dissolved oxygen in Segment 11 would generally be less than those identified for Alternative 2 and Alternative 3 because less water would be diverted at the Poudre Valley Canal.

Glade Reservoir would be constructed only in Alternative 2 and is anticipated to have water quality similar to Horsetooth Reservoir, although total organic carbon concentrations may be greater. Periods of low dissolved oxygen near the bottom are likely in the summer. Metal concentrations are likely to be within standards. Fish consumption advisories are likely because of mercury in fish tissues. In Alternative 2, with the Reclamation Action Option, minor effects on Horsetooth Reservoir water quality are anticipated, with no exceedances of water quality standards expected.

Galeton Reservoir would be constructed in all action alternatives. Nutrient and chlorophyll *a* concentrations are likely to exceed interim value standards. Specific conductance, pH, and selenium concentrations are likely to be high. Low dissolved oxygen concentrations near the bottom are expected in the summer. Water quality in Galeton Reservoir would be somewhat similar to the water quality found in Riverside and Jackson Reservoirs.

Cactus Hill Reservoir would be constructed in the No Action Alternative (120,000 AF) and Alternatives 3 and 4 (190,000 AF). Water quality in Cactus Hill would be lower than Glade Reservoir, but better than Galeton Reservoir. Water quality would be slightly lower under Alternative 4 because a portion of the water would come from the diversion on the Poudre River at the New Cache Canal headgate, which has lower water quality than diversions at the upstream Poudre Valley Canal.

S.7.3 Stream Morphology and Sediment Transport

The effects of the action alternatives on channel morphology and sediment transport are predicted to be similar and may result in minor detectable changes in the Poudre River mainstem reaches upstream of I-25; downstream of I-25 predicted effects may result in moderate detectable changes due to the accumulation of sediments (Table S-7). The existing trajectory of channel morphology and sediment transport is predicted to continue. All action alternatives would reduce flows in the mainstem of the Poudre River and are predicted to contribute to the existing trend of channel contraction, loss of channel complexity, and increased flooding downstream of I-25. The differences in the alternatives would result in some minor differences among the alternatives in predicted effects on channel morphology and sediment transport (Table S-7). The No Action Alternative is addressed in Section S.8.2. All of the action alternatives would reduce the duration of flows above 1,000 cfs, reduce the 2% high flow, flushing of fines, and duration of bed material movements (Table S-7) which would affect channel morphology. In general,

Alternative 3 would have the greatest predicted reductions. Reductions in these parameters would be similar for Alternatives 2 and 4 depending upon the river reach, with Alternative 4 having less effect in the Fort Collins reach. For all of the action alternatives, channel contraction is predicted to occur downstream of I-25 as an extension of the processes already underway by deposition on bars, islands, riffles, and channel margins. It is likely that the acceleration of channel contraction would lead to an increased frequency of flooding downstream of 1-25.

Table S-7. Comparison of action alternatives effects on channel morphology and sediment transport for the Poudre River mainstem under Current Conditions Effects.

Potential Effect	Current Conditions	Current Conditions Effects		
		Alternative 2	Alternative 3	Alternative 4
Duration of Flows at or above 1,000 cfs (% reduction)	—	30-35	30-40	20-25
2% High Flow (% reduction)	—	10-30	15-37	12-30
Flushing of Fines				
Laporte Reach				
No. of events	15	10	11	11
Duration (total days)	132	94	82	88
Fort Collins Reach				
No. of events	23	16	18	20
Duration (total days)	325	222	205	231
Timnath, Windsor, Greeley Upstream, Greeley Channelized, and Greeley Reaches				
No. of events	18	19	16	17
Duration (total days)	292	218	197	217
Duration of Bed Material Movement (% reduction)	—	21; up to 40 in some locations	26; up to 40 in some locations	24; up to 40 in some locations

S.7.4 Ground Water

S.7.4.1 Reservoir Sites

S.7.4.1.1 Glade Reservoir

Ground water level data collected during 2008 and 2009 indicated that water levels vary by as much as 10 feet between seasons. Water levels reach their lowest level by late spring and then begin rising through the summer, remaining high through much of the winter. Although there are large variations within ground water levels in the area throughout the year, the residual trichloroethene mass near the source area appears to no longer affect downgradient areas, which is where the Glade forebay would be located. The 2008/2009 sampling results indicate that the trichloroethene plume has retracted and currently no detectable trichloroethene is within the footprint of the proposed Glade Reservoir forebay. As the contaminant mass continues to naturally attenuate, the plume will continue to decrease in size.

S.7.4.1.2 Galeton Reservoir

Oil and gas well sites within the reservoir site have had reported spill incidents. The incidents are closed and no additional remedial activities are required. If the Galeton Reservoir site were permitted by the Corps, a detailed analysis of oil and gas facilities would be conducted prior to construction. No other known hazardous sites were identified within or adjacent to the proposed Galeton Reservoir study area. No selenium or salinity impacts are predicted to occur to the ground water underlying Galeton Reservoir and no impacts are predicted to occur to the South Platte River from ground water at the Galeton Reservoir site.

S.7.4.2 Poudre River

Changes in Poudre River flow and stage in all alternatives would affect alluvial ground water levels adjacent to the river. The difference between the alternatives in ground water level reductions associated with predicted maximum river stage reductions would be small. For the four river segments that were analyzed (A, B, C, and F shown in Figure S-1), the predicted reductions in maximum river stage would range from about 1.8 feet to 3.0 feet. The effect of reductions in maximum river stage on ground water levels would be greatest adjacent to the river and decrease with increasing distance from the river. The predicted declines in ground water levels are for a maximum-case situation that may occur typically once in 26 years, as predicted by the CTP hydrologic modeling. More frequently, the predicted reductions in river stage range from 0 to 1 foot, and less frequently, reductions range between 1 and 2 feet, depending on location and alternative. With predicted stage reductions of 1 to 2 feet, ground water level reductions in the alluvium in the vicinity of the river would be less than what is predicted for the maximum-case situation and would not likely be discernible by alluvial well owners, given the range of natural variability in water levels.

S.7.5 Soils

The permanent effects on Prime Farmland would be greatest for the No Action Alternative because irrigation would be removed from 64,200 acres of irrigated land. While the total acreage cannot be determined because the exact location of the dry up is not known, it is likely that more than 9,447 acres of Prime Farmland (or 1% of the total acres of Prime Farmland in Larimer and Weld Counties) would be lost, which would be considered a moderate impact. The loss could be substantially higher. The level of permanent impacts to Prime Farmlands for all action alternatives would be minor, considering the impacts would be less than 1% of all Prime Farmland in Larimer and Weld Counties. Alternatives 3 and 4 would have greater permanent effects on Prime Farmland than Alternative 2 because of the higher number of acres impacted by the Cactus Hill Reservoir compared to Glade Reservoir. The permanent effects on Prime Farmland for conveyance systems would be slightly more for the No Action Alternative. There would be no permanent effects on Prime Farmland due to flow changes in the Poudre and South Platte Rivers in all alternatives.

S.7.6 Wetlands, Riparian Resources and Other Waters

The No Action Alternative would have substantially more estimated permanent wetland effects (251 acres) than the other alternatives because an estimated 219 acres of wetlands would be permanently dewatered due to the transfer of agricultural water rights from 64,200 acres of irrigated lands to provide water to the NISP Participants. Alternative 2 is predicted to have the least amount of permanent wetland effects (44 acres of permanently filled wetlands within the study areas). Alternatives 3 and 4 are estimated to have 81 acres of permanent wetland effects (34 acres of permanently filled wetlands within the study areas and 47 acres of wetlands downslope of the Poudre Valley Canal permanently affected by a loss of hydrologic support). Changes in ground water levels along the Poudre River in Alternatives 2 and 3 also may adversely affect 9 acres of wetlands along the river. Alternative 2 also would have the least amount of permanent effects on other waters (12 acres). Alternatives 3 and 4 would permanently fill 92 acres of other waters, mostly as a result of lining the Poudre Valley Canal (Table S-8). The disclosure of potential effects to wetlands, riparian resources and other waters is based on the evaluation of effects without consideration of the mitigation measures proposed by the District (Appendix F).

The plains cottonwood woodlands along the Poudre River are on a trajectory of decline. Nonnative woody vegetation (e.g., green ash, Russian olive, and Siberian elm) are predicted to increase as a result of the current trajectory. In some years, a decrease in river stage of 0.5 to 1.0 foot during the growing season is predicted in all action alternatives. Declines in river stage would be greater and more frequent in Alternative 3 than the other alternatives. In Alternatives 2 and 3, an estimated 9 acres of herbaceous wetlands are potentially sensitive to declines in the ground water table within 100 feet of the riverbanks (Table S-8). The effect is predicted to occur in Segment B in Alternative 2 and in Segments C and D in Alternative 3; river segments are shown on Figure S-1). In all alternatives, reed canarygrass is predicted to continue to colonize areas of the formerly active channel downstream of I-25. All alternatives are predicted to further reduce inundation of wetlands and riparian areas immediately adjacent to the Poudre River. Changes in flows associated with all alternatives are predicted to accelerate and/or reinforce the well-established trajectory.

Table S-8. Summary of unmitigated direct and indirect effects on wetlands and other waters.

Variable	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Permanently filled wetlands (acres)	32	44	34	34
Wetlands with permanently altered hydrologic support (acres)	219	0	47	47
Permanently filled other waters (acres)	6	12	92	92
Wetlands potentially sensitive to changes in wetland species due to permanent seasonal declines in ground water levels along Poudre River (acres)	Not analyzed under Current Conditions	9	9	0
Total	**257**	**65**	**182**	**173**

Note: The disclosure of potential effects to wetlands and other waters is based on the evaluation of effects without consideration of the mitigation measures proposed by the District (Appendix F).

S.7.7 Wildlife

The differentiating effects to wildlife are primarily associated with the size and location of proposed reservoirs. Table S-9 compares the estimated effects on winter ranges, winter concentration areas and severe winter ranges for deer, pronghorn and elk. These habitat components are typically the most critical or limiting for these species. The disclosure of potential effects on wildlife habitat is based on the evaluation of effects without consideration of the mitigation measures proposed by the District (Appendix F).

Table S-9. Estimated permanent effects on wildlife habitat.

Wildlife Species	Alternative 1	Alternative 2 Proposed Action		Alternative 3	Alternative 4
		Reclamation Action Option	No Reclamation Action Option		
Mule Deer					
Winter Range (acres)	2,602	3,789	3,789	5,687	5,688
Severe Winter Range (acres)	0	228	128	45	45
Winter Concentration Areas (acres)	1,635	70	70	2,332	2,332
White-Tailed Deer					
Winter Range (acres)	2,602	416	416	3,929	3,929
Pronghorn					
Winter Range (acres)	220	2,256	2,256	2,317	2,317
Severe Winter Range (acres)	0	2,254	2,254	1,927	1,927
Elk					
Overall Range (acres)	0	2,043	2,043	46	46
Winter Range (acres)	0	186	196	10	10
Severe Winter Range (acres)	0	2	2	0	0
Winter concentration area (acres)	0	124	124	0	0

Generally the No Action Alternative would have the least effect on habitat for these species because it would have the least area affected by reservoir construction with a single 120,000 AF Cactus Hill Reservoir. Alternatives 3 and 4 would have the greatest effect on deer habitats, except for mule deer severe winter range, which would be most affected by Alternative 2. Alternative 2 would have substantially greater effects on elk habitat compared to the other alternatives because the Glade Reservoir site is partially located within areas of elk habitat.

S.7.8 Special Status Species

Alternative 2 is predicted to result in a loss of 53 acres of Preble's meadow jumping mouse (Preble's) habitat associated with the construction of Glade Reservoir. Preble's is federally listed as a threatened species. None of the other alternatives are predicted to cause a permanent loss of Preble's habitat, although they may cause minor temporary effects.

In Alternative 2, a portion of U.S. 287 would need to be relocated to accommodate Glade Reservoir. The relocation of U.S. 287 is predicted to cause 29 acres of loss and 45 acres of

temporary disturbance to Bell's twinpod habitat. Bell's twinpod is a plant listed by the Colorado Natural Heritage Program as imperiled due to its rarity. The No Action Alternative would have no effects and Alternatives 3 and 4 are predicted to cause 1 acre of Bell's twinpod habitat loss due to the lining of the Poudre Valley Canal.

S.7.9 Aquatic Biological Resources

Relative to the other alternatives, Alternative 3 would divert the most water from the Poudre River in Segment B (Fort Collins reach) and is predicted to have a moderate adverse effect on adult trout. The other alternatives are predicted to have negligible to minor adverse effects on Poudre River fish. In Segment B, Alternative 2 would have a moderate beneficial effect on aquatic biological resources due to augmented flows in winter, early spring, and in September. All other alternatives are predicted to have minor adverse effects on changes in species composition of macroinvertebrates in the Poudre River.

S.7.10 Recreation

Reduction in Poudre River flow is predicted to adversely affect boating on Segment B of the Poudre River through Fort Collins in all alternatives. Under Current Condition Effects, Alternatives 2 and 3 are predicted to reduce the average number of boating days (based on a target flow of greater than 150 cfs) from 54 days to 35 and 36 days respectively during May through August. Alternative 4, which would allow more flow to pass through the Fort Collins reach before being diverted at the New Cache Canal, is predicted to reduce the average number of boating days from 54 days to 50 days during May through August.

Alternative 3 is predicted to have a moderate adverse effect on adult trout in Segment B of the Poudre River through Fort Collins, which in turn would have a moderate to major adverse effect on anglers fishing for trout through Fort Collins. The other alternatives are predicted to have no to minor effects on fishing in the Poudre River. In Alternative 2, Glade Reservoir would be managed for public recreation, to include a managed fishery, and would provide a major benefit to the region as a public recreational resource, with fishing, boating, camping, hiking, horseback riding, and biking potential recreation opportunities provided.

S.7.11 Cultural, Historical and Paleontological Resources

The No Action Alternative is predicted to have no direct effects on cultural, historical, and paleontological resources. As described below, Alternative 2 would have the greatest adverse effect on cultural resources. Effects to cultural and historic resources resulting from Alternative 2 would potentially be greater under the No Reclamation Action Option than the Reclamation Action Option due to an increase in pipeline construction with the No Reclamation Action Option. The effects on cultural resources from Alternatives 3 and 4 would be similar under both alternatives.

In Alternative 2, 2 known and an estimated 35 National Register of Historic Places eligible sites would be affected by the construction of Glade Reservoir or by inundation. The realignment of U.S. 287 in Alternative 2 would affect seven known and seven unrecorded cultural resource sites. Of the known sites, one is eligible for listing on the National Register of Historic Places, three are not eligible, and three have been not assessed. No cultural resources have been identified at the proposed Cactus Hill Reservoir site (Alternatives 1, 3, and 4). Fifteen known cultural resources are associated with the proposed Galton Reservoir, a component of Alternatives 2, 3, and 4. Of these 15 sites, 13 have not had an official determination and may be eligible for listing in the National Register of Historic Places. The other two are not eligible.

There are no predicted effects to paleontological resources for Alternatives 1, 3, and 4. The realignment of U.S. 287 under Alternative 2 would affect known fossil-bearing geologic units primarily associated with the road cut through the hog back. Additionally, the construction of Glade Dam may also affect fossil-bearing geologic units.

S.7.12 Socioeconomic Resources

The No Action Alternative would have moderate to major effects on water rates and affordability for most Participants. The other alternatives would have minor to moderate effects on water rates and affordability for most Participants. Alternative 2 and Alternative 3 would have major effects on the nonuse values associated with the Poudre River for Fort Collins residents.

Construction of reservoirs associated with all of the alternatives would adversely affect residences. The two residences adversely affected by the construction of Glade Reservoir under Alternative 2 are owned by the District. In the No Action Alternative, the smaller Cactus Hill Reservoir would inundate two residences and six residences would be within 500 feet of the reservoir. In Alternatives 3 and 4, Cactus Hill Reservoir would inundate six residences and ten residences would be within 500 feet of the reservoir. There would be a moderate to major adverse effect under Alternative 2 to a gas station and campground at Ted's Place associated with the realignment of U.S. 287.

Alternative 2 would provide a major regional recreation benefit due to the development of Glade Reservoir. Glade Reservoir levels should support a viable recreation facility with respect to seasonal water levels, but Glade's recreation value may diminish toward the end of prolonged dry periods. Annual visitation of 338,600 visitor days is estimated based on a projected average Glade Reservoir surface area during the recreation season of 1,240 acres. It would likely take a number of years to reach this estimated visitation due to the time needed to develop the facilities. The annual value of recreation at Glade Reservoir, at full development, would be an estimated $13.2 million.

Reductions in flows in Segment B of the Poudre River associated with Alternatives 2 and 3 are predicted to result in average flows in May and June below 100 to 150 cfs, which is the approximate flow range needed to sustain recreational boating in this segment. Boating visitation is projected to be reduced by two-thirds, resulting in a projected annual decrease in recreation value of $241,000.

The No Action Alternative would transfer agricultural water rights from 64,200 acres of irrigated lands to provide a water supply to the Participants. Because dryland farming or revegetation are less economically productive, less labor and input intensive, and produce less revenue than irrigated farming, such changes in land use would have an impact on the region's economy. The annual total effect on economic output in the study area is estimated at $87 million, with a projected loss of 738 agriculture-related jobs. With appropriate changes in land management these lands could still be used for agricultural production (e.g., dry land crops and grazing) which could reduce some of these estimated economic and fiscal effects, but agricultural production would be substantially reduced without irrigation. The other alternatives are predicted to have minor effects on agriculture, including exchanges to canals that could increase the salinity of irrigation water and have a minor effect on the production of crops most sensitive to increased salinity.

S.7.13 Hazardous Materials

Alternatives 1, 3, and 4 are not predicted to affect known hazardous sites. For Alternative 2, the proposed Glade Reservoir forebay is located near a known trichloroethene plume. Currently no detectable trichloroethene occurs within the footprint of the proposed forebay and the trichloroethene plume is contracting. Soil containing trichloroethene is not expected within the footprint of the proposed forebay.

S.7.14 Energy Use and Greenhouse Gases

All of the alternatives would involve pumping to convey water. The pumping would require electrical energy and would generate greenhouse gases such as carbon dioxide. The No Action Alternative would have the least predicted annual carbon dioxide emissions and Alternative 4 would have the greatest predicted annual carbon dioxide emissions (Table S-10).

Table S-10. Estimated annual electrical energy use and carbon dioxide emissions during operations.

Variable	Alternative 1	Alternative 2		Alternative 3	Alternative 4
		Reclamation Action Option	No Reclamation Action Option		
Kilowatt Hours Used	34,828,300	48,135,987	61,302,050	59,074,504	64,445,426
Carbon Dioxide Emissions (Tons)	27,087	37,259	47,677	45,944	50,122

S.8 CUMULATIVE EFFECTS (EIS CHAPTER 5)

A cumulative effect is defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and RFFAs regardless of what agency (federal or nonfederal) or person undertakes such other actions" (40 CFR 1508.7). Past actions have resulted in cumulative effects, which continue to influence the present

environmental conditions, which in turn are predicted to be affected by the NISP alternatives and RFFAs. Section 5.1 of this SDEIS discusses past and ongoing actions and the flow-related and land-based RFFAs considered in assessing cumulative effects, including the flow-based RFFAs included in the CTP modeling for cumulative effects. This summary focuses on the cumulative effects that can be used to differentiate the alternatives. All of the cumulative effects for the alternatives are presented in Chapter 5.

Each resource section in Chapter 5 includes a discussion of how climate change may affect the respective resource. In addition to the analysis of predicted changes to the hydrology of the Poudre River with climate change, other future factors associated with climate change (e.g., increases in temperature, increases in the number and duration of droughts and increases in evaporation and transpiration) are identified that could affect each resource.

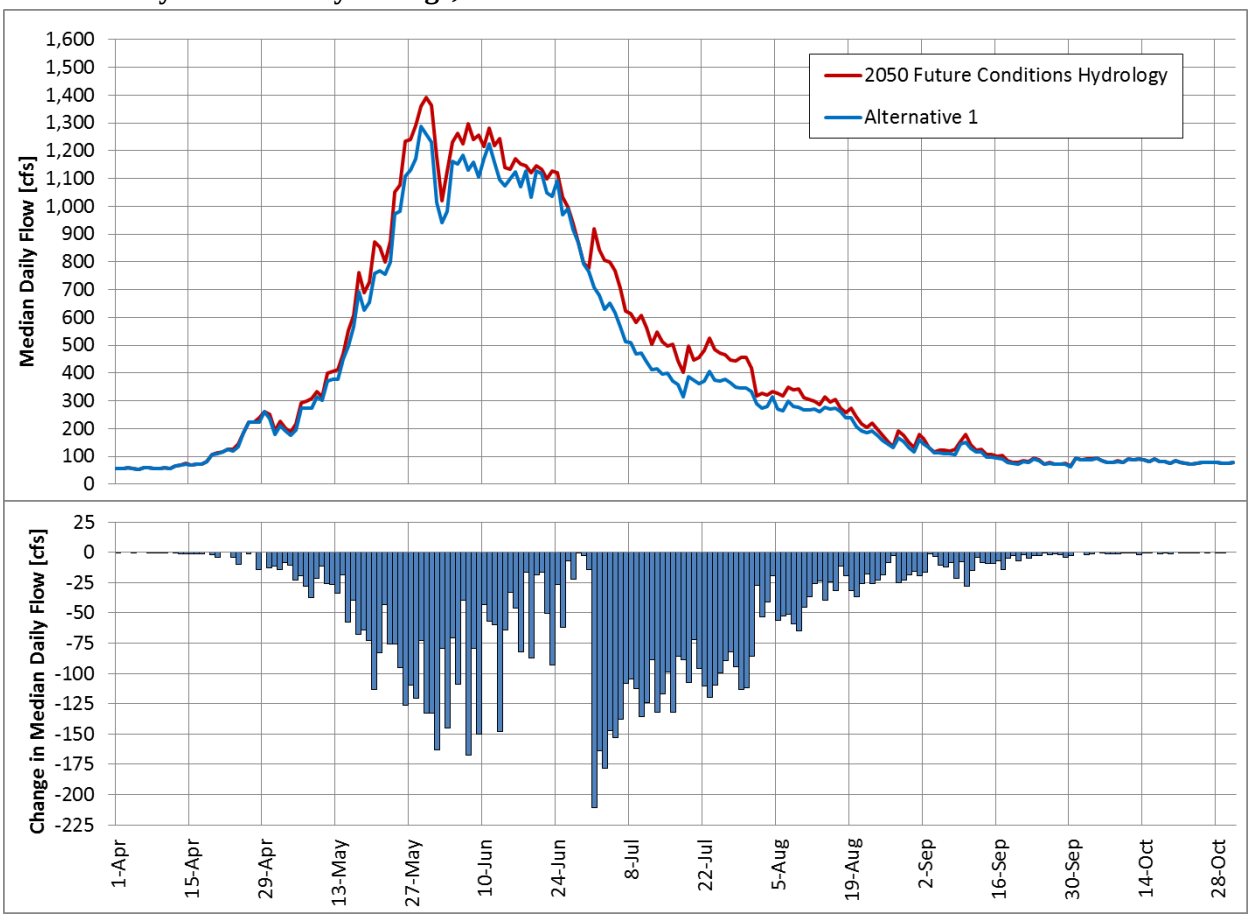
S.8.1 Surface Water

The RFFAs, along with 2050 municipal and agricultural water demands, define the Future Conditions hydrology (CTP Run 2). The Future Conditions hydrology with each of the action alternatives (NISP Run 4 series) is used for comparison to determine cumulative effects for the alternatives (NISP Run 5 series). The Run 5 series of the CTP hydrologic modeling was used to predict the cumulative effects of NISP and the HSWSPs on flows when combined with RFFAs.

The No Action Alternative would require the least diversions from the Poudre River upstream of the New Cache Canal headgate (Table S-11). Nearly all effects to Poudre River flows associated with the No Action Alternative would occur in the nearly 23-mile reach of the Poudre River mainstem between the Poudre Valley Canal headgate and the New Cache Canal headgate between May and September. The greatest effect of the No Action Alternative would be in July, when the diversions would be the greatest and Poudre River flow is less than in May and June (Figure S-8).

The differences in average annual diversions of Alternatives 2, 3, and 4 between Current Conditions Effects and Future Conditions Effects or Cumulative Effects would be small (Table S-11). Average annual diversions from the Poudre River decrease in the future scenarios in all alternatives except the No Reclamation Action Option of Alternative 2. Under Future Conditions scenarios, the junior Grey Mountain right would be in priority somewhat less than with Current Conditions. As a result, the full NISP demand would be met by a rebalancing of sources, drawing more on the SPWCP exchanges from the Larimer-Weld and New Cache irrigation systems. This, in turn, would result in small increases in diversions from the South Platte River.

Figure S-8. Alternative 1 (No Action Alternative) Median Daily Flow and Modeled Change in Median Daily Flow at Canyon Gage, IY 1980-2005.



Reasonably foreseeable future actions, primarily HSWSP, would generally increase Poudre River diversions. At the Canyon Gage, the incremental cumulative effect would be 0 to 100 cfs greater than compared to Future Conditions Effects during May and July and 0 to 25 cfs less compared to Future Conditions Effects during April and September. The incremental cumulative effect varies from beneficial to adverse during June and August. The difference in the incremental cumulative effect between the alternatives is negligible (Figure S-9 and Figure S-10). The incremental cumulative effect at the Lincoln Street Gage would have a similar pattern as that of the Canyon Gage, but the magnitude of the incremental effect would be less. At the Greeley Gage, the incremental cumulative effect would generally be beneficial, with flow increases of 0 to 25 cfs compared to Future Conditions Effects. The incremental cumulative effect at the Kersey Gage would be similar to the Canyon Gage.

Table S-11. Average annual diversion amounts by alternative.

CTP Flow Condition River Location Canal	Alternative 1 (AFY)	Alternative 2 Reclamation Action Option (AFY)	Alternative 2 No Reclamation Action Option (AFY)	Alternative 3 (AFY)	Alternative 4 (AFY)
Current Conditions Effects					
Poudre River (see footnote)		**35,100**†	**43,300**	**49,200**	**48,800**
Location					
Poudre Valley Canal	**Not evaluated**	35,100†	43,300	49,200	37,800
Larimer-Weld Canal		0	0	0	0
New Cache Canal		0	0	0	11,000
South Platte River		**28,400**	**28,400**	**30,000**	**32,000**
Big Thompson River		**0**	**0**	**0**	**0**
Future Conditions Effects					
Poudre River	**35,900**	**34,400**	**43,300**	**48,900**	**48,000**
Location					
Poudre Valley Canal	17,900	34,400	43,300	48,900	35,700
Larimer-Weld Canal	5,000	0	0	0	0
New Cache Canal	13,000	0	0	0	12,300
South Platte River	**0**	**29,800**	**29,800**	**30,600**	**32,200**
Big Thompson River	**4,000**	**0**	**0**	**0**	**0**
Cumulative Effects					
Poudre River		**34,000**	**43,600**	**48,900**	**47,800**
Location					
Poudre Valley Canal	**Not evaluated**	34,000	43,600	48,900	35,200
Larimer-Weld Canal		0	0	0	0
New Cache Canal		0	0	0	12,600
South Platte River		**30,500**	**30,500**	**31,700**	**32,500**
Big Thompson River		**0**	**0**	**0**	**0**

†Flows in the 1.48-mile river reach between the Poudre Valley Canal and the Hansen Supply Canal would be greater (average of 8,200 AFY) than the No Reclamation Action Option due to exchanges with C-BT and the associated bypass of divertible flows by NISP. The combination of bypassed diversions, releases from Glade Reservoir, and reduced releases from the Hansen Supply Canal would be such that the streamflow effects of the Reclamation Action Option below the Hansen Supply Canal would be nearly identical to the No Reclamation Action Option, i.e., the net effect of both Alternative 2 options downstream of the Hansen Supply Canal would be a streamflow reduction of 43,300 AFY.

Figure S-9. Cumulative Effects Median Daily Flow at Canyon Gage, IY 1980-2005.

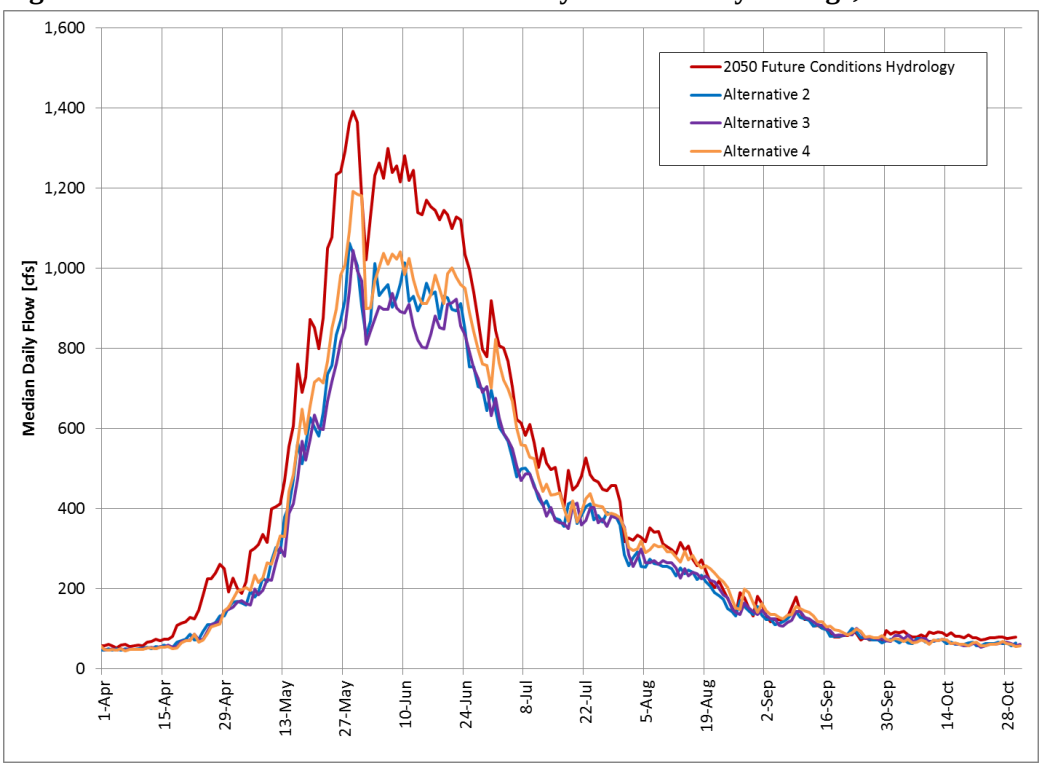
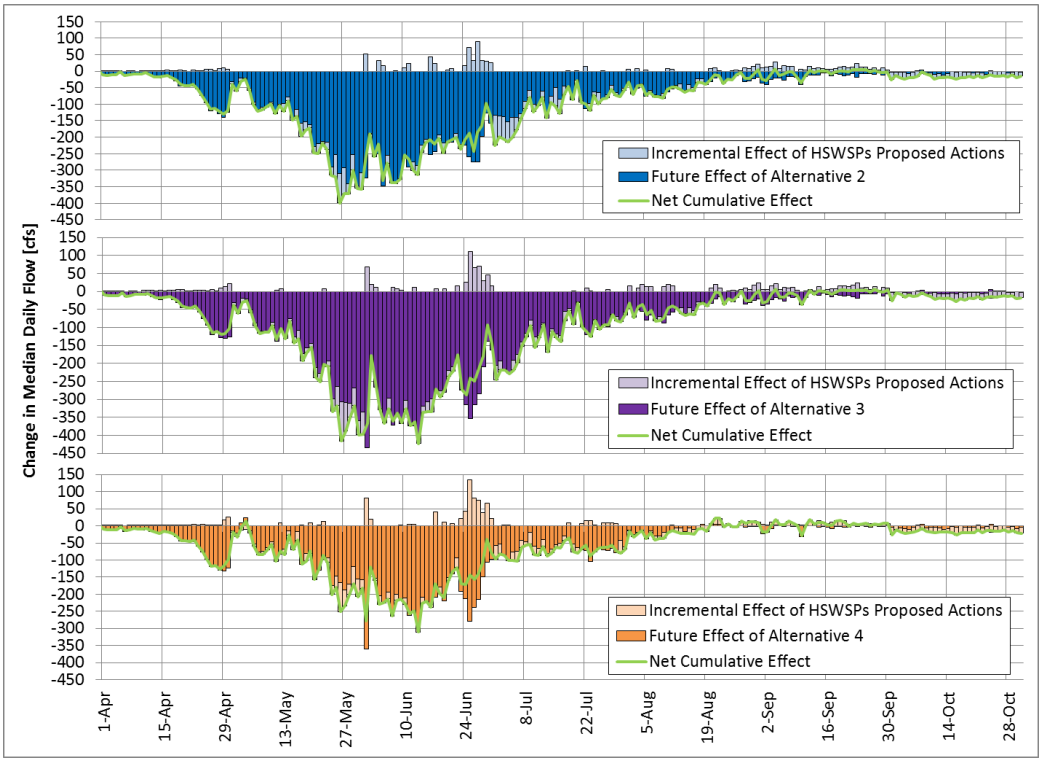


Figure S-10. Future Conditions and Cumulative Effects Change in Median Daily Flows at Canyon Gage, IY 1980-2005.



S.8.2 Surface Water Quality

The difference between the diversions under Future Conditions and Cumulative Effects in all alternatives is small. The cumulative reduction in flows from May to August at the Canyon Gage would increase with the addition of the reasonably foreseeable actions. Metal and nutrient concentrations and the potential for standard exceedances in the Poudre and South Platte Rivers would be similar as to those predicted to occur under Current Conditions Effects under all the alternatives (Table S-6). Total phosphorus would have a medium potential for exceedance of standards in the Poudre River. Selenium, which currently exceeds standards in Segments 11 and 12 of the Poudre River, would continue to have a high potential for standard exceedance. In Segment 1b of the South Platte River, the potential for continued exceedance of the total recoverable iron, total phosphorus, and total sulfate standards would be high. The potential for exceedance of the dissolved manganese and ammonia standard would be medium on the South Platte River.

The frequency and magnitude of temperature excursions upstream of the Hansen Supply Canal on the Poudre River in July and August is likely to increase with further decreases in flow. In Alternative 2, during September and the winter months flows in the lower Segment 10 reach would increase slightly from augmentation releases from Glade Reservoir. These releases would have a beneficial effect on water quality parameters compared to Current Conditions hydrology. Lower flows under all the alternatives could increase temperature standard exceedances upstream of Boxelder Creek in Segment 12 of the Poudre River, particularly in July and August. With Cumulative Effects hydrology, some increase in Poudre River temperature in Segment 12 is possible depending on changes in ground water inflow and WWTP discharges. The potential for exceedance of temperature standards in the South Platte River would be low under all the alternatives.

The 404(b)(1) Guidelines at 40 CFR 230.10(b) specify that no discharge of dredged or fill material may be permitted if it will cause or contribute to violations of any applicable State water quality standard. Therefore, in order for the proposed Project to be permitted, the District must propose measures to avoid causes or contributions specifically attributable to the Project that would result in standard violations. The disclosure of potential effects to water quality is based on the evaluation of effects without consideration of the avoidance measures proposed by the District (Appendix F).

Alternatives 1, 3, and 4 would have no effect on Horsetooth Reservoir water quality under Cumulative Effects hydrology. Alternative 2 would have negligible effects on Horsetooth Reservoir under the Reclamation Action Option and no effect with the No Reclamation Action Option.

S.8.3 Stream Morphology and Sediment Transport

The trajectory of channel morphology and sediment transport is predicted to amplify under Future Conditions Effects and Cumulative Effects as the result of ongoing channel contraction, fining of surficial material, and loss of channel complexity. These predicted changes in river

condition are a fluvial response to historical and contemporary physical and hydrologic changes to the river, floodplain, and watershed. Under Future Conditions Effects and Cumulative Effects, all alternatives would reduce flows in the mainstem of the Poudre River and are predicted to contribute to the existing trend of channel contraction, loss of channel complexity, and increased flooding downstream of I-25. The differences in the alternatives previously described (Table S-7) would result in some minor differences among the alternatives in predicted Cumulative Effects on channel morphology and sediment transport (Table S-12). In general, the No Action Alternative would have the least effect and Alternative 3 would have the greatest predicted effect.

Based on the current trajectory, there is predicted to be a propensity toward channel contraction throughout the system, but this is predicted to mainly occur downstream of I-25 where there would be material of the relevant size fraction available for deposition and vegetation within the formerly active channel is predicted to trap sediment which feeds the cycle of channel contraction that in turn provides additional substrate for the establishment of additional vegetation to trap more sediment. It is likely that the acceleration of channel contraction would lead to an increased frequency of flooding downstream of I-25. The complexity of in-channel morphologic features is currently low in the reaches downstream of I-25 as the result of sand deposition smothering the bed and reducing the magnitude and frequency of pool and riffle sequences. Further channel contraction under Future Conditions Effects and Cumulative Effects is predicted to exacerbate this condition.

The incremental impact of the Cumulative Effects (Run 5 series) on morphology and sediment transport is similar to the impact of Future Conditions Effects (Run 4 series) except that the introduction of the HSWSPs (Run 5 series) consistently increases the impacts beyond the impacts of the Future Conditions Effects by about 10% to 15%.

Implementation of any of the alternatives with Future Conditions Effects and/or Cumulative Effects is not predicted to affect the morphology of the South Platte River downstream of the confluence with the Poudre River. No new studies or analysis were done for the SDEIS for the South Platte River. Section 4.4.1 of the DEIS concluded that channel-forming flows (1.5-year peak flows of 3,858 cfs) would occur or be exceeded about 3% of the time. Under the action alternatives, flows of this magnitude would occur less than 1% of the time.

Table S-12. River morphology and sediment transport cumulative effects in the Poudre River mainstem.

Potential Effect	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Reduction in 2% Probability Discharge (Flood Flows)	0% to 5%	6% to 11%	4% to 11%	3% to 12%
Fining of Surficial Material	Slight decreases in the number of flushing events at a few representative sections.	No decreases in the number of flushing events at about half of the representative sections. At about half of the representative sections, the number of flushing events would decrease by 1% to 50%.	No decreases in the number of flushing events at about two to thirds of the representative sections. At about one to third of the representative sections, the number of flushing events would decrease by 1% to 50%.	No decreases in the number of flushing events at about half of the representative sections. At about half of the representative sections, the number of flushing events would decrease by 2% to 50%.
Movement of Bed Material	Slight to no decreases in the number of events that move bed material.	At about one to third of the representative sections, the number of events that move bed material would decrease by 3% to 35%.	At about one to third of the representative sections, the number of events that move bed material would decrease by 1% to 50%.	At about one to third of the representative sections, the number of events that move bed material would decrease by 12% to 100%.

S.8.4 Ground Water

S.8.4.1 Reservoir Sites

The Future Conditions Effects at the Glade and Galeton reservoir sites would be the same as the Current Conditions Effects. Reasonably foreseeable future actions would not cumulatively affect ground water conditions at the Glade Reservoir or Galeton Reservoir sites.

S.8.4.2 Poudre River

For the four river segments that were analyzed (A, B, C, and F shown in Figure S-1), the predicted reductions in maximum river stage would range from about 0.4 foot to 1.0 foot with Future Conditions Effects in the No Action Alternative. The difference between the predicted maximum ground water level reductions associated with the No Action Alternative and the action alternatives, particularly in the near-bank areas, would likely be observable.

In the action alternatives, the predicted reductions in maximum river stage would range from about 1.4 feet to 3.4 feet for the action alternatives with Future Conditions Effects and 2.0 feet to 3.2 feet with Cumulative Effects. The difference between the action alternatives in ground water level reductions associated with predicted maximum river stage reductions would be small.

S.8.5 Wetlands, Riparian Resources, and Other Waters

The NISP alternatives are predicted to affect river stage, ground water levels, and inundation (Section S.7.6). The current trend leading to shifts in woody riparian species composition along the mainstem is expected to continue and to be affected by the NISP alternatives. The combined effects of the RFFAs, NISP alternatives, and the HSWSPs (cumulative effects) are predicted to further reinforce and/or accelerate the previously described trajectory of wetland and riparian resources along the mainstem.

The degree to which impacts on wetland and riparian resources along the mainstem of the Poudre River increase with Cumulative Effects can be seen in how predicted effects increase from Current Conditions Effects hydrology to Cumulative Effects. This is particularly evident when comparing the predicted effects of stage changes on shallowly rooted near-bank herbaceous wetland vegetation (within 100 feet of the riverbanks). Alternative 3 is predicted to have the greatest effect on river stage. Under Current Conditions Effects hydrology, the greatest predicted indirect effect would be to an estimated 9 acres of vegetation classes that are potentially sensitive to declines in the ground water table within Segment B. Under Future Conditions hydrology, the greatest predicted effect would be to an estimated 60 acres of vegetation classes that are potentially sensitive to declines in the ground water table within Segments B, C, and D (Table S-13). Under Cumulative Effects, the greatest predicted effect would be to an estimated 148 acres of vegetation classes that are potentially sensitive to declines in the ground water table within Segments B, C, D, and E. This progression of predicted effects shows how effects are predicted to become more widespread along the mainstem with Future Conditions Effects and Cumulative Effects.

Generally, the No Action Alternative with Future Conditions Effects would have the least predicted flow-related indirect effect on wetland and riparian resources, and Alternative 3 would have the greatest predicted indirect effect on wetland and riparian resources along the mainstem. Alternative 3 with Cumulative Effects consistently would have the greatest number of weeks and percentage of the period of record with a decline in ground water levels of 0.5 foot or greater. For river Segments A, B, and C, Alternative 4 consistently would have the fewest number of weeks and percentage of the period of record with a decline in ground water levels of 0.5 foot or greater among the action alternatives.

Table S-13. Summary of flow-related indirect cumulative effects on Poudre River wetland and riparian resources.

Variable and Modeled Hydrologic Condition	Alternative 1	Alternative 2 (Both Reclamation Options)	Alternative 3	Alternative 4
Predicted Change in River Stage	Minor predicted changes in river stage	Decrease river stage by 0.5 to 1.0 foot during the growing season	Declines in river stage would be greater and more frequent than the other alternatives	Decrease river stage by 0.5 to 1.0 foot during the growing season
Segments (Figure S-1) with Predicted Weekly Average Stage Declines that Exceed Impact Threshold†				
Future Conditions Effects	None	Segment B	Segment B, C, and D	Segment D
Cumulative Effects	None	Segment B, C, and D	Segment B, C, D and E	Segment B and D
Alluvial Ground Water Levels	Predicted changes in ground water levels would be within or very close to the observed range	Infrequent short-lived declines below the observed maximum ground water depths during the growing season in Segments C, D, E, and F; negligible effects on Segments A and B	Declines similar to and slightly more frequent than under Alternative 2	Similar to Alternatives 2 and 3, except fewer declines in ground water levels are predicted in Segments A and B due to shifting some diversions to downstream of Fort Collins.
Acres of Wetland Vegetation Classes Potentially Sensitive to Changes in Wetland Species Due to Declines in the Ground Water Table				
Current Conditions Effects	0	9	9	0
Future Conditions Effects	0	9	60	21
Cumulative Effects	0	60	148	30

†Impact threshold used in the SDEIS is a decline in river stage of 0.5 foot or greater in herbaceous wetlands within 100 feet of the river for more than 10% of the period of record.

Note: The disclosure of potential effects to wetlands, riparian resources and other waters is based on the evaluation of effects without consideration of the mitigation measures proposed by the District (Appendix F).

S.8.6 Wildlife

In the No Action Alternative, the combined effects of human population growth, commercial and residential development, transportation improvements and water storage and delivery, including the loss or degradation of 2,280 acres of grassland habitat due to the construction of a 120,000 AF Cactus Hill Reservoir would result in the loss or degradation of habitat, mortality from ground-disturbing activities and increased traffic, and creation or expansion of movement barriers. The No Action Alternative would not affect elk habitat and no cumulative effect would occur on elk.

Construction and/or expansion of Chimney Hollow, Halligan and Seaman Reservoirs (RFFAs) would all occur within elk and mule deer winter range and winter concentration areas. Because

different populations of big game occur in the plains grasslands (Cactus Hill and Galeton Reservoirs) compared to the Foothills grasslands (Chimney Hollow and Seaman Reservoirs), the No Action Alternative and RFFAs would not affect the same populations. On a regional scale, cumulative effects would be negligible for big game species because less than 1% of habitat available within each Game Management Unit established by CPW would be affected and the No Action Alternative and RFFAs would not likely have a noticeable effect on big game populations or sex ratios at a regional scale. On a local scale, cumulative effects would be major for mule deer because effects on winter concentration areas would be greater than 20% and moderate for pronghorn and white-tailed deer because the moderate direct effect at Cactus Hill and the loss of habitat associated with the RFFAs would not result in the loss of more than 20% of the local habitat.

The No Action Alternative would contribute to cumulative losses of migratory bird, reptile and amphibian and other wildlife habitat. Some of these cumulative effects would be offset by the construction and expansion of the Cactus Hill Reservoir that would provide new open water habitat for waterfowl as well as foraging habitat for fish-eating birds such as osprey. Drying of irrigated lands would likely contribute to cumulative losses of wetland, irrigated meadow and grassland habitats. Dry up could include reestablishing native vegetation in some areas that would provide habitat for grassland-associated wildlife.

Cumulative effect of the action alternatives would be similar. On a regional scale, cumulative effects in all action alternatives would be negligible for big game species because these projects would not likely have a noticeable effect on big game populations or sex ratios at a regional scale. In Alternative 2, cumulative effects on a local scale would be minor for white-tailed deer and major for mule deer, pronghorn, and elk, particularly to local and resident herds in the Seaman to Glade/realigned U.S. 287 area because greater than 20% of the local habitat would be lost and more fragmented. In Alternatives 3 and 4, cumulative effects on a local scale would be major for mule deer, white-tailed deer, and pronghorn because the alternatives would cumulatively result in the loss of greater than 20% winter range, winter concentration area, and severe winter range.

S.8.7 Aquatic Biological Resources

For almost all of the individual metrics of fish habitat availability (weighted usable area), values gradually increased from Current Conditions through Future Conditions to Future Conditions Effects. The incremental change between Future Conditions Effects and Cumulative Effects is mostly negligible in all alternatives. The effects summary focuses on Segment A, B and C of the mainstem (shown on Figure S-1) because the predicted effects in these segments distinguish the alternatives, and the two recreationally important fish species, brown and rainbow trout, occur in these segments.

The No Action Alternative would have negligible to minor impacts to aquatic resource components in the mainstem. In the South Platte River, the changes in flow would be relatively small and there would be negligible impacts. The No Action Alternative would have little effect on the adult life stage of brown and rainbow trout in Segments A and B, but in Segment C, the

lower runoff flows would reduce average habitat for these species in the spring and early summer and would have a minor adverse impact on trout in Segment C. There would be a gradual loss of average habitat availability for brown and rainbow trout with the reductions in spring runoff flows from Current Conditions through Future Conditions Effects, which results in decreases in average weighted usable area of 11% to 19%. These two species do not maintain resident, reproducing populations in Segment C, but seasonally use the habitat in the segment when temperatures are suitable. The increased temperatures with the No Action Alternative could further limit the time when temperatures are suitable for trout. The lowered spring flows would reduce habitat availability and the seasonal use by these recreationally important species in Segment C.

Alternative 2 with Cumulative Effects would have minor adverse cumulative impacts to most aquatic resource components in the mainstem. In the South Platte River, the changes in flow would be relatively small and there would be a negligible cumulative impact. In Segment B of the mainstem there would be a moderate beneficial cumulative impact with augmented low flows. In Segment B, the effect of Alternative 2 would be an overall moderate beneficial cumulative impact. The augmented winter flows would more than double minimum flows in most years. The occurrence of extreme low flows would be approximately 9% less and the frequency of extreme flow fluctuations would be reduced by nearly half. Habitat availability for almost all species of fish would benefit from the augmented flows during the winter, early spring, and other low flow times of the year in sections upstream of the Timnath Reservoir Inlet. Minimum weighted usable area values would increase substantially for every species and most average weighted usable area values would increase as well. Some species, such as longnose dace and rainbow trout juveniles and fry, would also benefit from the reduced spring flows. Abundance of fish likely would increase and some species that now maintain low population levels may account for a higher proportion of the community. These changes indicate there would be a moderate beneficial impact to the fish community. However, increases in summer temperatures could dampen the benefit to trout. Alternative 2 would have a moderate adverse cumulative impact on trout in Segment C. In Segment C, brown and rainbow trout do not maintain resident reproducing populations, but seasonally use the habitat when temperatures are suitable. The increased temperatures with Alternative 2 Cumulative Effects could further limit the time when temperatures are suitable for trout. The lowered spring flows would reduce habitat availability and the seasonal use by these recreationally important species. There likely would not be a change in the overall species composition of the fish community with Alternative 2, but the community relative abundance may shift to one more dominated by small-bodied warmwater species with fewer trout.

Alternative 3 Cumulative Effects would have minor adverse effects to most aquatic biological resource components in the mainstem and would be similar to the effects predicted for Alternative 2 in all segments except for Segment B of the mainstem. In Segment B there would be an overall moderate adverse cumulative impact. For most fish species and life stages other than for adult trout, many weighted usable area metrics would not change by more than 10% for Alternative 3 Current Conditions Effects, Future Conditions Effects and Cumulative Effects. For adult brown and rainbow trout, lower spring flows would reduce weighted usable area values

from Current Conditions through Future Conditions. For the increment between Alternative 3 Future Conditions Effects to Alternative 3 Cumulative Effects, the further reduction in spring flows reduces weighted usable area values for almost all species and life stages. For most species and life stages, this would result in a negligible reduction in habitat availability for Cumulative Effects, but for adult trout, the reductions would be greater. In the South Platte River, the changes in flow would be relatively small and there would be a negligible cumulative impact.

Alternative 4 Cumulative Effects would be negligible to minor adverse to most aquatic resource components in the mainstem. Changes in fish habitat availability would mostly be negligible while there would be minor adverse impacts with changes in macroinvertebrate and periphyton species composition. In Segments A and B, most species and life stages would have negligible changes in weighted usable area metrics for Alternative 4 Current Conditions Effects, Future Conditions Effects and Cumulative Effects. The few species with more substantial changes would have only a small incremental change between Alternative 4 Future Conditions Effects and Cumulative Effects. In Segments A, B, and C, macroinvertebrate community abundance may benefit slightly from lower spring flows and the community may sustain a higher proportion of species that prefer moderate to slow current velocity. Species composition may change to species more suited to the altered flow regime, which would be a minor adverse cumulative impact. Similarly, there may be a minor increase in in abundance of periphyton and aquatic plants and minor adverse cumulative impact due to changes in periphyton species composition and increases in filamentous green algae. In the South Platte River, the changes in flow would be relatively small and there would be a negligible impact.

S.8.8 Recreation

A cumulative reduction in Poudre River flow is predicted to adversely affect boating on Segment B of the Poudre River through Fort Collins in all alternatives. The Future Conditions Effects and Cumulative Effects are summarized in Table S-14.

Table S-14. Predicted boating days in the Poudre River at the Lincoln Street Gage.

Modeled Hydrologic Condition	Alternative 1	Alternative 2 (Both Reclamation Options)	Alternative 3	Alternative 4
Current Conditions	54	54	54	54
Current Condition Effects	Not analyzed	35	36	50
Future Conditions	54	54	54	54
Future Condition Effects	50	35	32	53
Cumulative Effects	Not analyzed	33	31	52

S.9 MITIGATION

The mitigation plan in the SDEIS is the draft conceptual mitigation plan proposed by the District (Appendix F). The draft Conceptual Mitigation Plan (Appendix F) outlines the proposed

avoidance, minimization and compensatory mitigation measures for key environmental resources, including water quality, stream morphology, fish and other aquatic life, wetlands, riparian vegetation, and terrestrial wildlife. Between the SDEIS and FEIS, the conceptual mitigation plan will be refined and a more comprehensive proposed mitigation plan will be included in the FEIS. The Corps will describe the final mitigation requirements in its Record of Decision and may incorporate mitigation required by the Colorado Wildlife Commission and the WQCD.

The District will submit to the Corps a proposed final Mitigation Plan that will include components of:

- A mitigation plan for fish and wildlife resources approved by the Colorado Wildlife Commission
- Water quality mitigation measures that may be required by the WQCD as part of a water quality certification
- Reasonable and prudent measures and terms and conditions of the Biological Opinion of the USFWS addressing ESA compliance
- Mitigation identified by the USFWS in its Fish and Wildlife Coordination Act Report
- Mitigation that addresses specifically identifiable environmental effects determined to be significant, as required by Corps regulation (33 CFR 320.4(r)(2)), as well as mitigation for impacts to aquatic resources, as required by Corps regulations (33 CFR 332).

CHAPTER 1

PURPOSE AND NEED

CHAPTER 1

PURPOSE AND NEED

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Chapter 1. Purpose and Need

1.1 INTRODUCTION

The U.S. Army Corps of Engineers (Corps) has issued a Supplemental Draft Environmental Impact Statement (SDEIS) to disclose additional direct, indirect, and cumulative effects of the Northern Integrated Supply Project (NISP or Project). The proposed Project is a regional water supply project designed to serve the current and a portion of the future water needs of 15 towns and water districts in Boulder, Larimer, Morgan, and Weld Counties within the Northern Colorado Water Conservancy District (District). Construction of the proposed Project would involve the discharge of fill material into jurisdictional waters of the United States, thereby requiring a Clean Water Act Section 404 permit from the Corps. The District, acting by and through the Northern Integrated Supply Project Water Activity Enterprise, notified the Corps that it will seek a Section 404 permit for the Project.

The Corps published a Draft Environmental Impact Statement (DEIS) for NISP on April 30, 2008 for public comment. Substantial comments were received during three public hearings held for the DEIS as well as during the comment period. The Corps determined that additional analysis was required and that the purposes of the National Environmental Policy Act (NEPA) would be furthered through the issuance of a SDEIS. As a SDEIS, this document does not repeat information in the DEIS. Major changes to the analysis in the DEIS are described in Section S.1 of the Summary.

This SDEIS was prepared in accordance with the NEPA of 1969 (40 Code of Federal Regulations (CFR) 1500), as amended, and the Corps regulations for NEPA implementation (33 CFR 325, Appendices B and C). The Corps, Omaha District, Regulatory Branch is the lead agency responsible for preparation of this SDEIS. A third-party consulting team led by ERO Resources Corporation (ERO), working under the direction of, and in cooperation with, the Corps, assisted the Corps in data collection, effects analysis, and document production in accordance with December 17, 1997 guidance from the Chief of Engineers regarding EIS preparation.

The District's Preferred Alternative (Alternative 2 - Glade Reservoir and SPWCP) would deliver water to the Participants by using existing water rights, constructing a new reservoir at the Glade Reservoir site, and developing the South Platte Water Conservation Project (SPWCP). The District's Preferred Alternative is more fully described in Chapter 2, which also includes Project location maps. Background information on the District was presented in Section 1.3.1 of the DEIS.

1.1.1 Cooperating Agencies

The Corps requested that six agencies and one local government with statutory authority or special expertise with an environmental issue participate in the EIS process as cooperating agencies (40 CFR 1501.6 and 1508.5): U.S. Bureau of Reclamation (Reclamation), U.S. Fish and Wildlife Service (USFWS), U.S. Environmental Protection Agency (EPA), Colorado Department of Transportation (CDOT), Colorado Department of Natural Resources (CDNR), Colorado Department of Public Health and Environment (CDPHE) and Larimer County. Reclamation is a cooperating agency because the District would need a Reclamation contract and special use permit to facilitate water delivery to the Participants for one option under its Preferred Alternative. Reclamation will initiate their ROD and contract negotiation process subsequent to issuance of the Corps' ROD and 404 permit if the Reclamation Action Option for the District's Preferred Alternative was permitted by the Corps. Reclamation will make a decision about issuance of a special use permit for the connection of the Glade to Horsetooth Pipeline in a ROD addressing contracting actions, or a separate decision if it was determined the pipeline would be needed.

The District's Preferred Alternative includes realignment of a segment of U.S. 287 at the proposed Glade Reservoir site. CDOT was responsible for selection of the preferred alignment of U.S. 287.

The EPA is a cooperating agency on issues for which the agency has special expertise. The USFWS is responsible for consultation with the Corps and the District under the Endangered Species Act (ESA) and the Fish and Wildlife Coordination Act. In the DEIS, Larimer County was a cooperating agency due to their statutory requirements to allow a decision to be rendered by the Larimer County Planning Commission for Location and Extent Review (CRS 30-28-110) for project components located in Larimer County. Subsequent to the DEIS, Larimer County initiated the process of adopting 1041 regulations for domestic water supply storage reservoirs. If the Corps permitted Alternative 2, the construction of Glade Reservoir may require a 1041 permit from Larimer County or alternatively, the County and the District may enter into an intergovernmental agreement that would specify the permitting process required by the County for Glade Reservoir and associated facilities located in Larimer County. Other authorizations by Larimer County could include approval of site plans and building permits.

After the Draft EIS was published, the CDNR became a cooperating agency to facilitate Federal and State coordination under the Fish and Wildlife Coordination Act and development of a State Fish and Wildlife Mitigation Plan pursuant to the requirements of Colorado Revised Statutes (CRS) 37-60-122.2. The CDPHE became a limited-scope cooperating agency due to their statutory authority under Section 401 of the Clean Water Act and their special expertise related to water quality issues, with their scope limited to addressing water quality assessment methodology and water quality impact analyses.

Additionally, implementation of any of the alternatives will require compliance with applicable state and local regulatory agency reviews, approvals, and permitting requirements.

1.2 PROJECT PURPOSE AND NEED

1.2.1 Purpose and Need Statement

The Corps and District jointly developed the purpose and need statement as follows:

> *To provide the Project Participants with approximately 40,000 acre-feet of new reliable municipal water supply annually through a regional project coordinated by the District, which will meet a portion of the Participants' current and reasonably projected future additional water supply needs.*

1.2.2 Basic Project Purpose

The Corps will evaluate the District's 404 permit application in accordance with EPA's Guidelines for Specification of Disposal Sites for Dredged or Fill Material (404(b)(1) Guidelines), 40 CFR 230. The basic project purpose is examined by the Corps to determine if the project is water-dependent. A project is water dependent if it requires access or proximity to, or siting within, a special aquatic site in order to fulfill its basic purpose. The Corps determined that the basic project purpose for the NISP is to provide water. Because supplying water, whether for municipal, industrial or agricultural uses, does not fundamentally require access or proximity to, or siting within, a special aquatic site to meet this basic project purpose, the 404(b)(1) Guidelines stipulate that practicable alternatives are (1) presumed to exist and (2) presumed to be less environmentally damaging than the proposed action, unless clearly demonstrated otherwise. The District's Preferred Alternative is not "water dependent" for the purposes of the 404(b)(1) Guidelines and the rebuttable presumptions apply.

1.2.3 Overall Project Purpose

The Corps uses the overall project purpose to evaluate whether less environmentally damaging practicable alternatives are available and to help make a decision whether to issue or deny a Section 404 permit. The 404(b)(1) Guidelines state that an alternative is practicable if it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purpose (40 CFR 230.10(a)(2)). This evaluation applies to all waters of the United States, not just special aquatic sites.

Determination of the overall project purpose is the Corps' responsibility. The Corps defines the overall project purpose in light of an applicant's stated objectives as well as the public's perspective (33 CFR Part 325 Appendix B, Section 9(b)(4)). The NISP overall project purpose is synonymous with the purpose and need statement for NISP.

The purpose and need statement is specific enough to define the District's needs, but not so restrictive as to constrain the range of alternatives that must be considered under the 404(b)(1) Guidelines. For the NEPA analysis, the Corps considers and expresses the proposed project's underlying purpose and need from a public interest perspective when appropriate, but generally

focuses on the applicant's purpose and need statement. The Council on Environmental Quality (CEQ) regulations at 40 CFR 1502.13 stipulate that the EIS purpose and need statement "shall briefly specify the underlying purpose and need to which the agency is responding in proposing the alternatives including the proposed action." The Corps will, in all cases, exercise independent judgment in defining the purpose and need for a project to be permitted under its regulatory program from both the applicant's and public's perspective (33 CFR 325 Appendix B(9)(b)(4)). While the Corps considers the views of the applicant regarding the project purpose and the existence (or lack) of practicable alternatives, the Corps must determine and evaluate these matters itself, with no control or direction from the applicant, and without undue deference to the applicant's wishes.

1.2.4 Need for the Project

The DEIS discussed 12 NISP Participants, after the Town of Berthoud withdrew as a Participant in NISP in April 2008 as the DEIS was being released to the public. Frederick requested the project yield previously allocated to Berthoud. In the DEIS, the NISP yield requests for the Town of Frederick, Town of Firestone, and City of Dacono were combined with the yield request for Central Weld County Water District that serves these communities. In the SDEIS, the 15 Participants are discussed individually (Table 1-1).

Information on Project background and Project development were presented in Section 1.3.2 of the DEIS. The District has estimated that future municipal and industrial (M&I) water needs within the District will increase by 300,000 AF when the city and towns within the District complete their planned buildouts (District 2000). The Statewide Water Supply Initiative (SWSI) estimated a shortfall of M&I water by 2050 of 131,200 AF to 184,900 AF in the northern region of the South Platte Basin (Boulder, Larimer, and Weld Counties), which includes most of the District (CDM Smith 2011a).

Table 1-1. Participants and new firm yield goal from NISP.

Participant	Approximate Firm Yield Goal (AF)
Central Weld County Water District (CWCWD)	3,500
City of Dacono	1,000
Town of Eaton	1,300
Town of Erie	6,500
City of Evans	1,600
Town of Firestone	1,300
Fort Collins-Loveland Water District (FCLWD)	3,000
City of Fort Lupton	3,000
City of Fort Morgan	3,600
Town of Frederick	2,600
City of Lafayette	1,800
Lefthand Water District (LHWD)	4,900
Morgan County Quality Water District (MCQWD)	1,300
Town of Severance	1,300
Town of Windsor	3,300
Total	**40,000**

Unlike other water supply projects that address the full future water supply needs of an applicant projected to a specified time, the Participants in NISP requested new firm yield to meet only a portion of their projected demand through 2060. The Participants are requesting 40,000 AF of new firm yield from NISP (Table 1-1). The requests for new firm yield are based on the Participants' analyses of their projected needs, the potential future demands as modeled by the District and verified by the Corps, plus a 10% safety factor to account for uncertainty about future demand (see Section 1.1.8.2). Based on current population and future population projections, some Participants face immediate water shortages; for others, shortages of firm water supply are expected over the next 10 to 20 years, as discussed in Section 1.1.6 of this chapter. Participants who face shortages before NISP is implemented would likely use strategies such as short-term leases for temporary water supplies, which are not a reliable long-term water supply. Since the DEIS, the Participants have continued to purchase Colorado-Big Thompson (C-BT) units to add to their water supplies. The C-BT Project is described in Section 1.1.9.

The Participants' existing water supplies and projected future demands were analyzed by Harvey Economics (2006, 2011) on behalf of the Participants and the District. This analysis was begun in 2004 and updated in 2011. Most of the water usage estimates for the DEIS were based on 1998 through 2003 usage rates. The usage estimates were updated through 2009 for the SDEIS. More detailed information on the projections developed for the Participants and the District can be found in Harvey Economics (2011). The demand projections developed for the Participants and the District were independently reviewed by the Corps and its third-party contractor. That review led to the development of additional demand scenarios. Further information on the review can be found in BBC Research and Consulting (BBC) 2011.

1.2.5 NISP Participant Service Areas

The Participants' service areas include towns and small communities and surrounding rural areas in Boulder, Larimer, Morgan, and Weld Counties (Figure 1-1). Most of the water supplied by the Participants, and the majority of anticipated future water needs, is for residential uses. Many of the Participants also supply water for public, commercial, and industrial uses, including parks, golf courses, businesses, schools, dairies, and beef and food processing plants.

1.2.6 Current and Projected Population

Population growth is widespread among all the Participants. The Town of Erie and the Town of Severance grew faster than the other Participants; Severance grew from a population of 89 in 1990 to 2,600 people by 2009. The Town of Erie grew almost 1500% from 1990 through 2009. Of the Participants, the most heavily populated water suppliers in 2009 were the Fort Collins-Loveland Water District with 38,800 residents followed by the City of Lafayette with about 27,500 residents. Together, these two water providers accounted for about one-third of the total population of all of the Participants in 2009. The 15 Participants served water to 76,000 persons in 1990, increasing to 202,000 persons by 2009 (Figure 1-2). This expansion represents an average annual growth rate of 5.3%. This unusually rapid growth indicates the considerable in-

migration that occurred in northern Colorado between 1990 and 2009, likely attributable to both relatively affordable housing costs and a substantial increase in job opportunities in the northern Front Range during this time. From 2004 to 2009, the average annual population growth rate for the Participants was 3.7%, reflecting the recent economic slowdown (HE 2011).

The DEIS was issued during the 2007–2009 recession. Some comments received on the DEIS indicated concerns that the population growth estimates in the DEIS were too high given the current recession. In 2011, the District updated the population growth estimates for the Participants and projected them to 2060 (HE 2011). The Participants' projected growth rates are based on regional and statewide population projections, planning estimates of various municipalities, and other economic factors as described in Harvey Economics (2011) and BBC (2011).

Figure 1-1. Service Areas of NISP Participants.

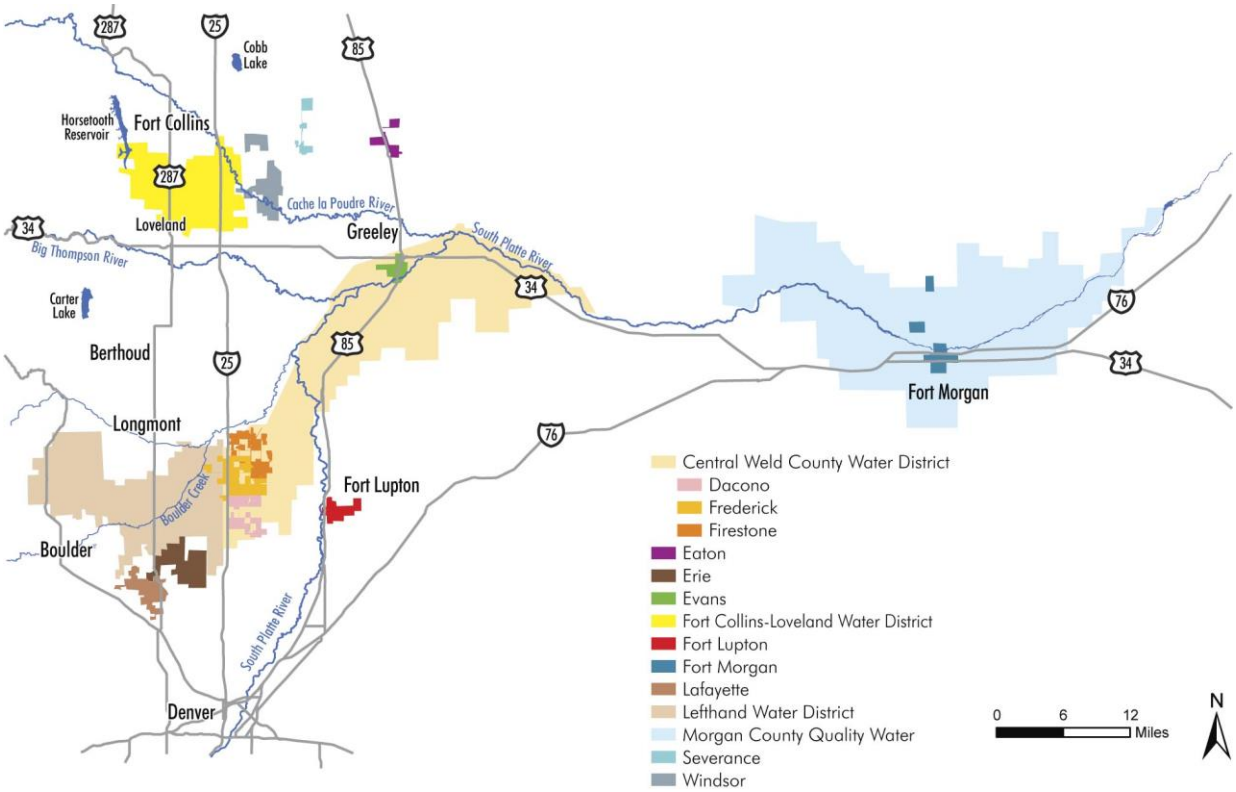
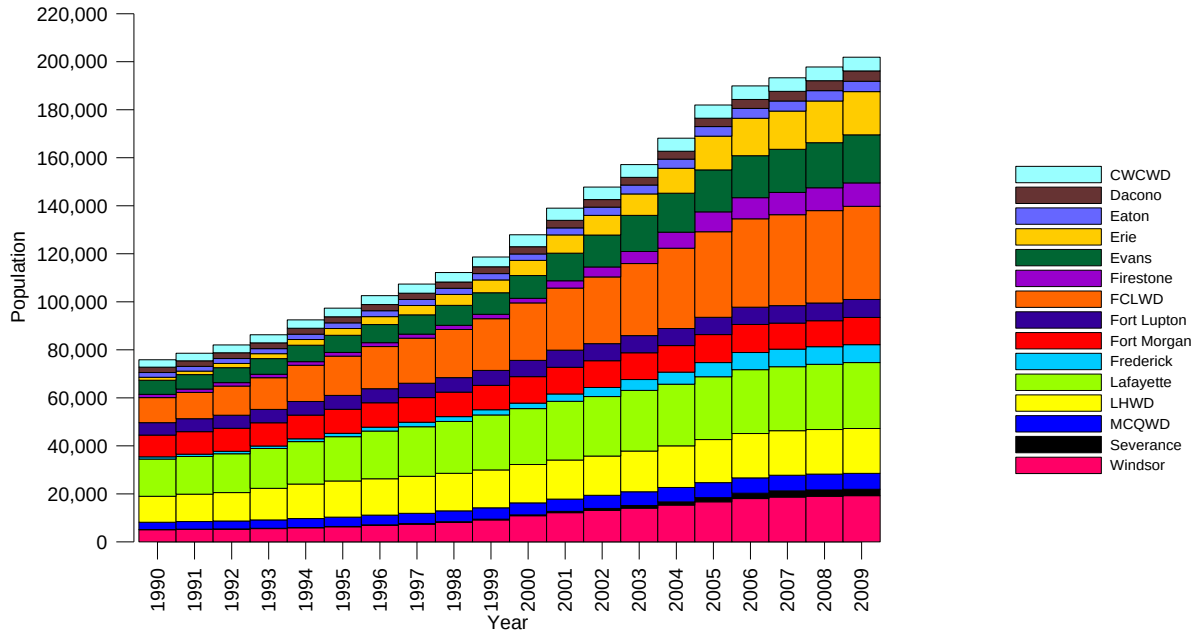


Figure 1-2. Population Growth for Each NISP Participant, 1990 through 2009.



The projected need for additional water supplies for the Participants are based on long-term projections and are not substantially affected by short-term population increases or declines. The 2005 DEIS projections anticipated higher population totals in 2010 (226,500 residents) and 2030 (388,300 residents) than were predicted for the revised 2010 SDEIS projections (Table 1-2). The revised SDEIS projections anticipate more rapid population growth after 2030 than the previous DEIS projections, leading to a larger projected population in the NISP service areas in 2050 than was predicted previously.

Table 1-2. Comparison of NISP population projections performed in 2010 and 2005.

	Projected Population			
	2010	**2030**	**2050**	**2060**
2010 Projections (SDEIS)	**211,424**	**365,698**	**496,340**	**575,683**
Average Annual Growth Rate				
By period	NA	2.8%	1.5%	1.5%
From 2010 forward	NA	2.8%	2.2%	2.0%
2005 Projections (DEIS)	**226,524**	**388,320**	**470,826**	**NA**
Average Annual Growth Rate				
By period	NA	2.7%	1.0%	NA
From 2010 forward	NA	2.7%	1.8%	NA

Source: Harvey Economics (2006, 2011).

Note: Summary of 2005 projections excludes Berthoud for comparability purposes. The 2005 projections used in the DEIS included Berthoud, which has withdrawn from NISP.

NA=Not Applicable.

The District's population projections were updated before the availability of the 2010 Census population data. The District's updated population projections were independently reviewed by the Corps (BBC 2011, 2013) again after the 2010 Census population data were available. BBC concluded that Harvey Economics' population estimates for the NISP Participants in 2010, developed prior to the 2010 Census, were too high. BBC estimated an adjusted overall 2060

population forecast for the NISP Participants of 562,054 residents, 2.4% lower than the 2060 population projection in the 2011 Harvey Economics report. BBC's analysis determined the NISP Participants' populations are projected to grow considerably over this planning horizon. Based on BBC's analysis (2013), the four counties that include the Participants (Boulder, Larimer, Morgan, and Weld) are expected to add about 605,000 residents between 2010 and 2040 (Table 1-3).

Although the Participants' projected growth rates vary, average annual growth rates generally range from 2% to 5% per year. BBC determined that the adjusted projections through 2040 were consistent with the Colorado State Demography Office's 2012 projections of regional growth (Table 1-3). The adjusted projections imply that the NISP Participants will capture 36.5% of the State Demography Office's projected regional growth in Boulder, Larimer, and Weld Counties between 2010 and 2040 (the end of the State Demography Office forecast). By comparison, the Participants captured 39.7% of the region's growth between 1990 and 2010. Based on BBC's review, the Corps determined that the adjusted (lowered) population estimates, consistent with the State Demography Office forecasts, would be used for the NISP EIS. The Corps concluded the NISP need of supplying 40,000 AF of water is supported by the anticipated population growth in the Participant's service areas.

Table 1-3. Comparison of NISP historical population, adjusted population projections and regional population projections from the Colorado State Demography Office.

County	1990	2010	2040 Colorado State Demography Office Projections	Change by Period	
				1990–2010	2010–2040
Boulder	225,339	295,605	390,228	70,266	94,623
Larimer	186,136	300,532	481,193	114,396	180,661
Morgan	21,939	28,196	45,098	6,257	16,902
Weld	131,821	254,230	567,218	122,409	312,988
Total	565,235	878,563	1,483,737	313,328	605,174
NISP Group	76,000	200,366	421,537	124,366	221,171
NISP Share	13.4%	22.8%	28.4%	39.7%	36.5%

Source: BBC 2013.

1.2.7 Historical Water Use and Conservation Programs

The most recent year for which complete water use data are available for all of the NISP Participants is 2009. Considering historical water use, no year is perfectly average, and the selection of an earlier year is complicated by the changes in water use over time due to conservation and the implementation of drought restrictions during the drier years closer to 2009 (e.g., 2002-2004). Therefore, Participant water deliveries in 2009 are presented in Table 1-4. While 2009 data provide the most recent available information on water use by the NISP Participants, 2009 was a relatively wet year, with reduced demand for landscape irrigation. NISP deliveries per capita in 2009 were about 10% lower than in the 1999-2009 average (Table 1-5). By way of comparison, Denver Water's demand per capita in 2009 was 13% lower than in 2008. Consequently, the 2009 water use by the NISP Participants was likely 10% to 15% lower than it would have been under "average" weather conditions.

Table 1-4. Total nonpotable and potable water deliveries by NISP Participants, 2009.

NISP Participant	Potable Deliveries (mg)	Nonpotable Deliveries (mg)	Total Deliveries (mg)	Total Deliveries (AF)
CWCWD	800	0	800	2,455
Dacono	152	0	152	466
Eaton	183	88	271	832
Erie	865	62	927	2,845
Evans	735	82	817	2,507
Firestone	518	0	518	1,590
FCLWD	2,392	0	2,392	7,341
Fort Lupton	400	395	795	2,440
Fort Morgan	1,278	159	1,437	4,410
Frederick	477	0	477	1,464
Lafayette	1,189	107	1,296	3,977
LHWD	1,109	0	1,109	3,403
MCQWD	693	0	693	2,127
Severance	111	18	129	396
Windsor	524	0	524	1,608
Total	**11,426**	**911**	**12,337**	**37,861**

Source: HE 2011.

Table 1-5. Total potable water use for each NISP Participant, 1999 and 2009.

Participant	1999 (gpcd)	2009 (gpcd)	1999–2009 Average (gpcd)	Change 1999–2009
CWCWD[1]	599	382	460	-36%
Dacono	117	98	111	-17%
Eaton	153	157	156	2%
Erie	125	132	156	6%
Evans	189	101	148	-47%
Firestone	123	146	176	18%
FCLWD	192	164	198	-15%
Fort Lupton	121	147	122	21%
Fort Morgan	153	172	177	12%
Frederick	132	176	185	33%
Lafayette	134	119	132	-12%
LHWD	176	163	185	-8%
MCQWD[2]	284	285	276	0%
Severance	210	116	145	-45%
Windsor	137	75	104	-46%
Total Participant Average	**190**	**162**	**182**	**-15%**

Source: HE 2011.

[1]Includes Aurora Dairy and other large commercial water users.

[2]Includes Leprino Foods, dairies, and other large water users.

Historical water requirements for the NISP Participants include both potable and nonpotable deliveries. Nonpotable deliveries do not reduce the quantity of water delivered to or consumed by a Participant; nonpotable supplies are merely not treated to drinking water standards before use. Potable water deliveries are typically made to residential and M&I customers as well as parks, golf courses, and other public uses, depending on the economic and demographic makeup of the water provider's service area. Nonpotable deliveries are typically conveyed through

existing ditch systems that previously served agricultural lands. Parks, school grounds, golf courses, and open space are increasingly served by nonpotable water systems to avoid drinking water treatment costs and to take advantage of available water resources. In addition, some of the Participants are encouraging dairies and other agricultural users to use nonpotable water supplies. Because nonpotable delivery systems are a relatively new practice, they do not have a well-documented usage in northeastern Colorado.

The annual combined gallons per capita per day (gpcd) for the Participants from 1999 to 2009 indicates usage rates that fluctuate largely with weather and water use restrictions during times of drought. For that same period, average potable water use for all 15 Participants was 182 gpcd (Table 1-5).

Almost all Participants experienced a substantial decline in use of potable water in 2003 due to drought restrictions (Table 1-5). Additionally, almost all of the Participants had a substantial decline in potable water in 2009, a wet spring and summer that substantially reduced the demand for water for landscape irrigation. Each Participant's water use pattern is unique because the mix of customer types varies; the presence of large water users such as dairies or industry, new large lot homes versus small in-town lots, and the presence of commercial activity affect the water use patterns of a single Participant.

The water providers with lower gpcd, including Dacono, Windsor, Fort Lupton, and Lafayette, are largely bedroom communities with a higher number of persons per tap than other water providers, which tends to lower potable gpcd. Several NISP Participants, including CWCWD, MCQWD, and FCLWD, provide potable water supplies to dairy operations, which require relatively large volumes of potable water.

1.2.7.1 Historical Water Use Patterns in Northern Colorado

Two sources of information offer a comparison of historical water use with current water use patterns in Northern Colorado: the original Windy Gap Project EIS, which was prepared in the late 1970s and early 1980s (U.S. Department of the Interior 1981); and the Northern Colorado Water Conservancy District's Regional Water Supply Study (District 1991).

The Windy Gap EIS focused on water use patterns of the original Participants of that project: Boulder, Estes Park, Greeley, Longmont, Loveland, and the Platte River Power Authority. Although none of these water providers are Participants in NISP, geographically they are representative of the NISP Participants. The average water use of the Windy Gap Participants, excluding Platte River Power Authority, was 250 gpcd in the 1980s, compared to an average of 182 gpcd for the Participants in NISP from 1999 through 2009.

The District's 1991 Regional Water Supply Study included estimates of actual water use patterns for water providers in Northern Colorado and projections of future water use for municipal and industrial water providers from the Northern Denver Metropolitan area in Boulder, Larimer, and Weld Counties, including many of the Participants (Table 1-6).

Table 1-6. Actual and projected water use by NISP Participants.

NISP Participant	1988 GPCD	Average GPCD 1999–2009	Change 1988–2009
CWCWD	395	460	17%
Eaton	183	156	-15%
Erie	389	156	-60%
Evans	216	148	-31%
FCLWD	199	198	0%
Fort Lupton	326	122	-62%
Fort Morgan	280	177	-37%
LHWD	177	185	4%
MCQWD	245	276	13%
Windsor	140	104	-26%
Average	255	198	-22%

Source: HE 2011.

The average gpcd for these Participants for 1999 through 2009 was about 22% less than the average that those same Participants exhibited in 1988. This significant reduction in water use indicates that the conservation efforts undertaken by Participants have been effective. It also suggests that additional savings will be more difficult and costly to achieve as described below.

Typically, water providers and their customers are motivated to take the first steps in conservation programs that achieve the largest savings at the least incremental cost. The Participants have reduced use by implementing relatively inexpensive water-saving measures such as public education, watering restrictions, low-flow fixture requirements, and landscaping regulation for new construction (HE 2011). These water-saving measures are required for new home construction within the Participants' service areas.

The Harvey Economics demand projections for some of the Participants reflect increasing water use per capita, while the projections for others show decreases in gpcd. In general, most (but not all) of the Participants with substantial projected increases in gpcd during the 2030-2050 time period were either projected to experience substantial increases in nonpotable deliveries, or particularly in the case of CWCWD, to experience substantial increases in demand from large customers (e.g., dairies). Harvey Economics (2011) noted that there are a number of factors that tend to increase water use per capita in the NISP area over time. These include further development of commercial employment centers in the northern Front Range and the potential transition of at least some of the NISP Participants away from being primarily "bedroom communities" with relatively little commercial water use.

1.2.7.2 Comparison of NISP Participant Water Use to Water Use by Other Municipal Providers

In the DEIS, the Corps developed a benchmark to evaluate whether the current water use by NISP Participants is reasonable, and to obtain insight into the potential reductions in their future demand from additional conservation efforts. The benchmark is intended as a means to place the intensity of water use by the NISP Participants in a broader context, by comparing their use—on

a gpcd basis—to other water providers. The benchmark itself is not used in any way in the calculation of the future water demand projections. The establishment of such a benchmark is a challenge for a number of reasons.

(1) Numerous jurisdictions, including the States of Texas, California, and Utah, have attempted to establish water conservation benchmarks, but each developed that benchmark in a unique manner suitable to its own purpose. California has probably taken this concept the furthest in its statewide *20x2020 Water Conservation Plan* finalized in 2010. The plan requires urban water providers to achieve a 20% reduction from 2005 use per capita by 2020. While each provider's historical usage number is different, the plan identifies 192 gpcd as the statewide average in 2005 and targets a 20% reduction in statewide municipal use (to 154 gpcd) by 2020 (California Department of Water Resources 2010). It remains the case, however, that no single, commonly accepted gpcd benchmark has been developed to date.

(2) Many measures of water use exist, and the calculation of water use is performed differently by agencies and jurisdictions. For example, water use can be measured by gpcd, gallons per tap per day, gallons per household per day, residential water use per capita per day, and so on. Further, the point of measurement, i.e., public water supplies versus all water supplies, or population within the city limits versus service area population, is also not uniform.

(3) Customer characteristics vary from provider to provider and small providers are especially sensitive to changes in customer type. As smaller communities grow, it is common for them to add more retail and commercial development to their residential base, which tends to inflate overall water use per capita. For very small communities, the location of a single large water user within their service area can affect their overall water use rate per capita.

In the DEIS, a range of 194 to 224 gpcd was selected as a regional water use benchmark. The range was based on data from a variety of sources including the original SWSI study completed in 2004 and other water use studies from the 2000 to 2005 period. More recent water use data indicate that the reductions in demand exhibited by the NISP Participants shown in Table 1-6 have also occurred among other municipal providers. The most recent SWSI update in 2010 estimated that average M&I use in the South Platte Basin (which includes the region served by the NISP Participants) had declined from an estimated 246 gpcd in the 2004 study to 188 gpcd (CDM Smith 2011a). Denver Water's average potable water use over the 1990-2009 period was 180 gpcd (HE 2011). The District used a benchmark of 215 gpcd in its updated assessment (HE 2011).

Current water use (gpcd) among the NISP Participants, as depicted in Table 1-5 and Table 1-6, is generally consistent with other water providers in the region with a couple of exceptions. As noted previously, CWCWD, MCQWD, and FCLWD provide potable water supplies to dairy operations. These operations require relatively large volumes of potable water and tend to distort the system-wide average gpcd for these providers.

In sum, current water use (gpcd) by the NISP Participants is reasonable by comparison with other municipal water providers in Northern Colorado. Both the NISP Participants and other water providers have experienced significant reductions in water use over the past 10 to 20 years. The potential for further reductions in NISP Participant water use per capita is discussed in Section 1.1.7.

1.2.7.3 Participant Water Conservation Efforts

Water conservation measures are programs consistently applied every year to reduce water demands. These ongoing measures are distinguished from more severe drought restrictions typically reserved by water resource managers for unusually adverse hydrologic conditions or for unexpected circumstances that threaten the ability of the water provider to meet its customers' requirements.

All of the NISP Participants have ongoing water conservation programs to educate users about their water supply and discourage unnecessary use of water on a long-term basis. Conservation is included in each NISP Participant's present and future water demand and is represented as a reduction in demand for NISP rather than as an additional source of water.

The Participants' ongoing water conservation programs are typical among Colorado water providers, with a stronger emphasis on price signals to promote efficient use. Almost all of the Participants' water conservation programs have an educational component that ranges from including water conservation reminders with bills to websites, newspaper and television ads, and school programs. All of the Participants generally practice universal metering to keep track of water use patterns and to charge customers for the water they consume. The water price signal to customers is emphasized by the increasing block rate structure in place for almost all of the Participants in which those who use the most water proportionally pay more. In addition, 5 of the 15 Participants have an excess water use surcharge. Many Participants also commonly use leak detection and repair or replace inefficient water mains, pipes, and meters.

A number of Participants have landscape ordinances and permanent outdoor watering restrictions in place. Water audits and the promotion of water efficient appliances also are practiced by a number of Participants. Certain Participants have nonpotable irrigation systems or a water reuse system in which wastewater is used for irrigation. Additionally, CWCWD is encouraging dairy and other agricultural customers to use nontreated water when possible.

Each Participant applies a unique mix of conservation measures suitable to the particular conditions in its community and to the operation of their water system. Details regarding each Participant's conservation efforts are provided in Harvey Economics (2011).

1.2.8 Water Demand Projections

NISP differs from many other proposed water supply projects in that NISP Participants have requested only a portion of their projected demand through 2060 (Table 1-1). Changes in the future demand projections, such as population projections, conservation, or benchmarks, may

affect the overall future demand, but they do not affect the near-term need of the Participants for the 40,000 AF of firm yield from NISP, which is the need the Corps is analyzing in this EIS.

1.2.8.1 Updated Projections

The updated demand projections developed by the District and Participants essentially incorporate the same methodology as the previous projections in 2004–2005. The demand projections were developed on a Participant by Participant basis. In essence, the contractor for the District and Participants gathered or developed projections of future demographic growth for each Participant, then combined projected growth in population (or accounts) with assumptions regarding water use per resident (or per account) specific to each Participant based on their historical water use.

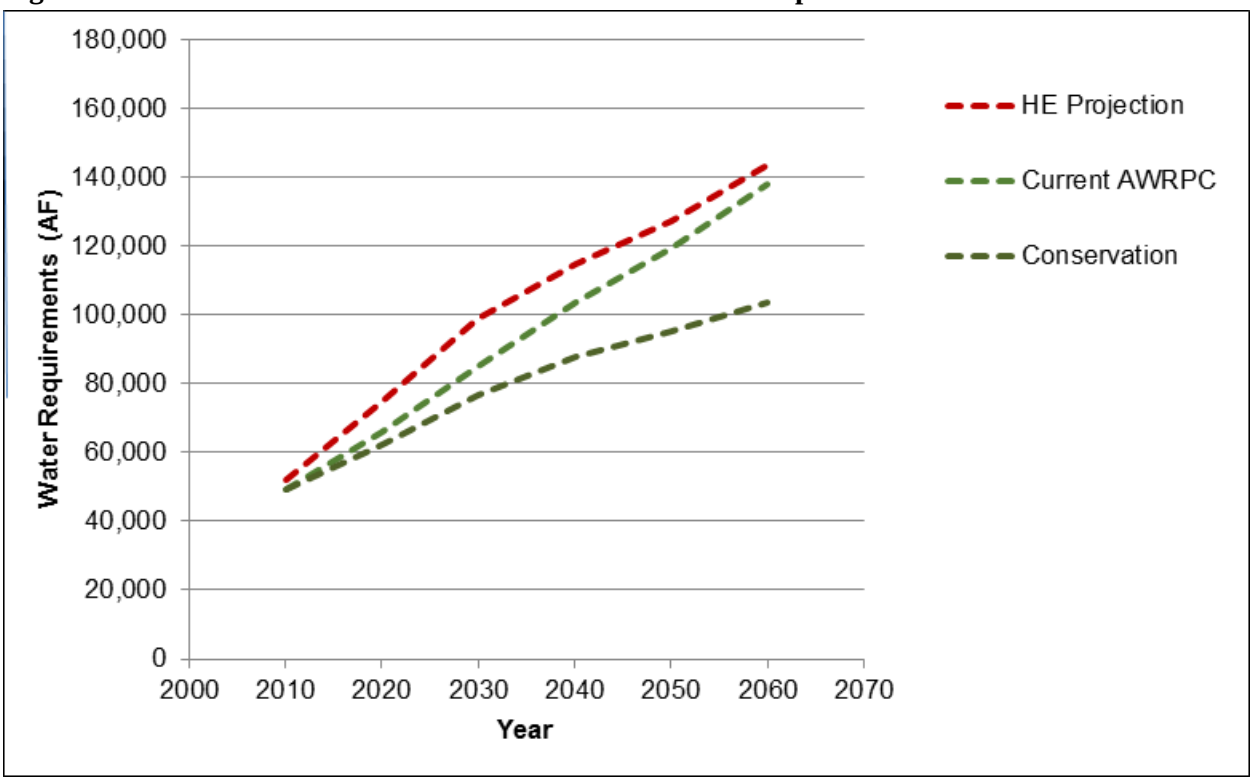
Water requirements for the Participants, which include potable and nonpotable deliveries, losses, and wholesale water resource fees, were projected to increase from 48,800 AF in 2007, the peak historical year, to 143,400 AF by 2060 (HE 2011).

The Corps independently identified two alternative future demand scenarios after reviewing the projections developed for the Participants and the District (BBC 2011). Both alternative scenarios incorporated the revised population projections by BBC that were based on the 2010 Census data for the Participants.

The first alternative scenario assumed the continuation of recent (1999–2009) overall average annual water requirements per capita (AWRPC) among the NISP Participants. The Corps selected AWRPC as the metric for water use intensity (as opposed to gpcd) to clarify that the metric (and the corresponding demand projections) includes nonpotable deliveries and losses as well as metered potable uses. The first scenario, termed "Current AWRPC," resulted in somewhat lower projected demands through approximately 2050, but similar projected demands by 2060 (137,900 AF) (Figure 1-3).

The second alternative scenario, termed the Conservation Scenario, assumed that average annual water requirements per capita for the Participants as a group will decline by approximately 5% per decade, or by 25% by 2060, accounting for both passive and future active conservation. While the NISP Participants' ability to achieve such savings is uncertain, the Conservation Scenario helped assess the need for additional water supplies if such conservation savings were to be achieved in the future. Under the Conservation Scenario, total water demands for the Participants would reach about 103,400 AF by 2060 (Figure 1-3).

Figure 1-3. Alternative Demand Scenarios for the NISP Participants.



Sources: BBC 2011, HE 2011.

The magnitude of these assumed reductions in AWRPC is generally comparable to assumptions regarding potential future municipal conservation developed for the 2010 SWSI Report for passive conservation and medium level active conservation. Achieving such conservation would require additional conservation efforts by the NISP Participants beyond their current programs, such as: landscape water budgets, irrigation efficiency evaluations, and targeted residential and nonresidential audits for high use customers, among others. Aquacraft, Inc. and Headwaters Corporation (2011) provide further detail on the types of measures, anticipated water savings, and costs associated with potential water use reductions of this magnitude.

Figure 1-3 depicts projected aggregate water requirements for the 15 NISP Participants under the three scenarios just described: 1) the demand projections developed by the District and the Participants (Harvey Economics Projection), 2) demands based on continuation of recent overall average annual water requirements per capita for the Participants as a group (Current AWRPC), and 3) demands based on the Conservation Scenario. Based on the Corps' independent analysis, the Corps concluded:

- The NISP Participants' water supply needs during the planning period (through 2060) is at least 40,000 AF
- The three demand scenarios affect when (but not if) additional supplies beyond NISP are projected to be needed
- Under any of the three demand scenarios, both NISP and additional supplies would be required to meet the NISP Participants' future water supply needs (Figure 1-3)

1.2.8.2 Demand Projection Safety Factor

A safety factor of 10% was added to the projected total annual water requirements under each of the alternative demand projection scenarios. The safety factor is intended to account for faster or higher future demands than those projected and unforeseen events that could rapidly diminish supplies.

Incorporating a safety factor is a common practice in long term water resource planning for municipal water providers. For example, Denver Water includes a 30,000 acre-foot (AF) safety factor in its long-term demand projections (about 12% of current demand). The Metropolitan Water District of Southern California uses a 10% safety factor in demand planning, while the San Antonio Water System adds 5 years of projected account growth to its forecasts for safety purposes (approximately equivalent to a 10% safety factor). The City of Greeley established a 7,300 AF safety factor in 2003, equivalent to about 18% of its obligated demands at that time.

1.2.9 Sources and Yields of Current Water Supply

The NISP Participants' existing water supplies include: direct flow from the Poudre, St. Vrain, and Big Thompson Rivers and their tributaries; transbasin supplies from the Colorado River Basin; reservoir storage; and mutual ditch, irrigation, and reservoir company shares within the Poudre, St. Vrain, South Platte, and Big Thompson River Basins.

The common water supply among all the Participants is the C-BT Project. The C-BT Project was developed by Reclamation on behalf of the District between 1938 and 1957. Twelve reservoirs, 35 miles of tunnels, 95 miles of canals, and 700 miles of transmission lines comprise the complex C-BT collection, distribution, and power system. The project was designed to provide water for agricultural, municipal, and industrial beneficial uses. The C-BT Project provides supplemental water to about 30 cities and towns and is used to help irrigate more than 600,000 acres of northeastern Colorado farmland. On average, about 220,000 AF of water is delivered to northeast Colorado.

As a supplemental water supply for the northern Front Range, the goal of the operation of the C-BT Project has been to provide a smaller amount of water in wet years when less supplemental water is needed and more water in dry years when the native flows are reduced and more supplemental water is needed. C-BT units are allocated as a percent of an AF every year. The quota (the AF of water/C-BT unit), or percent of an AF, is initially set in October and reevaluated in April by the District Board and can be increased later in the summer. Historically, C-BT quotas have ranged between 0.5 and 1.0 AF per unit; however, quotas are adjusted to deliver more water in dry years, except in extreme drought periods when water supply can affect quota.

Five of the Participants are allottees in the Windy Gap Project. The Windy Gap Project consists of a diversion dam on the Colorado River, a 445-AF reservoir, a pumping plant, and a 6-mile pipeline to Granby Reservoir. Currently, Windy Gap Project water is stored and conveyed through C-BT Project facilities prior to delivery to Windy Gap Project allottees.

The sources and yields of the Participants' current water supplies are shown in Table 1-7. Annual yield from the NISP Participant supplies vary depending on available water each year and system losses. Average supplies are determined from historical yields, and dry year firm yields are determined from the drought period on record. The firm yields differ for each supply, depending on the priority of the water right in the river system providing the supply. In total, the estimated annual dry firm yield of the Participants' existing water supplies is 59,490 AF.

Table 1-7. Existing Participant water supplies.

Participant	Dry Year (Firm) (AF)	Source
CWCWD	3,100	C-BT and Windy Gap units and mutual company shares
Dacono	1,100	C-BT units
Eaton	1,650	C-BT units, mutual company shares, and irrigation wells
Erie	4,600	C-BT and Windy Gap units, mutual company shares, and reservoirs
Evans[1]	8,600	C-BT and Windy Gap units and mutual company shares
Firestone	3,000	C-BT units
FCLWD	11,400	C-BT units and mutual company shares
Fort Lupton	1,900	C-BT and Windy Gap units, mutual company shares, and direct flows
Fort Morgan	4,000	C-BT units, and direct flows for irrigation and Cargill
Frederick	3,400	C-BT units, mutual company shares, and reservoir storage
Lafayette	4,500	C-BT, mutual company shares, and reservoir storage
LHWD	5,800	C-BT and Windy Gap units, mutual company shares, and reservoir storage
MCQWD	2,900	C-BT units and direct flows
Severance	640	C-BT units, mutual company shares, and irrigation wells
Windsor	2,900	C-BT units and mutual company shares
Total	**59,490**	

Source: HE 2011.

[1]Evans Ditch water (2,367 AFY) currently is not available for potable use and is not included in the total.

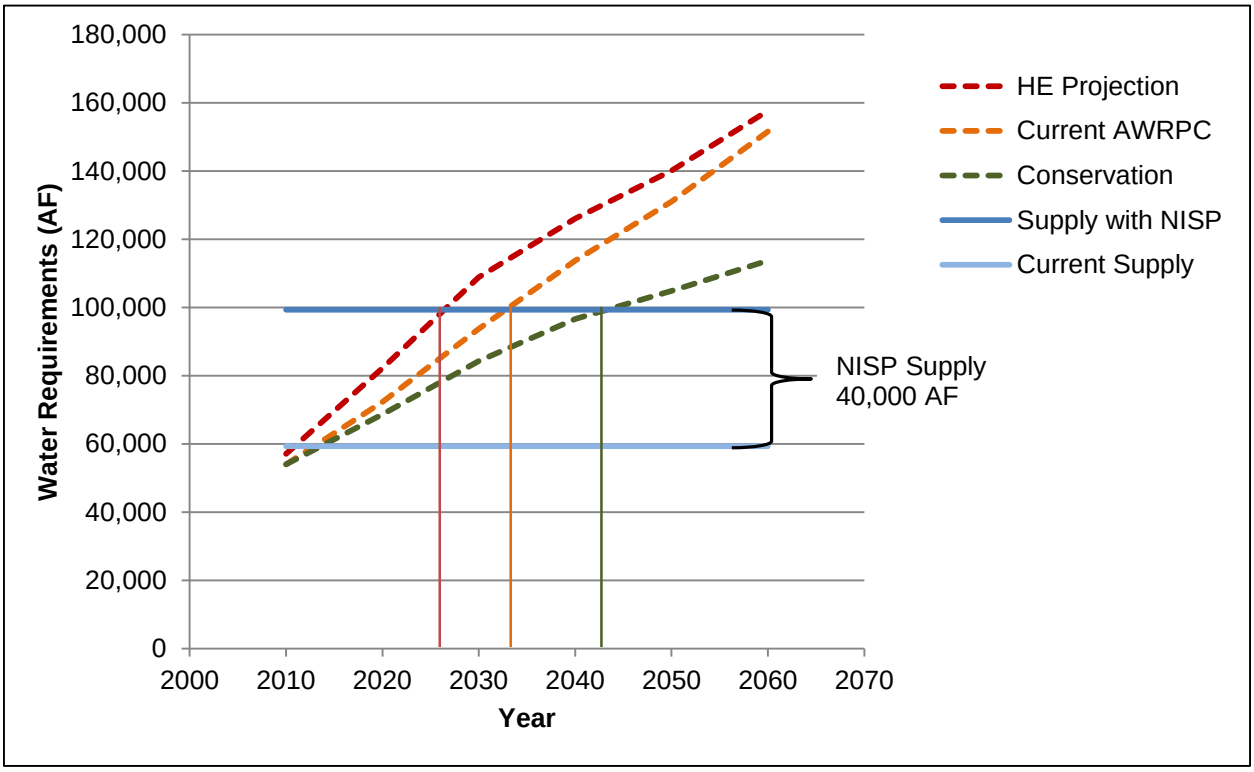
1.2.10 Determination of Need and Demand Scenarios

Based on the demand projections developed by the Participants and the District, the combined total future water demand for the NISP Participants will exceed their combined existing annual firm yield (59,400 AF) by 2015. By 2030, the excess of combined demands over current firm supplies would almost exceed the 40,000 AF firm annual yield from NISP (Figure 1-4), and by 2060 projected demand over current firm supplies is projected to be about 84,000 AF, or more than double the requested firm yield from NISP. From a combined standpoint, the NISP Participants are projected to need the full yield and storage from NISP no later than 2030. The Participants would need additional supplies from that point forward (HE 2011).

Figure 1-4 provides a comparison of the NISP Participants' projected future demands under all three demand projection scenarios with the firm yield of the Participants' existing supplies and their projected supplies with the proposed NISP project, after adding the 10% safety factor discussed in Section 1.2.8.2. Under the alternative demand projection scenarios developed by the Corps, full use of the projected 40,000 AF of yield from the proposed NISP would occur somewhat later than under the demand projections developed for the Participants and the District. Under the Current AWRPC scenario, demands (including the safety factor) would reach the combined firm yield of NISP and the Participants' existing supplies by about 2030.

Under the Conservation Scenario, demands (including the safety factor) would reach the combined yield of NISP and the existing supplies by about 2040.

Figure 1-4. Comparison of Demand Scenarios (including Safety Factor) with Existing Supplies and Supplies with NISP.



Source: BBC 2011.

1.2.11 Relationship to Other Water Supply Projects

Other water supply projects are proposed for northeastern Colorado. The Municipal Subdistrict of the Northern Colorado Water Conservancy District (Subdistrict), on behalf of several of the Windy Gap Project Participants and the Middle Park Water Conservancy District, is currently pursuing the Windy Gap Firming Project (WGFP). Some of the NISP Participants are also participating in the proposed WGFP (CWCWD, Town of Erie, City of Evans, City of Fort Lupton, and the City of Lafayette). The NISP and WGFP are separate projects with independent utility. The relationship of these water supply projects was discussed in Section 1.8.1 of the DEIS.

1.3 REQUIRED PERMITS AND APPROVALS

The federal actions and NEPA process of the Corps and Bureau of Reclamation have not changed since the DEIS and descriptions of these actions are in Section 1.1.1 of the DEIS. The Corps, as the lead agency, is responsible for NEPA compliance including preparation of the EIS. This SDEIS was prepared to provide additional information about the District's Preferred Alternative and other alternatives and their impacts on the environment. The EIS also addresses

the information requirements associated with the Corps' public interest review (33 CFR Part 320.4).

This document has been prepared to comply with the requirements of NEPA, the CEQ regulations for implementing NEPA, (40 CFR 1500-1508), and the Corps' Regulatory Program NEPA implementing regulations at Appendix B to 33 CFR 325. On August 20, 2004, the Corps determined that an EIS is required for this proposed project because of the project's potential to significantly affect the quality of the human and natural environment. The purpose of this EIS is to assess the environmental impacts associated with the construction and operation of NISP.

Pursuant to its responsibilities under Section 404 of the CWA, the Corps reviews permit requests seeking authorization to discharge dredged or fill material into all waters of the United States. The Corps review considers the District's purpose and need from a public interest perspective. The public interest determination involves more than an evaluation of impacts to the aquatic environment. Once the project has been determined to comply with the 404(b)(1) Guidelines, the project must also be evaluated to ensure that it is not contrary to the public interest. Twenty public interest factors are listed in 33 CFR 320.4(a)(1). A project may have an adverse effect, a beneficial effect, a negligible effect, or no effect on any or all of these factors. The Corps must evaluate the project in light of these factors, other relevant public interest factors, and the interests of the District to determine the overall balance of the project with respect to the public interest. The EIS provides the basis for this public interest review, as outlined in 33 CFR 320.4, which states:

> The decision whether to issue a permit will be based on an evaluation of the probable impacts, including cumulative impacts, of the proposed activity and its intended use on the public interest. Evaluation of the probable impact that the proposed activity may have on the public interest requires a careful weighing of all those factors, which become relevant in each particular case. The benefits that reasonably may be expected to accrue from the proposal must be balanced against its reasonably foreseeable detriments. The decision whether to authorize a proposal, and if so, the conditions under which it will be allowed to occur, are therefore determined by the outcome of this general balancing process. That decision should reflect the national concern for both protection and utilization of important resources. All factors which may be relevant to the proposal must be considered including the cumulative effects thereof: among those are conservation, economics, aesthetics, general environmental concerns, wetlands, historic properties, fish and wildlife values, flood hazards, floodplain values, land use, navigation, shore erosion and accretion, recreation, water supply and conservation, water quality, energy needs, safety, food and fiber production, mineral needs, considerations of property ownership and, in general, the needs and welfare of the people.

The public interest review is thus a balancing test by the Corps of the foreseeable benefits and detriments of proposed projects on an individual and cumulative basis. The following general criteria of the public interest review must be considered in the evaluation of every permit application (see 33 CFR 320.4(a)(2)):

> (i) The relative extent of the public and private need for the proposed structure or work

(ii) Where there are unresolved conflicts as to resource use, the practicability of using reasonable alternative locations and methods to accomplish the objective of the proposed structure or work; and

(iii) The extent and permanence of the beneficial and/or detrimental effect(s) that the proposed structure or work is likely to have on the public and private uses to which the area is suited.

The Corps is neither a proponent nor opponent of any permit proposal. The decision to issue or deny a permit is based, in part on the weighing and balancing of the public interest factors. In order to issue a permit, the Corps must determine that it would not be contrary to the public interest (33 CFR 320.4(a)). Further, the 404(b)(1) Guidelines prohibit the issuance of a permit if the discharge is not the least environmentally damaging practicable alternative (LEDPA), or would cause or contribute to significant degradation of waters of the United States (40 CFR 230.10(a)(4).

After issuance of the Final EIS, the Corps must wait at least 30 days before issuing a Record of Decision (ROD) as specified in 40 CFR 1506.10 and 33 CFR 325 Appendix B Section 18. The Corps' ROD will include information prescribed at 40 CFR 1505.2 as well as a determination relative to its Public Interest Review (33 CFR 320) and 404(b)(1) Guidelines compliance determination (40 CFR 230). The decision options available to the Corps' district engineer, are issue the permit, issue with modifications or conditions or deny the permit (33 CFR 325 Appendix B Section (9)(b)(5)). The Corps may add special conditions to the permit to satisfy public interest requirements provided those conditions are directly related to the impacts, are appropriate to the scope and degree of those impacts, and are reasonably enforceable (33 CFR 325.4(a)). Conditions may also be added to address the requirements of the 404(b)(1) Guidelines (40 CFR 230.12(a)(2)).

The issuance of the SDEIS will be accompanied by a public comment period. During this period, the Corps will hold public hearings on the SDEIS. The Corps will provide responses to significant comments in the Final EIS (CEQ 1981). A Final EIS will be completed following the publication of the SDEIS and consideration of comments on the SDEIS. The Corps' decision on whether to permit the District's Preferred Alternative or another alternative will be documented in a ROD. Tasks remaining for NEPA compliance, Section 404 permit decision, and Reclamation contract decision are summarized below.

NEPA

- Corps will receive comments during the SDEIS public comment period
- Corps will hold public hearings during the SDEIS public comment period
- Corps will respond to comments on the SDEIS
- Corps will publish a Final EIS
- Corps will complete ROD concurrently with 404 permit decision

Section 404 Permit Decision

- District has submitted a Section 404 permit application to the Corps; the Corps is evaluating application concurrently with EIS process
- Corps will complete a 404 permit decision concurrently with a ROD

Reclamation Contract and Special Use Permit Decisions

- Reclamation will initiate their ROD and contract negotiation process subsequent to issuance of the Corps' ROD and 404 permit if the Reclamation Action Option for the District's Preferred Alternative was permitted by the Corps.
- After contract negotiations were completed, Reclamation will evaluate all contract terms and conditions pursuant to 40 CFR 1502.9(c)(1)(ii) to determine if additional NEPA analysis is warranted.
- Reclamation will make a decision about issuance of a special use permit for the connection of the Glade to Horsetooth Pipeline in the ROD addressing contracting actions or a separate decision once it is determined if the pipeline would be needed.

1.4 AGENCY AND PUBLIC SCOPING ISSUES

Public scoping outreach activities and key issues identified for analysis in the EIS are summarized in Section 1.9 of the DEIS. The Corps considered public and agency comment on the DEIS in developing the analysis for the SDEIS. Table 1-8 summarizes the SDEIS themes that respond to substantive comments on the DEIS.

Table 1-8. SDEIS themes that respond to key substantive comments on the DEIS.

Theme	Comments on DEIS
1. Changes to hydrology modeling – A new common technical platform (CTP) hydrology was developed that includes the monthly flow disaggregated into daily flows and extends the period of record through 2005. The development of the CTP is discussed in the Executive Summary,	• Monthly time steps do not adequately predict aquatic habitat. • The hydrologic period of record does not include 2002, a severe drought year.
2. Revised aquatics habitat assessment – Six representative 2-D hydraulic sites were established on the Poudre River below the canyon mouth, and site-specific habitat suitability curves for Poudre River fish were developed. These sites will serve as the CTP for assessing impacts to aquatic resources on the Poudre River below the canyon mouth.	• PHABSIM used for the DEIS did not allow for an adequate assessment of impacts to aquatic resources. • Consistency was needed with the HSWSPs EIS, which was using 2-D to assess impacts to aquatic habitat.
3. Revised water quality assessment – Two additional years (2008 and 2009) of water quality data were collected and evaluated, with a focus on effects to wastewater treatment plants (WWTPs) and the Poudre River in the vicinity of the WWTPs.	• Fort Collins may be required to spend up to $125 million on wastewater facilities to protect the Poudre River and comply with their discharge permits. • Degradation of Horsetooth Reservoir with increased total organic carbon (TOC) levels could require Fort Collins to spend in excess of $90 million in capital costs and almost $3 million annually to maintain the quality of water delivered to customers. • Reduced flows in the Poudre River would increase the temperature of the river and would affect pH and anionized ammonia.
4. Revised assessment of trichloroethene (TCE) contamination near Glade Reservoir – Additional monitoring of TCE in ground water was conducted.	• Glade Reservoir would increase the likelihood and rate of TCE migration to the Poudre River. • A more reliable and comprehensive plan is needed to avoid, minimize, and mitigate impacts associated with the TCE contamination.
5. Revised channel morphology assessment – Using the CTP hydrology, additional data collected on sediment size and distribution, and a review of historical aerial photography, trends in channel changes, sediment, and flooding were determined.	• Without the flushing and overbank flows, the Poudre River may become choked with sediment that cannot be flushed on a regular basis. • Additional sediment and plant growth would tend to reduce the ability of the Poudre River to handle flooding when it occurs.
6. Revised assessment of ground water-surface water relationships – Ground water monitoring wells and crest gages were installed and monitored at representative sites along the Poudre River.	• The high flows that would be diverted from the Poudre River for NISP are critical to maintaining the water table that supports adjoining wetlands and the cottonwood gallery forest along the Poudre River. • Reductions in Poudre River flows would cause a decline in water quality.
7. Revised assessment of riparian resources – Data on ground water-surface water relationships, nonnative species, review of historical aerial photography, and existing wetland and riparian mapping were used to revise the assessment of riparian resources and develop information on trends for riparian resources.	• The reduction of flows in the Poudre River could lead to a loss of many important native species and lead to increased invasion by pest species such as Russian olive or tamarisk. • The DEIS failed to identify wetlands along the Poudre River riparian corridor through Fort Collins. • Reductions in flows in the Poudre River would reduce ground water levels that support riparian vegetation.
8. Revised mitigation plan – The mitigation plan presented in the DEIS was conceptual and presented mitigation options intended to stimulate comment. The mitigation plan in the SDEIS (Appendix F) provides greater detail and is presented as mitigation proposed by the District. The Corps will describe the final mitigation requirements in its ROD and may incorporate mitigation required by CPW and CDPHE.	• There is no guarantee that the mitigation would be implemented. • There is not enough detail to determine what mitigation is being proposed. • There is not enough information to determine if the proposed mitigation would mitigate the targeted adverse effects.

CHAPTER 2

PROPOSED ACTION AND ALTERNATIVES

CHAPTER 2

PROPOSED ACTION AND ALTERNATIVES

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Chapter 2. Proposed Action and Alternatives

2.1 INTRODUCTION

This chapter provides new and updated information relevant to the revised analysis presented in Chapter 4. The descriptions of the No Action Alternative (also referred to as Alternative 1 for hydrologic modeling and comparison purposes), Alternative 3-Cactus Hill Reservoir, Poudre Valley Canal Diversion, and SPWCP, and Alternative 4-Cactus Hill Reservoir, Multiple Diversion Locations, and SPWCP are revised from that presented in the DEIS. The four alternatives analyzed in detail in this SDEIS are:

- No Action Alternative (Alternative 1) — Cactus Hill Reservoir (120,000 AF) and Agricultural Water Transfer
- Alternative 2 — Glade Reservoir (170,000 AF) and the South Platte Water Conservation Project (SPWCP) (Proposed Action and District's Preferred Alternative)
- Alternative 3 — Cactus Hill Reservoir (190,000 AF), Poudre Valley Canal Diversion, and the SPWCP.
- Alternative 4 — Cactus Hill Reservoir (190,000 AF), Multiple Diversion Locations, and the SPWCP.

Comments on the DEIS included a request for more detail on the specific features of the No Action Alternative. The Corps requested that the District describe the No Action Alternative in comparable detail to the Action Alternatives. The Corps also asked that the Participants describe their current plans in the absence of NISP, if different from the DEIS. Discussions between the District and the Participants indicated that the DEIS No Action Alternative was not feasible particularly due to its reliance on gravel pit storage, C-BT unit purchases, and ground water use, and that substantial changes to the DEIS No Action Alternative were needed. The Participants developed a new No Action Alternative in 2010 (MWH 2010). The new No Action Alternative was independently reviewed by the Corps prior to its inclusion in the SDEIS for evaluation.

The size of Galeton reservoir, which is part of the SPWCP and all of the action alternatives, was increased from 40,000 AF in the DEIS to 45,624 AF in the SDEIS to maximize beneficial use of 1992-priority storage rights.

The structural components of Alternative 2 are the same as those described in the DEIS. The Proposed Action includes realignment of a segment of U.S. 287 at the proposed Glade Reservoir site. Two alignment options, the northern alignment and the western alignment, were analyzed in detail in the DEIS. Since the DEIS issuance, CDOT selected the western alignment as the preferred alignment. The elimination of the northern alignment from further analysis is discussed in Section 2.2.7.2. The discussion of the proposed U.S. 287 realignment is

incorporated into the description of the Proposed Action in Section 2.5 and into the effects analysis of the Proposed Action in Chapters 4 and 5.

The structural components of Alternative 3 are the same as those described in the DEIS. The size of Cactus Hill Reservoir, 180,000 AF in the DEIS, was increased to 190,000 AF of active storage capacity to account for updated evaporation estimates from the reservoir. The pipeline alignment from Cactus Hill Reservoir to the Participants was revised from that presented in the DEIS. The pipeline alignment is similar to the alignment that would be used in the new No Action Alternative. In the DEIS, a Reclamation Contract Option and a Reclamation No Contract Option were a component of each action alternative. At the request of Reclamation, these options were renamed the Reclamation Action Option and the No Reclamation Action Option in the SDEIS. The Corps eliminated the Reclamation Action Option for Alternatives 3 and 4, as discussed in Section 2.2.7.3.

Alternative 4 in the DEIS was replaced in its entirety by a new alternative: Cactus Hill Reservoir, Multiple Diversion Locations, and the SPWCP. Alternative 4 in the DEIS was similar to the District's Proposed Action except that about 12,000 AF of the Participants' requested firm yield would come from the purchase and transfer of agricultural water rights to municipal and industrial (M&I) use. The concept of transferring agricultural water rights to meet the project purpose is included in the No Action Alternative. Consequently, it was eliminated from Alternative 4 in this SDEIS.

2.2 PRELIMINARY ALTERNATIVE SCREENING PROCESS

The Corps' alternatives screening and development process was described in Section 2.1 of the DEIS. This section presents new and updated information relevant to the screening process.

2.2.1 Development of Alternatives

2.2.1.1 Independent Review of NISP Alternatives Evaluation

In 2003, prior to the NISP EIS and as part of the development of a reliable future regional water supply for the Participants, the District studied potential project alternatives (Phase II report, MWH 2004). The Corps' independent analysis of the District's alternatives analysis (MWH 2004) is summarized in Volume I of the Northern Integrated Supply Project EIS Alternatives Evaluation Report (HDR 2007). Volume II of the Phase II report includes the Corps' independent alternatives analysis, screening process, and action and No Action Alternatives selection (HDR 2007).

2.2.1.2 Alternative Refinement

The Corps determined the District's Phase II report provides a thorough compilation of data and alternatives analysis. The Corps completed further refinement of the alternative screening and selection process to address the requirements of the 404(b)(1) Guidelines. To comply with the

404(b)(1) Guidelines, the Corps reevaluated all of the alternatives identified in the Phase II report, as well as other new alternatives identified subsequent to the Phase II report and during scoping. Additional detail on the Corps' evaluation of alternatives is found in the NISP EIS Alternatives Evaluation Report (HDR 2007).

2.2.2 Alternative Screening

To ensure the alternatives analysis met the requirements of the 404(b)(1) Guidelines, the Corps reviewed the screening criteria used in the 2007 NISP EIS Alternatives Evaluation Report (HDR 2007). The Corps eliminated timeliness under the purpose and need screening category and reevaluated the alternatives for the land use criterion in the practicable screening category; these changes are discussed in the following sections. The alternatives re-evaluation is described in more detail in an addendum to the 2007 NISP EIS Alternatives Evaluation Report (ERO 2014a).

2.2.2.1 Purpose and Need Screening Category

Both NEPA and the 404(b)(1) Guidelines recognize that alternatives must address a project's purpose and need. Alternatives need to achieve basic goals that are established in the purpose and need statement. The purpose and need for NISP are presented in Chapter 1 of the EIS. For the DEIS, project concepts and elements were screened using three purpose and need criteria: firm yield, timeliness, and regional project. During the period in which the Corps' independent alternatives analysis was completed, the majority of NISP Participants had an immediate demand for water because between 2005 and 2010 the total demand of all the Participants combined was expected to exceed their combined firm annual yield. When the Corps published the DEIS in 2008, the United States was in a severe recession that began in 2007, which substantially altered the timing of the Participants' future water demands increases. The District reevaluated the NISP Participant demands in 2011 (HE 2011). The Corps reviewed these 2011 demand projections in connection with the validity of the need (BBC 2011) and found that 40,000 AF of firm annual yield is still valid for NISP. The need for the project and the Corps' independent review of the 2011 demand projections are discussed in Section 1.2 of this SDEIS.

The Corps determined that "regional project" is an appropriate screening criterion for the alternatives screening process for NISP. The District is the permit applicant (not the 15 individual NISP Participants). As discussed in Section 1.1.2 of the DEIS, NISP would be constructed and owned by the District if the Corps issued a permit. While the District would retain ownership and operational responsibility of the project, the Participants would own a perpetual contract right to a defined portion of the project facilities and a defined portion of the water diverted by the project. The District is a regional water supply entity with responsibilities for water supply planning and management for the region and what it is proposing is a regional water supply project to meet the water supply needs of 15 Participants providing water to an area of about 945 square miles.

2.2.2.2 Environmental Screening Category

The Corps used two environmental screening criteria, wetlands and waterways, in the DEIS. These two criteria were not changed in the SDEIS.

2.2.2.3 Practicable Screening Category

The screening criteria described in Volume II of the NISP EIS Alternatives Evaluation Report (HDR 2007) included land use considerations under the logistics criterion. To advance, water sources or infrastructure components could not be located in National parks, state parks, and designated wilderness and scenic areas that were established to create or preserve areas of common use, aesthetics, environmental values, and ecosystems. For the SDEIS, the Corps reconsidered the rationale for the land use screening criterion and determined that all factors except local open space (e.g., city or local open space) remain valid. The Corps determined sites currently managed for local open space would be available for NISP purposes due to general limited ecological function in comparison to other nationally recognized natural areas (National Parks, Wilderness, or Wild and Scenic Rivers) and the applicant could condemn such land. The Corps determined local open space could reasonably be obtained, utilized, expanded, or managed in order to fulfill the basic project purpose (40 CFR 230.10(a)(2)). For the above reasons, the Corps no longer considers local open space an appropriate screening criterion for NISP. In the alternatives analysis completed for the DEIS, no project concepts or elements were eliminated on the basis of county open space.

2.2.3 Concepts

2.2.3.1 Concepts Considered and Retained

The Corps evaluated and screened concepts according to the NISP screening criteria described in the DEIS. Of the original 16 concepts, three concepts—water rights development, South Platte Water Conservation Project, and agriculture to municipal transfers—were retained for further evaluation in the DEIS. No new concepts were retained as a result of the elimination of timeliness as a screening criterion. Concepts retained and eliminated, and the reasons they were retained or eliminated, were discussed in the DEIS and are described in greater detail in the NISP EIS Alternatives Evaluation Report (HDR 2007).

2.2.3.2 Concepts Considered but Eliminated

In the NISP EIS Alternatives Evaluation Report Volume II (HDR 2007), the Corps considered a concept of supplying water for NISP through the development of, or participation in, other projects that are proposed to bring water across the Continental Divide or other mountain ranges to the Front Range of Colorado. Projects evaluated were:

- Colorado River Return Project
- Yampa River Project

- Green River Pipeline Project
- Increased transmountain diversions from the North Platte and/or Laramie River Basins

All of these concepts except increased transmountain diversions from the North Platte and/or Laramie River Basins were eliminated in whole or in part because of the timeliness criterion. The reevaluation of the Colorado, Yampa, and Green river projects without timeliness as a criterion is discussed briefly below and in more detail in the addendum to the NISP EIS Alternatives Evaluation Report (ERO 2014a).

In the NISP EIS Alternatives Evaluation Report, the Corps eliminated the Colorado River Return Project on the basis of timeliness, reliability, and logistics (HDR 2007). No subsequent studies have altered the analysis associated with the project's reliability or logistics. The Corps determined the issues of reliability and logistics are still appropriate reasons for eliminating the Colorado River Return Project as a water supply concept from detailed analysis in the EIS.

In 2011, the BLM revised the Little Snake Resource Management Plan and identified three segments of the Yampa River totaling 22 miles as eligible and suitable for inclusion in the National Wild and Scenic Rivers System. The Outstandingly Remarkable Value (ORV) of the upper segment is wild, the ORV of the middle segment is scenic, and the ORV for a lower segment is recreational (BLM 2011). The Corps eliminated the Yampa River Project from detailed analysis because it would affect the free-flowing characteristics of the eligible and suitable Yampa River segments, result in depletive effects to the expected higher quality functions of the Yampa River that support its listing in contrast to the effects on aquatic resources in the Colorado Front Range, and other reasonable water supply alternatives were available to avoid such effects.

In the NISP EIS Alternatives Evaluation Report Volume II, the Corps considered a project then called the Green River Pipeline Project. In 2009, the Corps issued a Notice of Intent to prepare an EIS on the Regional Watershed Supply Project (RWSP) that embodied the concept of the Green River Pipeline Project. Because the project proponent was unable to define the project purpose, the Corps notified interested parties in 2011 that it had withdrawn the Section 404 permit application for the proposed RWSP and terminated the process to develop a DEIS. In late 2011, Wyco Power and Water, Inc. (Wyco) filed a preliminary permit application to study the RWSP with the Federal Energy Regulatory Commission (FERC). FERC staff clarified to Wyco that because the Commission would only license the proposed hydropower developments, which are discrete components of the 501-mile-long water conveyance pipeline, construction of substantial portions of the overall project may require authorization from other federal agencies. FERC dismissed Wyco's application in 2012 as premature and reiterated staff positions from 2011. Wyco's request for a re-hearing was subsequently denied.

In 2012, two other entities were evaluating conveyance of water from the Green River's Flaming Gorge Reservoir to the Front Range. The Basin Roundtable Project Exploration Committee received funding from the Colorado Water Conservation Board to explore interests and issues related to a possible Flaming Gorge water supply project, gather and analyze current information about the potential impacts of such a project, and explore what additional work or activities

would be needed to address the issues and interests. The Basin Roundtable Project Exploration Committee delivered a report of findings in January 2013 and is no longer active. The Colorado/Wyoming Coalition is also analyzing the feasibility of the project. Established in 2010, the coalition is a joint collaboration between Colorado and Wyoming entities. The Colorado entities are Douglas County, South Metro Water Supply Authority, Parker Water and Sanitation District, Town of Castle Rock, and Pikes Peak Regional Water Authority. The Wyoming entities are City of Cheyenne, City of Torrington, and Laramie County.

In the addendum to the NISP EIS Alternatives Evaluation Report (ERO 2014a), the Corps concluded that this concept and the water it provides is integral to the plans of those entities that were documented as interested in participating in the referenced projects. The Corps also determined that the concept offers no identifiable environmental advantages, including less effect to waters of the U.S., over the concepts evaluated in detail based on the initial resource concerns identified during the scoping process associated with the RWSP. For these reasons, the concept was eliminated from detailed analysis.

2.2.4 Elements

In the DEIS, 215 potential elements were screened and included 15 reservoir rehabilitation sites, 35 reservoir enlargement sites, 147 new reservoir sites, six ground water aquifers, and 12 gravel lakes (HDR 2007). These elements were screened using the NISP alternatives screening criteria. Information on the various elements is summarized in the Alternatives Evaluation Report (HDR 2007). Following the screening and evaluation of 215 potential elements, 11 elements, all new reservoirs, remained. The elements associated with reservoir rehabilitation, reservoir enlargement, ground water, and gravel lakes were eliminated in the DEIS (Table 2-1).

The eight project elements eliminated in the prior analysis in whole or in part on the basis of timeliness were: Horsetooth Reservoir or Carter Lake enlargement; Bear Creek Lake enlargement, Hertha Reservoir enlargement, and five new reservoir sites (Dowe Flats, Dry Creek, Meadow Hollow, Sprenger Ranch, and Stone Canyon). Enlargements of Horsetooth Reservoir or Carter Lake were eliminated from consideration because of the adverse effect to current operations and water deliveries to C-BT water users contrary to Reclamation obligations (Senate Document 80) and the need for and uncertainty of Congressional action. Bear Creek Lake enlargement was eliminated from detailed analysis because it failed the waterway criterion due to the need to fill Bear Creek to enlarge the dam (ERO 2014a).

Five elements, Hertha Reservoir Enlargement and reservoir sites at Dry Creek, Meadow Hollow, Sprenger Ranch and Stone Canyon would neither individually nor collectively provide sufficient storage to meet the NISP storage and firm yield requirements. The Corps considered combining either an enlarged Hertha Reservoir or one of the other four reservoir sites with the proposed but reduced Glade Reservoir site. Reducing the size of the Glade Reservoir would have a negligible reduction in the amount of wetlands and open water affected by Glade Reservoir. Decreasing Glade Reservoir by 100,000 AF would reduce wetland effects by 0.8 acres and open water effects by 0.4 acres. A reduction of 58,000 AF would reduce wetland effects by 0.4 acres and open water effects by 0.2 acres (ERO 2014a).

Enlarging Hertha Reservoir would have more effect on waters of the U.S. than would be avoided by reducing the size of Glade Reservoir (ERO 2014a). Constructing a new reservoir at Dry Creek, Meadow Hollow, Sprenger Ranch and Stone Canyon, in combination with a reduced capacity Glade Reservoir, would have similar or greater effects as creating similar capacity at Glade Reservoir. Overall effects would likely be greater when the additional infrastructure necessary to construct multiple storage elements, such as pipelines and access roads, are factored into the analysis. Therefore, the Corps eliminated these five elements from detailed analysis.

The Corps did not identify any new concepts or elements during the 2014 alternatives re-evaluation and concluded the "best fit" evaluation performed in 2007 was still valid. The best fit evaluated equivalent elements from the 2007 short list of elements to avoid redundancy among equivalent elements. Equivalent elements were new reservoir sites similar in capacity, general location, and river basin. The best fit evaluation was completed based on environmental factors and capacity comparisons. Galeton Reservoir was retained as the best fit element in the lower South Platte River Basin because it has the fewest acres of wetlands among the equivalent elements. Cactus Hill Reservoir was retained as the best fit element in the Poudre Basin because it has the fewest acres of wetlands among the equivalent elements (HDR 2007).

The three retained concepts and retained best fit elements identified in 2007 were then combined to develop a reasonable range of alternatives. The alternatives developed for evaluation in the SDEIS reflect the combined retained concepts and elements (Table 2-1).

2.2.5 Healthy Rivers Alternative

During the 2008 public comment period on the DEIS, the Healthy Rivers Alternative (HRA) was submitted to the Corps by the Save the Poudre Coalition (now known as Save the Poudre: Poudre Waterkeeper, hereafter referred to as "Save the Poudre"). The alternative is presented in an undated document titled "Healthy Rivers, Healthy Communities – A Balanced Proposal for the Cache la Poudre River in Colorado."

The NISP need of 40,000 AFY of annual firm yield has not changed since the DEIS was issued. The HRA report proposes a lower need of 35,000 AFY based on Save the Poudre's analysis of the NISP Participants' future water demands and proposed reduction of system losses, and the options proposed in the HRA to meet this lower demand.

Table 2-1. Number of elements screened.

Category	Number of Elements Screened	Purpose and Need		Practicable						Environmental	
				Logistics					Existing Technology		
		Timeliness†	Regional Project	Land Use	Geographic Location	Element Capacity	Not Integral to Other Development Plans	No Congres-sional Action Required	Construction, Operation, and Safety Factors	Wetlands	Waterways
Reservoir Rehabilitation	15	0	0	0	0	13	0	0	0	0	2
Reservoir Enlargement	35	0	0	2	2	24	4	1	1	7	9
New Reservoir	147	0	0	14	23	72	1	0	4	10	97
Ground Water	6	0	0	0	0	0	0	0	6	0	0
Gravel Lake	12	0	6	0	0	6	0	0	0	0	0
Total	**215**	**0**	**6**	**16**	**25**	**115**	**5**	**1**	**11**	**17**	**108**

†The Corps eliminated timeliness as a screening criterion in the SDEIS.

As defined by Save the Poudre, the HRA would not meet the NISP need of 40,000 AFY. However, the Corps determined the water supply concepts and elements used in the development of the HRA may constitute viable components of an alternative. The Corps evaluated these individual components using the NISP alternative screening criteria; findings are documented in Hydros 2012. The HRA describes four agricultural water transfer concepts that could potentially provide additional water supply to the NISP Participants:

- Rotational fallowing
- Use of Colorado-Big Thompson Project (C-BT) units
- Traditional agricultural transfers where a water provider purchases agricultural water rights and transfers the water to municipal use, and the associated farmlands are permanently removed from irrigated agricultural production
- Development displaced water where agricultural water is transferred to municipal use in a similar manner as traditional agricultural transfers but is limited to transfers from irrigated land being developed for municipal use.

The HRA arranged combinations of these four agricultural transfer components into two alternative options to supply 35,000 AFY of firm yield to the NISP Participants. The two options presented in the HRA were:

- **Option 1** — Purchase 13,500 C-BT units to generate 9,450 AFY firm yield based on assumed C-BT quota = 0.7 AF/unit. Acquire remaining 25,550 AFY of firm yield through phased traditional buy-and-dry agricultural to municipal water transfers.
- **Option 2** — Generate 12,000 AFY of firm yield through rotational fallowing, 7,200 AFY through the purchase of C-BT units, and 15,800 AFY through phased traditional buy-and-dry agricultural to municipal water transfers.

The Corps' evaluation of the four HRA concepts is discussed in the following sections.

2.2.5.1 Rotational Fallowing

Rotational fallowing was a component of several agricultural to municipal water right transfers considered in the DEIS (HDR 2007). Since the DEIS was issued, new information has become available about rotational fallowing. The State of Colorado has sponsored studies and pilot projects that involve rotational fallowing and other transfer methods that do not result in permanent dry-up (CWCB 2011). The Colorado Water Conservation Board (CWCB 2011) identified several barriers to the implementation of rotational fallowing, including high transaction costs, uncertainty with water rights administration and accounting, long-term permanence, and infrastructure and water quality needs. Another state-sponsored study found that 82% of surveyed municipal providers in the South Platte Basin were familiar with the rotational fallowing concept, but 68% stated they would not consider it primarily due to the lack of permanence of the supply if the water rights were retained by the agricultural users (DiNatale 2012).

The additional review of the rotational fallowing concept found that the NISP firm yield criterion could be met if NISP were able to acquire ownership of the water rights, but would fail the firm yield criterion if ownership was left with the agricultural users because the perpetuity of the supply would last only as long as the initial lease. There are currently no large-scale rotational fallowing programs in Colorado, and the most significant pilot project, the Super Ditch in the Arkansas Basin, has not shown a proven ability to deliver a firm water supply. As a result, the rotational fallowing concept has not progressed to the point of being considered a proven technology (Hydros 2012). Therefore, the scenarios evaluated in the DEIS and for the SDEIS involving rotational fallowing would fail the NISP proven technology and firm yield screening criteria, if irrigators retained ownership of the water rights.

2.2.5.2 Acquisition of C-BT Units

The availability of C-BT units was evaluated in the DEIS and C-BT units comprised a substantial portion of the No Action Alternative presented in the DEIS (21,600 C-BT units). Comments about the availability of C-BT water were raised on the DEIS and the Corps evaluated the availability of C-BT water again for the SDEIS (Hydros 2012). In 2010, the District revised its No Action Alternative (MWH 2010) and concluded that C-BT should not be considered as a regional source due to the diminishing availability of C-BT units. Additionally, in 1995 the District established caps on municipal purchases to prevent speculation in the purchase of C-BT water for future demands. Hydros (2012) used the District's analyses (Pineda 2009) during the CTP process to estimate the number of C-BT units available for transfer to municipal use. The District's analyses indicated that as of 2009, 34,000 units were estimated as available for transfer to municipal owners, and are projected to be transferred at a rate of 2,000 units per year. Based on this annual transfer rate, about 28,000 C-BT units were available for transfer in 2012 (Hydros 2012). The availability of C-BT units for transfer to municipal owners continues to decline. Between 2004 and 2010, NISP Participants alone acquired an additional 13,286 C-BT units. Acquisitions by NISP Participants alone in the 6-year period of 2004 to 2010 exceed the 2,000 unit/year assumption made by Pineda (2009), and do not include acquisitions by other water providers in the region. This indicates existing strong competition for the remaining C-BT units.

Throughout the 50-plus years that the C-BT Project has been in operation, the annual quota has ranged from 0.5 to 1.0 AF, with an average of about 0.7. This quota represents the fraction of 1 AF that allottees receive for each C-BT unit owned. The HRA proposed a 70% quota (0.7 AF/unit) for firm yield, which is the average yield of C-BT supplies, not the firm yield. HRA Option 1 proposes 9,450 AFY of firm yield to be met by C-BT and Option 2 proposes 7,200 AFY of firm yield to be met by C-BT. The two HRA water supply options use an assumed 70% firm yield, resulting in 13,500 units for Option 1 and 10,286 units for Option 2.

However, 70% is not a reasonable firm yield quota value because in years of lower quota, the yield from C-BT units is lower than 0.7 AF/unit. The District allows providers to elect for a fixed quota of 0.7 AF/unit, but even the fixed quota allotment has been reduced under severe drought conditions (Hydros 2012). The actual number of units required for Option 1 is 15,450 to

18,900 units (60% and 50% firm yield quota, respectively) and Option 2 would require 12,000 to 14,400 units (60% and 50% firm yield quota, respectively).

The NISP firm yield screening criteria include providing at least 12,000 AFY of firm yield of the full 40,000 AFY firm yield requirement for a component of an alternative to be considered potentially feasible.

To meet the firm yield screening criteria of 12,000 AF, 20,000 to 24,000 C-BT units would be required, assuming a quota of 0.6 or 0.5, respectively. Given the strong competition for C-BT units from non-NISP entities, diminishing C-BT availability, and the municipal caps in place by the District, it is not likely that NISP Participants would be able to acquire 20,000 to 24,000 of the remaining 28,000 C-BT units available for transfer to municipal ownership. It is more likely that NISP Participants would be able to continue to acquire smaller amounts of C-BT to augment their overall supply portfolio. Therefore, acquisition of additional C-BT water fails the firm yield criterion.

2.2.5.3 Traditional Agricultural Transfers

Traditional agricultural transfers were previously evaluated as a partial supply for NISP as part of Alternative 4 in the DEIS. Additionally, the water source for the revised No Action Alternative is comprised primarily of agricultural transfers from three large ditch companies in the Poudre and Big Thompson Basins and includes pro-rata use of storage within the existing agricultural reservoirs. The traditional agricultural transfers concept as proposed in the Healthy Rivers Alternative does not differ fundamentally from the Corps' previous analyses.

2.2.5.4 Development of Displaced Water

Hydros (2012) investigated a sub-category of agricultural water transfers referred to as development displaced water. Development displaced water is agricultural water transferred to municipal use in a similar manner as traditional agricultural transfers, but is limited to transfers from irrigated land being developed for municipal use. Based on 2060 population projections (Harvey Economics 2011), Hydros (2012) found that NISP Participant municipality future planning areas that are not currently developed total 190,000 acres, 78,000 acres of which is developable irrigated acreage with transferable water. Based on projected population growth, the NISP Participants were estimated to develop onto 25,000 irrigated acres. Using estimates of consumptive use and farm efficiency from the State's consumptive use model (Leonard Rice Engineers, Inc. [LRE] 2010), 36,600 AFY of water is delivered to farm headgates on these 25,000 acres. Use of the farm headgate delivery by municipalities is possible provided return flow obligations are met (e.g., by wastewater effluent and releases from gravel pits or other storage). The transferable consumptive use is 25,600 AFY. NISP Participants would face several challenges in acquiring development displaced water due to several factors, including potential ownership of the water rights (or shares in ditch companies) by other municipalities (e.g., purchase and lease-back programs already in place by others), water quality concerns, and lack of adequate infrastructure to deliver water to the potable water system. Assuming these

challenges could be overcome, development displaced water satisfies the firm yield criterion for a partial supply.

The nature of development displaced water is a local water supply. Water is derived from lands within the NISP Participant future planning areas and will likely be integrated into local water systems and used for meeting a portion of the Participants' future water needs, provided other legal and logistical challenges can be overcome. Acquisition of development displaced water by individual Participants does not constitute a regional project and therefore fails the regional project criterion (Hydros 2012).

2.2.6 A Better Future for the Poudre River Alternative

In 2012, after the end of the DEIS comment period, Western Resource Advocates submitted to the Corps an alternative to the NISP; it was called "A Better Future for the Poudre River" (WRA 2012). Western Resource Advocates developed the alternative to incorporate more current Colorado State Demography Office population projections, revised NISP Participant demands and supplies from a 2011 report by Harvey Economics (2011), data from the Colorado 2010 Statewide Water Supply Initiative (CDM Smith 2011a), and other recent reports. The Better Future Alternative relied on water from growth onto agricultural lands, conservation, reuse, and cooperative agreements with agriculture. Based on Colorado State Demography Office population estimates, recent NISP Participant per capita water use, and applying passive conservation savings, the Western Resource Advocates calculated that water requirements for NISP Participants would total 72,100 AF in 2030 and 109,100 AF in 2060. Western Resource Advocates' estimate was 27,000 AF and 34,300 AF less than current NISP projections for 2030 and 2060, respectively. To meet the reduced water requirements, Western Resource Advocates' alternative suggested the following supplies:

- Current firm yield supplies of 60,550 AF
- Active conservation savings of 6,401 AF by 2030 and 20,482 AF by 2060
- Reuse of existing supplies yielding 4,900 AF by 2030
- Annual firm yield from traditional agricultural transfers from urban growth onto previously irrigated lands of 7,360 AF by 2030 and 19,150 AF by 2060
- Agricultural-Urban cooperation of 5,000 AF by 2030 and 10,000 AF by 2060

The Corps independently reviewed the Better Future Alternative, focusing on Western Resource Advocates' calculated water requirements (BBC 2013). Western Resource Advocates' calculated water requirements were based in part on a lower future population in the NISP Participant service areas. BBC concluded that Harvey Economics' population estimates for the NISP Participants in 2010, developed prior to the 2010 Census, were too high. As discussed in Section 1.2.6, BBC estimated an adjusted overall 2060 population forecast for the NISP Participants of 562,054 residents, 2.4% lower than the 2060 population projection in the 2011 Harvey Economics report. BBC's population estimate was 10.9% higher than Western Resource Advocates' population projection. BBC's adjusted Harvey Economics' projections are

consistent with recent (2012) State Demography Office projections through 2040 for overall regional growth (see Table 1–3 in Chapter 1).

Western Resource Advocates reviewed the water use per capita assumptions from the Harvey Economics report and suggested revisions to these assumptions. Western Resource Advocates' alternative water use assumptions were then applied to their alternative population growth assumptions to produce alternative water demand projections. Western Resource Advocates assumed that passive conservation would reduce NISP Participant water demands by 10.2% by 2050 and that active conservation efforts would contribute 20,482 AF to NISP supplies (or, viewed differently, reduce NISP demands) by 2060. To address the increase in water use intensity for the first few decades of the Harvey Economics demand projections and the likely decline in NISP Participant water use intensity, the Corps developed a Conservation Scenario as one of three demand projections (see Section 1.2.8 in Chapter 1). The Conservation Scenario assumes that the combination of passive and active conservation would reduce total water requirements for the Participants by 35,252 AF by 2060. If Western Resource Advocates was correct in assuming that passive conservation would reduce demand by 10.2% over the forecast period, passive conservation would account for 14,405 AF of the projected demand reductions under the Conservation Scenario. Active conservation would account for the remaining 20,847 AF. This figure is very close to the Western Resource Advocates conservation projection. Based on BBC's review, the Corps determined that the adjusted (lowered) population estimates, consistent with the State Demography Office forecasts, would be used for the NISP SDEIS. The Corps concluded the NISP need of supplying 40,000 AF of water is supported by the anticipated population growth in the Participant's service areas.

Western Resource Advocates' demand projection assumed a starting water use intensity for the NISP Participants based on their 2004-2009 average use. The Harvey Economics projection used an 11-year period (1999-2009). BBC concluded the Harvey Economics' period was reasonable, and that the 2004-2009 period used by Western Resource Advocates may not provide a reliable starting point because this short period gives too much weight to water demand in 2009, which was an extremely low demand year due to unusually wet and cool conditions throughout the summer.

Western Resource Advocates' suggested supplies of traditional agricultural transfers from urban growth onto previously irrigated lands and agricultural-urban cooperation were components to the previously discussed Healthy Rivers Alternative. Western Resource Advocates' suggested supply of 4,900 AF by 2030 from reuse was a minor component to the alternative's total supply. Existing reuse by the Participants was considered as a component of their existing supplies; any future reuse would contribute to meeting future 2060 water demands not met by NISP. For the preceding reasons and the reasons discussed in the previous section on the Healthy Rivers Alternative (Section 2.2.5), the Corps eliminated the "A Better Future for the Poudre River" alternative from detailed analysis.

2.2.7 Analysis of Specific Project Components

After the DEIS was issued and public comment on the alternatives described in the DEIS was considered, the Corps reexamined the DEIS alternatives and various options of the alternatives. The Corps' rationale for eliminating these options from detailed analysis in the SDEIS is described in the following sections.

2.2.7.1 Glade Reservoir and SPWCP with Agricultural Transfers and Cactus Hill Reservoir and SPWCP with Agricultural Transfers

The DEIS presented Alternative 4 – Glade Reservoir and SPWCP with Agricultural Transfers and Subalternative 4.2 – Cactus Hill Reservoir and SPWCP with Agricultural Transfers. For these alternatives, about 12,000 AF of the Participants' requested yield would come from the purchase and transfer of agricultural water rights to M&I water supply use. These alternatives would likely reduce the amount of water that would need to be diverted from the South Platte River through the SPWCP when compared to the Proposed Action. Associated with these alternatives, Galeton Reservoir would be reduced to 20,000 AF to reflect the contribution of the transferred water. The DEIS estimated that about 21,500 AF of agricultural water rights associated with about 17,150 acres of irrigated land would have to be purchased by NISP to produce the 12,000 AF of transferable consumptive use water associated with the alternatives. The DEIS developed a scenario involving the transfer of agricultural water rights to M&I use from irrigated lands served by the Larimer-Weld and New Cache Canals.

Alternative 4 and Subalternative 4.2 were not carried forward in the SDEIS for the following reasons:

- The new No Action Alternative evaluated in the SDEIS would derive its water supply from the transfer of agricultural water rights to M&I use for the Participants. Much of the transferred rights would come from irrigated lands served by the Larimer-Weld and New Cache Canals. Therefore, the use of agricultural water rights transfers to M&I use as a water supply element is addressed by the No Action Alternative in the SDEIS.
- Removing irrigation from about 17,150 acres of agricultural land would cause the loss of an estimated 384 to 397 acres of wetlands supported by irrigation. This large loss of wetlands would negate any possibility of this action alternative being the least environmentally damaging practicable alternative, as required by the 404(b)(1) Guidelines (40 CFR Part 230.10).
- Comments on the DEIS focused on the effects to changes in flows of the Poudre River. These alternatives would not minimize these effects.

2.2.7.2 U.S. 287 Northern Alignment Option

Section 2.7.2 of the DEIS described the process used in identifying alignment options for the U.S. 287 relocation proposed in Alternative 2. Two alignments, the western alignment and the northern alignment, were analyzed in detail in the DEIS. Since the DEIS issuance, CDOT identified the western alignment as its preferred alternative (CDOT 2013). The northern

alignment was eliminated from detailed analysis in the SDEIS for the following reasons. The northern alignment would have three horizontal curves at the minimum design radius standard, two of which would be on relatively steep slopes. The combination of the vertical geometry and tight horizontal curves could cause the northern alignment to operate at a level of safety less than the western alignment. The northern alignment would have more intersections and access road approaches than the western alignment. More intersections and access points would increase the number of potential collision locations, which degrades the overall safety of the roadway. The northern alignment would require acquisition of 100 more acres of land for right of way and affect more land owners than the western alignment. The northern alignment would be 1.4 miles longer than the existing alignment and would have 50 total lane miles of pavement. Comparatively, the western alignment would be 2.3 miles shorter than the existing alignment and have 30 total lane miles of pavement. Due to the additional lane miles, the 20-year maintenance costs of the northern alignment would be almost $2 million more than the western alignment.

2.2.7.3 Reclamation Action Option in Alternatives 3 and 4

The use of a Reclamation contract and special use permit to facilitate water delivery to the Participants was analyzed in the DEIS. The Corps determined delivery of water by exchange, conveyance and/or storage using C-BT Project infrastructure was not practicable due to the location of the Cactus Hill Reservoir in Alternatives 3 and 4. Under the Reclamation Action Option, NISP would need to pay C-BT back for any water delivered to the Participants out of Carter Lake. To accomplish this pay-back in Alternatives 3 and 4, water would be diverted from the Poudre River at the Poudre Valley Canal diversion, conveyed through nearly 30 miles of the Poudre Valley Canal to the Cactus Hill Reservoir and then pumped back upstream in a pipeline near the diversion location. The Corps therefore eliminated the Reclamation Action Option for Alternatives 3 and 4 from detailed analysis in the SDEIS.

2.2.7.4 Winter Flow Augmentation in Alternatives 3 and 4

Infrastructure associated with a Reclamation Action Option was eliminated for Alternatives 3 and 4. There would be no pipeline to deliver water from Cactus Hill Reservoir to an upstream location near the diversion for Greeley's Bellvue Filter Plant or the Hansen Supply Canal outlet. Therefore, Alternatives 3 and 4 would not include a flow augmentation program analogous to that proposed for Alternative 2 and described in Section 2.5.6.

2.2.7.5 Diversion Locations in Alternative 4

Alternative 4 includes diversion of Poudre River flows at the Poudre Valley Canal and the New Cache Canal. The Corps examined median monthly flows at the Canyon, Lincoln, and Boxelder Gages on the Poudre River in six scenarios, beginning with the Larimer-Weld and New Cache Canal diversions each split 50% to storage and 50% to direct use (CDM Smith 2011b). New Cache diversions to storage were increased in 10% increments up to 100%, and the inverse was done for Larimer-Weld Canal, with the final (sixth) scenario having the New Cache demand split

100% to direct use and 0% to storage. Specialists in fisheries, stream morphology, and water quality reviewed the scenarios and concluded the scenario reflected in Alternative 4 provided the most environmental benefit (ERO, GEI, and ACE 2011). For these reasons, the Corps eliminated the other diversion scenarios from detailed analysis.

2.3 OVERVIEW OF ALTERNATIVES

The alternatives developed for evaluation reflect the combined retained concepts and elements (Table 2-2). Table 2-3 provides a summary comparing the major features associated with the alternatives, with the length of conveyance pipelines in each alternative shown in Table 2-4.

Table 2-2. Retained concepts and elements combined to develop alternatives.

Alternative	Concept	Element
No Action	Agricultural to municipal transfers	Cactus Hill Reservoir
Glade Reservoir and SPWCP	Water rights development and SPWCP	Glade Reservoir and Galeton Reservoir
Cactus Hill Reservoir, Poudre Valley Canal Diversion, and SPWCP	Water rights development and SPWCP	Cactus Hill Reservoir and Galeton Reservoir
Cactus Hill Reservoir, Multiple Diversion Locations, and SPWCP	Water rights development and SPWCP	Cactus Hill Reservoir and Galeton Reservoir

2.4 NO ACTION ALTERNATIVE (ALTERNATIVE 1)

2.4.1 Introduction/Abstract

NEPA requires that the EIS alternatives analysis include the alternative of "no action" (40 CFR 1502.14[d]). The CEQ explains that "No Action" means "the proposed activity would not take place and the resulting environmental effects from taking no action would be compared with the effects of permitting the proposed activity or an alternative activity to go forward" (CEQ 1981). For this EIS, the No Action Alternative considers what the Participants would do to meet their need of 40,000 AFY of new firm yield if the Corps did not issue a Section 404 permit to the District for construction of NISP.

The No Action Alternative presented in the DEIS was replaced by a new No Action Alternative, as described in this section. After the DEIS was issued in 2008, the NISP Participants and the District reviewed the No Action Alternative presented in the DEIS and evaluated what the most likely action or actions taken by the District and the Participants would be to provide 40,000 AFY of firm yield if a permit for NISP was not issued by the Corps. In the No Action Alternative in the DEIS, some of the Participants that would pursue common projects were grouped (Southern group, Northern group, and Eastern group) while some of the Participants would pursue water independently.

In 2010, the Participants identified a new No Action Alternative (MWH 2010) for the SDEIS that assumes the Participants would collectively pursue a regional project, independent of the District, in the event of a permit denial for the proposed NISP.

Table 2-3. Comparison of features for each alternative.

Feature	Alternative 1 — No Action Alternative	Alternative 2 — Glade Reservoir and the SPWCP (Proposed Action)		Alternative 3 — Cactus Hill Reservoir, Poudre Valley Canal Diversion, and SPWCP	Alternative 4 — Cactus Hill Reservoir, Multiple Diversion Locations, and Modified SPWCP
		Reclamation Action	No Reclamation Action		
Glade or Cactus Hill Reservoir active storage capacity (AF)	120,000	170,000	170,000	190,000	190,000
Glade Reservoir and forebay or Cactus Hill Reservoir footprint[1] (acres)	2,456	1,882	1,882	3,728	Same as Alternative 3
Galeton Reservoir active storage capacity (AF)	Not used	45,624	45,624	Same as Alternative 2	Same as Alternative 2
Galeton Reservoir footprint[1] (acres)	Not used	1,928	1,928	Same as Alternative 2	Same as Alternative 2
South Platte diversion forebay and facilities[2] (acres)	Not used	22	22	Same as Alternative 2	Same as Alternative 2
Other permanent impacts (pump stations, WTPs, etc.) (acres)	15	19	19	177 (174 is PVC)	178 (174 is PVC)
Temporary Impacts (acres)					
Construction disturbance areas (acres)	284	283	283	285	285
Access roads	10	33	33	38	Same as Alternative 3
U.S. 287 realignment	0	124	124	0	Same as Alternative 3
Pipelines and canals	828	343	455	949	1,009
Infrastructure Relocation					
County road realignment (acres permanent)	144	0	0	144	Same as Alternative 3
(miles)	10.3	0	0	10.3	Same as Alternative 3
U.S. 287 realignment (acres permanent)	0	145	145	0	Same as Alternative 3
(miles)	0	7.0	7.0	0	Same as Alternative 3
Oil and gas wells within footprint (#)	0	16	16	1	Same as Alternative 3
within 500 feet (#)	0	3	3	3	Same as Alternative 3
Residences within footprint (#)	2	1	1	5	Same as Alternative 3
within 500 feet (#)	5	5	5	9	Same as Alternative 3
Transmission line (miles)	6.8	0.6	0.6	6.8	Same as Alternative 3
Total[3]					
Permanent (acres)	2,615	3,996	3,996	5,999	6,000
Temporary (acres)	1,122	782	894	1,271	1,332

[1]Includes permanent facilities: reservoir, dam, forebay, spillway, and associated facilities.
[2]Includes South Platte River diversion, forebay, and dam.
[3]Total permanent and temporary impacts may vary due to rounding.

Table 2-4. Conveyance pipelines for each alternative.

Pipeline	Alternative 1 — No Action Alternative	Alternative 2 — Glade Reservoir and the SPWCP (Proposed Action)		Alternative 3 — Cactus Hill Reservoir, Poudre Valley Canal Diversion, and SPWCP	Alternative 4 — Cactus Hill Reservoir, Multiple Diversion Locations, and Modified SPWCP
		Reclamation Action	No Reclamation Action		
Raw Water to Treatment Plant	39.1	0	0	0	Same as Alternative 3
Treated Water to Participants	70.3	0	0	0	Same as Alternative 3
Untreated Water to Participants	0	0	0	98.1	Same as Alternative 3
Poudre Valley Canal to Cactus Hill Reservoir	5.0	0	0	3.9	Same as Alternative 3
Glade Reservoir to Horsetooth Reservoir	0	5.5	0	0	Same as Alternative 3
Glade Reservoir to Carter Filter Plant	0	0	31.3	0	Same as Alternative 3
South Platte River to Galeton Reservoir	0	15.3	15.3	Same as Alternative 2	Same as Alternative 2
South Platte River to Larimer-Weld and New Cache Canals	0	14.2	14.2	Same as Alternative 2	Same as Alternative 2
Munroe Bypass	0	3.5	3.5	0	Same as Alternative 3
New Cache Canal to Cactus Hill Reservoir	0	0	0	0	12.7

All units are miles.

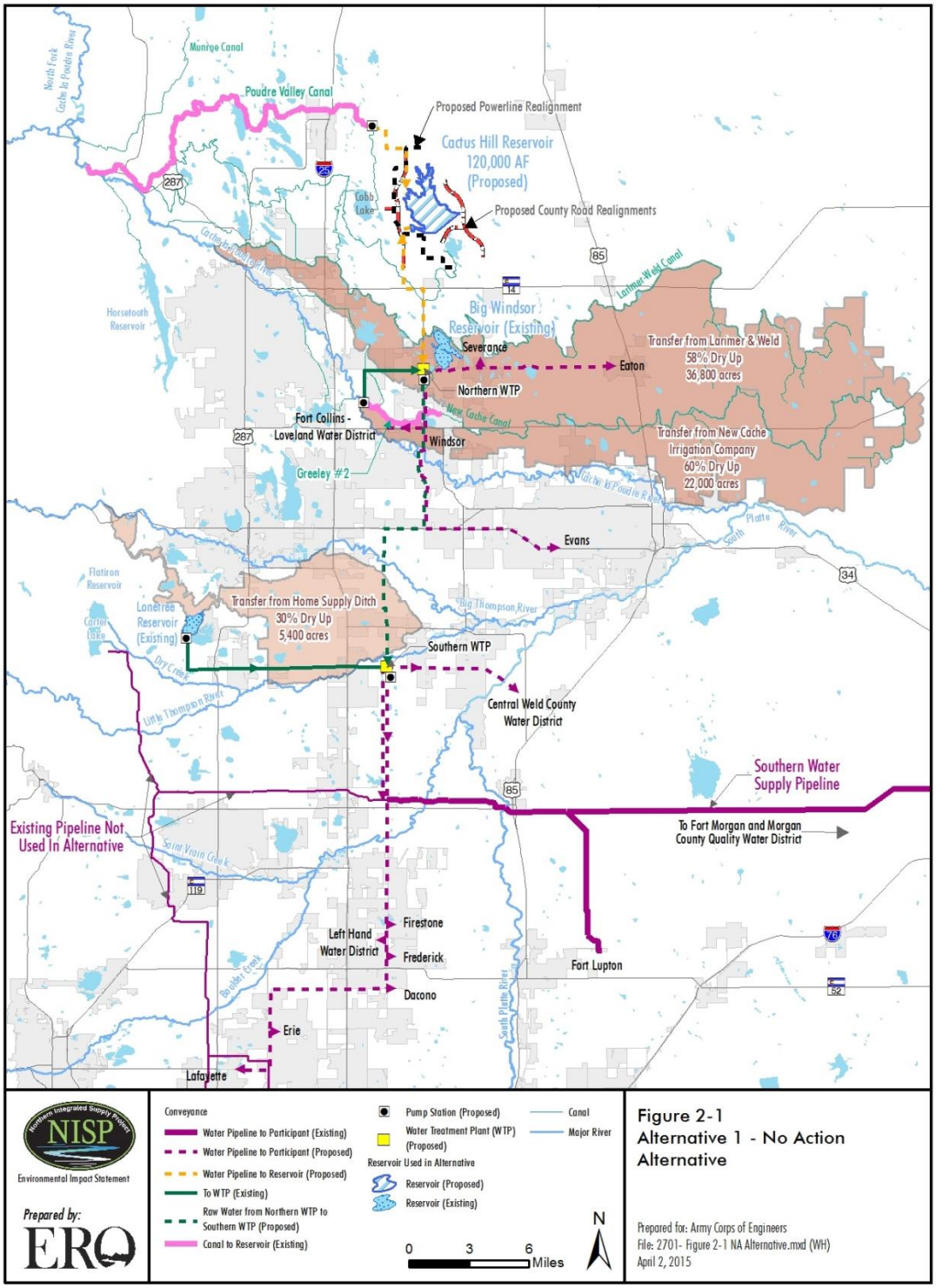
The No Action Alternative would be designed and constructed by the Participants without involvement of the District or the Northern Integrated Supply Project Water Activity Enterprise. Consequently, the conditional Grey Mountain water right and the SPWCP conditional water rights on the South Platte River, which are owned by the District and would be used in the action alternatives, would not be used in the No Action Alternative. The District would continue to own these water rights and would continue to pursue development of these water rights for other uses. In the absence of NISP, the independent Participants must meet their future water demands and it is not possible to predict with certainty the actual future response of the Participants. The Corps determined the new No Action Alternative to be a reasonable representation of an alternative that would occur if the NISP permit was denied. It is one of several options identified by MWH (2010) as outlined below. It is not known with certainty if the Participants could acquire adequate agricultural water rights to meet a firm yield of future demands.

In developing the new No Action Alternative, the Participants identified several possibilities to meet future water demands. These fall into three general strategies: (1) each Participant would act individually to develop the necessary water supplies and infrastructure; (2) Participants would form subregional groups of about two to four entities, similar to the No Action Alternative described in the DEIS; or (3) Participants would develop one or two regional projects where all Participants would share ownership, water supplies, and infrastructure capacity. The Participants identified a regional alternative as a reasonable future action in the absence of NISP due to efficiencies in operation and cost, access to higher quality water supplies, and a history of water providers in the area developing regional projects successfully. If smaller subregional or individual projects were developed, the primary difference from the regional alternative would be smaller but more storage facilities, and increased conveyance and treatment infrastructure.

The No Action Alternative presented in the SDEIS would deliver water to the Participants by transferring agricultural water supplies from the Poudre and Big Thompson Basins, using a pro rata amount of existing storage in those systems, and constructing a new reservoir at the Cactus Hill Reservoir site. The components of the No Action Alternative are shown in Figure 2-1. Key components of the No Action Alternative are:

- Transfer of water from 64,200 acres of irrigated land in the Larimer-Weld, New Cache, and Home Supply irrigation systems to municipal use
- Storage of water in the existing Big Windsor Reservoir, Lonetree Reservoir, and a new 120,000-AF Cactus Hill Reservoir
- Construction of two new regional water treatment plants
- Construction of 121 miles of water pipelines and nine pumping stations
- Realignment of three 2-lane Weld County roads totaling 10.3 miles
- Realignment of 6.8 miles of a 230-kV electric transmission line owned by Platte River Power Authority

Figure 2-1. Alternative 1—No Action Alternative.



2.4.2 Water Supplies

The No Action Alternative would transfer water from irrigated land in the Larimer-Weld, New Cache, and Home Supply irrigation systems to municipal use by the Participants. Transferred water would include the historical consumptive use portion of these water rights only. Historical return flow patterns would need to be maintained to prevent injury to senior water rights. Transfers would include pro rata storage in existing reservoirs associated with these systems. The total water supplies transferred from these systems would be about 45,200 AF on average (Table 2-5). Consistent with the Proposed Action, the firm yield to Participants would be 40,000 AF. The 5,200 AF of water supplies that would be in excess of the 40,000 AF required for delivery to the Participants would be consumed as evaporation in the reservoirs used in the alternative, or spilled under certain conditions.

Table 2-5. Water rights transfers needed for the No Action Alternative.

Canal	Transferable Ditch Consumptive Use (AF/ac)	Irrigated Land Affected (acres)	Average Yield (AF)	Percent of Ditch Right (%)	In-Ditch Storage Transferred (AF)
Larimer-Weld	0.54	36,800	19,900	58	13,569
New Cache	0.97	22,000	21,300	60	6,145
Home Supply	0.74	5,400	4,000	30	5,998
Total or Weighted Average	**0.70**	**64,200**	**45,200**	**55**	**25,712**

For the Home Supply system, transferred water would continue to be diverted from the Big Thompson River at its existing diversion location and delivered to Lonetree Reservoir southwest of Loveland. From the reservoir, a new pump station and pipeline would deliver water to a new southern treatment facility.

For the Larimer-Weld and New Cache irrigation systems, water would be diverted from the Poudre River either at existing diversion locations or at the Poudre Valley Canal diversion at the mouth of the Poudre Canyon. When diverted at its existing diversion location, Larimer-Weld Canal diversions would flow by gravity in the existing canal system to Big Windsor Reservoir. New Cache water would flow in its existing canal system to a point immediately west of Big Windsor Reservoir. At this location, a pump station and pipeline would be constructed to deliver water directly to Big Windsor Reservoir. When diverted through the Poudre Valley Canal, the Larimer-Weld and New Cache water would be delivered through the existing canal to the proposed Cactus Hill Reservoir just east of the existing Cobb Lake Reservoir.

In developing the No Action Alternative, the Participants assumed that based on existing water rights, exchanges could not provide a reliable water supply. In actual operations, alternative points of diversion or exchange water rights would be filed, and water transferred from the Larimer-Weld and New Cache systems would be diverted through the Poudre Valley Canal to Cactus Hill Reservoir when the alternative point of diversion or exchange would not injure senior water rights to provide the higher quality source water for delivery and storage. Based on NISP hydrologic modeling (CDM Smith and DiNatale 2013), water from Larimer-Weld and/or New Cache systems would be exchanged up to the Poudre Valley Canal in 250 out of

672 months in the 56-year study period. The average annual exchange to Poudre Valley Canal under the No Action Alternative would be 17,900 AFY. The rate of exchange would range from about 30 AF to more than 15,000 AF, depending on water available at Larimer-Weld and/or New Cache, exchange potential between those headgates and the Poudre Valley Canal, and available capacity in the Poudre Valley Canal. The hydrologic modeling assumed a 250-cfs capacity limitation on the canal, with no improvements made to the existing canal or headgate.

In addition to water rights transfers, a junior water right would be filed in the Poudre Basin (MWH 2010). Hydrologic modeling results (CDM Smith and DiNatale 2013) indicate that the new junior water right would yield about 750 AFY, but all of that yield is based on the water right being in priority only in the two wettest years in the historical study period. The water would be diverted through the existing Poudre Valley Canal and conveyed to Cactus Hill Reservoir.

2.4.3 South Platte Water Conservation Project

The SPWCP would not be a component of the No Action Alternative.

2.4.4 Storage

2.4.4.1 Existing Storage

Water would be stored in existing reservoirs that are part of the Larimer-Weld, New Cache, and Home Supply systems. Water would be held using pro rata ownership of several reservoirs connected to these systems, including the Larimer-Weld high mountain system, the Poudre Valley Canal system, Terry Lake, Timnath Reservoir, Big Windsor Reservoir, Lonetree Reservoir, Mariano Reservoir, and Lon Hagler Reservoir. Big Windsor Reservoir would be a key facility, serving as a terminal storage facility for the proposed North Water Treatment Plant, and partially serving as terminal storage for the proposed South Water Treatment Plant. Lonetree Reservoir would also serve as terminal storage for the proposed South Water Treatment Plant. Reservoirs would be operated in a manner to optimize water quality, which would require rotating releases among reservoirs to prevent evapoconcentration of salts from occurring in any one reservoir.

2.4.4.2 Cactus Hill Reservoir

Cactus Hill Reservoir, at 120,000 AF, would be built to store water from the Poudre River system. The reservoir site would be about 6 miles north of Severance and 6 miles east of I-25. The dam for the proposed reservoir would be built across Black Hollow, to the northwest of the existing Black Hollow Reservoir (Figure 2-2). The dam would be about 140 feet high and constructed with on-site excavated materials. The maximum water surface elevation of Cactus Hill at 120,000 AF would be about 5,216 feet for a maximum depth of about 136 feet. At full capacity, the surface area would be 2,550 acres (4 square miles). The Cactus Hill Reservoir in

the No Action Alternative would be smaller than the Cactus Hill Reservoir in Alternatives 3 and 4.

The proposed Cactus Hill Reservoir would include a multilevel outlet tower to allow for selective withdrawals from different reservoir elevations. The exact configuration of this tower, including gate spacing, screening requirements, and flow requirements, would be determined after consultation with Colorado Parks and Wildlife (CPW) and the Dam Safety Branch of the Colorado Division of Water Resources.

2.4.5 Conveyance

2.4.5.1 Conveyance to and from Reservoirs

The proposed Cactus Hill Reservoir would be filled from new pipelines from Big Windsor Reservoir and the Poudre Valley Canal. A pipeline from Big Windsor Reservoir would be required because there would likely be times when water available in the New Cache system could not be exchanged to the Poudre Valley Canal. The pipeline from Big Windsor Reservoir to Cactus Hill Reservoir would be a bi-directional pipeline, which would allow releases from Cactus Hill Reservoir back to Big Windsor Reservoir and the regional water treatment plant. The capacity of the pump station to Cactus Hill Reservoir would be 60 cfs, while the maximum release rate from Cactus Hill Reservoir through the pipeline would be 80 cfs.

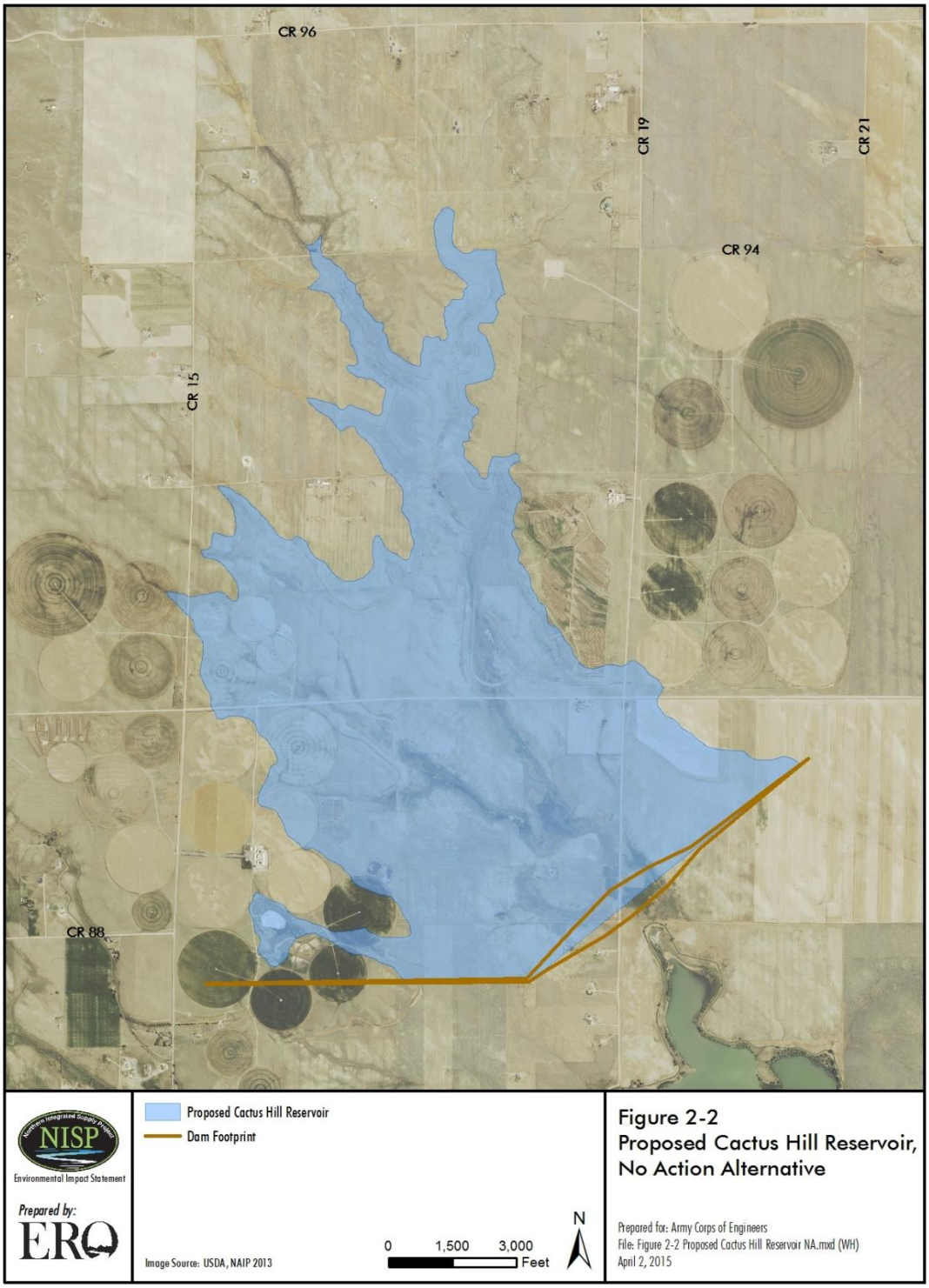
The second way that the proposed Cactus Hill Reservoir could be filled is from the existing Poudre Valley Canal. No changes to the Poudre Valley Canal would be made. To ensure adequate capacity for filling the reservoir from the canal, the capacity of the pump station and pipeline from the Poudre Valley Canal to Cactus Hill Reservoir was estimated at 200 cfs.

A diversion structure would be built adjacent to the canal bank where new diversions on existing canals would be needed (the New Cache Canal and the Lonetree Reservoir Outlet Canal). The diversion structure would include a concrete headwall, diversion box, and regulating gates outside of the canal. After these facilities were built, the canal bank would be breached, allowing flow to enter the diversion.

2.4.5.2 Deliveries to Participants

Untreated water from the New Cache system would be diverted from the Greeley No. 2 Ditch and pumped to the North Water Treatment Plant and Big Windsor Reservoir in a 4-mile pipeline. Untreated water would be pumped from Big Windsor Reservoir and the North Water Treatment Plant to the South Water Treatment Plant in a 21-mile pipeline. Treated water from the North Water Treatment Plant would be pumped to Fort Collins-Loveland Water District, Severance, Windsor, Evans, and Eaton through pipelines (Figure 2-1).

Figure 2-2. Proposed Cactus Hill Reservoir, No Action Alternative.



Untreated water would be pumped from Lonetree Reservoir to the South Water Treatment Plant via a 15-mile pipeline. From the South Water Treatment Plant, treated water would be pumped to CWCWD via an 11-mile pipeline and to the Lefthand Water District, Dacono, Frederick, Firestone, Erie, and Lafayette via a 24-mile pipeline. To convey water to Fort Morgan and MCQWD, treated water would be delivered to the Southern Water Supply Pipeline (SWSP) via a 5-mile pipeline with a capacity of 21 cfs (Figure 2-1). It is possible that water conveyed to the SWSP would be treated to a slightly different finished quality since SWSP conveys untreated water rather than treated water to the Participants. Tie-in locations to existing systems would be determined by the Participants at the time of design, and most likely would be at existing or future water storage tanks within the distribution systems. All pipeline stream crossings would be made using trenchless techniques, such as bore-and-jack or conventional tunneling.

2.4.6 Advanced Water Treatment

The No Action Alternative would use water supplies of lower quality than the Proposed Action and generally lower quality than the Participants' current supplies. Based on a mass balance assessment completed by MWH (2010) and verified by the Corps, the average total dissolved solid (TDS) concentration in untreated water would be 354 mg/L, less than the secondary maximum contaminant limit of 500 mg/L and the water quality goal of 400 mg/L used by MWH in developing the No Action Alternative. Assuming diversions would take place upstream, the two water treatment plants would not require reverse osmosis. If supplies were diverted at the canal headgates, the No Action Alternative would be obtaining 43% of supplies downstream of municipal wastewater discharges and developed areas. The No Action Alternative untreated water quality may be improved by exchanging New Cache water to diversion points further upstream. Due to the potential for lower untreated water quality, the Participants would likely construct advanced water treatment facilities. If water treatment was needed, it would likely involve the following treatment steps: precipitative softening, ultraviolet advanced oxidation, granular media filtration, and carbon adsorption.

2.4.7 Infrastructure Relocation

Most of Cactus Hill Reservoir site is owned by Anheuser-Busch and is used for disposal of wastewater associated with beer production. Anheuser-Busch's wastewater disposal facilities would require relocation. Construction of Cactus Hill Reservoir would require the realignment of three 2-lane Weld County roads totaling 10.3 miles and 6.8 miles of a 230-kV electric transmission line owned by the Platte River Power Authority. Road realignments would be on both the east and west sides of the reservoir and the electric transmission line realignment would be on the west side of the reservoir (Figure 2-1).

2.4.8 Implementation

Implementation of the No Action Alternative would take about 10 to 12 years and differs from the Proposed Action due to the additional time required to procure a change in agricultural water

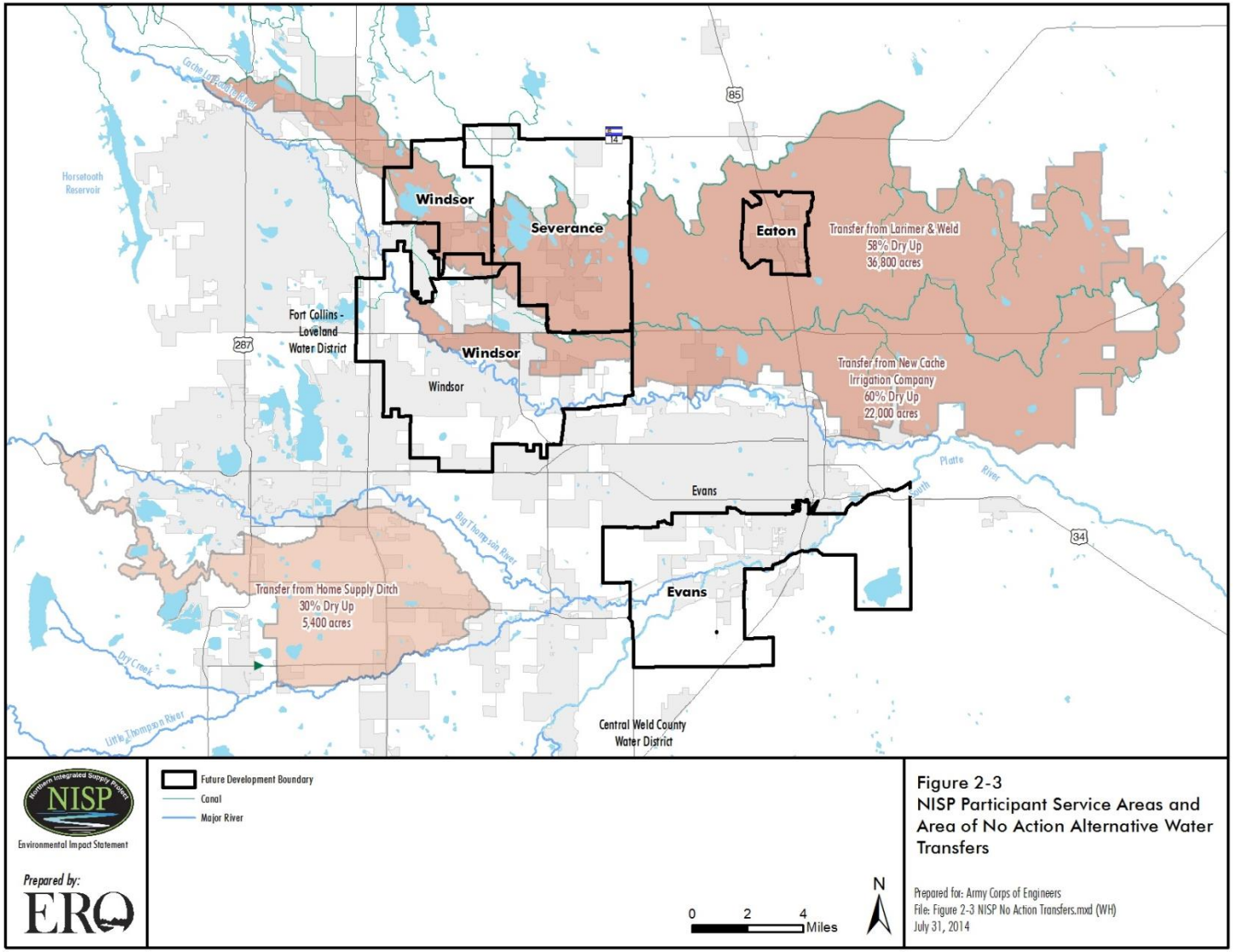
rights. The transfer of ditch shares from agricultural to municipal use would be a lengthy process for the Participants. The process would include conducting initial studies and making purchase offers to individuals within the ditch companies involved, procuring shares, participating in a change case in water court, performing actual dry-up and revegetation, and finally, constructing facilities and delivering water.

The first steps in the irrigated lands transfer process would be to perform an initial analysis that would include a "due diligence" investigation into the legal status and sustainability of the potential water rights, followed by initial engineering and hydrologic evaluations and review of other legal issues. Once this investigation was completed, the Participants would approach the ditch company shareholders regarding purchasing ditch shares. Several types of agreements could potentially be established during this initial offering, including an outright purchase of shares, first right of refusal on shares, and potentially, even some rotational fallowing types of arrangements with certain subsets of the ditch system.

It is likely that the initial offering and transfer of shares would not produce all of the water ultimately needed to meet yield requirements. Enough shares would need to be required for the Participants to be comfortable constructing the facilities that were needed to deliver the water. Participants would likely have a standing offer with shareholders for purchase of shares as they become available. Because precedence would be set through the initial water court proceedings regarding the change in point of diversion and use, water court proceedings would become more streamlined for subsequent share purchases and speed the change process for these shares. Points of diversion and allowable uses for the ditch shares purchased would need to be "changed" in the Colorado water court system. The City of Thornton underwent a similar type of change when they purchased and changed shares of the Water Supply and Storage Company, which took about 8 years to complete. Because of the magnitude of change and numerous parties involved, the process would likely take 5 to 7 years to resolve. Changing points of diversions and allowable uses would require an engineering evaluation to ensure that no senior water rights are injured by the proposed change and would include historical consumptive use evaluations, return flow evaluations, operational investigations, and other technical analyses to prove non-injury. Some of the existing system storage would likely be required to meet return flow obligations.

Dry-up and revegetation would likely be required for most shares purchased. The only case where a dry-up and revegetation clause would not be required would be if the land were to ultimately be developed for municipal use. Hydros (2012) analyzed acquisition of water rights when irrigated lands are developed for municipal use. Most of the irrigated lands served by the Larimer-Weld, New Cache, and Home Supply Canals would be outside of the future planning areas of NISP Participants (Figure 2-3). Consequently, most acquired irrigated lands would have to be revegetated. In any case, irrigated agriculture would have to cease on acquired lands before the Participants could take delivery of the water. Dry-up could consist of either reestablishing native vegetation on the acreages involved, or conversion of farming practices to the production of dry-land crops such as winter wheat.

Figure 2-3. NISP Participant Service Areas and Area of No Action Alternative Water Right Transfers.



Delivery of water from these transferred agricultural water rights to the Participants could only be made after all water court proceedings and revegetation requirements are complete. Because of the uncertain nature in these types of change cases, it is likely that the Participants would choose not to construct facilities until the entire change case is complete and any appeals are settled. For certain Participants, it may be possible to implement interim measures to take delivery of some water prior to completion of facilities.

Construction of facilities would likely commence with the construction of the pipeline segment from New Cache to Big Windsor Reservoir and the Northern Water Treatment Plant, and the pipeline segment from Lonetree Reservoir to the Southern Water Treatment Plant. All delivery infrastructure from the water treatment plants to the Participants would need to be constructed at this time as well. Because the water supplied by Home Supply would only meet a limited amount of demand, the pipeline segment from Big Windsor Reservoir to the Southern Water Treatment Plant would need to be constructed soon after. The last facility to be constructed would likely be the Cactus Hill Reservoir and associated infrastructure.

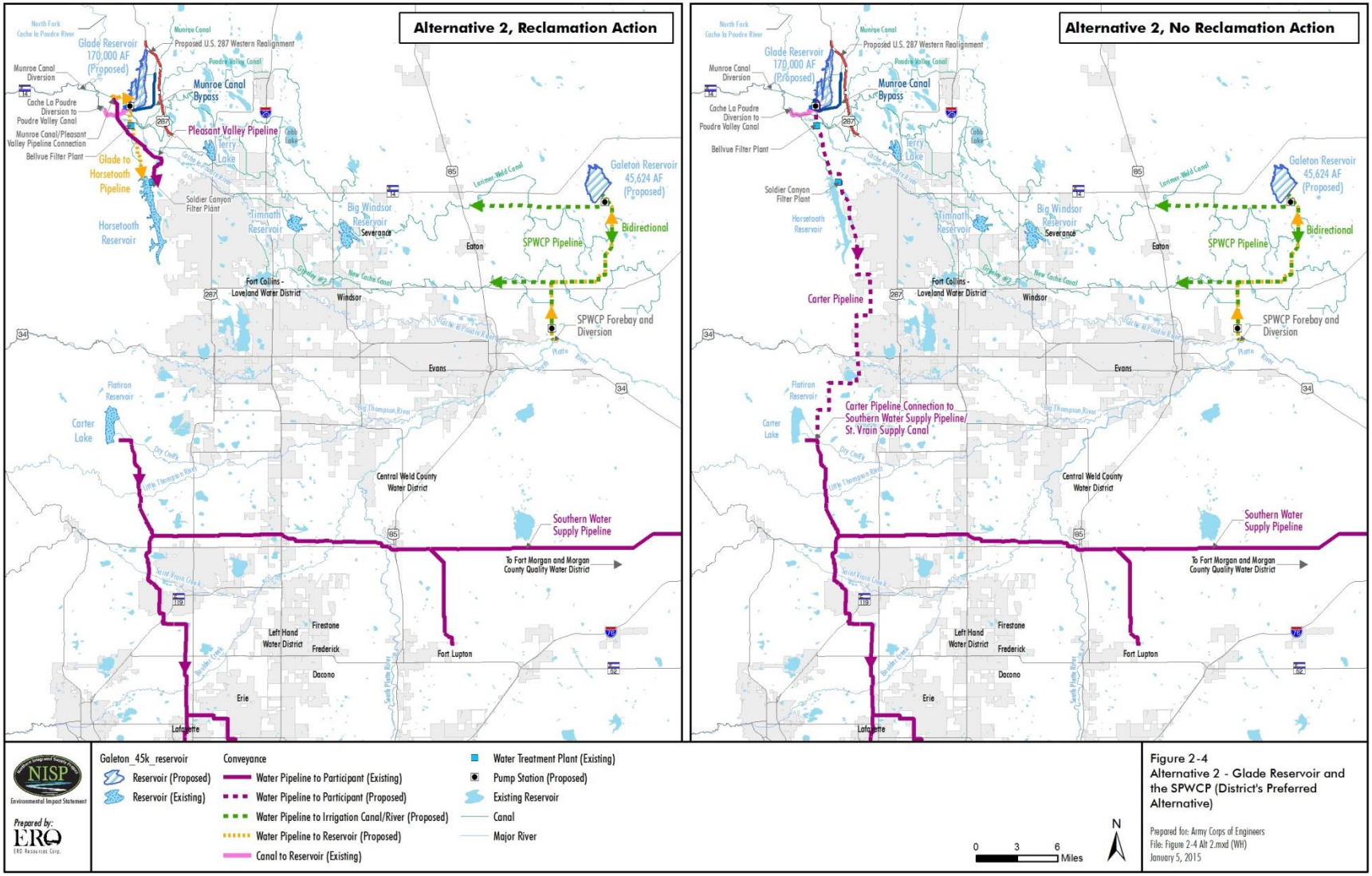
2.5 ALTERNATIVE 2 – GLADE RESERVOIR AND THE SPWCP (DISTRICT'S PREFERRED ALTERNATIVE)

2.5.1 Introduction/Abstract

The District's Preferred Alternative would deliver water to the Participants by using existing water rights, constructing a new reservoir at the Glade Reservoir site, and developing the SPWCP. The components of Alternative 2 are shown on Figure 2-4. Key components of the District's Preferred Alternative are:

- Diversion from the Poudre River at the Poudre Valley Canal for the District's Grey Mountain water right, SPWCP exchanges with Larimer-Weld Canal and New Cache Canal, and reservoir exchanges with Terry Lake, Big Windsor Reservoir, and Timnath Reservoir
- Storage of water diverted from the Poudre river in a new 170,000 AF Glade Reservoir
- Augmenting flows in the Poudre River by releases from a designated 3,600-AF release pool in Glade Reservoir with a target of maintaining a 10-cfs flow below the Larimer-Weld Canal headgate in November through April and September 1 through September 30
- Construction of the SPWCP, which includes the new 45,624 AF Galeton Reservoir
- Construction of new pumping stations and water pipelines, the length of which would depend on whether Reclamation issued a contract and special use permit, discussed in Section 2.5.5.2
- Realignment of 7 miles of U.S. 287 near Laporte, Colorado
- Realignment of four electrical transmission line structures totaling 0.6 miles of a 69-kV line owned by Poudre Valley REA

Figure 2-4. Alternative 2—Glade Reservoir and the SPWCP (District's Preferred Alternative).



The Corps' third-party consultant through CDM Smith, in collaboration with the District, prepared a Final Draft SDEIS Operations Plan Report (CDM Smith 2014b). The objective of the report was to document the proposed plan of operations for NISP; in particular the reservoir operations, exchanges, and deliveries to the project Participants that would occur once water was diverted from the Poudre River and the South Platte River. The Operations Plan will be updated if needed for the FEIS to reflect any additional proposed operational changes.

2.5.2 Water Supplies

2.5.2.1 Water Conservation

The Participants' ongoing water conservation measures would continue. These measures are summarized in Section 1.2.7 and described in detail by Harvey Economics (2011).

2.5.2.2 Cache la Poudre River Water Rights

The District and Cache la Poudre Water Users Association hold 1980 conditional storage rights on the Poudre River for the Poudre Project, which includes water rights for the Grey Mountain Dam and Reservoir and the Cache la Poudre Forebay Reservoir. The District owns a seven-eighths interest in these conditional rights. The total aggregate storage for these water storage rights is 220,000 AF. None of the alternatives would use the District's entire interest in the Grey Mountain water right.

The District completed a change of water rights for the Grey Mountain Dam and Reservoir and Cache la Poudre Forebay Reservoir water rights to provide three alternate points of diversion on the Cache la Poudre River (Poudre River) and storage in the proposed Glade Reservoir. The Proposed Action would use only one of these points of diversion, the Poudre Valley Canal (see the subsequent discussion on conveyance). The District has a right to divert up to 3,000 cfs from the Poudre River. With a 1980 priority date, the Grey Mountain water rights are very junior water rights, and opportunities to divert are generally limited to years with above-average precipitation and streamflow. The water rights change case was decreed in 2006 and applies only to Glade Reservoir as an alternate point of storage.

2.5.2.3 South Platte Water Conservation Project Water Rights

The District filed applications for conditional water rights for the SPWCP in 1992, which were amended in 1997 and 2003. These applications were consolidated into a single case (92CW130). The proposed uses of water identified in the applications were all beneficial uses and reuse to extinction. The SPWCP conditional water rights include direct flow and storage rights as well as exchanges up the Poudre River that would use the Larimer-Weld Canal and the New Cache Canal, and several reservoirs operated under the umbrella of these ditch companies. The final decree for the SPWCP conditional water rights was issued in 2005.

2.5.2.4 Environmental Streamflows

As part of the adjudication of the Grey Mountain water right, the District subordinated to three water rights on the Poudre River used for fishery, recreation, and other environmental purposes (Table 2-6). These streamflow requirements would be met in all action alternatives.

Table 2-6. Fishery, recreational, and environmental streamflows in the Poudre River.

Location	Modeled Streamflow	Decreed Streamflow Requirement
Watson Lake Fish Hatchery	50 cfs year-round	25 cfs (Oct. 15-April 14); 50 cfs (April 15-Oct. 14)
Fort Collins boat chute	30 cfs year-round	5 cfs (Sept. 1-April 30); 30 cfs (May 1-Aug. 31)
Fort Collins Nature Center†	25 cfs (Oct. 15-April 14); 50 cfs (April 15-Oct. 14)	5 cfs, with all river flows between 5 cfs and 25 cfs to be shared equally between Fort Collins and the City of Thornton, and Fort Collins is entitled to no more than 15 cfs (September 1-April 30) 30 cfs (May 1-August 31)

†Although the Nature Center recreational water right was not made absolute until Case No. 2000CW236, at the flow rates specified above, the District and the City of Fort Collins have an Amended Stipulation (1992). Both entities assume this stipulation supersedes the language in the decrees governing operations as it affects the water rights of the District and Fort Collins. Specifically, the Amended Stipulation calls for flow rates of 50 cfs (April 15-October 14) and 25 cfs (October 15-April 14) at the Nature Center diversion dam.

For example, the Timnath Reservoir exchange is subject to the Watson Lake and boat chute water rights. Exchanges from Larimer-Weld Canal, Big Windsor Reservoir, and Terry Lake may be limited by the Watson water rights (RTi 2005). The New Cache Canal is the farthest downstream exchange point, allowing for possible limitations to satisfy the Nature Center water rights. As a result of the stipulations, exercise of the proposed SPWCP exchanges into the proposed Glade Reservoir would not cause the flow rates of the Poudre River at the locations of these water rights to drop below the specified minimum levels.

There are no other known environmentally related minimum streamflows that exercise of the Grey Mountain or SPWCP water rights could affect.

2.5.3 South Platte Water Conservation Project

The SPWCP is a component of all action alternatives. With the SPWCP, the irrigation companies' Poudre River water would be diverted at the Poudre Valley Canal headgate for use by the Participants. In exchange, NISP would provide water to the irrigation companies from the SPWCP. The exchanges would be operated when Larimer-Weld Canal and/or New Cache Canal were diverting water for direct irrigation or to storage.

The SPWCP would include a proposed Galeton Reservoir with an active storage capacity of approximately 45,624 AF. Construction of the proposed Galeton Reservoir would include a diversion and forebay on the South Platte River, a pump station, and pipelines to deliver water diverted from the South Platte River to Galeton Reservoir and ditch systems for exchange. Water would be pumped into Galeton Reservoir from a new diversion dam/forebay complex

located on the South Platte River 500 feet downstream of the confluence of the Poudre River with the South Platte River. The diversion dam would consist of a fixed concrete weir, weir sections with adjustable gates at the main river channel, a radial gate section near the north river bank, and short embankment sections at each end of the weir. Diversion capacity of 200 cfs would be provided through headworks with an intake section on the north river bank to a 150-foot-long concrete box flume (or large diameter conduit) that would release to a forebay for the SPWCP South Platte pumping station. Modeled diversions averaged 28,400 AFY with a maximum of 63,500 AFY.

Diversions from the South Platte River would enter a forebay reservoir (formally decreed as the SPWCP Pumping Station Forebay Reservoir), from which water would be delivered to Galeton Reservoir by way of the SPWCP Pumping Station and Pipeline. If either Larimer-Weld or New Cache direct flow diversions were in priority at the same time as the SPWCP South Platte River diversion, SPWCP water might also be pumped directly to the canals. This approach to SPWCP operation would bypass storage in Galeton Reservoir and minimize the project's pumping costs. The direct pumping operation is not anticipated to happen frequently, but the concurrence of the Poudre exchanges and South Platte diversion being in priority can happen under certain flow conditions. There would be no difference in streamflow effects if the water diverted from the South Platte River was routed directly to the canals, or stored in Galeton prior to delivery.

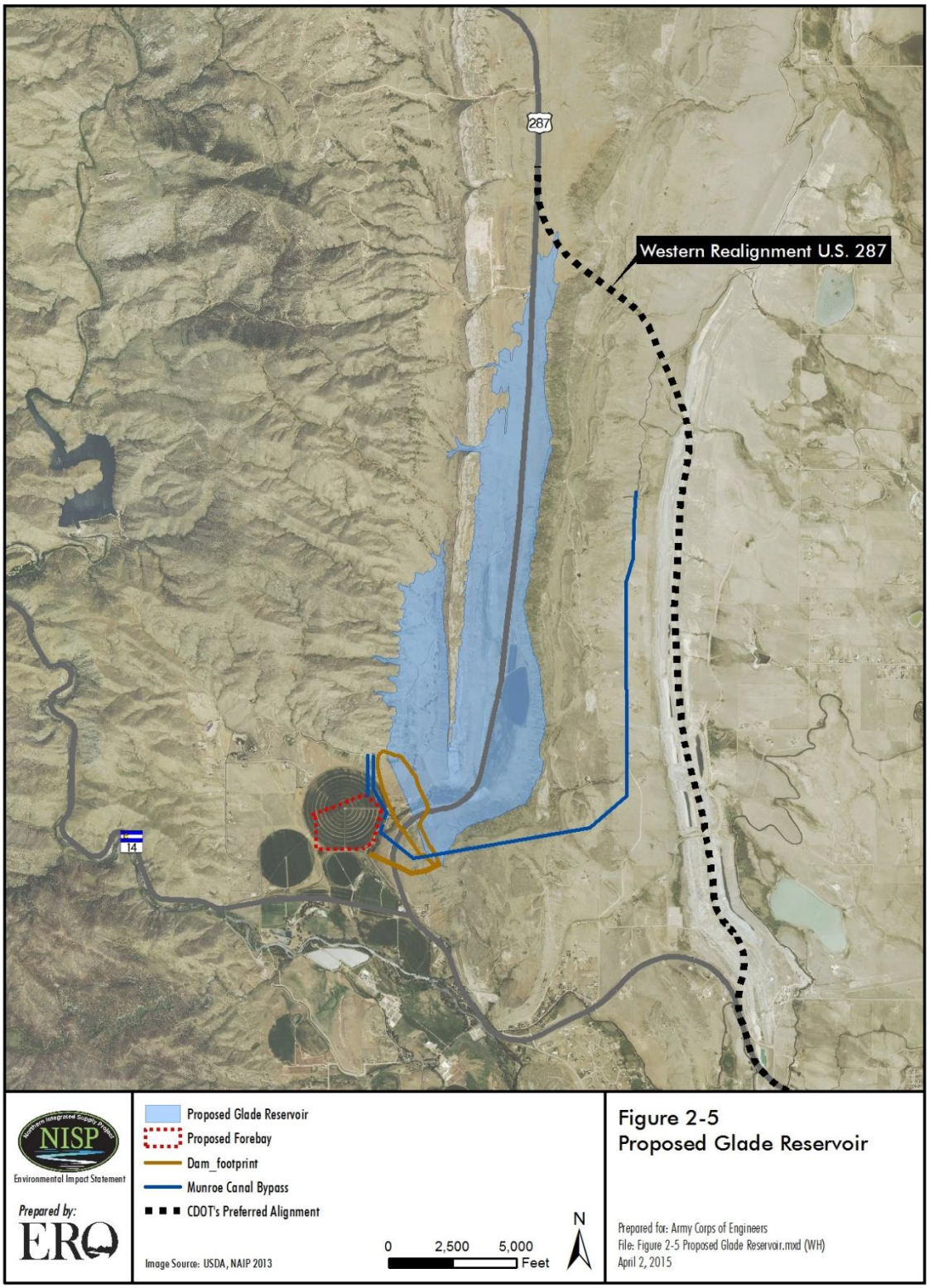
2.5.4 Storage

2.5.4.1 Glade Reservoir

Water for Alternative 2 would be stored in two new reservoirs, Glade Reservoir and Galeton Reservoir. The Glade Reservoir site is 4 miles north of Laporte, Colorado and would serve as the primary storage reservoir (Figure 2-5). The reservoir would have an active storage capacity of 170,000 AF to hold water diverted from the Poudre River using the Grey Mountain water right and water to be exchanged with the SPWCP. A forebay and pump station would also be constructed southwest of the reservoir. The dam would be about 270 feet high and constructed with on-site excavated materials (GEI 2006a). The dam would include a spillway, a multilevel inlet/outlet tower, and a 120-inch inlet/outlet pipe from Glade Pumping Station and Forebay. At maximum capacity, Glade Reservoir would have a surface area of 1,635 acres (2.5 square miles) and a water surface elevation of 5,517 feet. The modeled hydraulic residence time (the length of time diverted water would remain in the reservoir) would be 4.6 years. Residence time for each alternative was calculated by averaging the reservoir volume for a given year and dividing it by the average outflow volume for the same year (ERO 2014b).

The proposed Glade Reservoir would include a multilevel outlet tower to allow for selective withdrawals from different reservoir elevations. The exact configuration of this tower, including gate spacing, screening requirements, and flow requirements, would be determined after consultation with CPW and the Dam Safety Branch of the Colorado Division of Water Resources.

Figure 2-5. Proposed Glade Reservoir.



Construction would require realignment of 7 miles of U.S. 287 (see Section 2.5.8). The Colorado Department of Transportation (CDOT) would maintain a segment of highway between the new 287 alignment and State Highway 14. Two segments of U.S. 287 would be abandoned and CDOT would convey the right of way to the District. The two segments would be a segment north of the intersection of State Highway 14 to the proposed Glade Reservoir Dam and a segment north of the maximum water elevation of Glade Reservoir that would not be inundated. The District would use these segments during construction. The District would maintain the segment from Ted's Place to the dam after construction for access and remove the abandoned segment north of the reservoir.

The District would coordinate with CPW to establish a sport fishery in Glade Reservoir. The establishment and management of the fishery would be the responsibility of CPW. If requested by CPW, the District would provide bottom contours and structures to enhance the reservoir fishing as part of reservoir construction. The District would provide public access to the Glade Reservoir fishery. The District would seek a qualified vendor or lessee (e.g., Larimer County or Colorado State Parks) to develop a recreation plan and manage recreation at Glade Reservoir. The District would fund development of the recreation plan and approve the plan before implementation. A future agreement with Colorado State Parks or Larimer County to manage Glade Reservoir for public recreation could allow for water-based recreational activities.

2.5.4.2 Galeton Reservoir

The Galeton Reservoir site is about 11 miles east of Ault, Colorado (Figure 2-6). It would be sized to have 45,624 AF of active storage capacity to store water diverted from the South Platte River using the SPWCP conditional water rights. The dam would be about 75 feet high and constructed with on-site excavated materials (GEI 2006b). The dam would include an inlet/outlet tower and a spillway. The mean depth of Galeton Reservoir would be about 46 feet and maximum depth would be 57 feet. At the proposed maximum active capacity of 45,624 AF, Galeton Reservoir would have a surface area of 2,010 acres (3.1 square miles) and a water surface elevation of 4,872 feet. The modeled hydraulic residence time would be 1.6 years.

The SPWCP also would substitute Galeton Reservoir and/or South Platte River water in exchange for water in three existing reservoirs that are affiliated with the Larimer-Weld and New Cache companies: Terry Lake, Big Windsor Reservoir, and Timnath Reservoir (Table 2-7). Each of these reservoirs stores water that is subsequently released to either Larimer-Weld (Terry Lake) or New Cache (Big Windsor and Timnath) for irrigation. Big Windsor Reservoir is owned by the Windsor Reservoir and Canal Company and filled by the Larimer-Weld Irrigation Canal, but due to its location on the downstream side of the canal, the reservoir primarily releases stored water to New Cache under an existing exchange.

Figure 2-6. Proposed Galeton Reservoir.

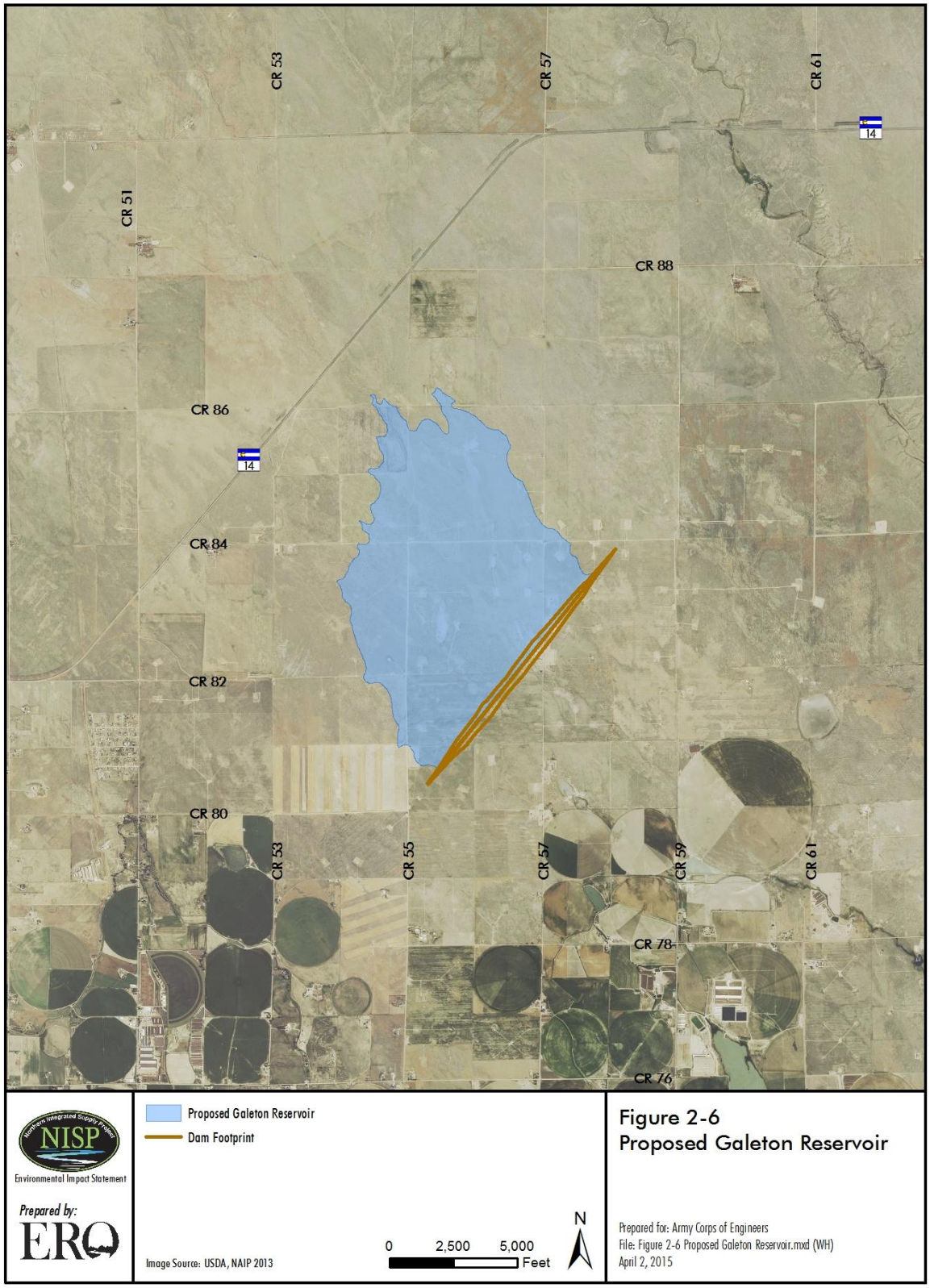


Table 2-7. Estimated NISP diversions by exchange with area reservoirs.

Alternative	Current Conditions		Future Conditions	
	Max. (AF)	Ave. (AF)	Max. (AF)	Ave. (AF)
Terry Lake				
Alternative 2	5,800	3,100	5,800	3,200
Alternative 3	5,800	3,300	5,800	2,900
Alternative 4	5,800	4,000	5,800	3,800
Big Windsor Reservoir				
Alternative 2	5,600	1,300	5,600	1,400
Alternative 3	5,600	1,400	4,900	1,100
Alternative 4	5,600	1,700	5,600	1,300
Timnath Reservoir				
Alternative 2	2,200	440	2,000	330
Alternative 3	2,100	420	2,000	300
Alternative 4	2,200	510	2,100	410

Under typical operation of the proposed reservoir exchanges, Galeton Reservoir would make releases to Larimer-Weld or New Cache when the ditch systems made storage releases to meet irrigation demands. Accounting for these Galeton releases would be maintained, and NISP would make equivalent diversions at the PVC when the appropriate reservoir water rights are in priority during the following winter or spring. The Water District 3 Water Commissioner would administer the actual river exchanges, and the District would be responsible for the accounting with the ditch companies.

The District is presently negotiating with the Larimer-Weld and New Cache Canal companies regarding the compensatory measures that the ditch companies may require for allowing NISP to exchange on irrigation water delivered by the ditch companies. These measures would address concerns expressed in discussions with the ditch companies related to the requested change in their historical ditch operations and their perceived receipt of lesser quality water. The specific measures to be provided under agreements reached by Northern Water and the ditch companies may include a range of options, such as monetary compensation and/or the District providing the ditch companies water and storage from NISP or another facility. The Corps will analyze effects associated with these measures and determine whether additional NEPA evaluation is needed.

CPW has expressed interest in using the Galeton facilities to establish a facility for raising native fish for reintroduction. The District would coordinate with CPW on development of such a facility for the Galeton forebay if CPW wanted to pursue such a facility.

2.5.4.3 Evaporation

All reservoirs constructed for the alternatives would lose diverted water to evaporation. The amount of evaporation is a function of the surface area of the stored water. Estimates of evaporation from the reservoirs based on the hydrologic modeling (CDM Smith and DiNatale 2013) for Alternative 2 are shown in Table 2-8. Modeled reservoir evaporation is a function of calculated reservoir surface area, which is a function of the modeled storage volume. In all alternatives, yield from the Grey Mountain right, which would be stored in Glade Reservoir in

Alternative 2 and in Cactus Hill in Alternatives 3 and 4, would decline slightly in future conditions and the yield from the SPWCP would increase slightly. Consequently, evaporation from Glade Reservoir is predicted to be less in future conditions than current conditions and the evaporation from Galeton Reservoir in all alternatives would be the same or slightly greater.

Table 2-8. Estimated average annual evaporation, Alternative 2.

Reservoir	Current Conditions (AFY)	Future Conditions (AFY)
Glade		
Reclamation Action	2,600	2,500
No Reclamation Action	2,800	2,700
Galeton	4,000	4,000

2.5.5 Conveyance

2.5.5.1 Conveyance to and from Reservoirs

2.5.5.1.1 Glade Reservoir

The Grey Mountain water right has three adjudicated points of diversion: the Poudre Valley Canal headgate, Munroe Canal headgate, and the original Grey Mountain Dam location on the Poudre River mainstem. The District proposes to use only the Poudre Valley Canal headgate as the point of diversion into Glade Reservoir for Alternative 2 (Figure 2-4). The use of the Munroe Canal discussed in the DEIS is no longer proposed. Likewise, the original Grey Mountain Dam location on the Poudre River mainstem is not proposed to be used as a diversion location into Glade Reservoir for any of the NISP action alternatives. The use of the Poudre Valley Canal and diversion would require modifications to the existing diversion on the Poudre River, upgrades to 10,800 feet of the canal, and a turnout structure to the Glade Forebay. Canal modifications would include widening the cross section at necessary locations, raising embankments where required, re-grading the canal bottom to re-establish appropriate profile, lining the canal with clay or concrete, and placing necessary flow regulation structures. Additionally, the Poudre Valley Canal would be the operational and emergency discharge conveyance from Glade Reservoir to the Poudre River (east-to-west). A new spillway/discharge facility from the Poudre Valley Canal to the Poudre River would be required for emergency discharge conveyance.

Construction of the Glade Reservoir would require relocation of the Munroe Canal. Alternate conveyance would be provided by a 72-inch pipeline to the valley below the proposed Glade Reservoir Dam, an 8-foot tunnel beneath the ridge to the east, and a 72-inch pipeline up the adjacent valley to connect to the existing canal. Up to 100 cfs would flow through the system by gravity. Above 100 cfs and up to 250 cfs, pumps located in the planned Glade Reservoir pump station would add enough head to make the full canal capacity delivery.

Conveyance of water out of Glade Reservoir would depend on whether Reclamation issued a contract and special use permit for exchange, conveyance and/or storage in Carter Lake and

Horsetooth Reservoir. Conveyance of water out of Glade Reservoir is discussed in Section 2.5.5.2.1.

2.5.5.1.2 Galeton Reservoir

A forebay and pump station would be built below the confluence of the Poudre River and the South Platte River (Figure 2-4). Proposed new pipelines would deliver water directly from the South Platte River and/or released from Galeton Reservoir to the Larimer-Weld Canal and the New Cache Canal as part of the proposed SPWCP exchanges. This water would be used as a source of substitution for an exchange of water historically diverted by the irrigation companies.

The turnouts to the canals from the pipelines would be no further east than shown on Figure 2-4. The turnouts may be farther west than shown, and the location of the turnouts would be decided during final design and after consultation with the ditch companies. Water from Galeton Reservoir or the South Platte River would be blended with water normally conveyed by the canals. The District estimated the percentage of South Platte River/Galeton Reservoir water that would mix with canal water (Table 2-9). The percentage under future conditions would be similar. The NISP SDEIS Final Draft Operations Plan Report (CDM Smith 2014b) describes proposed exchanges in greater detail.

Table 2-9. Average delivery of South Platte River water in the SPWCP as a percentage of canal diversions under Current Conditions.

Month	Alternative 2		Alternative 3		Alternative 4	
	Larimer-Weld	New Cache	Larimer-Weld	New Cache	Larimer-Weld	New Cache
April	2%	0%	2%	0%	2%	0%
May	17%	39%	17%	38%	17%	40%
June	14%	27%	14%	29%	18%	29%
July	10%	15%	13%	18%	19%	19%
August	23%	17%	25%	18%	13%	21%
September	24%	0%	21%	0%	0%	1%
Annual	13%	21%	14%	23%	15%	24%

Source: CDM Smith 2014b.

The District assessed the risk of the purchase of shares in the two ditch companies by others and the subsequent conversion of agricultural water to municipal use (Brouwer 2013). A variety of techniques are available to ensure long-term reliability of exchange operations, including:

- A broad exchange area
- Direct farm delivery contracts
- First use rights
- Right of first refusal option purchase
- Share purchase with leaseback
- Provide return-flow obligations associated with municipal transfers

2.5.5.2 Deliveries to Participants

2.5.5.2.1 Reclamation Action Option

In the Reclamation Action Option, the District would deliver water to most of the NISP Participants by entering into an excess capacity contract with Reclamation for carriage of NISP water through existing East Slope facilities of the C-BT Project. A special use permit may also be required. Most C-BT facilities are owned by the United States and operated by Reclamation in coordination with the District (see Section 1.1.1 of the DEIS for a description of the C-BT facilities). The contract would cover the use of the following C-BT facilities owned by the United States and operated by Reclamation: Carter Lake, Carter Lake Pressure Tunnel, Flatiron Unit #3 (Carter Pump), Flatiron Reservoir, Hanson Feeder Canal, and Horsetooth Reservoir.

The District intends to request a contract for the utilization of unused capacity within C-BT Project facilities to facilitate: 1) the storage and conveyance of NISP water which has been introduced into the C-BT Project either directly or through an exchange of NISP water for C-BT water; and 2) the delivery of NISP water within the C-BT Project either directly or through an exchange of C-BT water for NISP water. The District recognizes that this contract would operate on a space-available basis and could not impact either the amount of C-BT Project water available to C-BT Project allottees and beneficiaries or C-BT Project deliveries. Additionally, the contract would be operated so as not to affect or modify C-BT Project operations for C-BT Project purposes. The District agrees that operations under such contract would not affect the following C-BT Project operations: water conveyed through the Adams Tunnel, diversion of skim water at Olympus Dam and Dille Diversion, and diversion of Big Thompson River Decree water at Olympus Dam or at the Dille Diversion. Furthermore, the introduction, storage, conveyance, exchange, and delivery of NISP water would be done in such a manner so as not to affect the C-BT Project operational ability to maintain required flows in the Hansen Feeder Canal, particularly during those winter months when adequate flows are necessary to prevent freezing. The District has committed that the Reclamation Action Option would not affect the amount of water available for hydropower generation at the C-BT power facilities including Reclamation's Big Thompson Power Plant. Additionally, the District has committed that the associated flow in the Big Thompson River would be unaffected.

Reclamation intends to initiate their ROD and begin the contract negotiation process subsequent to issuance of the Corps' ROD, if the Corps determined that the Reclamation Action Option for the District's Preferred Alternative was the least environmentally damaging practicable alternative and a Section 404 permit was issued. Based on the best available information, the Corps disclosed potential effects on Horsetooth Reservoir and Carter Lake, components of the C-BT Project, in the EIS. The updated effects on water quality in Horsetooth Reservoir and Carter Lake are discussed in Sections 4.3 and 5.3 of this SDEIS. The changes to Horsetooth Reservoir and Carter Lake as a result of proposed NISP operations were modeled for the NISP DEIS. The modeling is discussed in the 2014 Operations Plan Report (CDM Smith 2014b). The 2006 modeling of Horsetooth Reservoir and Carter Lake (Pineda and Brouwer 2006) was not updated as part of the CTP hydrologic modeling for the SDEIS. Although the specific operational concept of the Reclamation Action Option was developed subsequent to the 2006

modeling, changes in operations and water levels at the two C-BT Project reservoirs are anticipated to be similar to those model results.

Prior to entering into any contract with the District, Reclamation would determine all potential impacts of the contract on the C-BT Project, its operation, and beneficiaries. Negotiations, and ultimately the contract and contract conditions, if awarded, would address the effects of the potential NISP connections, exchanges, conveyance and/or storage on C-BT facilities, operations, and beneficiaries. Reclamation will evaluate all contract terms and conditions pursuant to 40 CFR 1502.9(c)(1)(ii) to determine if additional NEPA analysis is warranted.

The exchange with C-BT would allow an annual average of 29,500 AF to be delivered from the outlet of Carter Lake to the 10 NISP Participants located in the southern and eastern areas of the District. As proposed, NISP water stored in Glade Reservoir would be used to meet some requests for C-BT Project water from Horsetooth Reservoir and Carter Lake, and these deliveries of NISP water from Glade Reservoir would be exchanged for a like amount of water to be delivered to the Participants from Horsetooth Reservoir or Carter Lake. The remaining 10,500 AFY of NISP firm yield for Evans (1,600 AFY), Fort-Collins-Loveland Water District (3,000 AFY), and Eaton, Severance, and Windsor (5,900 AF) is not anticipated to be delivered via C-BT facilities under the Reclamation Action Option. All action alternatives are expected to use existing C-BT canals south of Carter Lake and the existing SWSP to deliver water to the NISP Participants located in the southern and eastern areas of the District (Figure 2-4). NISP operations are not anticipated to change operation of these structures in any significant way, other than to add flows in some or all months of the year. Existing operations of these facilities would not be impeded.

The Participants that would take delivery out of Carter Lake requested an average firm yield of 29,500 AFY. The variability and maximum delivery is unknown because it would be a product of year-to-year hydrology and Participant demands, the Participants' water supply portfolios, and other considerations. The total firm yield of 40,000 AFY would be calculated as a 10-year running average.

The use proposed in the Reclamation Action Option for Alternative 2 would not change C-BT West Slope operations or West Slope diversions, and water deliveries to the East Slope would not increase. C-BT operational changes would occur in certain East Slope storage and distribution facilities. For example at Carter Lake, the average annual release of 29,500 AFY to NISP Participants would require pumping more water from Flatiron Reservoir into Carter Lake using Flatiron Pump Unit #3. The operation of Carter Lake would change slightly, with additional C-BT Project water routed through the reservoir for release to the NISP southern and eastern Participants. Flatiron Reservoir functions as a forebay from which C-BT water is delivered north to Horsetooth Reservoir and south to Carter Lake. To accomplish the proposed deliveries to the NISP Participants, water historically routed to storage in Horsetooth Reservoir would instead be pumped to, and then released from, Carter Lake. Horsetooth Reservoir would also experience operational changes. Less water would be released from Horsetooth Reservoir via the Hansen Supply Canal, so less water would need to be delivered from Flatiron Reservoir to Horsetooth Reservoir via the Hansen Feeder Canal. The amount of reduced deliveries to

Horsetooth Reservoir would be about equal to the amount of increased deliveries into Carter Lake.

The most important changes to C-BT operations as a result of the Reclamation Action Option for Alternative 2 would be water deliveries from Glade Reservoir to Horsetooth Reservoir via a new 5.5-mile Glade-to-Horsetooth Pipeline and the changes in Hansen Supply Canal and Windsor Extension deliveries of C-BT water to the Poudre River and the Poudre Valley Canal, respectively. These operations are described in the following sections.

In conjunction with the proposed releases from Carter Lake, Horsetooth Reservoir releases to the Poudre River through the Hansen Supply Canal would be curtailed. NISP would complete an exchange to repay the deliveries from the C-BT by several means, including: 1) bypassing divertible flows at the Poudre Valley Canal, 2) releasing stored water back to the Poudre River or Poudre Valley Canal in lieu of Hansen Supply Canal deliveries, and 3) pumping directly from the Glade Reservoir to Horsetooth Reservoir to make up for any year-end exchange deficit. A blend of these operations could be used depending on whether the Glade-to-Horsetooth Pipeline was constructed. In planning for NISP operations with the Reclamation Action Option, the District assumed that Reclamation would impose a 1% surcharge for the exchange. The CTP modeling assumed Alternative 2 would deliver 29,795 AFY back to the C-BT system. The imposed surcharge would be part of contract negotiations between Reclamation and the District.

Horsetooth Reservoir releases an average of nearly 60,000 AF to the Poudre River each year. Therefore, much of the time, the combined delivery from Glade Reservoir to the Poudre River and bypassed NISP diversions could cover the proposed 29,500 AFY exchange volume to Carter Lake. There could be times, however, particularly in years when the annual quota was less than 60% and C-BT deliveries were consequently low, that the C-BT deliveries to the Poudre River would be less than the amount of NISP water proposed to be exchanged, conveyed and/or stored into Horsetooth Reservoir. Alternative 2 would have a deficit to C-BT at the end of these years.

It is proposed that NISP would make up these deficits to C-BT by delivering water directly from Glade Reservoir to Horsetooth Reservoir through a new 36-inch diameter pipeline with a capacity of 2,000 AF per month, or about 33 cfs. The Glade-to-Horsetooth Pipeline (Figure 2-4) would only be necessary under the Reclamation Action Option for Alternative 2 in the event that C-BT deliveries to the Poudre River drop below the average volume of water that NISP would deliver to project Participants by storage, carriage, exchange, or in-lieu delivery through C-BT. The elevation of the proposed pipeline release into Horsetooth Reservoir at Satanka Dike would be 5,440 feet and the modeled water surface elevation of Glade Reservoir would be above this elevation most of the time. Consequently, most deliveries made by the Glade-to-Horsetooth Pipeline would be done by gravity. When deliveries were not made by gravity, water would be pumped to Horsetooth Reservoir using the two Munroe Bypass pumps housed in the Glade pumping station. The final operations of the Glade-to-Horsetooth Pipeline would be determined in contract negotiations with Reclamation. If a Glade to Horsetooth pipeline was not built, the District would install 0.5 mile of pipeline from Glade Reservoir to the Poudre River for flow augmentation in the Poudre River (discussed in Section 2.5.6).

Deliveries to the five Participants that would not use C-BT facilities would be:

- Fort-Collins-Loveland Water District (3,000 AFY) would use its own capacity in the existing Pleasant Valley Pipeline by direct connection from Glade Reservoir.
- Evans (1,600 AFY) would be by direct release to the Bellvue Filter Plant. The mechanism of delivery would be determined in consultation with plant operator the City of Greeley, but options include 1) a direct pipeline connection from the outlet works of Glade Reservoir to the treatment plant headworks, and 2) Release of water from Glade Reservoir to the Poudre River and diversion by exchange at the Greeley Filters Pipeline intake to the Bellvue Filter Plant a short distance upstream.
- Eaton, Severance, and Windsor (5,900 AFY) would be by direct pipeline connection from Glade Reservoir to the Soldier Canyon Filter Plant.

2.5.5.2.2 No Reclamation Action Option

In the No Reclamation Action Option for Alternative 2, NISP water would be delivered to all of the Project Participants via the proposed Carter Pipeline. The Carter Pipeline would not require a contract between the District and Reclamation or a connection to Horsetooth Reservoir (i.e., there would be no discretionary action by Reclamation associated with this option). The Carter Pipeline would extend 31 miles from the proposed Glade Reservoir south, around the east side of Horsetooth Reservoir, and south to Carter Lake where it would tie into the existing SWSP and the existing St. Vrain Supply Canal (Figure 2-4). Turnouts from the Carter Pipeline would provide water to Evans at the Bellvue Filter Plant; to Eaton, Severance, and Windsor at the Tri-Districts' Soldier Canyon Filter Plant; and to most other NISP Participants by the tie-in to existing C-BT and SWSP infrastructure owned by the District below Carter Lake. Intake structures for Central Weld County Water District's existing water treatment facility and the existing SWSP are located 0.5 mile below the Dam #1 outlet works. From this location, Central Weld County Water District distributes treated water to its customers as well as to Frederick, Firestone, and Dacono. The SWSP delivers untreated water to Erie, Fort Lupton, Fort Morgan, and Morgan County Quality Water District. A turnout at the Poudre River would allow releases for flow augmentation (discussed in Section 2.5.6). This description of conveyance through the Carter Pipeline is conceptual in nature; the exact routing and sizing of the pipeline is subject to revision and refinement based on final users and a routing analysis.

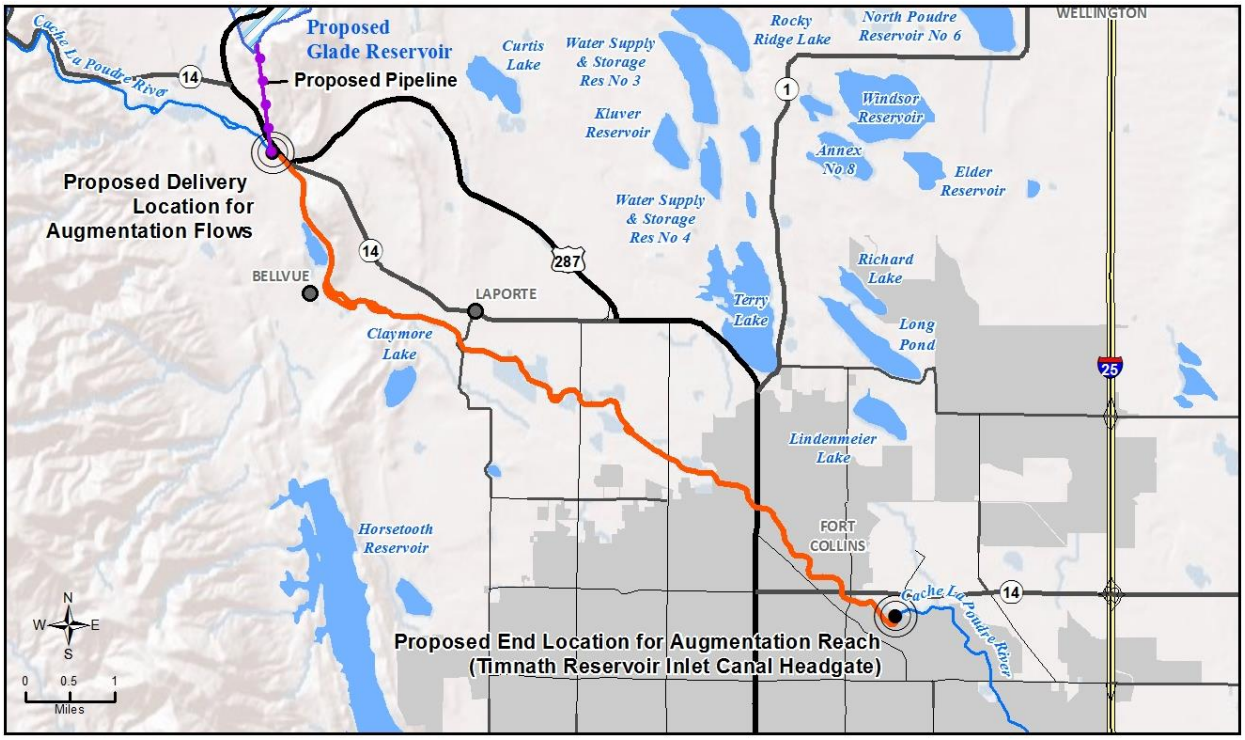
2.5.6 Flow Augmentation

The District proposes to include a flow augmentation program to improve Poudre River streamflows, primarily during winter months when flows are low and NISP would generally not be diverting, in Alternative 2 (both the Reclamation Action Option and the No Reclamation Action Option). The District would use water diverted into Glade Reservoir under its Grey Mountain right for flow augmentation. Beneficial uses for the Grey Mountain water include irrigation, municipal, domestic, replacement, recreation, industrial, and production of electrical power and energy. Water that is reduced to storage becomes the personal property of the District. The District intends to exercise its statutory right to release stored water for delivery downstream for a decreed beneficial use and to inform the state and division engineers that the water released from storage is to be shepherded downstream to a specified diversion point

without being diverted by others, as required by Colorado law (Colorado Revised Statute [CRS] 37-87-103). The proposed program would have the following characteristics:

- **Volume of water available:** A pool of 3,600 AF would be designated in Glade Reservoir at the start of each irrigation year. Any unused volume of water would not be carried over to subsequent years and would revert to NISP supply available for delivery to the Participants.
- **Dates of flow releases:** November 1 through April 30 and September 1 through September 30 if water remained in the designated augmentation pool in Glade Reservoir. Real-time monitoring of the augmentation pool and streamflows may allow releases on additional days outside of this designated period.
- **Rate of flow release:** Water would be released from Glade Reservoir as necessary to maintain a flow of 10 cfs at the target location.
- **Target location:** The downstream side of the Larimer-Weld Canal headgate. This location was selected for monitoring the target flow because it is administered as a dry-up point during the winter and it is upstream of the Martinez Park reach of the Poudre River, which is a critical site for several resources (aquatic habitat, water quality, and geomorphology).
- **Proposed delivery point for augmentation flows:** For NEPA analyses, it was assumed that flows would be released from a pipeline to the river upstream of the Larimer County Canal headgate, south of the proposed Glade Reservoir site and across the river from Greeley's Bellvue pipeline intake (Figure 2-7).
- **Proposed end point for augmentation reach:** For NEPA analyses, it was assumed that the flows would be re-diverted at the Timnath Reservoir (also known as Cache la Poudre Reservoir) inlet canal headgate, about 12 miles downstream (Figure 2-7). The Corps assumed that the State Engineer would assess a ¼% per mile loss on the flow augmentation releases, and any recaptured volume would be reduced accordingly. A method of exchange to return the water to Glade Reservoir would be determined between the SDEIS and FEIS.

Figure 2-7. Proposed Flow Augmentation Reaches.



Curtailment of streamflow augmentation releases may be required under extreme drought conditions when reservoir levels are low. Hydrologic modeling performed for the SDEIS shows that this would have occurred once during the 56-year hydrologic study period, in the year 2005. Any curtailment would be planned and coordinated with CPW in advance of the curtailment to maximize benefits of the water available for release. Further details regarding curtailment of streamflow augmentation releases during extreme drought conditions will be discussed with CPW during the state's Fish and Wildlife Mitigation Plan development process.

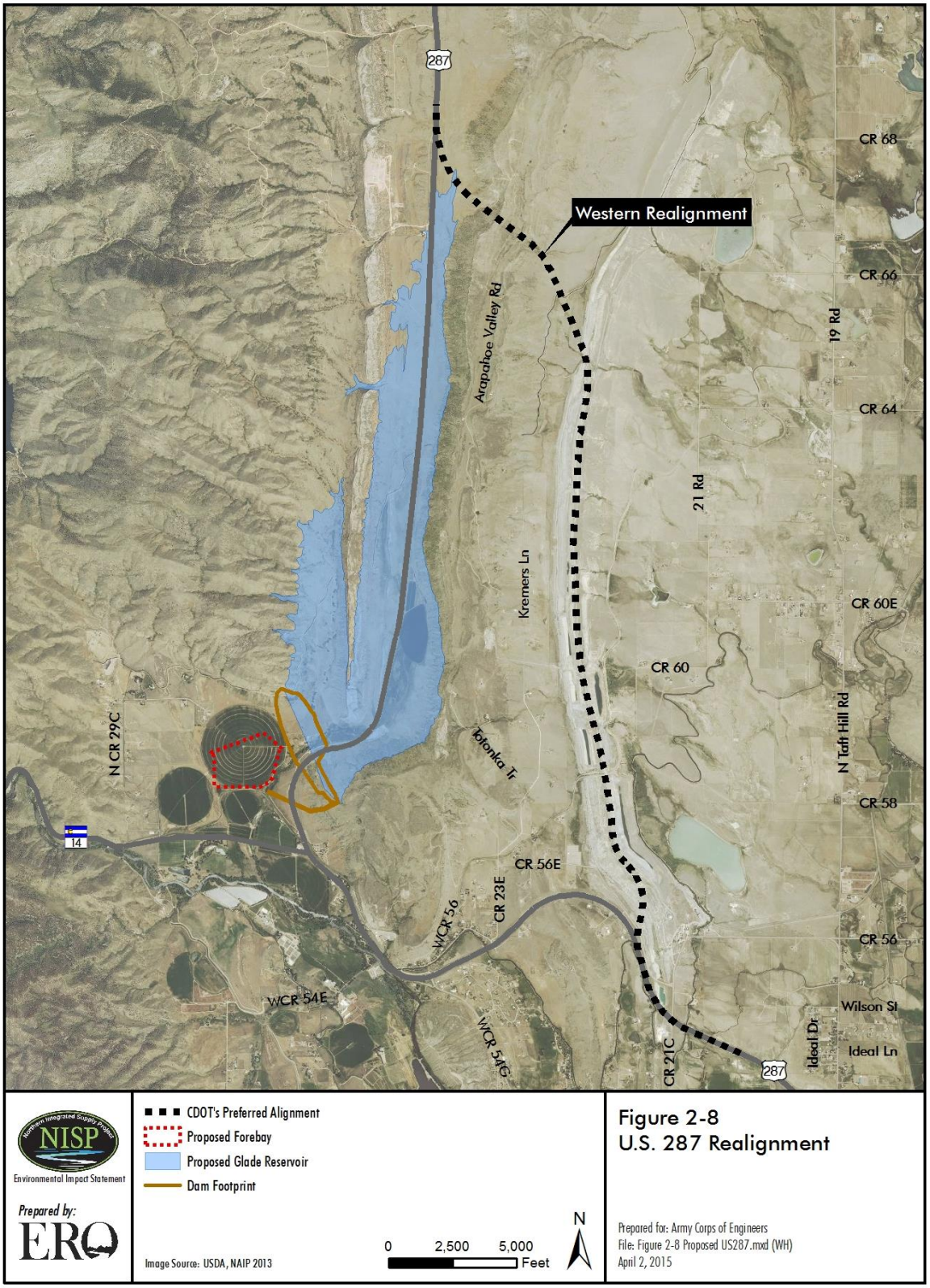
2.5.7 Advanced Water Treatment

Advanced water treatment would not be necessary under Alternative 2.

2.5.8 Infrastructure Relocation

The Proposed Action includes realignment of a portion of U.S. 287 at the proposed Glade Reservoir site (Figure 2-8). The proposed alignment would travel through the decommissioned Holcim Mine for about 6 miles, then cut west through the hogback to meet the existing U.S. 287 alignment near the northern end of the proposed reservoir. The new road would accommodate current and future traffic through the design of intersections and other access locations in accordance with State Highway Access Code requirements and applicable access design standards. Additional information about the proposed realignment is provided in the U.S. 287

Figure 2-8. U.S. 287 Realignment.



Relocation Study (Muller 2007). Two towers on the Platte River Power Authority 230-kV transmission line would have to be relocated to accommodate the proposed intersection and tie in to the existing U.S. 287. For the western alignment, a section of this line would have to be raised over or buried beneath the roadway fill section approaching the hogback cut. Alternative 2 also would require realigning four H-frame structures and 0.6 miles of a 69-kV electric transmission line owned by the Poudre Valley REA at the Glade Reservoir site.

Oil and gas development has occurred at the proposed Galeton Reservoir site subsequent to the DEIS. The potential effects of this oil and gas development were not addressed in the NISP DEIS. The Corps prepared a technical memorandum addressing the potential environmental effects of oil and gas development at and near the proposed Galeton Reservoir site (ERO 2012c) and these effects are summarized in Section 3.6.2.2 and Section 3.21.2.2 of the SDEIS. The number of wells within the site was updated in October 2013 using data from the Colorado Oil and Gas Conservation Commission. Sixteen wells are within the reservoir footprint and three wells are within 500 feet of the footprint. The District anticipates that all of the wells would be abandoned by the operator before Galeton Reservoir was built. The District would relocate any well that would interfere with reservoir operations.

2.5.9 Operational Flexibility

In response to comments on the DEIS regarding NISP operations, an operations plan was prepared that described the operations of the three alternatives analyzed in the EIS. A component of the operations plan addresses the District's need for flexibility for specific operational scenarios as follows:

- The ability to use sources of water other than the Grey Mountain water right—such as the Participants' own C-BT water—for the initial fill of the Glade Reservoir
- The ability to use out-of-priority storage to fill Galeton Reservoir when situations allow
- The ability to enter into dry-year leasing or interruptible supply contracts with agricultural irrigation users to meet project water needs during droughts similar to that which occurred in the early 2000s

In addition to these three operational scenarios, which are discussed in the following sections, NISP Participants would have the ability to buy and sell their portion of NISP yield by contract.

2.5.9.1 Sources of Water for Initial Fill of NISP Storage Reservoirs

The Corps' evaluation of Glade Reservoir operations are based on a modeled initial fill volume of about 100,000 AF, as discussed in the CTP hydrologic modeling report (CDM Smith and DiNatale 2013). The initial volume is a modeling assumption that is not meant to imply that the storage volume in Glade Reservoir would need to reach 100,000 AF before deliveries to the Project Participants could begin; the same is true for the modeled initial storage volumes for Galeton Reservoir. The anticipated sequence of Alternative 2 construction is to build the Glade Reservoir followed by the SPWCP. Until operations of the SPWCP commenced, Glade

Reservoir would be wholly dependent on the Grey Mountain water right. Modeling indicates that there can be several years in a row of divertible flow followed by as many as 8 years with no flow available. Therefore, it is possible that divertible flows from the Poudre River may not be available under the Grey Mountain water right to fill Glade Reservoir at the start of NISP.

Upon completion of Galeton Reservoir, both reservoirs would be subject to a first-fill plan administered by the Dam Safety Branch of the DWR. Typically, a new dam is restricted to a rate of fill of 1 foot per day for the first fill in order to monitor the performance of the new facility. The District determined that the first 50 feet, which would be about 2,800 AF of storage in Glade Reservoir could be filled at a more rapid rate (Brouwer 2011). In order to fill Glade Reservoir sufficiently such that the District could capture water and not be significantly hindered by a 1-foot per day fill criterion of the State Engineer, the DEIS described the potential of filling Glade Reservoir with up to 100,000 AF from transmountain sources, including water from the C-BT Project, the Windy Gap Project, the Grand River Ditch, and the Laramie-Poudre Tunnel. Based upon comments raised on the DEIS and a re-evaluation of the duration of the first fill, a lesser amount of storage based on the NISP Participants' C-BT allocation is now proposed. According to Harvey Economics (2011), the NISP Participants cumulatively owned nearly 60,000 units of C-BT water as of the end of 2010. If water supply was physically and legally limited at the time of first fill, it is proposed that a combination of the Participants' C-BT water (about 20% of annual yield) and yield from the District's Grey Mountain right could fill the primary NISP reservoir to 40,000 AF after 2 years of operation. Based on analysis by Brouwer (2011), the allottee-delivered C-BT water would be limited to 20,000 AF under the first fill of Glade Reservoir.

2.5.9.2 Out-of-Priority Storage for Galeton Reservoir

Out-of-priority storage is when a junior diverter, such as the SPWCP, diverts a senior downstream reservoir's water right during the winter-to-spring fill season. This practice is allowed by the State Engineer's Office. In years when the runoff was sufficient for senior diverters to fill later in the season, the out-of-priority fill of Galeton Reservoir could occur and downstream senior diverters would not be harmed. In years in which runoff was insufficient for senior diverters to fill, the out-of-priority storage would be required to be released back to the South Platte River. This would be accomplished by running the pipeline from the SPWCP South Platte River diversion to Galeton Reservoir backwards in order to deliver water from storage to the river. The frequency of the potential out-of-priority storage is not known because the hydrologic modeling for yield indicates it would not be necessary. Although this out-of-priority operation is not captured in the hydrologic modeling of the NISP action alternatives effects, the likely effect would be to increase the relative proportion of NISP diversions from the South Platte River during the winter. It is described as a possible operational flexibility scenario in case the call regime on the South Platte River changes in the future. The total diversions over the course of a year would not be affected because the need for South Platte water is limited by storage capacity in Galeton Reservoir and demand for delivery of exchange water to the Larimer-Weld and New Cache systems.

2.5.9.3 Sources of Water for Drought Conditions

Each of the NISP alternatives was evaluated in the context of historical hydrology for the period 1950-2005. This 56-year period experienced a number of droughts, including those of the mid-1950s and early 2000s. The alternatives are not sized to meet full firm yield requirements during more severe droughts, such as the recent drought of the early- through mid-2000s. For example, the most recent drought (2000–2005) was more severe than those experienced earlier in the modeled period. Based on model results, in severe droughts such as that of the early 2000s, it is anticipated that the NISP Participants—either as a group or individually—may pursue water supplies through any available options declared legal by the state. As an example, alternative supplies could include an interruptible water supply agreement approved by the State Engineer and implemented on a temporary basis. Water sources could include Larimer-Weld and New Cache, subject to the same constraints as the proposed SPWCP exchanges; if Galeton Reservoir was empty and could not execute the exchanges, NISP could pursue buying out the Larimer-Weld and New Cache water for a year. This type of temporary alternate source of water supply is not captured in the modeling for the NISP SDEIS but would be operated in compliance with all state regulations in order to prevent injury to other water users. In such severe drought events, it is expected that NISP Participants, while curtailing their demands, would still require water supplies. Additionally, because of the conservative nature of municipal water supply planning, it is unlikely that Participants would be willing to fully draw down their supplies in the Glade Reservoir in the hope that supplies would be available the following year. This type of response to drought would be similar to actual operations of other major municipal water supply systems along the Front Range during the early 2000s drought.

2.5.10 Implementation

The District owns the water rights with the necessary points of diversion and storage for Alternative 2. Following final design, the District would relocate U.S. 287, build the Munroe Bypass, and then build the Glade Reservoir and associated infrastructure. Construction of facilities associated with the SPWCP would follow after Glade Reservoir was constructed. The Glade-to-Horsetooth Pipeline would only be necessary under the Reclamation Action Option for Alternative 2 in the event that C-BT deliveries to the Poudre River decline to an amount that is consistently less than the volume required to facilitate the NISP exchange. The implementation sequence described for Alternative 2 may be revised during final design from that described. Changes in implementation sequence would have an inconsequential effect on the duration and intensity of effects described in Chapter 4.

2.6 ALTERNATIVE 3 – CACTUS HILL RESERVOIR, POUDRE VALLEY CANAL DIVERSION, AND THE SPWCP

2.6.1 Introduction/Abstract

Alternative 3 is similar to the District's Proposed Action except that water diverted from the Poudre River would be stored in the proposed Cactus Hill Reservoir instead of the proposed Glade Reservoir. The components of Alternative 3 are shown in Figure 2-9. Key components of Alternative 3 are:

- Diversion from the Poudre River at the Poudre Valley Canal for the District's Grey Mountain water right, SPWCP exchanges with Larimer-Weld Canal and New Cache Canal, and reservoir exchanges with Terry Lake, Big Windsor Reservoir, and Timnath Reservoir
- Storage of water in a new 190,000 AF Cactus Hill Reservoir
- Construction of the SPWCP described in Section 2.5.3
- Construction of new pumping stations and water pipelines
- Realignment of three, two-lane Weld County roads totaling 10.3 miles
- Realignment of 6.8 miles of a 230–kV Platte River Power Authority transmission line

2.6.2 Water Supplies

The water conservation measures and supplies used in Alternative 3 would be the same as Alternative 2.

2.6.3 South Platte Water Conservation Project

For Alternative 3, the SPWCP South Platte River diversion dam, intake structure, forebay, and pumping station infrastructure would be the same as Alternative 2. Modeled diversions averaged 30,000 AFY with a maximum of 63,600 AFY.

2.6.4 Storage

Cactus Hill Reservoir, with 190,000 AF of proposed active storage capacity, would be constructed to store water from the Poudre River. The reservoir location is described in the No Action Alternative (Section 2.4.4.2) and shown on Figure 2-10. The current proposed reservoir capacity of 190,000 AF is 10,000 AF larger than the Cactus Hill Reservoir described in the DEIS and 20,000 AF larger than the proposed Glade Reservoir in Alternative 2. A larger storage capacity would be required due to the plains location of the Cactus Hill site, which has higher evaporation and transit losses than the foothills location of the Glade Reservoir site. Transit

Figure 2-9. Alternative 3—Cactus Hill Reservoir, Poudre Valley Canal Diversion, and the SPWCP.

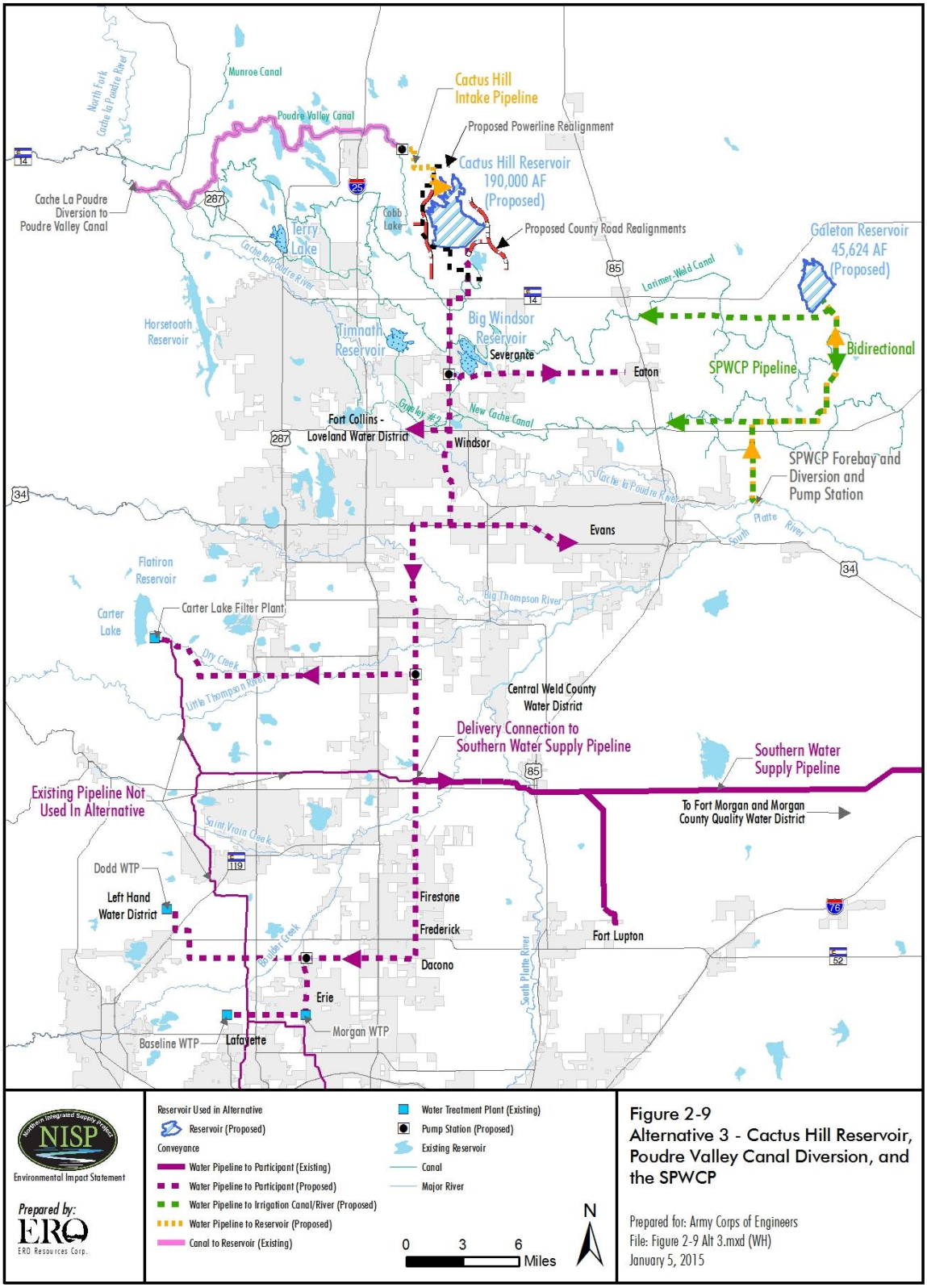
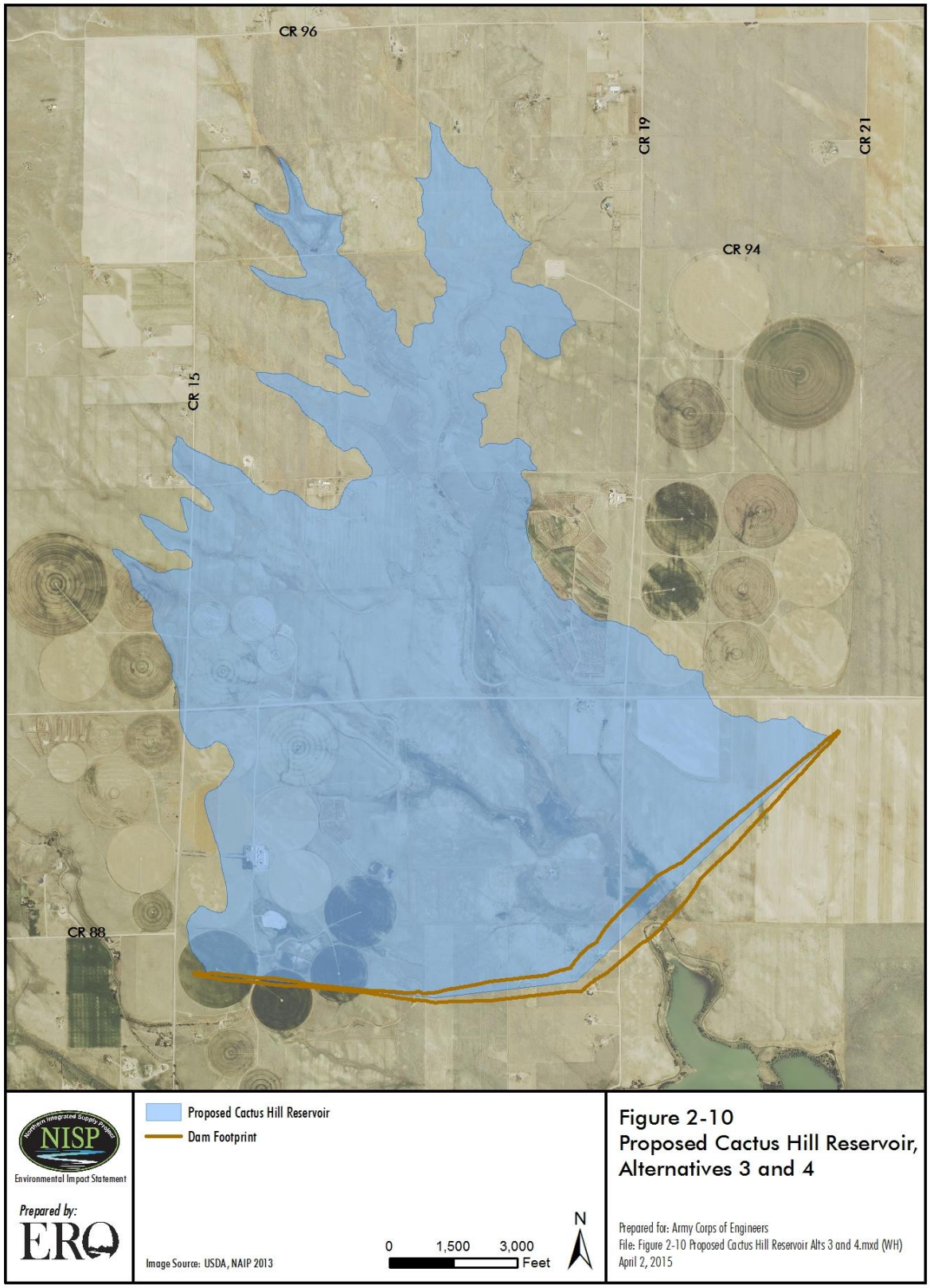


Figure 2-10. Proposed Cactus Hill Reservoir, Alternatives 3 and 4.



losses from the Poudre Valley Canal would be minimized by lining the canal with clay or concrete. For the CTP hydrologic modeling, Poudre Valley Canal transit losses were modeled as 5% of diversions based on losses of similar C-BT canals. Cactus Hill Reservoir would include up to an additional 3,000 AF of inactive storage. In Alternative 3, the dam would be about 170 feet high and constructed with on-site excavated materials. The maximum depth of the reservoir would be 158 feet and the mean depth would be about 140 feet. At the maximum active capacity of 190,000 AF, Cactus Hill Reservoir would have a surface area of 3,705 acres (5.8 square miles) and a maximum water surface elevation of 5,239 feet. The modeled hydraulic residence time of water in Cactus Hill Reservoir would be 5.2 years. Storage associated with the SPWCP at the new Galeton Reservoir would be the same as Alternative 2.

Estimates of evaporation from the reservoirs based on the hydrologic modeling (CDM Smith and DiNatale 2013) for Alternative 3 are shown in Table 2-10. The estimated decreased evaporation in Cactus Hill Reservoir in future conditions is due to the slight decrease in the yield of the Grey Mountain right compared to current conditions. Similarly, a slight increase in yield in the SPWCP would lead to more storage in Galeton Reservoir and more evaporation under future conditions.

Table 2-10. Estimated average annual evaporation, Alternative 3.

Reservoir	Current Conditions (AFY)	Future Conditions (AFY)
Cactus Hill	6,500	6,100
Galeton	3,900	4,000

The proposed Cactus Hill Reservoir would include a multilevel outlet tower to allow for selective withdrawals from different reservoir elevations. The exact configuration of this tower, including gate spacing, screening requirements, and flow requirements, would be determined after consultation with CPW and the Dam Safety Branch of the Colorado Division of Water Resources.

2.6.5 Conveyance

The conveyance associated with the SPWCP, with a pipeline from the South Platte River and pipelines to the Larimer-Weld and New Cache Canals, would be the same as Alternative 2. Water from the SPWCP would be exchanged up to the Poudre Valley Canal, with releases from Galeton Reservoir to the Larimer-Weld and New Cache Canals.

Conveyance of water into Cactus Hill Reservoir in Alternative 3 would use the Poudre Valley Canal. The Grey Mountain water right supply would be a direct diversion out of the Poudre River into the canal. The Poudre Valley Canal diversion on the Poudre River would be upgraded. Thirty miles of the canal would be lined and enlarged by up to 1,200 cfs above existing capacity or about 1,450 cfs total capacity after enlargement. A pipeline would convey water from the Poudre Valley Canal to the Cactus Hill Reservoir (Figure 2-9). A small forebay would be constructed ahead of the pump station to equalize the canal flows and pumping rate along with a short conduit from the pump station into the reservoir. The forebay would be

designed to hold up to one day of storage (2,000 AF). The selection of the Cactus Hill inlet pumping configuration and location would be determined during final design.

Conveyance of water out of Cactus Hill to the following Participants would be the same or similar to the No Action Alternative: Severance, Eaton, Windsor, Evans, Fort-Collins-Loveland Water District, Fort Lupton, Fort Morgan, Morgan County Quality Water District, Firestone, Frederick, Dacono, and Erie. These entities would receive untreated water and Severance, Eaton, Windsor, Evans, Fort-Collins-Loveland Water District, Firestone, Frederick, and Dacono would have to develop capacity for water treatment. Untreated water would be piped to the Carter Filter Plant near Carter Lake for treatment and subsequent distribution to the Central Weld County Water District. Untreated water would be piped to the Dodd Water Treatment Plant northeast of Boulder Reservoir for treatment and subsequent distribution to the Lefthand Water District. Untreated water would be piped to the Morgan Water Treatment Plant in Erie for treatment and subsequent distribution to Erie. Untreated water would be piped to the Baseline Water Treatment Plant in Lafayette for treatment and subsequent distribution to Lafayette.

2.6.6 Advanced Water Treatment

Alternative 3 would use water supplies of similar quality as Alternative 2. Advanced water treatment would not be necessary.

2.6.7 Infrastructure Relocation

Relocation of Anheuser-Busch's wastewater disposal facilities, realignment of three Weld County roads and a 230-kV Platte River Power Authority transmission line at the Cactus Hill Reservoir site would be the same as the No Action Alternative (see Section 2.4.7). The relocation of oil and gas wells at the Galeton Reservoir site would be the same as Alternative 2 (see Section 2.5.8).

2.6.8 Operational Flexibility

The District would require the same operational flexibility described for Alternative 2 in Section 2.5.9. The discussion of initial fill of Glade Reservoir also would apply to the Cactus Hill Reservoir. The first 50 feet of fill in would be about 8,300 AF in Cactus Hill Reservoir.

2.6.9 Implementation

The District would be required to go through water court to change the Grey Mountain water rights to allow Cactus Hill Reservoir as an alternate point of storage if an alternative involving Cactus Hill Reservoir was selected. It is not known if the District would be successful in changing the point of storage for these water rights to Cactus Hill Reservoir. Following final design and the water rights change, the District would build facilities associated with Cactus Hill Reservoir and then the SPWCP.

2.7 ALTERNATIVE 4 – CACTUS HILL RESERVOIR, MULTIPLE DIVERSION LOCATIONS, AND SPWCP

2.7.1 Introduction/Abstract

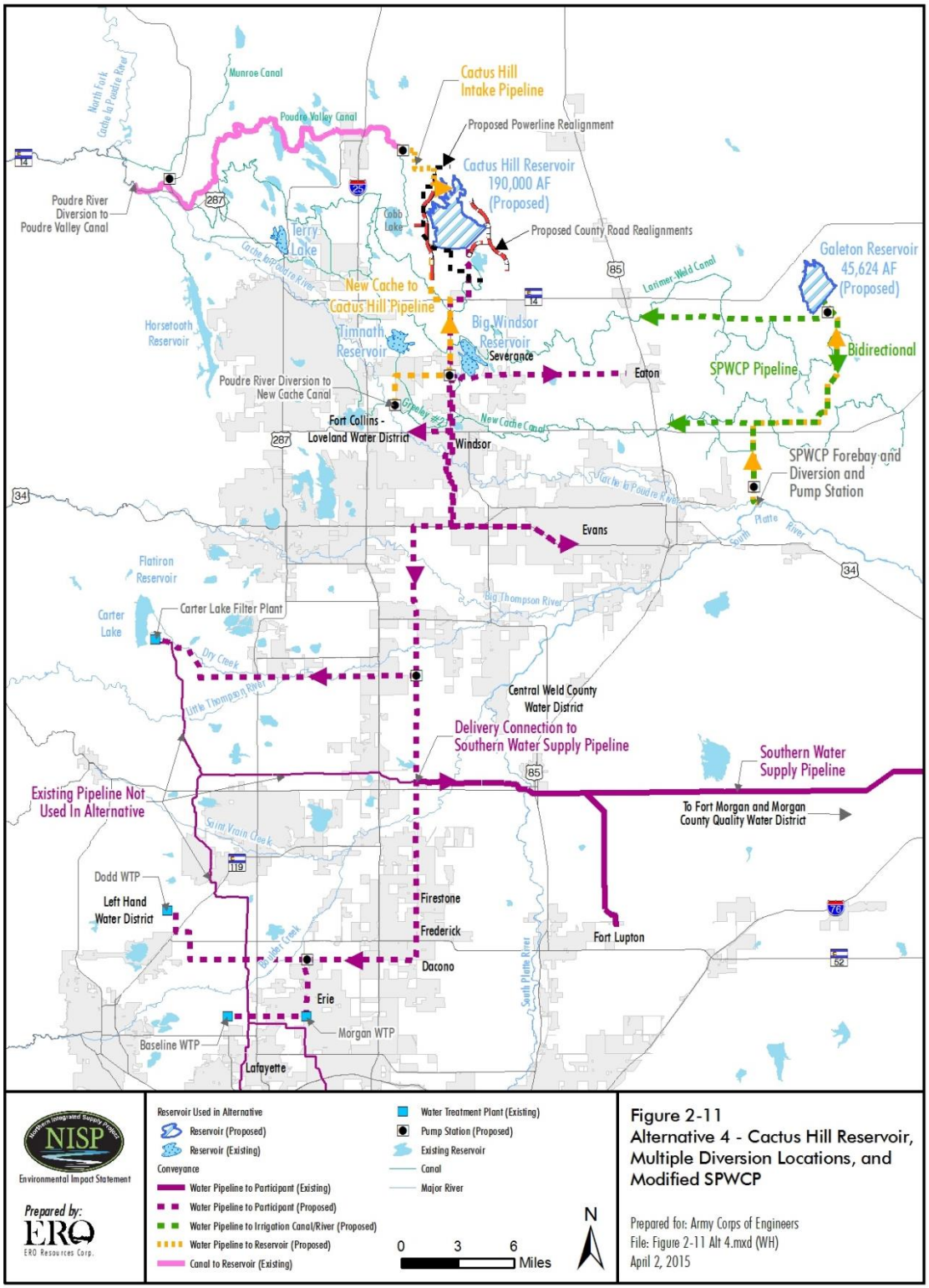
Alternative 4 is a new alternative developed for the SDEIS in response to comments on the DEIS requesting that alternatives be considered that would divert water from the Poudre River farther downstream than the Poudre Valley Canal, with storage of the water in a plains reservoir. Relative to the other action alternatives, Alternative 4 would allow more water to remain in the Poudre River between the Poudre Valley Canal and the New Cache canal before it was diverted for exchanges. As Alternative 4 was modeled, 100% of direct flow exchange water from Larimer-Weld would be diverted or re-exchanged at or near the Poudre Valley Canal as it would be in Alternatives 2 and 3. In Alternative 4, 100% of the New Cache direct flow exchange water would continue to flow downstream in the Poudre River channel to its current diversion location at the New Cache headgate east of Fort Collins and I-25. This water would then be taken through a turnout from the New Cache Canal and routed by pump station and pipeline to storage in Cactus Hill Reservoir. The use of the New Cache canal would be similar to the No Action Alternative (Alternative 1). The components of Alternative 4 are shown in Figure 2-11. Key components of Alternative 4 are:

- Diversion from the Poudre River at the Poudre Valley Canal for the District's Grey Mountain water right supply, SPWCP exchanges with Larimer-Weld Canal and New Cache Canal, and reservoir exchanges with Terry Lake, Big Windsor Reservoir, and Timnath Reservoir
- Diversion from the Poudre River at the New Cache Canal for the New Cache exchange water from the SPWCP
- Storage of water diverted from the Poudre River in a new 190,000 AF Cactus Hill Reservoir
- Construction of the SPWCP infrastructure, which includes the new 45,624 AF Galeton Reservoir
- Construction of new pumping stations and water pipelines
- Realignment of three 2-lane Weld County roads totaling 10.3 miles
- Realignment of 6.8 miles of a 230-kV Platte River Power Authority transmission line

2.7.2 Water Supplies

The water conservation measures and supplies used in Alternative 4 would be the same as Alternatives 2 and 3.

Figure 2-11. Alternative 4—Cactus Hill Reservoir, Multiple Diversion Locations, and Modified SPWCP.



2.7.3 South Platte Water Conservation Project

For Alternative 4, the SPWCP South Platte River diversion dam, intake structure, forebay, and pumping station infrastructure would be the same as Alternative 2. Modeled diversions averaged 32,000 AFY with a maximum of 63,600 AFY.

2.7.4 Storage

Storage in the Cactus Hill and Galeton Reservoirs would be the same as Alternative 3. The modeled hydraulic residence time of water in Cactus Hill Reservoir would be 4.6 years. Estimates of evaporation from the reservoirs based on the hydrology modeling (CDM Smith and DiNatale 2013) for Alternative 4 are shown in Table 2-11. The estimated decreased evaporation in Cactus Hill Reservoir in future conditions is due to the slight decrease in the yield of the Grey Mountain right compared to current conditions. Similarly, a slight increase in yield in the SPWCP would lead to more storage in Galeton Reservoir and more evaporation under future conditions.

Table 2-11. Estimated average annual evaporation, Alternative 4.

Reservoir	Current Conditions (AFY)	Future Conditions (AFY)
Cactus Hill	6,600	6,200
Galeton	3,800	3,900

2.7.5 Conveyance

Conveyance of water diverted under the Grey Mountain right into Cactus Hill Reservoir would use the Poudre Valley Canal and a new inlet pipeline, as described for Alternative 3. Improvements to the diversion structure and lining of the canal would be the same as Alternative 3. Conveyance of water out of Cactus Hill Reservoir would be the same as Alternative 3.

Conveyance into and out of Galeton Reservoir would be the same as Alternatives 2 and 3. In contrast to Alternatives 2 and 3, the SPWCP exchanges would be split under Alternative 4, with exchange water from Larimer-Weld diverted upstream at the Poudre Valley Canal and New Cache water diverted at its original downstream headgate and delivered to Cactus Hill Reservoir by pipeline. The proposed SPWCP exchanges with Terry Lake, Big Windsor Reservoir, and Timnath Reservoir would be diverted at the Poudre Valley Canal. Alternative 4 would complete the exchanges associated with the SPWCP similar to Alternatives 2 and 3, with pipelines from Galeton Reservoir to a delivery location east of Highway 85.

Water would continue to be diverted at the Larimer-Weld and New Cache headgates as historically done, but existing storage associated with the canal companies would be used to facilitate pumping into storage at Cactus Hill. The Big Windsor Reservoir, which is part of the Larimer-Weld system but cannot be used directly due to location below the canal, would be used as a forebay or temporary storage facility for water from the New Cache system. This water

would then be pumped to Cactus Hill Reservoir using a new pipeline and pump station for storage until it was needed by the NISP Participants.

2.7.6 Advanced Water Treatment

Alternative 3 would use water supplies of similar quality as Alternative 2. Advanced water treatment would not be necessary.

2.7.7 Infrastructure Relocation

Relocation of Anheuser-Busch's wastewater disposal facilities, realignment of three Weld County roads and a 230-kV Platte River Power Authority transmission line at the Cactus Hill Reservoir site would be the same as the No Action Alternative (see Section 2.4.7). The relocation of oil and gas wells at the Galeton Reservoir site would be the same as Alternative 2 (see Section 2.5.8).

2.7.8 Operational Flexibility

The District would require the same operational flexibility described for Alternative 2 in Section 2.5.9. The discussion of initial fill of Glade Reservoir also would apply to the Cactus Hill Reservoir.

2.7.9 Implementation

The District would be required to go through water court to change the Grey Mountain water rights to allow Cactus Hill Reservoir as an alternate point of storage as described for Alternative 3. The District also would need to go through water court for an alternate point-of-diversion. Following final design and the water rights change, the District would build facilities associated with Cactus Hill Reservoir and then the SPWCP.

2.8 CONSTRUCTION ACTIVITIES FOR ALL ACTION ALTERNATIVES

The construction sequencing for all the Action alternatives includes the construction of the main reservoir (Glade or Cactus Hill) and the construction of the SPWCP (Galeton Reservoir). Based on information provided by the District, the Corps' analysis assumes that the main reservoir (Glade Reservoir or Cactus Hill Reservoir) would be developed before the SPWCP (Figure 2-12). Detailed design, right-of-way acquisition, and other preparatory work for the main reservoir would occur over 3 to 4 years. In total, the period of activity from detailed design of the main reservoir to completion of the entire project is estimated to take about 10 years. The following is the anticipated sequencing associated with the alternatives.

Figure 2-12. Estimated Construction Sequencing.

2.8.1 Glade Reservoir (Alternative 2)

Construction of Glade Reservoir would require the relocation of U.S. 287, the relocation of the Munroe Canal, and the construction of the dam, forebay, pump station, and inlet canal. The No-Reclamation Action Option also would include a piped delivery conveyance system. Its construction is estimated to take 4 years: 1 year excavating and preparing the foundation and 3 years of dam construction.

2.8.2 Cactus Hill Reservoir (Alternatives 3 and 4)

Construction of Cactus Hill Reservoir would involve the relocation of the Anheuser-Busch waste-water disposal area, realignment of 6.8 miles of a 230–kV Platte River Power Authority transmission line, relocation of three, two-lane Weld County roads totaling 10.3 miles, construction of the dam, forebay, pump station, and inlet canal. A piped conveyance system also would be required. Alternative 4 would also include the construction of a pump station and pipeline from the New Cache Canal headgate to Cactus Hill Reservoir. The construction of the Cactus Hill Dam is estimated to take 3 years: 1 year excavating and preparing the foundation and 2 years of dam construction.

2.8.3 South Platte Water Conservation Project (All Action Alternatives).

Construction of the SPWCP would involve the construction of an intake structure on the South Platte River, a forebay, two pump stations, conveyance pipelines, and Galeton Dam. The work would be completed over 2 years.

2.9 COMPARISON OF ALTERNATIVES

2.9.1 Costs

The Corps updated estimated costs in two sequential steps. The DEIS issued in 2008 contained cost estimates for the then proposed No Action Alternative and action alternatives. The DEIS cost estimates were based on estimates developed in 2005 and 2006. Alternatives were revised for the SDEIS and costs were initially updated to 2010 dollars (ERO 2014c). In the 2015 Socioeconomic Resources Effects Report, BBC described how 2010 costs were updated for the financial analysis (BBC and Honey Creek Resources [HCR] 2015b). Design and construction costs were distributed over a 13-year project development period and inflated at a 4% annual inflation rate.

The No Action Alternative would transfer water from irrigated land in the Larimer-Weld, New Cache, and Home Supply irrigation systems to municipal use by the Participants. In 2010, MWH (2010) provided an estimated cost for acquiring these water rights of between $6,600 and $8,900 per AF of average, transferrable yield including legal costs and costs for revegetation. Due to the economic rebound in Northern Colorado (and elsewhere) since 2010, the value of agricultural water rights has increased rapidly in Northern Colorado. The District reports that prices for C-BT units, the most consistently tracked indicator of water rights values in the region, have approximately doubled since 2010. The District estimates that the cost of other agricultural water transfers has also approximately doubled over this timeframe (District 2014). Based on this information, the estimated current cost in 2014 for acquiring agricultural water supplies is between $13,200 and $17,800 per AF, including legal costs and the costs of revegetation. The midpoint of this range ($15,500 per AF) was used in the financial effects analysis for the costs of acquiring water rights under the No Action Alternative and for the cost of acquiring additional

water supplies for NISP Participants that need additional water supplies, beyond NISP, to meet their projected future demands.

Table 2-12 provides the estimated costs of the alternatives in 2010 dollars and the cumulative projected capital costs over a 13-year project development period, including projected inflation. The No Action Alternative has the highest estimated cumulative capital cost ($1,373,000,000) and Alternative 2 has the lowest estimated cumulative capital cost ($718,000,000). The estimated costs for Alternative 2–Reclamation Action Option, however, do not include payments to Reclamation for the contract and special use permit or the increased costs of pumping water into Carter Lake.

2.9.2 Environmental Impacts

The alternatives analyzed in this EIS were developed in response to the criteria discussed in Section 2.2. These alternatives are described in detail in this chapter. A detailed discussion of the alternatives' impacts is contained in Chapter 4. The effects of the alternatives are summarized in the *Summary* section of this EIS.

Table 2-12. NISP estimated alternative costs, 2010 dollars.

Item	Alternative 1 — No Action Alternative	Alternative 2 — Glade Reservoir and the SPWCP (Proposed Action)		Alternative 3 — Cactus Hill Reservoir, Poudre Valley Canal Diversion, and SPWCP	Alternative 4 — Cactus Hill Reservoir, Multiple Diversion Locations, and SPWCP
		Reclamation Action	No Reclamation Action		
Capital Costs					
New Storage Reservoir Cactus Hill: Alts 1, 3, and 4 Glade + Forebay: Alt 2	$145,503,000	$222,138,000	$222,138,000	$229,506,000	$229,506,000
Glade to Horsetooth (Reclamation Action Option) Carter Pipeline (no Reclamation Action Option)	$0	$8,553,000	$84,460,000	$0	$0
Conveyance to Reservoirs	$52,477,000	$5,851,000	$5,851,000	$103,236,000	$144,843,000
Conveyance to Participants	$117,682,000	$8,553,000	$84,460,000	$144,536,000	$144,536,000
Munroe Canal Bypass	$0	$36,423,000	$36,423,000	$0	$0
Galeton Reservoir	$0	$54,140,000	$54,140,000	$54,140,000	$54,140,000
SPWCP Infrastructure	$0	$127,253,000	$127,253,000	$127,253,000	$127,253,000
Advanced Water Treatment	$56,500,000	$0	$0	$0	$0
Water Rights Acquisition, Legal and Revegetation	$350,000,000	$0	$0	$1,000,000	$1,000,000
U.S. 287 Realignment	$0	$44,914,600	$44,914,600	$0	$0
Total	**$722,162,000**	**$507,825,600**	**$659,639,600**	**$659,671,000**	**$701,278,000**
Annual Costs					
Operations and Maintenance (annual cost)	$1,706,000	$2,165,000	$2,542,000	$3,007,000	$3,214,000
Pumping Power Cost (annual cost)	$2,438,000	$2,663,000	$4,291,000	$4,135,000	$4,511,000
Reclamation Contract and Permit (annual cost)	$0	*See note	$0	$0	$0
Projected Cumulative Nominal Costs over a 13-Year Project Development Period					
	$1,372,688,000	$718,257,000	$932,979,000	$933,024,000	$991,872,000

Source: ERO 2014c; BBC and HCR 2015b.

*Note: The estimated costs for Alternative 2 – Reclamation Action Option do not include payments to Reclamation for the contract and special use permit or the increased costs of pumping water into Carter Lake, which are unknown at this time.

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CHAPTER 3

AFFECTED ENVIRONMENT

CHAPTER 3

AFFECTED ENVIRONMENT

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Chapter 3. Affected Environment

3.1 INTRODUCTION

Chapter 3, Affected Environment, provides new and updated information on the existing physical, biological, social, and economic conditions of the environment that may be directly or indirectly affected by the alternatives. The resource descriptions in this chapter provide context for the impact assessments presented in Chapters 4 and 5. Table 3-1 summarizes where information about affected environment resources can be found in the DEIS and SDEIS.

Revisions have been made where new information is available or where comments on the DEIS warranted revisions. If a section description has not changed since the DEIS, reference to where that information can be found in the DEIS is given. If the project alternatives would not affect the resource within a given study area, the existing conditions for that resource are not described. Information is presented on the affected environment for the new No Action Alternative and new Alternative 4. New and updated information on resources within the U.S. 287 western alignment study area is provided under the Glade Reservoir subsection for each affected resource. Climate change is described in Chapter 5, Cumulative Effects, as a reasonably foreseeable future condition of the affected environment.

Table 3-1. Affected environment resources described in DEIS and SDEIS.

Resource	DEIS Section	SDEIS Section
Surface water	3.3	3.2
Surface water quality	3.5	3.3
Stream morphology and sediment transport	3.4	3.4
Ground water	3.7	3.5
Geology	3.8, 3.27.2	3.6
Soils	3.9, 3.27.4	3.7
Vegetation	3.10	3.8
Riparian and wetland areas	3.12, 3.13, 3.27.5, 3.27.6	3.9
Wildlife	3.14, 3.27.7	3.10
Special status species	3.16, 3.27.8	3.11
Aquatic biological resources	3.15	3.12
Traffic and transportation	3.20, 3.27.12	3.13
Air quality	3.25, 3.27.11	3.14
Noise	3.24, 3.27.10	3.15
Recreation	3.17	3.16
Land use	3.21, 3.27.13	3.17
Visual resources and aesthetics	3.19	3.18
Cultural, historical, and paleontological resources	3.18, 3.27.3, 3.27.9	3.19
Socioeconomics	3.22, 3.27.14	3.20
Hazardous materials	3.23, 3.27.15	3.21

More detailed information is provided in the technical memos and reports produced for each resource for the DEIS and SDEIS. These studies are summarized in Table 3-2 and Table 3-3 below. These documents are available at http://www.nwo.usace.army.mil/Missions/RegulatoryProgram/Colorado/EISNISP.aspx, and full citations are listed in Chapter 7 References.

Table 3-2. Affected environment DEIS technical memos and reports.

Resource	DEIS Technical Memos and Reports	Citation	Abbreviated Title in SDEIS
Surface water	Water Resources Technical Report	HDR 2008	2008 Water Resources Report
Surface water quality	Water Quality Technical Report	ERO and HDR 2008	2008 Water Quality Report
Stream morphology and sediment transport	South Platte River near Kersey Stream Morphology Technical Report	ERO 2008a	2008 South Platte River Stream Morphology Report
	River Morphology and Sediment Transport Technical Report for the Cache la Poudre River	ACE 2008	2008 River Morphology Report
Ground water	Ground Water Issues –Proposed Reservoir Sites, Cache la Poudre River, and South Platte River Memorandum	ERO 2007	2007 Ground Water Memo
Geology	Glade Dam Technical Memorandum Galeton Dam Technical Memorandum Cactus Hill Dam Technical Memorandum	GEI 2006a GEI 2006b GEI 2006c	2006 Geologic Memorandums
Soils	Land Use Technical Report	ERO 2008b	2008 Land Use Report
Vegetation	Vegetation Technical Report	ERO 2008c	2008 Vegetation Report
Riparian and wetland areas	Wetlands and Other Waters Technical Report	ERO 2008d	2008 Wetland Report
	Vegetation Technical Report	ERO 2008c	2008 Vegetation Report
Wildlife	Wildlife Technical Report	ERO 2008e	2008 Wildlife Report
Special status species	Endangered Species Habitat Assessment Report	ERO 2006a	2006 Endangered Species Report
	Species of Concern Technical Report	ERO 2008f	2008 Species of Concern Report
Aquatic biological resources	Aquatic Biological Resources Technical Report	GEI 2008	2008 Aquatic Resources Report
Traffic and transportation	U.S. 287 Relocation Study	Muller 2007	2007 U.S. 287 Relocation Study
	Land Use Technical Report	ERO 2008b	2008 Land Use Report
Air quality	Air Quality Technical Report	MERCO 2006a	2006 Air Quality Report
Noise	Noise Assessment Report	MERCO 2006b	2006 Noise Report
Recreation	Recreation Resources Technical Report	ERO 2008g	2008 Recreation Report
Land use	Land Use Technical Report	ERO 2008b	2008 Land Use Report
Visual resources and aesthetics	Visual Resources Comprehensive Technical Report	ERO 2008h	2008 Visual Resources Report
	Visual Resources Technical Report for the Highway 287 Realignment Alternatives	ERO and HLA 2008	2008 Visual Resources Highway 287 Report
Cultural, historical, and paleontological resources	Cultural Resources Technical Report	WCRM 2008	2008 Cultural Resources Report
	Paleontological Technical Report	RMP 2006	2006 Paleontological Report
Socioeconomics	Socioeconomic Resources Technical Report	HDR and BBC 2008	2008 Socioeconomic Resources Report
Hazardous materials	Hazardous Materials Technical Memorandum	ERO 2006b	2006 Hazardous Materials Memo

Table 3-3. Affected environment SDEIS technical memos and reports.

Resource	SDEIS Technical Memos and Reports	Citation	Abbreviated Title in SDEIS
Surface water	Water Administration Technical Memorandum	CDM Smith, DiNatale, and Hydros 2011	2011 Water Administration Memo
	Water Resources Technical Report	CDM Smith 2014a	2014 Water Resources Report
Surface water quality	Common Technical Platform Water Quality Baseline Report	ERO 2012a	2012 Water Quality Baseline Report
	Stream Temperature and Dissolved Oxygen Analysis for NISP Supplemental EIS Summary of Current Conditions and Qualitative Anticipated Effects of NISP Alternatives	Hydros 2014a	2014 Stream Temperature and DO Analysis
	Reservoir Comparative Analysis for the NISP SDEIS Technical Memorandum	Hydros 2014b	2014 Reservoir Comparative Analysis Memo
	Water Quality Assessment Report, Phase 1	GEI 2015a	2015 Water Quality Report
Stream morphology and sediment transport	Stream Morphology and Sediment Transport Cache la Poudre River Mainstem Baseline Report	ACE 2013	2013 Stream Morphology Baseline Report
	Two Dimensional Hydraulic Modeling Report Cache la Poudre River Mainstem	ACE 2011	2D Hydraulic Modeling Report
Ground water	Ground Water Technical Report for the Mainstem of the Cache la Poudre River	ERO 2012b	2012 Ground Water Report
Geology	Oil and Gas Development at the Proposed Galeton Reservoir Site Technical Memorandum	ERO 2012c	2012 Oil and Gas Development Memo
Vegetation	Vegetation and Wetland Resources Technical Report Supplement	ERO 2015b	2015 Vegetation and Wetland Resources Supplement
Riparian and wetland areas	Wetlands and Riparian Resources Baseline Technical Report for Mainstem of the Cache la Poudre River	ERO 2012d	2012 Wetlands and Riparian Resources Baseline Report
	Vegetation and Wetland Resources Technical Report Supplement	ERO 2015b	2015 Vegetation and Wetland Resources Supplement
Wildlife	Wildlife Technical Report Supplement	ERO 2015c	2015 Wildlife Supplement
Special status species	Species of Concern Technical Report Supplement	ERO 2015d	2015 Species of Concern Supplement
Aquatic biological resources	Common Technical Platform Aquatic Biological Resources Baseline Report for the Mainstem Cache la Poudre River and South Platte River	GEI 2013	2013 CTP Aquatic Resources Baseline Report
Recreation	Recreation Resources Technical Report Supplement	ERO 2015e	2015 Recreation Supplement
Socioeconomics	Socioeconomic Resources Affected Environment Technical Report	BBC and HCR 2015a	2015 Socioeconomic Resources Affected Environment Report
Hazardous materials	Impact of F.E. Warren Missile Site 13 TCE Plume on Construction Activities for the Proposed Glade Reservoir Forebay Memorandum	ERO 2010a	2010 TCE Plume Memo
	Hazardous Materials Assessment Addendum Memorandum	ERO 2010b	2010 Hazardous Materials Assessment Addendum

3.1.1 Study Areas

The NISP Affected Environment includes several study areas as described below.

3.1.1.1 NISP or Project

This general term includes the proposed reservoir sites for the action and no action alternatives, proposed conveyance systems, Poudre and South Platte River segments that could be affected by NISP, and the Participant Service Areas.

3.1.1.2 No Action Alternative

Within the No Action Alternative study area, irrigated lands produce alfalfa, corn, hay/pasture, and other crops. Larimer-Weld and New Cache Canal water irrigates lands east of Fort Collins and north of Evans, and Home Supply Ditch water irrigates lands between the Big Thompson and Little Thompson Rivers south of Loveland (Figure 2-2). A portion of this irrigation water is proposed for transfer from agricultural to M&I use for the NISP Participants under the No Action Alternative.

3.1.1.3 Proposed Reservoir Sites

- **Glade Reservoir Study Area (includes U.S. 287 Realignment)** – The Glade Reservoir study area is described in Section 3.2.2 of the DEIS. In 2013, the Colorado Department of Transportation (CDOT) selected the western alternative for the U.S. 287 realignment for Alternative 2. The U.S. 287 realignment (Figure 2-4) would proceed north from SH 14 through the decommissioned Holcim Mine, which occurs on a shale/limestone ridge and consists mostly of spoil piles. The proposed alignment would cross two valleys containing native and introduced grasslands with several large wet meadows divided by a north/south trending hogback covered with shrublands and grasslands. Two large canals, the North Poudre Supply Canal and the Poudre Valley Canal, meander from southwest to northeast across the U.S. 287 realignment study area.
- **Galeton Reservoir and SPWCP Study Area** – The Galeton Reservoir and SPWCP study area is described in Section 3.2.4 of the DEIS. Since publication of the DEIS, numerous oil and gas wells have been constructed in the study area. More detailed information about these wells is presented in Section 3.21.2.2 of the SDEIS.
- **Cactus Hill Reservoir Study Area** – The Cactus Hill Reservoir study area is described in Section 3.2.5 of the DEIS.

3.1.1.4 Proposed Conveyance Systems

- **Glade to Horsetooth Pipeline Study Area** – The Glade to Horsetooth Pipeline study area is described in Section 3.2.6 of the DEIS.
- **Carter Pipeline Study Area** – The Carter Pipeline study area is described in Section 3.2.7 of the DEIS.

- **Poudre Valley Canal Study Area** – The Poudre Valley Canal study area is described in Section 3.2.8 of the DEIS.
- **Cactus Hill to Horsetooth Reservoir Pipeline Study Area** – The Corps determined construction of this pipeline would be infeasible due to site geography and infrastructure requirements, and this component was eliminated.
- **Other Conveyance Systems Study Areas** – In addition to the Glade to Horsetooth Pipeline, Carter Pipeline, and Poudre Valley Canal study areas, there are miles of proposed water conveyance pipeline associated with the alternatives that would convey water to the Participants. The exact location and configuration of this infrastructure has not yet been determined. Between the SDEIS and FEIS these alignments will be refined, and additional information on resources and potential effects to those resources associated with construction of the pipelines will be presented in the FEIS. Construction of the conveyance systems may also require additional consideration under Clean Water Act Section 404.

3.1.1.5 Poudre River

In addition to the study areas above where there would be direct effects from ground disturbance associated with construction of the alternatives, changes in streamflow (increase or decrease) in the Cache la Poudre (Poudre) River associated with operation of the alternatives could indirectly affect the following resources:

- 3.2 Surface Water
- 3.3 Surface Water Quality
- 3.4 Stream Morphology and Sediment Transport
- 3.5 Ground Water
- 3.9 Riparian and Wetland Areas
- 3.10 Wildlife
- 3.11 Special Status Species
- 3.12 Aquatic Biological Resources
- 3.16 Recreation
- 3.18 Visual Resources
- 3.20 Socioeconomics

The geographic scope of the study area for the flow-related resources is described below.

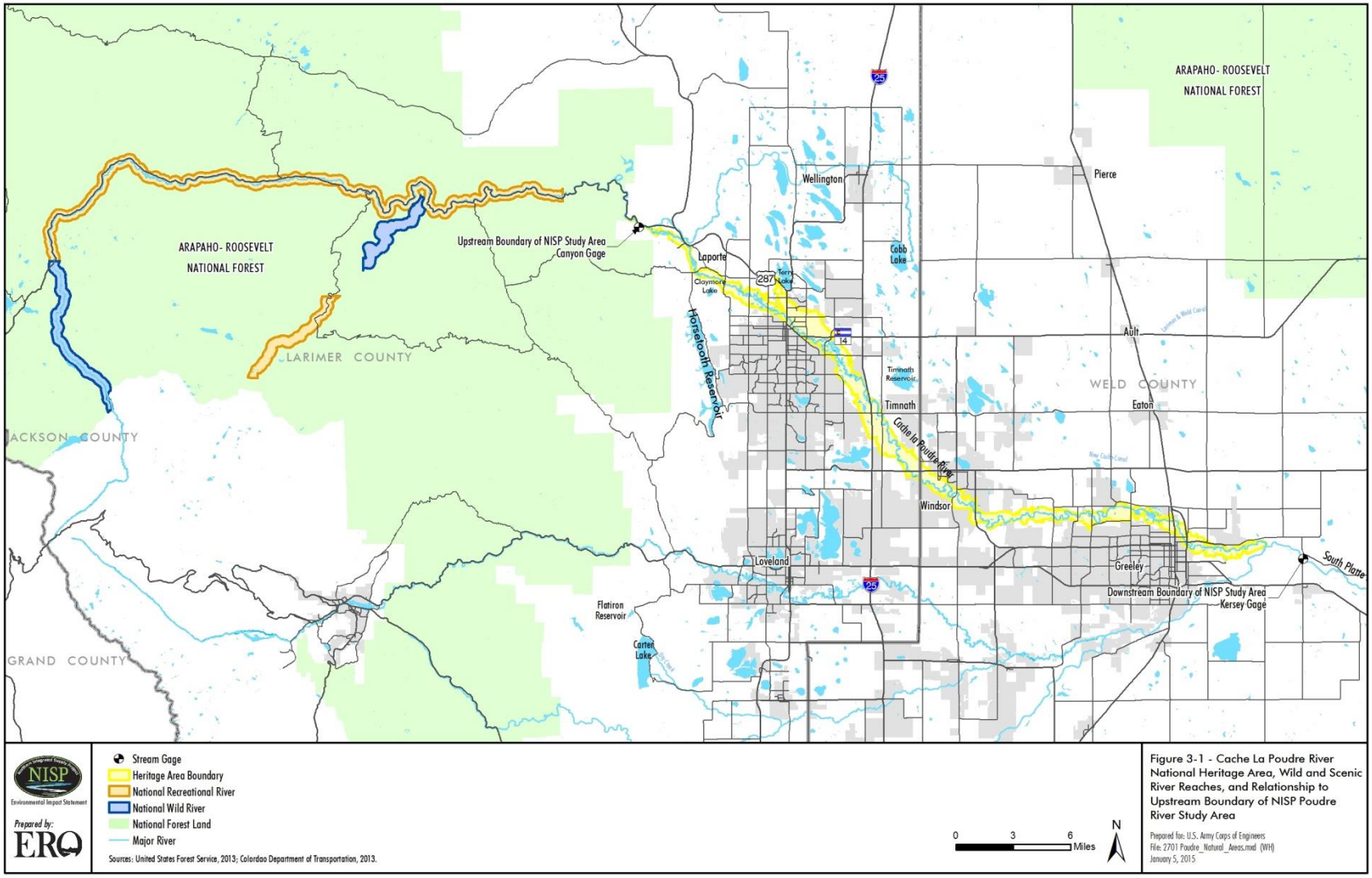
- Mainstem Study Area – river segments that may be affected by NISP.
- Representative Sites – sampling sites along affected river segments for field data collection.

3.1.1.6 Mainstem Study Area

The mainstem study area for the flow-related resources for the Poudre River is from the canyon mouth (approximate downstream limit of the Poudre Canyon where the river transitions from the

confinement of the canyon to an unconfined alluvial channel) to the confluence with the South Platte River. The study area largely coincides with the Cache la Poudre River National Heritage Area and is downstream of the Wild and Scenic River designated reaches (Figure 3-1). National Heritage Areas are designated by Congress as places where natural, cultural, and historic resources combine to form a cohesive, nationally important landscape. The National Park Service describes them as "lived-in landscapes." The National Wild and Scenic Rivers System was created by Congress in 1968 to preserve certain rivers with outstanding natural, cultural, and recreational values in a free-flowing condition for the enjoyment of present and future generations. In 1986, 75 miles of the Poudre River were designated as part of the National Wild and Scenic Rivers System. Thirty miles are designated Wild and 45 miles are designated Recreational (Figure 3-1). The Poudre River upstream of Poudre Park is the only Wild and Scenic designated river in Colorado.

Figure 3-1. Cache la Poudre River National Heritage Area, Wild and Scenic River Reaches, and Relationship to Upstream Boundary of NISP Poudre River Study Area.



The mainstem is about 55 miles long. At times, there is not a continuous flow throughout the entire length of the mainstem. The following alterations of the channel and flows have contributed to the current condition of the mainstem:

- Water diversions for municipal, industrial, and agricultural uses
- Water storage
- Channel confinement
- Channel realignment
- Levee construction
- Bank armoring
- Floodplain development
- Bridge construction
- Snag clearing
- Clearing of riparian areas for agriculture
- Aggregate mining within the floodplain
- Invasion of wetlands and riparian areas by nonnative species
- Encroachment of the active channel by wetland and riparian vegetation resulting in narrowing of the active channel

Many of these factors have occurred for more than 100 years and have contributed to the trends for the river and its associated resources discussed below.

3.1.2 Trends in Flow Related Resources on the Poudre River

There are several trends that occur on the Poudre River as it changes from a montane to a transitional to a plains river over its approximate 55 mile course within the NISP study area. These trends are affected by the natural environment (e.g., gradient, geology, and water source) as well as anthropogenic (human-caused) factors (e.g., diversions, discharges, channel alterations, flood control, and aggregate mining). The trends are the response of the river to changes in the watershed over the last two centuries. In particular, stream morphology continues to respond to changes in hydrology associated with water resources development and direct interference with the river channel through channel modification associated with gravel extraction, urban development, and structures. Many of these trends align with an approximate geographic divide for the mainstem where I-25 crosses the Poudre River (about 3 miles downstream of Fort Collins and about a 0.5 mile upstream of Timnath). The relative magnitude of flow diversions along the river is shown for a selection of flows in Figure 3-2 and Figure 3-3. Additional information on each resource can be found in the respective sections of Chapter 3.

Figure 3-2. Cache la Poudre River Average Annual Volumetric Flows, Major Diversions, and Discharges (North).

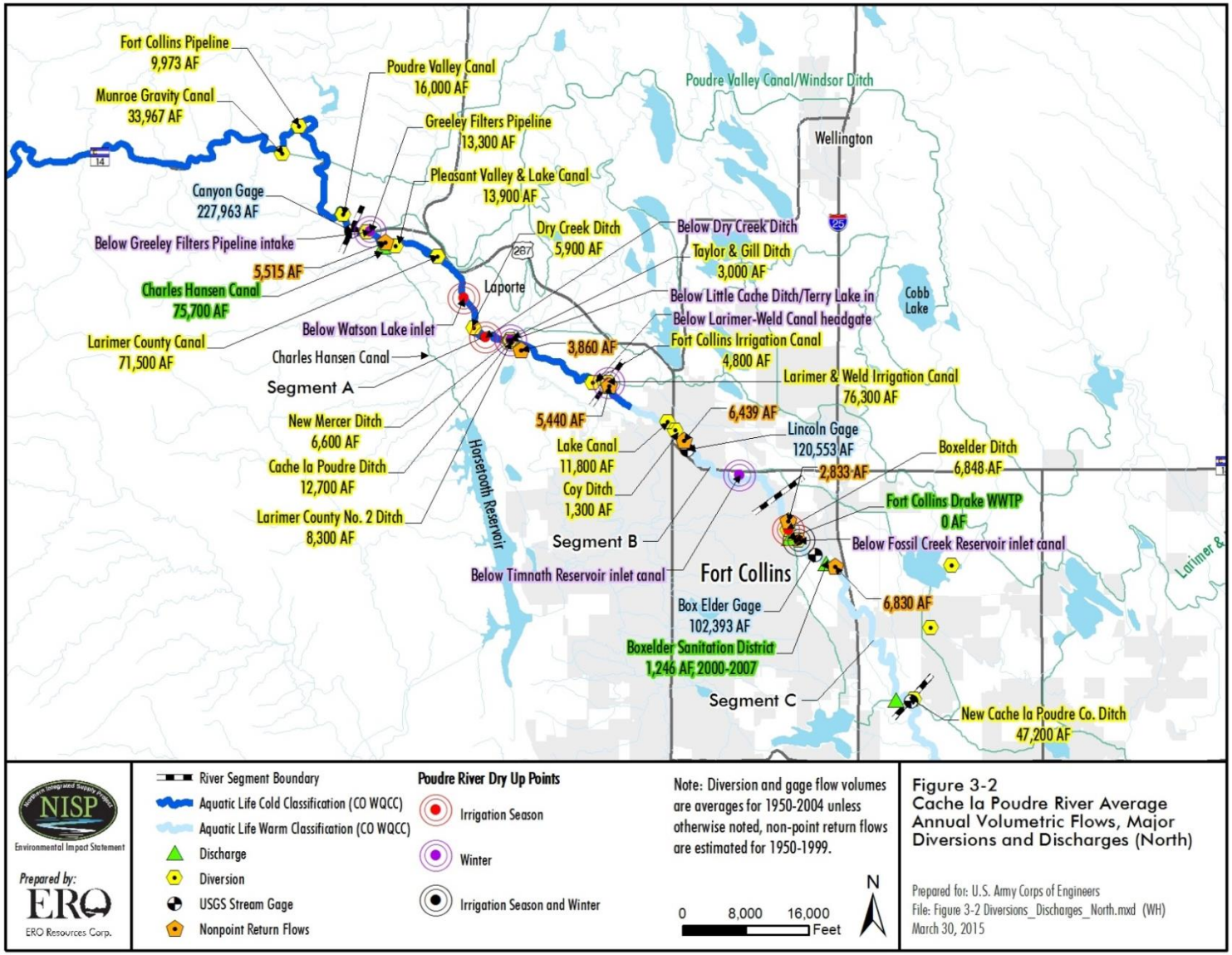
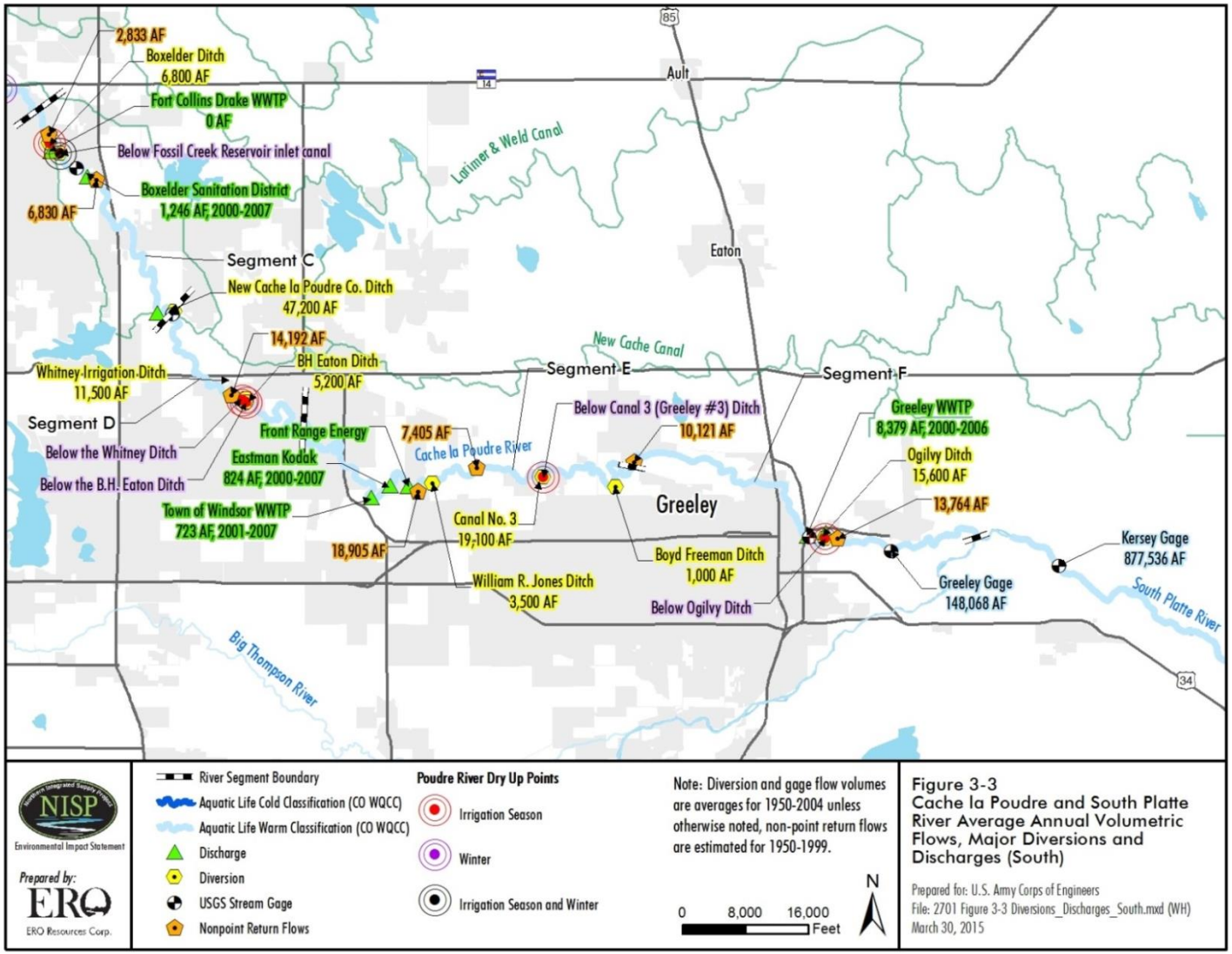


Figure 3-3. Cache la Poudre and South Platte River Average Annual Volumetric Flows, Major Diversions, and Discharges (South).



The following general trends on the Poudre mainstem are described upstream to downstream:

- Average annual peak flows (related to seasonal snow melt and not rain events) are highest at the canyon mouth (2,552 cfs at Canyon Gage), lowest at the Boxelder Gage (1,571 cfs) downstream of Fort Collins, and then increase slightly in the lower reaches of the river (1,856 cfs at Greeley Gage) primarily due to return flows and ground water discharge.
- Poudre River water quality is considered good near the canyon mouth then begins to show some degradation in Fort Collins and continues to decline from east of Fort Collins to Greeley. East of Greeley, river water quality improves slightly.
- Total dissolved solids concentrations in the Poudre River increase in a downstream direction from about 50 mg/L near the canyon mouth to about 1,200 mg/L starting east of Fort Collins. The dominant dissolved cations and anions also change from calcium or sodium bicarbonate within the canyon to calcium sulfate downstream of the canyon. For example, the sulfate concentration changes from less than 5 mg/L near the canyon mouth to more than 500 mg/L starting east of Fort Collins.
- Hydrologic change has been greatest in the vicinity of Fort Collins; however, the morphologic results of this hydrologic change have been greater downstream of I-25.
- Stream morphology from the canyon mouth to around I-25 is flood-dominated. At most cross sections upstream of I-25, bankfull discharge rarely occurs. Stream morphology downstream of I-25 tends to be deposition-dominated.
- Channel size and capacity are reduced in the downstream direction except for the Greeley Channelized Reach, which has an artificially high hydraulic depth and high bankfull discharge. Downstream of I-25, the river channel has contracted to as little as 15 feet wide at some riffles. It takes substantially less flow to flood the lower reaches of the Poudre River (except for the Greeley Channelized Reach) as was observed during recent high flows in 2011, 2013, and 2014.
- The Poudre upstream of I-25 appears to be sediment supply-limited and downstream of I-25 appears to be sediment transport-limited. This has led to channel narrowing downstream of I-25, and in some sections the riffle-pool complexes of the river are changing with the filling of pools with sediment. A transport-limited system is more sensitive to changes in hydrology because its behavior is controlled by the hydraulics of the system rather than by sediment supply.
- Coarser cobble and gravel river substrate is more common upstream of I-25 and a substrate of silt and sand is more common downstream of I-25. Sands and gravels that have moved through the upstream reaches are in greater supply relative to the more limited transport capacity of the river. No continuous armor layer is present downstream of I-25.
- Generally, there is much more recruitment of trees (seedlings and saplings) in the riparian corridor from the canyon mouth through Fort Collins than downstream of Fort Collins. However, much of the observed recruitment between the canyon mouth and Fort Collins is non-cottonwood species such as green ash and box elder. The eventual maturing of these non-cottonwood species may lead to future shifts in the species composition of the riparian woodland.

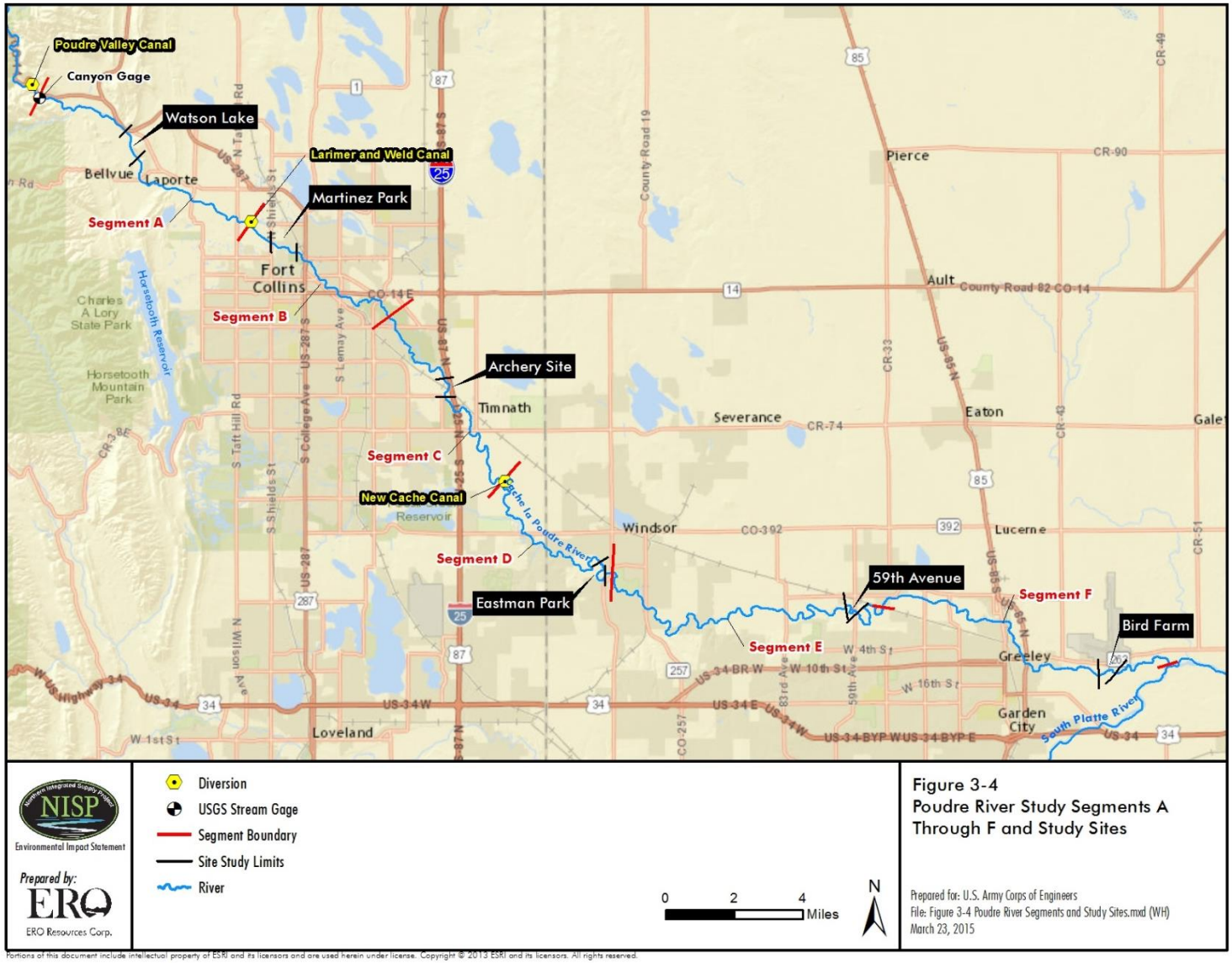
- As would be expected given the trend in bankfull flows described above, the minimum inundation flow for cottonwood woodlands tends to decrease in a downstream direction. Minimum inundation flows for cottonwood woodlands range from about 1,500-3,000 cfs upstream of Fort Collins, to 2,000-3,200 cfs through Fort Collins, to about 850-2,200 cfs on the lower reaches of the river. However, despite the decrease in the minimum inundation flow for the woodlands on the downstream reaches, a greater level of recruitment of riparian trees was observed in the upstream reaches.
- Vegetation encroachment of the channel is more common in the lower reaches than the upper reaches of the river. Vegetation (particularly reed canarygrass) colonizes rapidly in areas of deposition at or near water level throughout the lower river system. The rapid spread and growth of this species may result from sustained summer water levels associated with return flows from irrigated areas and wastewater treatment plants (WWTPs). Reed canarygrass appears to be in a bio-geomorphic feedback loop in which channel contraction allows colonizing vegetation that then encourages further deposition, further vegetation colonization, and so on.
- The Colorado Department of Public Health and Environment (CDPHE) has classified the stream segment from the Munroe Canal to Shields Street in Fort Collins as Aquatic Life Cold 2 (expected aquatic resources include coldwater species, such as trout). CDPHE has classified the rest of the Poudre River downstream as Aquatic Life Warm 2. This indicates that warmwater species are expected to be present. The Class 2 designation for these reaches indicates that the river does not support the expected number and abundance of species and that there may be some impairment of aquatic resources.

Representative Sites - In response to comments on the DEIS requesting additional information about Poudre River resources, the mainstem was divided into six representative segments (Table S-4 and Figure 3-4) to collect baseline data on aquatic resources, ground water, water quality, stream morphology, and wetland and riparian vegetation. Segment selection was determined based on discussions between the Corps, U.S. Geological Survey, and NISP third-party contractors. Within each segment, study sites considered representative of the aquatic biological resources, riparian vegetation, wetlands, and river geomorphology were selected for intensive data collection (Anderson Consulting Engineers, Inc. [ACE] 2011; GEI 2013), and these are referred to as the Poudre River study sites throughout this document. Although the 2013 flood on the mainstem may have altered some of the vegetation communities and land forms within the representative segments, the Poudre River study sites remain a representative sample of the conditions along the river, which have developed in response to cycles of flooding and other forces that alter the river and the riparian environment.

Table 3-4. Poudre River study segments.

Segment	Reach	Representative Poudre River Study Site
A	From the mouth of Poudre Canyon to the Larimer-Weld Canal	Watson Lake
B	Larimer-Weld Canal to Spring Creek in Fort Collins	Martinez Park
C	Spring Creek to the New Cache Canal Diversion; this segment continues through Fort Collins and crosses under I-25	Archery Site
D	New Cache Canal to County Road 17, near of the Town of Windsor; this segment runs through the Town of Timnath	Eastman Park
E	County Road 17 to the 59th Ave. Railroad Bridge upstream of Greeley; this segment contains the Town of Windsor	59th Avenue
F	The 59th Ave. Railroad Bridge upstream of Greeley to the South Platte River; this segment is adjacent to and downstream of the City of Greeley	Bird Farm

Figure 3-4. Poudre River Study Segments A through F.



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3.1.3 South Platte River

The South Platte River study area is described in Section 3.2.11 of the DEIS. The streamflow gage on the South Platte River near Kersey (USGS 06754000/DWR PLAKERCO) was the furthest downstream point evaluated for flow effects in the NISP DEIS. The downstream extent of the study on the South Platte River was re-evaluated for the SDEIS based on average monthly hydrologic changes under the proposed NISP action alternatives using the results of the CTP hydrologic modeling. A change in flow threshold of 10% on an average monthly basis (i.e., the average of months across all conditions) was selected and is consistent with methods used for other EISs including the Moffat Collection System Project EIS. As shown in Table 3-5 below, the average monthly changes in flow under the NISP action alternatives would be less than 10% at the Kersey Gage in all months and annually for all scenarios. The Kersey Gage was therefore retained as the downstream end point for flow-related effects analyses for the NISP SDEIS.

Resource evaluations were conducted to determine impacts at the Kersey Gage and assess the validity of the downstream study area extent. Results of the resource evaluations indicate effects would be negligible to minor; therefore, extension of the study area further downstream on the South Platte River was not warranted. In addition, changes in flow are not significant as a percentage of the total streamflow downstream of these points because flows increase from contributing drainage basin and tributaries. No representative sites were selected in the South Platte River Basin due to results obtained from other sites and the relatively low flow changes predicted on the South Platte River.

The exception to the downstream extent includes evaluation of special status species. In the Platte River Basin, the evaluation of special status species considered depletion effects on federally listed species in Nebraska as described in the NISP EIS Biological Assessment (DEIS, Appendix B). Prior to issuance of the FEIS or ROD, the Corps will reinitiate consultation with the USFWS regarding South Platte River depletions.

Table 3-5. Average monthly flow at Kersey (all years, IY 1980-2005).

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Annual
Alternative 2 with Current Conditions													
CTP Run 1 (cfs)	964	851	842	856	943	1,157	2,492	3,126	979	809	814	937	1,231
NISP Run 3a (cfs)	904	798	792	832	931	1,093	2,385	2,912	954	786	772	926	1,174
Change in Flow (cfs)	60	53	50	25	12	63	107	214	26	23	42	11	57
Percent Difference	6%	6%	6%	3%	1%	5%	4%	7%	3%	3%	5%	1%	5%
Alternative 2 with Future Conditions													
CTP Run 2 (cfs)	961	879	874	865	930	1,225	2,752	3,275	1,127	929	919	1,001	1,311
NISP Run 4a (cfs)	914	809	822	844	928	1,167	2,589	3,067	1,093	904	874	992	1,250
Change in Flow (cfs)	47	70	52	21	2	58	163	207	35	25	45	10	61
Percent Difference	5%	8%	6%	2%	0%	5%	6%	6%	3%	3%	5%	1%	5%
Alternative 3 with Current Conditions													
CTP Run 1 (cfs)	964	851	842	856	943	1,157	2,492	3,126	979	809	814	937	1,231
NISP Run 3b1 (cfs)	899	788	785	823	924	1,085	2,363	2,870	953	784	773	925	1,164
Change in Flow (cfs)	65	63	58	33	20	72	129	256	26	25	41	12	67
Percent Difference	7%	7%	7%	4%	2%	6%	5%	8%	3%	3%	5%	1%	5%
Alternative 3 with Future Conditions													
CTP Run 2 (cfs)	961	879	874	865	930	1,225	2,752	3,275	1,127	929	919	1,001	1,311
NISP Run 4b1 (cfs)	910	808	814	842	927	1,167	2,564	3,020	1,094	903	873	992	1,243
Change in Flow (cfs)	51	71	60	23	3	58	188	255	33	26	46	10	69
Percent Difference	5%	8%	7%	3%	0%	5%	7%	8%	3%	3%	5%	1%	5%
Alternative 4 with Current Conditions													
CTP Run 1 (cfs)	964	851	842	856	943	1,157	2,492	3,126	979	809	814	937	1,231
NISP Run 3b2 (cfs)	890	775	777	820	929	1,084	2,365	2,887	947	787	779	926	1,164
Change in Flow (cfs)	74	76	65	36	14	73	127	239	32	22	35	11	67
Percent Difference	8%	9%	8%	4%	2%	6%	5%	8%	3%	3%	4%	1%	5%
Alternative 4 with Future Conditions													
CTP Run 2 (cfs)	961	879	874	865	930	1,225	2,752	3,275	1,127	929	919	1,001	1,311
NISP Run 4b2 (cfs)	901	798	815	839	926	1,168	2,567	3,033	1,091	908	879	992	1,243
Change in Flow (cfs)	60	81	58	26	4	56	185	242	37	21	40	9	68
Percent Difference	6%	9%	7%	3%	0%	5%	7%	7%	3%	2%	4%	1%	5%

3.2 SURFACE WATER

3.2.1 Overview

This section describes the surface water resources that could potentially be affected by implementation of any of the action alternatives or the No Action Alternative described in Chapter 2. The geographic scope of this section includes existing reservoirs that would be involved via NISP exchanges, affected river basins, and other waters at the proposed reservoir sites that could be affected by ground disturbance associated with construction of the alternatives. Temporary impacts could occur to waters within the conveyance system study areas due to construction of pipelines.

Subsequent to the DEIS, new Poudre River hydrologic modeling was performed for the SDEIS and is discussed in the 2013 CTP Modeling Report (CDM Smith and DiNatale 2013). Information on surface water resources is summarized from the 2011 Water Administration Memo (CDM Smith, DiNatale, and Hydros 2011) and 2014 Water Resources Report (CDM Smith 2014a).

3.2.2 Horsetooth Reservoir

Horsetooth Reservoir supplies water to Fort Collins, Greeley, and several rural domestic suppliers, industries, and agriculture. The primary inflows to the reservoir are Big Thompson River water supplied from the Hansen Feeder Canal and Colorado River water transported through the Continental Divide via the Adams Tunnel. The main outlet is through Horsetooth Dam, which supplies water to the Poudre River, City of Greeley, and several smaller water users via the Hansen Supply Canal (District 2007). The other outlet is the Soldier Canyon Outlet, which provides water to the City of Fort Collins and Soldier Canyon water treatment facilities, Colorado State University, and Dixon Reservoir. Horsetooth Reservoir has stored water since 1951. Water surface elevations fluctuate annually 35 to 50 feet in response to reservoir operations and are lowest after the end of the irrigation season and rise over the winter as the reservoir is filled.

3.2.3 Flatiron Reservoir

Flatiron Reservoir, located southwest of Loveland and north of Carter Lake, serves as a central distribution point for Colorado-Big Thompson (C-BT) water to northeastern Colorado. Water flows from Pinewood Reservoir through Bald Mountain Tunnel and down the Flatiron Penstocks into the Flatiron Power Plant, which discharges into Flatiron Reservoir.

Flatiron Reservoir stores C-BT Project water for delivery to the Big Thompson River and Horsetooth Reservoir via the Hansen Feeder Canal. Construction of the reservoir was completed in 1953.

3.2.4 Carter Lake

Carter Lake is the second largest reservoir in northeastern Colorado and is the principal storage site for C-BT water deliveries to the south and east. Most of the water stored in the lake comes from Colorado's West Slope. Water is pumped into Carter Lake from Flatiron Reservoir via the Carter Lake Pressure Tunnel. Longmont, Boulder, Broomfield, and other cities and rural-domestic water districts are recipients. Water from Carter Lake is also used to irrigate cropland in Boulder and Weld Counties. Operations of Carter Lake began in 1954. Average monthly storage volumes ranged from around 50,000 to 100,000 AF during IY 1950-2005.

3.2.5 Terry Lake, Big Windsor Reservoir, and Timnath Reservoir

Terry Lake (also known as Larimer-Weld Reservoir) has an active storage capacity of about 8,000 AF and is filled through the Little Cache la Poudre Ditch. Water stored in Terry Lake is released to the Larimer-Weld Canal for irrigation use. Terry Lake is not operated for flood control or hydropower. Review of the historical end of month storage records indicates that Terry Lake fills in most years. Since the early 1970s, Terry Lake has typically not been drained. However, in drought years, such as 2002, Terry Lake was drained. Monthly storage volumes ranged from 0 to around 8,000 AF during IY 1950-2005 (LRE 2005a).

Big Windsor Reservoir (formally known as Windsor Reservoir) has an active storage capacity of about 15,200 AF and is filled through the Larimer-Weld Canal. Big Windsor Reservoir can be used for storage and equalization of flow in Larimer-Weld Canal. Water storage in Big Windsor is delivered by exchange to Larimer-Weld Canal through releases to the Greeley No. 2 Canal (aka New Cache Canal). Big Windsor Reservoir is not operated for flood control or hydropower. Review of the historical end of month storage records indicates that since the mid-1970s, Big Windsor Reservoir has filled in most years. However, in drought years, such as 2002, Big Windsor Reservoir did not fill to maximum capacity. Monthly storage volumes ranged from 0 to around 17,700 AF (total reservoir capacity, including inactive storage) during IY 1950-2005 (LRE 2005a).

Timnath Reservoir (also known as Cache la Poudre Reservoir) has an active storage capacity of about 10,070 AF, and is filled through the Timnath Reservoir Inlet Canal. Timnath Reservoir fills in most years. During periods of drought, such as during the early- to mid-1950s, mid-1970s and in 2002, Timnath Reservoir does not typically fill to maximum capacity. Timnath Reservoir is used predominantly for storage of irrigation water. The reservoir is managed by a private party for recreational purposes including hunting, boating, and fishing. Timnath Reservoir is not managed for flood control and does not have hydropower facilities. Timnath water is used for irrigation under the New Cache system and also is delivered to the Lake Canal Ditch. Monthly storage volumes ranged from 0 to around 10,700 AF (includes inactive storage) during IY 1950-2005 (LRE 2005b).

During the winter, Terry Lake has the most senior storage right on the Poudre River (1890 priority), followed by Timnath Reservoir (1892 priority) and Big Windsor (1904 priority). However, Terry Lake is filled and then Big Windsor Reservoir is often allowed to divert out of

priority—and to take all the available water in the river at the point of diversion—to fill before Timnath Reservoir. These operations sometimes lead to river dry-up points that are administered by the Water Commissioner (CDM Smith 2014b).

The NISP action alternatives (Alternatives 2, 3, and 4) would involve SPWCP exchanges with Terry Lake, Big Windsor Reservoir, and Timnath Reservoir. Under the No Action Alternative (Alternative 1), Big Windsor Reservoir would function as the forebay for pumping water from the Larimer-Weld and New Cache systems directly to new treatment facilities or to storage in the proposed Cactus Hill Reservoir.

3.2.6 Proposed Reservoir Sites

3.2.6.1 Glade (Alternative 2)

Glade Reservoir would occur on an unnamed ephemeral western tributary to Owl Creek, which runs north to south through the valley between the foothills and the western-most hogback ridge. Owl Creek, which is classified by USGS as an intermittent stream, runs approximately parallel to U.S. 287. Approximately 2,000 feet downstream (south) of U.S. 287, the western tributary flows into Owl Creek, which flows to the Poudre Valley Canal. The Poudre Valley Canal is in the southern portion of the Glade Reservoir study area and conveys water diverted from the Poudre River about 1 mile west of the Glade Reservoir study area. The Munroe Canal (also known as the North Poudre Supply Canal) crosses the central and northern portions of the Glade Reservoir study area. A series of small drainages with scattered wetlands occur in the vicinity of the ridge that forms the Holcim Mine in the vicinity of the proposed U.S. 287 realignment. Several drainages flow east to the Poudre Valley Canal, drainages, or ponds in the broad valley east of the Holcim Mine.

3.2.6.2 Galeton (Alternatives 2, 3, and 4)

Galeton Reservoir would occur on a poorly defined ephemeral drainage runs northwest to southeast through the Galeton Reservoir study area. A small stock pond occurs within the easternmost drainage.

3.2.6.3 Cactus Hill (Alternative 1, 3, and 4)

Intermittent drainages (the main one is Black Hollow Creek) and two agricultural ponds are within the proposed Cactus Hill Reservoir footprint. Black Hollow Reservoir occurs in the southeastern portion of the study area.

3.2.7 Conveyance Systems

3.2.7.1 Glade to Horsetooth Pipeline (Alternative 2, Reclamation Action Option)

The Glade to Horsetooth Pipeline study area includes the Poudre River at its northern end. The study area also contains other drainages flowing easterly from the foothills, three canals (the Poudre Valley Canal, Pleasant Valley and Lake Canal, and Charles Hansen Canal), and three reservoirs including Horsetooth Reservoir, Watson Lake, and an unnamed reservoir. A series of small drainages occurs at the southern end of the study area.

3.2.7.2 Carter Pipeline (Alternative 2, No Reclamation Action Option)

In addition to the waters described under the Glade to Horsetooth Pipeline study area, the Carter Pipeline study area consists of the Big Thompson River and smaller drainages generally flowing east. College Lake, Dixon Reservoir, Boedecker Lake, a portion of Horsetooth Reservoir, and several smaller agricultural ponds occur within the Carter Pipeline study area.

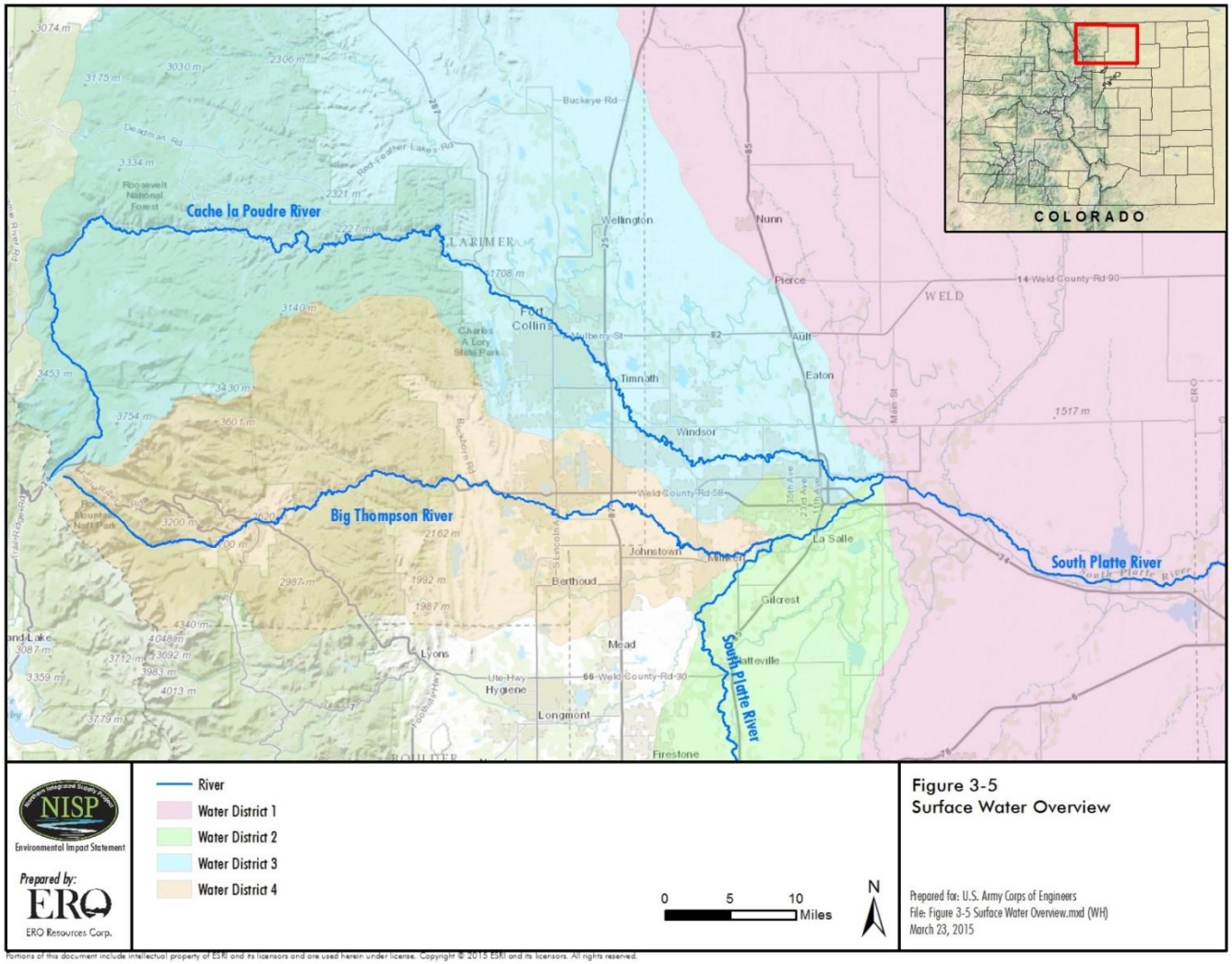
3.2.7.3 SPWCP (Alternatives 2, 3, and 4)

The SPWCP study area includes the South Platte River and several small drainages. The New Cache Canal, Larimer-Weld Canal, and several small- to medium-sized agricultural ponds occur within the study area.

3.2.8 Poudre River Basin

Located in north-central Colorado and part of south-central Wyoming, the Poudre River Basin (Poudre Basin) is a major tributary to the South Platte River. Flowing generally west to east, the headwaters of the Poudre are located high in the Rocky Mountains at the Continental Divide. The confluence of the Poudre and South Platte Rivers is on the plains east of the City of Greeley (Figure 3-5). In Colorado, about 80% of the Poudre Basin is located in Larimer County, and the remaining 20% is in Weld County. The Poudre Basin has two distinct topographic regions: the mountainous, forested, sparsely inhabited upper Poudre Basin (1,890 square miles) that generates most of the Poudre Basin water supply, and the plains of the lower Poudre Basin (840 square miles), which are home to the agriculture, industry, and municipalities that use the water supply. Water is administered by the District 3 (Poudre River) Water Commissioner, Division 1, State Engineer's Office.

Figure 3-5. Surface Water Overview.



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Elevations in the Poudre Basin range from over 13,000 feet near the headwaters to 5,300 feet at the canyon mouth to about 4,600 feet at the confluence with the South Platte. Most of the land in the upper Poudre Basin is included in Rocky Mountain National Park or the Roosevelt National Forest. Much of the Poudre River headwaters streams and tributaries (including the South Fork) above Poudre Park (a few miles above the canyon mouth) have been designated as part of the National Wild and Scenic Rivers System.

3.2.8.1 Water Supply

Surface water is supplied to the Poudre Basin by precipitation, runoff, and transbasin diversions. The total of estimated annual average natural flows and imported flows to the Poudre River is about 367,300 AFY. Water sources in the Poudre Basin are described in the following sections.

3.2.8.1.1 Precipitation and Runoff

Annual precipitation in the Poudre Basin is closely correlated with elevation, ranging from nearly 40 inches per year in the headwaters region to 12 inches per year near Greeley (CWRPDA 1987). Analyses completed for the development of hydrologic modeling inputs determined that precipitation falling in the upper Poudre Basin results in natural flows averaging approximately 277,200 AFY at the mouth of Poudre Canyon (CDM Smith 2014a). This equates to about 380 cubic feet per second (cfs) on an average annual basis; in actuality, the flow rate in the river exhibits a great deal of temporal variation.

Upper Poudre Basin snowmelt is the single largest component of the overall Poudre Basin water supply and runs off primarily during May through July each year (Figure 3-6). Total annual volumes vary considerably from year-to-year (Figure 3-7). In general, annual runoff peaks are frequently cyclic, with periods of increasing and decreasing flows.

Figure 3-6. Hydrograph of Average Daily Flows, Poudre River at Canyon Mouth.

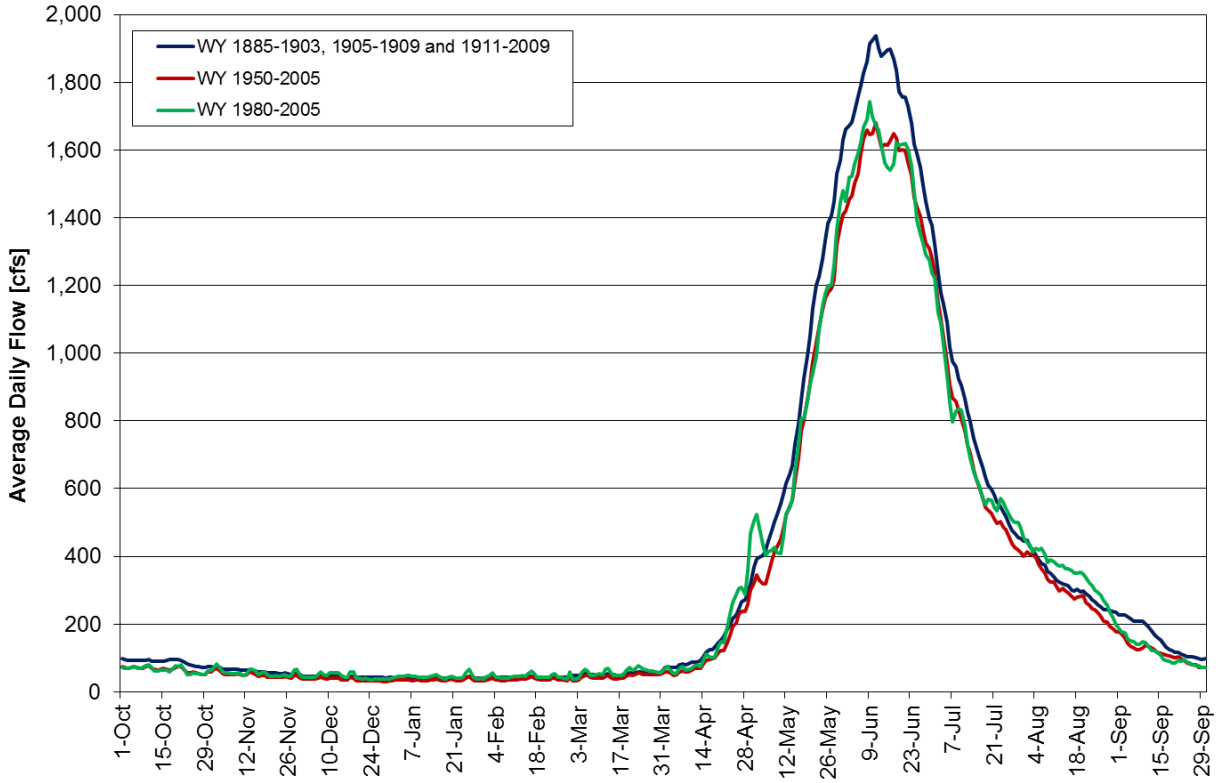
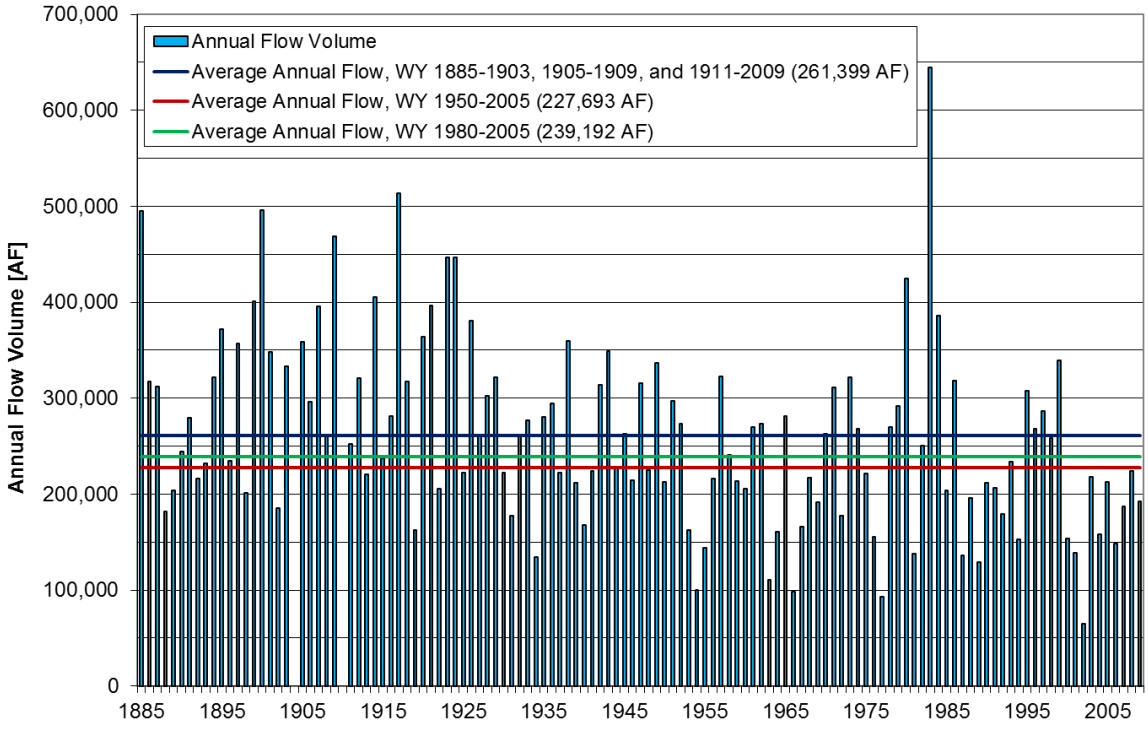


Figure 3-7. Annual Flow Volume, Poudre River at Canyon Mouth.



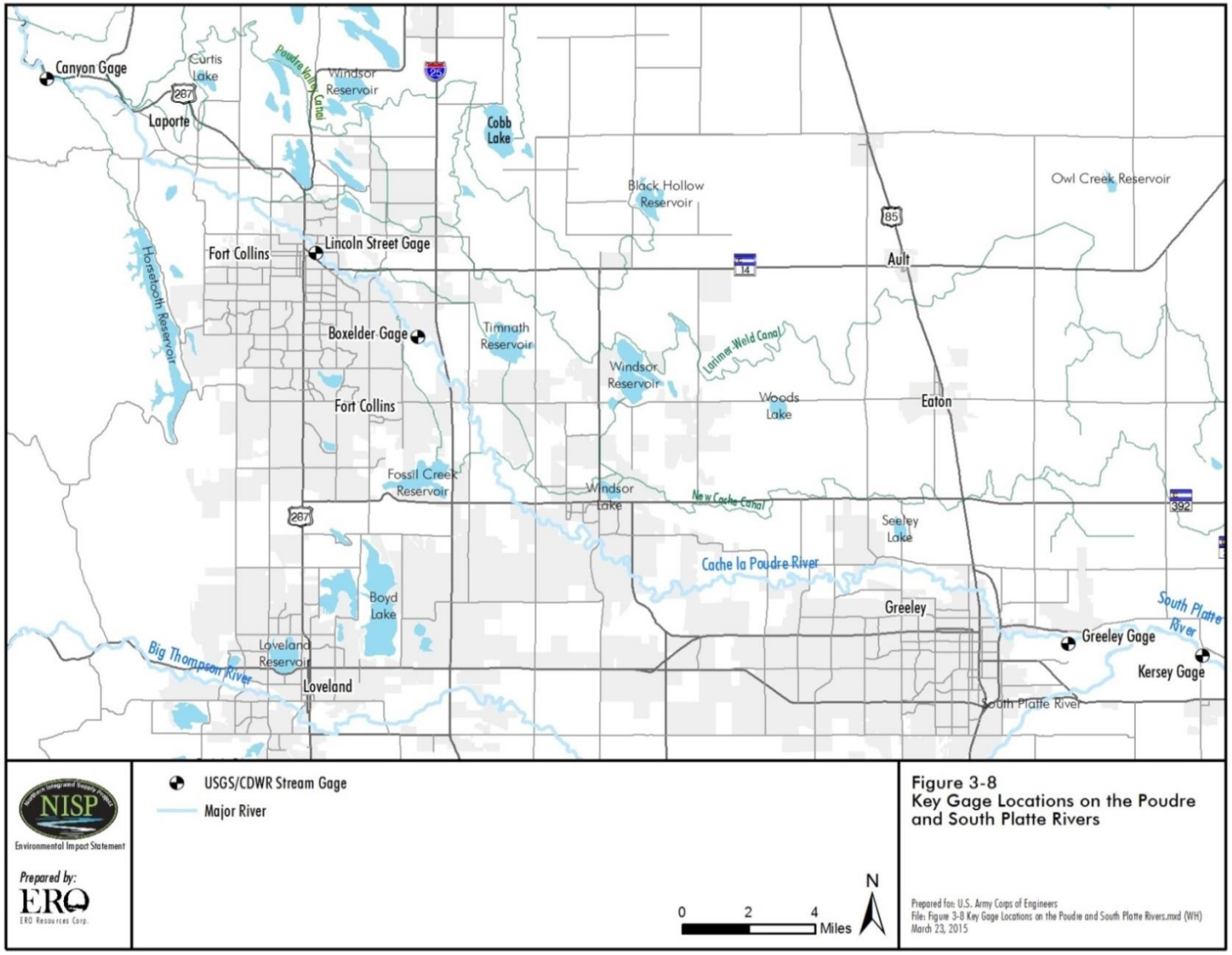
The USGS and Colorado Division of Water Resources (DWR) operate a number of streamflow gages on the Poudre and South Platte Rivers. Gaged streamflows represent actual river conditions and reflect diversions and other human activities. There are four primary streamflow gages on the Poudre River mainstem: Canyon Gage, Lincoln Street Gage, Boxelder Gage, and Greeley Gage. Data from these gages provide a reliable point of reference where Poudre streamflows have historically been monitored. Additionally, data from Kersey Gage, located on the South Platte River below the confluence with the Poudre River, was incorporated to model flow changes that could occur on the South Platte due to operation of the SPWCP. Table 3-6 presents gage information including period of record and average annual streamflows. Gage locations are shown in Figure 3-8.

Table 3-6. Streamflow at key gages on the Poudre and South Platte Rivers.

Gage Location and Name	USGS Gage ID Number	Colorado DWR ID Code	Period of Record [WY]	Average Annual Streamflow[1] [AF]		
				Period of Record	WY 1950-2005	WY 1980-2005
Poudre River at Mouth of Canyon near Fort Collins – Canyon Gage	06752000	CLAFTCCO	1885-1903, 1905-1909, 1911-2009	261,399	227,693	239,192
Poudre River at Lincoln Street in Fort Collins – Lincoln Street Gage	06752260	CLAFORCO	1976-2009	108,582	N/A	120,553
Poudre River above Boxelder Creek, near Timnath – Boxelder Gage	0675280	CLABOXCO	1980-2009	94,993	N/A	102,393
Poudre River near Greeley – Greeley Gage	06752500	CLAGRECO	1915-1919, 1925-2009	97,637	115,842	148,068
South Platte River at Kersey – Kersey Gage	06754000	PLAKERCO	1902-1903, 1906-1912, 1915-2009	633,141	719,439	877,536

[1] Average annual streamflow values based on USGS historical gaged streamflow values, supplemented as necessary by DWR records from the Colorado Decision Support System (CDSS) HydroBase.

Figure 3-8. Key Gage Locations on the Poudre and South Platte Rivers.



3.2.8.1.2 Transbasin Imports

Additional water supply is delivered to the Poudre Basin by a series of transbasin imports (Table 3-7 and Table 3-8). These imports originate in the Colorado, Laramie, or North Platte River Basin and are delivered to the headwaters of the Poudre River upstream of the Canyon Gage by ditches or tunnels. Three interstate compacts potentially affect operations of some of the transbasin diversions: 1) the North Platte River Basin Decree; 2) the Laramie River Decree; and 3) the Sand Creek Memorandum of Agreement (MOA).

The combined annual average transbasin imports to the upper Poudre Basin above the Canyon Gage are nearly 39,500 AFY. Ownership in the various importing ditches is held by: Divide Reservoir and Canal Company; Water Supply and Storage Company (WSSC); Larimer Weld Irrigation Company; City of Fort Collins; City of Greeley; and the Tri-Districts (Fort Collins-Loveland Water District, East Larimer County Water District, and North Weld County Water District).

The C-BT Project is also a key source of supply for many Poudre Basin water users. This transbasin project collects flow from the headwaters of the Colorado River and delivers it through a series of canals, tunnels, and pipelines to the Poudre, Big Thompson, Boulder Creek, St. Vrain and South Platte River Basins. Historically, agricultural irrigation was the major user of C-BT water, but today M&I entities own a greater percentage of the C-BT supply. C-BT deliveries to the Poudre River from Horsetooth Reservoir via the Hansen Supply Canal averaged nearly 75,700 AFY for the period including WY 1952-2009 (CDM Smith, DiNatale, and Hydros 2011). Additional C-BT water is delivered to Poudre Basin municipal users by direct release from Horsetooth Reservoir to nearby water treatment facilities.

Table 3-7. Transbasin diversion structures delivering to the Poudre Basin.

Importing Ditch or Tunnel	Basin of Origin	Decreed Flow Rate and Maximum Observed Daily Diversion
Grand River Ditch	Colorado River	524.6 cfs; 347.0 cfs maximum observed daily diversion
Laramie-Poudre Tunnel	Laramie River	300 cfs; limited by Laramie River Decree; tunnel design capacity = 1,000 cfs
Skyline Ditch	Laramie River	300 cfs total, headgate + intercepted tributaries; limited by Laramie River Decree
Bob Creek Ditch	Laramie River	60.0 cfs (less than design capacity); limited by Laramie River Decree
Columbine Ditch	Laramie River	N/A; ditch operations ceased after WY 1956; limited by Laramie River Decree
Deadman Ditch	Laramie River	N/A; no associated direct flow water rights; limited by Laramie River Decree
Wilson Supply Ditch	Sand Creek	288 cfs; decreed under the Sand Creek Ditch System; 156.0 cfs maximum observed daily diversion; limited by Laramie River Decree and Sand Creek MOA
Cameron Pass Ditch	North Platte River	28.0 cfs; subject to North Platte River Basin Decree; 12 cfs maximum observed daily diversion
Michigan Ditch	North Platte River	340.0 cfs; limited to 146 cfs; 88.0 cfs maximum observed daily diversion; subject to North Platte River Basin Decree

Table 3-8. Average monthly and annual transbasin imports to Poudre Basin, WY 1950–2009.

Month	Grand River Ditch GRNDRDCO (5104601/ 0304601) [AF]	Laramie-Poudre Tunnel LAPTUNCO (4800576/ 0304600) [AF]	Skyline Ditch SKYDCLCO (4800577/ 0304605) [AF]	Bob Creek Ditch[1] BOBGLNCO (4800573/ 0304606) [AF]	Wilson Supply Ditch[2] WSDEARCO (7600600/ 0304604) [AF]	Cameron Pass Ditch CAPDCPCO (4704602/ 0304602) [AF]	Michigan Ditch MICDCPCO (4704603/ 0304603) [AF]
Oct	28	16	0	0	0	0	51
Nov	0	0	0	0	0	0	31
Dec	0	0	0	0	0	0	20
Jan	0	0	0	0	0	0	14
Feb	0	0	0	0	0	0	11
Mar	0	0	0	0	0	0	10
Apr	10	23	0	0	5	0	19
May	1,383	2,557	68	111	1,092	3	237
Jun	7,974	4,912	634	112	846	74	980
Jul	6,136	5,795	484	2	90	29	615
Aug	1,897	2,176	20	0	3	0	201
Sep	368	341	3	0	0	0	90
Total	**17,796**	**15,819**	**1,210**	**226**	**2,037**	**105**	**2,280**

[1] Bob Creek Ditch average deliveries are based on records for water years 1950-1956 and 1998-2009. The ditch was not in operation for the period of water years 1957-1997 (LRE 2005a).
[2] Includes Deadman Ditch (7600530/0304608).

3.2.8.2 Water Use

The following sections summarize surface water uses in the Poudre Basin. The Poudre Basin has a long history of agricultural water use and also has increasing M&I uses. Annual M&I diversions from the river have increased steadily. Figure 3-2 shows the trend of increasing municipal pipeline diversions. Average annual irrigation diversions between the Canyon Gage and the Lincoln Avenue Gage in Fort Collins (Pleasant Valley and Lake Canal through the Coy Ditch) are 216,200 AFY or about 95% of the flows measured at the Canyon Gage. If M&I diversions are added to the irrigation diversions between the Canyon Gage and Lincoln Avenue Gage, the average annual diversions are 229,500 AFY, or 101% of the flows measured at the Canyon Gage (i.e., diversions over 100% are possible because they are in part diverting return flows and ground water discharge to the river). These comparisons illustrate the large volume of agricultural and M&I diversions upstream of the Lincoln Street Gage relative to the streamflow at the Canyon Gage, and do not account for additional inflows to the Poudre River from the C-BT Project, tributary plains streams, wastewater effluent discharges, point and non-point return flows from agricultural water uses, and other sources.

3.2.8.2.1 Agricultural Use

Agriculture has long been the dominant user of water in the Poudre Basin. Historical average diversions for 22 major irrigation ditches over the period encompassing IY 1950-2009 and subsets of years related to the NISP EIS modeling are provided in Table 3-9.

The combined average annual diversions for these 22 ditches totals nearly 405,100 AFY for the full available period of record, IY 1950-2009. There are other small ditches within the Poudre Basin, including several diverting from the North Fork and other tributary streams, but the

ditches and canals identified in Table 3-5 account for the majority of all irrigation diversions. The recorded diversions for each ditch account for all water sources, including native river water, transbasin imports, C-BT water, exchanges, and diversions to storage. Many ditches, particularly those in the lower Poudre Basin, rely on return flows from upstream uses to meet irrigators' demands.

The North Poudre Canal (aka Livermore Canal, owned by the North Poudre Irrigation Company [NPIC]); Larimer County Canal (owned by WSSC); Larimer-Weld Canal (owned by the Larimer-Weld Irrigation Company); and the New Cache la Poudre Co. Ditch (aka Greeley No. 2, owned by the New Cache la Poudre Irrigation Company) are regarded as the "Big Four" ditches in the Poudre Basin. Collectively, these four ditches account for 225,800 AFY, or about 55% of Poudre River irrigation diversions each year on average based on IY 1950-2005 data presented in Table 3-9.

The Munroe Gravity Canal (aka North Poudre Supply Canal) is also part of the NPIC system, and the Cache la Poudre Ditch (aka the Little Cache Ditch) and Poudre Valley Canal are part of the Larimer-Weld Irrigation Company system. If diversions for these ditches are added to the Big Four totals, the systems operated by the Big Four account for more than 290,000 AFY, or 71% of agriculture diversions from the Poudre River for IY 1950-2005.

Table 3-9. Major Poudre Basin irrigation diversions.

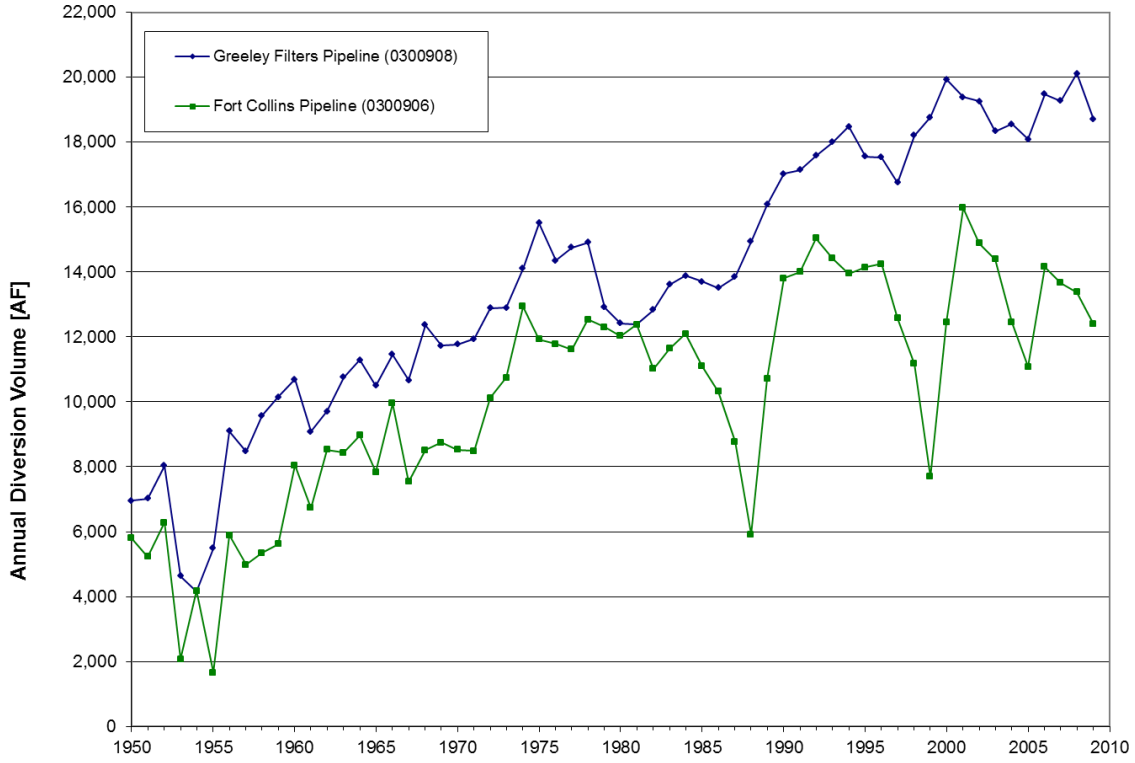
Ditch	DWR Structure ID Number	Decreed Amount[1] [cfs]	Average Annual Diversion, IY 1950-2009 [AFY]	Average Annual Diversion, IY 1950-2005 [AFY]	Average Annual Diversion, IY 1980-2005 [AFY]
North Poudre Canal	0300994	715.03	30,671	30,859	33,983
Munroe Gravity Canal (aka North Poudre Supply Canal)[2]	0300905	250	34,137	34,137	31,204
Poudre Valley Canal	0300907	29.51	15,781	16,232	17,631
Pleasant Valley & Lake Canal	0300910	137.93	13,725	13,923	11,711
Larimer County Canal	0300911	750.01	70,726	71,496	65,412
Dry Creek Ditch (aka Jackson Ditch)	0300912	50.92	5,981	5,948	5,077
Cache la Poudre Ditch (aka Little Cache)	0300915	82.5	12,829	12,690	15,347
Taylor & Gill Ditch	0301029	12.17	2,944	2,959	2,856
New Mercer Ditch	0300913	85	6,473	6,596	6,509
Larimer County No. 2 Ditch	0300914	178.5	8,139	8,292	7,160
Fort Collins Irrigation Canal (aka Arthur Ditch)	0300918	108.73	4,597	4,755	3,520
Larimer-Weld Canal	0300919	2797.47	75,834	76,300	74,188
Lake Canal	0300922	158.35	11,674	11,850	11,325
Coy Ditch	0300923	31.63	1,283	1,348	1,442
Boxelder Ditch	0300926	52.76	6,870	6,846	6,694
New Cache la Poudre Co. Ditch (aka Greeley No. 2)	0300929	650	47,453	47,155	47,394
Whitney Irrigation Ditch	0300930	61.18	11,293	11,452	11,779
BH Eaton Ditch	0300931	41.70	5,195	5,243	5,618
William R. Jones Ditch	0300932	15.52	3,572	3,513	3,420
Canal No. 3 (aka Greeley No. 3)	0300934	174.89	19,245	19,062	18,456
Boyd Freeman Ditch	0300935	54.05	941	994	870
Ogilvy Ditch	0300937	91.06	15,711	15,568	17,509
Total	**---**	**---**	**405,075**	**407,219**	**399,103**

[1] Decreed amounts based on water rights records (sum of absolute rates) downloaded from CDSS HydroBase on 08/23/2007; physical capacities of canals may vary from the stated flow rates.
[2] The period of record for the Munroe Canal is IY 1954-2009; the ditch was built as part of the C-BT Project.

3.2.8.2.2 Municipal and Industrial Use

Presently, the cities of Fort Collins and Greeley, along with the Tri-Districts, are the largest providers of M&I water in the Poudre Basin. The cities' water use has increased steadily from the 1950s to the present as the result of increased water demands and greater exercise of direct flow water rights. This is illustrated in Figure 3-9, which is based on CDSS HydroBase historical diversion records for the Fort Collins Pipeline (Structure ID 0300906) and the Greeley Filters Pipeline (Structure ID 0300908) for IY 1950-2009. These diversion records may include sources other than river water, such as C-BT supplies, that are not diverted directly from the Poudre River.

Figure 3-9. Greeley and Fort Collins Pipeline Diversions from the Poudre River, IY 1950-2009 (Source: CDSS HydroBase 2011).



Construction of the Pleasant Valley Pipeline was completed in spring 2004 to supplement existing M&I diversions and to provide greater system operational flexibility for Fort Collins, Greeley, and the Tri-Districts. The Pleasant Valley Pipeline uses the Munroe Canal headgate as the point of diversion from the Poudre River, and the pipeline intake withdraws from the Munroe Canal. For the available period of record since Pleasant Valley Pipeline operations began (IY 2004-2009), M&I diversions through the Pleasant Valley Pipeline have averaged just over 5,000 AFY.

Fort Collins, Greeley, and the Tri-Districts do not account for all M&I use in the Poudre Basin. Although these three entities are the largest providers, there are many other smaller municipalities and rural domestic water providers in the basin. In addition, there are many other smaller municipalities and rural domestic water providers in the basin, as well as industrial enterprises such as Kodak (near Windsor), Leprino Foods in Greeley, and the Anheuser-Busch brewery northeast of Fort Collins. Industrial users may be self-supplied or rely on service from one of the municipal water providers. Anheuser-Busch is not self-supplied; the brewery is a large contractual user and receives a combination of reusable and single-use potable supplies from Fort Collins, which are reflected in the city's M&I diversions.

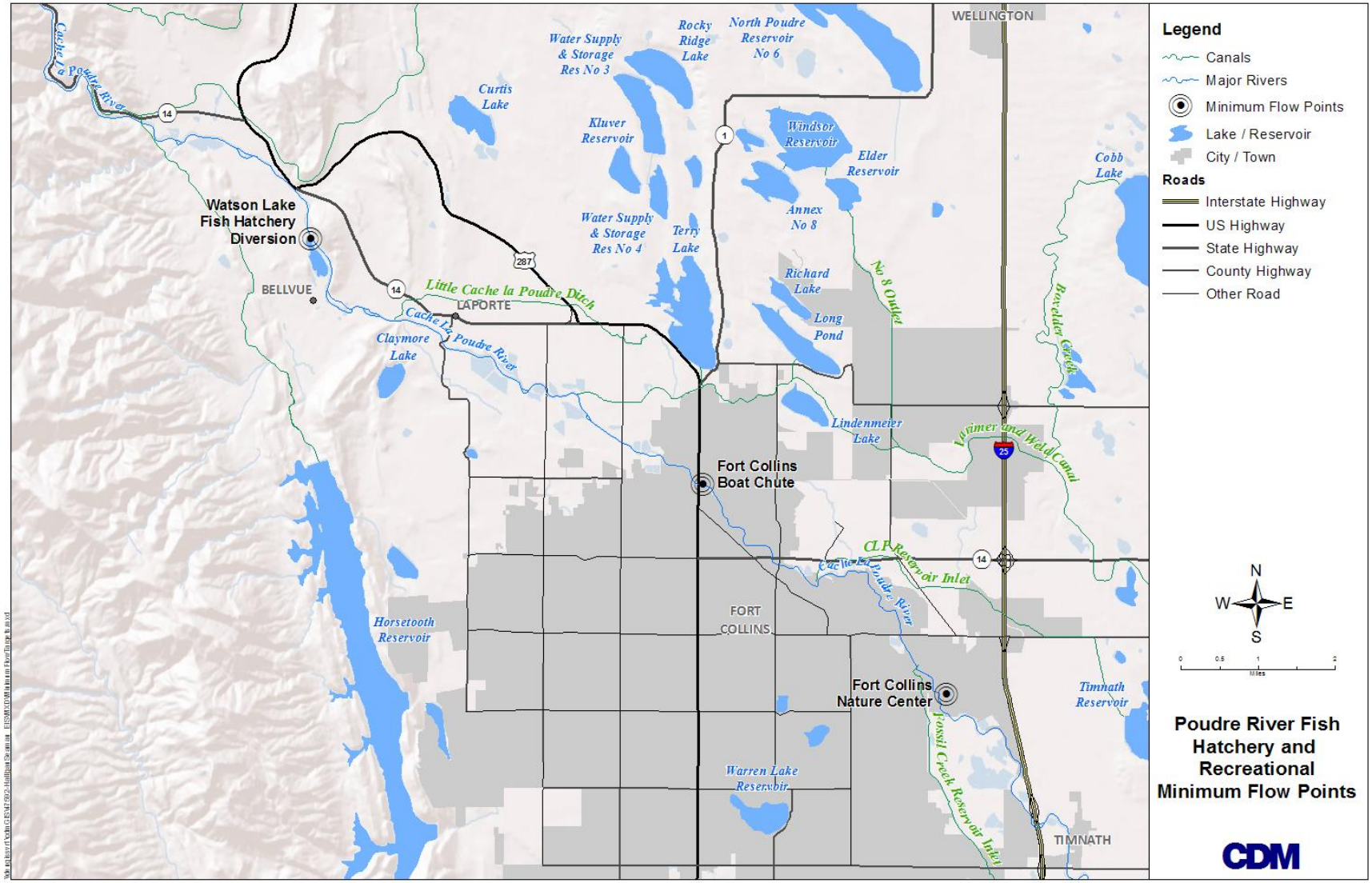
3.2.8.3 Administration of Dry-up Points

Water is administered by the District 3 (Poudre River) Water Commissioner, Division 1, State Engineer's Office. Water administration in the Poudre River Basin involves agreement among water users and water supply entities to fill basin reservoirs beginning at the highest elevation first, then gradually moving down the basin to fill reservoirs at lower elevations. This approach to reservoir filling is exemplified by the upstream-to-downstream sequential filling of Terry Lake, Big Windsor Reservoir, and Timnath Reservoir. During the winter, Terry Lake has the most senior storage right on the Poudre River (1890 priority), followed by Timnath Reservoir (1892 priority) and Big Windsor (1904 priority). However, Terry Lake is filled and then Big Windsor Reservoir is often allowed to divert out of priority—and to take all the available water in the river at the point of diversion—to fill before Timnath Reservoir. This operation sometimes leads to river dry-up points that are administered by the Water Commissioner. In practice, the occurrence of a dry-up point means that a particular diversion structure (i.e., headgate or pipeline intake) diverts the entire flow of the Poudre River to satisfy the owner's water rights (CDM Smith, DiNatale, and Hydros 2011). The diversions that result in the dry-up points may be for either direct use or for reservoir storage. Dry-up points occur at different locations during the non-irrigation (winter) and irrigation (summer) seasons. Downstream of the dry-up points, the river is dry for various distances as flow returns to the river from ground water discharge, return flows, or tributaries. In general, return flows begin accruing to the river shortly below a dry-up point. These return flows may be from subsurface sources (e.g., irrigation seepage losses or residential septic system effluent) or surface returns (e.g., irrigation tailwater returns, M&I wastewater treatment plant effluent discharges, or tributary inflows).

3.2.8.4 Minimum Instream Flow Rights

There are three water rights decreed for fish hatchery and recreational purposes below the canyon mouth that are junior to most water rights in the basin—including the District's Grey Mountain storage rights (priority date May 2, 1980) proposed to be used for NISP—but are senior to several of the exchanges proposed for NISP. Although fish hatchery and recreational water rights are junior to the Grey Mountain right, the District has agreed to curtail in-priority NISP diversions under the Grey Mountain storage right to the extent curtailment of the NISP diversions would meet the minimum flow criteria at these downstream points (CDM Smith 2014a). The fish hatchery and recreational water rights are decreed for the Watson Lake Fish Hatchery, the Fort Collins boat chute, and the Fort Collins Nature Center (Figure 3-10).

Figure 3-10. Watson Lake Fish Hatchery, Fort Collins Boat Chute, and Fort Collins Nature Center.



The recreational minimum flows are not part of the Colorado Water Conservation Board (CWCB) Instream Flow Program but were decreed for instream beneficial use prior to the 2001 legislation (Senate Bill 01-216) authorizing Recreational In-Channel Diversions. At the Watson Lake fish hatchery, water is diverted from the river and routed through the hatchery and returned to the river upstream of other users. The reach between the Watson Lake diversion weir and outlet may be occasionally dried up by the diversion.

Flow requirements from the various decrees are summarized as follows:

- Watson Lake Fish Hatchery (Case No. 85CW201; Admin No. 49308.41098)
  - 50 cfs summer (April 15-October 14)
  - 25 cfs winter (October 15-April 14)

- Fort Collins boat chute (Case Nos. 86CW371 and 2000CW236; Admin No. 50038.00000)
  - 30 cfs (May 1-August 31)
  - 5 cfs (September 1-April 30)

- Fort Collins Nature Center (Case Nos. 86CW371 and 2000CW236; Admin No. 49722.00000)
  - 30 cfs (May 1-August 31)
  - 5 cfs, with all river flows between 5 cfs and 25 cfs to be shared equally between Fort Collins and the City of Thornton, and Fort Collins is entitled to no more than 15 cfs (September 1-April 30)

Although the Nature Center recreational water right was not made absolute until Case No. 2000CW236, at the flow rates specified above, Northern Water and the City of Fort Collins have an Amended Stipulation (Consolidated Case Nos. 85CW206, 85CW207, 85CW208, 85CW209, 85CW210, and 89CW122) that is dated June 1992 and assumed by both entities to supersede the language in the decrees governing operations as it affects the water rights of the District and Fort Collins. Specifically, the Amended Stipulation calls for flow rates of 50 cfs (April 15-October 14) and 25 cfs (October 15-April 14) at the Nature Center diversion dam. Based on this information, it was assumed for the purposes of modeling the NISP action alternatives that the minimum flow targets specified in the 1992 Amended Stipulation supersede the later absolute decree for the Nature Center recreational water rights (CDM Smith and DiNatale 2013).

3.2.9 South Platte River Basin

The lower South Platte River study area extends from the South Platte-Poudre confluence downstream to the Kersey Gage. This reach of river is included in Water Districts 1 (Greeley to Balzac). The South Platte River Compact requires curtailment of water rights junior to June 14, 1897 in Water District 64 to maintain 120 cfs at the Julesburg gaging station between April 1 and October 15. For the rest of the year, Colorado has the right to full use of its South Platte River waters.

Peak runoff occurs primarily in May through early July (Figure 3-11). Total annual flow volumes vary considerably from year-to-year (Figure 3-12). Streamflow in the lower South Platte Basin during the spring and early summer is reliant on snowmelt runoff from headwaters watersheds, and during the remainder of the year is reliant on return flows from upstream use of native water and C-BT water. Occasional heavy precipitation events in the watershed results in associated peak flows from spring through early fall.

Figure 3-11. Hydrograph of Average Daily Flows, South Platte River at Kersey Gage.

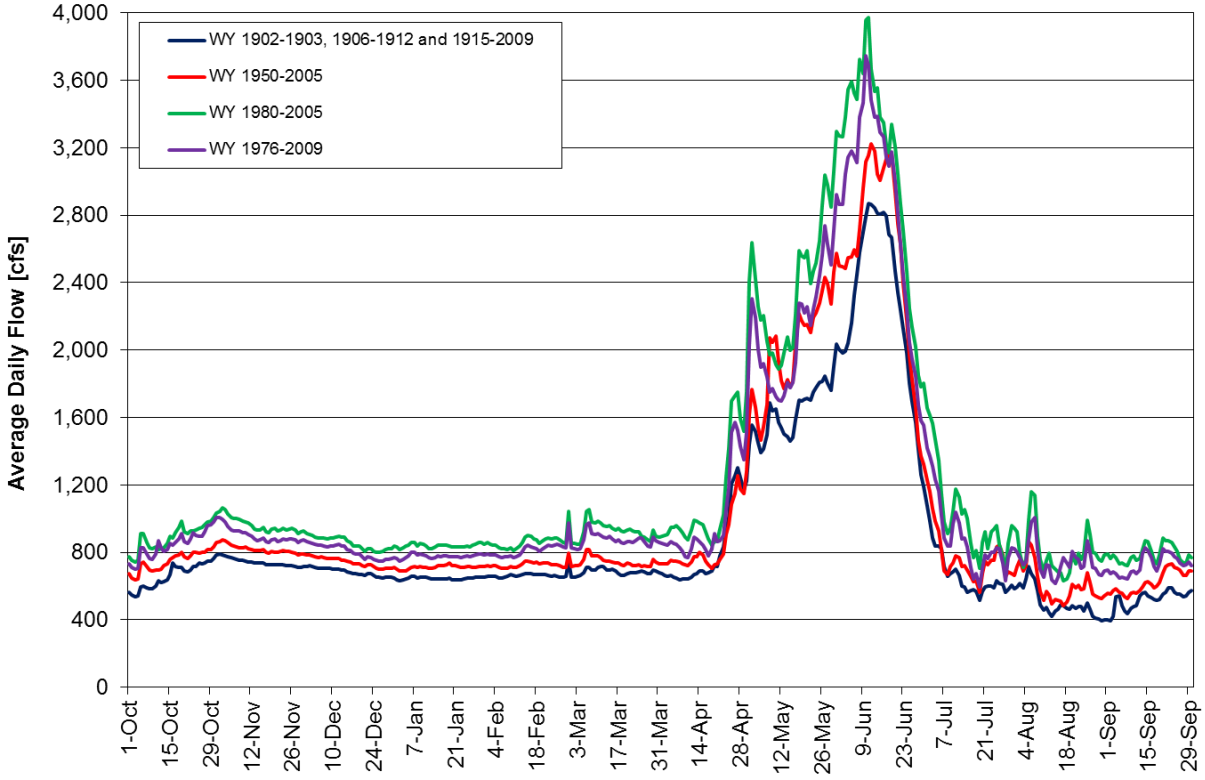
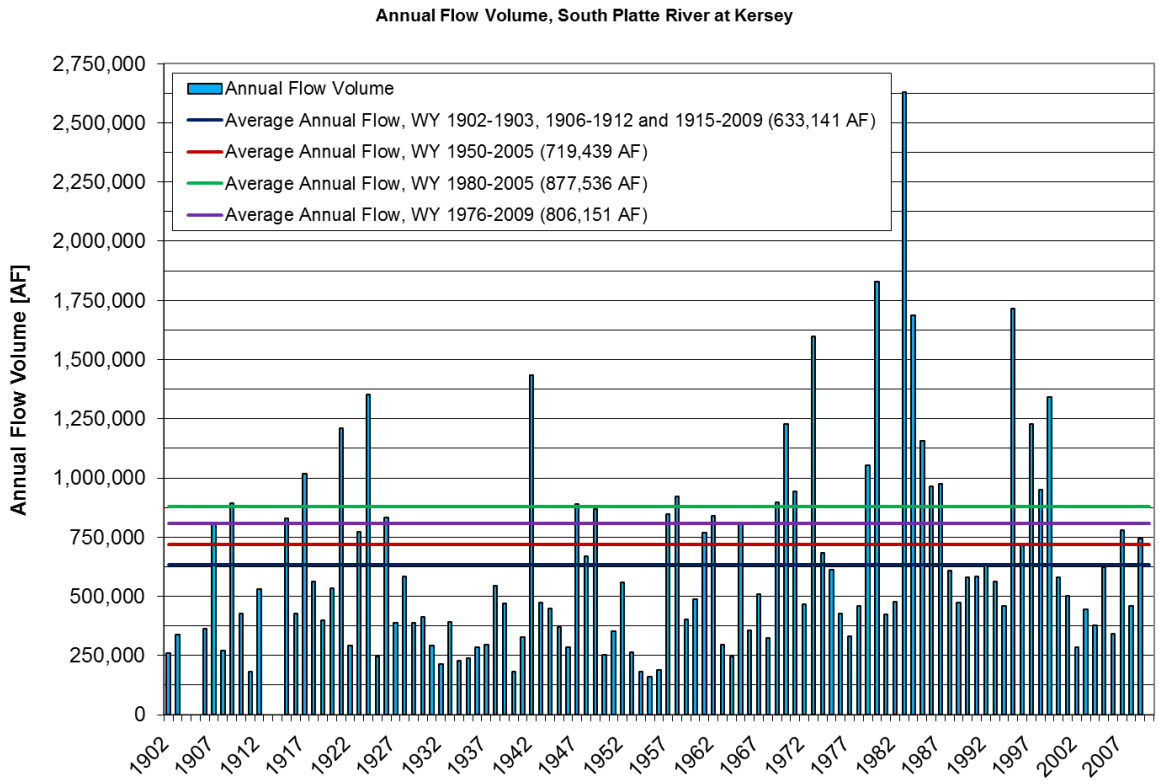


Figure 3-12. Annual Flow Volume, South Platte River at Kersey.



Nineteen major ditches divert a combined average of nearly 432,200 AF of surface water in District 1 each year (Scott and Paulson 2003). In District 64, 23 ditches divert a combined average of about 179,500 AFY. For individual ditches, average annual diversions range from 770 AFY (Carlson Ditch) to almost 65,200 AFY (North Sterling Canal). These ditches serve large acreages of irrigated cropland. They also deliver storage water to several large reservoirs on the lower South Platte River including Riverside, Prewitt, Jackson, Empire, North Sterling, and Jumbo (Julesburg) Reservoirs.

3.2.10 Big Thompson River Basin

The Big Thompson River (Water District 4) headwaters originate in Rocky Mountain National Park on the East Slope of the Continental Divide. It flows eastward to its confluence with the South Platte River near LaSalle, Colorado. Major tributaries include the North Fork of the Big Thompson River, Buckhorn Creek and the Little Thompson River. The mean annual flow of the Big Thompson River at the mouth of the canyon near Drake is 79,700 AFY (period of record WY 1927-2013) and 61,300 AFY near LaSalle (period of record WY 1914-2013). Like most of northeast Colorado, agriculture has historically been the dominant user of water in the Big Thompson Basin. The long-term trend has been an increase in M&I use with a corresponding decrease in agricultural use. The City of Loveland and the City of Greeley are the primary users of M&I water from the Big Thompson Basin.

In addition to native precipitation and runoff, the C-BT Project delivers Colorado River water through the Alva B. Adams Tunnel to the headwaters of the Big Thompson River. This water passes through a series of conduits to terminal storage facilities at Carter Lake and Horsetooth Reservoir. Water is released from these reservoirs to meet the demands of C-BT unit holders.

3.3 SURFACE WATER QUALITY

3.3.1 Overview

This section provides information on existing surface water quality of the affected environment for the proposed NISP. NISP could affect surface water quality of the Poudre River downstream of the Poudre Valley Canal diversion and on the South Platte River downstream of the confluence with the Poudre River as a result of changes in hydrology. Water quality effects are also possible at new reservoir sites and from changes in operations at existing reservoirs.

Under the Alternative 2 Reclamation Action Option, a pipeline delivering water from Glade Reservoir to Horsetooth Reservoir would be constructed, which could affect water quality in Horsetooth Reservoir. The operation of Carter Lake would change slightly, with additional C-BT Project water routed through the reservoir for release to the NISP southern and eastern Participants. Flatiron Reservoir functions as a forebay from which C-BT water is delivered north to Horsetooth Reservoir and south to Carter Lake. To accomplish the proposed deliveries to the NISP Participants, water historically routed to storage in Horsetooth Reservoir would instead be pumped to, and then released from, Carter Lake.

New water quality assessments have been performed for the SDEIS based on comments on the DEIS. Additional surface water quality data for numerous parameters were compiled for 17 new sites on the Poudre River and one location on the South Platte River near Kersey subsequent to the DEIS and new technical reports were prepared.

Information on surface water quality for this section is summarized from several technical reports including:

- 2012 Water Quality Baseline Report (ERO 2012a)
- 2015 Water Quality Report, Phase I (GEI 2015a)
- 2014 Stream Temperature and DO Analysis (Hydros 2014a)
- 2014 Reservoir Comparative Analysis for the NISP SDEIS Technical Memorandum (Hydros 2014b)

Water quality information is also presented from the following sources:

- CDPHE Water Quality Control Commission (WQCC) Classification (CDPHE 2014)
- State of Colorado (State) Section 303(d) and Monitoring and Evaluation List of Impaired Waterbodies, per Regulation 93 (CDPHE 2014)
- Existing water quality data for various parameters (multiple sources)

3.3.1.1 Water Quality Standards, Regulations, and Classifications

The Colorado WQCC adopted beneficial use classifications for streams, lakes, and reservoirs that identify the uses to be protected on a stream segment or in a lake or reservoir. The WQCC

also adopted numerical and narrative standards for specific pollutants to protect these uses. WQCC classifications are defined as follows (CDPHE 2014):

Recreation

- **Class E – Existing Primary Contact Use.** These surface waters are used for primary contact recreation or have been used for such activities since November 28, 1975.
- **Class P – Potential Primary Contact Use.** These surface waters have the potential to be used for primary contact recreation.
- **Not Primary Contact Use.** These surface waters are not suitable or intended to become suitable for primary contact recreation uses.
- **Class U – Undetermined Use.** These are surface waters whose quality is to be protected at the same level as existing primary contact use waters, but for which there has not been a reasonable level of inquiry about existing recreational uses and no recreation use attainability analysis has been completed.

Agriculture

- These surface waters are suitable or intended to become suitable for irrigation of crops usually grown in Colorado and which are not hazardous as drinking water for livestock.

Aquatic Life

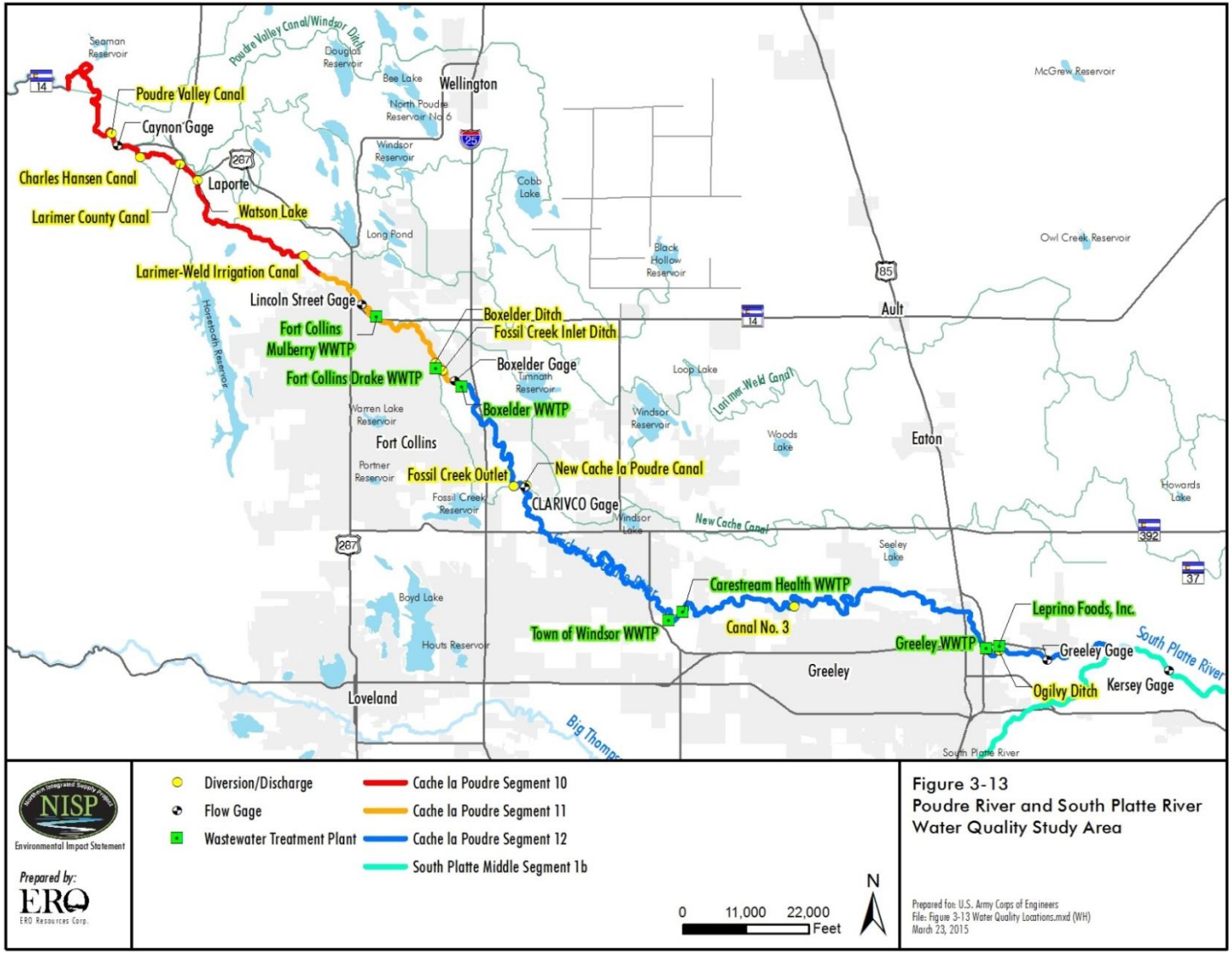
- **Class 1 – Cold Water Aquatic Life.** These are waters that (1) currently are capable of sustaining a wide variety of cold water biota, including sensitive species, or (2) could sustain such biota but for correctable water quality conditions.
- **Class 1 – Warm Water Aquatic Life.** These are waters that (1) currently are capable of sustaining a wide variety of warm water biota, including sensitive species, or (2) could sustain such biota but for correctable water quality conditions.
- **Class 2 – Cold and Warm Water Aquatic Life.** These are waters that are not capable of sustaining a wide variety of cold or warm water biota, including sensitive species, due to physical habitat, water flows or levels, or uncorrectable water quality conditions that result in substantial impairment of the abundance and diversity of species.

Domestic Water Supply

- These surface waters are suitable or intended to become suitable for potable water supplies. After receiving standard treatment (defined as coagulation, flocculation, sedimentation, filtration, and disinfection with chlorine or its equivalent) these waters will meet Colorado drinking water regulations and any revisions, amendments, or supplements thereto.

The WQCC divides streams into segments for assigning water use classifications. NISP may affect Segments 10, 11, and 12 of the Poudre River and Segment 1b of the South Platte River (Figure 3-13). Horsetooth Reservoir is located in Segment 14. These stream segments do not directly correspond to the representative river segments used for aquatic biological resources, riparian and wetland resources, and channel morphology. The WQCC has assigned stream classifications for various uses for each of these segments as shown in Table 3-10. All of these segments are designated for primary contact recreation and agriculture.

Figure 3-13. Poudre River and South Platte River Water Quality Study Area.



Additionally, Segment 10 on the Poudre River, Horsetooth Reservoir (Segment 14), and Segment 1b on the South Platte River are designated for use as a domestic water supply. Aquatic life classifications change from upstream to downstream over these reaches, reflecting the thermal transition zones from the mountains to the plains. The uppermost segment (Segment 10 on the Poudre River) is designated as Cold Water Aquatic Life, Class 2. The remaining segments (Poudre River Segments 11 and 12 and South Platte Segment 1b) are designated as Warm Water Aquatic Life, Class 2. The WQCC has established numeric standards for each of these segments and for the different use classifications. Select water quality standards for these segments are shown in Table 3-11 to Table 3-14.

The WQCC also has designated a narrative temperature standard (CDPHE 2013):

Temperature shall maintain a normal pattern of diel and seasonal fluctuations and spatial diversity with no abrupt changes and shall have no increase in temperature of a magnitude, rate, and duration deleterious to the resident aquatic life.

All of the streams and reservoirs potentially affected by the NISP alternatives are subject to antidegradation review and must be maintained and protected at their existing water quality unless it is determined by the WQCC that allowing lower water quality is necessary to accommodate important economic or social development in the area (CDPHE 2014).

Table 3-10. Stream classifications by segment.

CDPHE Stream Segment Description	Classifications
Segment 10. Mainstem of the Poudre River from the Monroe Canal/North Poudre Supply Canal diversion to Shields Street in Fort Collins, Colorado	Aquatic Life Cold 2 Recreation E Water Supply Agriculture
Segment 11. Mainstem of the Poudre River from Shields Street in Fort Collins to a point immediately above the confluence with Boxelder Creek	Aquatic Life Warm 2 Recreation E Agriculture
Segment 12. Mainstem of the Poudre River from a point immediately above the confluence with Boxelder Creek to the confluence with the South Platte River	Aquatic Life Warm 2 Recreation E Agriculture
Segment 14. Horsetooth Reservoir	Aquatic Life Cold 1 Recreation E Water Supply Agriculture
Segment 1.b. Middle South Platte River from the Poudre River confluence to the Weld/Morgan County line.	Aquatic Life Warm 2 Recreation E Agriculture Water Supply

Stream segments that do not meet water quality standards are reported every 2 years in the State's 303(d) list. Stream segments, lakes, or reservoirs on the 303(d) list are considered impaired for one or more water quality parameters and a Total Daily Maximum Load (TMDL) effort will need to occur to resolve the impairment. If impairment is suspected and there are insufficient data to draw a conclusion, the water segment is placed on the Monitoring and Evaluation (M&E) list. Stream and reservoir segments in the study area that are on the 303(d) list for nonattainment of water quality standards for certain parameters include:

- Poudre River, Segment 10 — copper and temperature
- Poudre River, Segment 11 — selenium
- Poudre River, Segment 12 — selenium and seasonally (May to October) for *E. coli*
- Horsetooth Reservoir, Segment 14 — mercury in fish tissue, copper, and arsenic
- Middle South Platte River Segment 1b — selenium

Table 3-11. Numeric standards for Poudre River Segment 10.

Parameter	Standard	Type	Parameter	Standard	Type
Physical and Biological			***Metals (µg/L)***		
pH	6.5-9.0	Aquatic Life	Arsenic	340 (ac) 0.02 -3.0 (ch Trec)	Aquatic Life Water + Fish
Dissolved oxygen	6.0 7.0 (spawn)	Aquatic Life	Cadmium	TVS[3] (ac trout) TVS[3] (ch) 10 (Trec) 5.0 (1-day)	Aquatic Life Agriculture Water Supply
Temperature	Apr-Oct 23.9C (ac) 18.3C (ch) Nov-Mar 13C (ac) 9C (ch)	Aquatic Life	Chromium III	50 (1-day Trec)	Water Supply
E. coli (#/100 mL)	126	Recreation	Chromium VI	16 (ac), 11 (ch) 100 (Trec) 50 (1-day)	Aquatic Life Agriculture Water Supply
Inorganic (mg/L)			Copper	TVS[3] (ac/ch) 200 (Trec) 1,000 (Trec)	Aquatic Life Agriculture Water Supply
Total ammonia	TVS[1] (ac/ch)	Aquatic Life	Iron	1,000 (Trec) 300	Aquatic Life Water Supply
Chlorine	0.019 (ac) 0.011 (ch)	Aquatic Life	Lead	TVS[3] (ac/ch) 100 (Trec) 50 (1-day)	Aquatic Life Agriculture Water Supply
Cyanide	0.005	Aquatic Life	Manganese	TVS[3] (ac/ch) 200 (Trec) 50	Aquatic Life Agriculture Water Supply
Sulfide as H_2S	0.002	Aquatic Life	Mercury	0.01 (ch Tot)	Aquatic Life
Boron	0.75	Agriculture	Nickel	TVS[3] (ac/ch) 200 (Trec) 100 (Trec)	Aquatic Life Agriculture Water Supply
Nitrite	0.05[2] 10 1.0	Aquatic Life Agriculture Water Supply	Selenium	18.4 (ac), 4.6 (ch) 20 (Trec) 50 (Trec)	Aquatic Life Agriculture Water Supply
Nitrate	10	Water Supply	Silver	TVS[3] (ac) TVS (ch trout) 100 (Trec 1-day)	Aquatic Life Water Supply
Chloride	250	Water Supply	Zinc	TVS[3] (ac/ch) 2,000 (Trec) 5,000 (Trec)	Aquatic Life Agriculture Water Supply
Sulfate	250	Water Supply			
Total Phosphorus	0.110[4]	Aquatic Life			
Total Nitrogen	1.25[4]	Aquatic Life			

Parameters with standards shown as TVS (table value standards) represent equations that include pH or hardness and will vary by site. All metal standards are as dissolved, except where noted. All agriculture and water supply standards are 30-day except as noted. 'Ac' = acute, 'ch' = chronic, 'Trec' = total recoverable, 'dis' = dissolved.

[1] pH dependent, varies by site; [2] chloride dependent; [3] hardness dependent, varies by site; [4] interim numeric value.

Table 3-12. Numeric standards for Poudre River Segments 11 and 12.

Parameter	Standard	Type	Parameter	Standard	Type
Physical and Biological			***Metals (µg/L)***		
pH	6.5-9.0	Aquatic Life	Arsenic	340 (ac) 7.6 (ch Trec)	Aquatic Life Fish Ingestion
Dissolved oxygen	5.0 mg/L	Aquatic Life	Cadmium	TVS[2] (ac/ch) 10 (Trec)	Aquatic Life Agriculture
Temperature	Mar-Nov 29C (ac) 24.2C (ch) Dec-Feb 14.5C (ac) 12.1C (ch)	Aquatic Life	Chromium III	TVS (ac/ch) 100 (Trec)	Aquatic Life Agriculture
E. coli (#/100 mL)	126	Recreation	Chromium VI	16 (ac), 11 (ch) 100 (Trec)	Aquatic Life Agriculture
Inorganic (mg/L)			Copper	TVS[2] (ac/ch) 200 (Trec)	Aquatic Life Agriculture
Total ammonia	TVS[1] (ac/ch)	Aquatic Life	Iron	1,000 (Trec)	Aquatic Life
Chlorine	0.019 (ac) 0.011 (ch)	Aquatic Life	Lead	TVS[3] (ac/ch) 100 (Trec)	Aquatic Life Agriculture
Cyanide	0.005	Aquatic Life	Manganese	TVS[3] (ac/ch) 200 (Trec)	Aquatic Life Agriculture
Sulfide as H_2S	0.002	Aquatic Life	Mercury	0.01 (ch Tot)	Aquatic Life
Boron	0.75	Agriculture	Nickel	TVS[3] (ac/ch) 200 (Trec)	Aquatic Life Agriculture
Nitrite	0.05[2] 10	Aquatic Life Agriculture	Selenium	18.4 (ac), 4.6 (ch) 20 (Trec)	Aquatic Life Agriculture
Nitrate	100	Agriculture	Silver	TVS[3] (ac/ch)	Aquatic Life
Total Phosphorus	0.170[4]	Aquatic Life	Zinc	TVS[3] (ac/ch) 2,000 (Trec)	Aquatic Life Agriculture
Total Nitrogen	2.01[4]	Aquatic Life			

Parameters with standards shown as TVS (table value standards) represent equations that include pH or hardness and will vary by site. All metal standards are as dissolved, except where noted. All agriculture and water supply standards are 30-day except as noted. 'Ac' = acute, 'ch' = chronic, 'Trec' = total recoverable, 'dis' = dissolved.
[1] pH dependent, varies by site; [2] chloride dependent; [3] hardness dependent, varies by site; [4] interim numeric value.

Table 3-13. Numeric standards for South Platte River Segment 1b.

Parameter	Standard	Type	Parameter	Standard	Type
Physical and Biological			***Metals (µg/L)***		
pH	6.5-9.0	Aquatic Life	Arsenic	340 (ac) 0.02 – 3.0 (Trec)	Aquatic Life Water + Fish
Dissolved oxygen	5.0 mg/L	Aquatic Life	Cadmium	TVS[3] (ac/ch) 10 (Trec) 5.0 (Trec 1-day)	Aquatic Life Agriculture Water Supply
Temperature	Mar-Nov 28.6C (ac) 27.5C (ch) Dec-Feb 14.3C (ac) 13.8C (ch)	Aquatic Life	Chromium III	TVS[3] (ch) 100 (Trec) 50 (Trec 1-day)	Aquatic Life Agriculture Water Supply
E. coli (#/100 mL)	126	Recreation	Chromium VI	16 (ac), 11 (ch) 100 (Trec) 50 (Trec 1-day)	Aquatic Life Agriculture Water Supply
Inorganic (mg/L)			Copper	TVS[3] (ac/ch) 200 (Trec) 1,000 (Trec)	Aquatic Life Agriculture Water Supply
Total ammonia	TVS[1] (ac/ch)	Aquatic Life	Iron	1,000 (Trec) 300	Aquatic Life Water Supply
Chlorine	0.019 (ac) 0.011 (ch)	Aquatic Life	Lead	TVS[3] (ac/ch) 100 (Trec) 50 (Trec 1-day)	Aquatic Life Agriculture Water Supply
Cyanide	0.005	Aquatic Life	Manganese	TVS[3] (ac/ch) 200 (Trec) 50	Aquatic Life Agriculture Water Supply
Sulfide as H_2S	0.002	Aquatic Life	Mercury	0.01 (ch Tot)	Aquatic Life
Boron	0.75	Agriculture	Nickel	TVS[3] (ac/ch) 200 (Trec) 100 (Trec)	Aquatic Life Agriculture Water Supply
Nitrite	0.05[2] 10 1.0	Aquatic Life Agriculture Water Supply	Selenium	18.4 (ac), 4.6 (ch) 20 (Trec) 50 (Trec)	Aquatic Life Agriculture Water Supply
Nitrate	10	Water Supply	Silver	TVS[3] (ac/ch) 100 (Trec 1-day)	Aquatic Life Water Supply
Chloride	250	Water Supply	Zinc	TVS[3] (ac/ch) 2,000 (Trec) 5,000 (Trec)	Aquatic Life Agriculture Water Supply
Sulfate	250	Water Supply			
Total Phosphorus	0.170[4]	Aquatic Life			
Total Nitrogen	2.01[4]	Aquatic Life			

Parameters with standards shown as TVS (table value standards) represent equations that include pH or hardness and will vary by site. All metal standards are as dissolved, except where noted. All agriculture and water supply standards are 30-day except as noted. 'Ac' = acute, 'ch' = chronic, 'Trec' = total recoverable, 'dis' = dissolved.

[1] pH dependent, varies by site; [2] chloride dependent; [3] hardness dependent, varies by site; [4] interim numeric value.

Table 3-14. Numeric standards for Horsetooth Reservoir.

Parameter	Standard	Type	Parameter	Standard	Type
Physical and Biological			***Metals[1] (µg/L)***		
pH	6.5-9.0	Aquatic Life			
Dissolved oxygen (mg/L)	6.0	Aquatic Life	Aluminum (total)	512 (ac) 73 (ch)	
	7.0 (spawn)	Aquatic Life	Arsenic	340 (ac) 150 (ch)	Aquatic Life Water Supply
Temperature	Apr-Dec 22.8C (ac) 18.2C (ch) Jan-Mar 13.0C (ac) 9.0C (ch)	Aquatic Life	Cadmium[3]	0.5 (ac) 0.15 (ch) 5 (Trec)	Aquatic Life Agriculture Water Supply
	Apr-Dec Jan-Mar	Aquatic Life	Chromium III[3]	183 (ac) 24 (ch) 50 (Trec)	Aquatic Life Agriculture Water Supply
E. coli (#/100 mL)	126	Recreation	Copper[3]	3.6 (ac) 2.7 (ch) 200 (Trec)	Aquatic Life Agriculture Water Supply
Inorganic (mg/L)			Iron	300 (diss)	Aquatic Life Water Supply
Total ammonia[1]	TVS (ac/ch)	Aquatic Life	Iron	1,000 (Trec) 300	Aquatic Life Water Supply
Chlorine	0.019 (ac) 0.011 (ch)	Aquatic Life	Lead[3]	TVS (ac/ch) 100 (Trec) 50 (Trec)	Aquatic Life Agriculture Water Supply
Cyanide	0.005	Aquatic Life	Manganese	TVS (ac/ch) 200 (ch) 50 (dis)	Aquatic Life Agriculture Water Supply
Boron	0.75	Agriculture	Mercury	0.01 (ch, total)	Aquatic Life
Nitrite	0.05	Aquatic Life Agriculture Water Supply	Nickel	TVS (ac/ch) 200 (Trec) 100 (Trec)	Aquatic Life Agriculture Water Supply
Nitrate	10	Water Supply	Selenium	18.4 (ac), 4.6 (ch) 20 (Trec) 50 (Trec)	Aquatic Life Agriculture Water Supply
Chloride	250	Water Supply	Silver	TVS (ac/ch) TVS (ch trout) 100 (Trec)	Aquatic Life Water Supply
Sulfate	250	Water Supply	Zinc	TVS (ac/ch) 2,000 (Trec) 5,000 (Trec)	Aquatic Life Agriculture Water Supply

Parameters with standards shown as TVS (table value standards) represent equations that include pH or hardness and will vary by site. All metal standards are as dissolved, except where noted. All agriculture and water supply standards are 30-day except as noted. 'Ac' = acute, 'ch' = chronic, 'Trec' = total recoverable, 'Dis' = dissolved.
[1] pH temperature dependent; [2] chloride dependent; [3] hardness dependent, varies by site.

3.3.1.2 Data Sources

Water quality data have been collected throughout the Poudre River and South Platte River within the study area by multiple entities. Water quality data were provided by Boxelder Sanitation, Carestream Health, CDPHE, University of Colorado, ERO Resources, City of Fort Collins, Greeley Water Pollution Control Facility, Leprino Foods, Metro Wastewater Reclamation District, Northern Water, USGS, and Windsor Wastewater Treatment Plant. The

available water quality database contains 43 surface water sites along the Poudre River with data representing more than 100 water quality parameters. Sample locations covered the entire study area from the canyon mouth to the confluence with the South Platte River. Water quality data from the Kersey Gage was used to assess water quality on the South Platte River below the confluence with the Poudre River. The number of constituents measured at each site varied, as did the period over which samples were collected. Water quality data on the Poudre River and South Platte River from 1994 to 2013 were reviewed to assess trends and to establish current water quality trends.

3.3.1.3 Water Quality Metrics and Parameter Selection

Available water quality data were evaluated on an individual site basis using the basic descriptive statistics of sample size, number of nondetects, minimum, 15th percentile, 50th percentile, 85th percentile, and maximum values. For the preliminary analysis of each parameter for each site, the entire dataset was used to derive each metric. Non-detect results were treated as zeros in the calculation of percentiles, which is consistent with the State's water quality assessment approach used for 303(d) listing purposes (CDPHE 2012). Given the various sources of the data, there was a range of detection limits (method detection limit or reporting limit) for each water quality parameter, although no effort was made to account for the variability in detection limits. The assessment metrics for water quality standards are based on either the 50th (total recoverable) or 85th (dissolved) percentile; therefore, the treatment of multiple non-detects limits had minimal effect on the assessment values when non-detect results were a minor component of the data. In cases when non-detect results were the majority of the available data for a parameter at each site, and the assessment metrics were calculated as zero, the final assessment metrics were qualified as non-detects.

To identify water quality parameters that may be affected by NISP operations, the 50th and 85th percentiles for each parameter were compared to the relevant standard. For those parameters with a standard based on hardness, the average in-stream hardness concentration for that site was applied to the respective equation. The maximum pH and temperature results recorded at each site were used to calculate the most conservative ammonia standard for the respective site. If the assessment metric was within 20% of the regulatory standard, that parameter was included in the qualitative evaluation. The data for each site were summarized using this approach to identify parameters of interest and to document reaches where specific water quality concerns may exist. Temperature and dissolved oxygen also were selected for evaluation because of their importance in protecting aquatic life and because Segment 10 of the Poudre River is included on Colorado's 303(d) list of impaired water for temperature (CDPHE 2012). Based on discussions with the WQCD, a subset of parameters was selected for qualitative analysis in the SDEIS (Table 3-15). The regulatory assessment metrics were calculated for all water quality parameters for comparison to the water quality standard. Some parameters (e.g., silver and arsenic) exceeded or were within 20% of the regulatory standard at sites upstream of the Poudre Valley Canal (Segment 10); however, these parameters were excluded from further analysis because the sample size was small and the majority of the data were non-detects, plus sites further downstream did not show a potential to exceed the relevant standard. Other parameters were excluded due to low sample size,

(e.g., n = 3, n = 1), lack of data to adequately characterize conditions throughout the entire study reach, existing concentrations are relatively low, or other considerations for the reasons noted in Table 3-15. Future water quality modeling for the Final EIS and 401 certification will be conducted; at which time, additional parameters may be included or excluded for detailed analysis.

Table 3-15. Selected water quality parameters and the rationale for inclusion or exclusion.

Parameter	Rationale
Included in the Evaluation	
Temperature	Included due to presence on 303(d) list for Segment 10.
Dissolved oxygen	Included due to a few exceedances in Segment 11 and more frequent exceedances in Segment 12.
Chloride (total)	Included due to potential use as a tracer for flow/concentration relationships with other parameters.
Copper (dissolved)	Included due to presence on 303(d) list for Segment 10.
Iron (dissolved)	Included due to a few exceedances to the Domestic Water Supply 30-day average standard.
Iron (total recoverable)	Included due to four water quality exceedances and the potential for exceedances at five separate sample locations all in Segment 12.
Manganese (dissolved)	Included due to several exceedances of the Domestic Water Supply 30-day average standard in Segment 10, and the Agriculture standard in Segments 11 and 12.
Manganese (total recoverable)	Included due to a few exceedances of the Agriculture standard in Segments 11 and 12.
Ammonia	Included due to several exceedances in Segment 12 using a conservative approach with the highest pH and temperature value to calculate the ammonia standard.
Nitrate (total)	Included even though concentrations are well below the established numeric water quality standard. No paired TKN data available.
Total Nitrogen	Included due to several sites in Segments 11 and 12 exceeding or showing the potential to exceed the interim total nitrogen value. Total nitrogen is calculated as the sum of total Kjeldahl nitrogen and nitrate + nitrite nitrogen and was calculated only when each constituent was present.
Total Phosphorus	Included due to several exceedances of the interim numeric value in Segment 12.
Selenium (dissolved)	Included due to presence on 303(d) list for Segments 11 and 12.
Sulfate	Included due to potential use as a tracer for flow/concentration relationships with other parameters.
Excluded	
E. coli	Present on 303(d) list for Segment 12; however, excluded due to limited data and inability to adequately model effects.
Nitrite	Excluded because the 85th percentile was considerably less than the Drinking Water Supply Standard. The combined nitrate-nitrite results are considered for other nitrogen calculations.
Total Inorganic Nitrogen	Excluded due to limited paired data. Total inorganic nitrogen is computed as the sum of ammonia nitrogen, nitrate + nitrite nitrogen and was calculated only when each constituent was present.
Silver (dissolved)	Excluded although one site in the upper portion of Segment 10 showed an exceedance; no other sites were within 20% of the site-specific hardness-based standard.
Arsenic (total recoverable)	Excluded even though two sites in the upper portion of Segment 10 showed a potential to exceed the Arsenic (ch) = hybrid threshold of 3 µg/L (i.e., within 20% of the standard); no other sites were within 20% of the threshold.
Zinc (dissolved)	Excluded because the 85th percentile concentrations were less than the hardness-based water quality standards.
Lead (dissolved)	Excluded because the 85th percentile concentrations were considerably less than the hardness-based water quality standards.
Mercury (total)	Excluded because the 50th percentile concentrations were less than the water quality standard, plus there is a decreasing trend in mercury levels in recent years.
Aluminum (total recoverable)	Excluded even though one sample exceeded the water quality standard and one site showed the potential to exceed the water quality standard. All sites had very limited data available to perform an analysis.

3.3.1.4 Method Detection Limits

Due to the large dataset and number of laboratories involved in analyzing water quality constituents for the Poudre River, the detection limits vary greatly. Some of the non-detects were reported as a true "method detection limit" (MDL[1]), while most non-detects were reported at a "reporting limit" (RL[2]). The derivation of the RLs is also variable; some are equivalent to MDLs, while others are the MDL multiplied by a factor. For all the data in the database that should have an MDL qualifier (i.e., excluding parameters such as temperature, dissolved oxygen, pH, etc.) approximately 25% of the data were reported as a non-detect result. Of these non-detect values, only 20% of them had a reported MDL, while almost 100% of the non-detect values had a RL.

Based on the parameters of interest used in the water quality assessment, approximately 25% of the data were reported as a non-detect result. Of these non-detects, approximately 15% of them had a reported MDL, while almost 100% had a RL. In total, only 32% of the data for the parameters of interest were qualified by a MDL, indicating that 68% of MDL qualifiers are missing in the database. The RLs are better represented in the entire database and qualified 63% of the data; however the difference between MDLs and RLs vary greatly depending upon laboratory. Table 3-16 summarizes the full range of MDLs and/or RLs used by all laboratories. For almost all parameters, the range of detection limits varied by at least an order of magnitude, which can be a problem for several of the parameters, such as copper or selenium, in which the detection limits exceed the water quality standard. All other parameters have MDLs or RLs that are less than the water quality standards, therefore, any non-detect values would be below the current water quality standard and would not present a problem.

Table 3-16. Summary of method detection limits or reporting limits for the parameters of interest.

Parameter	Method Detection Limit (MDL)	Reporting Limit (RL)
Chloride	0.03 – 1.0	0.06 – 3.0
Copper	0.03 – 10.0	0.02 – 40.0
Iron (dissolved)	0.04 – 20.0	2.0 – 100
Iron (total recoverable)	0.04 – 20.0	2.0 – 100
Manganese (dissolved)	0.02 – 5.0	0.2 – 50.0
Manganese (total recoverable)	0.1 – 10.0	0.2 – 80.0
Ammonia	0.001 – 0.1	0.0001 – 0.2
Nitrate	0.006	0.0003 – 0.05
Total Phosphorus	0.001 – 0.019	0.0006 – 0.1
Selenium (dissolved)	0.0004 – 1.0	1.0 – 5.0

[1] MDL is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the parameter concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the parameter.

[2] RL is defined as the minimum value below which data are documented as non-detects or the minimum value of the instrument calibration range. RLs can also be defined as a set multiplier of the MDL (i.e. 3xMDL). Concentrations between the MDL and RL are reported as having estimated concentrations.

3.3.1.5 Water Quality Site Selection

Based on the water quality metric assessment process, individual sites were examined in the context of the WQCC Regulation 38 stream classifications and standards with specific sites being selected to best represent parameters of concern. Within Segments 10, 11, and 12 of the Poudre River there is a diversity of landscapes and hydrologic conditions and because of this variability it was decided to characterize the hydrologic conditions in the upper and lower boundaries of each segment. The data for each site was reviewed and sites were also selected to best represent conditions near the upstream and downstream boundaries for each segment. Sample size, years sampled, and parameters sampled were incorporated in the site review process, but there was special consideration of hydrological inputs and diversions (e.g., WWTP discharges, agricultural returns, ground water, and diversions) in the selection of sites. Some of the reaches where water quality data were pooled contained diversions from the Poudre River. Such hydrological features do not alter the concentration of a parameter but they do affect the load. In contrast, documenting point source hydrological inputs in these reaches were of key concern because these inputs could alter both the concentration and the load. The key unknown in terms of hydrological inputs in the reaches with pooled water quality data is the potential ground water input. Ground water inputs could alter the concentration and the load, yet their relative contribution to surface water flows is poorly documented; although assumed to occur along the Poudre River with more influence in Segment 12.

The sampling effort was not equal across all sites, so sites excluded from further analysis had limited sampling events and/or limited parameters sampled. If individual sites revealed relatively low sample size for some parameters of interest, then multiple sites were pooled to provide a better representation of the water quality conditions for the respective boundary conditions of each stream reach. Furthermore, some sites contained mainly nutrient data so pooling with nearby sites that contained more metals or anion/cation data increased representation of all parameters. Temperature and dissolved oxygen were evaluated at representative sites in Poudre River and South Platte River segments with a sufficient sample size to allow comparison with water quality standards.

3.3.2 Poudre River

3.3.2.1 Overview

In the upper Poudre River watershed, the majority of the river flow is from snowmelt, with additional input from overland storm runoff during summer and some ground water inflow. As described in Surface Water Section 3.2.8.1.2, natural flows are augmented by nine transbasin diversions that deliver water into the upper Poudre River. The water quality in the upper Poudre River is high-quality mountain runoff, but water quality generally degrades downstream as it flows through urban and agricultural lands.

The Poudre River has 21 major diversions at multiple locations primarily for municipal water supply and agricultural use (see Surface Water Section 3.2.8.2). These diversions often result in

dry-up points along the river that occur during winter and summer. At least 12 dry-up points were identified between the Greeley Filters Pipeline and the Ogilvy Ditch headgate based on discussions with Water Commissioners and reviews of historical data, although several are reported to occur only in the driest of years, such as 2002 (see Surface Water Section 3.2.8.3, Figure 3-2 and Figure 3-3). The river is recharged downstream of the dry-up points by surface water discharges and/or by ground water inflows. Ground water inflows are variable from the canyon mouth to the confluence with the South Platte River, but generally increase downstream of Boxelder Creek. Poudre River minimum instream flow rights for a fish hatchery and recreational purposes rarely make a call on the stream, so flows are typically not affected by these water rights. Water is returned to the river through a variety of point and nonpoint discharges.

Historically, pollution has been present in the Poudre River for at least 50 years. The U.S. Environmental Protection Agency (EPA) reported that in 1964 the lower Poudre River was the most polluted river in the South Platte River Basin (EPA 1972), and in 1996, the Environmental Working Group stated that the Poudre River was the most polluted river in Colorado as a result of legal discharges (Laflin 2005). However, in recent years a number of the former industrial sources of pollutants to the Poudre River have ceased discharging or have improved treatment processes (OtterTail 2009), resulting in somewhat improved water quality over the past decade.

Primary sources of anthropogenic input to the Poudre River that impact water quality are WWTP discharges, stormwater drains and runoff from urban areas, and return flow from irrigated agriculture. Tributary inflows to the Poudre River downstream of the canyon are minimal except during storm events. Seven permitted WWTPs currently discharge to Segments 11 and 12 of the Poudre River (Figure 3-15 and Table 3-17). Discharges are regulated by Colorado's Discharge Permit System (CDPS), which establishes regulatory low flows and water quality standards for the receiving stream. Low flows are used to identify how much dilution of the wastewater effluent is available in the receiving stream under worst-case conditions. It has been reported that WWTP effluent may be the primary source of nutrient input (nitrate, ammonia, and phosphorous) to Front Range streams (Dennehy et al. 1998). However, a recent Colorado State University study of the Poudre River found that during high flows, WWTPs are a minor total phosphorus input (Sons et al. 2015). The major sources of phosphorus loading to the Poudre River during high flows are urban runoff and agricultural runoff, as a combination of both nonpoint source pollution and point discharge from return ditches and pipelines. There are currently no permitted concentrated animal feeding operations that discharge directly into the Poudre River (DeViolin, pers. comm. 2011).

Table 3-17. Summary of WWTPs discharging to the Poudre River and CDPS permit conditions.

WWTP/ Permit	Classified Stream Segment	Permit Expiration Date	mgd	cfs	Chronic Low Flow 30E3 (cfs)	Chronic Ammonia (mg/L)	Acute Ammonia (mg/L)
Fort Collins Mulberry CO-0026425	11	Oct 2013	6	9.3	1.5 – 14.0	4.3 - 8.7	15 - 36
Fort Collins Drake CO-0047627	11	Oct 2013	23	35.6	0.1 – 0.3	3.3 - 7.3	13 - 26
Boxelder CO-0020478	12	Aug 2013	2.34	3.62	1.6 – 14.9	5.9 - 10 (1)	15 - 39 (1)
Windsor CO-0020320	12	Apr 2014	2.8	4.3	17.8 – 32.0	16 - 25	Report
Carestream Health CO-0032158	12	Dec 2013	1.8	2.8	20.1 – 39.0	17 - 25	Report
Greeley CO-0040258	12	Mar 2017	Tiered 10 12 14.7	Tiered 15.5 18.6 22.7	25 - 50	Tiered 7.2 - 18.1 6.5-16 6-14	Tiered 32 – 50 29-46.5 26-44
Leprino Foods CO-0048860	12	Oct 2016	2.3	3.6	25	6.0 - 10	10 - 50

[1] Beginning October 1, 2015.
mgd = million gallons per day; cfs = cubic feet per second.

Several recent studies have investigated emerging contaminants in the Poudre River and have detected antibiotics. The source of some of the antibiotics is dairy lagoon water that is transported to the river via ditches, or from municipal WWTPs. Steroid sex hormones have also been found in the Poudre River, some at concentrations high enough to create a risk of endocrine disruption. The sources for these hormones include wastewater and runoff from agricultural fields. However, there are insufficient data to conduct a water quality assessment or mass-balance model for these contaminants.

Segment 12 is currently on the WQCD 303(d) list for *E. coli*. Available stream data indicate that *E. coli* can be high during all seasons, particularly from July to early September downstream from Lincoln Street in Fort Collins. The WQCD is not aware of any study completed to positively identify the sources of *E. coli* in the Poudre River Basin (Hegeman, pers. comm. 2011). Sampling conducted at four locations in 2009 near Fort Collins found substantially higher *E. coli* concentrations following a large precipitation event compared with low-flow summer periods. *E. coli* concentrations were greater than 2,400 MPN (most probable number)/100 mL at all locations after the storm event, but were 120 MPN/100 mL or less during low flow in August. The standard for *E. coli*, which is an indicator of the potential presence of pathogenic organisms, is expressed as a 2-month geometric mean, and is 126 organisms per 100 mL.

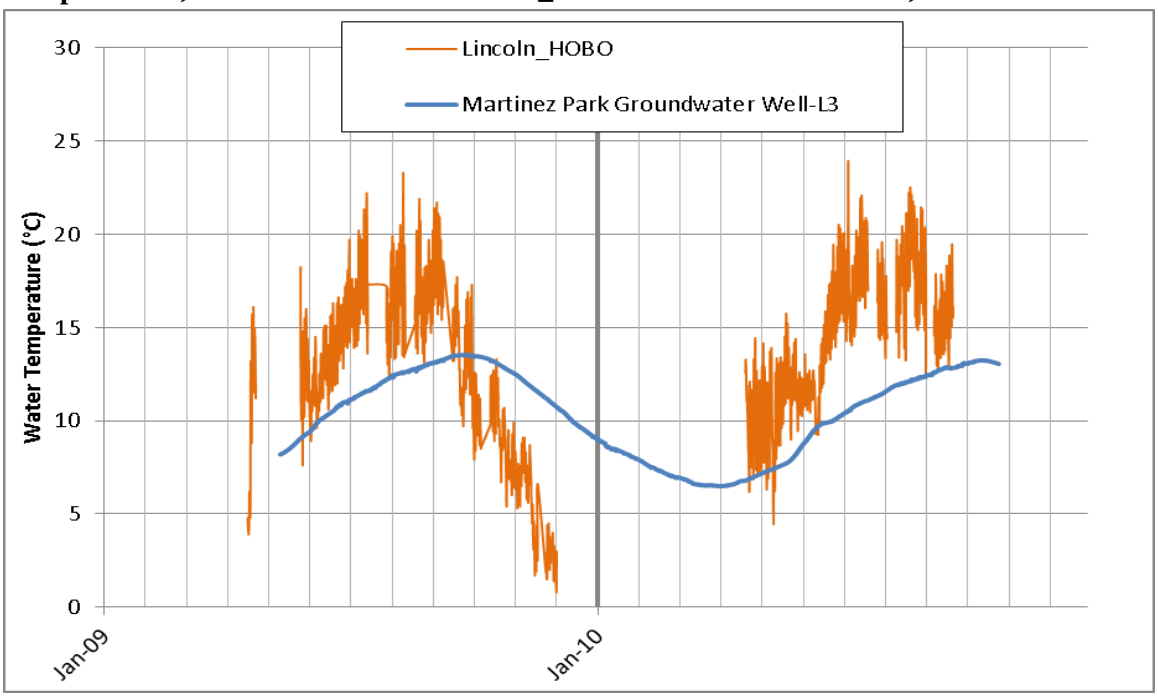
A review of *E. coli* data collected by others indicated that snowmelt runoff is not a source of *E. coli* to the Poudre River. This suggests that elevated *E. coli* concentrations in the Poudre River can be the result of large summer storm events, although other routes by which *E. coli* reaches the river include nonstorm runoff in areas used by livestock or wildlife. Several 303(d) listed stream segments for *E. coli* in Colorado are located entirely within urban settings

(Hegeman, pers. comm. 2011); therefore, cities along the Poudre River may be a source of elevated *E. coli* concentrations (due possibly to leaking sewer lines, pets, etc.), as well as septic tanks located near the river. *E. coli* can survive in ground water and may reach the Poudre River via this route (Brennan et al. 2010).

The Poudre River is a gaining river through its entire length within the NISP study reach from the mouth of the canyon to the South Platte River confluence, and there are multiple factors that affect the exchange of water between the alluvium and surface water flows. These factors include, but are not limited to, diversion dry up points, agricultural return flows, precipitation, wastewater return flows, and water storage in historical gravel pits. Some of these factors exhibit seasonal effects on the river while others provide a more uniform contribution of flow throughout the year. While the Poudre River is a gaining river, the contribution of ground water is not uniformly distributed along the entire study reach. Where diversions remove essentially all of the surface water flows, ground water return flows then can be a larger component of the total flow. Ground water gains to the river originating from precipitation or agricultural irrigation return flows are greatest just downstream of Boxelder Creek, and over the lower 15 to 20 miles of the Poudre River (ERO 2012b).

Ground water inflow into the Poudre River is also a potential source of dissolved constituents. Water that percolates into ground water from agricultural areas may contain elevated nutrients, pesticides, and other constituents. Wastewater treatment facilities provide a source of dissolved solids, sulfate, and nutrients, while agricultural fertilizers provide additional nutrients, and urban land use is an additional source for dissolved solids. In addition, marine shale deposits along the Front Range are a natural source of metallic and nonmetallic salts (e.g., sulfate, sodium, calcium, and selenium), and as surface or ground water passes over or through these deposits, the salts are transported to the streams. Ground water return flows may also influence stream temperature as noted from near-river ground water temperatures measured in Segment 11 where ground water temperatures were 5°C to 10°C cooler than stream temperature during the summer and warmer in the winter. Additional discussion on ground water is found in Section 3.5.

Figure 3-14. Comparison of Near-River Ground Water Temperatures and Poudre River Temperatures, Martinez Park and Lincoln_HOBO north of Fort Collins, 2009 and 2010.

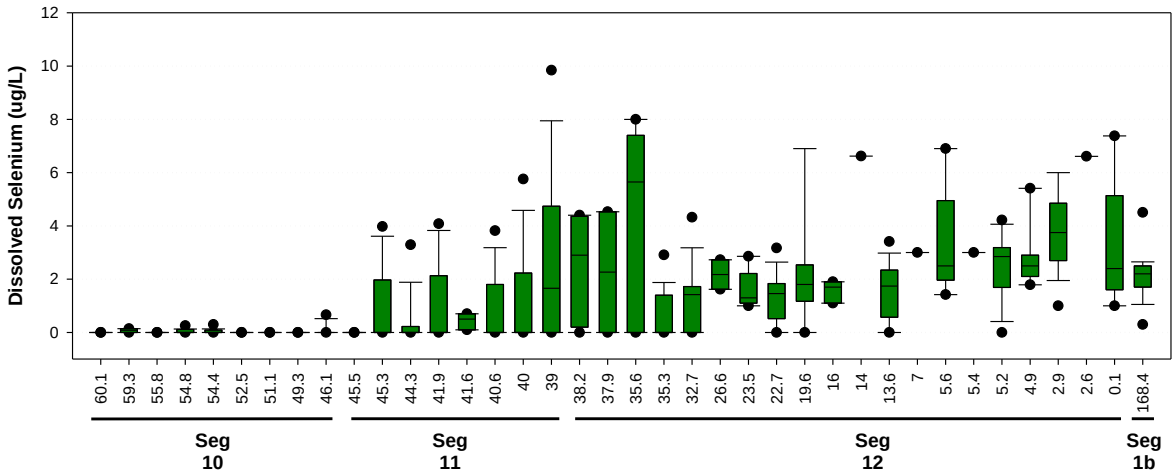


3.3.2.2 Trends and Relationships in Water Quality

Changes in existing water quality from the mouth of the Poudre River Canyon to the confluence with the South Platte River were reviewed to determine how water quality for various parameters changes over the course of 60 miles. In general, the concentration of metals and nutrients increases downstream. However, it is difficult to predict the flow and water quality of the river at a specific time and location due to natural variability (e.g., climate, snowpack, storm events, and ground water discharges to the river), variation in irrigation practices that influence return flows to the river, and the complex administration of the river.

Chloride and total recoverable manganese concentrations increase from Segment 10 to Segment 12. Dissolved iron concentrations were variable throughout all segments, with no discernable trends. Total recoverable iron was low at all sites in Segments 10 and 11 and increased slightly throughout Segment 12. Dissolved selenium and sulfate were low in Segment 10 and began increasing in Segment 11, with the highest selenium concentrations at the beginning of Segment 12 (Figure 3-15).

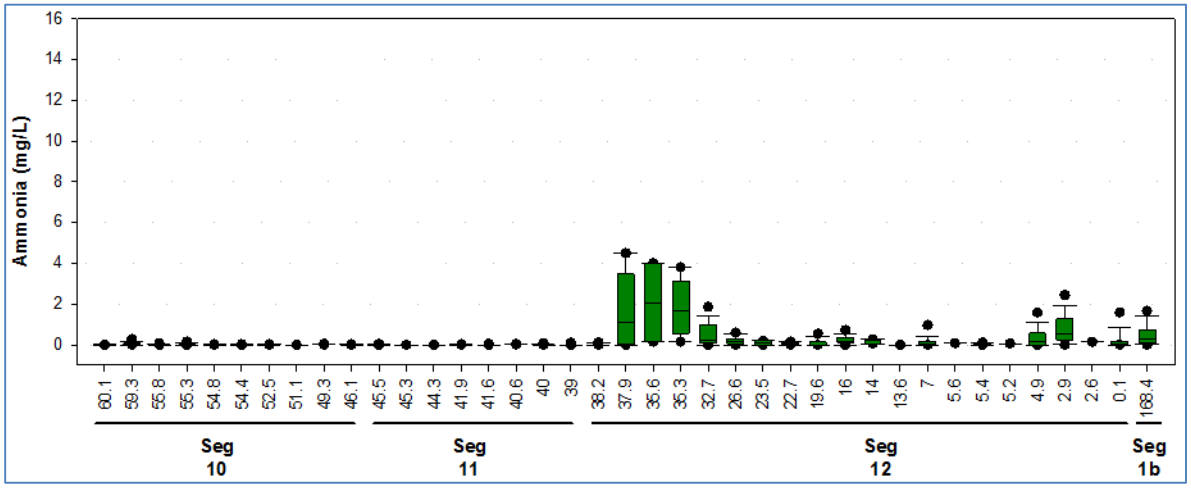
Figure 3-15. Longitudinal Trend in Selenium Concentrations on the Poudre River and South Platte River from Upstream of the North Fork to the Confluence with the Kersey Gage on the South Platte River.



Note: Box plots represent the 25th, 50th, and 75th percentiles, including the upper and lower 95% confidence intervals with circles representing the 5th and 95th percentiles.

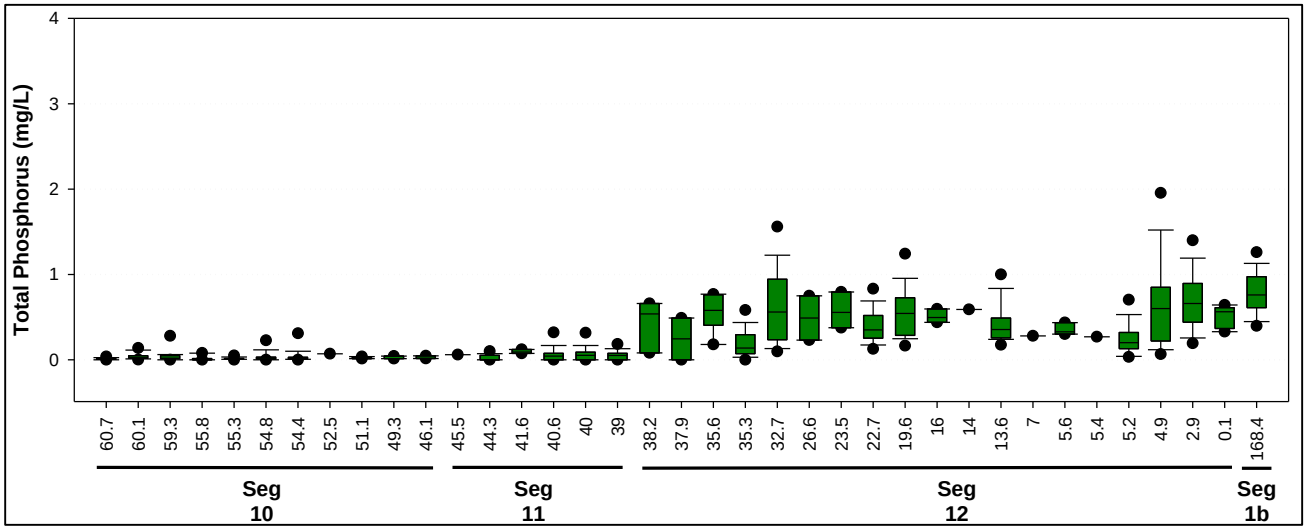
Nutrient concentrations were relatively low in Segment 10, with increasing concentrations near the downstream boundary of Segment 11 (below the Boxelder WWTP) as well as the downstream boundary of Segment 12 (below the Greeley WWTP). Ammonia concentrations were relatively low throughout Segments 10 and 11, with elevated concentrations at the top and bottom of Segment 12 (Figure 3-17). Nitrate and total phosphorus concentrations (Figure 3-17) were low throughout Segments 10 and 11 and increased in Segment 12.

Figure 3-16. Longitudinal Trend in Poudre River and South Platte River Water Quality for Ammonia from Upstream of the North Fork to the Kersey Gage on the South Platte River.



Note: Box plots represent the 25th, 50th, and 75th percentiles, including the upper and lower 95% confidence intervals with circles representing the 5th and 95th percentiles.

Figure 3-17. Longitudinal Trend in Poudre River and South Platte River Water Quality for Total Phosphorus from Upstream of the North Fork to the Kersey Gage on the South Platte River.



Note: Box plots represent the 25th, 50th, and 75th percentiles, including the upper and lower 95% confidence intervals with circles representing the 5th and 95th percentiles.

The concentration – flow relationships help illustrate how constituents may change with respect to different flow levels. The relationships may also contain information regarding the source of the constituents such as seasonal snow-melt runoff, non-point wet weather events, point source discharge, and ground water inflows, although the relative contribution of each source is not always known. Constituents that are derived from non-point sources tend to reveal greater concentrations with increasing flow. Whereas, constituents derived from point-sources generally show an increase in concentration as flow decreases or remain relatively stable across a ranges of flow if the receiving stream is mostly effluent-dependent. For example, WWTPs generally discharge constituents at a relatively uniform concentration and flow, thus when less streamflow is available, the dilution potential decreases. Both cases are applicable to the Poudre River, given the source water characterization at the canyon mouth and the multiple diversions and WWTP inputs further downstream. Other factors such as ground water inputs, industrial and wastewater discharges, stream bank erosion, and various agricultural inputs may influence water quality parameters.

Low-flow conditions in the Poudre River may represent hydrological conditions strongly influenced by ground water (ERO 2012b), although the effect is likely much less during typical and high flow conditions. Ground water inflows are more predominant and comprise a greater portion of the flow downstream of dry-up points, thus water quality may reflect the ground water influence. Furthermore, ground water has more influence on the hydrology in Segment 12, east of I-25 to the South Platte River thus water quality conditions during low flows may be more representative of ground water.

Diversion points along the stream may affect the concentration-flow relationships by removing water while not affecting the concentration of constituents. There is also the possibility that

other tributary source water inputs or ground water inputs to the Poudre River may affect the concentration-flow relationships by the addition of constituents at a higher concentration.

Temperature in the Poudre River generally increases from upstream to downstream as cooler mountain waters and snowmelt reach the plains and are warmed by greater solar radiation. Temperatures are also affected by changes in flow rates from diversions, and contributions from WWTP outfalls, tributaries, and ground water return flows. Higher stream temperature standards and a change in water use classification for aquatic life from upstream to downstream reflect the warmer temperatures that occur between Segments 10 and 12. Key inflows and outflows that affect river temperature in Segments 10, 11, and 12 during the irrigation season are shown in Table 3-18. Dissolved oxygen (DO) concentrations and associated standards also decrease from upstream to downstream. DO concentrations are influenced by temperature, re-aeration, sediment oxygen demand, organic matter loading, biological activity, and inflows and outflows to the river.

Table 3-18. Key inflows and outflows affecting current temperature in the Poudre River.

Poudre River Segment	Key Inflows and Outflows Affecting Current Temperatures
10	Hansen Supply Canal – Cooling Effect Major Irrigation-Season Diversions (including Larimer Co, Larimer and Weld) – Warming Effect
11	Major Irrigation-Season Diversions (including Fossil Creek Inlet) – Warming Effect
12	Inflow from Ground Water – Cooling Effect (ERO 2012b) Major Irrigation Season Diversions (including New Cache, Greeley #3, Ogilvy) – Warming Effect WWTP Effluent – Cooling in Peak Temperature Months; Warming at Other Times

Despite existing variability, several patterns in existing water quality were observed based on historical data:

- During higher flows, total metals, total organic carbon, and turbidity concentrations tended to be higher than during lower flows.
- During lower flows, total dissolved solids, sulfate, chlorophyll *a*, nutrient concentrations, and river temperature tended to be higher than during higher flows.
- Elevated total metal concentrations were generally associated with elevated turbidity, but at some downstream locations were also due to elevated dissolved metal concentrations as a result of ground water discharge to the river from local bedrock formations.
- Some of the natural contaminants to the river (e.g., selenium) are exacerbated by human activities such as runoff from agricultural fields.
- Poudre River temperate generally increases and DO typically decreases from upstream to downstream.
- Poudre River water quality was generally the poorest between Boxelder Creek and Greeley.

3.3.2.3 Segment 10 Water Quality

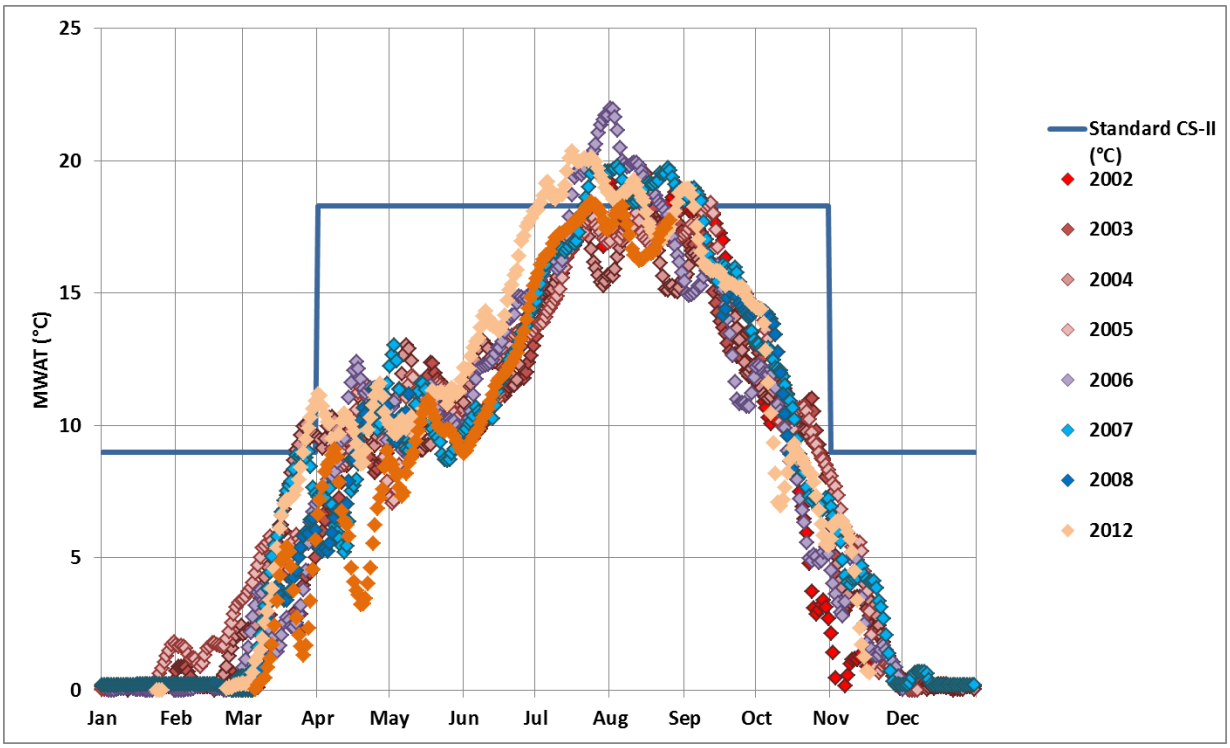
Current inorganic and metal water quality conditions for sites representative of Segment 10 were established by pooling between 5 and 10 years of data from 2000-2010. The amount of data

used was dependent on the number of parameters analyzed at each site, as well as any trends in observed data. The assessment metrics (85th percentile for dissolved metals, and 50th percentile for total recoverable iron and manganese) were compared with the appropriate water quality standards to determine attainment of instream standards for current conditions at one individual site and one pooled site. In Segment 10, the only potential exceedance issue of a parameter of concern was for dissolved copper. However, the data causing this exceedance were all from 2006, and primarily during the summer months when copper sulfate was being used to control vegetation. Some individual maximum values (dissolved and total recoverable iron, ammonia, and total phosphorus) did exceed standards; however, maximum values are not used to determine regulatory exceedance of instream standards.

Seasonality in the concentrations for each parameter were analyzed using all available data collected between 1980 and 2014. Dissolved and total recoverable iron concentrations increased during May and June, while chloride concentrations were slightly lower in the summer months. Dissolved manganese concentrations were relatively low throughout the year and total recoverable manganese concentrations were greater during spring runoff. No seasonal trends were observed for ammonia, nitrate, or total phosphorus. Selenium concentrations were greatest in January and sulfate concentrations were greatest in the winter months; however, available data for these months are limited so it is unclear if there is a seasonal pattern.

Annual stream temperature patterns in Segment 10 are typically characterized by two peaks. The first smaller peak is observed in April and May prior to snowmelt runoff, when streamflow is still low but air temperature begins to rise. Steam temperatures cool in May and June in response to increased flow rates from snowmelt. The second larger peak temperatures occur in mid-summer when air temperatures are higher and flows are lower. Temperature data at the Canyon Gage at the upstream end of Segment 10 (Figure 3-15) indicate exceedance of both the daily maximum (DM) and maximum weekly average temperature (MWAT) during mid-summer (Figure 3-18). Exceedance of MWAT tends to be in greater magnitude and longer in duration than the DM exceedances. In some years, there are exceedances of the DM and MWAT in the early shoulder season in March. This temperature condition continues downstream to the Hansen Supply Canal. Just downstream of the Hansen Supply Canal, which delivers water from the cool bottom of Horsetooth Reservoir, peak temperatures are lower and temperatures generally remain below standards. Water temperatures in the Hansen Supply Canal begin to exceed Poudre River temperatures in October, which can cause November shoulder season MWAT temperature issues immediately downstream of the canal inlet. Toward the downstream end of Segment 10, due to diversion of water downstream of Hansen Supply Canal inflows, temperature standard exceedances may occur in some years. Potential irrigation season dry-up conditions that can affect temperature occur adjacent to Watson Lake, although flows routed to the lake are returned immediately downstream after being routed through the fish hatchery.

Figure 3-18. Poudre River Canyon Gage Temperature, MWAT Values Compared with Relevant Standards.



DO concentrations in Segment 10 are consistently above the aquatic life standard of 6 mg/L, with a few drops below the 7 mg/L spawning standard in Segment 10 in 2006. The Hansen Supply Canal inflow tends to increase Poudre River DO concentrations for much of the irrigation season, but values can be lower than the river in September and October when Horsetooth Reservoir DO concentrations at the bottom of the reservoir are lower. Overall, Segment 10 DO concentrations do not indicate a substantial concern for drops below the standard due to cooler stream temperatures, inflows from the Hansen Supply Canal, and relatively low organic matter loading.

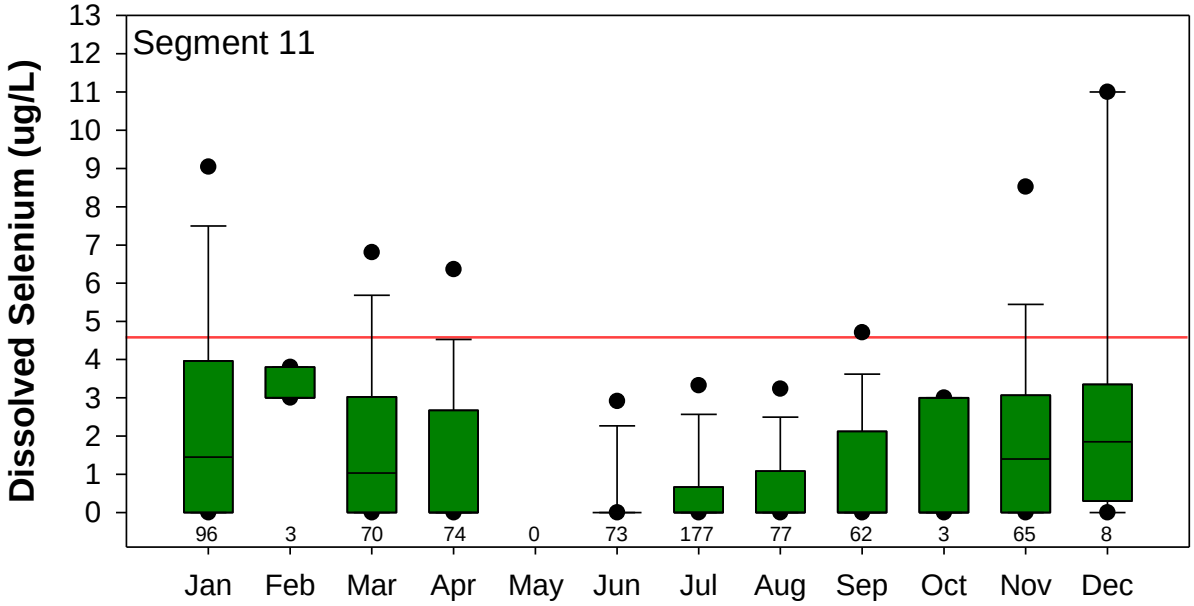
3.3.2.4 Segment 11 Water Quality

Inorganic and metal water quality current conditions for sites considered representative of Segment 11 were established by using 5 years of data from 2006-2010. The assessment metrics were compared with the appropriate water quality standards to determine attainment of instream standards for current conditions at one individual site and one pooled site. Both the selected upper site and lower pooled sample sites in this reach were in attainment with all instream standards. The upper site in the Segment 11 reach had several maximum values that exceeded water quality standards (total recoverable iron, ammonia, and total phosphorus), as did the lower site (total recoverable iron, total recoverable manganese, ammonia, and total phosphorus). Further evaluation of individual sites indicates one location above the Box Elder WWTP (PR-39)

with a standard exceedance for dissolved selenium. This occurred prior to 2004 and the trend seems to be downward since that time. Segment 11 is currently on the 303(d) list for selenium.

Seasonality patterns show higher recoverable iron in May and June and consistent copper concentrations throughout the year. Median total recoverable manganese concentrations were higher in the spring, while there was no discernable trend in dissolved manganese. There was no seasonal trend for ammonia or total phosphorus. Nitrate concentrations were slightly lower during the summer months. Dissolved selenium concentrations were slightly elevated in the winter months (Figure 3-19). The 95th percentile selenium values exceeded the chronic standard.

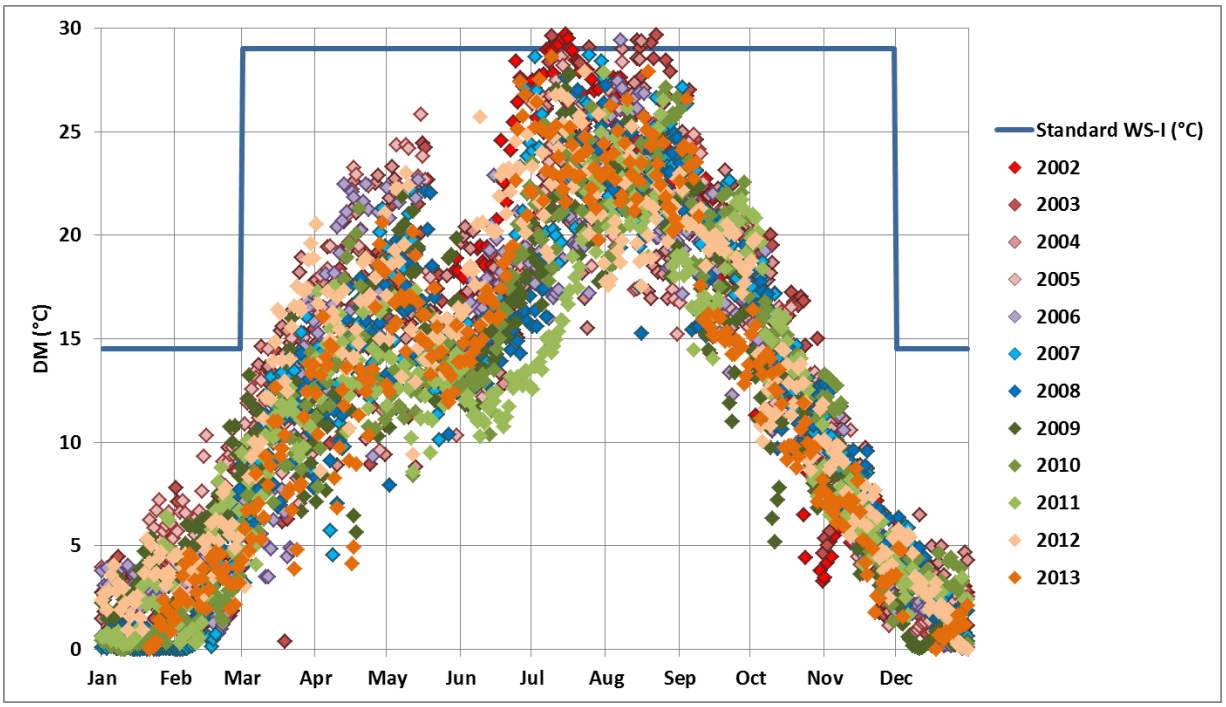
Figure 3-19. Seasonal Selenium Concentrations at All Sample Sites within Segment 11.



Note: The red line indicates the chronic water quality standards and the dashed red line indicates the acute standard for this segment. Numbers above the x-axis indicate the number of samples collected. Box plots represent the 25th, 50th, and 75th percentiles, including the upper and lower 95% confidence intervals with circles representing the 5th and 95th percentiles.

Poudre River temperatures peak during the summer. Small tributary inflows and the Fort Collins Mulberry Water Reclamation Facility add to streamflow, and a large irrigation season diversion at Fossil Creek can cause the river to dry up over a short reach near the end of Segment 11. Temperature standards increase in Segment 11 from Cold Stream II to Warm Stream I. Records for the most upstream gage in this segment near Lincoln Street show no exceedance of the DM or MWAT standards. Downstream of the fossil Creek diversion, temperatures increase sharply due to reduced flow rates. The temperature gage above Boxelder Creek (Figure 3-13), exhibited DM exceedances in 4 years of record (2002 to 2006) in July and/or August (Figure 3-20). DM exceedances were more common than MWAT exceedances.

Figure 3-20. Above Boxelder Creek Temperature Gage DM Values Compared with Relevant Standards.



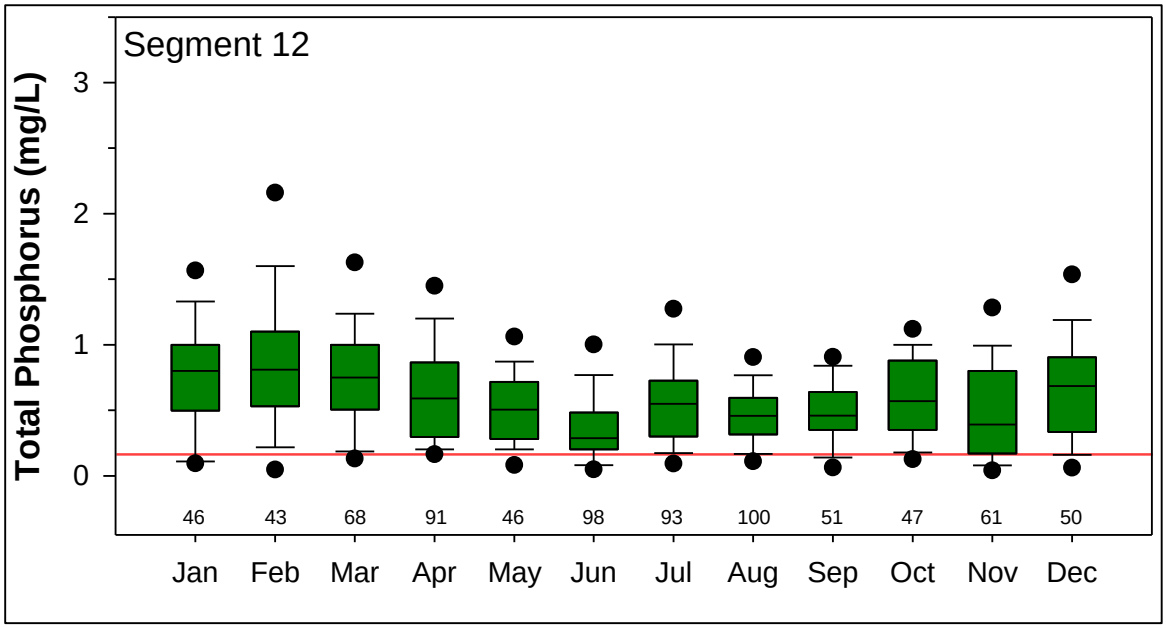
As a Warm Water I classification, this reach has a DO standard lower than Segment 10. DO in this segment has generally been above the 5 mg/L standard, except for infrequent localized drops below the standard. These isolated drops below the standard appear to reflect the effects of sediment oxygen demand, particularly during low-flow conditions behind diversion dams. Ground water, which generally has lower DO concentrations than the stream, may also play a small role at the lower end of this segment.

3.3.2.5 Segment 12 Water Quality

Inorganic and metal water quality current conditions for sites considered representative of Segment 12 were established by pooling between 5 and 8 years of data from 2003-2014. Assessment metrics were compared with the appropriate water quality standards to determine attainment of instream standards for current conditions at six individual sites and one pooled site. Several sites in the mid to lower portion of Segment 12 exceeded nutrient and some metal criteria. Standard exceedances occurred for total phosphorus, ammonia, total recoverable iron, and dissolved selenium. The upper pooled sites and one of the sites in the middle of the reach were in attainment of instream standards. Several individual sites had maximum values that exceeded water quality standards. Individual sites not used in the overall assessment of water quality showed exceedances of water quality standards for total recoverable iron, ammonia, total phosphorus, and dissolved selenium. Some of these sites had a small number of samples over a short period.

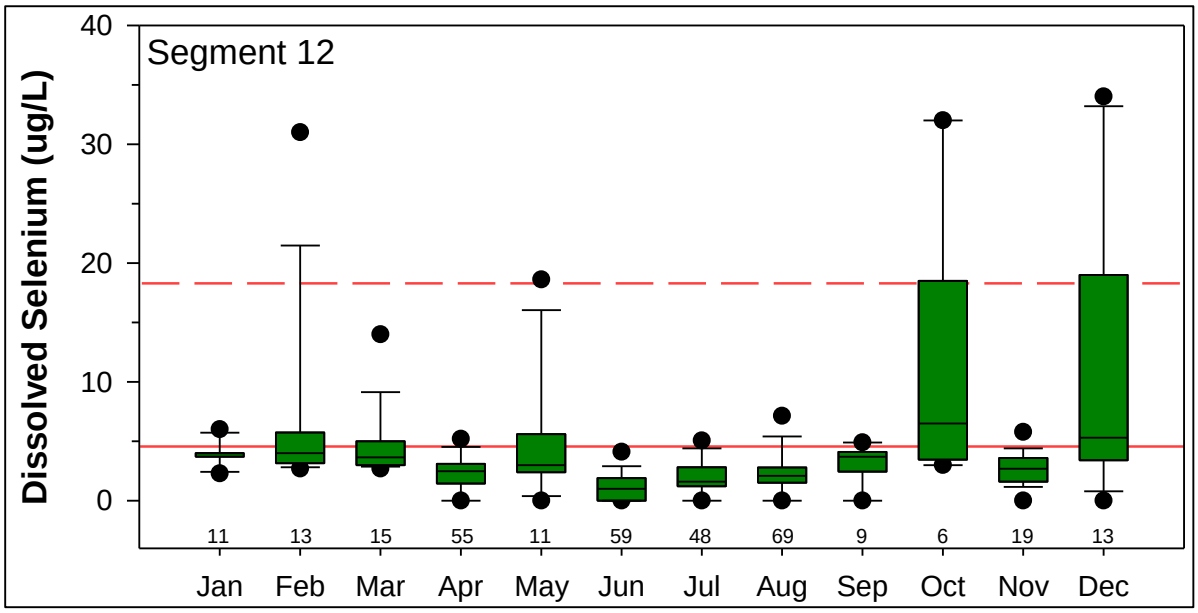
Seasonal concentration patterns indicate slightly higher dissolved copper concentrations in the late spring and summer. Total recoverable iron concentrations showed a strong trend with higher concentrations from May to August. Dissolved manganese concentrations were most variable during spring runoff, while total recoverable manganese concentrations showed no seasonal trend. Ammonia concentrations were lower in the summer months. Nitrate concentrations were fairly consistent throughout the year. Total phosphorus concentrations had lower concentrations and less variability from May to September (Figure 3-21). Selenium concentrations exceeded the chronic standard in October and December with the lowest values in summer (Figure 3-22).

Figure 3-21. Seasonal Phosphorus Concentrations at All Sample Sites within Segment 12.



Note: The solid red line indicates the chronic water quality standard for this segment. Numbers above the x-axis indicate the number of samples collected. Box plots represent the 25th, 50th, and 75th percentiles, including the upper and lower 95% confidence intervals with circles representing the 5th and 95th percentiles.

Figure 3-22. Seasonal Selenium Concentrations at All Sample Sites within Segment 12.



Note: The solid red line indicates the chronic water quality standard and the dashed red line indicates the acute standard for this segment. Numbers above the x-axis indicate the number of samples collected. Box plots represent the 25th, 50th, and 75th percentiles, including the upper and lower 95% confidence intervals with circles representing the 5th and 95th percentiles.

Summer temperatures in Segment 12 are influenced by multiple large irrigation season inflows from the Fossil Creek Outlet, Greeley and Windsor WWTPs, and ground water inflows. Temperatures are also influenced by the New Cache la Poudre, Greeley #3, and Ogilvy diversions in this segment. Overall, these inflows and outflows result in fluctuating river temperatures, with inflows providing both cooler and warmer water and outflows allowing greater warming of the river with reduced water depth. The Fossil Creek Outlet may increase stream temperatures at times but also increases flow rates. The Windsor and Greeley WWTPs' effluent temperatures are generally higher than river temperature in all months except the peak river temperature months. Ground water may be 5°C to 10°C cooler than stream temperature at some locations during the spring and summer months and warmer than the river in the fall and early winter (ERO 2012b).

The temperature standard for Segment 12 is Warm Water I, the same as Segment 11. There are no recorded exceedances of DM or MWAT standards in peak or shoulder seasons in the upstream section of Segment 12, which is largely ground water fed through much of the summer. Downstream of Fossil Creek (CLARIVCO Gage) to the confluence with the South Platte River, recorded data indicate no apparent exceedances of DM standards, although temperatures have been within 1.5°C of the standard in July and August of some years. MWAT standard exceedances were observed in July and August at several locations above the Greeley WWTP outfall. No MWAT or DM exceedances are recorded in the last few miles of the river before the confluence.

Segment 12 exhibits more frequent and recent drops below the DO standard than Segments 10 and 11, primarily in the central 20 miles of the 38-mile segment. Observations in the lower

5 miles of Segment 12 to the confluence with the South Platte River show a reduced frequency of DO concentrations below the standard and higher relative DO concentrations compared with the upper reach of Segment 12. This may be attributable to increased algal activity in this portion of the reach, providing DO loading by photosynthesis. Given the low DO ground water inflows, WWTP effluent, respiration from high algal concentrations, and the effects of diversions, DO concentrations in the river may, at times, reach values below the standard during non-daylight hours. Nighttime observations, however, are not available to verify or quantify this possibility. Thus, factors contributing to lower DO conditions in Segment 12 may include:

- Low-flow rates decreasing water depth, thereby increasing the effects of sediment oxygen demand
- WWTP and return-flow loading of organic matter and ammonia contributing to oxygen demand from the sediments and water column
- Inflow of low DO ground water
- Diversion dams (pooling water immediately upstream)

3.3.3 South Platte River

3.3.3.1 Overview

The South Platte River serves as the principal source of water for eastern Colorado and is diverted extensively for agricultural use. The South Platte River originates in Park County, Colorado and flows north through Denver and east of Greeley, receiving tributary inputs from Cherry Creek, North Fork, Bear Creek, Clear Creek, St. Vrain Creek, Big Thompson River, and the Poudre River. The portion of the South Platte River in the study area begins at the confluence with the Poudre River and extends 2.4 miles downstream to the Kersey Gage. Except during the late spring to early summer snowmelt runoff period, much of the flow of the South Platte River near Kersey is wastewater discharge to the river and irrigation return flows (Dennehy et al. 1998). In general, water quality is poor at the Kersey Gage as a result of upstream discharges and diversions (ERO 2012a).

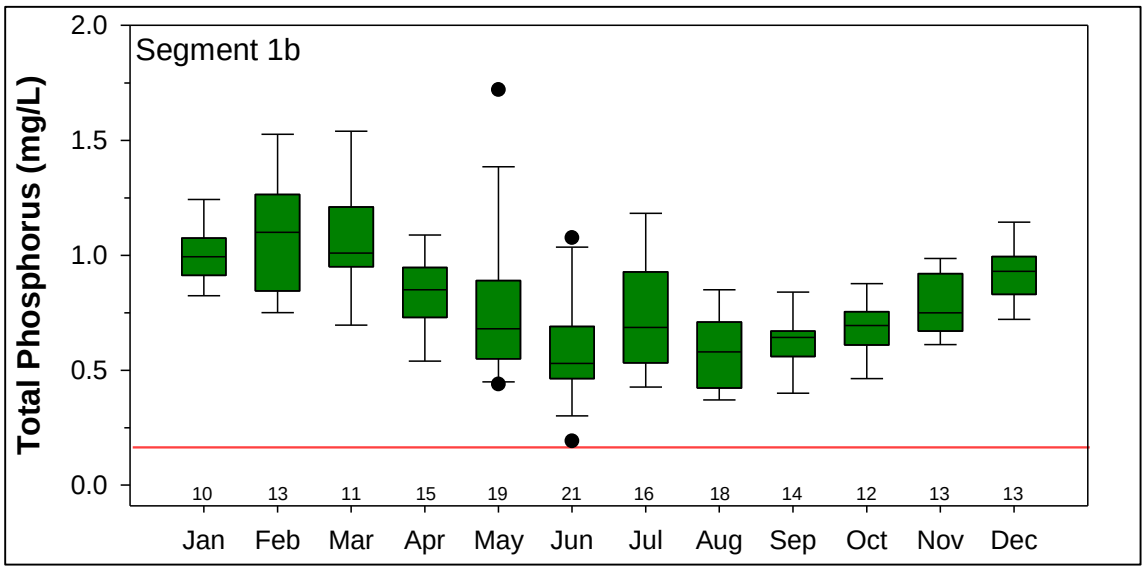
Within the South Platte River Basin primary sources of anthropogenic water pollutants are urban stormwater, WWTP discharges, and runoff or subsurface flows from agricultural fields. Agricultural runoff to the Poudre and South Platte Rivers is a combination of nonpoint source discharges from fields and discharges from ditches and pipelines. Another source of pollution is water that percolates into ground water from farm fields and then flows into the streams. Agriculture contributes nutrients, suspended sediments, pesticides, and other pollutants to South Platte River Basin streams. Marine shale deposits along the Front Range are a natural source of metallic and nonmetallic salts to the South Platte River (e.g., sulfate, sodium, calcium, and selenium). Irrigation and standing water bodies such as unlined ponds on soils derived from marine shales increase the loading of these salts to streams. Acute (DM) river temperature standards have been exceeded at the Kersey Gage during the summer when river flow was low and air temperatures were high (2002 and 2012).

3.3.3.2 South Platte River Segment 1b

Data from the Kersey Gage were used to represent current water quality conditions of the South Platte River for Segment 1b. The years 2003 to 2011 were determined to provide a representative period for examining existing water quality for inorganic and metal parameters. The record indicates several exceedances of nutrient and metal standards in Segment 1b, including total recoverable iron, sulfate, and total phosphorus interim standard. There were also several additional parameters with maximum values that exceeded water quality standards (dissolved iron and selenium); however, maximum values are not used to determine regulatory exceedance of instream standards. The exceedance of the total phosphorus interim standard is consistent with the exceedance observed in Segment 12 of the Poudre River above the confluence with the South Platte River.

Seasonality of concentrations was evaluated by comparing median values with water quality standards. Median chloride concentrations were below the water supply standard of 250 mg/L for all months. Concentrations were slightly lower in the summer months compared with median values in the winter. Median dissolved iron concentrations were well below the water supply standard throughout the year, although a few sample results were greater than the standard from May to October. Median dissolved manganese concentrations were less than the water supply standard for all months, although the 75th percentile concentrations for February and August were greater than the standard. Median ammonia values were below the calculated monthly standards and showed slightly lower concentrations in the summer. Median nitrate concentrations were less than the water supply standard with lower concentrations and more variability in May and June. All phosphorus values were above the interim standard for all months (Figure 3-23). There was a seasonal trend in concentrations, with lower values in the summer months and higher values in the winter months. Selenium data were limited, but all values were below the chronic standard, with highest values in August. Median sulfate concentrations were above the water supply standard in all months except for May and June.

Figure 3-23. Seasonal Total Phosphorus Concentrations at the Kersey Gage on the South Platte River, Segment 1b.



Note: The red line indicates the interim water quality standard of 0.170 mg/L for this segment. Numbers above the x-axis indicate the number of samples collected. Box plots represent the 25th, 50th, and 75th percentiles, including the upper and lower 95% confidence intervals with circles representing the 5th and 95th percentiles.

Temperature standards in the South Platte River change to Warm Water II, which allows slightly lower DM values and higher MWAT values than Segment 12 of the Poudre River. The relative contribution of flows from the Poudre River varies seasonally and by year. Poudre River flows constitute about 19% of the South Platte River flow at the Kersey Gage over the last 5 years. Flows from the Poudre River into the South Platte are likely to cause a small amount of warming between October and April and a small amount of cooling between May and September. DM and MWAT temperatures at the Kersey Gage (Figure 3-13) tend to be higher than those in the lower Poudre River. There are no recorded MWAT exceedances (Figure 3-24); however, DM exceedances occurred in 2 of the 12 years of compiled data (2002 and 2012) (Figure 3-25). These were hot and dry years. Other years show values approaching the DM standard.

Figure 3-24. South Platte, Kersey Gage MWAT Values Compared with Relevant Standards.

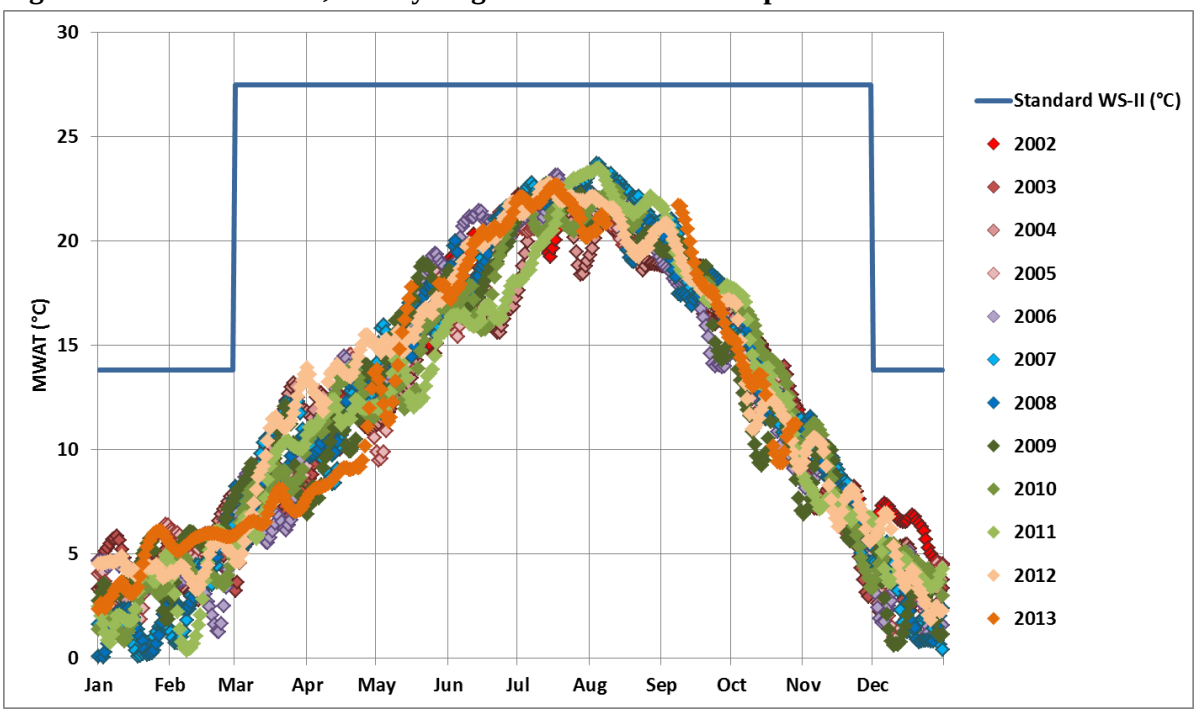
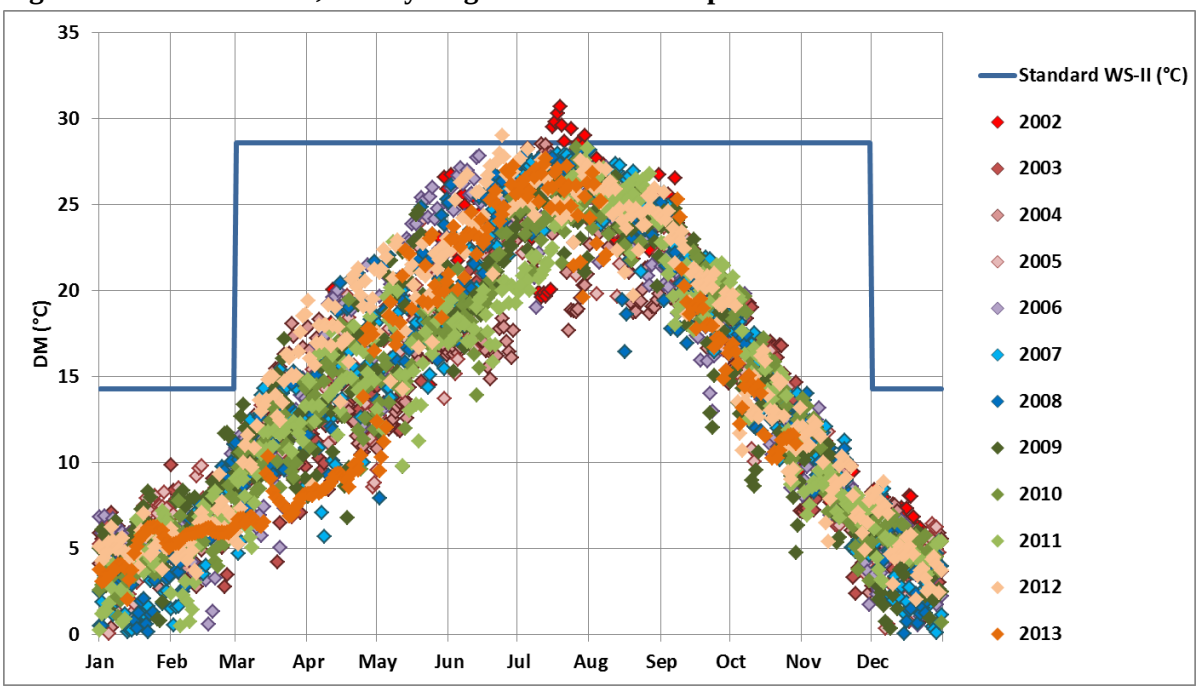


Figure 3-25. South Platte, Kersey Gage DM Values Compared with Relevant Standards.



No DO concentrations at or below the 5 mg/L standard have been measured at the Kersey Gage on the South Platte River. The lowest observed DO concentration was 6.2 mg/L, while a typical annual minimum value is about 7.0 mg/L. This reach of the South Platte River does not currently appear to be a sensitive reach in terms of DO concentrations.

3.3.4 Horsetooth Reservoir

Under the Alternative 2 Reclamation Action Option, a pipeline bringing water from Glade Reservoir to Horsetooth Reservoir may be constructed and, therefore, the water quality of Horsetooth Reservoir could be affected. Horsetooth Reservoir is within WQCC Segment 14 of the Poudre River Basin and is classified as Aquatic Life Cold 1, Recreation E, Water Supply, and Agriculture (CDPHE 2014). Numeric standards for Horsetooth Reservoir are provided in Table 3-14. The reservoir is considered mesotrophic based on clarity, nutrient, and chlorophyll *a* concentrations, meaning that it contains moderate quantities of nutrients and is moderately productive in terms of aquatic animal and plant life.

The water quality of Horsetooth Reservoir is generally good, with low dissolved solids, hardness, sodium, sulfate, and nutrient concentrations, and mostly low metal concentrations. Horsetooth Reservoir is on the 303(d) list for aquatic life use due to elevated mercury levels in some fish species in the reservoir; the source of mercury is atmospheric deposition from coal-fired power plants. The reservoir is also on the WQCC's 303(d) list for copper and arsenic. Arsenic was detected at two locations in the reservoir in 2006 but was well below the standard. Dissolved copper was detected at two locations in the reservoir from 2000 to 2006; some of these samples exceeded the dissolved copper standard.

Very low DO concentrations are measured nearly every year in the reservoir, almost always between July and October. High manganese concentrations occur in Horsetooth Reservoir as a result of low DO concentrations in the bottom of the reservoir in late summer and early fall. Dissolved manganese concentrations exceeded the secondary water supply standard in 4 years between 1998 and 2006. Total phosphorus concentrations increase through summer and into fall as phosphorus is transported from the bottom sediment to the lower level of the reservoir when oxygen levels are depleted.

Total organic carbon (TOC) is a measure of dissolved organic matter in the water. Organic matter is naturally occurring from sources such as vegetation and aquatic organisms found in reservoirs or transported from receiving waters. Although there are no water quality standards for TOC, it is often a concern for domestic water treatment where it can react with chlorine and produce disinfection byproducts that are regulated carcinogenic compounds. TOC concentrations in Horsetooth Reservoir have shown an upward trend between 1997 and 2009. TOC concentrations in the reservoir average 3 to 4 mg/L during most of the year, but are higher during spring runoff (about 5 to 10 mg/L in mid-May to mid-June). Natural processes within the reservoir result in a net decrease in TOC concentrations between the reservoir inflow and outflow.

Geosmin, a naturally occurring organic compound produced by blue-green algae, imparts an earthy odor to water. Geosmin concentrations in the reservoir have occasionally resulted in taste and odor complaints from water users and are difficult to remove during domestic water treatment. The Hansen Feeder Canal is a potential source of geosmin to the reservoir, as well as geosmin that is produced within the reservoir.

In 2008, the District began collecting samples of emerging contaminants in waters of the C-BT system, including Horsetooth Reservoir. The evaluation included 51 pharmaceuticals and 103 pesticides. The only compound detected in Horsetooth Reservoir was the pesticide DEET, which was detected at the laboratory reporting limit for DEET.

3.3.5 Carter Lake and Flatiron Reservoir

Carter Lake and Flatiron Reservoir are components of the C-BT Project. Under the Alternative 2 Reclamation Action Option, water deliveries to NISP Participants would be made through releases from Carter Lake. NISP would supply like amounts of water to the Poudre River from Glade Reservoir in lieu of releases from Horsetooth Reservoir to the Poudre River via the Hansen Supply Canal. The exchange with C-BT would allow an average of 29,500 AFY to be delivered from the outlet of Carter Lake to the 10 NISP Participants located in the southern and eastern areas of the District. The exchanges proposed under the Reclamation Action Option would not affect C-BT West Slope operations or result in additional West Slope diversions. Under the Reclamation Action Option, less water would be released from Horsetooth Reservoir via the Hansen Supply Canal, so less water would need to be delivered from Flatiron Reservoir to Horsetooth Reservoir via the Hansen Feeder Canal. There would also be operational changes at Carter Lake, where the average annual release to NISP Participants would require pumping more water from Flatiron Reservoir into Carter Lake. However, this would be primarily a flow-through operation and typical operational reservoir levels would be maintained in Carter Lake. The amount of reduced deliveries to Horsetooth Reservoir would be about equal to the amount of increased deliveries into Carter Lake. There would be very little net effect on Horsetooth Reservoir and Carter Lake as a result of NISP-related operational changes. Because no new sources of water would be introduced into Carter Lake or Flatiron Reservoir and the net operational changes are expected to be minor, water quality impacts for these reservoirs are expected to be minimal.

3.3.6 Proposed Reservoir Sites

3.3.6.1 Glade

Glade Reservoir would be located on an unnamed intermittent tributary to the Poudre River. This tributary has not been sampled, but Stonewall Creek (which occupies an adjacent drainage to the west, is in similar terrain, and also is intermittent) has been sampled by Greeley. The creek generally has good water quality, with mostly low metal and nutrient concentrations. Total iron and manganese concentrations are sometimes elevated. The water is very hard and total dissolved solids concentrations are somewhat elevated. *E. coli* concentrations are generally low, but there have been some standard exceedances.

3.3.6.2 Galeton

Galeton Reservoir would be located on a small poorly defined drainage. The upstream drainage area at the reservoir site is about 23 square miles. The quality of the water that drains through the Galeton Reservoir footprint is unknown. However, water quality data have been collected by the USGS from nearby Lonetree and Owl Creeks near Eaton, Colorado. These sites have much larger watersheds, but the water quality may be comparable to the Galeton drainage. In general, the water quality is poor: alkaline, very hard, and with high dissolved solids concentrations. Ammonia and nitrite concentrations were low, but total phosphorus concentrations were sometimes elevated, and nitrate concentrations sometimes exceeded the standard. Sodium concentrations were somewhat elevated, and sulfate concentrations sometimes exceeded the standard. The only metals sampled were dissolved iron and manganese, and concentrations were low.

3.3.6.3 Cactus Hill

Black Hollow Creek is the primary intermittent drainage within the proposed Cactus Hill Reservoir footprint. The water quality of Black Hollow Creek and the other drainages may be similar to the quality of Lonetree Creek, a stream located north and east of the proposed Cactus Hill Reservoir. Lonetree Creek was sampled by the USGS at a location north of the Cactus Hill Reservoir site near Carr, Colorado. The water is generally of good quality, but is alkaline, has somewhat elevated dissolved solids concentrations, and is very hard. Nutrient and metal concentrations are low. TOC concentrations range from 2 to 6 mg/L. Part of the Cactus Hill Reservoir site is used as a land application site for wastewater byproducts from the Anheuser-Busch brewing process. The effluent is applied at an agronomic rate through center pivots at concentrations not to exceed specified CDPS (CO39977) discharge limitations.

3.4 STREAM MORPHOLOGY AND SEDIMENT TRANSPORT

3.4.1 Overview

This section describes the physical condition of the Poudre mainstem that may be affected by implementation of the project alternatives. It includes a description of the existing physical condition of the river in the study area, the morphologic processes that are occurring in the river, and the trajectory of the existing stream condition assuming a continuation of current conditions hydrology. This characterization of existing conditions provides the basis for comparisons related to potential flow alterations presented in Chapters 4 and 5. Based on comments received on the DEIS, additional analyses were performed for channel morphology and sediment transport for the SDEIS, including reviewing and further subdividing the reaches of the Poudre River to more accurately describe past trends and potential impacts on different segments of the Poudre River. A new technical report was prepared using new and revised information and the CTP hydrology. More detailed information on stream morphology and sediment transport can be found in the 2013 Stream Morphology Baseline Report (ACE 2013).

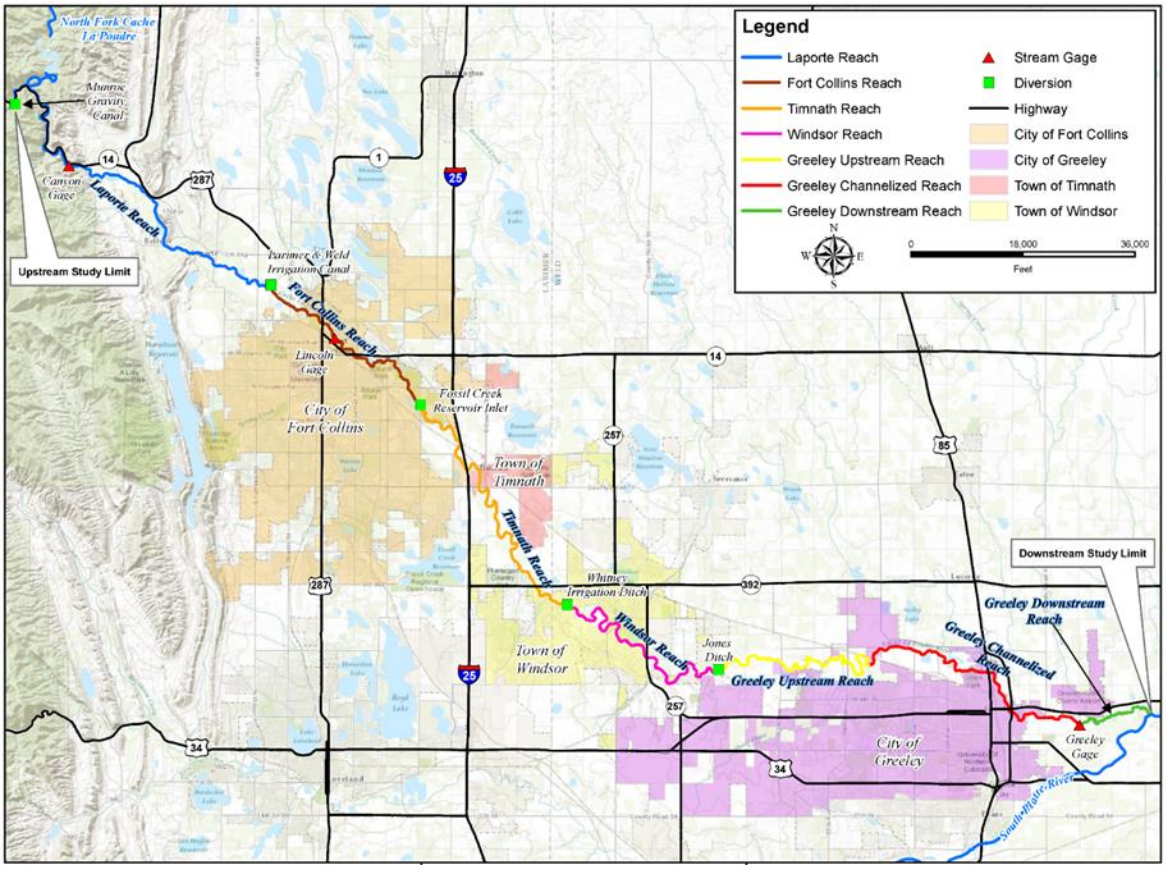
Information on stream morphology of the South Platte River can be found in Section 3.4.1 of the DEIS and the South Platte Stream Morphology Report (ERO 2008a).

3.4.2 Poudre River

The river transitions from a steep, narrow bedrock-confined gorge to a low gradient, unconfined alluvial channel meandering in a broad floodplain. Most of the transition occurs in the upper reaches from the vicinity of Bellvue through Fort Collins to Timnath. The river was divided into reaches (Figure 3-26) to form the basis for analysis and impact assessment. These reaches represent lengths of river with similar geomorphic and sediment transport characteristics. Reaches were delineated and refined progressively on the basis of aerial photograph interpretation, field data and observations, and results related to hydrologic, hydraulic, geomorphic and sediment transport analyses. For most of its length, the mainstem of the Poudre River is affected by development including:

- Water storages, structures, ditches and interbasin diversions
- The extensive urban areas of Fort Collins, Windsor and Greeley; and associated clearing of vegetation, flood mitigation works, meander cutoffs, channel realignment, urban and industrial encroachment and recreational developments
- Large areas of gravel mining in the floodplain and associated realignment, excavation, clearing and leveeing of the river channel
- Meander cutoffs, straightening and dredging of the river channel associated with bridging or flood mitigation
- Clearing of floodplain and riparian vegetation for agriculture
- Changes to land use in the watershed

Figure 3-26. Stream Morphology and Sediment Transport Study Limits and River Reaches.



Stream condition assessment schemes combine a number of attributes to characterize the degree of disturbance to a watercourse. Key physical attributes seen as important to river health include (Norris et al. 2001):

- Hydrology: the magnitude, frequency and duration of flows are discriminating characteristics that influence the physical form, water quality, vegetation and aquatic life of the waterway.
- Physical form: the size, shape and slope of the waterway and its in-stream features: pools, bars, meanders, riffles, in-channel wood and composition of the bed are the building blocks for aesthetic and environmental functions.

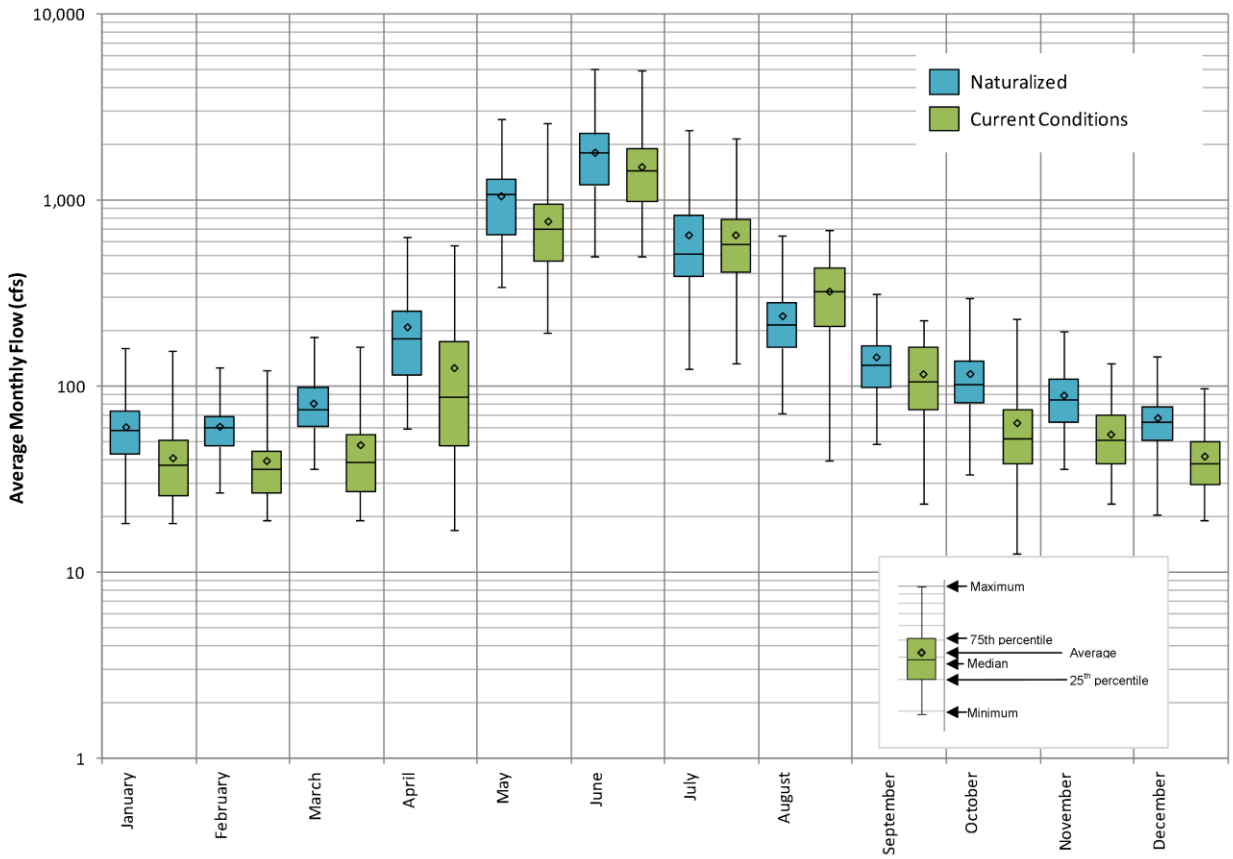
By any measure, these attributes are heavily disturbed throughout the mainstem, and any method of river condition assessment that is based on disturbance would ascribe a low ranking to river condition. That is not to say that the Poudre River no longer contributes to the environmental functions and economic and social values of the region; just that these functions and values, at least the environmental functions that depend on physical condition, are considerably compromised by historical human impacts (Wohl 2005).

3.4.2.1 Hydrologic Impact of Past Water Resources Development

Just as the river has facilitated and guided the last two centuries of settlement and development in the region, the current state of the river has been and is, in turn, heavily influenced by the effects of that development. Dominant among the effects of development is the impact on the river of the numerous projects that over a century and a half have impacted the hydrology of the watershed by developing water resources for agricultural, domestic and industrial use.

The net effects of past water resources development, combined with operation and management strategies, have been illustrated by comparing current flows to those that would have occurred naturally without transbasin imports/diversions or diversions from the river. Figure 3-27 provides data developed at the Canyon Gage to emphasize the change in flow regime from natural to current conditions.

Figure 3-27. Monthly Flows at Canyon Gage: Naturalized and Current Conditions (1950-2005).



3.4.2.2 Anthropogenic Influence

Throughout the mainstem, but concentrated near the urban areas, there are numerous other examples of extreme anthropogenic influence on stream morphology. These include: planform changes upstream of Mulberry (Fort Collins) and downstream of Windsor, channelization associated with gravel extraction near Fort Collins and Windsor and throughout the Greeley

Channelized Reach; floodplain encroachment and levees; straightening, dredging and constrictions associated with road and railway bridges and the direct influence of the numerous structures built across the river to divert water.

3.4.2.3 Morphologic Consequences of Past Development

The morphologic consequences of past development vary along the river, generally increasing in a downstream direction. The compilation of evidence indicates that this is not only because the effects of diversions on hydrology are cumulative downstream but also because stream morphology becomes more susceptible to reduced flows as the channel character changes downstream. These consequences of past development are reflected in the current trajectory of the morphologic and sediment transport conditions of the mainstem.

3.4.2.3.1 Supply-Limited and Transport-Limited Reaches

Even though diversions are concentrated in the Laporte and Fort Collins reaches, the impacts of diversions on the channel are currently more evident downstream of Timnath than upstream. Upstream, channel morphology is flood-dominated. The bed is armored with cobbles and coarse gravels that only move rarely in response to floods, flows cannot access the finer material beneath the armor layer, and the transport of sediment is limited by the amount of sediment supplied from upstream. Bars, islands and marginal deposits do form but signs of consistent, contiguous aggradation are not evident. Such a reach is described as "supply-limited."

Downstream of Timnath, where the bed is dominated by sands and small gravels, armoring becomes less common. In general, the finer sediments in the bed are accessible to the flow. The control on sediment transport shifts so that it is mainly limited by transport capacity, and as such is defined as "transport-limited." Aggradation in a transport-limited system is inherently more sensitive to changes in hydrology than in a supply-limited system because its behavior is controlled by the hydraulics of the system rather than by sediment supply (Gordon 1995).

3.4.2.3.2 Bio-geomorphic Feedback

Further compounding the difference in response between upper and lower reaches of the river is the bio-geomorphic feedback loop, which appears to be more prevalent in the lower reaches. Vegetation (particularly reed canarygrass) colonizes rapidly in areas of deposition at or near water level throughout the lower river system (ERO 2012b). The rapid spread and vigorous growth of this species is probably encouraged by sustained summer water levels associated with return flows from irrigated areas. In their investigation of a similar phenomenon, the Platte River Recovery Program has demonstrated that reed canarygrass will bend and streamline in response to high flows. The rhizomes are highly resistant to uprooting and scour (Pollen-Bankhead, Thomas, & Simon 2011). In the lower Poudre River, this pattern has been confirmed by observations before and after the 2010 flood when there was little evidence of scour of reed canarygrass (ERO 2010c). Instead, even where some of the upper part of the plant was lost, the root mass remained and has now regrown without significant loss of the deposited material. Stands of reed canarygrass are observed to encourage a bio-geomorphic feedback loop of colonization and channel contraction that then encourages further deposition, further vegetation and so on.

3.4.2.3.3 Rates of Change

Sediment modeling together with historical comparisons and recent observations suggest that despite the gross historical changes in hydrology, the overall process of channel contraction remains gradual throughout the mainstem – with changes, where they are observed at all, occurring on a time scale of decades rather than years. In general, the rate of change is probably limited by supply of available sediment in the fractions that are of a size that will deposit. Encroachment by vegetation tends to facilitate and accelerate channel change as observed in the reaches below Timnath.

3.4.2.3.4 Trajectory of Changes

The above discussion is not meant to imply that there are no consequences of hydrologic change in supply-limited reaches such as the Fort Collins and Laporte Reaches. Localized deposits of sands and gravels are still observed in those reaches forming bars and islands. There are also sands, silts and muds evident on the cobble bed. These deposits are spatially discrete, but vegetation is observed to colonize on some deposits potentially reducing channel conveyance through marginal encroachment and contraction. While a consistent depositional trend has not emerged here as it has further downstream, this does not obviate the potential for localized channel contraction under a continuation of current conditions hydrology, or the possibility that contraction could become more extensive in these reaches if an extrinsic or intrinsic threshold is reached.

3.4.2.3.5 Extrinsic and Intrinsic Thresholds and Nonlinear Response

While historic response (trajectory) provides probably the best indicator of dominant morphologic processes, it is also clear that, just because channel contraction has not occurred at a location in the past does not mean it will not occur in the future, even with a continuation of the same flow regime. River response to the impact of water resources development is nonlinear. The processes that link stream morphology to system hydrology are nonlinear response functions. In other words, a progressive change in hydrology is unlikely to produce a correspondingly progressive or immediate change in stream morphology. The natural system is often able to accommodate considerable change in its controlling parameters without a consequential response, until some threshold is reached beyond which major response is initiated. For instance, in a flood dominated regime, channel change only occurs once the flows are big enough to cause movement of the bed or banks; or in a potentially aggrading reach, progressive reductions in the frequency of flushing flows may not initiate channel contraction until a threshold is reached where the time between flushing flows allows vegetation to establish to the point that it resists further removal by flow.

In addition to these *extrinsic* thresholds, crossed as the result of a change in an external parameter such as hydrology, Schumm (1974) identified that *intrinsic* thresholds can also be crossed, leading to a channel response that is not directly related to an external change. Applying this to the mainstem, even if there is no further change in channel hydrology, it is possible that changes already occurring in the system may reach an internal threshold and lead to a new or an accelerated response. The likelihood of such non-linear response thresholds can be elucidated by observation or space for time substitution but accurate prediction is generally

beyond current analytical techniques. For example, the influence of progressive invasion of a particular vegetation species (reed canarygrass) on the occurrence and rate of aggradation has been observed downstream of I-25. This certainly alerts us to the possibility that the same process could also lead to a tipping point upstream. However, whether or when it might occur, what influence it will have, or whether other as yet unidentified step changes could dominate, is not readily predicted using deductive processes.

3.4.2.4 Morphologic and Sediment Transport Conditions Upstream of I-25

Stream morphology in the upstream reaches from the canyon through Fort Collins to the vicinity of I-25 is a flood-dominated morphology (Section 3.4.2.3). The channel is highly variable through the Laporte and Fort Collins Reaches with bankfull discharge varying from around 1,000 cfs to over 20,000 cfs in these reaches. River channel change occurs episodically during large flow events, which are the flows capable of moving the material that forms the bed. Episodes of bed movement appear to be rare in time and discrete in space.

The river bed in this reach varies from cobbles to gravels. There is a variety of channel patterns from straight to meandering and even a short section upstream of Mulberry Street that is almost braided. In-channel features include pools and riffles, point bars, mid channel bars and bank attached side bars. Some mid channel bars have formed into islands. There are bedrock runs as far downstream as Lincoln Avenue in Fort Collins. Floodplain features include meander cutoffs, terraces, anabranches and abandoned channels. Riparian vegetation is discontinuous but in places occupies all the lower terraces. Natural features are supplemented by man-made weir pools, weir chutes and free overfalls. The high variability through this section of river makes for significant channel complexity providing a large range of biotopes.

The stability of bed material, except during floods, is supported by observation. During a major flow event, an episode of bank erosion or a localized break in the armor layer could trigger a localized change in the location, size or character of the channel. Such channel change could be caused or exacerbated by episodic influxes of sediment from the canyon upstream, which would deposit progressively downstream causing channel aggradation, bars or islands and consequent bank erosion and channel movement. There is isolated on-ground evidence of such occurrences (e.g., behind the Laporte elementary school or between Shields Street and College Avenue) but this evidence is several years old and there were no further examples observed during the 2010 peak flows. Once a flood is over, further channel change would be slow – if at all, and the bed and banks soon restabilize.

It might be expected that during lower flows, gravels and sands that are smaller than the critical size for the threshold of motion would start to deposit in these reaches. Indeed, some accumulations are seen, but only in isolated locations such as the downstream end of bars and lee side deposits behind obstructions – or where hydraulic conditions are controlled by a downstream diversion structure. It seems apparent that deposition of material is limited and localized because of the very high sediment transport potentials that are shown throughout this reach. In other words, channel hydraulics dictate that even non-flood flows are capable of moving most of the sands and gravels that are available to the system from upstream or from

local erosion and sediment sources. There are no available measurements of sediment inflow to the reach but the ubiquitous armor layer in this part of the river is indicative of a flood-dominated morphology where sediment supply is generally less than sediment transport capacity.

Some bars and islands in the reach are colonized by vegetation, and vegetation encroaches on channel margins and terraces, particularly in weir pools or in the multi-channel section upstream of Mulberry Street. Instances of deposition of fine sediments on channel margins and in lee side deposits have increased since the wildfires in the watershed in 2012; however much of this fine material was removed during the flooding in September 2013. Nevertheless, the weight of observational and historic evidence suggests that deposition and channel contraction associated with vegetation encroachment is spatially discrete and that the bio-geomorphic feedback loop is only weakly established. Evidence for this includes the historic photographs, bridge cross sections and specific gage plots, which show examples of increased vegetation but no contiguous channel contraction trend. This situation could change if reed canarygrass were to become dominant in this section of river.

While ecological functions and recreational and aesthetic values have likely suffered through much of this reach because of heavy anthropogenic influences, there is no clear observational or analytical evidence of a continuing trajectory of morphologic change that would reduce channel complexity. Detailed sediment modeling in this reach of river shows no loss of pool-riffle sequences. Similarly, observation and historical comparisons do not reveal consistent morphologic trends toward loss of complexity.

Occasional flushing of fines from the river bed is of environmental benefit: it prevents filling of interstices, strips algae and generates habitat opportunity for macro-invertebrates. The analytical results, based on a criterion by Milhous (1998), suggests that under current conditions, sufficient movement of bed material to release fines from the bed material matrix is generated throughout much of the reach at least part of the time.

Broadly, for the reasons discussed above, channel change in the existing river condition is as much a consequence of direct interference in the river (gravel extraction, floodplain encroachment, realignment, channel modification, structures, etc.) as it is a consequence of hydrologic change. The trajectory for the channel upstream of I-25 under current conditions is a continuation of spatially discrete episodes of alignment and profile instability during short periods of unusually high flow with prolonged periods of relative stability at other times. Particular areas, such as upstream of Mulberry are vulnerable to such change.

Despite the relative stability of the existing condition, there is still a propensity to aggradation, limited in the current condition by the availability of incoming sediment compared to the ability of the channel to transport it. Deposition and vegetation encroachment will continue in discrete areas – probably at a similar rate to the current unless some unpredicted intrinsic threshold is reached or some other change occurs such as an invasion of reed canarygrass or a substantial increase in sediment supply from upstream sources. Localized areas of bank erosion will continue, especially during larger flow events.

3.4.2.5 Morphologic and Sediment Transport Conditions Downstream of I-25

Downstream of I-25, the existing channel is observed to be depositional with the majority of the channel showing evidence of ongoing channel contraction by aggradation and narrowing, associated with encroachment of vegetation. While by no means definitive, the various strands of historical evidence support this general observation. Of course there are numerous exceptions to the generality – most notably the heavily modified Greeley Channelized Reach.

The channel characteristics are less variable downstream of I-25 than upstream. Channel size and capacity reduce progressively in a downstream direction except for the Greeley Channelized Reach, which stands out in this comparison as having high hydraulic depth and high bankfull discharge.

With depositional morphology, river channel change is expected to be progressive and less dominated by floods than the upstream section of river. Episodes of bed movement are common in both time and space.

The river bed in this section of river comprises gravels and coarse sands. The channel pattern is meandering except where it has been artificially straightened. In-channel features other than the pool-riffle sequence are limited to depositional features such as point bars, mid channel bars, bank attached side bars and islands. Floodplain features include meander cutoffs, terraces and abandoned channels. Riparian vegetation is discontinuous. The Greeley Channelized Reach is devoid of natural channel features. Despite the range of features elsewhere, there is a degree of uniformity to the channel that reduces the heterogeneity of biotopes.

The analytical results show a several-fold decrease in sediment transport potential downstream of I-25. In contrast to the river upstream of I-25, sands and gravels that have moved through the upstream reaches are in greater supply relative to the more limited transport capacity of the river. No continuous armor layer is present. Sediment behavior downstream of I-25 moves toward transport-limited characteristics.

One-dimensional sediment modeling supports the current broad aggradational trend in this section of river, suggesting net bed material deposition at all modeled sites. There is a tendency for the smaller bed material fractions to build a very small secondary channel within the larger historic channel. Some indication of this can be observed at numerous locations downstream of I-25.

Channel contraction is dependent on the same set of constraints that have been described for the reaches upstream of I-25: the sediment must be available in sufficient quantities for it to deposit and effect channel change. In the case of the reaches downstream of I-25, vegetation also appears to play a significant role in realizing channel change. In particular, encroachment of reed canarygrass has an important influence on channel morphology downstream of I-25, it creates a powerful bio-geomorphic feedback loop that accelerates channel contraction (Section 3.4.2.3.2).

There is observational and analytical evidence of an ongoing loss of channel complexity in this section of river. This is in addition to the obvious loss of channel complexity associated with the major straightening efforts that have affected this section of river.

Downstream of I-25, the flushing of fines is less relevant because an armor layer is not generally present and bed material is prone to frequent movement. Flows capable of flushing fines from within interstices in the bed material matrix occur regularly through this section of river – except for the Greeley Channelized Reach, where bed material is coarser and less prone to movement**.**

Ongoing channel contraction and related vegetation encroachment will continue to increase flood risk under baseline conditions. This has been recognized by the U.S. Army Corps of Engineers (OtterTail 2010) in their investigation of flooding in the vicinity of Greeley.

There are two main reasons why the trajectory for the river downstream of I-25 is different from the trajectory for the river upstream.

- Under current conditions, sediment transport in the upstream section is supply-limited whereas sediment transport in the downstream section tends toward transport-limited behavior. A transport-limited system is more sensitive to changes in hydrology because its behavior is controlled by the hydraulics of the system rather than by sediment supply.
- Under baseline conditions, downstream of I-25, vegetation (reed canarygrass in particular) is playing a dominant role in channel contraction processes. Even temporary deposition of material at or near the water surface allows rapid establishment of vegetation, which then encourages further deposition and so on.

The broad prognosis for the channel downstream of I-25 is a continuation of the current aggradational trend. Deposition of sands and fine gravels will continue in preferential zones; narrowing riffles, forming bars and islands and gradually accreting from the toe of banks. In many places this will result in a narrow secondary channel, probably 10 to 20 feet wide, formed by slow terracing within the larger historic channel. Progress is gradual, limited by constraints in sediment supply. The river is not truly transport-limited for all size fractions, otherwise pools would fill with sediment and channel change would be rapid. The process is heavily influenced by vegetation, which stabilizes recently deposited material near water level and then provides the hydraulic conditions to encourage further deposition. Vegetation is probably encouraged by long periods of constant water levels from return flows.

Floods and high flows will occasionally disrupt the channel contraction trend, partially stripping vegetation and mobilizing bed material. Evidence from comparable systems, e.g., the Central Platte River (Pollen-Bankhead, Thomas, & Simon 2011) suggests that wholesale removal of vegetation is unlikely and if the time between scouring flows is sufficient for the vegetation to become established, it will resist removal and continue to stabilize deposits. This behavior is supported by observation in the mainstem below I-25.

A trend of ongoing channel contraction and loss of channel complexity in the mainstem downstream of I-25 characterizes the current condition of the river and is already adversely impacting riverine functions. The trend represents the response of the river to a myriad of changes in the watershed over the last two centuries. The trend of channel contraction and loss

of channel complexity is projected to continue under a continuation of current conditions hydrology.

Table 3-19 presents a summary of key Current Conditions characteristics for channel morphology and sediment transport for the mainstem.

3.4.3 South Platte River

Stream morphology of the South Platte River is described in Section 3.4.1 of the DEIS. More detailed information can be found in the South Platte River Stream Morphology Report (ERO 2008a).

Table 3-19. Summary of current conditions channel morphology and sediment transport analyses for the Poudre River mainstem.

Analysis	Current Conditions Results				Impact Indicator
Hydrologic Regime	Hydrologic computations for current conditions hydrology is spatially varied along the 60-mile study reach (with some computations computed at as many as 48 locations). See Chapter 5 of the 2013 Stream Morphology Baseline Report (ACE 2013) for full detailed data. Shown at right is the range of seasonal mean daily discharge, 2% exceedance discharge, and 10-year flood discharge computed along the study reach above and below I-25.	**Hydrologic Computation**	**Above I-25 (cfs)**	**Below I-25 (cfs)**	**Change in Flow Regime**
		Mean Daily Discharge - October through February	2 to 56	39 to 130	
		Mean Daily Discharge - March through April 15	8 to 75	63 to 170	
		Mean Daily Discharge - April 16 through July 15	361 to 1,033	364 to 535	
		Mean Daily Discharge - July 16 through September 30	11 to 401	17 to 136	
		2% Exceedance Discharge	1,603 to 2,315	1,674 to 1,812	
		10-Year Flood Discharge	3,337 to 4,122	4,308 to 4,595	
Flushing of Fines	Flushing of fine material from the bed was analyzed at 407 cross section locations within the mainstem. Under the Current Conditions hydrologic regime, flushing of fine material from the bed occurs at 237 cross sections (103 cross section upstream of I-25, and 144 cross sections downstream of I-25). Flows that flush fines from the bed are highly varied in magnitude and spatial distribution due to hydraulic conditions present at each of the cross sections in the river. The value, duration, and spatial variability of flushing flows are discussed in Section 7.2 and shown graphically in Figure 7.5 of the 2013 Stream Morphology Baseline Report.				**Fining of Surficial Material**
Flushing of Fines Spells	Spells of flushing flows were evaluated at specific reach representative cross sections (10 cross sections upstream of I-25 and 5 cross sections downstream). Upstream of I-25, the flow required to flush fines ranged from 1,115 cfs up to 9,260 cfs. Under Current Conditions hydrology, flushing events occurred between 0 and 23 times with an average event duration ranging from 0 to 14 days. Downstream of I-25, flushing flows at reach representative cross sections range from 10 to 3,892 cfs. Flushing events occurred between 2 and 176 times under Current Conditions hydrology with average event duration ranging from 13 to 96 days. More specific information is provided in Section 5.5.1, Table 5.5, and Figure 5.6 of the 2013 Stream Morphology Baseline Report.				
Movement of Bed Material	Movement of bed material was analyzed at 407 cross section locations along the mainstem. Under the current conditions hydrologic regime, bed material is mobilized at 57 cross sections upstream of I-25 (28%) and 121 cross sections downstream (60%). Flows that initiate movement of bed material are highly varied in magnitude and spatial distribution due to hydraulic conditions in the river. The value, duration, and spatial variability of flows that move bed material are discussed in Section 7.1.5 and shown graphically in Figure 7.4 of the 2013 Stream Morphology Baseline Report.				**Loss of Morphologic Complexity**
Movement of Bed Material Spells	Movement of bed material spells were evaluated at specific reach representative cross sections (10 cross sections upstream of I-25 and 5 cross sections downstream). Upstream of I-25, the flow required to initiate movement of bed material ranged from 2,208 cfs up to >10,000 cfs. Under Current Conditions hydrology, events of bed material movement occurred between 0 and 12 times with an average event duration ranging from 0 to 9 days. Downstream of I-25, flows that move bed material at reach representative cross sections range from 260 to 5,344 cfs. Events of bed material movement downstream of I-25 occurred between 2 and 98 times under Current Conditions hydrology with average event duration ranging from 3 to 16 days. More specific information is provided in Section 5.5.1, Table 5.6, and Figure 5.6 of the 2013 Stream Morphology Baseline Report. Changes in the frequency and duration of movement of bed material may result in loss of morphologic complexity.				
Sediment Transport Potential	Reach-averaged sediment transport potential under Current Conditions was computed along the mainstem, see Section 8.1.2 of the 2013 Stream Morphology Baseline Report. Total sediment transport potential upstream of I-25 ranges from 10,000 tons/year (9,000 tons/year of sands and 1,000 tons/year of gravels) to 430,000 tons/year (275,000 tons/year of sands and 155,000 tons/year of gravels). Downstream of I-25 total sediment transport potential ranges from 13,000 tons/year (9,000 tons/year of sands and 4,000 tons/year of gravels) up to 48,000 tons/year (45,000 tons/year of sands and 3,000 tons/year of gravels). Note that sediment transport potential represents the amount of sediment that could be moved *if it were available to be moved*, but takes no account of assumptions about limitations in sediment supply. The reach upstream of I-25 has been identified as supply-limited.				**Channel Contraction**
Sediment Transport - Effective Discharge	A magnitude frequency analysis of sediment transport was conducted to evaluate how sediment transport potential varies across the flow range when combined with flow frequency. The analysis results in a set of curves that indicate the effective discharge (see Section 8.1.3 in the 2013 Stream Morphology Baseline Report). The curves indicate the flows that would be most effective at moving sediment in a given reach *if* sediment were available for transport. Upstream of I-25, the curves show an effective discharge between 800 and 2,200 cfs (see Figure 8.2 and Section 9.2.2 of the 2013 Stream Morphology Baseline Report). Downstream of I-25, the effective discharge is generally around 2,200 cfs; however, there is a second peak in the curves occurring between 30 and 350 cfs (see Figure 8.2 of the 2013 Stream Morphology Baseline Report). Double-peaked curves indicate a two-stage compound channel geometry, and when combined with vegetation encroachment and observed deposition indicates that the current trajectory of the river downstream of I-25 is trending towards channel aggradation and contraction (see Section 9.3.1 of the of the 2013 Stream Morphology Baseline Report).				

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3.5 GROUND WATER

3.5.1 Overview

This section provides updated information on existing ground water resources in the study area. The study area includes the Poudre mainstem, the South Platte River from its confluence with the Poudre River to the Kersey Gage, and the locations of the proposed Glade, Cactus Hill, and Galeton Reservoirs. Ground water resources evaluated include alluvial and shallow bedrock aquifers. Studies subsequent to the DEIS included the installation and monitoring of ground water monitoring wells at six study sites along the Poudre River. This hydrologic study is summarized in Section 3.5.3.4. Alluvial ground water levels were used to describe current conditions for riparian and wetland resources along the mainstem, and information on observed alluvial ground water levels is presented in Section 3.9.5.4. Additional information about ground water can be found in the 2012 Ground Water Technical Report (ERO 2012b), and the 2012 Water Quality Baseline Report (ERO 2012a).

3.5.1.1 Ground Water Quality Standards

The WQCC has adopted ground water classifications and water quality standards for such classifications to protect existing and potential uses of ground water (CDPHE 2009). Ground water is classified as "Domestic Use – Quality" if ground water is used for domestic use within a specified area, or is classified as "Agricultural Use – Quality" if ground water is used for agricultural use within the specified area. In an area where ground water is not used for domestic or agricultural purposes, it is classified as "Potentially Usable Quality" if total dissolved solids (TDS) concentrations are less than 10,000 mg/L, but ground water concentrations exceed human health and agricultural standards; or is classified as "Limited Usable Quality" if TDS concentrations exceed 10,000 mg/L. Water quality standards for TDS in ground water are based on background TDS values. If the background value is 500 mg/L or less, the standard is 400 mg/L or 1.25 times the background level, whichever is the least restrictive. For background values of 501 to 10,000 mg/L, the standard is 1.25 times the background value, and if the background value exceeds 10,000 mg/L, there is no ground water TDS standard (CDPHE 2009). Ground water also may be classified as "Surface Water Quality Protection" within a specified area when a human activity impacts ground water such that surface water quality standards are exceeded. Within the study area, ground water is used for both domestic and agricultural use; therefore, both human health and agricultural water quality standards apply. The numeric standards for ground water are provided in Table 3-20.

Table 3-20. Numeric ground water standards.

Parameter	Standard	Parameter	Standard
Domestic		**Agricultural**	
Total coliforms, #/100 mL (30-day avg/30-day maximum)	2.2/23	Aluminum, dissolved, mg/L	5
Arsenic, dissolved, mg/L	0.01	Arsenic, dissolved, mg/L	0.1
Cadmium, dissolved, mg/L	0.005	Cadmium, dissolved, mg/L	0.01
Chromium, III and VI, dissolved, mg/L	0.1	Chromium, dissolved, mg/L	0.1
Lead, dissolved, mg/L	0.05	Copper, dissolved, mg/L	0.2
Mercury, dissolved, inorganic, mg/L	0.002	Iron, dissolved, mg/L	5
Nitrate, dissolved, mg/L	10	Lead, dissolved, mg/L	0.1
Nitrite, dissolved, mg/L	1	Manganese, dissolved, mg/L	0.2
Selenium, dissolved, mg/L	0.05	Mercury, dissolved, mg/L	0.01
Silver, dissolved, mg/L	0.05	Nitrite, dissolved, mg/L	10
Chloride, dissolved, mg/L	250	Nitrate + Nitrite, dissolved, mg/L	100
Copper, dissolved, mg/L	1	Selenium, dissolved, mg/L	0.02
Iron, dissolved, mg/L	0.3	Zinc, dissolved, mg/L	2
Manganese, dissolved, mg/L	0.05	pH	6.5 – 8.5
pH	6.5 – 8.5		
Sulfate, dissolved, mg/L	250		
Zinc, dissolved, mg/L	5		

Source: CDPHE 2009.

3.5.2 Proposed Reservoir Sites

3.5.2.1 Glade

Ground water quality data available from the USGS was considered from wells located south of the Glade Reservoir site that range in depth from 20 to 44 feet below ground surface (bgs). Ground water quality in these wells is characterized as being very hard and somewhat mineralized. The pH of the ground water is neutral to alkaline (7 to 9). The dominant anion is bicarbonate and the dominant cation is calcium. Total organic carbon concentrations are low, and selenium concentrations range from below the detection limit to 0.005 mg/L. Nitrate concentrations vary widely (0.03 mg/L to 3.7 mg/L) based on location. Additional information on Glade Reservoir ground water can be found in Section 3.7.1 of the DEIS. Information on the TCE plume located within the proposed Glade Reservoir study area can be found in Section 3.21.2.1 of the SDEIS.

3.5.2.2 Galeton

USGS ground water quality data was considered from wells located within a few miles east or southeast of the Galeton Reservoir site that range in depth from 20 to 25 feet bgs. Ground water quality data was also collected from wells installed as part of NISP surveying near the proposed Galeton Reservoir Dam site that range in depth from 40 to 55 feet bgs. The pH of the ground water is neutral to alkaline, ranging from 7.5 to 8.5, and the specific conductivity ranges from 1,200 to 3,200 µS/cm. The dominant cation is sodium, with lesser amounts of calcium and magnesium. The ground water is extremely hard, ranging from 530 to 1,100 mg/L. The dominant anion is sulfate, with some bicarbonate and chloride. Nitrate concentrations vary

widely based on location, ranging from below the detection limit to about 22 mg/L, which exceeds the ground water nitrate standard. The selenium concentration is about 4 µg. Additional information on Galeton ground water can be found in Section 3.7.3 of the DEIS. Information on the oil and gas wells located within the proposed Galeton Reservoir study area can be found in Section 3.6.2.2 and Section 3.21.2.2 of the SDEIS.

3.5.2.3 Cactus Hill

Ground water quality data available from the USGS was considered from wells located within a few miles southeast or southwest of the Cactus Hill Reservoir site that range in depth from 15 to 150 feet bgs. Ground water quality in these wells is characterized as being high in dissolved solids (particularly the shallower wells), very hard, and with high sulfate concentrations. The pH of the ground water is neutral to somewhat alkaline (7 to 8). The dominant anion is sulfate, and the dominant cation is calcium. Nitrate concentrations range from below the detection limit to more than 40 mg/L, and selenium concentrations range from 0.005 to nearly 0.02 mg/L. Additional information on Cactus Hill ground water can be found in Section 3.7.2 of the DEIS.

3.5.3 Poudre River

Through the entire reach of the river, the river gains ground water from bedrock formations because the river is the topographic low area, and in general, ground water moves from areas of higher elevation to areas of low elevation (more specifically, from areas of high hydraulic pressure to areas of low hydraulic pressure) (ERO 2012b). The alluvium beneath and adjacent to the Poudre River is normally saturated because it is perched on the low permeability marine shales and is hydraulically connected to the river. As a result of the numerous active, inactive, and buried channels within the broad floodplain of the Poudre River there is great variation in grain size (and therefore hydraulic conductivity). The river loses water to alluvial ground water where the river crosses very permeable former channels and regains that water when the river crosses former channels farther downstream (ERO 2012b).

The course of the Poudre River can be divided into two distinct geographical areas:

- From the uppermost tributaries of the Poudre River to the canyon mouth, the river flows within relatively narrow canyons eroded into Precambrian metamorphic rocks; the only exception is the area at the canyon mouth where the river flows through several steeply dipping sedimentary formations.
- Between the canyon mouth and the confluence with the South Platte River, the Poudre River flows within a broad channel incised primarily in marine shales and sandstones. The incised channel is filled with alluvium varying in thickness from less than 10 feet (at Archery Park north of East Horsetooth Road) to more than 100 feet east of Greeley and is made up of sand, gravel, clay, and silt (Topper et al. 2003).

Ground water discharge to the Poudre River, derived from the percolation of precipitation, leakage from ditches, reservoirs, and streams, and the percolation of irrigation water from farm

fields, is a major source of water to the Poudre River, particularly east of I-25 (ERO 2012b). As a result of contacting the marine shales and areas where fertilizers are applied, shallow ground water flowing toward the Poudre River typically contains elevated total dissolved solids and nutrient concentrations. The dissolved elements and compounds in the bedrock ground water are reflective of the chemical nature of the marine sediments, which contribute calcium, sulfate, iron, magnesium, and selenium, as well as other metals and compounds in lesser amounts to the ground water. Because of ground water discharge to the river and its alluvium between the canyon mouth and the confluence with the South Platte River, the water chemistry of the river and alluvial ground water is influenced by the water chemistry of the bedrock ground water.

3.5.3.1 Upstream of the Canyon Mouth

In the Poudre River above the canyon mouth, relatively thin alluvium overlies Precambrian metamorphic rocks. Ground water flow within the metamorphic rocks is restricted to fractures and joints in the otherwise very low permeability rock. Along the Front Range, ground water in Precambrian metamorphic rocks is generally considered to be of good quality, usually with total dissolved solids of less than 500 mg/L (Topper et al. 2003). The bedrock ground water is typically calcium bicarbonate water, but the dominant ions may vary somewhat from area to area. In the Poudre Canyon, ground water from the Precambrian rocks discharges to the alluvium along the river channel (ERO 2010a).

Despite the discharge of bedrock ground water to the alluvium, the water quality of the alluvial ground water is likely dominated by the water quality of the river. This is primarily because the contribution of bedrock ground water is relatively small due to the low permeability of the bedrock compared to the relatively large flow in the generally high permeability alluvium. During periods of low flow in the river, alluvial water quality may start to show similarities to that of the bedrock water quality downstream of higher bedrock flow areas, such as a fault or highly fractured zone. However, within the canyon, the contrast between river water and bedrock ground water may not be sufficiently large for this change to be detectable.

The quality of the shallow alluvial ground water is generally excellent, although hard, with low dissolved solids and nutrient concentrations. In general, metal concentrations are low, but dissolved iron and manganese concentrations are sometimes high where water quality is more highly influenced by ground water from bedrock fractures.

3.5.3.2 Canyon Mouth to the Confluence with the South Platte River

Between the canyon mouth and the confluence with the South Platte River, the Poudre River flows within a broad channel incised primarily in marine shales and sandstones. The incised channel is filled with alluvium varying in thickness from less than 10 feet to more than 100 feet east of Greeley and is comprised of sand, gravel, clay, and silt (Topper et al. 2003). Ground water in the marine shales and sandstones and the overlying soils and weathered bedrock flows from the higher areas on either side of the Poudre River toward the Poudre River and river

alluvium. The source of the bedrock ground water is infiltration of precipitation and irrigation water over much of the area on either side of the river.

As a result of contacting the marine shales and areas where fertilizers and other chemicals are applied, shallow ground water flowing toward the Poudre River typically contains elevated cation and anion concentrations (such as calcium, sodium, sulfate, and chloride) and dissolved nutrients. The dissolved elements and compounds in the bedrock ground water are reflective of the chemical nature of the marine sediments. Specifically, the marine sediments contribute calcium, sodium, sulfate, iron, magnesium, and selenium, as well as other metals and compounds in lesser amounts to the ground water. Agricultural use of lands containing elevated concentrations of naturally occurring selenium increases the rate of weathering and dissolution of selenium to the environment due to the increased volume of applied water and the use of nitrogen-based fertilizers. Selenium oxidation and mobilization increases as a function of nitrate concentration (ERO 2010b).

Previous studies have indicated that ground water may be a source of nutrients and/or pesticides to streams during low flow conditions (McMahon et al. 1994). Near Greeley, ground water adjacent to the river has been shown to have much higher nitrate and atrazine (an agricultural pesticide) concentrations than the Poudre River.

In samples collected in ground water wells at the Poudre River study sites, there is a transition from lowest to highest TDS concentration, with the lowest in the river and the highest in the well farthest from the river (ERO 2012a). This trend in TDS concentrations along the transects is indicative of recharging bedrock ground water mixing with lower TDS concentration river and alluvial ground water.

Bedrock ground water discharge to the Poudre River channel and its floodplain between the canyon mouth and the confluence with the South Platte River strongly influences the water chemistry of the alluvial ground water. TDS concentrations in alluvial monitoring wells increase down river. Correspondingly, the dominant dissolved cations and anions also change from calcium or sodium bicarbonate within the canyon to calcium sulfate downstream of the canyon.

3.5.3.3 Relationship between Surface and Ground Water along the Poudre River

The water quality of the Poudre River and river alluvium at lower flow is controlled by the water quality of shallow bedrock ground water. This relationship also is true during spring runoff, but to a lesser degree. For shallow bedrock ground water quality to exert such control over the river and alluvial ground water chemistry, there has to be significant ground water discharge to the river along the reach between the canyon mouth and the confluence. Water quality sampling of the river and alluvial ground water indicates that ground water recharge to the river and alluvium, particularly starting at about Boxelder Creek near I-25, is a large proportion of the total flow in the river downstream of the canyon mouth. This is most true during lower river flows, which generally occur after spring runoff, but also can occur during spring runoff due to numerous surface diversions from the river.

In 1884, the Agricultural College in Fort Collins performed an experiment along the Poudre River to quantify the amount of ground water discharging to the river between the canyon mouth and Greeley. As part of the experiment, all diversions and return flows to the river were turned off along this reach, and the river flow was carefully measured at the canyon mouth and at Greeley. The College documented that the river gained 86 cfs between the canyon mouth and Greeley, all of which was attributed to gains from ground water (Laflin 2005). At present, there are numerous dry-up points in the Poudre River due to large surface diversions that take nearly all of the river flow during the irrigation season and/or the winter months. Where there are no large surface discharges (such as the Charles Hansen Canal), the river flow increases below these dry-up points are due primarily to ground water recharge. Bedrock ground water discharge to the river and alluvium is very likely not distributed uniformly along the entire reach of the Poudre River below the canyon mouth due to natural variability in bedrock permeability, bedrock depth and thickness where it contacts the river channel, and variability in infiltration of water from the land surface (precipitation and irrigation).

Ground water recharge is likely greater in the vicinity of tributaries to the Poudre River, such as Boxelder Creek, where ground water from tributary channels flows into the Poudre River Basin (Topper et al. 2003). The rapid increase in TDS, sulfate, sodium, and other concentrations downstream of Fort Collins suggests that shallow ground water contributions to the river are greater downstream of Fort Collins than upstream of Fort Collins. The water quality of the Poudre River seems to reach an equilibrium east of Greeley. The "equilibrium" may be the result of the river and alluvial ground water reaching concentrations similar to that of the shallow bedrock ground water, thus concentrations do not continue to increase. Another explanation for why the river does not appear to further degrade east of Greeley (and to a certain extent, improves) may be because bedrock is more deeply buried under surficial deposits (such as nearly 120 feet of alluvium). Unlike upstream, where the depth to bedrock is much shallower, the bedrock water quality may have less influence on the water quality of the alluvial water adjacent to the river and the quality of the river. In addition, just upstream from Greeley, the bedrock changes from predominantly marine shale to nonmarine deposits, such as sandstone, which would result in generally lower TDS contributions to ground water from bedrock.

Comments on the DEIS suggested that the Poudre River loses water and recharges the mountain front as the water leaves the relatively narrow canyon upstream of the canyon mouth. The hydrogeology of the mountain front of the Poudre River is very different from those of the two study areas referenced in comments on the DEIS (Covino and McGlynn 2007; Niswonger et al. 2005). The additional studies and investigations performed for the SDEIS along the Poudre River support the conclusion that the Poudre River does not lose water to the mountain front, but rather gains water from the surrounding bedrock. Surface water that may be lost to the alluvium after the river leaves the canyon does not appear to leave the drainage, but rather returns to the river along former flow channels, and is not lost from the river system. Hydrogeologic conditions at the mountain front of the Poudre River are discussed in more detail in the Ground Water Technical Report (ERO 2012b).

3.5.3.4 Poudre River Study Sites

As discussed in detail in the Ground Water Technical Report (ERO 2012b), transects at the six Poudre River study sites (Figure 3-4) between the canyon mouth and east of Greeley were established to investigate the relationship between surface and ground water along the Poudre River. At each transect, a staff gage was installed in the river to measure and record river stage and numerous monitoring wells were installed in lines generally perpendicular to the river. Considerable water quality, water level and stage data were collected from these transects, beginning in spring/summer 2009 through 2011.

Water level observations at the six transects show a range of relationships between the alluvial ground water and river stage. At the upstream-most three Poudre River study sites (Watson Lake, Martinez Park, and Archery Park), the ground water levels indicate ground water from outside of the river channel is moving toward the river throughout the year. Although this flow path is somewhat complicated by what appears to be a former channel at the Watson Lake site, the general flow direction is toward the river. At these three sites, ground water levels are typically higher in elevation than that of river stage, but there are short periods when a rapidly rising river may exceed nearby ground water elevations, suggesting the alluvium receives recharge from the river during those periods. Ground water responses appear to lag by about 18 hours behind river stage. In these areas, if alluvium receives recharge from a rising river stage, the alluvium discharges this water back to the river within a very short period.

The hydrologic behavior at the three downstream Poudre River study sites (Eastman Park, 59th Avenue, and Bird Farm) is more controlled by the occurrence of large meanders and former channels, than by ground water flowing toward the river from outside of the river. This does not imply that the river does not receive ground water from outside of the channel, but rather its observation is an artifact of the well transect lengths compared to the width of the overall river channel and alluvium at these locations. The river is probably receiving ground water from outside of the river channel system, but it was not identified because of the transect lengths relative to the broad river channel and alluvium. At these three sites, river stage is typically higher in elevation than the alluvial ground water levels, with the exception of the Eastman Park site where ground water levels are influenced by artificial lakes and are at times higher than river stage.

In general, the flow direction at the Bird Farm site is from the river to the alluvium and the combined hydrographs of river stage and ground water levels indicate the systems are synchronized. At this study site the observed delay between river stage and ground water levels was about 9 hours. River water that appears to recharge the alluvium flows downstream along relatively short flow paths between an upstream arm of a meander and a downstream arm of a meander or toward a former meander that is connected to the river downstream of the ground water monitoring well transect.

3.5.3.5 Conceptual Model of Hydrogeology Study Area

Based on data and observations collected during the multi-year hydrologic study, the conceptual model of the hydrogeology study areas includes the following key characteristics:

The conceptual model of the hydrogeology study areas includes:

1. A channel incised in low permeability bedrock.
2. A channel filled with alluvium – thickness ranges from thin (10 feet or less, although areas of thicker alluvium may exist) in the mountainous portion of the river to moderately thick (120 feet) near the confluence with the South Platte River.
3. The river does not lose water to areas outside of its broad channel and floodplain.
4. The river temporarily loses water to cross cutting former channels and meanders within its floodplain.
5. The river gains water along its path from bedrock ground water discharge.
6. The water quality of the river is controlled or influenced (particularly during periods of low flow) by bedrock ground water quality.

The river and adjacent alluvium represent a dynamic hydrologic system that interacts intimately throughout the river system. The permeability of the river alluvium is sufficiently high that recharge to and discharge from the alluvium is very rapid, as established by considerable water level and river stage measurements at the six transect locations (ERO 2012b). During the high flow event of 2010, there were areas of overbank flooding in the lower reaches of the river (from the Eastman Park site downstream to the confluence with the South Platte River). The ground water monitoring during this period at the three downstream study sites did not identify any residual alluvial recharge that maintained elevated ground water levels beyond the period of high river stage (ERO 2012b). In other words, ground water discharge from the alluvium back to the river occurs soon after the recharging event, regardless of whether the recharge is the result of high river stage or overbank flooding.

3.5.4 South Platte River

Information on ground water in the South Platte River corridor from the confluence with the Poudre down to Kersey can be found in Section 3.7.4 of the DEIS.

3.6 GEOLOGY

3.6.1 Overview

This section describes existing geological resources in the NISP study area. These resources could be affected by construction of reservoirs, conveyance systems, and the U.S. 287 realignment. More detailed information is available in the Geological Technical Memorandum Review (GEI 2006a, 2006b, 2006c).

3.6.2 Proposed Reservoir Sites

3.6.2.1 Glade

The geology of the Glade Reservoir study area is described in Section 3.8.1 of the DEIS. The geology for the U.S. 287 study area is described in Section 3.27.2 of the DEIS.

Karst features (solution cavities) were reported in the Lower Ingleside Formation near the contact with the Morrison Formation during construction of the Monroe Canal Tunnel No. 3 (GEI 2006a). The features consist of isolated voids of up to 3 feet in average dimension with limited reported interconnectivity. The Lower Ingleside Formation has been mapped in the lower right abutment area of the proposed Glade Dam (GEI 2006a). Effects associated with Glade Reservoir construction relative to this formation are described in Section 4.6.3.1 of the SDEIS.

Seismic activity in the region is considered low to moderate and numerous north-northwest to south-southeast-trending faults bisect the region (CGS 1999; Braddock et al. 1998). The largest seismic event on record in Colorado occurred in 1882 and is estimated to have been located about 22 miles southwest of the study area in Rocky Mountain National Park at a magnitude of 6.6 (CGS 2002). Effects associated with Glade Reservoir construction relative to seismic activity are described in Section 4.6.3.1 of the SDEIS.

3.6.2.2 Galeton

The geology of the Galeton Reservoir study area is described in Section 3.8.3 of the DEIS. Since publication of the DEIS, oil and gas wells have been drilled within the Galeton Reservoir study area. As of December 2011, there were 39 producing wells and an additional 33 proposed wells on and within 0.5 mile of the proposed Galeton Reservoir site (ERO 2012c). The targeted oil and gas reservoirs are in the Lyons Formation at depths of about 9,000 to 10,000 feet, and the Codell and Niobrara formations, typically at depths of about 6,500 to 7,000 feet. Some hydrogeological fracturing (fracking) has occurred in the Lyons Formation, but fracking was not used at all locations. Because of the nature of the Codell and Niobrara formations, fracking appears to have always been used to increase production at all well locations in these formations. Information on oil and gas well drilling activities at Galeton will be updated for the FEIS.

Information on spills or incidents within the study area that resulted in remedial activities can be found in Section 3.21.2.2.

3.6.2.3 Cactus Hill

The geology of the Cactus Hill Reservoir study area is described in Section 3.8.2 of the DEIS.

3.6.3 Conveyance Systems

The geology of the Glade to Horsetooth Pipeline, Carter Pipeline, and the SPWCP conveyance system (pipeline corridors) is described in Section 3.8.4 of the DEIS.

3.7 SOILS

3.7.1 Overview

Section 3.9 of the DEIS provides a summary of the soils within the NISP study area that may be affected by construction of reservoirs and forebays. More detailed information on soils is provided in the 2008 Land Use Report (ERO 2008b).

Descriptions of the soils in the three reservoir study areas are based on the NRCS soils surveys of Larimer and Weld Counties (NRCS 1980, 1982a). The NRCS-mapped soil types in the Glade (including the U.S. 287 realignment study area), Galeton, and Cactus Hill study areas were assessed to determine if they are Prime Farmland soils or soils that would be Prime Farmland if they were irrigated, as determined by the NRCS in the Important Farmland Inventory (NRCS 1982b).

Important farmlands are defined in the regulations implementing the Farmland Protection Policy Act (7 CFR 658). The purpose of the Farmland Protection Policy Act is to minimize the extent to which federal programs contribute to the unnecessary and irreversible conversion of farmland to nonagricultural uses. The Farmland Protection Policy Act defines four types of important farmlands: prime farmland, unique farmland, farmland of statewide importance, and farmland of local importance. The NRCS identifies important farmlands in each county based on national regulations and state guidance.

Prime farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is also available for these uses. It has the soil quality, growing season, and moisture supply needed to economically produce sustained high yields of crops when treated and managed, including water management, according to acceptable farming methods. In general, prime farmlands have an adequate and dependable water supply from precipitation or irrigation, a favorable climate and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content, and few or no rocks. These soils are also permeable to water and air, they are not excessively erodible or saturated with water for a long period, and they either do not flood frequently or are protected from flooding (7 CFR 657.5).

Farmland of statewide importance is land other than prime farmland that nearly meets the requirements for prime farmland and that economically produces high yields of crops when treated and managed according to acceptable farming methods.

3.7.2 Proposed Reservoir Sites

3.7.2.1 Glade

The soils and potential presence of Prime Farmland in the Glade Reservoir study area are described in Section 3.9.1 of the DEIS. Information on these resources within the U.S. 287 realignment study area can be found in Section 3.27.4 of the DEIS.

3.7.2.2 Galeton

The soils and potential presence of Prime Farmland in the Cactus Hill Reservoir Study Area are described in Section 3.9.2 of the DEIS.

3.7.2.3 Cactus Hill

The soils and potential presence of Prime Farmland in the Galeton Reservoir Study Area is described in Section 3.9.3 of the DEIS.

3.7.3 Conveyance Systems

The conveyance systems study areas have a variety of soils ranging from fine sandy loams to clay loams. None of the soil mapping units in the conveyance systems study areas are potential Prime Farmlands without irrigation. Soil mapping units that are potential Prime Farmlands if irrigated are the Altvan loam, the Ascalon loam, the Ascalon sandy loam, the Colby loam, the Colombo clay loam, the Fort Collins loam, the Kim loam, the Nunn clay loam, the Otero sandy loam, the Stoneham loam, the Ulm clay loam, the Weld loam, the Wiley silt loam, and the Wiley-Colby complex.

3.7.4 No Action Irrigated Lands

Three areas associated with the No Action Alternative are proposed for the transfer of agricultural water to municipal supplies for the Participants. Soils associated with irrigated lands supplied by the New Cache Canal are Nunn clay loam, Olney fine sandy loam, Kim loam, and Otero sandy loam. All of these soils are deep, well-drained soils of the plains, formed from alluvium and Aeolian deposits, or outwash.

Soils associated with irrigated lands supplied by the Larimer-Weld Canal include Ascalon sandy loam, Fort Collins loam, Garrett loam, Nunn clay loam, Santana variant clay loam, Loveland clay loam, Otero sandy loam, Kim loam, Santana loam, Thadalund loam, Table Mountain loam, Stoneham loam, and Tassal sandy loam.

Soils associated with irrigated lands supplied by the Home Supply Ditch include Cushman fine sandy loam, Colby loam, Cascajo gravelly sandy loam, Fort Collins loam, Kim loam, Heidt clay loam, Longmont clay, Modway clay loam, Nunn clay loam, Nelson fire sandy loam, Otero sandy loam, Renohill clay loam, Stoneham loam, Thedalund loam, Ulm clay loam, Weld loam, Weld silt loam, and Wiley silt loam.

Potential Prime Farmland irrigated by the New Cache Canal and the Larimer-Weld Canal is described in Section 3.9.4 of DEIS.

Potential Prime Farmlands (if irrigated) supplied by the Home Supply Ditch include Held clay loam, Fort Collins loam, Kim loam, Longmont clay, Nunn clay loam, Stoneham loam, Ulm clay loam, Weld silt loam, and Wiley silt loam.

3.8 VEGETATION

3.8.1 Overview

This section describes the vegetation types and noxious weeds in the proposed reservoir sites, conveyance systems, and no action irrigated lands study areas. The vegetation cover types, including grasslands, shrublands, and woodlands are described in Sections 3.10.2, 3.10.3, and 3.10.4 of the DEIS. Information on miscellaneous cover types, including agricultural lands, revegetated areas, disturbed areas, landscaped areas, and roads are found in Section 3.10.5 of the DEIS. The 2008 Vegetation Report (ERO 2008c) and the 2015 Vegetation and Wetland Resources Supplement (ERO 2015b) provide more detailed descriptions of the vegetation resources evaluated in these study areas. Wetland and riparian vegetation are described in Section 3.9 of the SDEIS. Information on federal- and state-listed threatened, endangered, and candidate plant species were updated for the SDEIS and are described in Section 3.11 of the SDEIS, and updated information is provided in the 2015 Species of Concern Supplement (ERO 2015d). Information on Colorado Natural Heritage Program-designated sensitive plant communities that occur in the study areas was also updated for the SDEIS and is presented in the 2015 Vegetation and Wetland Resources Supplement (ERO 2015b).

3.8.1.1 Noxious Weeds

Noxious weeds are regulated by the State of Colorado. According to the Colorado Noxious Weed Act, a noxious weed is an alien plant or parts of an alien plant that have been designated by rule as being noxious or has been declared a noxious weed by a local advisory board, and meets one or more of the following criteria (Colorado Department of Agriculture [CDA]):

a) Aggressively invades or is detrimental to economic crops or native plant communities;

b) Is poisonous to livestock;

c) Is a carrier of detrimental insects, diseases, or parasites; or

d) The direct or indirect effect of the presence of this plant is detrimental to the environmentally sound management of natural or agricultural ecosystems.

Information on noxious weeds commonly found within the study areas can be found in Section 3.11 of the DEIS. Information on noxious weeds observed along the Poudre River mainstem can be found in Section 3.9.5.2 of the SDEIS.

3.8.2 Proposed Reservoir Sites

Table 3-21 provides updated information on the vegetation cover types at the Glade (including the U.S. 287 realignment), Galeton, and Cactus Hill reservoir study areas. The vegetation types in the NISP study areas were classified according to the dominant life forms (such as grasses, shrubs, or trees), dominance by native or introduced species, and moisture regime. Information specific to noxious weeds at the reservoir sites is presented in Table 3-22.

Table 3-21. Vegetation cover types at Glade, Galeton, and Cactus Hill study areas.

Vegetation Cover Type	Glade and U.S. 287 Study Areas (acres)	Galeton and SPWCP Study Area (acres)	120,000 AF Cactus Hill Study Area (acres)	190,000 AF Cactus Hill Study Area (acres)
Upland native grasslands	1,505	1,378	651	857
Upland mixed grasslands	498	340	1,648	2,287
Upland introduced grasslands	2	154	0	0
Mesic native grasslands	72	0	1	4
Mesic mixed grasslands	133	144	127	167
Upland native shrublands	924	0	0	0
Mesic native shrublands	29	0	0	0
Mesic mixed shrublands	57	0	0	0
Upland native woodlands	<1	0	0	0
Mesic mixed woodlands	40	2	14	15
Agricultural lands	220	86	226	581
Revegetated areas	743	0	0	0
Disturbed areas[1]	111	0	30	75
Landscaped areas	0	0	0	0
Palustrine emergent wetlands	70	<1	42	42
Palustrine scrub-shrub wetlands	6	<1	0	0
Total	**4,410**	**2,104**	**2,738**	**4,028**

[1]Disturbed areas have received heavy human use and are either bare or dominated by annual weeds.

Table 3-22. Noxious weeds observed or expected to be present in the study areas.

Common Name	Scientific Name	Glade	Galeton	Cactus Hill	Conveyance Systems	Irrigated Lands	State List Category
Bouncingbet	*Saponaria officinalis*	E	E	E	E	E	B
Bull thistle	*Cirsium vulgare*	E	E	E	E	E	B
Common burdock	*Arctium minus*	E	E	E	E	E	C
Canada thistle	*Cirsium arvense*	O	O	O	O	O	B
Chicory	*Cichorium intybus*	E	E	E	E	E	C
Common mullein	*Verbascum thapsus*	O	O	O	O	O	C
Common teasel	*Dipsacus fullonum*	E	E	E	E	E	B
Dalmatian toadflax	*Linaria dalmatica*	O	E	E	E	E	B
Dames rocket	*Hesperis matronalis*						B
Diffuse knapweed	*Centaurea diffusa*	E	E	E	E	E	B
Downy brome (cheatgrass)	*Bromus tectorum*	O	O	O	O	O	C
Field bindweed	*Convolvulus arvensis*	O	O	O	O	O	C
Hoary cress (whitetop)	*Cardaria draba*	E	E	E	E	E	B
Houndstongue	*Cynoglossum officinale*	E	E	E	E	E	
Johnsongrass	*Sorghum halepense*	E	E	E	E	E	C
Jointed goatgrass	*Aegilops cylindrica*	E	E	E	E	E	B
Leafy spurge	*Euphorbia esula*	E	E	E	E	E	B
Musk thistle	*Carduus nutans*	O	O	O	O	O	B
Perennial pepperweed	*Lepidum latifolium*	E	E	E	E	E	B
Puncturevine	*Tribulus terrestris*	E	E	E	E	E	C
Quackgrass	*Elytrigia repens*	E	E	E	E	E	B
Redstem filaree	*Erodium cicutarium*	O	O	O	O	O	C
Russian knapweed	*Acroptilon repens*						B
Russian olive	*Elaeagnus angustifolia*	E			O	E	B
Saltcedar	*Tamarix chinensis*						B
Scotch thistle	*Onopordum tauricum*	E	E	E	E	E	B
Spotted knapweed	*Centaurea maculosa*	E	E	E	E	E	B
Velvetleaf	*Abutilon theophrasti*					E	C
Wild proso millet	*Panicum milliaceum*	E	E	E	E	E	C
Yellow nutsedge	*Cyperus esculentus*	E	E	E	E	E	B

O = Known occurrence based on field observance.
E = Expected to occur.
B = Species managed by State noxious weed management plans with the goal of stopping the continued spread of these species.
C = Species for which the State, in conjunction with other interested parties, will develop management plans with the goal of supporting local governing bodies in implementing more effective integrated weed management.

3.8.3 Conveyance Systems

Agricultural lands are the dominant vegetation cover type within the conveyance systems study areas. Landscaped areas are also common where the conveyance systems cross through towns and other residential areas. Where the conveyance systems cross grasslands, vegetation is mostly upland mixed grasslands with an abundance of nonnative species. Mesic grasslands, shrublands, and woodlands occur with fairly low cover. Wetlands are mostly along the banks of ditches or associated with the many natural and artificial water bodies within the conveyance systems study areas.

The conveyance systems for all alternatives are proposed to be in rural, suburban, and agricultural areas and along existing road rights-of-way, all of which have a high abundance of noxious weeds. Where the conveyance systems cross native grasslands, the abundance of noxious weeds would be lower. Noxious weeds observed and likely to be present along the conveyance system alignments are presented in Table 3-22.

3.8.4 No Action Irrigated Lands

The No Action Irrigated Lands are mostly agricultural lands with pockets of residential areas that include landscaped areas. Many water bodies with associated wetlands are scattered throughout the Irrigated Lands. Wetlands also occur along ditches and streams within the Irrigated Lands.

Noxious weeds within the No Action Irrigated Lands that are known to occur or are likely to occur are presented in Table 3-22. Noxious weeds in the No Action Irrigated Lands study area are expected to have the highest cover in areas that have been disturbed in the past such as along roads, canals, and on the edges of agricultural fields.

3.9 WETLANDS, RIPARIAN RESOURCES, AND OTHER WATERS

3.9.1 Overview

This section describes the riparian areas, wetlands, and other waters that may be affected by NISP, either directly by construction of reservoirs, forebays, or other associated facilities, or indirectly through changes to streamflows. The acreages of wetlands within the reservoir study areas have changed slightly since the DEIS and are shown in Table 3-23. Additionally, in the DEIS, the U.S. 287 realignment study area was not included in the Glade Reservoir study area and was reported separately. Detailed information about wetlands and other waters at the reservoir sites can be found in the 2008 Wetland Report (ERO 2008d). Since publication of the DEIS, more detailed data were collected on wetland and riparian vegetation and surface water-ground water relationships at the six Poudre River study sites on the Poudre mainstem. Information on the Poudre River study sites can be found in the 2012 Wetlands and Riparian Resources Baseline Report (ERO 2012d). The CTP hydrology was used to assess the frequency of flooding of riparian and wetland resources along the mainstem. Post flood reviews of the mainstem were conducted in 2010, 2011, and 2013. The wetland functional assessment performed for the DEIS was replaced using the Functional Assessment of Colorado Wetlands (FACWet) method that was adopted by the Corps' Denver Regulatory Office as the standard for wetland functional assessment subsequent to the DEIS.

Table 3-23. Wetlands and other waters in the reservoir study areas.

Wetlands and Other Waters (acres)	Glade Reservoir (including U.S. 287 Realignment)	Galeton Reservoir	Cactus Hill Reservoir
Palustrine Emergent and Scrub-shrub Wetlands	76	1	42
Stock and Irrigation Ponds	11	0	5
Creeks, Streams, Ditches, and Canals	25[1]	1	3
Total	**112**	**2**	**50**

[1]Canals and ditches comprise about 14 acres of the 25 acres of creeks, streams, ditches, and canals in the Glade and U.S. 287 study areas.

Wetlands are "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas" (33 CFR 328.3(b)). Many wetlands are protected under Section 404 of the CWA. Other waters include surface water features such as streams, ditches, and ponds, many of which are also under the jurisdiction of the Corps under Section 404 of the CWA. Information on regulations pertaining to wetlands and other waters can be found in Section 3.12.1 of the DEIS. Prior to the FEIS, the Corps will complete an approved jurisdictional determination (JD) to determine the presence or absence of jurisdictional waters of the U.S. within the study area.

Riparian areas are a transitional habitat between terrestrial and aquatic ecosystems found immediately adjacent to rivers, streams, and sometimes lakes. They differ from wetlands in that riparian areas are generally linear, more terrestrial, are often dependent on a natural disturbance regime, and do not include the instream environment (Naiman et al. 2005). Riparian areas are further defined as:

> Those plant communities adjacent to and affected by surface or ground water of perennial or ephemeral water bodies such as rivers, streams, lakes, ponds, playas, or drainage ways. These areas have distinctly different vegetation than adjacent areas or have species similar to surrounding areas that exhibit a more vigorous or robust growth form (CDOW 2004).

Wetland and riparian habitats cover only about 2% of the land in Colorado but provide benefits to the majority of the wildlife species in the state. Colorado Senate Bill 40 (SB 40) requires any agency of the State of Colorado to obtain wildlife certification from the CPW when the agency plans construction in a stream or its bank or tributaries (CDOT 2003). Along with impacts to fisheries, wildlife, threatened or endangered species, and other impacts to streams, SB 40 regulates permanent fills of greater than 0.25 acre of wetlands and 0.5 acre of riparian areas at a single location, and temporary fills of greater than 0.5 acre of wetlands and 1 acre of riparian areas at a single location (CDOW 2004). CDOT is an agency of the state of Colorado and is responsible for the realignment of U.S. 287 associated with Alternative 2, which would involve filling wetlands or riparian areas.

3.9.1.1 Wetland Classification, Functions, and Values

Wetlands within the study areas were classified according to the Cowardin classification system, which is commonly used to identify types of wetlands. Wetland types include coastal wetlands (also known as tidal or estuarine wetlands) and inland wetlands (also known as freshwater or palustrine wetlands). The wetlands are further classified in increasing detail by water flow, type of substrate, type of vegetation, and dominant species.

Types of Cowardin wetlands that occur in the study areas include: palustrine persistent emergent (PEM) wetlands dominated by grasses, sedges, and rushes; and palustrine scrub-shrub wetlands (PSS) dominated by willows and other shrubs. Descriptions of these types of wetlands are found in Section 3.12.1.1.1 and 3.12.1.1.2 of the DEIS. Some wetlands contain more than one type of wetland; in those cases, the dominant wetland type was used. Some wetlands may include scattered deciduous trees such as cottonwood and willow.

Wetland functional assessments were conducted based on hydrogeomorphic classes using the FACWet Method – Version 2.0 Review Draft (Johnson et al. 2010). HGM classes are riverine (associated with a stream channel, floodplain, or terrace), lacustrine fringe (topographic depression with permanent water >2 meters deep), depressional (topographic depression without permanent water >2 meters deep), and slope (located on a topographic slope with ground water as primary water source).

The FACWet method[3] is based on assessing how outside stressors impact nine fundamental variables and then modeling the resultant effects on natural functions and overall conditions of the assessment site. The nine variables are:

- habitat connectivity – neighboring wetland habitat loss
- habitat connectivity – migration/dispersal barriers
- buffer capacity
- water source
- water distribution
- water outflow
- chemical environment
- geomorphology
- vegetation structure and complexity

The functions of the wetland are graded on a scale of 1.00 (A – Reference Standard) to below 0.60 (F – Nonfunctioning), similar to an academic grading scale. Grades for variables are affected by the extent and intensity of stressors. For example, a wetland isolated from riparian or upland habitat by roads, trails, or other development would be graded lower for habitat connectivity – migration/dispersal barriers than would a wetland that is contiguous with adjacent vegetation types. Scores of each variable are provided in the 2015 Vegetation and Wetland Resources Supplement (ERO 2015b) for the reservoir sites and in the 2012 Wetlands and Riparian Resources Baseline Report (ERO 2012d) for the Poudre River study sites.

From the variable scores functional capacity indices are calculated, which relate the functional assessment to the following seven key functions performed by wetlands:

- Support of characteristic wildlife habitat
- Support of characteristic fish/aquatic habitat
- Flood attenuation
- Short- and long-term water storage
- Nutrient/toxicant removal
- Sediment retention/shoreline stabilization
- Production export and food chain support

A composite functional capacity index score is derived by totaling the functional capacity indices of the functions and dividing by the number of functions scored. The composite functional capacity index score gives an indication of the overall function for the wetland.

[3] Because it is evidence- based, any facet of a FACWet evaluation can be corroborated or modified based on additional evidence, such as quantitative data, information gleaned from scientific literature or web-based data mining tools, reliable local knowledge, or subject-specific expertise.

3.9.2 Proposed Reservoir Sites

3.9.2.1 Glade

Within the Glade Reservoir study area, including the U.S. 287 realignment study area, all of the wetlands were classified as PEM or PSS. HGM types included depressional and riverine wetlands. The FACWet composite functional capacity index score ranged from 0.69 (functioning impaired) for Wetland 5 to 0.93 (reference standard) for Wetlands 1 and 2 (Table 3-24). The difference in scores is the result of Wetland 5 being supported mostly by unnatural water sources and the level of surrounding disturbances. Wetlands 1 and 2, two small wetlands, were in a relatively natural state and their remoteness allowed for fewer human-generated stressors on the wetlands and surrounding area. The composite functional capacity index scores of wetlands in the U.S. 287 realignment study area ranged from 0.76 (functioning) to 0.94 (reference standard). Mesic mixed shrublands and mesic native shrublands occur along creeks in the study area. The mesic mixed woodlands are dominated by cottonwoods and other trees and shrubs.

Table 3-24. Glade wetland Cowardin classification, HGM type, area, and FACWet score.

Wetland	Cowardin Classification	HGM Type	Area (acres)	FACWet Score
Wetland 1	PEM	Depressional	0.1	0.93
Wetland 2	PEM	Depressional	<0.1	0.93
Wetland 3	PEM	Riverine	0.7	0.89
Wetland 4	PEM	Depressional	9.0	0.71
Wetland 5	PEM	Depressional	26.4	0.69
Wetland 6	PEM	Depressional	1.1	0.71
Wetland 7 a-d	PEM	Riverine	8.0	0.71
Wetland 8	PEM	Depressional	<0.1	0.71
Wetland 9	PEM	Depressional	0.1	0.94
Wetland 10 a-c	PSS	Riverine	0.2	0.94
Wetland 11	PEM	Depressional	4.2	0.93
Wetland 12 a-f	PEM	Riverine	5.4	0.79
Wetland 13 a-b	PEM	Depressional	1.2	0.76
Wetland 14 a-b	PEM	Riverine	0.2	0.80
Wetland 15 a-c	PEM	Riverine	0.8	0.80
Wetland 16 a-b	PEM	Riverine	1.7	0.79
Wetland 17 a-b	PEM	Depressional	1.4	0.79
Wetland 18	PEM	Riverine	<0.1	0.80
Wetland 19	PEM	Riverine	0.4	0.79
Wetland 20	PEM	Riverine	0.3	0.79
Wetland 21	PSS	Riverine	6.1	0.80
Wetland 22	PEM	Riverine	9.4	0.85
		Total Wetlands	**76.2**	

3.9.2.2 Galeton

Within the Galeton Reservoir study area, all of the wetlands were classified as PEM. HGM types included depressional and riverine wetlands. The wetlands were in close proximity to each

other and experienced similar stressors, resulting in a FACWet composite functional capacity index score of 0.82 (highly functioning) for all of the wetlands (Table 3-25).

Table 3-25. Galeton wetland Cowardin classification, HGM type, area, and FACWet score.

Wetland[1]	Cowardin Classification	HGM Type	Area (acres)	FACWet Score
Wetland 1	PEM	Depressional	<0.1	0.82
Wetland 2	PEM	Depressional	<0.1	0.82
Wetland 3	PEM	Depressional	<0.1	0.82
Wetland 4	PEM	Depressional	<0.1	0.82
Wetland 5	PEM	Depressional	<0.1	0.82
Wetland 6	PEM	Depressional	<0.1	0.82
Wetland 7	PEM	Depressional	0.2	0.82
Wetland 8	PEM	Depressional	<0.1	0.82
Wetland 9	PEM	Depressional	0.1	0.82
		Total Wetlands	**0.3+**	

[1]Wetland 10 was listed in the DEIS but is outside of the study area and is not further discussed.

3.9.2.3 Cactus Hill

Within the Cactus Hill Reservoir study area, all of the wetlands were classified as PEM. The only HGM type observed was depressional. FACWet composite functional capacity index scores ranged from 0.67 (functioning impaired) to 0.70 (functioning) (Table 3-26). The three depressional wetlands at Cactus Hill experienced similar stressors that affected the scores.

Table 3-26. Cactus Hill wetland Cowardin classification, HGM type, area, and FACWet score.

Wetland	Cowardin Classification	HGM Type	Area (acres)	FACWet Score
Wetland 1	PEM	Depressional	14.5	0.67
Wetland 2	PEM	Depressional	16.1	0.70
Wetland 3	PEM	Depressional	11.6	0.69
		Total Wetlands	**42.2**	

3.9.3 Conveyance Systems

In the Glade to Horsetooth and Carter pipeline study areas, and other areas without access, wetlands were mapped remotely and reviewed from public roads where possible. Palustrine scrub-shrub wetlands occur around ponds and along creeks in the Carter pipeline study area.

Mesic mixed woodlands occur along the South Platte River in the SPWCP study area at the proposed South Platte River diversion and in the Glade to Horsetooth pipeline study area at the proposed Poudre River crossing. These mesic mixed woodlands are dominated by cottonwoods and other trees and shrubs. Mesic mixed shrublands and mesic native shrublands occur along creeks in the Poudre Valley Canal study area. Riparian areas in the Carter pipeline study area include mesic mixed woodlands along the St. Vrain Creek and the Big Thompson River and mesic mixed and mesic native shrublands along other creeks in the study area.

No Action Alternative pipelines are proposed to cross the riparian corridors of the Poudre, South Platte, Big and Little Thompson Rivers, and St. Vrain and Boulder Creeks. Cottonwood-dominated mesic native and mesic mixed woodlands are common along these streams. The riparian areas along these stream corridors also likely include mesic mixed and mesic native shrublands as well as palustrine emergent and scrub-shrub wetlands.

3.9.4 No Action Irrigated Lands

Based on comments received on the DEIS, a new study was conducted to estimate wetlands supported by irrigation in the agricultural areas within the No Action Study Area (West 2010). The new study used a systematic sampling design to evaluate about 20% (192 square miles) of the 960-square-mile agricultural transfer lands study area and estimate the percentage of irrigation-induced wetlands within the irrigated agricultural transfer lands of the No Action Alternative study area. Based on this evaluation, about 0.35% of the agricultural transfer lands are PEM wetlands and 0.00053% are PSS wetlands. Within the total area of 64,200 acres that is estimated to be dried up by agricultural transfers, 218 acres of PEM and PSS wetlands are estimated to occur (West 2010).

3.9.5 Poudre River

Within the Poudre River study sites, wetlands were classified as PEM and PSS. HGM types included depressional wetlands throughout the floodplain and riverine wetlands along the banks. FACWet composite functional capacity index scores ranged from 0.69 (functioning impaired) to 0.77 (functioning) (Table 3-27). Sites that scored lower were typically within municipal areas or had more disturbances to the wetlands and surrounding area.

Table 3-27. Poudre River study sites wetland Cowardin classification, HGM type, area, and FACWet score.

Wetland	Cowardin Classification	HGM Type	Area (acres)	FACWet Score
Watson Lake	PEM/PSS	Riverine	3.3	0.70
Watson Lake	PEM	Depressional	3.4	0.72
Martinez Park	PEM/PSS	Riverine	3.7	0.71
Martinez Park	PEM/PSS	Depressional	5.0	0.70
Archery Site	PEM/PSS	Riverine	2.8	0.69
Archery Site	PEM/PSS	Depressional	3.9	0.72
Eastman Park	PEM/PSS	Riverine	4.1	0.70
Eastman Park	PEM	Depressional	0.2	0.73
59th Avenue	PEM/PSS	Riverine	1.9	0.70
59th Avenue	PEM/PSS	Depressional	2.5	0.76
Bird Farm	PEM/PSS	Riverine	4.3	0.73
Bird Farm	PEM	Depressional	8.5	0.77
		Total Wetlands	**43.6**	

3.9.5.1 CDOW Riparian Vegetation Mapping

Several public comments received during the NISP EIS scoping process and the DEIS public comment period expressed concern about effects on riparian resources. In response to these comments, additional studies were conducted to evaluate riparian resources. Colorado Division of Wildlife[4] (CDOW) riparian mapping (2004) was used to identify about 2,755 acres of riparian vegetation along the Poudre from the Canyon Gage to the confluence with the South Platte River. The CDOW riparian mapping was superimposed on National Agriculture Imagery Program (NAIP) 2009 color aerial imagery and field reviewed for accuracy from publicly accessible sites. The mapping review tracked inaccuracies (i.e., errors in delineation and errors in labeling of units) to estimate the accuracy of the CDOW riparian mapping. The results of the field review are provided in Appendix A of the 2012 Wetlands and Riparian Resources Baseline Report (ERO 2012d). In early 2011, the Colorado Natural Heritage Program (CNHP) mapped wetlands along a portion of the Poudre River and South Platte River in accordance with the National Wetlands Inventory (NWI) mapping standards (CNHP 2011). In January 2012, ERO downloaded NWI mapping for the Poudre River corridor (USFWS 2012) and compared it to CDOW mapping and site specific mapping at the Poudre River study sites. After the review, ERO determined that the CDOW mapping better represents the riparian communities along the Poudre River. NWI wetland mapping is based on the Cowardin definition of a wetland and does not use the same criteria as the Corps (Environmental Laboratory 1987; Corps 2010). The revised NWI mapping is not used for the description of riparian habitat because the CDOW mapping was determined to be more complete for riparian vegetation.

The riparian corridor was defined as areas adjacent to the Poudre River, the river, and areas that had an obvious connection to the Poudre River such as oxbow channels. The review did not include tributaries to the Poudre River, areas outside of the riparian corridor, uplands, or developed areas adjacent to the riparian corridor. This mapping was used to provide an approximation of the current composition, distribution, and amount of riparian associations associated with the mainstem of the Poudre River corridor.

As shown in Table 3-28, riparian deciduous tree-cottonwood was the most prevalent riparian vegetation cover type with about 1,165 acres of cover. Riparian herbaceous-sedges/rushes/mesic grasses (waterlogged soils or moist soils) also had a high occurrence with about 1,062 acres of cover. Riparian herbaceous with permanent standing water had 262 acres of cover. The remaining categories, riparian herbaceous-general, riparian deciduous tree-general, riparian deciduous tree-willow, and riparian deciduous tree-Russian olive, each had less than 100 acres of cover. Riparian deciduous tree-boxelder occurred infrequently with less than 1 acre of cover. Upland grassland occurred frequently within the Poudre River 100-year floodplain with about 1,467 acres of cover. Similarly, irrigated agriculture had about 1,615 acres of cover.

[4] In 2011, the Colorado Division of Wildlife was combined with Colorado State Parks to form the Colorado Division of Parks and Wildlife. Because the information used in this report was prepared by the Colorado Division of Wildlife before this organizational change, it will be referred to as the Colorado Division of Wildlife or CDOW.

Table 3-28. Area of CDOW mapping units along Poudre River mainstem within the defined riparian corridor.

CDOW Mapping Unit Riparian Vegetation Cover Types	Area (acres)[1]
Riparian Deciduous Tree-Boxelder	0.6
Riparian Deciduous Tree-Cottonwood	1,165.7
Riparian Deciduous Tree-General	22.8
Riparian Deciduous Tree-Russian Olive	2.7
Riparian Deciduous Tree-Willow	6.4
Riparian Herbaceous-Cattails/Sedges/Rushes (permanent standing water)	262.9
Riparian Herbaceous-Sedges/Rushes/Mesic Grasses (waterlogged soils or moist soils)	1,062.5
Riparian Herbaceous-General	92.9
Riparian Shrub-General	17.9
Riparian Shrub-Willow	121.4
Total	**2,755.8**

[1]Acres represent vegetation communities mapped by CDOW, some of which were field checked and revised by ERO.

3.9.5.2 Poudre River Study Sites

Additional data were collected at the six Poudre River study sites to characterize the structure and distribution of riparian vegetation (ERO 2012d). The location of the six Poudre River study sites, Watson Lake, Martinez Park, Archery Site, Eastman Park, 59th Avenue, and the Bird Farm, are shown in Poudre River Study Segments A through F (Figure 3-4).

Riparian vegetation at the Poudre River study sites was classified according to Carsey et al. (2003), which is based on plant associations. The Poudre River study site detailed mapping was used to develop equivalency between the CDOW riparian mapping classification and the Carsey et al. (2003) classification (Table 3-29). The Carsey et al. (2003) classification was used at the six Poudre River study sites because it provides more detail on species within each vegetation association and has the advantage of being able to clearly separate wetlands from nonwetland riparian associations.

Table 3-29. Equivalency between CDOW and Carsey et al. classifications.

Carsey Vegetation Classification	CDOW Riparian Mapping Classification
American Mannagrass Herbaceous	Riparian Herbaceous-General
American Mannagrass[Reed Canarygrass] Herbaceous	Riparian Herbaceous-General
Big Bluestem-Yellow Indiangrass [Reed Canarygrass] Herbaceous	Riparian Herbaceous-General
Box Elder Alliance	Riparian Deciduous Tree-Boxelder
Boxelder-Narrowleaf Cottonwood/Red-Osier Dogwood Woodlands	Riparian Deciduous Tree-General
Boxelder/Emory's Sedge-Reed Canarygrass	Riparian Deciduous Tree-Boxelder
Cattail Herbaceous Vegetation	Riparian Herbaceous-Cattails/Sedges/Rushes (permanent standing water)
	Riparian Herbaceous-Sedges/Rushes/Mesic Grasses (waterlogged)
Cattail-[Reed Canarygrass] Herbaceous	Riparian Herbaceous-Cattails/Sedges/Rushes (permanent standing water)
Common Threesquare Herbaceous	Riparian Herbaceous-Sedges/Rushes/Mesic Grasses (waterlogged)

Carsey Vegetation Classification	CDOW Riparian Mapping Classification
Crack Willow Woodland	Riparian Deciduous Tree-General
Crack Willow/[Reed Canarygrass] Woodland	Riparian Deciduous Tree-General
Developed/Disturbed	Unvegetated
Emory's Sedge Herbaceous	Riparian Herbaceous-Sedges/Rushes/Mesic Grasses (waterlogged)
Emory's Sedge [Reed Canarygrass] Herbaceous	Riparian Herbaceous-Sedges/Rushes/Mesic Grasses (waterlogged)
Narrowleaf Cottonwood-[Crack Willow]/Mesic Graminoid Woodland	Riparian Deciduous Tree-Cottonwood
Narrowleaf Cottonwood-[Crack Willow]/Sandbar Willow Woodland	Riparian Deciduous Tree-Cottonwood
Narrowleaf Cottonwood-[Siberian Elm]/Thinleaf Alder Woodland	Riparian Deciduous Tree-Cottonwood
Narrowleaf Cottonwood/Common Snowberry Woodland	Riparian Deciduous Tree-Cottonwood
Narrowleaf Cottonwood/Mesic Graminoid Woodlands	Riparian Deciduous Tree-Cottonwood
Narrowleaf Cottonwood/Thinleaf Alder Woodland	Riparian Deciduous Tree-Cottonwood
Open Water	Open Water-Canal
	Open Water-Riverine
	Open Water-Standing
Peachleaf Willow Woodlands	Riparian Deciduous Tree-General
Peachleaf Willow/[Reed Canarygrass] Woodlands	Riparian Deciduous Tree-General
Plains Cottonwood (Peachleaf Willow) [Russian Olive]/Smooth Brome Woodland	Riparian Deciduous Tree-Cottonwood
Plains Cottonwood-(Peachleaf Willow)/Sandbar Willow Woodland	Riparian Deciduous Tree-Cottonwood
Plains Cottonwood-(Peachleaf Willow)/Sandbar Willow/[Reed Canarygrass] Woodland	Riparian Deciduous Tree-Cottonwood
Plains Cottonwood-Narrowleaf Cottonwood Woodland	Riparian Deciduous Tree-Cottonwood
Plains Cottonwood-[Crack Willow]/Smooth Brome Woodland	Riparian Deciduous Tree-Cottonwood
Plains Cottonwood-[Russian Olive]/Smooth Brome Woodland	Riparian Deciduous Tree-Cottonwood
Plains Cottonwood/Chokecherry Woodland	Riparian Deciduous Tree-Cottonwood
Plains Cottonwood/Prairie Cordgrass-Sedge Woodland	Riparian Deciduous Tree-Cottonwood
Plains Cottonwood [Russian Olive]/Slender Wheatgrass Woodland	Riparian Deciduous Tree-Cottonwood
Plains Cottonwood/Slender Wheatgrass Woodland	Riparian Deciduous Tree-Cottonwood
Plains Cottonwood/Slender Wheatgrass-[Reed Canarygrass] Woodland	Riparian Deciduous Tree-Cottonwood
Plains Cottonwood/Smooth Brome Woodland	Riparian Deciduous Tree-Cottonwood
Prairie Cordgrass-[Reed Canarygrass] Western Herbaceous	Riparian Herbaceous-Sedges/Rushes/Mesic Grasses (waterlogged)
Prairie Cordgrass Western Herbaceous	Riparian Herbaceous-General
Privet Shrubland	Riparian Shrub-General
Reed Canarygrass Herbaceous	Riparian Herbaceous-Sedges/Rushes/Mesic Grasses (waterlogged)
Russian Olive Woodland	Riparian Deciduous Tree-Russian Olive
Sandbar	Sandbar

Carsey Vegetation Classification	CDOW Riparian Mapping Classification
Sandbar Willow-[Russian Olive]/Mesic Graminoid-[Reed Canarygrass] Shrubland	Riparian Shrub-Willow
Sandbar Willow/Bare Ground Shrubland	Riparian Shrub-Willow
Sandbar Willow/Mesic Grassland Shrubland	Riparian Shrub-Willow
Sandbar Willow/Mesic Graminoid-[Reed Canarygrass] Shrubland	Riparian Shrub-Willow
Sedge Herbaceous	Riparian Herbaceous-Sedges/Rushes/Mesic Grasses (waterlogged)
Siberian Elm Woodland	Riparian Deciduous Tree-General
Siberian Elm/Bare Ground Shrubland	Riparian Deciduous Tree-General
Upland Grassland	Upland Grass

More detail on the vegetation associations is found in the 2012 Wetlands and Riparian Resources Baseline Report (ERO 2012d). The vegetation cover types and acreages at each of the Poudre River study sites are presented in Table 3-30.

Table 3-30. Vegetation cover types at Poudre River study sites.

Cover Type	Area (acres)
Watson Lake	
American Mannagrass Herbaceous	0.2
American Mannagrass[Reed Canarygrass] Herbaceous	2.0
Box Elder Alliance	0.3
Boxelder-Narrowleaf Cottonwood/Red-Osier Dogwood Woodlands	13.7
Developed/Disturbed	2.1
Narrowleaf Cottonwood/Common Snowberry Woodland	5.6
Narrowleaf Cottonwood/Mesic Graminoid Woodlands	3.8
Narrowleaf Cottonwood/Thinleaf Alder Woodland	2.5
Narrowleaf Cottonwood-[Crack Willow]/Mesic Graminoid Woodland	1.3
Narrowleaf Cottonwood-[Crack Willow]/Sandbar Willow Woodland	1.3
Narrowleaf Cottonwood-[Siberian Elm]/Thinleaf Alder Woodland	0.8
Open Water	27.1
Reed Canarygrass Herbaceous	1.5
Sandbar Willow/Bare Ground Shrubland	0.6
Sandbar Willow/Mesic Grassland Shrubland	0.8
Sandbar Willow/Mesic Graminoid-[Reed Canarygrass] Shrubland	0.5
Upland Grassland	49.3
Watson Lake Total	**113.4**
Martinez Park	
Boxelder/Emory's Sedge-Reed Canarygrass	0.2
Cattail - [Reed Canarygrass] Herbaceous	1.7
Cattail Herbaceous Vegetation	1.6
Crack Willow Woodland	1.2
Crack Willow/[Reed Canarygrass] Woodland	0.7
Developed/Disturbed	5.3
Emory's Sedge [Reed Canarygrass] Herbaceous	0.0
Open Water	18.2
Plains Cottonwood-(Peachleaf Willow)/Sandbar Willow Woodland	0.1
Plains Cottonwood-(Peachleaf Willow)/Sandbar Willow/[Reed Canarygrass] Woodland	1.2
Plains Cottonwood/Chokecherry Woodland	0.7
Plains Cottonwood/Slender Wheatgrass Woodland	3.9
Plains Cottonwood/Slender Wheatgrass-[Reed Canarygrass] Woodland	1.4

Cover Type	Area (acres)
Plains Cottonwood/Smooth Brome Woodland	24.1
Plains Cottonwood-[Crack Willow]/Smooth Brome Woodland	13.8
Reed Canarygrass Herbaceous	0.3
Russian Olive Woodland	0.3
Sandbar	0.1
Sandbar Willow/Bare Ground Shrubland	0.5
Sandbar Willow/Mesic Graminoid-[Reed Canarygrass] Shrubland	2.1
Sandbar Willow/Mesic Grassland Shrubland	0.2
Sedge Herbaceous	0.1
Siberian Elm/Bare Ground Shrubland	0.0
Upland Grassland	42.7
Martinez Park Total	**120.3**
Archery Site	
Big Bluestem - Yellow Indiangrass [Reed Canarygrass] Herbaceous	0.0
Box Elder Alliance	0.2
Cattail - [Reed Canarygrass] Herbaceous	0.5
Cattail Herbaceous Vegetation	0.4
Crack Willow/[Reed Canarygrass] Woodland	0.2
Developed/Disturbed	0.2
Open Water	5.4
Peachleaf Willow Woodlands	0.3
Plains Cottonwood (Peachleaf Willow) [Russian Olive]/Smooth Brome Woodland	1.0
Plains Cottonwood-(Peachleaf Willow)/Sandbar Willow Woodland	0.5
Plains Cottonwood-(Peachleaf Willow)/Sandbar Willow/[Reed Canarygrass] Woodland	0.7
Plains Cottonwood/Prairie Cordgrass-Sedge Woodland	0.5
Plains Cottonwood/Slender Wheatgrass Woodland	0.9
Plains Cottonwood/Smooth Brome Woodland	5.4
Plains Cottonwood-[Crack Willow]/Smooth Brome Woodland	0.2
Plains Cottonwood-Narrowleaf Cottonwood Woodland	0.7
Prairie Cordgrass Western Herbaceous	0.1
Prairie Cordgrass-[Reed Canarygrass] Western Herbaceous	0.1
Reed Canarygrass Herbaceous	0.5
Sandbar Willow/Mesic Graminoid-[Reed Canarygrass] Shrubland	3.0
Sandbar Willow/Mesic Grassland Shrubland	0.2
Upland Grassland	22.3
Archery Site Total	**43.1**
Eastman Park	
Cattail Herbaceous Vegetation	0.2
Crack Willow Woodland	0.9
Developed/Disturbed	1.1
Open Water	5.9
Plains Cottonwood [Russian Olive]/Slender Wheatgrass Woodland	1.1
Plains Cottonwood-(Peachleaf Willow)/Sandbar Willow Woodland	0.2
Plains Cottonwood/Slender Wheatgrass Woodland	0.2
Plains Cottonwood/Smooth Brome Woodland	29.8
Prairie Cordgrass-[Reed Canarygrass] Western Herbaceous	0.2
Privet Shrubland	0.2
Reed Canarygrass Herbaceous	1.1
Sandbar	0.1
Sandbar Willow/Mesic Graminoid-[Reed Canarygrass] Shrubland	3.0
Sandbar Willow/Mesic Grassland Shrubland	0.1
Siberian Elm Woodland	0.1

Cover Type	Area (acres)
Upland Grassland	27.1
Eastman Park Total	**71.3**
59th Avenue	
Cattail - [Reed Canarygrass] Herbaceous	0.1
Cattail Herbaceous Vegetation	2.6
Common Threesquare Herbaceous	0.1
Developed/Disturbed	2.6
Emory's Sedge Herbaceous	0.0
Open Water	3.1
Peachleaf Willow/[Reed Canarygrass] Woodland	1.1
Plains Cottonwood/Smooth Brome Woodland	13.3
Reed Canarygrass Herbaceous	1.6
Sandbar	0.7
Upland Grassland	36.2
59th Avenue Total	**61.5**
Bird Farm	
Cattail Herbaceous Vegetation	6.8
Developed/Disturbed	5.9
Open Water	3.8
Plains Cottonwood-(Peachleaf Willow)/Sandbar Willow Woodland	1.8
Plains Cottonwood-(Peachleaf Willow)/Sandbar Willow/[Reed Canarygrass] Woodland	2.2
Plains Cottonwood/Prairie Cordgrass-Sedge Woodland	0.3
Plains Cottonwood/Smooth Brome Woodland	34.7
Plains Cottonwood-[Crack Willow]/Smooth Brome Woodland	0.4
Plains Cottonwood-[Russian Olive]/Smooth Brome Woodland	1.7
Prairie Cordgrass-[Reed Canarygrass] Western Herbaceous	4.2
Reed Canarygrass Herbaceous	4.6
Russian Olive Woodland	0.9
Sandbar Willow/Bare Ground Shrubland	1.1
Sandbar Willow/Mesic Graminoid-[Reed Canarygrass] Shrubland	3.3
Sandbar Willow/Mesic Grassland Shrubland	0.1
Upland Grassland	55.2
Bird Farm Total	**126.9**

At each of the Poudre River study sites, the following information was collected:

- Estimated size class distribution of tree species
- Recruitment of trees
- Presence, distribution, and composition of nonnative species

Size classes were estimated for woody species within belt transects at the Poudre River study sites. The majority of cottonwood trees are between 2 inches and 12 inches in diameter at breast height (dbh), with a few individual cottonwoods with a dbh greater than 12 inches. Cottonwoods are common along the Poudre; however, older cottonwoods are not being replaced readily by new recruitment. The last establishment of large areas of young cottonwood forest along the mainstem is attributed to the 1983 flood, which is the year with the longest duration of consecutive days above bankfull (45 days) (Gilliam 2006). An examination of cottonwood age classes in the Fort Collins reach of the Poudre River also found the last major recruitment year was 1983 (Shanahan 2011). The lack of natural lateral migration of the Poudre River has

manifested a riparian forest that is no longer connected to the high flows and flooding with which the forest historically evolved (City of Fort Collins 2011).

Recruitment of woody riparian vegetation was a fairly uncommon observation across the Poudre River study sites but appeared to decline in a downstream direction. Recruitment of green ash and narrowleaf cottonwood was more commonly observed on the upstream reaches of the mainstem. Green ash is a nonnative tree that is not common in the mature overstory of these sites. The common occurrence of young green ash trees at these sites indicates that the woody riparian vegetation at these sites is transitioning from cottonwood (narrowleaf or plains) riparian woodlands to woodlands dominated by cottonwood and green ash. Crack willow, green ash, Russian olive, and Siberian elm are infrequently scattered within the woodlands although crack willow and Russian olive can occur more commonly in certain associations. Other infrequently occurring non-native woody species are American elm, apple, honey locust, northern catalpa, privet, salt cedar, and white mulberry.

Many species of noxious weeds were found along the Poudre River corridor during surveys conducted in 2010 at the Poudre River study sites. The most common noxious weed species are bindweed, Canada thistle, cheatgrass, leafy spurge, and musk thistle (ERO 2012d). Most species are scattered throughout the riparian corridor and are not associated with a particular vegetation community. Other species that are found with less frequency but are still fairly common along the corridor are bouncing bet, burdock, chicory, diffuse knapweed, mullein, puncturevine, quackgrass, saltcedar, and Scotch thistle. Uncommonly observed species are Dalmation toadflax, filaree, spotted knapweed, and velvetleaf.

3.9.5.3 Riparian Vegetation Water Sources

In addition to the Poudre River and its alluvial ground water, a variety of water sources support wetland and riparian resources in the riparian corridor of the mainstem. All of the Poudre River study sites have additional water sources, which may include ditches, drainage or seepage from nearby ponds, stormwater drains, springs and seeps, and tributaries. Information on each water source is described in the 2012 Wetlands and Riparian Resources Baseline Report (ERO 2012d).

3.9.5.4 Riparian Vegetation Ground Water Levels

Generally, ground water levels at the Poudre River study sites were at their highest elevations during the growing season in June and at their lowest levels in late September (ERO 2012d). The range in ground water fluctuations during the growing season varied by site, and generally fluctuated 1 to 3 feet. The Watson Lake site had the least fluctuation in ground water levels during the growing season, with fluctuations of about 1 foot and the Eastman Park site had the greatest fluctuations in ground water levels during the growing season, with fluctuations of about 3 feet. Monitoring wells at sites dominated by plains cottonwood typically had depths to ground water during the growing season ranging from about 2.4 feet in June to about 5 to almost 7 feet by late September (Table 3-31).

Table 3-31. Ground water levels and vegetation cover types for monitoring wells at the Poudre River study sites.

Site/Well	Vegetation Cover Type	High and Low Ground Water Elevation (in feet) Below Ground Surface During Growing Season[1]	
		High	Low
Watson Lake			
G-1	Upland grassland	2.38[2]	3.73
G-2	Upland grassland	3.50	4.62
G-3	Narrowleaf cottonwood/common snowberry woodland	1.88	2.79
G-4	Upland grassland	4.28	5.46
G-5	Box elder-narrowleaf cottonwood/red-osier dogwood woodland	1.78	2.95
Martinez Park			
L-1	Plains cottonwood-crack willow/smooth brome woodland	2.88	5.29
L-2	Upland grassland	3.49	6.22
L-3	Upland grassland	4.58	7.19
L-4	Plains cottonwood-slender wheatgrass woodland	2.81	6.04
L-5	Plains cottonwood-smooth brome woodland	0.91	4.78
Archery Site			
A-1	Upland grassland	1.43	2.25
A-2	Upland grassland	2.96	6.11
A-3	Plains cottonwood/prairie cordgrass-sedge woodland	3.16	6.05
A-4	Plains cottonwood/smooth brome woodland	3.43	6.22
Eastman Park			
Y-1	Upland grassland	2.83	5.61
Y-2	Plains cottonwood/smooth brome woodland	2.41	5.52
Y-3	Plains cottonwood/smooth brome woodland	2.69	5.92
Y-4	Plains cottonwood/smooth brome woodland	3.31	6.79
Y-5	Plains cottonwood/smooth brome woodland	3.17	6.85
59th Avenue[3]			
59-1	Plains cottonwood/smooth brome woodland	1.91	5.63[2]
59-2	Plains cottonwood/smooth brome woodland	2.38	6.20[2]
59-3	Plains cottonwood/smooth brome woodland	2.07	6.232[2]
59-4	Reed canarygrass herbaceous	1.80	2.13
Bird Farm[2]			
D-1	Upland grassland	1.48	2.97
D-2	Upland grassland	3.37	4.92
D-3	Upland grassland	4.48	6.29
D-4	Plains cottonwood/smooth brome woodland	3.11	5.59[2]
D-5	Plains cottonwood/smooth brome woodland	4.42	6.84[2]

[1]Growing season is estimated to be May 1 through September 30; 2009 data were collected weekly throughout the growing season, except for 59th Avenue and Bird Farm sites (maximum ground water levels for Wells 59-3 and D-4 for June were obtained from datalogger data). 2010 and 2011 data were collected twice during the growing season for each year on 5/11/10, 7/27/10, 5/20/11, and 8/24/11.

[2] Datalogger data have been added since the data were presented in ERO 2012d.

[3]The 59th Avenue and Bird Farm sites were not monitored for the full growing season in 2009.

3.9.5.5 Inundation of Riparian and Wetland Resources

The establishment of new large cottonwood stands along the Poudre River appears to now be limited to large flood events similar in scale to the 1983 flood event, as observed by Gilliam (2006). Flood events of this magnitude and duration tend to not be substantially affected by diversions, flood large areas of the riparian zone, and have a slow descending limb of the hydrograph favorable to cottonwood establishment.

Flooding of the riparian areas is also associated with a variety of ecological processes including:

- Creating open, bare substrate for the establishment of riparian and wetland vegetation
- Flushing of salts and pollutants from the flooded area
- Adding sediments, nutrients, and pollutants to the flooded areas
- Export of nutrients to downstream reaches (food chain support)
- Recharge of the soil moisture of flooded areas
- Enhanced decomposition in flooded areas
- Short-term recharge of the alluvial ground water
- Effects on the distribution and composition of vegetation

The requirements for the establishment of plains cottonwood in riparian settings is relatively well understood (Scott et al. 1993). Plains cottonwood produces an abundance of small seeds that are dispersed by wind and moving water. Seeds ripen at different times across individual trees and dispersal can occur over a 6-week period. Seed dispersal typically coincides with peak flows. Following germination, young seedlings require a continuously moist substrate during at least the first week of growth. Ideal conditions for seed germination and establishment typically occur on freshly deposited alluvial substrates in channel positions low enough to provide adequate moisture but high enough to escape scour from subsequent floods. Once seedlings are established, root growth must keep pace with declining river stage and the associated alluvial ground water table. If river stages decline too rapidly, drought stress produces substantial seedling mortality (Scott et al. 1993). Cottonwood seedling recruitment is episodic and relatively rare even along free-flowing streams (Mahoney and Rood 1998).

Along meandering rivers, successful establishment is characteristically associated with medium to large floods. Researchers have also determined that it is moderate and large flood events that directly enable cottonwood recruitment, whereas smaller flood events are often insufficient for cottonwood replenishment. Although smaller peaks moisten the suitable recruitment zone, the receding limb of the hydrograph is very rapid after the peak flow, and thus the rate of stage decline is too abrupt for seedlings to retain root contact with the declining moist zone (Mahoney and Rood 1998). These large flood events occur infrequently on the Poudre River and may no longer occur with enough frequency to maintain extensive viable cottonwood woodlands along the mainstem. Moderate flood events may continue to promote the establishment of cottonwoods on channel bars and streambanks but appear insufficient to establish large stands of plains cottonwoods. The most substantial recent plains cottonwood recruitment observed along

the Poudre River is associated with the shores of reclaimed gravel pits. These sites provide the needed combination of a moist bare mineral substrate and supportive hydrology.

In a study of the lower Poudre River, Gilliam (2006) determined that meander migration produces only limited cottonwood establishment. Within this system, flooding results in the largest changes in channel shape by increasing channel width, promoting channel abandonment, and floodplain inundation. The changes within this system following floods are the primary controls on cottonwood regeneration.

Water development for irrigation, similar to what has occurred on the Poudre River for more than 125 years, generally decreases the total annual discharge and alters the shape of the hydrograph. There is typically some attenuation of the peak and a shortening and steepening of the receding limb of the hydrograph. This presents cottonwood seedlings with a more rapidly declining water table and may increase drought mortality. Summer flows may also be lower, producing additional drought stress on seedlings (Scott et al. 2000).

3.9.5.6 Spells Analysis

Spells Analysis combines elements of the flow duration analysis and flood frequency analysis. It is different from a flow duration analysis in that the Spells Analysis considers individual flow events rather than combining them. The Spells Analysis is different from a flood frequency analysis in that the Spells Analysis considers the duration of individual flood events, not just their occurrence. The Spells Analysis determines the flow that will inundate a selected elevation.

A Spells Analysis was used to gain insight into how river inundation may influence wetland and riparian vegetation along the mainstem of the Poudre River. A total of 49 points (elevations), distributed across 13 riparian vegetation transects at the six Poudre River study sites were evaluated for the current conditions modeled flow at which the point first became inundated, the number of times (spells) the point was inundated for a 26-year period of record (1980 to 2005), and the duration of that inundation. The points evaluated were distributed over a range of elevations, distances from the riverbank, and vegetation cover types (Table 3-32).

Table 3-32. Spells analysis of selected points along riparian transects for Poudre River study sites.

Study Site/Transect/ Point	Elevation NGVD (ft)	Approx. Distance from River Bank (ft)	Vegetation Cover Type[1]	Minimum Inundation Flow (cfs)	Number of Spells Inundated	Mean Duration of Spell (days)	No. of Years Inundated (out of 26 years)	% of Years Inundated
Watson Lake								
Transect 1								
WLT1.1	5,143.18	210	N/A	3,000	11	5.3	7	27
WLT1.2	5,140.93	75	NC-MGW	1,500	38	8.6	17	65
WLT1.3	5,139.10	10	RCH	800	102	10.0	26	100
WLT1.4	5,141.70	205	BE-NC-ROD W	3,000	11	5.3	7	27
WLT1.5	5,141.32	500	AM-RCH	3,000	11	5.3	7	27

Study Site/Transect/ Point	Elevation NGVD (ft)	Approx. Distance from River Bank (ft)	Vegetation Cover Type[1]	Minimum Inundation Flow (cfs)	Number of Spells Inundated	Mean Duration of Spell (days)	No. of Years Inundated (out of 26 years)	% of Years Inundated
Transect 2								
WLT2.1	5,137.65	50	BE-NC-ROD W	2,500	16	6.4	9	35
WLT2.2	5,135.85	350	BE-NC-ROD W	3,000	11	5.3	7	27
WLT2.3	5,133.65	450	AMH	2,300	16	8.0	11	42
Martinez Park								
Transect 2								
LMT2.1	4,971.81	375	ROW	2,000	17	7.8	11	42
LMT2.2	4,969.95	30	RCH	2,000	17	7.8	11	42
LMT2.3	4,971.52	5	PC-SB W	2,000	17	7.8	11	42
LMT2.4	4,965.25	140	OW	40	205	16.3	26	100
LMT2.5	4,972.45	180	PC-SW W	3,000	7	6.9	5	19
LMT2.6	4,970.47	250	PC-SB W	3,000	7	6.9	5	19
Transect 3								
LMT3.1	4,969.11	90	UG	2,500	13	6.4	7	27
LMT3.2	4,969.03	40	PC-SW W	3,200	7	5.7	4	15
LMT3.3	4,967.66	140	PC-SB W	3,200	7	5.7	4	15
LMT3.4	4,969.22	190	N/A	3,200	7	5.7	4	15
Archery Site								
Transect 1								
AT1.1	4,859.15	65	PC-PC-S W	4,000	1	28.0	2	8
AT1.2	4,857.28	100	PC-(PW)-SW[RC] W	1,900	19	7.1	10	38
Transect 2								
AT2.1	4,857.06	25	PC-SB W	2,500	11	6.0	7	27
AT2.2	4,853.46	40	SW-MG-[RC] S	100	206	6.0	26	100
AT2.3	4,851.38	50	OW	10	132	67.9	26	100
AT2.4	4,858.67	15	UG	4,600	2	6.5	1	4
Eastman Park								
Transect 2								
EPT2.1	4,760.65	40	SW-MG-[RC] S	330	44	12.0	16	62
EPT2.2	4,767.01	70	PC-SB W	2,200	16	6.8	10	38
EPT2.3	4,765.91	225	PC-SB W	2,200	16	6.8	10	38
EPT2.4	4,766.83	275	PC-SB W	2,100	20	6.2	10	38
EPT2.5	4,764.55	675	PC-SB W	2,100	20	6.2	10	38
Transect 3								
EPT3.1	4,760.54	305	PC-SB W	2,100	20	6.2	10	38
EPT3.2	4,762.18	40	PC-SB W	1,900	23	6.7	11	42
59th Avenue								
Transect 1								
59T1.1	4,694.35	145	PC-SB W	4,000	3	11.0	3	12
59T1.2	4,692.97	5	PC-SB W	980	24	13.2	11	42
59T1.3	4,686.93	10	RCH	160	136	10.5	25	96
59T1.4	4,694.00	5	PC-SB W	2,300	14	7.6	9	35
Transect 3a								
59T3a.1	4,687.76	280	PC-SB W	580	32	12.9	15	58
59T3a.2	4,691.19	230	PC-SB W	1,900	22	7.3	11	42
59T3a.3	4,691.62	5	PC-SB W	1,900	22	7.3	11	42
59T3a.4	4,688.31	35	RCH	1,820	112	11.1	11	42
59T3a.5	4,691.89	5	PC-SB W	2,100	19	6.9	11	42

Study Site/Transect/ Point	Elevation NGVD (ft)	Approx. Distance from River Bank (ft)	Vegetation Cover Type[1]	Minimum Inundation Flow (cfs)	Number of Spells Inundated	Mean Duration of Spell (days)	No. of Years Inundated (out of 26 years)	% of Years Inundated
Transect 3b								
59T3b.1	4,689.84	70	UG	580	32	12.9	15	58
59T3b.2	4,692.68	10	PC-SB W	2,000	19	7.5	11	42
59T3b.3	4,689.97	125	PC-SB W	850	21	16.6	11	42
59T3b.4	4,689.27	150	PC-SB W	850	21	16.6	11	42
Bird Farm								
Transect 2								
BF2.1	4,612.98	155	PC-SB W	1,500	24	9.8	11	42
Transect 3								
BR3.1	4,608.70	160	PC-PW-SW-RC W	2,200	17	7.0	11	42
BF3.2	4,608.95	5	UG	2,300	14	7.9	10	38
BF3.3	4,606.12	30	SW-MG-[RC] S	520	41	11.2	18	69
BF3.4	4,607.80	360	PC-SB W	1,500	24	9.8	11	42

[1] AM[RC] H - American Mannagrass[Reed Canarygrass] Herbaceous; BE-NC/ROD W - Boxelder-Narrowleaf Cottonwood/Red-Osier Dogwood Woodlands; N/A – Not Applicable; NC/MG W -Narrowleaf Cottonwood/Mesic Graminoid Woodlands; OW – Open Water; PC-(PW)/SW[RC] W - Plains Cottonwood-(Peachleaf Willow)/Sandbar Willow/[Reed Canarygrass] Woodland; PC/PC-S W - Plains Cottonwood/Prairie Cordgrass-Sedge Woodland; PC/SB W - Plains Cottonwood/Smooth Brome Woodland; PC/SW W - Plains Cottonwood/Slender Wheatgrass Woodland; RC H -Reed Canarygrass Herbaceous; RO W - Russian Olive Woodland; SW/MG-[RC] S - Sandbar Willow/Mesic Graminoid-[Reed Canarygrass] Shrubland; UG – Upland Grassland; NGVD - National Geodetic Vertical Datum.

About 57% of the points evaluated occurred in riparian woodlands dominated by plains cottonwood and 47% of the points evaluated occurred in the plains cottonwood-smooth brome woodland (PC-SB W) vegetation cover type. The plains cottonwood-smooth brome woodland is the most widely distributed riparian woodland along the mainstem of the Poudre River. Based on the Spells Analysis and current conditions modeled flows, the plains cottonwood-smooth brome woodland has a diversity of modeled inundation events ranging from being inundated 15% to 56% of the years in the 26-year period of record, with 7 to 32 inundation events (spells), and a mean duration varying from 1.0 day to 16.6 days per spell. This wide diversity of inundation signatures indicates the following regarding the most common riparian woodland along the Poudre River:

- The plains cottonwood-smooth brome woodland vegetation cover type is tolerant of a wide range of inundation frequency, tolerating as many as 32 inundation events over a 26-year period for a total of 414 days of inundation with a maximum duration of 83 days in 1983.
- This vegetation cover type does not rely on frequent inundation for continued support. At some sites the woodland is inundated as infrequently as 11% of the years, with no more than three spells with a mean duration of one day over the 27-year period of record.

More frequent modeled inundation events with longer mean duration for each event are typically associated with vegetation cover types that are not dominated by plains cottonwood (e.g., sandbar willow-mesic graminoid-reed canarygrass shrubland, narrowleaf cottonwood-mesic graminoid woodland, and boxelder-narrowleaf cottonwood-red osier dogwood woodland). These vegetation cover types were inundated 27% to 100% of the years of record with the

number of spells ranging from 11 to 27 and a mean duration of spell ranging from 5 days to 12 days. These vegetation cover types are less widely distributed than the plains cottonwood woodlands and typically occur at lower elevations in the riparian zone. The combination of increased inundation and lower elevations (with potentially shallower ground water levels) provide a hydrologic regime different than the widely distributed plains cottonwood woodland.

Flooding in the lower mainstem in 2010 provided the opportunity to determine how flood flows affect riparian vegetation establishment. On June 14 and 15, 2010, the Poudre River flows peaked at about 3,100 cfs at the Greeley Gage. These flows resulted in flooding along the mainstem from about Windsor to the confluence with the South Platte River. Flows of 3,100 cfs inundated all of the Eastman Park riparian transect points, all but one of the 59th Avenue riparian transect points, and all of the Bird Farm riparian transect points (Table 3-21). A post-flood review of these sites on July 2, 2010 and August 20, 2010 indicated floods of this magnitude (2,500 to 3,000 cfs) and duration (about three days) have very little long-term effect on riparian vegetation (ERO 2010c). While flood flows of this magnitude are sufficient to cause property damage (*Greeley Tribune* 2010), they are not sufficient to aid in substantial recruitment of woody riparian vegetation or produce dynamic changes to existing riparian vegetation (woody or herbaceous). Very little post-flood cottonwood seedling establishment was observed in 2010. The limited and localized areas of cottonwood seedling establishment typically occurred immediately adjacent to the river and within a narrow band of the active channel. There were no observations of cottonwood seedling establishment outside of the active channel. The lack of cottonwood seedling establishment except immediately adjacent to the river channel appears to be related to the lack of any extensive area of suitable bare mineral substrate.

On July 2, 2010, the Poudre River study sites were covered with cottonwood seed and the soils were moist and muddy from recent inundation. However, most of the potentially suitable areas for cottonwood seedling establishment at the Poudre River study sites are dominated by a dense cover of reed canarygrass within or adjacent to the active channel or by dense stands of smooth brome on the floodplain. The dense cover of these grasses competes with cottonwood seeds that germinate and prevents the establishment of cottonwood seedlings. Floods of the magnitude and duration that occurred in 2010 serve to promote the growth of smooth brome and reed canarygrass through irrigation and an input of nutrients, which in turn creates conditions more challenging for future cottonwood recruitment. Flood flows along the mainstem appear to no longer be capable of producing suitable habitat for the large-scale recruitment of plains cottonwood. Flood flows now appear to be part of a cycle that further advances the establishment of smooth brome and reed canarygrass, which in turn minimizes the potential for the establishment of cottonwood seedlings.

In 2011, overflow channels and backwaters were reviewed to determine if the high flows and prolonged inundation in 2011 had observable effects on riparian vegetation. Newly deposited sediments were observed in scattered locations along these features and newly established seedlings of green ash, silver maple, and chokecherry were observed. Green ash seedlings were relatively common along the banks of old channels and in newly deposited sediments at Martinez Park.

The Martinez Park site demonstrates the trajectory of the riparian woodlands associated with the Poudre River from about Fort Collins to the confluence with the South Platte River. This trajectory consists of the following elements:

- Plains cottonwood seedling establishment is rare and does not occur except in the active portions of the channel.
- Plains cottonwood recruitment is not keeping pace with plains cottonwood maturation and loss, and the recruitment by other woody riparian species.
- Other woody riparian species, which are more shade tolerant than plains cottonwood, are becoming established in the understory and as they mature, will continue to shade areas preventing the establishment of cottonwood seedlings.

These elements are combining to set the trajectory of the riparian woodlands associated with the Poudre River on a trend that increasingly resembles riparian and bottomland woodlands further to the east (e.g., Kansas, Nebraska, and Oklahoma). Green ash, the most common nonnative tree in the Martinez Park riparian woodlands, will likely replace plains cottonwood because it is more shade tolerant, can persist in a wide range of soils and moisture regimes, and can germinate, grow, and remain healthy despite long periods of flooding (ERO 2012d).

3.9.6 South Platte River

Herbaceous wetlands dominated by cattails, sedges, rushes, and grasses occur throughout the South Platte River floodplain below the confluence with the Poudre River to the Kersey Gage (CDOW 2004). On the south side of the South Platte River, some herbaceous wetlands are associated with an abandoned side channel that has areas of open water. Smaller areas of herbaceous wetlands border the north banks of the South Platte River or are associated with a tributary. Bare sand bars likely become colonized by sandbar willow at different times.

The riparian associations are similar to those on the Poudre River with plains cottonwood associations dominating the floodplain (CDOW 2004). Upland grasslands are interspersed between the stands of cottonwood. Other species likely associated with the cottonwood include peachleaf willow, crack willow, and green ash with a high cover of smooth brome in the understory.

3.10 WILDLIFE

3.10.1 Overview

The following section presents a description of wildlife and their habitats in the study areas. Wildlife resources discussed include migratory birds and raptors, big game, reptiles and amphibians, and other wildlife species. A list of common wildlife species that may occur in the reservoir and conveyance study areas is provided in Table 3-33. Riparian wildlife and habitat are described in Section 3.10.5 of the SDEIS. A detailed description of species expected to occur in the study areas, including their scientific names, is provided in the 2008 Wildlife Report (ERO 2008e).

The Corps is required to consider the effects of their decisions on wildlife resources (33 CFR 320.4). As directed by CRS 33-1-101-124, the Colorado Wildlife Commission issues regulations and develops management programs for wildlife, which are then implemented by CPW. Take of game species, such as deer, elk, pheasant, quail, and some species of waterfowl, is permitted through a hunting license. Take of nongame species, such as small mammals, birds, and reptiles, is permitted for specific activities such as scientific collecting.

Migratory birds, including raptors, and any active nests, are protected under the Migratory Bird Treaty Act (MBTA). The MBTA prohibits activities by the project sponsors that may harm migratory birds, their young, or their eggs, including the removal of active nests that results in the loss of eggs or young. In Colorado, most nongame birds except for European starling, house sparrow, and rock dove (pigeon) are protected under the MBTA (§§ 703-712).

The Bald and Golden Eagle Protection Act (BGEPA) (16 United States Code [USC] 668 *et seq*.), administered by the USFWS, protects bald eagles, including active nest sites and habitat. In 2007, "disturb" under the BGEPA was further defined to mean agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause (based on the best scientific information available) (1) injury to an eagle; (2) a decrease in its productivity by substantially interfering with normal breeding, feeding, or sheltering behavior; or (3) nest abandonment by substantially interfering with normal breeding, feeding, or sheltering behavior (16 USC 668c; 50 CFR 22.3). The USFWS defines as *Inactive nest* as a bald eagle or golden eagle nest that is not currently being used by eagles as determined by the continuing absence of any adult, egg, or dependent young at the nest for at least 10 consecutive days immediately prior to, and including, at present (50 CFR §22.3). However, CPW defines an active raptor nest as "Any nest that is frequented or occupied by a raptor during the breeding season, or which has been active in any of the five previous breeding seasons. Many raptors use alternate nests in various years. Thus, a nest may be active even if it is not occupied in a given year" (CDOW 2008). The USFWS has published bald eagle management guidelines that include recommended buffer distances surrounding active nest sites.

The Fish and Wildlife Coordination Act requires the federal action agency to consult with the USFWS and the CPW where the "waters of any stream or other body of water are proposed or authorized, permitted or licensed to be impounded, diverted or otherwise controlled or modified"

by any agency under a Federal permit or license. Consultation is to be undertaken for the purpose of "preventing loss of and damage to wildlife resources" (16 USC 661–667e). A Fish and Wildlife Coordination Act report will be completed as part of the Final EIS.

The State of Colorado requires that CPW and the CWCB review and provide input on mitigation for fish and wildlife impacts resulting from a federally approved water project (CRS 37-60-122.2). The rules at Section 1604B instruct the Wildlife Commission to ensure that "the mitigation plan is economically reasonable and reflects a balance between protecting the fish and wildlife resources and the need to develop the State's water resources." Prior to the FEIS, the District will coordinate directly with CPW to develop a mitigation plan that addresses impacts to fish and wildlife resources. The state fish and wildlife mitigation plan will be available for public review and comment and the Colorado Wildlife Commission will hold hearings on the mitigation plan between the SDEIS and FEIS.

Table 3-33. Common wildlife species potentially occurring in the reservoir and conveyance system study areas.

Habitat	Mammals	Birds	Reptiles and Amphibians
All habitats (except water)	Mule deer, eastern cottontail rabbit, fox squirrel, striped skunk, raccoon, red fox, coyote, plains pocket gopher deer mouse	American robin, black-capped chickadee, spotted towhee, northern flicker, house finch, house sparrow, western meadowlark, Canada goose, red-tailed hawk, mourning dove, American crow, great horned owl	Plains, western terrestrial, and common gartersnakes; eastern fence lizard, short-horned lizard, bullsnake, western hognose snake, plains milk snake, western rattlesnake
Grassland (includes native prairie, pastures, agricultural fields, and open space)	White-tailed deer, pronghorn, raccoon, skunk, coyote, red fox, swift fox, badger, black-tailed jackrabbit; desert, eastern, and mountain cottontail rabbit, cottontail rabbit, Ord's kangaroo rat, black-tailed prairie dog, thirteen-lined ground squirrel, spotted ground squirrel, plains pocket gopher; olive-backed, plains, and hispid pocket mouse; deer mouse, prairie vole	Raptors, spotted towhee, scrub jay, dusky flycatcher, green-tailed towhee, western meadowlark, lark sparrow, vesper sparrow, killdeer, horned lark, mourning dove, eastern kingbird, black-billed magpie, waterfowl	Plains spadefoot, Great Plains toad, Woodhouse's toad, box turtle, many-lined skink, six-lined racerunner, lesser earless lizard, eastern yellow-bellied racer, plains black-headed snake
Grasslands with prairie dog colonies	Black-tailed prairie dog, badger, coyote, grasshopper mouse	Raptors, burrowing owl, horned lark, mountain plover	Rattlesnake

Habitat	Mammals	Birds	Reptiles and Amphibians
Riparian and wetland	White-tailed deer, raccoon, meadow vole, western harvest mouse, striped skunk, white-footed mouse, hoary bat, little brown myotis, silver-haired bat	Raptors, red-winged blackbird, yellow-headed blackbird, song sparrow, common snipe, great blue heron, house wren, Bullock's oriole, northern flicker, tree swallow, yellow warbler, blue grosbeak, Lazuli bunting, common yellowthroat, American goldfinch, black-capped chickadee, black-headed grosbeak, western wood Pewee, Lewis's woodpecker, downy woodpecker	Plains spadefoot, northern leopard frog, Woodhouse's toad, tiger salamander, bullfrog, western chorus frog; painted, soft-shelled, ornate, and snapping turtle; northern water snake, bull snake, eastern yellow-bellied racer, prairie rattlesnake
Open water: lakes, ponds, rivers (Poudre and South Platte River corridors)	American beaver, muskrat	Raptors, red-winged blackbird, yellow-headed blackbird, song sparrow, common snipe, American coot, American widgeon, blue-winged teal, mallard, spotted sandpiper, American avocet, wood duck, Canada goose, loon, grebe, cormorant, heron, ibis, rail, crane, gull, tern	Common gartersnake, northern leopard frog, Woodhouse's toad, tiger salamander, bullfrog, western chorus frog; painted, soft-shelled, ornate, and snapping turtle; northern water snake
Foothills habitats (xeric shrub and grassland) and rocky habitat	Elk, mountain lion, black bear, bushy tailed wood rat, Mexican wood rat, rock squirrel, rock mouse, little brown myotis, big brown bat	Raptors, cliff swallow	Rattlesnake, black-headed snake, plateau lizard

Source: Fitzgerald et al. 1994; Colorado Breeding Bird Atlas II (COBBAII) 2014; Hammerson 1999.

Subsequent to the DEIS, the CPW revised the Colorado Natural Diversity Information Source (NDIS). The NDIS is a combined effort of several agencies and hosted by Colorado State University to provide information on hunting, fishing, wildlife, habitat, and conservation planning in Colorado. The revised NDIS (CPW 2013) was used to update descriptions of the affected environment for wildlife in the NISP study areas for the SDEIS. Elk habitat mapping in the vicinity of the Glade Reservoir study area was revised in coordination with the CPW (Vieira 2009). Relevant changes in wildlife habitat mapping from 2005 include:

- Mule deer severe winter range mapping has greatly expanded and includes parts of the Glade to Horsetooth and Carter pipeline study areas and a large area west of the Glade Reservoir study area.
- Pronghorn severe winter range mapping has expanded considerably and includes the entire Galeton Reservoir study area and part of the SPWCP pipeline corridor.
- A large white-tailed deer concentration area between the towns of Wellington and Ault has been added.
- Elk winter range mapping has expanded to part of the Glade Reservoir study area and an area northwest of it.

Prairie dog mapping was not revised subsequent to the DEIS because maps of individual black-tailed prairie dog colonies are no longer available from NDIS. Because they typically change over time, it is assumed that any changes in prairie dog colonies that may have occurred at the reservoir study areas were of similar extent. For the DEIS, ERO obtained NDIS data and verified the size and extent of prairie dog colonies at the reservoir sites during field surveys.

Federally listed threatened and endangered species, Colorado state species of concern, and rare and imperiled species tracked by the CNHP are referred to in this document as Special Status Species and are addressed in Section 3.11.

3.10.2 Proposed Reservoir Sites

3.10.2.1 Glade

Information on wildlife in the Glade Reservoir study area can be found in Section 3.14.3 of the DEIS. A portion of Glade Reservoir has elk, mule deer, and white-tailed deer ranges and concentration areas. These areas and ranges are shown in Figure 3-28.

3.10.2.2 Galeton

Information on wildlife in the Galeton Reservoir study area can be found in Section 3.14.4 of the DEIS. Concentration areas and ranges of big game species are shown in Figure 3-29, Figure 3-30, and Figure 3-31.

3.10.2.3 Cactus Hill

Information on wildlife in the Cactus Hill Reservoir study area can be found in Section 3.14.5 of the DEIS. Concentration areas and ranges of big game species are shown in Figure 3-29, Figure 3-30, and Figure 3-31.

3.10.3 Conveyance Systems

3.10.3.1 SPWCP Pipeline Study Area

Wildlife and habitat within the SPWCP pipeline study area are described in Section 3.14.6 of the DEIS. Mule deer severe winter range and a white-tailed deer concentration area occur within the SPWCP study area. The northern end of the study area traverses a pronghorn winter concentration area and pronghorn severe winter range. Concentration areas and ranges of big game species are shown in Figure 3-29, Figure 3-30, and Figure 3-31.

3.10.3.2 Glade to Horsetooth Study Area

Wildlife and habitat within the Glade to Horsetooth pipeline study area are described in Section 3.14.7 of the DEIS. The entire Glade to Horsetooth pipeline study area includes a muledeer

winter concentration area and a white-tailed deer concentration area. These areas and ranges are shown in Figure 3-28.

3.10.3.3 Carter Pipeline Study Area

Wildlife and habitat within the Carter pipeline study area are described in Section 3.14.9 of the DEIS.

3.10.3.4 Poudre Valley Canal Study Area

Wildlife and habitat within the Poudre Valley Canal Study Area are described in Section 3.14.10 of the DEIS.

3.10.4 No Action Irrigated Lands

Areas proposed for the transfer of agricultural uses to municipal uses are irrigated agricultural lands used for cultivation of alfalfa, corn, hay, and other crops or as pastureland. Big game such as pronghorn, mule deer, and white-tailed deer, as well as raccoons and skunks, potentially forage in these areas. Waterfowl may stop in fields to rest and feed during winter, spring, and fall migration. Raptors may forage in these areas, which likely support numerous small mammals.

Figure 3-28. Big Game Habitat at Glade Reservoir, U.S. 287 Realignment, and Glade to Horsetooth and Carter Pipeline Study Areas.

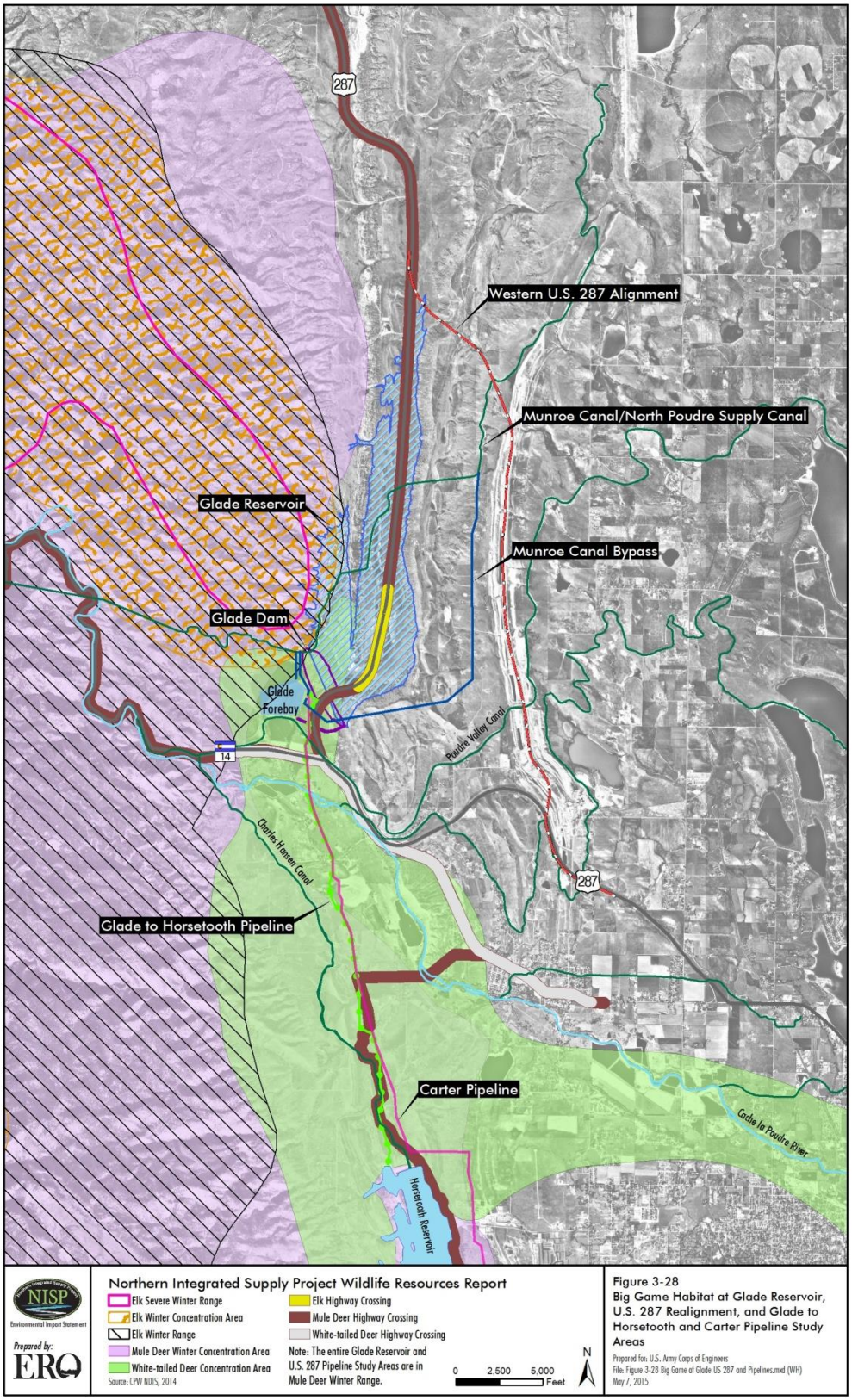
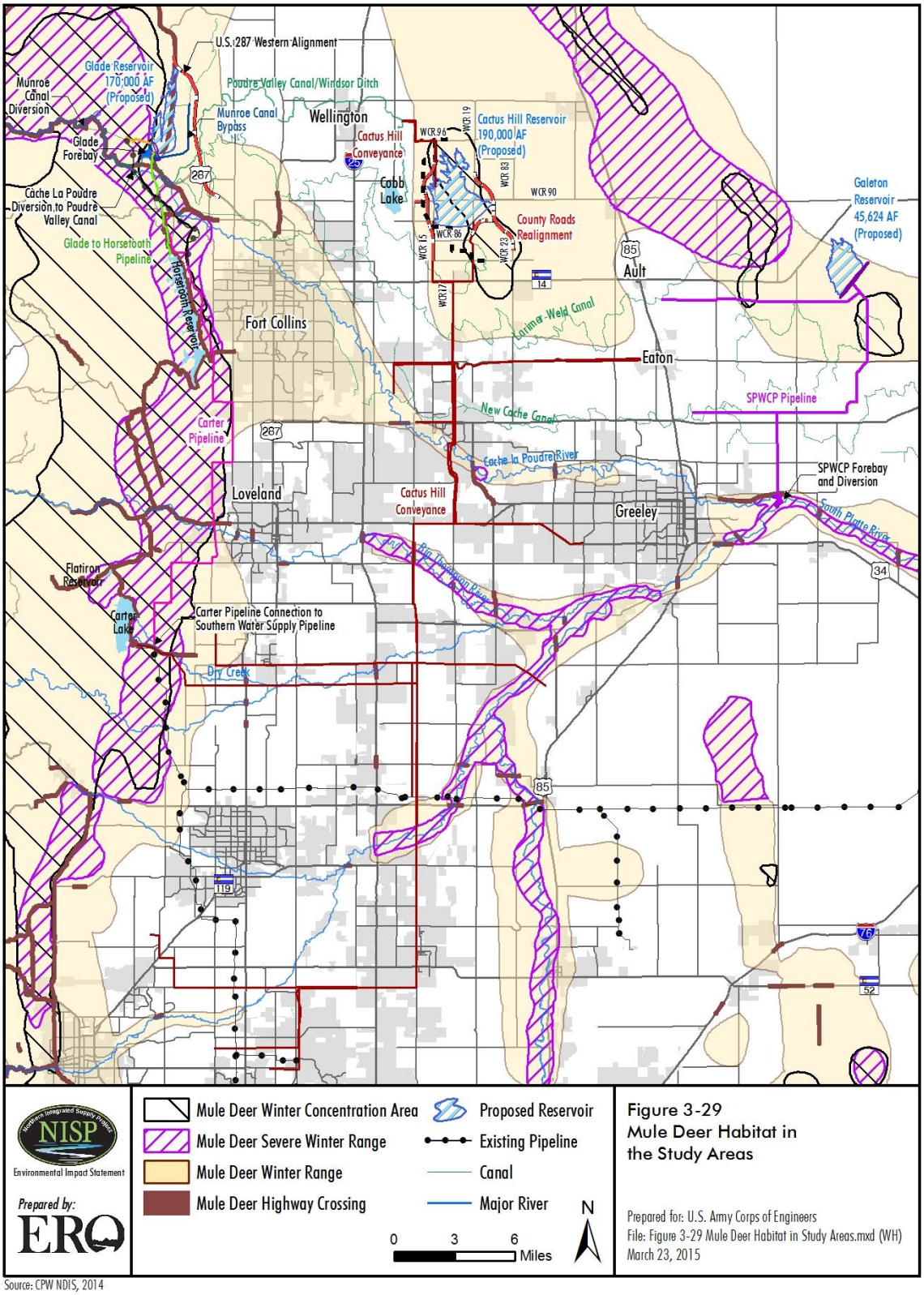


Figure 3-29. Mule Deer Habitat in Study Areas.



Source: CPW NDIS, 2014

Figure 3-30. White-tailed Deer Habitat in the Study Areas.

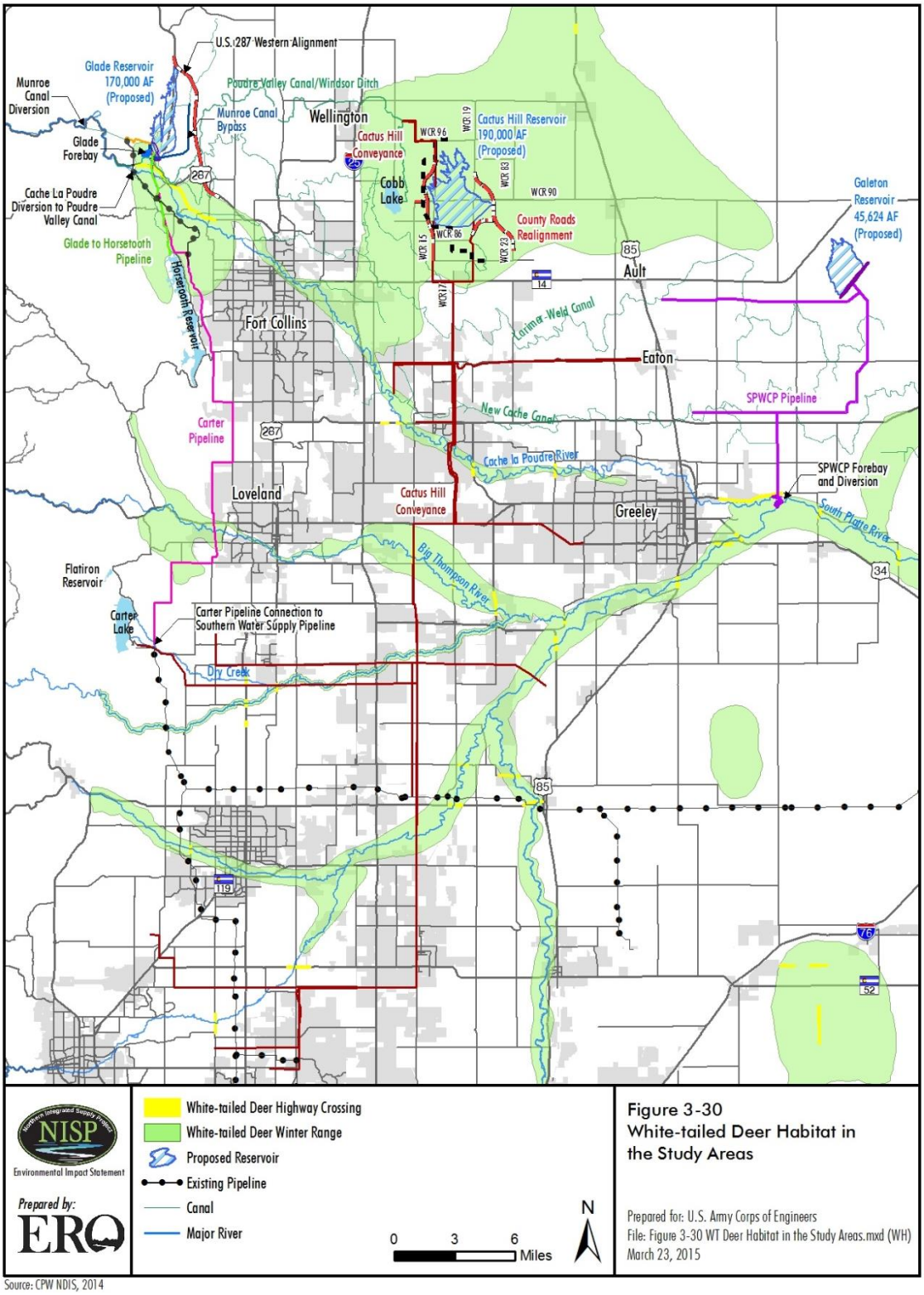
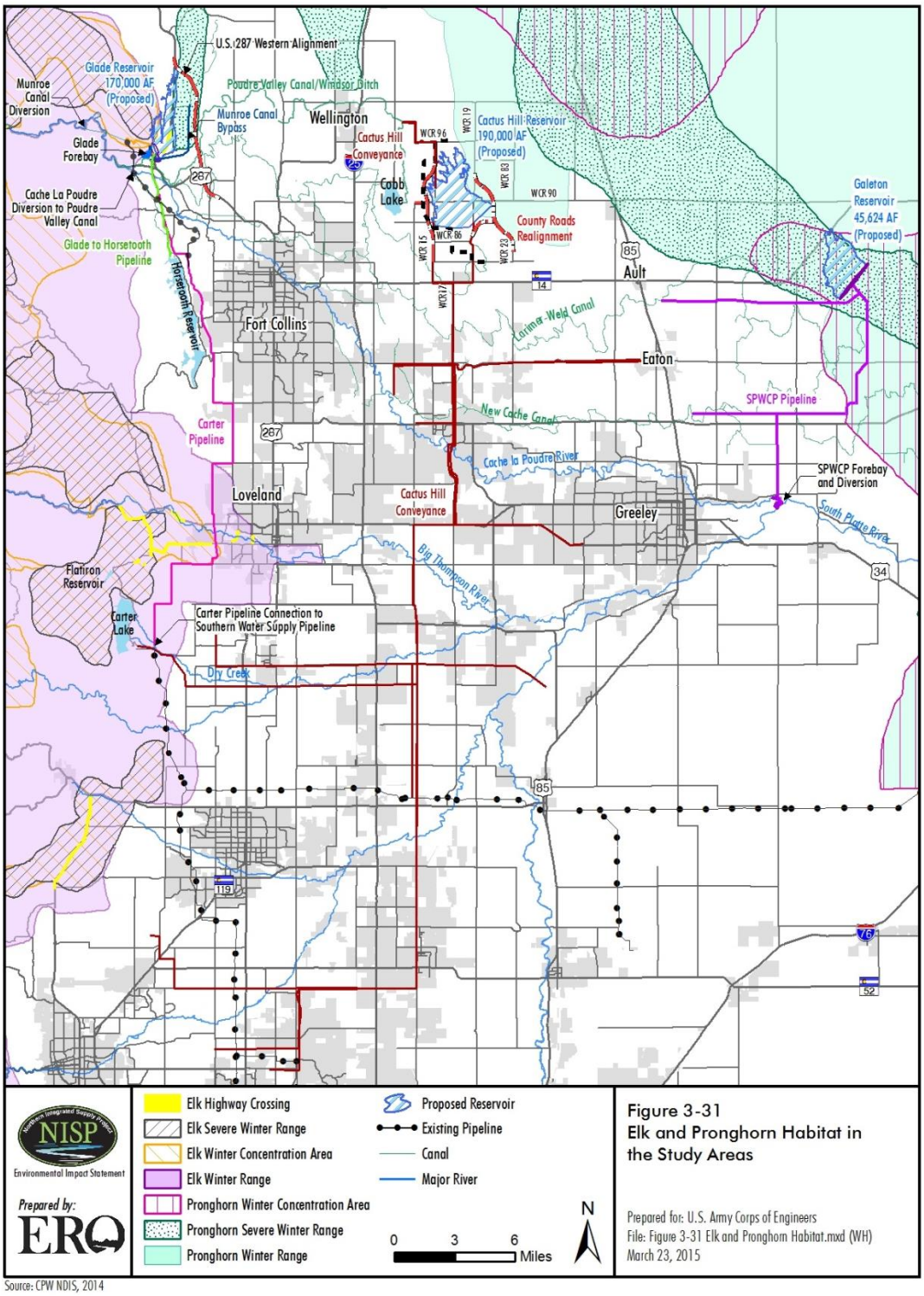


Figure 3-31. Elk and Pronghorn Habitat in the Study Areas.



Source: CPW NDIS, 2014

3.10.5 Poudre and South Platte River Corridors

The diversity of habitats along the Poudre and South Platte River riparian corridors are important resources for existing wildlife. Many species use the riparian habitat for cover, resting, foraging, breeding, nesting, and roosting. Riparian corridors are especially important to wildlife in urban areas, such as the cities of Fort Collins, Windsor, and Greeley, where riparian vegetation provides a refuge from developed and landscaped areas. Streams and ponds adjacent to riparian habitat provide an important source of food in the form of emerged adult aquatic insects for bats, lizards, and insectivorous birds (Nakano and Murakami 2001; Baxter et al. 2005; Macdade et al. 2011). Habitats along the Poudre River include cottonwood woodlands, mixed species woodlands, upland and riparian shrublands, upland and mesic grasslands, wetlands, and open water often with emergent vegetation along the edges. Maps of wetland, riparian and upland habitat along the Poudre River can be found in the Wetlands and Riparian Resources Baseline Technical Report (ERO 2012d). Many species of wildlife rely on these habitats for all or some of their life cycle. The Fort Collins Natural Areas Program has documented 230 species of birds, 32 species of mammals, 5 species of amphibians, and 8 species of reptiles within the Poudre River corridor from Highway 14 to I-25 (Fort Collins Natural Areas Program 2011). The Fort Collins Audubon Society also provides a list of birds found in Larimer County (Fort Collins Audubon Society 2004). In 2007 the Fort Collins Audubon Society nominated a 22-mile reach of the Poudre River downstream of the community of Bellvue to be designated as the Cache la Poudre Urban River Corridor Important Bird Area. Important Bird Areas are sites that provide essential habitat for one or more species of birds (National Audubon Society 2010). As of June 2014, this reach of the Poudre River has not been designated as an Important Bird Area by the Audubon Society.

Where development occurs close to the Poudre River, a narrow band of riparian vegetation provides important habitat for wildlife. Areas with broader riparian and natural vegetation, such as at some of the Fort Collins Natural Areas (McMurry, Salyer, River's Edge, Running Deer, and more) and closer to the confluence with the South Platte River have higher species diversity and abundance, especially bird species. The greater structural diversity of woodlands dominated by cottonwood and other species create more habitat types that tend to have a greater number of species and higher abundance.

Common mammals in the riparian corridor along the Poudre River and South Platte River are Eastern cottontail rabbit, fox squirrel, striped skunk, raccoon, red fox, coyote, Plains pocket gopher, and deer mouse. Many of these species are generalist and can be found in different habitats, ranging from upland grassland to cottonwood woodlands. Mule deer and white-tailed deer also are common in the Poudre River riparian corridor. While not common, larger mammals such as black bear, mountain lion, and bob cat may occasionally use the riparian corridor, especially on the higher reaches near the canyon mouth. White-tailed deer winter range and concentration areas occur throughout the Poudre River corridor study area (Figure 3-30).

Many neotropical migrant bird species use the riparian corridor for either foraging, nesting, or resting. Species commonly associated with upland and riparian shrublands include yellow warbler, song sparrow, blue grosbeak, Lazuli bunting, and common yellowthroat. Breeding

birds commonly found in mixed species and cottonwood woodlands include Bullock's oriole, American goldfinch, yellow warbler, black-capped chickadee, black-headed grosbeak, and western wood pewee**.** Cottonwood woodlands provide nesting sites for cavity nesting species such as house wren, Lewis's woodpecker, downy woodpecker, and northern flicker, communally nesting species such as great blue heron, and raptors including red-tailed hawk, Swainson's hawk, Cooper's hawk, sharp-shinned hawk, and great-horned owl. As described in greater detail in the 2008 Species of Concern Report (ERO 2008f), bald eagles nest in large cottonwoods located along the Poudre River corridor. Many other raptor species may take shelter or forage in the riparian corridor during winter or migration.

The many ponds along the riparian corridor (mostly created from past gravel mining) provide open water habitat for water fowl including wood ducks, mallards, Canada geese, loons, grebes, cormorants, herons, ibises, rails, cranes, avocets, sandpipers, gulls, and terns. Habitats along pond margins provide breeding and foraging habitat for songbirds such as song sparrows, common yellowthroat, and both yellow-headed and red-winged blackbirds. The ponds also provide habitat for amphibians including western chorus frog, Woodhouse's toad, Plains spadefoot, and bullfrog, an introduced species. Reptiles include bull snake, eastern yellow--bellied racer, Western terrestrial garter snake, Plains garter snake, common garter snake, prairie rattlesnake, snapping turtle, painted turtle, and ornate box turtle.

3.11 SPECIAL STATUS SPECIES

3.11.1 Overview

This section discusses the special status species that may occur in the NISP study areas. Special status species include Federal and State listed threatened, endangered, and candidate species and CNHP listed species. Additional information about these species can be found in Section 3.16 of the DEIS. A detailed description of species of concern expected to occur in the study areas is provided in the 2008 Species of Concern Report (ERO 2008f) and the 2015 Species of Concern Supplement (ERO 2014c).

Federally threatened and endangered species are protected under the Endangered Species Act of 1973 (16 USC 1531 et seq.). The ESA provides a program for the conservation of threatened and endangered plants and animals and the habitats in which they are found. The law requires federal agencies, in consultation with the U.S. Fish and Wildlife Service (terrestrial and freshwater species) and/or the NOAA Fisheries Service (marine species), to ensure that actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of designated critical habitat of such species. The law also prohibits any action that causes a "taking" of any listed species of endangered fish or wildlife. Consultations are not required for effects to candidate species; however, if a species were to become listed during project planning or construction, consultation with the USFWS would be required. The Corps submitted a Biological Assessment (BA) to the USFWS in August 2007 (Appendix B of the DEIS). Prior to issuance of the FEIS or a ROD, the Corps will reinitiate consultation with USFWS to address potential effects to federally listed species as part of the Section 7 consultation process.

Colorado maintains a list of species determined to be endangered or threatened within the State (CRS 33-2-102-106). State-listed wildlife species are protected by Colorado wildlife statutes concerning nongame and endangered species conservation, which are enforced by the CPW (CRS 33-2-101-108). Although state statutes prohibit the take, possession, and sale of a state-listed species, it does not include protection of their habitat.

The Fish and Wildlife Coordination Act requires the federal action agency to consult with the USFWS and the fish and wildlife agencies of States where the “waters of any stream or other body of water are proposed or authorized, permitted or licensed to be impounded, diverted . . . or otherwise controlled or modified” by any agency under a Federal permit or license. Consultation is to be undertaken for the purpose of “preventing loss of and damage to wildlife resources” (16 USC 661-667e). State-listed species would be considered during such consultation with the CPW and development of the state fish and wildlife mitigation plan (see Section 3.10.1). Table 3-34 Table 3-34 shows federally listed threatened, endangered, and candidate species that the USFWS has identified as potentially occurring in each study area (USFWS 2014). Habitat potential of all study areas is rated for each species according to the quantity, quality, and type of habitat available. On July 9, 2007, the bald eagle was removed from the list of threatened and endangered species (72 Federal Register [FR] 32346 [July 9, 2007]). The bald eagle continues to

be federally protected under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA), and is also discussed in this section.

Table 3-34. Federally listed endangered, threatened, and candidate species potentially occurring in the reservoir and conveyance system study areas and habitat potential.

Common Name	Scientific Name	Federal Status[1,2]	Habitat	Habitat Potential					
				Glade	U.S. 287 Realign-ment	Cactus Hill	Galeton	Pipelines and Other Facilities	No Action
Mammals									
Canada lynx	*Lynx canadensis*	T	Spruce/fir forests	0	0	0	0	0	0
Black-footed ferret	*Mustela nigripes*	E	Rangeland and shortgrass prairie with large prairie dog colonies	0	0	0	0	0	0
Preble's meadow jumping mouse	*Zapus hudsonius preblei*	T	Wetland and riparian areas with shrubs	3	1	0	0	3	2
Birds									
Mexican spotted owl	*Strix occidentalis lucida*	T	Old growth forests with cliffs	0	0	0	0	0	0
Plants									
Colorado butterfly plant	*Gaura neomexicana coloradensis*	T	Floodplains	1	1	0	0	2	2
Ute ladies'-tresses orchid	*Spiranthes diluvialis*	T	Floodplains and subirrigated wetlands	1	1	0	0	2	2

Source: USFWS 2014.
[1]E = Endangered; T = Threatened, C = Candidate
[2]The bald eagle has been removed from the list of threatened and endangered wildlife and is now protected under the MBTA and BGEPA.
Habitat rating:
0 = No habitat
1 = Limited habitat present, species unlikely to occur
2 = Potential breeding and foraging habitat for wildlife, and potential habitat for plants
3 = Known to occur

The black-footed ferret, Preble's meadow jumping mouse (Preble's), Colorado butterfly plant (CBP), and Ute ladies'-tresses orchid (ULTO) are the only federally listed species potentially occurring in the study areas. Critical habitat has been designated for Preble's (75 Fed. Reg. 78430 [December 15, 2010]). The closest designated critical habitat for Preble's to the NISP study areas is the North Fork Cache la Poudre critical habitat unit several miles to the west of the Glade Reservoir site. The bald eagle also potentially occurs in the study areas.

Depletions to the Poudre and South Platte Rivers associated with all of the alternatives have the potential to affect federally listed species and their designated critical habitat in Nebraska. Whooping crane (*Grus americana*), least tern (*Sterna antillarum*), Eskimo curlew (*Numenius borealis*), piping plover (*Charadrius melodus*), pallid sturgeon (*Scaphirhynchus albus*), and western prairie fringed orchid (*Platanthera praeclara*) are species that rely heavily on habitat

provided by the Platte River system in central Nebraska. Whooping crane, least tern, Eskimo curlew, and piping plover may migrate through Colorado or may occasionally nest on wide, sandy shores of reservoirs, typically in eastern Colorado. These species are addressed in the Biological Opinion (DEIS, Appendix B).

State species of concern include species that are not already protected under ESA but that are listed by the CPW as state threatened, endangered, or of special concern; and species ranked as rare, vulnerable, or imperiled in the State by the CNHP. State species of concern potentially occurring in the study areas and their status are presented in Table 3-35.

Table 3-35. State-listed endangered, threatened, and candidate species, and CNHP sensitive species potentially occurring in each study area.

Common Name	Scientific Name	State Status[1]	CNHP Rank[2]	Habitat	Possible Location[3]
Mammals					
Black-tailed prairie dog	*Cynomys ludovicianus*	SC	G3/4, S3	Rangeland; shortgrass prairie	All
Townsend's big-eared bat	*Plecotus townsendii*	SC	G4, S2	Woodlands with rocky outcrops	GL, U.S. 287, GL-HT, CP
Dwarf shrew	*Sorex nanus*		G4, S2	Alpine areas to shrubby, wooded foothills	GL, U.S. 287, GL-HT, CP
Swift fox	*Vulpes velox*	SC	G3, S3	Shortgrass prairie	GL, U.S. 287, GA, CH, SPWCP, PVC, NA
Birds					
Bald eagle	*Haliaeetus leucocephalus*	ST	G5, S1/3	Trees and cliffs, rivers, large lakes; forages in rivers and lakes	GL, GL-HT, CLP/SP
Burrowing owl	*Athene cunicularia*	ST	G4, S4	Rangeland and shortgrass prairie containing prairie dog colonies	All
Ferruginous hawk	*Buteo regalis*	SC	G4, S3	Shortgrass prairie	GL, U.S. 287, GA, CH, GL-HT, CP, SPWCP, PVC
McCown's longspur	*Calcarius mccownii*		G5, S2	Rangeland and shortgrass prairie	GA, CH, SPWCP, PVC
Chestnut-collared longspur	*Calcarius ornatus*		G5, S1	Shortgrass prairie	GA, CH, SPWCP, PVC
Mountain plover	*Charadrius montanus*	SC	G2, S2	Rangeland and shortgrass prairie	GA, CH, SPWCP
Peregrine falcon	*Falco peregrinus*	SC	G4, S2	Steep cliffs and canyons	GL, U.S. 287, GL-HT
Black-necked stilt	*Himantopus mexicanus*		G5, S3	Freshwater lakes, ponds, and marshes	GL, U.S. 287, NA
Long-billed curlew	*Numenius americanus*	SC	G5, S2	Native grassland and shortgrass prairie	GA, CH, SPWCP

Common Name	Scientific Name	State Status[1]	CNHP Rank[2]	Habitat	Possible Location[3]
Reptiles					
Common gartersnake	*Thamnophis sirtalis parietalis*	SC	NI	Wetland and riparian areas	GL, U.S. 287, CH, NA, GL-HT, CP, PVC, SPWCP, P-SP
Amphibians					
Northern leopard frog	*Rana pipiens*	SC	G5, S3	Wetlands	GL, U.S. 287, CH, NA, GL-HT, CP, PVC, SPWCP, P-SP
Fish					
Brassy minnow	*Hybognathus hankinsoni*	ST	G5, S3	Small, cool streams with sand or gravel substrate and aquatic vegetation	P-SP
Common shiner	*Luxilus cornutus*	ST	G5, S2	Small, cool streams with sand or gravel substrate and aquatic vegetation	P-SP
Iowa darter	*Etheostoma exile*	SC	G5, S3	Cool, clear streams of low to medium gradients with overhanging vegetation and undercut banks	P-SP
Insects					
Simius roadside skipper	*Amblyscirtes simius*		G4, S3	Open pinyon-juniper and shortgrass prairie dominated by blue grama	GL, GL-HT, CP
Arogos skipper	*Atrytone arogos*		G3/4, S2	Grasslands with abundance of big bluestem	GL, U.S. 287, GL-HT, CP
Dusted skipper	*Atrytonopsis hianna*		G4/5, S2	Mid-tallgrass prairie with abundance of big and little bluestem	GL, U.S. 287, GL-HT, CP
Kohler's fritillary	*Boloria selene sabulocallus*		G5T2/S1S2	Wet meadows and open areas of shrub wetlands	GL, U.S. 287, CH, NA, GL-HT, CP, PVC, SPWCP, P-SP
Moss' elfin	*Callophrys mossii*		G3/4, S2/3	Steep cliffs and canyons containing yellow stonecrop	GL, U.S. 287
Hops feeding azure	*Celastrina humulus*		G2/3, S2	Foothills, canyons usually with abundance of hops	GL, GL-HT, CP
Mottled duskywing	*Erynnis martialis*		G3/4, S2/3	Scrub-oak woodlands with abundance of buckbrush	GL, U.S. 287, GL-HT, CP
Two-spotted skipper	*Euphyes bimacula*		G4, S2	Sedge dominated meadows	GL, U.S. 287, GL-HT, CP, PVC, SPWCP

Common Name	Scientific Name	State Status[1]	CNHP Rank[2]	Habitat	Possible Location[3]
Ottoe skipper	*Hesperia ottoe*		G3/4, S2	Mid-tallgrass prairie with abundance of big bluestem	GL, U.S. 287, GL-HT, CP
Rhesus skipper	*Polites rhesus*		G4, S2/3	Shortgrass prairie dominated by blue grama	GL, U.S. 287, GA, GH, GL-HT, CP, SPWCP, PVC
Smoky-eyed brown butterfly	*Satyrodes eurydice fumosa*		G5, S1	Tallgrass prairie with abundance of sedges	GL, U.S. 287, GL-HT, CP, PVC, SPWCP
Regal fritillary	*Speyeria idalia*		G3, S1	Tallgrass prairie	GL, U.S. 287, GL-HT, CP, PVC, SPWCP
Plants[4]					
Lavender hyssop	*Agastache foeniculum*		G4/5, S1	Woodlands, stream bank, and riparian habitat within shortgrass prairie	GL, U.S. 287, CP
Rocky Mountain sedge	*Carex saximontana*		G5, S1	Pine forests, riparian woodlands	GL
Bell's twinpod	*Physaria bellii*		G2, S2	Dry, loose shale	GL, U.S. 287, GL-HT, CP
American currant	*Ribes americanum*		G5, S2	Moist woods and riparian woodlands at the base of foothills	GL, P-SP

[1]SE = State Endangered ST = State Threatened SC = Species of Concern

[2]CNHP Ranks:

G1 = Critically imperiled globally because of extreme rarity (5 or fewer occurrences or very few remaining individuals), or because of some factor of its biology making it especially vulnerable to extinction. (Critically endangered throughout its range.)

G2 = Imperiled globally because of rarity (6 to 20 occurrences) or because of other factors demonstrably making it very vulnerable to extinction throughout its range. (Endangered throughout its range.)

G3 = Vulnerable throughout its range or found locally in a restricted range (21 to 100 occurrences) (Threatened throughout its range.)

G4 = Apparently secure globally, though it might be quite rare in parts of its range, especially at the periphery.

GU = Unable to assign rank due to lack of available information.

S1 = Critically imperiled in state because of extreme rarity (5 or fewer occurrences, or very few remaining individuals, or because of some factor of its biology making it especially vulnerable to extirpation from the State. (Critically endangered in state.)

S2 = Imperiled in state because of rarity (6 to 20 occurrences) or because of other factors demonstrably making it very vulnerable to extirpation from the State. (Endangered or threatened in state.)

S3 = Vulnerable in state (21 to 100 occurrences).

S4 = Apparently secure in the State, though it might be quite rare in parts of its range, especially at the periphery.

SH = Extirpated or extinct from the State.

NI = No information.

T(1-5) = Trinomial Rank – Used for subspecies. These species are ranked on the same criteria as G1 to G5.

[3]Study Area Location Codes:

Glade Reservoir = GL, Galeton Reservoir = GA, Cactus Hill Reservoir = CH, Glade to Horsetooth pipeline = GL-HT, U.S. 287 realignment = U.S. 287, CP = Carter pipeline, South Platte Water Conservation Project = SPWCP, Poudre Valley canal = PVC, NA – No Action Alternative, Poudre–South Platte River corridor = P-SP.

[4]Only includes plants ranked as S1 or S2.

3.11.2 Proposed Reservoir Sites

3.11.2.1 Glade

3.11.2.1.1 Federally Listed Threatened, Endangered, and Candidate Species

Black-footed Ferret

In September 2009, the USFWS (2009) determined that eastern Colorado, including the entire NISP study area, no longer contains any wild free-ranging black-footed ferrets. Thus, no habitat for the black-footed ferret occurs at any proposed reservoir sites.

Preble's Meadow Jumping Mouse

Potential Preble's habitat in the study areas is shown on Figure 3-32. Two adult Preble's were captured on August 10, 2004, immediately southwest of the Glade Reservoir study area along an unnamed tributary to the Poudre River (ERO 2006aj). Additionally, Preble's are known to occur along portions of the Poudre River approximately 3 miles south of the Glade Reservoir study area.

Colorado Butterfly Plant

CBP was not found during vegetation surveys of the Glade Reservoir (including U.S. 287 realignment) study area (ERO 2008f). A CBP survey and habitat assessment report was submitted to the USFWS for the Glade study area. Although no CBP were found during surveys, the USFWS requested that all areas with suitable habitat be surveyed for 2 years before construction (USFWS 2007; Mayo, pers. comm. 2007).

Ute Ladies'-tresses Orchid

A ULTO survey and habitat assessment report was submitted to the USFWS for the Glade Reservoir study area. Although no occurrence of ULTO was found during surveys (ERO 2008f), the ULTO has been found near Fort Collins. Therefore, the USFWS recommends all suitable habitat be surveyed for 2 years prior to construction (USFWS 2007; Mayo, pers. comm. 2007).

3.11.2.1.2 State Species of Concern

As described above, one small prairie dog town occurs on the northeastern side of the Glade Reservoir study area. The extreme northern end of the Glade Reservoir study area is designated as swift fox overall range (CPW 2013). Marginal breeding habitat for peregrine falcon occurs in rocky outcrops and cliff areas located on the hogbacks in the study area. Two common gartersnakes were observed near an unnamed drainage, and leopard frogs were observed in wetland areas in the southern portion of the Glade Reservoir study area. One historical record (1890) of lavender hyssop occurs southwest of the Glade Reservoir study area near Rist Canyon (CNHP 2011). Potential habitat for this species may occur along the drainages of the Glade Reservoir study area, but none were observed during vegetation surveys. Potential habitat for the Rocky Mountain sedge exists within the riparian woodlands in the foothills on the western edge of the Glade Reservoir study area, although none were observed during vegetation surveys.

Bald Eagle

The DEIS reported that an active bald eagle nest mapped by CPW was located on the Poudre River on private land south of the Glade Reservoir study area across from the City of Greeley's water filtration plant. The original tree containing this nest fell down in 2013. A new replacement nest was constructed by eagles southwest of the proposed Glade Reservoir in 2015 (Figure 3 32). This nest is located approximately ¾ of a mile west of the original location (Sherman, pers. comm. 2015). In addition, bald eagle winter roost sites occur along the Poudre River south of the Glade Reservoir study area. Bald eagles from the nest or roost sites may occasionally forage in the Glade Reservoir study area.

3.11.2.2 Galeton

3.11.2.2.1 Federally Listed Threatened, Endangered, and Candidate Species

A 240-acre prairie dog colony located within the proposed Galeton Reservoir footprint area (Figure 3-32) is considered large enough to potentially support a population of black-footed ferret. Nocturnal ferret surveys of the Galeton Reservoir study area were conducted according to USFWS protocol (ERO 2006c). No ferrets or signs of ferrets were observed during the surveys. In September 2009, the USFWS (2009) determined that eastern Colorado, including the entire Galeton Reservoir study area, no longer contained any wild free-ranging black-footed ferrets.

3.11.2.2.2 State Species of Concern

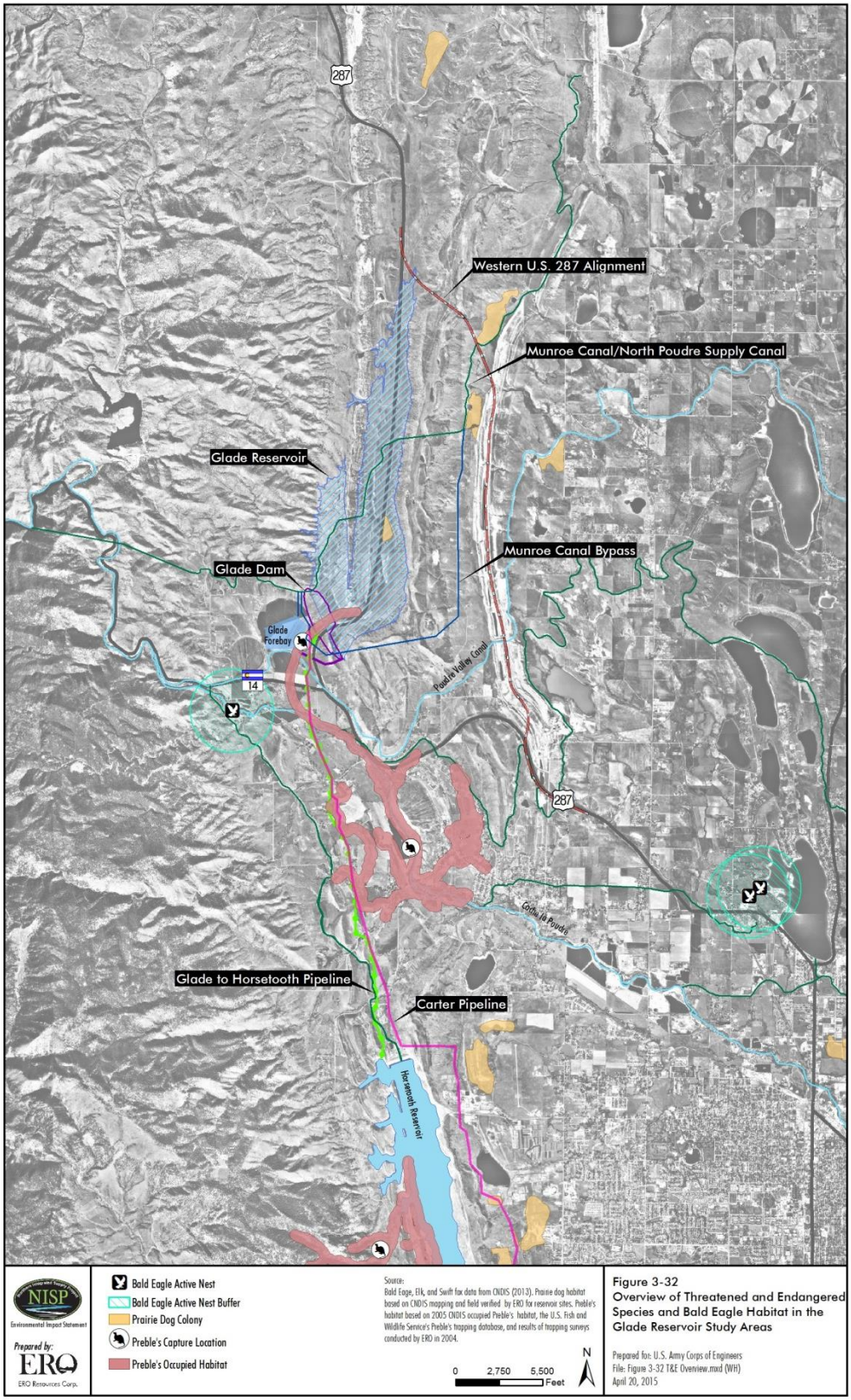
As described above, a large prairie dog colony is located in the Galeton Reservoir study area. Four swift fox were observed during ferret surveys of the Galeton Reservoir study area conducted in September 2005. Prairie dog towns in the Galeton Reservoir study area also provide habitat for the burrowing owl, which was observed at the study area during field surveys conducted in July 2005. The Galeton Reservoir study area supports abundant prey species, and provides suitable breeding and foraging habitat for the ferruginous hawk, burrowing owl and mountain plover. Although, no nesting of these three species has been observed at the Galeton Reservoir study area, known breeding populations of ferruginous hawk and burrowing owls occur in nearby areas (Kingery 1998; COBBAII 2014). The Galeton Reservoir study area also contains potential habitat for the long-billed curlew. This species is known to breed on the Pawnee National Grasslands north and east of the Galeton Reservoir study area (Nelson 1998).

3.11.2.3 Cactus Hill

3.11.2.3.1 Federally Listed Threatened, Endangered, and Candidate Species

No federally listed threatened, endangered, or candidate species have suitable habitat in the Cactus Hill Reservoir study area.

Figure 3-32. Overview of Threatened and Endangered Species and Bald Eagle Habitat in the Glade Reservoir Study Area.



3.11.2.3.2 State Species of Concern

An active bald eagle nest occurs at Black Hallow reservoir, just over ½ mile from the Cactus Hill reservoir study area. Several small (less than 80-acre) prairie dog colonies occur at the Cactus Hill Reservoir study area. The Cactus Hill Reservoir study area occurs within swift fox overall range and contains patches of suitable swift fox denning habitat. Prairie dog colonies in this study area provide habitat for the burrowing owl, which was observed at the study area during field surveys. The Cactus Hill Reservoir study area contains open grassland suitable for foraging and breeding ferruginous hawk, although no breeding has been recorded in this portion of Weld County (Kingery 1998). The dry playa areas and areas of buffalograss at this study area provide suitable breeding habitat for the mountain plover, although much of the study area contains vegetation over 6 inches tall. The nearest occurrences of this species are in the Pawnee National Grasslands (CNHP 2004). The Cactus Hill Reservoir study area contains potential habitat for the long-billed curlew. The species is also known to breed on the Pawnee National Grasslands (Nelson 1998).

3.11.3 Conveyance Systems

All of the proposed pipelines cross drainages with known or potential habitat for federally listed species. A CBP and ULTO survey and habitat assessment report was submitted to the USFWS for the Poudre River floodplain of the Glade to Horsetooth, Carter, and Cactus Hill to Horsetooth pipeline study areas, and the Carter pipeline crossing of the Big Thompson floodplain. Although the USFWS concurred that CBP and ULTO surveys would not be required in these areas, the USFWS recommends that all other areas where habitat disturbance is proposed be surveyed to identify potential habitat for ULTO and CBP (USFWS 2007). All pipeline areas with potential habitat should be surveyed for at least 2 years prior to construction (Mayo, pers. comm. 2007). Known habitat for bald eagle and Preble's are more localized than the CBP and ULTO and are discussed individually in the following sections for each pipeline study area.

Because the pipeline and canal study areas are linear, they include habitat for many of the same state species of concern, as previously described. Many of the pipeline and canal study areas include portions of small prairie dog colonies. These colonies are within a black-footed ferret block clearance area and are smaller than 80 acres, and thus USFWS has determined they no longer support the black-footed ferret, although they provide potential habitat for burrowing owl and mountain plover. The pipeline and canal study areas traverse swift fox overall range and suitable habitat. Western portions of the pipeline and canal study areas cross potential breeding and foraging habitat for ferruginous hawk and mountain plover. Wetland habitats in the pipeline alignments and along canals provide habitat for the common gartersnake and northern leopard frog.

3.11.3.1 SPWCP Pipeline Study Area

Wetlands and riparian areas in the SPWCP forebay and diversion study area are unlikely to support Preble's because they are dominated by weedy species, mostly disturbed, and lack the vertical vegetative structure preferred by Preble's. Stream banks are steep and in some places,

deeply incised, or debris-filled and the surrounding area is heavily disturbed by human activity. In addition, numerous surveys within higher quality potential habitat in the Poudre River or South Platte River corridors indicate the area is not occupied by Preble's (USFWS 2010). A Preble's habitat assessment report was submitted to the USFWS for the SPWCP forebay and diversion study area requesting concurrence that this area is not likely to support Preble's (ERO 2006a). The USFWS has concurred that this study area does not provide suitable habitat for Preble's (USFWS, pers. comm. 2008).

3.11.3.2 Glade to Horsetooth Pipeline Study Area

3.11.3.2.1 Federally Listed Threatened, Endangered, and Candidate Species

Preble's Meadow Jumping Mouse

Potential Preble's habitat in the Glade to Horsetooth study area is shown in Figure 3-32. According to the USFWS's Preble's occurrence database, Preble's are known to occur along portions of the Glade to Horsetooth pipeline study area.

Ute Ladies'-tresses Orchid

A population of ULTO occurs within 1 mile of the Glade to Horsetooth pipeline study area. Although suitable ULTO habitat could occur in the Glade to Horsetooth pipeline study area, none were found at the proposed crossing of the Poudre River floodplain.

3.11.3.2.2 State Species of Concern

The Glade to Horsetooth pipeline study area has potential habitat for Townsend's big-eared bat, Dwarf shrew, bald eagle, ferruginous hawk, peregrine falcon, common gartersnake, Northern leopard frog, and Bell's twinpod. Potential habitat occurs for all butterfly species except for the Moss' elfin (Table 3-35).

Bald Eagle

An active bald eagle nest located near the Glade to Horsetooth pipeline study area on the Poudre River on private land south of the Glade Reservoir study area fell down in 2013. A new replacement nest was constructed by eagles west of the study area in 2015 (Figure 3 32). This nest and its buffer is located approximately ¾ of a mile west of the original location (Sherman, pers. comm. 2015) and does not occur within the study area.

3.11.3.3 Carter Pipeline Study Area

3.11.3.3.1 Federally Listed Threatened, Endangered, and Candidate Species

Preble's Meadow Jumping Mouse

Preble's are known to occur in the northern portion of the Carter pipeline study area (USFWS 2010).

3.11.3.3.2 State Species of Concern

Potential Bell's twinpod habitat may occur in the Carter pipeline route on shale outcrops east and south of Horsetooth Reservoir. Surveys for this species will be conducted in the appropriate season prior to construction.

Bald Eagle

An active bald eagle nest is located near the southern portion of the Carter pipeline study area near Boedecker Lake (Figure 3-32).

3.11.4 Poudre and South Platte River Corridors

3.11.4.1.1 Federally Listed Threatened, Endangered, and Candidate Species

Preble's Meadow Jumping Mouse

Known occupied Preble's habitat in the study areas is shown on Figure 3-32. Preble's is not known to occur on the Poudre River downstream of Fort Collins or on the South Platte River downstream of its confluence with the Poudre River.

Colorado Butterfly Plant

Potential habitat for CBP may occur within the active floodplain of the Poudre and South Platte Rivers. However, no populations of the CBP are known in these corridors.

Ute Ladies'-tresses Orchid

Potential habitat for ULTO may occur within the wetlands and riparian areas in the Poudre-South Platte River corridor study area. However, no populations of the ULTO are known in these corridors.

3.11.4.1.2 State Species of Concern

Wetland and riparian habitats occurring in the Poudre-South Platte River corridor study area potentially support the common gartersnake, northern leopard frog, two-spotted skipper, smokey-eyed brown butterfly, and American currant. However, much of the study area occurs in urban areas, diminishing the value of these areas for wildlife. The brassy minnow, common shiner, and Iowa darter have been recorded within the Poudre-South Platte River corridor study area. The brassy minnow and common shiner were reported as last observed in the study area in 1992 by Bestgen and Fausch (1993), although a few brassy minnows have been collected in the study area in 2008 and 2010. The Iowa darter is still present in the study in low numbers and was last observed during the 2009 supplemental fish sampling.

Bald Eagle

Based on a review in 2014, four active bald eagle nests are known to be located along the Poudre River in the Poudre-South Platte River corridor study area. Several bald eagle roost sites occur in this study area downstream of Fort Collins (Figure 3-32).

3.12 AQUATIC BIOLOGICAL RESOURCES

3.12.1 Overview

This section presents a summary of the existing conditions of the aquatic biological resources for the Poudre mainstem and the South Platte River in reaches that would be affected by changes in streamflows associated with the NISP alternatives. Horsetooth Reservoir could also be affected by one alternative. The alternatives could potentially affect water bodies and fish, benthic macroinvertebrates, algae, and their habitat within the study areas through modified hydrology, changes in reservoir levels, creation of new aquatic habitat, or changes in water quality, riparian vegetation, and channel morphology. More detailed information on aquatic resources is presented in the 2013 CTP Aquatic Resources Baseline Report (GEI 2013).

The existing aquatic biological resources in the study reaches of the mainstem and the South Platte River were described from existing data and supplemental data collected specifically for the NISP SDEIS and the HSWSPs DEIS, and baseline report preparation. During initial scoping for the NISP DEIS, the District and the third-party contractor team met with CPW to identify data gaps and to coordinate the effects analysis for the project. Supplemental data collection sites for fish, benthic invertebrates, and fish habitat simulation were identified in 2005.

In response to the Corps decision to develop a CTP, additional supplemental data collection sites were identified in 2009 for fish habitat simulation. In coordination with the USGS, six representative 2-D hydraulic sites (Poudre River study sites) were established on the Poudre River mainstem to assess aquatic habitat (ACE 2011). These sites involved detailed topographic survey and aquatic habitat mapping.

The 2-D fish habitat modeling simulates and represents habitat for specific segments of a river that represent different sections with similar flow, channel characteristics, and biological conditions within the segments. In coordination with USGS, the study area on the mainstem was divided into six representative segments to represent fish habitat in the mainstem. In order to provide fish population information that is compatible with fish habitat simulation, and as a way of organizing the information available for the various sections of stream in the study area, the aquatic biological data in the CTP Aquatic Biological Resources Baseline Report (GEI 2013) and in this section is presented with respect to habitat segmentation. Fish, macroinvertebrate, and algae data were summarized into these segments. The six segments on the mainstem are:

- Segment A: Poudre Valley Canal to the Larimer-Weld Canal.
- Segment B: Larimer-Weld Canal to Spring Creek in Fort Collins.
- Segment C: Spring Creek to the New Cache Canal Diversion. This segment continues through Fort Collins and crosses under I-25.
- Segment D: New Cache Canal to County Road 17, near the Town of Windsor. This segment runs through the Town of Timnath.
- Segment E: County Road 17 to the 59th Avenue Railroad Bridge upstream of Greeley. This segment contains the Town of Windsor.

- Segment F: The 59th Avenue Railroad Bridge upstream of Greeley to the South Platte River. This segment is adjacent to and downstream of the City of Greeley.

In the South Platte River, there was one segment from the confluence with the mainstem downstream to the Kersey Gage.

In coordination with CPW, site-specific habitat suitability curves for habitat utilization by Poudre river fish were developed. Existing data and the supplemental data collected in 2005, 2006, and 2009 were used to describe the existing environment and to evaluate the effects of the proposed projects and their alternatives (GEI 2013).

None of the fish species collected in the NISP study area are federally listed as threatened or endangered; however, the greenback cutthroat trout is native to the basin and is listed as federally and state threatened but is not currently present in the study area.

Six species that potentially may be present in or near the study area are listed by the state of Colorado. The lake chub, northern redbelly dace, plains minnow, and suckermouth minnow are listed as endangered, and the brassy minnow and common shiner are listed as threatened by CPW. All six species have been collected within the study area in the past. Additionally, the Iowa darter is a Colorado state species of concern that is present in the study area.

The CPW has the authority to manage and conserve wildlife resources within the state of Colorado for hunted, fished, and nongame wildlife. The CPW enforces various fishing regulations, including regulations concerning the illegal take or use of threatened and endangered species. Colorado State Statute 33-2-102 states that endangered or threatened species should be protected for the purpose of maintaining and enhancing their numbers to the extent possible. Colorado's Comprehensive Wildlife Conservation Strategy, a document prepared in 2005 as part of the requirements of the State Wildlife Grants program (CDOW 2005), states that maintaining, creating, and managing habitat to support sustainable wildlife populations in Colorado and continuing to preserve, protect, and enhance wildlife species that are in danger of becoming endangered or threatened are two goals of the CPW.

Additionally, any agency of the state that is planning construction that could potentially affect streams, their banks, or their tributaries must obtain a wildlife certificate issued by the CPW as part of the effort to protect all fish and wildlife resources in Colorado. A wildlife certificate must also be obtained for any project that could potentially affect a federally or state listed threatened or endangered species, a Colorado species of concern, or the habitat of any of these species. In addition, all practicable effort should be expended to avoid and minimize impacts to streams, riparian areas, and wetlands (CDOT 2005). CDOT is a cooperating agency for the NISP EIS and would be involved with the realignment of U.S. 287.

On the federal level, the Fish and Wildlife Coordination Act (16 USC 661-667e) places a similar restriction on construction projects, as it requires that the department or agency involved with the project shall first consult with the USFWS and with the agency exercising administration over the wildlife resources of the state where the construction will occur. With specific regard to the impoundment or diversion of waters, the goal of the consultation should be to discuss

conservation of wildlife by preventing loss of and damage to the wildlife resources, and to provide for the development and improvement of these resources in connection with water-resource development. Based on this act, adequate provisions must be made for the management of wildlife and their habitat within the study area. The USFWS is a cooperating agency for the NISP EIS and has been actively involved in the EIS process.

For the purpose of this description of aquatic resources, the study area includes water bodies potentially affected by the NISP alternatives through changes in hydrology, including 1) the Poudre River from the Poudre Valley Canal diversion just upstream of the Canyon Gage downstream to the confluence with the South Platte River and 2) the South Platte River from the confluence downstream approximately 2.4 miles to the Kersey Gage. The study area additionally includes the proposed alternative locations of the off-channel reservoirs: Glade Reservoir, Cactus Hill Reservoir, and Galeton Reservoir. Horsetooth Reservoir also might be affected by the NISP alternatives and is included in the study area. These streams and reservoir sites were collectively referred to as the study area for the purposes of this Aquatic Biological Resources section of the SDEIS. The proposed off-channel sites for the proposed reservoirs do not contain permanent surface water or aquatic resources. These locations are dry or nearly dry most of the time. Therefore, these areas do not provide habitat for fish or benthic invertebrates and are not described further in this section.

3.12.1.1 Habitat

Existing stream habitat information for the study area is limited and is mainly included as descriptive information from existing fish and macroinvertebrate studies. Several past studies were used to describe habitat in the study areas as discussed in the 2013 CTP Aquatic Resources Baseline Report (GEI 2013).

3.12.1.1.1 Historical Perspective

ACE (2013) and Section 3.4 of the SDEIS describe in detail the stream morphology and sediment characteristics of the mainstem. The existing environment of the mainstem in the study area is hydrologically and morphologically impacted by development and adjacent land uses. The natural processes of the river are heavily disturbed. There are at least 22 irrigation diversions along the mainstem in the study area, which act as barriers to upstream movements of fish as well as alter the hydrology of the mainstem. Ten dry-up points along the mainstem temporarily limit or eliminate habitat for aquatic organisms. Geomorphic features such as debris jams, meanders, and pools have been reduced by snag clearing and other historical activities, further limiting the diversity of the habitat available for fish and invertebrates. The channel has been straightened and narrowed throughout portions of the mainstem, and the ongoing encroachment of riparian vegetation continues a trend toward channel narrowing. Sediment inputs to Segments A, B, and C in the upstream reaches of the mainstem are limited and the reduced seasonal high flows are still sufficient to prevent deposition of sediment. The downstream reaches in Segments D, E, and F have higher sediment inputs, lower channel slopes, and reduced peak flows, resulting in sand and silt deposition in the channel, which is changing the composition of riffle-pool complexes.

The Poudre River has changed over time as a result of human activity, as described in ACE (2013) and in Section 3.4 of the SDEIS. Transition-zone streams such as the Poudre River mainstem were primarily single thread systems (Fausch and Bestgen 1997). The reach of the river in Segments A, B, and C upstream of I-25 was historically characterized by large woody debris inputs and migrating channels (Ayres Associates 2008), which can make habitat for aquatic organisms more complex and diverse. Lower in the river, in Segments D, E, and F downstream of I-25, the historical channel of the mainstem was wide, shallow, and characterized by braids, oxbows, and backwaters, but these off-channel habitats for aquatic organisms are no longer connected to the main channel (ACE 2013; Ayres Associates 2008) because of gravel pits, flood control structures, channelization, stabilization around bridges, and other factors. Lower flows have allowed vegetation encroachment of the floodplain and narrowing of the channel, especially in the lower sections. This is made worse by encroachment of riparian vegetation into the channel, which encourages further narrowing (ACE 2013). Mid-channel bars have become vegetated and disconnected from the main channel, or they have disappeared (Ayres Associates 2008). Geomorphic features such as debris jams, meanders, and pools were also reduced by snag clearing and extensive tie-driving operations that involved floating railroad ties down the river channel (Wohl 2001). The result has been less diverse habitat for the native species of fish and invertebrates over time.

The morphology of the South Platte River has also changed dramatically since settlement in the mid to late 1800s. Historically, streams of the western Great Plains were braided, shallow, and wide, and the available stream habitat was not structurally complex (Wohl et al. 2009; Fausch and Bestgen 1997). The shifting, braided channels of the South Platte, North Platte, and Platte Rivers have been converted into single-thread or anastomosing (i.e., narrow, multi-thread channels with stable, vegetated islands) systems as a result of ground water pumping, water withdrawals, water storage, and the creation of a hydrograph that mirrors irrigation demand (Wohl et al. 2009; Strange et al. 1999). The narrowing of these channels has been dramatic; the width of some stream sections within the Platte River drainage has decreased by one to two orders of magnitude (Wohl et al. 2009). The habitat in the South Platte River now is less diverse than in the past. However, more permanent flow likely has increased the quality of the habitat for nonnative species of fish and invertebrates.

3.12.1.2 Fish Populations

Existing data on fish collected in the mainstem in the study area are available from 1912 to 2012, as discussed in detail in the 2013 CTP Aquatic Resources Baseline Report (GEI 2013). The early records of fish collection are sparse. No data are available between 1914 and 1959. Sampling frequency increased substantially after 1959, providing data in every decade since then. In the South Platte River in the study area, existing data are available only from 1980 through 2006 (GEI 2013).

The available fish data were separated into three time periods: 1912-1984 (Historical), 1985-2000 (Recent Past), and 2001-2012 (Current Conditions). Information from 2001 to 2012 were used to describe the existing environment, and the remaining two time periods were used to provide a

historical perspective to existing conditions and are discussed in more detail in the 2013 CTP Aquatic Resources Baseline Report (GEI 2013).

Coldwater fishes (species that require cold temperatures throughout the year) present in the study area are the nonnative brown trout, rainbow trout, and mountain whitefish. The native greenback cutthroat trout is also a coldwater fish, but no longer is present in the study area. The remaining species in the study area have varying preferences for water temperatures, but are considered warmwater species based on their tolerance for seasonally warmer water temperatures in the summer. A few native species, such as longnose dace, longnose sucker, and white sucker, are considered warmwater species, but have wide temperature tolerances and are commonly found with trout in coldwater sections of streams and rivers as well as in warmwater sections.

3.12.1.2.1 Historical Perspective

The evaluation of historical trends in fish species is complicated by the different levels of sampling effort over the years, the gap in data collection between 1914 and 1959, the paucity of the data from 1912 and 1914, and the lack of data from before 1912. This section of the EIS summarizes the current conditions of the fish community and makes general comparisons to a list of species assumed to be native to the study area on the mainstem and the South Platte River. These issues are described in more detail in the 2013 CTP Aquatic Resources Baseline Report (GEI 2013).

It is likely that 24 native species were present in the Poudre River and South Platte River in the study area prior to settlement (Table 3-36), based on the historical records from the study area and other nearby collections. Of the 24 likely native species, 17 species were still present in the 2001-2012 sampling period representing current conditions in the study area and 7 species have not been recently collected. Historically, limited collection efforts led to the capture of these 24 species. Given that collection efforts have intensified in recent years in most of the study segments, it can be presumed that the 7 species would be collected on at least some of the occasions if they were still present in appreciable numbers.

Table 3-36. Native species of the mainstem of the Poudre River and South Platte River and their present status in the study area.

Native Species	Present 2001-2012?
Bigmouth shiner	Yes
Black bullhead	Yes
Brassy minnow	Yes
Central stoneroller	No
Channel catfish	Yes
Common shiner	No
Creek chub	Yes
Fathead minnow	Yes
Green sunfish	Yes
Greenback cutthroat trout	No
Hornyhead chub	No
Iowa darter	Yes
Johnny darter	Yes
Longnose dace	Yes
Longnose sucker	Yes
Northern redbelly dace	No
Orangespotted sunfish	Yes
Plains killifish	Yes
Plains minnow	No
Plains topminnow	Yes
Quillback	No
Red shiner	Yes
Sand shiner	Yes
White sucker	Yes

This estimate of the historical native species assemblage is conservative. Species that were native to the South Platte Basin and collected in one or two of the historical surveys of the Colorado Front Range could also have been native to the mainstem and the section of the South Platte River in the study area. These include blacknose shiner, gizzard shad, lake chub, river carpsucker, stonecat, and suckermouth minnow.

The loss of several native species over the last century indicates that some environmental thresholds have already been crossed. The native greenback cutthroat trout, a federal and state threatened species, has long ago been replaced by nonnative brown and rainbow trout in the coldwater sections of the Poudre River. Hornyhead chub, quillback, and northern redbelly dace have not been collected from the Poudre River since 1914. This could be a result of early flow manipulation, channelization, changes in water quality, or some combination of these factors. For example, northern redbelly dace are often found in low-velocity stream habitat, such as side channels, with abundant aquatic vegetation (Bestgen 1989; Woodling 1985). The river's transformation from a wandering, braided system to a more confined, single-thread channel (City of Fort Collins 2008) may have excluded northern redbelly dace from the system. Hornyhead chub has apparently been eliminated from Colorado (Nesler 1997) and northern redbelly dace are listed as state endangered. The thresholds associated with the elimination of some native species and the introduction of other nonnative species have been crossed prior to 1912, the earliest sampling records for the study area.

Native fishes and nonnative game fishes in the mainstem are affected by channelization and fragmentation. These channel modifications may be partially responsible for the extirpation of some native species from the system. Common shiners are intolerant of channelization. They were not collected in channelized sections of a Midwestern stream even though they were abundant in unchannelized sections (Meneks et al. 2003). This species was also eliminated from Spring Creek, a small tributary to the Poudre River on the eastern edge of Fort Collins, after channelization and installation of multiple, vertical-drop grade control structures (Fausch, pers. comm. 2011). Brassy minnows rely on seasonal connectivity between different types of habitats in streams on Colorado's Eastern Plains (Scheurer et al. 2003)—multiple diversion dams in the Poudre River may have negatively affected this species. Common shiner and brassy minnow are state threatened species in Colorado. Trout could be found in the mainstem as far downstream as the mouth in some years (Bartholow 1991). However, because of the diversions in the mainstem, trout migrating downstream in the fall, winter, or spring cannot return to cooler, upstream waters in the summer and may be lost to the population. The native fishes that currently inhabit the mainstem are tolerant of harsh environmental conditions such as high variability in flow, dry-up points, low dissolved oxygen and high water temperatures (Smith and Fausch 1997; Fausch and Bestgen 1997; Matthews 1987).

3.12.1.3 Fish Habitat Availability Relationships

The Instream Flow Incremental Methodology (IFIM) (Bovee 1982) and the Physical Habitat Simulation (PHABSIM) model (Milhous et al. 1989) were used to model changes in habitat availability for fish. Modeling of fish habitat relationships uses a metric referred to as weighted useable area (WUA) which quantifies habitat availability based on preferences of each fish species and life stage for water depth, velocity, substrate, and cover. WUA varies at different flows and WUA versus discharge curves were used for species and life stages of fish in the study area, as described in detail in the 2013 CTP Aquatic Resources Baseline Report (GEI 2013).

For the CTP, supplemental 2-D (2-dimensional data collection) fish habitat information was collected in 2009 at six Poudre River study sites in Segments A through F along the mainstem to replace the 1-D (1-dimensional data collection) fish habitat information used in the NISP DEIS. This was done in response to comments to the NISP DEIS, to be consistent with data available on the North Fork of the Poudre River (North Fork). For Segment 1 on the South Platte River, the relationships were developed for the NISP DEIS from data collected in 2006.

In 2009, fish-habitat associations were evaluated by GEI and the CPW to develop site-specific habitat suitability curves for fish species in the mainstem of the Poudre River. These curves or habitat use relationships were used in the supplemental 2-D modeling. Daily time series of fish habitat availability were developed for each modeled species and life stage using the above relationships combined with daily Current Conditions CTP hydrology for each river segment in the study area. More detailed information on the 2-D modeling can be found in GEI (2013) and ACE (2011).

3.12.1.4 Macroinvertebrate Populations

Data on macroinvertebrate populations are available primarily from USGS, CSU, and supplemental data collected by GEI in 2005. The data are grouped into two time periods, Recent Past data through 2000 and Current Conditions data for the period from 2001 through 2009. The macroinvertebrate data are discussed in more detail in the 2013 CTP Aquatic Resources Baseline Report (GEI 2013).

Colorado macroinvertebrate multimetric index (MMI) scores were provided for samples by the Colorado Water Quality Control Division, CDPHE. This index was developed for and is used by the CDPHE to determine aquatic life use attainment in streams (CDPHE 2010). MMI scores above a threshold indicate the stream is attaining the aquatic life use and scores below the threshold indicate non-attainment.

The WQCD recognizes three biotypes in Colorado that are characterized by the ecoregion and elevation of the stream site location: Mountains (Biotype 2), Plains and Xeric (Biotype 3), and Transition (Biotype 1). The metrics and scoring methodology for the MMI were calibrated separately for each of these three biotypes. Biotype 1 (Transition) stream reaches are described as mid-elevation, low gradient, semi-cold streams. Biotype 2 (Mountains) stream reaches are high elevation, cold water sites, and Biotype 3 (Plains) stream reaches are low elevation, low gradient, warmwater streams (Jessup 2010). The data provided by the WQCD for the mainstem included sites in Segments A, B, and C located in Biotype 1 and sites in Segments E and F and in the South Platte River in Biotype 3. Individual metrics that are included in the MMI vary by biotype (Table 3-37).

Thresholds for aquatic life attainment or impairment based on the MMI score differ dependent on the biotype that the stream is located in as well as whether the stream is considered a Class 1 or Class 2 stream (CDPHE 2010). In Biotype 1 stream reaches, a MMI score of 52 or more is considered “attaining,” while a MMI score of 42 or less is considered “impaired” (Table 3-37). For those sites in Biotype 3, the MMI score must be at least 37 to be considered in attainment, with the impairment threshold set at 22. Scores between these thresholds are considered to be in the “gray zone”, and MMI scores in this zone are dealt with differently based on whether the water body is categorized as a Class 1 or Class 2 water. The portions of the mainstem and South Platte River within the study area are all categorized as Class 2 waters, indicating that there may be some impairment of aquatic resources. For such waters, an MMI score that is within the gray zone is considered to be in attainment of the aquatic life use.

Table 3-37. Individual metrics included in and scoring criteria for the MMI for Biotype 1 and Biotype 3 sites.

Biotype 1 (Transition)	Biotype 3 (Plains)
MMI Metrics	
Percent Non-Insect Taxa	Number of Insect Taxa
Number of Ephemeroptera and Plecoptera Taxa	Percent Non-Insect Taxa
Percent Chironomidae	Percent Sensitive Plains Families
Percent Sensitive Plains Families	Percent Dominant Taxon
Number of Predator and Shredder Taxa	Number of Predator and Shredder Taxa
Number of Clinger Taxa	Percent Sprawler Taxa
Scoring	
Attainment Score ≥ 52	Attainment Score ≥ 37
Gray Zone Score 43 - 51	Gray Zone Score 23 - 36
Impairment Score ≤ 42	Impairment Score ≤ 22

Source: CDPHE 2010.

3.12.1.4.1 Historical Perspective

Macroinvertebrate species composition in the mainstem has remained similar among the time periods. There have been only a few trends in macroinvertebrate metrics over time in most of the segments. All metrics were characterized by a wide range of values. There are recent trends towards slightly higher density in most segments and greater number of taxa and diversity in a few segments. However, differences in sampling methods may have contributed to the changes between the time periods. Most of the study segments exhibited some temporal changes, but they were less pronounced than the longitudinal changes along the river.

The macroinvertebrates that were collected regularly from the mainstem for Current Conditions and the Recent Past were widespread species with intermediate to high tolerances of environmental stresses (Hilsenhoff 1987; Voelz et al. 1993). Although pre-settlement data are lacking for the Poudre River Basin macroinvertebrate communities, field work by Gillette in the 1870s resulted in the collection of five species that are no longer present in the system: *Macdunnoa persimplex* (mayfly), *Taenionema pacifica* and *Isogenoides elongatus* (stoneflies), and *Smicridea signata* and *Oecetis ochracea* (caddis flies) (Kondratieff, pers. comm. 2011).

3.12.1.5 Algae

The only available algae data were collected from four sites in the Poudre mainstem in the 1990s as part of the NAWQA program.

3.12.1.5.1 Historical Perspective

Flow regime changes and urban land use may have affected the periphyton community. Algae living in stream systems depend upon current to deliver nutrients and remove metabolites, but they can also be displaced by high shear stresses associated with floods or spates (Biggs et al. 1998). Therefore, the current flow regime in the mainstem in the study area with diverted flows may allow for more frequent establishment of nuisance blooms of filamentous green algae or didymo than the historical flow regime.

3.12.1.6 Nuisance Species

Aquatic nuisance species are invasive species that can have harmful effects on aquatic resources (CDA & CDOW 2010). The NISP project has the potential to influence the distribution and prevalence of nuisance species.

3.12.1.6.1 Fishes

For the purposes of this report, a nuisance fish is nonnative, has limited or no recreational value and has the potential to negatively affect native or recreationally important species. Common carp and mosquitofish are the two primary nuisance species in the Poudre River Basin.

Common carp were only absent throughout the entire sampling period in Segment A, the coldwater segment of the mainstem. They were collected in Segment B in Fort Collins in 1994 and were likely present before then. In Segments C, D, and E of the river east of Fort Collins and downstream of I-25, they were first collected in 1970. Mosquitofish have not moved as far upstream as common carp. They were absent from Segments A and B of the mainstem through Fort Collins and upstream as of 2009. Mosquitofish were first collected in Segment E near Greeley in 1994, and have moved upstream toward Fort Collins since then.

Common carp have coexisted with native species in the Poudre River Basin since at least 1970, and likely well before that year, but mosquitofish appear to have deleterious effects on some of the similar small-bodied native fishes in the mainstem. Mosquitofish apparently compete with the native plains killifish and plains topminnow. Only one plains topminnow was collected in the study area during supplemental data collection in 2005 and 2009 and no plains killifish were collected.

An altered flow regime may have facilitated the invasion of these two nonnative species. Deeper-bodied fishes such as carp have a higher cost of transport than more streamlined fishes such as trout (Tudorache et al. 2008), and mosquitofish appear to lack behavioral mechanisms that allow them to cope with flashy flow regimes (Ward et al. 2003). The flashy hydrograph characteristic of unaltered streams on the Colorado Front Range (Wohl 2001; Strange et al. 1999), such as historical conditions on the mainstem, may have inhibited the spread of these two species and the current flow regime with less variable flows may have allowed these species to move upstream. They may also have moved throughout the basin by intentional or unintentional stocking in lakes and ponds. The current upstream distributional limit of both species could be determined not by high flows but by water temperatures, water velocity, stream fragmentation by diversions, or any combination of these factors.

3.12.1.6.2 Whirling Disease

Myxobolus cerebralis, the causative agent of whirling disease is prevalent in Colorado. Extensive research during the 1990s demonstrated that whirling disease was the cause of major population declines in wild rainbow trout, which are particularly sensitive to whirling disease, in rivers in Colorado (Nehring et al. 2000; Nehring 2006). *M. cerebralis* requires Tubifex worms to complete its life cycle (Markiw and Wolf 1983). Because *Tubifex tubifex* lives in fine sediments, sediment control is crucial in controlling production of triactinomyxons, the infectious form of *M. cerebralis* (Nehring 2006). Although *T. tubifex* is not common in the Poudre River Basin,

they exist in sufficient densities to produce the infective stage of whirling disease (Allen and Bergersen 2002).

Whirling disease has profoundly affected the trout populations in the Poudre River Basin by eliminating natural reproduction of rainbow trout. Brown trout, which have coevolved with whirling disease and are resistant to its effects, have essentially replaced rainbow trout in this system (Puttmann 1996). Beginning in 2008 and continuing in 2009, a whirling disease resistant strain of rainbow trout was stocked by CDOW (CDOW 2010) with the intent to increase survival and reproduction of this fish species in the future. Continued expansion of brown trout populations and reintroduction of rainbow trout into the Poudre Basin will facilitate the recovery of the recreational fishery from the effects of whirling disease.

3.12.1.6.3 Algae

Didymo is a stalked diatom that can form thick blooms that can affect the ecological function and aesthetic appeal of rivers (Spaulding and Elwell 2007). Didymo has been reported in the western U.S. for more than 100 years, but expansive nuisance blooms have become more common recently (Kumar et al. 2009). According to NAWQA data, didymo was present in the mainstem in 1994 in small numbers, but it was absent in 1993 and 1995. Didymo can form dense, localized blooms in the Poudre River, usually in the canyon (Beeby, pers. comm. 2011).

3.12.1.6.4 New Zealand Mud Snails, Quagga Mussels, and Zebra Mussels

New Zealand mud snails (*Potamopyrgus antipodarum*), zebra mussels (*D. polymorpha*), and Quagga mussels (*Dreissena bugensis*) are invasive molluscs that each have the potential for detrimental ecological and economic effects.

New Zealand mudsnails (NZMS) were found in Colorado in 2004 (http://nas.er.usgs.gov). Although the ecological consequences of New Zealand mud snail introductions are poorly understood, this species may inhibit substrate colonization by native macroinvertebrates (Kerans et al. 2005). According to the USGS nonindigenous aquatic species website, New Zealand mud snails were found in the Poudre River Basin in College Lake in 2011. They are absent from adjacent watersheds that are connected to the Poudre River Basin through transbasin diversions (http://nas.er.usgs.gov; CDA & CDOW 2010).

Zebra mussels were first found in North America in the Great Lakes in the mid-1980s (Carlton 2008), but they were not introduced into the western United States until the mid-2000s (Stokstad 2007). Both of these species of mussels can form dense colonies of up to 700,000 individuals per square meter (Stokstad 2007). Because these filter-feeding organisms consume zooplankton, high densities of either or both species can dramatically affect the nutrient load, planktonic community, and water clarity of lake environments (Western Regional Panel on Aquatic Nuisance Species 2009; Strayer 2009). Quagga mussels and zebra mussels have not invaded the Poudre River Basin. However, they are present in the Colorado River Basin that is connected to the Poudre River Basin through transbasin diversions (http://nas.er.usgs.gov; CDA & CDOW 2010). Zebra mussel and quagga mussel veligers (larvae) were collected in 2008 in Grand Lake in the Colorado River Basin, upstream of the analysis area (http://nas.er.usgs.gov). Quagga mussel veligers were also collected from Shadow Mountain Reservoir, Granby

Reservoir, and Willow Creek Reservoir in 2008 (http://nas.er.usgs.gov). Because of this and because their primary means of introduction into new waters in the western United States is by transfer of boats from one body of water to another (Western Regional Panel on Aquatic Nuisance Species 2009; Strayer 2009), future accidental introduction of these species into the Poudre River Basin is possible.

3.12.1.6.5 Mosquitoes and West Nile Virus

Approximately 50 mosquito species live in Colorado, but only two or three can transmit West Nile Virus (Turell et al. 2005). The U.S. Center for Disease Control has maintained records of human and veterinary (i.e., equine) cases of West Nile Virus (WNV) in Larimer County since 2001 (http://www.cdc.gov/ncidod/dvbid/westnile/). WNV cases in Larimer County ranged from 0 in 2001 to 546 in 2003. There was an average of 38 human cases of WNV per year from 2004 through 2007, and there were 25 human and four veterinary cases of WNV in 2009. Records were not available online for 2008. WNV peaked in 2003, 1 year after its introduction to Colorado and has been uncommon in recent years. The presence of mosquitoes, including those that can transmit WNV, is assumed for the study area. Mosquitoes are ubiquitous and can successfully reproduce in standing water in residential (e.g., rain barrels and bird baths), agricultural (e.g., standing water, irrigation ditches), and natural (e.g., ponds and backwaters) areas (http://www.comosquitocontrol.com).

Despite the potential for mosquitoes to affect human health, their eradication is not advisable or feasible; they are a common and integral part of the aquatic food web. Small-bodied fishes such as native plains topminnow, plains killifish, and the nonnative mosquitofish tend to inhabit slow-moving waters with emergent or submerged aquatic vegetation. All three of these species consume aquatic insects such as mosquito larvae (Woodling 1985; Pflieger 1997).

3.12.2 Poudre River

Altered flow regimes resulting from implementation and operation of the project alternatives could potentially affect aquatic biological resources in the segments of the mainstem of the Poudre River. The reach of the mainstem that may be affected by the NISP alternatives includes the section from the Poudre Valley Canal diversion just upstream of the Canyon Gage downstream to the confluence with the South Platte River.

3.12.2.1 Poudre River Habitat

Habitat data for the reach of the mainstem of the river within the study area are limited. Several aquatic biological studies (USGS 2003; Bestgen and Fausch 1993; Propst 1982) gave brief descriptions of habitat. General stream habitat observations were made during the collection of supplemental data in 2005, 2006, and 2009. Stream habitat is briefly described in this section of the EIS and described in more detail in the 2013 CTP Aquatic Resources Baseline Report (GEI 2013) and channel morphology is described in Section 3.4 of the SDEIS.

The stream habitat in the mainstem includes riffle-pool complexes (Photo 3-1). The river in the study area varies in width from approximately 12 feet at one site near Greeley to 128 feet at a site near Fort Collins with a trend toward narrower widths in downstream sections. The bottom substrate of the river varies from silt to boulders with coarser cobble and gravel substrate more common in upstream sections and silt and sand more common in sections downstream of I-25. Some sections of the river are channelized, especially near the urban areas in Fort Collins and Greeley.

Photo 3-1. Riffle-Pool Complex on the Poudre Mainstem.

The mainstem is classified as Cold 2 by CDPHE (CDPHE 2014) in the upstream section of the study area downstream to Shields Street in Fort Collins including all of Segment A and a small portion of Segment B. This classification indicates that the expected aquatic resources include coldwater species, such as trout. The remainder of Segment B and all of Segments C, D, E, and F of the mainstem in the study area is classified as Warm 2 by CDPHE. This indicates that warmwater species are expected to be present. The Class 2 designation indicates that the number and abundance of aquatic species may be below expectations, and that there may be some impairment of aquatic resources. The actual existing conditions of the aquatic species in the river in the study area are discussed in detail in this section of the SDEIS.

In Segments A, B, and C of the mainstem upstream of I-25, sediment inputs to the channel are limited. Therefore, despite reduced peak flows that are rarely high enough to clear sediment from the cobble substrate, there is little ongoing deposition of sediment. In Segments D, E, and F of the mainstem downstream of I-25, the channel slope is lower and sediment inputs are higher. In these segments, the reduced peak flows are not sufficiently high to move the sediment and there is deposition of sand and silt in the channel. In some sections of the river downstream of I-25, the riffle-pool complexes of the river are changing with the filling of pools with sediment (ACE 2013).

A wide range of flows normally occur in the mainstem every year (ACE 2013; CDM Smith 2014a). Base flows decrease as the mainstem flows through Fort Collins in Segments A, B, and C and then increase as the river flows from near Windsor to Greeley through Segments D, E, and F. Average annual peak flows are 15 to 150 times higher than base flows. As a large portion of the flow is diverted upstream of Fort Collins, average annual peak flows are highest upstream and much lower in the segments downstream. Flood flows that occur approximately once in 10 years are several times higher than average annual peak flows.

At times when water is diverted from the mainstem, there are sections of the river where the total flow is captured by the diversions and the river is dry immediately downstream of the diversions (Photo 3-2). Downstream of the dry-up points, the river is dry for various distances as flow returns from ground water or tributaries. In the dry sections, habitat for aquatic organisms is eliminated or, at best, very limited if some organisms can find refuge in isolated pools or by burrowing into moist substrate.

Photo 3-2. Low Flow Downstream of a Diversion on the Mainstem.

3.12.2.2 Poudre River Water Quality and Temperature

Water quality in the mainstem decreases in a downstream direction as the effects of urban and agricultural land use become more pronounced as described in more detail in ERO (2012a) and in Section 3.3 of the SDEIS. Upstream of Fort Collins in Segment A, water quality is generally good with occasional exceedances of standards. This section of the river is listed on the 303(d) list as impaired for copper and high water temperatures. There is some degradation as water flows through the urbanized portions of Fort Collins in Segment B. East of Fort Collins there begins to be a few more exceedances of standards including occasionally elevated levels of nitrogen and phosphorus, high water temperatures, low dissolved oxygen (DO), and elevated *E coli*.

Degradation becomes more pronounced downstream of the Fort Collins area in Segment C as conductivity and concentrations of suspended sediment, phosphorus, nitrates, and metals increase as a result of the use and reuse of river water for municipal and agricultural purposes (ERO 2012a). Dissolved oxygen is generally within acceptable limits throughout the mainstem, but periodic exceedances of the water quality standard for DO, with concentrations less than 5.0 mg/L, occur in the lower portion of Segment C and in the segments downstream of I-25. Downstream of Boxelder Creek, water quality becomes more degraded with exceedances of a wide variety of constituents (ERO 2012a). This continues through the river east of I-25 to the confluence with the South Platte River. The river is on the 303(d) list for selenium impairment from Shields Street downstream to its confluence with the South Platte River and on the list for high levels of *E coli* from Boxelder Creek to the confluence.

The temperature standard for Segment A of the river upstream of Shields Street is Cold Stream Tier II (DeViolin, pers. comm. 2011), which has a daily maximum (DM) temperature standard of 23.9ºC and a maximum weekly average temperature (MWAT) standard of 18.3ºC during the warm seasons from April to October. Exceedance of both the DM and MWAT occur in July, August, and occasionally September in the majority of years with observations (Hydros 2014a). MWAT exceedances tend to be greater in magnitude and longer in duration than the DM exceedances.

This section of the Poudre River is currently on the 303(d) list as impaired for temperature (Hydros 2014a; ERO 2012a).

The river downstream of Shields Street in Segments B through F has Warm Stream Tier I standards with a DM temperature standard of 29.0ºC and a MWAT of 24.2ºC from April to October. Downstream from Lincoln Street in a section just upstream of Boxelder Creek, the record in some years (2002, 2003, 2004, and 2006) indicates exceedance of the DM and MWAT standards in July and August (Hydros 2014a). Further downstream there are fewer exceedances of temperature standards.

High water temperatures in the mainstem could affect the distribution of coldwater fishes. Although Segments B and C of the river through Fort Collins are classified as warmwater sections, trout are present and the few exceedances of the warmwater temperature standards are not an adequate evaluation of habitat for the recreationally important coldwater trout species. Based on a discussion of trout temperature tolerances in the 2013 CTP Aquatic Resources Baseline Report (GEI 2013), temperatures of 19ºC or less are optimal for rainbow trout and brown trout, temperatures between 19ºC and 24ºC are stressful, and temperatures greater than 24ºC are increasingly lethal if sustained for periods of hours to days. The minimum temperature that is considered potentially lethal (24ºC) is considerably lower than the critical thermal maxima (CTM), or the short-term temperature at which death would occur rapidly (i.e., in minutes) for both species. The CTM for brown trout is 30ºC, and the CTM for rainbow trout is 29ºC (reviewed in Miller Ecological Consultants 2009). Therefore, the Warm Stream Tier I DM and MWAT standards are in a range that would be stressful or lethal to trout.

3.12.2.3 Poudre River Fish Populations

In Segment A of the mainstem upstream of Fort Collins, there is a mix of coldwater and warmwater fish species. Sampling during 2001 through 2012 representing Current Conditions resulted in the collection of 12 species, including a mix of native and nonnative species and coldwater and warmwater species. During the supplemental fish data collection in 2005, the assemblage in this section was dominated by brown trout and longnose dace. Nearly one-third of the fish assemblage was brown and rainbow trout in 2003. Besides longnose dace and suckers, other warmwater species comprise a small portion of the fish community. Native species that have been collected in low numbers since 2001 include two warmwater species: creek chub and green sunfish. The current dominance of species typical of coldwater systems is not surprising in this segment, given its proximity to Poudre Canyon and its classification as a coldwater segment of river.

In Segments B and C of the mainstem through Fort Collins downstream to I-25, there is a mix of coldwater and warmwater species, as described in detail in the 2013 CTP Aquatic Resources Baseline Report (GEI 2013). A total of 22 species were collected in Segment B and 25 species in Segment C in the Current Conditions period. Brown trout maintain self-sustaining populations, especially in the sections closer to Fort Collins in Segment B, but are rare in the warmer water of Segment C. Warmwater species including longnose dace and white sucker are abundant and other

warmwater species such as creek chub, fathead minnow, green sunfish, johnny darter, largemouth bass, longnose sucker, and sand shiner were also commonly collected. Native species that are sometimes present, but collected in relatively low numbers since 2001, include black bullhead, brassy minnow, Iowa darter, orangespotted sunfish, and plains topminnow.

Downstream of I-25, in Segments D, E, and F of the mainstem, warmwater species are most abundant and trout are rarely collected. The number of species collected in the Current Conditions period in these three segments was similar, ranging from 22 to 25. Native warmwater species including fathead minnow, johnny darter, orangespotted sunfish, sand shiner, and white sucker are commonly collected along with nonnative species such as carp, largemouth bass, and mosquitofish, as described in more detail in the 2013 CTP Aquatic Resources Baseline Report (GEI 2013). Carp, bass and gizzard shad tend to prefer lentic habitat in ponds and lakes or slow-flowing river habitat and the abundant young bass and shad probably entered the river from a hydrologically connected off-channel pond or lake. Native warmwater species that are usually present only in low numbers include black bullhead, plains topminnow, and plains killifish throughout these three segments and creek chub and bigmouth shiner in some sections.

Available CPW stocking records for the Poudre River Basin date back to 1973. Since then, the study area has been stocked exclusively with rainbow trout with a single exception; brown trout were stocked in the mainstem once in 1992 (CDOW 2010). No stocking occurred between 1993 and 2008. Whirling disease resistant rainbow trout fingerlings were stocked in the mainstem in 2008 and 2009, and rainbow trout x cutthroat trout hybrids (cutbows) were stocked in the river in early 2010 (CDOW 2010).

A total of 40 fish species have been collected in the mainstem of the river since 1912 (Table 3-38). Most (23) of the species are native and 17 are nonnative. Most (25) of the species were collected in each of the three time periods. The number of species collected in the three periods has varied little, from 32 in the Historical period to 33 in the Recent Past and in the Current Conditions period.

The number of native species declined slightly among the three time periods, with 21 native species in the Historical period, 20 in the Recent Past period, and 16 in the Current Conditions period. The number of nonnative species has increased slightly over these three periods from 11 to 13 to 17, respectively (Table 3-38). Of the 21 native species collected in the Historical period, 15 were also still present with Current Conditions and 11 of the 17 nonnative species collected in the Current Conditions period were already present in the Historical period.

Table 3-38. Fish species presence over three time periods in the mainstem.

Species	Historical 1912-1984	Recent Past 1985-2000	Current Conditions 2001-2012
Bigmouth shiner	**X**	**X**	**X**
Black bullhead	**X**	**X**	**X**
Black crappie	X	X	X
Bluegill	X	X	X
Brassy minnow	**X**	**X**	**X**
Brook stickleback	X	X	X
Brown trout	X	X	X
Central stoneroller	**X**	**X**	
Channel catfish		**X**	**X**
Common carp	X	X	X
Common shiner	**X**	**X**	
Creek chub	**X**	**X**	**X**
Fathead minnow	**X**	**X**	**X**
Gizzard shad			X
Goldfish			X
Green sunfish	**X**	**X**	**X**
Hornyhead chub	**X**		
Iowa darter	**X**	**X**	**X**
Johnny darter	**X**	**X**	**X**
Largemouth bass	X	X	X
Longnose dace	**X**	**X**	**X**
Longnose sucker	**X**	**X**	**X**
Mosquitofish		X	X
Mountain whitefish	X	X	X
Northern redbelly dace	**X**		
Orangespotted sunfish	**X**	**X**	**X**
Plains killifish	**X**	**X**	
Plains minnow		**X**	
Plains topminnow	**X**	**X**	**X**
Pumpkinseed	X	X	X
Quillback	**X**		
Rainbow trout	X	X	X
Red shiner	**X**	**X**	**X**
Sand shiner	**X**	**X**	**X**
Sauger			X
Smallmouth bass	X	X	X
White crappie		X	X
Walleye			X
White sucker	**X**	**X**	**X**
Yellow perch	X	X	X

Note: Native species in **bold**.

Species richness, including all species collected since 1912, varied by segment in the mainstem. Species richness was lowest in Segment A upstream of Fort Collins and highest in Segments B, C, E, and F. The number of fish species historically or currently present increased abruptly between Segments A and B, the boundary between the coldwater and warmwater sections of the mainstem in Fort Collins, without a clear increase in the number of species downstream of Segment B. An expected increase in fish species in a downstream direction has been proposed

under the River Continuum Concept (Vannote et al. 1980). Because this phenomenon has been documented in stream fishes (Rahel and Hubert 1991; Williams et al. 1996), the initial increase in species richness between the coldwater and warmwater sections of the mainstem can be expected. The abrupt increase in species richness between the two sections may be due to decreased elevation and increased water temperatures because low temperatures and high elevation can control the upstream distribution of warmwater fishes in streams in the transition zone between mountain and plains environments (Rahel and Hubert 1991; Quist et al. 2004). This appears to be the case in the mainstem as there are more warmwater species in Segment B than upstream in the coldwater section in Segment A in all three time periods. Segment B contains many of the warmwater species found in Segments C through F and there is only a small incremental increase in species in the downstream segments of the mainstem. However, longitudinal zonation patterns can be obscured by disturbances such as pollution (Tramer and Rogers 1973) or historical changes to fish assemblages from past impacts (Aarts and Neinhuis 2003). This suggests that anthropogenic factors (such as barriers to upstream movements at diversions and the channelization that characterizes the section near Greeley) also play a role in determining species richness and that a continuous increase in species richness should not be expected in this modified system.

3.12.2.4 Poudre River Fish Habitat Availability Relationships

Most of the WUA versus discharge curves (habitat availability relationships) show high habitat availability somewhere within the middle of the range of flows that normally occurs in the river with lower habitat availability as flows contained within the channel become higher. The flow ranges that provide the maximum and minimum habitat availability differ between fish species and life stages based on their various life history requirements. For some species and life stages, such as brown trout adults, lowest habitat availability occurs in winter at very low flows and is highest in the "shoulder seasons" at the intermediate flows before and after peak runoff flows. Habitat availability during peak runoff is less than during the shoulder seasons but higher than during winter. For other species and life stages, such as trout fry and juveniles and for some minnow species, peak runoff flows result in the lowest habitat availability of the year.

Segments A and B of the mainstem contain a mix of trout and warmwater species, both of which were modeled. Habitat availability for brown and rainbow trout adults is highest at intermediate flows from approximately 200 to 1,000 cfs. These flows occur in late spring and early summer during the highest flow periods of the year. Low flows in winter result in the lowest habitat availability for adult trout. For the younger life stages of trout, fry and juveniles, and for the warmwater species, habitat availability is generally greatest at lower flows than for adult trout, approximately 40 to 500 cfs. Flows during runoff are higher than this range, resulting in low habitat availability for these species and life stages. The moderate flows prior to and after runoff result in highest habitat availability for these fish.

Segment C of the mainstem contains mostly warmwater fish species. Since this segment also contains a recreational fishery for adult brown and rainbow trout that move downstream from Segment B, these two species were also modeled. Segment C is downstream of many diversions

on the mainstem and peak runoff flows are typically much lower than in Segments A and B, upstream. The runoff period and the moderate flows prior to and just after runoff in Segment C result in highest habitat availability for most of the modeled species and life stages. Low flows in fall and winter result in lowest habitat availability for most species and life stages in this segment.

Segments D, E, and F of the mainstem have warmwater fish communities. These segments have flows that vary less from season to season than flows in Segments A, B, and C. The flow regime in the lower three segments usually has peak runoff flows that are not much higher than flows during other seasons, and low flow periods are not as severe as in the upstream segments. Most of the modeled species have wide ranges of flows that result in high habitat availability. The wide flow ranges and the small seasonal changes in flow result in habitat availability for the warmwater species modeled in these three lower segments that does not vary much throughout the year.

3.12.2.5 Poudre River Macroinvertebrate Populations

In Segment A, the coldwater section of the mainstem upstream of Fort Collins, the macroinvertebrate community is generally healthy and contains a wide variety of insects and other organisms. Mayflies, stoneflies, caddis flies, true flies, and segmented worms were well represented in the samples. Most invertebrates in this segment prefer moderate to fast flow velocities based on a calculated flow metric. Comparisons of Current Conditions data with data from the Recent Past indicate that there is a slight trend towards water quality degradation since the 1990s. The Current Conditions data indicate slightly fewer species and fewer sensitive species compared to data from the 1990s. Almost all MMI scores for samples in Segment A of the river were above the threshold score of 43 for attaining the aquatic life use. Since 2002, MMI scores at the various sites in this segment ranged from 35.0 to 87.8 with most of the scores relative high, greater than 58. A few of the scores from 2002 and 2003 were less than 50 and near the threshold.

In Segment B of the mainstem through Fort Collins, the macroinvertebrate community is generally healthy and diverse, and most taxa present prefer moderate flow velocities. The community commonly contains high proportions of mayflies, caddis flies, and true flies. The Current Conditions data for this section indicates that the community has not changed much compared to data collected in the 1990s. MMI scores for samples in this section of the river since 2003 ranged from 60.2 to 69.7 and were well above the threshold score of 43 for attaining the aquatic life use.

East of Fort Collins and upstream of I-25 in Segment C, the mainstem contains a community of macroinvertebrates that is generally healthy but indicates some degradation due to water quality and/or low flows. The community commonly contains high proportions of mayflies, caddis flies, true flies, and segmented worms. Most taxa collected prefer moderate flow velocities. There are fewer sensitive species than in the upstream sections of the river. The data indicate little change in the community from the Recent Past to Current Conditions. The single MMI score of 48.5 for

a sample in this segment of the river from 1993 was higher than the threshold of 43 for Biotype 1 streams (transition zone) and indicated attainment of the aquatic life use.

Downstream of I-25 in Segments D, E, and F, the macroinvertebrate community contains mostly tolerant species of segmented worms, true flies, and mayflies, indicating somewhat degraded water quality. Some sensitive species are present, but fewer than in upstream segments of the river. Most taxa present prefer low to moderate flow velocities. The data indicate little change in the community since the 1990s. The few MMI scores for samples in this section of the river sometimes scored above and sometimes below the threshold for the attainment of the aquatic life use. There are no scores for Segment D. Samples in Segment E from 2001 and 1993 had scores of 59.1 and 35.4, respectively, well above the threshold of 23 for Biotype 3 streams (plains). One sample from Segment F in 2002 scored only 18.2, well below the threshold.

3.12.2.6 Poudre River Algae

The limited available data indicate that periphytic algae (periphyton) in the mainstem is comprised of numerous species, as described in more detail in the 2013 CTP Aquatic Resources Baseline Report (GEI 2013). The periphyton communities at each site were generally dominated by diatoms or blue-green algae, which is typical for rivers such as the mainstem. There was a trend for higher density of periphyton in a downstream direction along the river, suggesting enrichment by nutrients. The high diversity of the community and low proportion of species that are tolerant of disturbance indicates that there has not been unusual disruption of the bottom substrate of the river, such as from high flows and that the periphyton community is not stressed. Species that can form nuisance blooms were present but not prevalent in the samples.

3.12.2.7 Poudre River Nuisance Species

Two nuisance fish species have been collected in the mainstem: common carp and mosquitofish. These two nonnative species are present in most segments of the mainstem and discussed in Section 3.12.1.6.1. The causative agent of whirling disease is also considered a nuisance species in the mainstem and has profoundly affected rainbow trout populations. While New Zealand mud snails have been found in only one location and zebra mussels and Quagga mussels have not been found in the Poudre River Basin, their future accidental introduction is possible. The presence of mosquitoes that can transmit WNV is also assumed for the study area.

3.12.3 South Platte River

Altered flow regimes resulting from implementation and operation of the project alternatives could potentially affect aquatic biological resources in the South Platte River. The reach of the South Platte River that could be affected extends from the confluence with the Poudre River downstream 2.4 miles to the Kersey Gage.

3.12.3.1 South Platte River Habitat

Habitat data for the segment of the South Platte River downstream of its confluence with the Poudre River are very limited. Measurements in Propst (1982) and by the National Water Quality Assessment Program (NAWQA) in 1993 and 1994 (USGS 2003) indicate the channel width of various transects ranged from 99 to 303 feet. The substrate was described as mainly sand and gravel. Woody snags, overhanging vegetation, and undercut banks were present, but not in substantial amounts. This section of the river is classified as Warm 2 by CDPHE (2014) indicating some impairment of the warmwater aquatic community.

3.12.3.2 South Platte River Water Quality and Temperature

Water quality in the South Platte River in the section in the study area from the Poudre River downstream to the Kersey Gage is degraded. There are exceedances of a wide variety of constituents (ERO 2012a). This section of the South Platte River is on the 303(d) list for selenium.

The South Platte River in the study area has Warm Stream Tier II temperature standards with DM standards of 28.6ºC and 14.3ºC in the summer and winter seasons, respectively. There were exceedances of the DM standard in 2 of 12 years of data, such as during very low flows in the summer of the drought year of 2002 (Hydros 2014a; ERO 2012a). In other years with higher flow, the DM summer temperature standard was not exceeded. MWAT standards are 27.5ºC and 13.8ºC in summer and winter, respectively, and these standards are not exceeded. The water temperatures in this portion of the river are suitable to support warmwater fish species.

3.12.3.3 South Platte River Fish Populations

The South Platte River in the study area has limited sampling data, most of which were collected after 1993. Nonnative fish are much less prevalent in the South Platte River than they are in the lower sections of the mainstem. The relatively small number of nonnative species may be partially attributable to the fluctuating flow conditions on the South Platte River, which may discourage species that are not adapted to this flow regime.

A total of 24 species have been collected in the South Platte River in the study area in the three time periods, 16 of which were native species and 8 were nonnative (Table 3-39). The number of species collected in the Historical period was only 14, likely because only a single sample was taken in this period.

Table 3-39. Fish species presence over three time periods in the South Platte River.

Species	Historical 1912-1984	Recent Past 1985-2000	Current Conditions 2001-2009
Bigmouth shiner	**X**	**X**	**X**
Black bullhead	**X**		
Black crappie	X	X	
Bluegill		X	
Brassy minnow	**X**		
Brook stickleback	X	X	X
Common carp	X	X	X
Creek chub	**X**	**X**	**X**
Fathead minnow	**X**	**X**	**X**
Gizzard shad		X	X
Green sunfish	**X**	**X**	**X**
Iowa darter			**X**
Johnny darter			**X**
Largemouth bass	X	X	X
Longnose dace		**X**	**X**
Longnose sucker	**X**	**X**	**X**
Mosquitofish		X	X
Orangespotted sunfish			**X**
Plains killifish	**X**	**X**	**X**
Plains topminnow		**X**	
Red shiner		**X**	**X**
Sand shiner	**X**	**X**	**X**
White sucker	**X**	**X**	**X**
Yellow perch		X	

Note: Native species in **bold**.

In 2002 and 2003, native sand shiners, fathead minnows, and bigmouth shiners were most common in quantitative samples. In 2004, these three species were still abundant, but nonnative mosquitofish represented a relatively high proportion of the catch. The native plains killifish, red shiners and white suckers were also common in one or more samples. Several native species including creek chub, Iowa and johnny darters, green sunfish, orangespotted sunfish, and plains topminnow were collected in very low numbers, likely in part because the habitat in the South Platte River is not ideal for these species.

3.12.3.4 South Platte River Fish Habitat Availability Relationships

In the South Platte River in the study area, the modeled warmwater fish species have wide ranges of flow that result in high habitat availability, from approximately 1,000 to 5,000 cfs. As in the lower segments on the mainstem of the Poudre River, the wide flow ranges and the small seasonal changes in flow result in habitat availability that does not vary much throughout the year. Most of the modeled species and life stages have higher habitat availability at higher flows during runoff and lower habitat availability at low flow periods in late summer and winter.

3.12.3.5 South Platte River Macroinvertebrate Populations

The samples from the South Platte River in the study area consistently contained a few species of mayflies, caddisflies, and segmented worms and more species of true flies. Other invertebrate groups were rare. Most taxa collected prefer moderate flow velocities. Density was usually dominated by segmented worms, although in some years, true flies, mayflies, or caddis flies were also abundant. The dominance by true flies, segmented worms, and tolerant species of mayflies and caddis flies indicates water quality is somewhat degraded in this segment of the South Platte River. During the Recent Past, community metrics and species composition were similar to those for the Current Conditions data. While density tended to be higher with the samples from the Recent Past, the number of sensitive EPT taxa was lower than for the Current Conditions data, suggesting a slight improvement in water quality over time.

Most MMI scores for samples in this section of the South Platte River were above the threshold for attaining the aquatic life use although a few scores were below the threshold. The most recent samples from 2002 and 2003 at a site near Kersey had scores of 43.6 and 18.4, one above and one below the threshold of 23. Past scores from the 1990s at the same site ranged from 15.6 to 49.1, with three of the four scores above the threshold.

3.12.3.6 South Platte River Algae

No periphyton data are available for this portion of the South Platte River. The sandy substrate in the river is not very suitable for sustaining algae. Larger hard surfaces, such as large gravel, cobble, and boulders would provide more suitable substrate but are limited. This portion of the river likely supports many different species of periphyton in low densities limited by the available substrate.

3.12.3.7 South Platte River Nuisance Species

Two nuisance fish species have been collected in the South Platte River: common carp and mosquitofish. Common carp were first collected in 1980 and mosquitofish were not collected until 1994. Both species have commonly been found in recent samples.

New Zealand mud snails have been found in several locations and zebra mussels have been found at one location upstream in the South Platte Basin. Their presence in the river in the study area is possible in the future, although the sandy substrate and lack of more stable larger substrate is not very suitable habitat for these species. The presence of mosquitoes that can transmit WNV is assumed for the study area. Since this portion of the river does not support coldwater species such as trout, whirling disease is not a concern.

3.12.4 Horsetooth Reservoir

Altered flow regimes and reservoir operations resulting from implementation and operation of Alternative 2 could potentially affect aquatic biological resources in Horsetooth Reservoir.

3.12.4.1 Horsetooth Reservoir Habitat

Horsetooth Reservoir has a maximum surface area of 2,143 acres, an average depth of 73 feet and a maximum depth of 188 feet. This reservoir is 6.7 miles long, narrow, only 0.6 mile wide (ERO 2012a), and steep-sided. Horsetooth Reservoir stratifies during the summer (ERO 2012a) with a warmer, upper layer (epilimnion) and a cooler, bottom layer (hypolimnion) with a transitional layer between (metalimnion). The water surface elevation of Horsetooth Reservoir fluctuates by 35 to 50 feet per year. Water levels decrease during the irrigation season and increase again as the reservoir refills during fall and winter (ERO 2012a).

3.12.4.2 Horsetooth Reservoir Water Quality

Horsetooth Reservoir has generally good water quality, with low specific conductivity and hardness, and low concentrations of sodium, sulfate, nutrients, and most metals (ERO 2012a). However, Horsetooth Reservoir is on Colorado's 303(d) list for high levels of copper and arsenic (CDPHE 2012). This reservoir was also on Colorado's 2010 M&E List for low dissolved oxygen levels (<6 mg/L) in the metalimnion (ERO 2012a). Horsetooth Reservoir is on the 303(d) list for Aquatic Life Use due to high levels of mercury in the tissue of large, predatory fish; it is one of nine Front Range reservoirs with a mercury-related consumption advisory (CDPHE 2012).

3.12.4.3 Horsetooth Reservoir Fish Populations

Horsetooth Reservoir supports a relatively diverse community of nonnative game fishes and a small number of native and nonnative forage species. Rainbow trout, smallmouth bass, walleye, and white sucker were consistently present during all three study periods. The proportion of rainbow trout was variable within all three study periods, but rainbow trout were more abundant in the recent past and historical time periods than they are under current conditions. Smallmouth bass and walleye proportions have remained relatively stable from 1984 to the present. Brown trout were also present in all three study periods, but they were rare. Rainbow smelt were abundant from 1984 to 1995 and scarce from 1996 to 2011; this forage fish has largely been replaced by emerald shiner and spottail shiner.

The fish community in Horsetooth Reservoir contains self-reproducing populations of walleye and smallmouth bass. CPW has stocked small numbers of gizzard shad, yellow perch, and splake, but fish such as crappie and bluegill are likely the result of illegal introductions (Kehmeier, pers. comm. 2011a).

3.13 TRAFFIC AND TRANSPORTATION

3.13.1 Overview

The following discussion describes the areas that may have traffic or transportation impacts due to the construction of reservoirs (including the potential U.S. 287 realignment, forebays, and associated infrastructure) and conveyance systems. Subsequent to the DEIS, CDOT selected the western alignment as their preferred alternative for the realignment of U.S. 287 associated with Alternative 2 (Figure 3-33; Figure 3-39). More detailed information on traffic and transportation is provided in the 2008 Land Use Report (ERO 2008b).

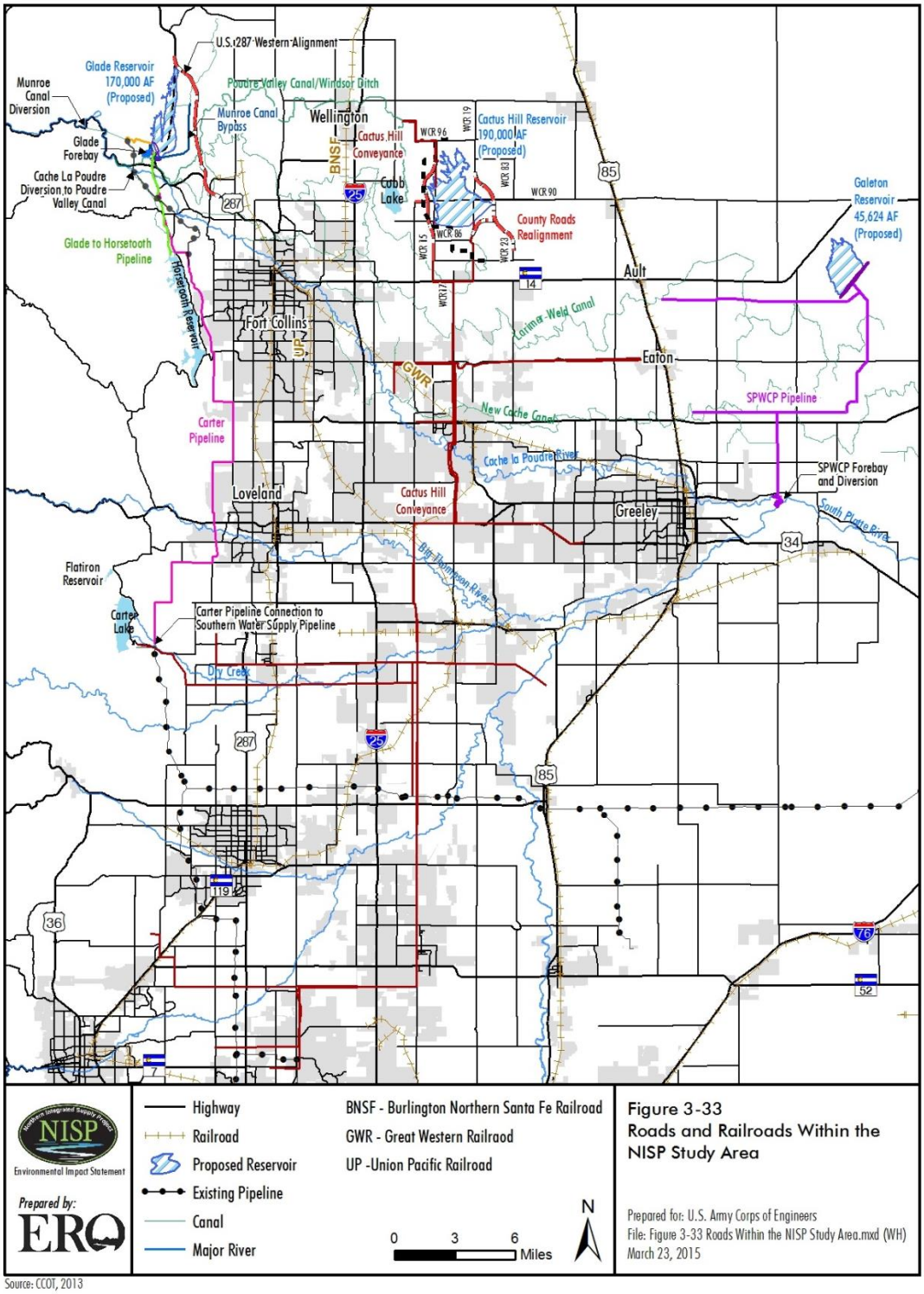
The NISP study area covers a large portion of north-central Colorado, including project components that could be constructed in Boulder, Larimer, Morgan, and Weld Counties. The surface transportation network in this region contains both roadways and railroads. The entities responsible for transportation planning within the study area include:

- North Front Range Metropolitan Planning Organization (NFRMPO)
  - Berthoud, Eaton, Evans, Fort Collins, Garden City, Greeley, Johnstown, Larimer County, La Salle, Loveland, Milliken, Severance, Timnath, Weld County, and Windsor
- Upper Front Range Transportation Planning Region (TPR)
  - Larimer, Morgan, and Weld Counties
- Denver Regional Council of Governments (DRCOG)
  - Denver, Broomfield, Arapahoe, Adams, Douglas, Gilpin, Jefferson, Boulder, and Clear Creek Counties

3.13.1.1 Study Area Transportation

There are numerous highways and roads within the study area that could potentially be affected by the proposed NISP as shown in Figure 3-33. Traffic volumes for roadways that could be affected by the NISP components will be updated in the FEIS. Planned road improvements, if needed to accommodate project-related traffic, also will be presented in the FEIS. Burlington Northern Santa Fe, Great Western, and Union Pacific railroads occur within the study area and could potentially be affected by the proposed NISP. The Cactus Hill conveyance would potentially cross the Great Western and Union Pacific Railroads in several places (Figure 3-33).

Figure 3-33. Roads and Railroads within the NISP Study Area.



Source: CCOT, 2013

3.13.2 Proposed Reservoir Sites

The construction of Glade, Cactus Hill, and Galeton Reservoirs would inundate existing roads and require the relocation of the inundated roads. These roads include state highways as well as county roads and other local access roads.

3.13.2.1 Glade

The existing road network, classification and use, traffic, and crash data for roads in the Glade Reservoir study area are described in Section 3.20.1 of the DEIS.

3.13.2.2 Galeton

The existing road network, classification and use, traffic, and crash data for roads in the Galeton Reservoir study area are described in Section 3.20.3 of the DEIS.

3.13.2.3 Cactus Hill

The existing road network, classification and use, traffic, and crash data for roads in the Cactus Hill Reservoir study area are described in Section 3.20.2 of the DEIS.

3.13.3 Conveyance Systems

All of the pipeline study areas (SPWCP pipelines, Glade to Horsetooth pipeline, and the Carter pipeline) and the Poudre Valley Canal study area contain federal, state, and/or local roads. The proposed pipeline alignments would cross a number of roads used for local, state, and in some cases, interstate travel (Figure 3-33).

3.14 AIR QUALITY

3.14.1 Overview

Air quality is determined primarily by how much pollution is emitted and how much dispersion (air movement and mixing) occurs in the area. Pollution sources include: stationary sources (e.g., factories, power plants), mobile sources (e.g., cars, planes), and naturally occurring sources (e.g., windblown dust, volcanic eruptions). Weather patterns, topography, and climate affect how air moves in the region and thus how these pollutants are transported. These factors and how they relate to the NISP study area are described in the following sections.

3.14.1.1 Meteorology and Climate in the Study Area

Both the geographical and meteorological characteristics of the NISP study area and the Rocky Mountains to the west are major factors affecting air quality conditions in the study area. Topography is particularly important in channeling pollutants along valleys, creating upslope and downslope circulation that entrains airborne pollutants, and blocking the flow of pollutants toward certain areas. The topography of the study area varies from hogbacks and valleys at Glade to flat plains near Kersey. Elevations range from about 5220 feet at Canyon Gage to around 4575 feet at Kersey Gage.

Table 3-40, Table 3-41, and Table 3-42 show meteorological data at weather stations within and near the study area (Western Regional Climate Center 2014). Wind data (Table 3-42) are not as available as the other meteorological parameters and thus are provided for only three weather stations within and near the study area.

Table 3-40. Average maximum and minimum temperatures (°F).

Station	Site ID	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Annual	
		Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Fort Collins	053005	41.1	13.7	44.2	17.1	51.2	24.0	60.6	33.0	69.1	42.1	79.3	50.4	85.2	56.0	83.5	54.2	75.4	45.1	64.2	34.2	51.1	23.1	42.5	15.5	52.3	34.0
Windsor	059147	42.1	12.3	43.4	15.6	49.4	22.2	60.9	33.3	68.1	41.0	79.6	49.3	90.0	54.9	88.2	54.5	79.4	42.6	67.2	34.4	51.5	20.9	43.7	16.3	63.6	33.1
Greeley	053546	40.1	8.8	43.7	13.2	51.7	21.6	62.4	32.0	72.0	42.0	82.8	50.7	89.4	55.8	87.4	53.8	79.0	43.8	67.0	32.1	52.2	19.6	41.7	11.0	64.1	32.0
Loveland NCWCD	055236	43.8	14.8	46.9	18.0	56.2	25.3	62.1	32.4	71.3	41.7	81.6	50.3	87.4	56.2	85.5	54.5	77.5	45.6	64.8	34.1	53.0	23.3	42.7	14.2	64.4	34.2
Longmont 2 ESE	055116	42.6	11.6	46.0	15.9	52.8	22.8	62.3	32.0	71.6	41.7	82.1	49.6	88.4	54.7	86.6	53.0	78.3	43.7	66.6	32.7	52.3	21.6	44.1	13.6	64.5	32.7
Fort Lupton 2 SE	053027	40.6	13.0	45.2	17.8	52.0	23.1	62.5	32.2	72.8	42.0	83.5	50.5	90.2	56.2	87.8	54.6	78.3	44.9	66.5	34.5	51.7	22.6	42.3	15.1	64.4	33.9
Boulder	050848	45.5	20.6	48.2	23.5	53.9	28.0	62.7	35.7	71.8	44.5	81.8	52.8	87.6	58.6	85.6	57.3	77.7	48.9	67.1	39.1	53.4	28.5	47.1	23.0	65.2	38.4

Table 3-41. Average total precipitation and snowfall (inches).

Station	Site ID	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Annual	
		Prec	Sno	Prec	Sno	Prec	Sno	Prec	Sno	Prec	Sno	Prec	Sno	Prec	Sno	Prec	Sno	Prec	Sno	Prec	Sno	Prec	Sno	Prec	Sno	Prec	Sno
Fort Collins	053005	0.36	6.0	0.48	6.8	1.18	10.2	1.97	6.2	2.74	1.2	1.83	0.0	1.62	0.0	1.42	0.0	1.27	0.5	1.13	3.1	0.59	6.5	0.49	6.7	15.1	47.1
Windsor	059147	0.34	3.8	0.28	2.5	0.86	4.2	1.47	2.5	2.34	0.1	1.93	0.0	1.43	0.0	1.06	0.0	0.96	0.1	0.97	0.3	0.50	2.4	0.35	3.2	12.5	19.1
Greeley	053546	0.27	3.5	0.36	5.1	0.74	6.5	1.42	4.1	2.40	0.5	1.56	0.0	1.15	0.0	1.09	0.2	1.00	0.3	0.91	1.6	0.39	3.3	0.39	4.2	12.0	29.3
Loveland NCWCD	055236	0.47	6.1	0.55	6.1	1.29	6.3	1.93	3.8	2.25	0.2	1.76	0.0	1.63	0.0	1.34	0.0	1.43	0.1	1.23	3.3	0.75	6.5	0.67	8.4	15.3	40.8
Longmont 2 ESE	055116	0.35	4.8	0.45	5.5	0.99	7.1	1.74	4.9	2.45	0.7	1.70	0.0	1.38	0.0	1.21	0.0	1.21	0.5	0.96	1.8	0.63	5.3	0.46	5.3	13.5	35.9
Fort Lupton 2 SE	053027	0.35	4.9	0.40	5.6	0.71	6.5	1.48	4.7	2.38	1.2	1.60	0.0	1.42	0.0	1.33	0.0	1.17	0.4	0.94	1.8	0.46	4.0	0.41	4.9	12.6	34.1
Boulder	050848	0.69	10.7	0.77	10.9	1.76	17.8	2.45	11.7	3.04	1.5	2.17	0.0	1.82	0.0	1.65	0.0	1.61	1.5	1.30	5.0	1.21	13.3	0.67	10.2	19.1	82.7

Table 3-42. Wind data.

Station	Monitored Metric	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Fort Collins-Loveland Airport (KFNL)	Prevailing Wind Direction	N	N	N	N	N	N	N	N	N	N	N	N	N
	Mean Wind Speed (mph)	6.2	7.1	7.9	8.9	7.6	7.2	6.9	6.7	6.4	6.5	6.3	6.6	7.0
Greeley Airport (KGXY)	Prevailing Wind Direction	N	N	N	N	E	E	E	E	E	N	N	N	N
	Mean Wind Speed (mph)	6.0	7.1	8.3	9.7	8.3	7.4	6.1	5.8	5.8	6.1	6.1	6.0	6.8
Boulder-Jefferson County Airport (KBJC)	Prevailing Wind Direction	W	W	W	N	N	N	N	NNW	N	N	W	W	W
	Mean Wind Speed (mph)	11.0	10.3	10.8	11.1	10.4	10.1	9.5	9.3	9.2	9.2	9.6	11.0	10.1

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3.14.2 National Ambient Air Quality Standards

The EPA has the responsibility for developing and enforcing regulations that govern air quality. The 1970 Federal Clean Air Act (CAA) requires EPA to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment. The Clean Air Act identifies two types of national ambient air quality standards. Primary standards provide public health protection, including protecting the health of “sensitive” populations such as asthmatics, children, and the elderly. Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings. EPA has set National Ambient Air Quality Standards for six principal pollutants, which are called "criteria" pollutants. Table 3-43 shows the NAAQS standards for each of the criteria pollutants. Units of measure for the standards are parts per million (ppm) by volume, parts per billion (ppb) by volume, and micrograms per cubic meter of air ($\mu g/m^3$).

Table 3-43. National Ambient Air Quality Standards (as of October 2011).

Pollutant [final rule cite]		Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide [76 Fed. Reg. 54294, Aug 31, 2011]		primary	8-hour	9 ppm	Not to be exceeded more than once per year
			1-hour	35 ppm	
Lead [73 Fed. Reg. 66964, Nov 12, 2008]		primary and secondary	Rolling 3 month average	0.15 μg/m^3 (1)	Not to be exceeded
Nitrogen Dioxide [75 Fed. Reg. 6474, Feb 9, 2010] [61 Fed. Reg. 52852, Oct 8, 1996]		primary	1-hour	100 ppb	98th percentile, averaged over 3 years
		primary and secondary	Annual	53 ppb (2)	Annual Mean
Ozone [73 Fed. Reg. 16436, Mar 27, 2008]		primary and secondary	8-hour	0.075 ppm (3)	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years
Particle Pollution Dec 14, 2012	$PM_{2.5}$	primary	Annual	12 μg/m^3	annual mean, averaged over 3 years
		secondary	Annual	15 μg/m^3	annual mean, averaged over 3 years
		primary and secondary	24-hour	35 μg/m^3	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24-hour	150 μg/m^3	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide [75 Fed. Reg. 35520, Jun 22, 2010] [38 Fed. Reg. 25678, Sept 14, 1973]		primary	1-hour	75 ppb (4)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		secondary	3-hour	0.5 ppm	Not to be exceeded more than once per year

[1] Final rule signed October 15, 2008. The 1978 lead standard (1.5 μg/m3 as a quarterly average) remains in effect until 1 year after an area is designated for the 2008 standard, except that in areas designated nonattainment for the 1978, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.

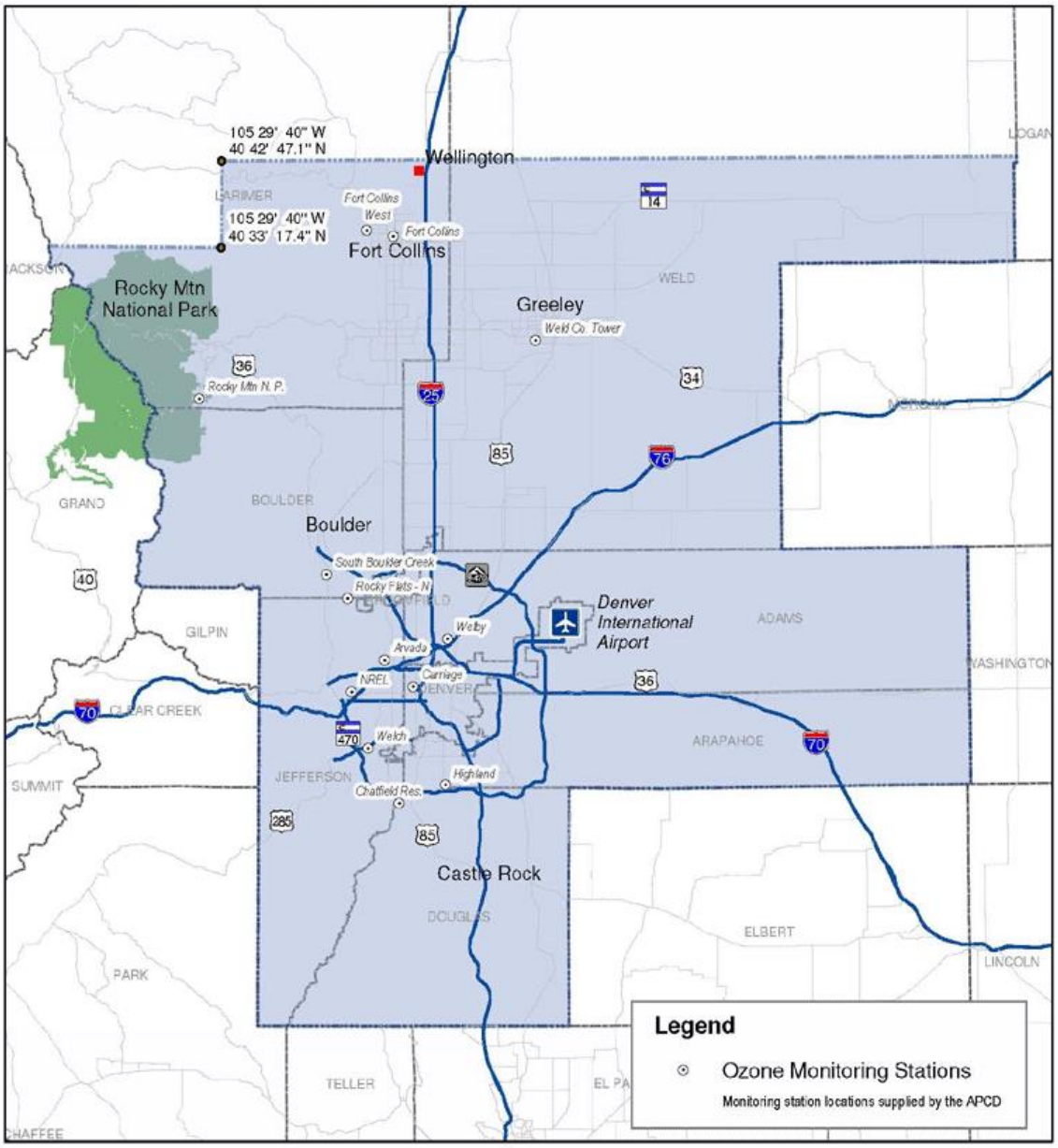
[2] The official level of the annual NO_2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard.

[3] Final rule signed March 12, 2008. The 1997 ozone standard (0.08 ppm, annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years) and related implementation rules remain in place. In 1997, EPA revoked the 1-hour ozone standard (0.12 ppm, not to be exceeded more than once per year) in all areas, although some areas have continued obligations under that standard ("anti-backsliding"). The 1-hour ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is less than or equal to 1.

[4] Final rule signed June 2, 2010. The 1971 annual and 24-hour SO2 standards were revoked in that same rulemaking. However, these standards remain in effect until 1 year after an area is designated for the 2010 standard, except in areas designated nonattainment for the 1971 standards, where the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standard are approved.

A Statewide monitoring network measures ambient concentrations of criteria pollutants. If ambient criteria pollutant concentrations do not exceed the NAAQS, an area is designated as an attainment area. Areas with pollutant concentrations exceeding the NAAQS for one or more pollutants are designated as nonattainment areas for those pollutants. Metropolitan Denver and the north Front Range were classified as a "marginal" ozone nonattainment area by the EPA effective July 20, 2012. The marginal nonattainment designation does not impose any new planning requirements on Colorado at this time; however, the nonattainment area must meet the standard before 2015 or new requirements may be imposed. Figure 3-34 shows the Denver Metropolitan Area and North Front Range 8-hour ozone nonattainment area boundaries.

Figure 3-34. Denver Metro and North Front Range 8-Hour Ozone Nonattainment Area.



Denver-Boulder-Greeley-Fort Collins, Colorado
Eight-Hour Ozone Control Area

DRCOG
Denver Regional Council of Governments
Metro Vision Resource Center

June 2004

3.14.3 Status of State Implementation Plans

Colorado is in attainment of all NAAQS except for the 8-hour ozone standard. The CDPHE Air Quality Control Commission (AQCC) adopted an Ozone Action Plan in 2004 and entered into the Early Action Compact in 2007. Table 3-44 shows the NISP-affected counties that are in non-attainment and maintenance areas for criteria pollutants.

Table 3-44. NAAQS non-attainment and maintenance areas in the NISP study area.

Pollutant	County
Non-Attainment	
Ozone (8-hour)	Boulder, Larimer, and Weld
Maintenance	
CO, PM_{10}	Boulder and Jefferson

Source: EPA 2010.
Notes:
CO = carbon monoxide.
PM = particulate matter.

3.14.3.1 Regional Haze and Visibility

Haze results in reduced visibility in many cities and scenic areas. Visibility is generally defined as the distance at which an object or light can be clearly discerned. Within the context of a landscape, visibility is closely associated with conditions that allow features such as form, contrast detail, and color to be perceived. Haze occurs when sunlight hits tiny particles in the air, which reduces the clarity and color of what we see, particularly during humid conditions.

EPA and other agencies have been monitoring visibility in national parks and wilderness areas since 1988. In 1999, EPA announced a major initiative to improve air quality in national parks and wilderness areas. The Regional Haze Rule calls for state and federal agencies to work together to improve visibility in 156 national parks and wilderness areas, known as Class I Areas. There are 12 Class I areas in Colorado (Table 3-45).

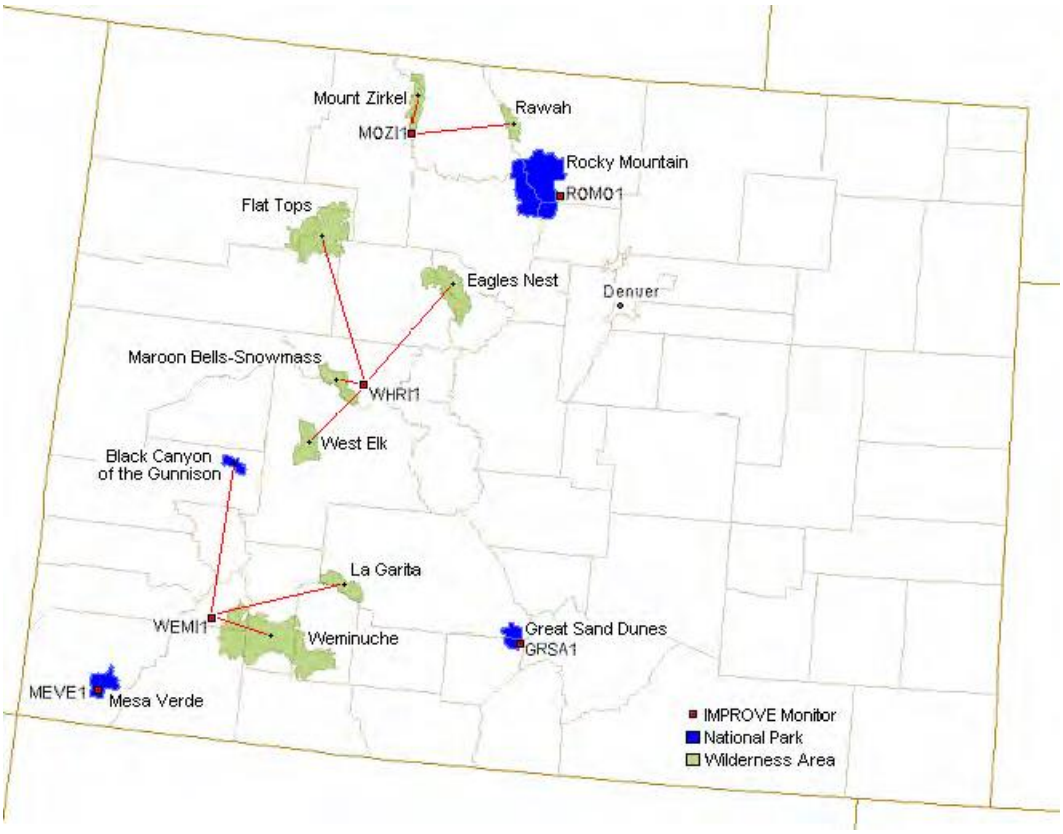
Table 3-45. Mandatory federal Class I areas in Colorado.

Black Canyon of Gunnison National Park	Mesa Verde National Park
Eagles Nest Wilderness Area	Mount Zirkel Wilderness Area
Flat Tops Wilderness Area	Rawah Wilderness Area
Great Sand Dunes National Monument	Rocky Mountain National Park
La Garita Wilderness Area	West Elk Wilderness Area
Maroon Bells-Snowmass Wilderness Area	Weminuche Wilderness Area

Source: NPS 2006.

The closest Class I areas to the Project are Rawah Wilderness Area (managed by the U.S. Forest Service) and Rocky Mountain National Park (managed by the National Park Service [NPS]). Visibility monitoring has been ongoing at 50 NPS locations, including Rocky Mountain National Park, as a part of the Interagency Monitoring of Protected Visual Environments (IMPROVE) program (Figure 3-35).

Figure 3-35. Colorado Class I Areas and IMPROVE Monitor Locations.



Colorado developed a federally required Regional Haze Plan, which was approved by the Air Quality Control Commission in January 2011. The plan includes new controls for oxides of nitrogen (NOx) at power and cement plants that will also benefit ozone reduction efforts.

3.14.4 Air Quality Conformity

The CAA's general conformity provisions require Federal agencies to ensure that planned Federal actions located in an area designated "non-attainment" or "maintenance" do not impair State and local efforts to improve or maintain air quality. General conformity provisions apply on a per-pollutant basis to areas that meet one of the following criteria:

1. The area is designated as non-attainment for one or more pollutants, or
2. The area is designated as a maintenance area (an area that was previously designated nonattainment and is working to maintain acceptable air quality).

The CDPHE AQCC incorporated by reference EPA's provisions of Title 40, Part 51, Subpart W, and Title 40, Section 6.303 in Air Quality Regulation 10.

The Federal agency responsible for approving an action is required to determine if the action conforms to the applicable non-attainment or maintenance area State Implementation Plan (SIP).

Colorado's SIPs establish conformity criteria and procedures that are consistent with Federal conformity provisions.

The general conformity process is broken down into two steps that must be completed prior to commencement of a Federal action:

1. A conformity analysis to determine if *de minimis* or regional significance thresholds are exceeded (Table 3-46). The conformity analysis has two steps:
   a) An applicability analysis, to determine whether the action meets a regulatory exemption (listed in 40 CFR 93.153c), and
   b) If the action is not exempt, emission calculations to determine if *de minimis* threshold is exceeded.
2. If the action is not exempt and *de minimis* or regional significance thresholds are exceeded, a Conformity Determination must be performed.

Table 3-46. Conformity *de Minimis* threshold levels.

Pollutants/Maintenance Areas	Tons/Year
Ozone (NO_X, SO_2 or NO_2) Marginal or moderate ozone non-attainment area	100
Ozone (VOCs) Maintenance areas inside an ozone transport region Maintenance areas outside an ozone transport region	50 100
CO All Maintenance Areas	100
PM_{10} All Maintenance Areas	100
Pb All Maintenance Areas	25

Source: 40 CFR 93.153.
Notes:
Denver is located outside of an ozone transport region.
CO = carbon monoxide; PM = particulate matter; NO_2 = nitrogen dioxide; SO_2 = sulfur oxide; NO_X = oxides of nitrogen; VOC = volatile organic compound; Pb = lead.

The general conformity threshold for volatile organic compounds (VOCs) is 100 tons/year assuming that the Denver/North Front Range 8-hour ozone non-attainment area classification is considered maintenance. Based on the information provided in the SIP, activities conducted inside the Denver Metropolitan/North Front Range areas would need to be evaluated for conformity.

3.14.4.1 North Front Range Transportation and Air Quality Planning Council

The North Front Range Transportation and Air Quality Planning Council (NFRTAQPC) is designated by the Governor as the lead air quality planning organization for the North Front Range region and is a nonprofit public organization of 15 local and county governments in Larimer and Weld Counties and is funded through federal and state grants and local funds. The

goal of NFRTAQPC is to enhance air quality and mobility among northern Colorado communities and between the North Front Range and the Denver Metro area by developing cooperative working relationships and financial partnerships among its member governments, CDOT, Federal Highway Administration (FHWA), the Federal Transit Administration (FTA), and the private sector. NFRTAQPC is responsible for proposing air quality measures affecting the North Front Range and performing conformity determinations to ensure its transportation plans and programs comply with the state implementation plan.

The realignment of U.S. 287 (Alternative 2, western alignment) is within the Denver/North Front Range ozone nonattainment area but outside of the Fort Collins carbon monoxide (CO) attainment/maintenance area. The geographic area of the realignment occurs within the Upper Front Range Transportation Planning Region (UFR TPR), not in the planning area of the NFRMPO.

Transportation conformity is the link between air quality planning and transportation planning. It is required under Section 176(c) of the Clean Air Act to ensure that federally supported highway and transit projects are consistent with air quality goals in the SIP. The Transportation Conformity Rule (40 CFR 93) and regulations (Transportation Conformity Regulations as of April 2012, EPA-420-B-12-013) are the mechanisms through which transportation plans, programs, and projects are evaluated for air quality impacts in nonattainment and attainment/maintenance areas.

The air quality conformity process has two levels: regional air quality conformity and project-level conformity. The regional conformity analysis is conducted for the regional transportation program (RTP) and the transportation improvement program (TIP). Regional conformity ensures that the RTP and TIP and the financially constrained projects therein are consistent with the emissions budgets (i.e., limits) in the air quality state implementation plan. In nonattainment areas, regional conformity analyses are conducted at least every 4 years as well as on an as-needed basis. A project must come from a conforming transportation plan and improvement program (40 CFR 93.115) before a conformity determination can be made for it. The design and concept for the proposed project must be adequately defined and must remain consistent with the project's definition in the conforming RTP and TIP. If the project changes in concept or design during the planning process, or if it was not originally included in the RTP and TIP, the regional conformity analysis would need to be revisited before the project can proceed.

Project-level conformity applies to transportation projects in air quality nonattainment and attainment/maintenance areas. Project-level conformity is conducted for projects that are funded and/or approved by the FHWA or FTA and/or considered regionally significant. To pass project-level conformity, the project must be included in a conforming RTP and TIP; and the project cannot create new, increase the frequency of, or exacerbate the severity of violations of the National Ambient Air Quality Standards (NAAQS). The NAAQS tests are conducted through a hotspot analysis for the applicable pollutant, such as CO.

For the U.S. 287 realignment, a conformity determination will be necessary for ozone but not for CO since the project is within the Denver/North Front Range ozone nonattainment area but outside of the Fort Collins CO attainment/maintenance area. The pollutant ozone is a regional

issue that involves the interaction of various chemicals (e.g., volatile organic compounds, oxides of nitrogen) in the presence of sunlight. As such, there is no detailed project-level hotspot analysis required for ozone, only a regional analysis.

In this case, the UFR TPR has an agreement with the NFRMPO that designates the NFRMPO as the agency that conducts the analysis for regional ozone conformity determinations even though the project lies outside of the NFRMPO planning area. This is due in part to the modeling domain and highway network of the NFRMPO regional travel demand model covering this part of the ozone nonattainment area. To do the analysis, the NFRMPO would include the project in the long-range, regional transportation plan highway network of their regional travel demand model. Once the project is included in the regional emissions analysis and the regional analysis meets the emission budget tests for ozone precursors, the NFRMPO can make the conformity determination for ozone. The project must also be included in the RTP of the UFR TPR. Since the TPRs in Colorado do not prepare their own transportation improvement programs, the project must also be listed in the Statewide Transportation Improvement Program (STIP) before it can proceed. To include the project in the STIP, it must have dedicated funding. The project sponsor would then work through the UFR TPR and Region 4 of CDOT to have the project added to the STIP.

To streamline and support the analysis, the transportation conformity rule requires an Interagency Consultation process (40 CFR 93.105). Discussion topics must include, at a minimum, agency roles and responsibilities, the process for circulating review documents and comments, models and methodology for the analysis, and regionally significant projects. The consultation process must involve representatives of the following:

- Local metropolitan planning organization (i.e., NFRMPO)
- State and local air quality planning agencies (e.g., Air Pollution Control Division of the Colorado Department of Public Health and the Environment [CDPHE])
- State and local transportation agencies (e.g., CDOT)
- EPA
- FHWA
- FTA

The realignment of U.S. 287 and the realignment of Weld CRs 15, 19, and 90 have been included in the regional air conformity analysis and STIP.

3.15 NOISE

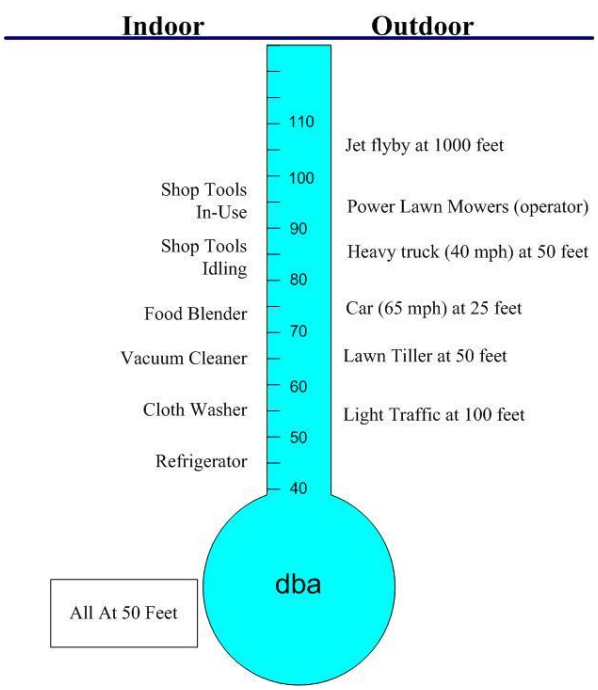
3.15.1 Overview

Noise is defined as unwanted sound and can have effects on human health and the environment. Noise associated with the Project includes additional vehicular traffic, construction equipment traffic and operation, and facility operations.

3.15.1.1 Measuring Noise

Noise is measured on the decibel scale, which is logarithmic. Zero dB is the quietest sound audible to a healthy human ear. Every increase of 3 dB represents a doubling of sound intensity. Sound levels are not additive when combined. For example, if two sounds each of 70 dB occur at the same time, the resulting sound measurement would be only a 3 dB increase to 73 dB. Noise levels are often given in dBA (A-weighted sound levels), which are decibel scale readings that have been adjusted to account for human hearing. The result is that low and very high frequencies are given less weight. Typical dBAs for commonly encountered noises are shown in Figure 3-36.

Figure 3-36. Typical Average A-weighted Sound Levels for Commonly Encountered Noises.



The EPA has adopted the following four descriptors for sound, all normally measured as dBA, which take into account how sound is propagated and heard (EPA 1974):

- A-weighted Sound Level (LA) – Corresponds to the way the human ear perceives the magnitude of sounds at different frequencies.

- A-weighted Sound Exposure Level (SEL) – This is the intensity of sound measured over a period for time, usually of one-second duration. The SEL allows direct comparison of sounds with different magnitudes and duration.
- Equivalent Sound Level (Leq) – A summation of the individual sound energies over a given period of time, usually one hour, and is expressed in dBA.
- Day-Night Average Sound Level (Ldn) – This is the Leq for a full 24-hour period taking into account the increased perception of sound at night by adding 10 dBA to the period between 10 p.m. and 7 a.m.

Noise levels above LA 134 dBA may cause temporary human hearing impairment and permanent damage may occur from exposure to LA 140 dBA or higher. EPA has predicted that exposure to an Leq of 70 dBA for 24 hours per day, 365 days per year over 40 years would result in a hearing loss of less than 5 dBA in 96% of the population. This degree of loss is generally acceptable for long-term human exposure (EPA 1974). The World Health Organization takes a more protective approach and recommends general human exposure to less than 50 dBA to protect from annoyance during daytime activities and less than 45 dBA at night (WHO 2000).

3.15.1.2 Federal Noise Control Act and Implementing Regulations

The Noise Control Act of 1972 (42 USC 4901 et seq.) authorized the establishment of federal noise emission standards. Companion legislation (23 USC 109(i)) directs the Secretary of Transportation to develop and implement traffic noise standards for highway projects.

Noise impact criteria and abatement are set forth in 23 CFR 772 (Procedures for Abatement of Highway Traffic Noise and Construction Noise). This regulation requires preparing a noise study to determine what noise impacts, if any, will result from the proposed highway improvement and what measures will be taken to lessen these impacts. If noise impacts are expected, noise-reduction measures that are determined by the state highway agency to be practicable, reasonable, and acceptable to the public must be incorporated into the highway improvements.

3.15.1.3 State Noise Legislation and Implementing Regulations

According to CDOT Policy Directive 1601, any project that includes state, local, and public-private partnership projects overseen by CDOT must comply with all the federal regulatory requirements. A noise analysis study is required for a Type 1 project (defined below) if noise-sensitive receivers are present within the project study zone. The study zone is defined as a 500-foot distance in all directions from the edge of traveled way through the project.

CDOT provides requirements to evaluate highway traffic noise and what must be considered to mitigate noise impacts during the planning, design, and construction of highways and transportation improvements. 23 CFR 772 mandates that a traffic noise analysis is required by law for federally funded projects, and required by state policy for other funded projects that: (1) involve construction of a new highway, (2) significantly change the horizontal or vertical

alignment of an existing highway, or (3) increase the number of through traffic lanes on an existing highway. Relocation of U.S. 287 is such a Type I project.

A noise-sensitive receiver is any location where a traffic noise impact may be detrimental to the enjoyment and functional use of the property. A traffic noise impact is considered to occur when any noise-sensitive receiver is subjected to either: 1) existing or future noise levels that approach or exceed the noise abatement criteria; or 2) future noise levels that substantially exceed the existing noise levels. A substantial increase over existing noise levels is considered by CDOT to be an increase over existing noise levels of at least 10 dBA.

3.15.1.4 Highway Traffic Noise

Vehicle noise is a combination of the noises produced by engines, exhaust, and tires. Noise levels are affected by the distance of the receptor (such as a human or a neighborhood) from the noise, the terrain, vegetation, and natural and manmade obstacles. Heavier traffic volumes, higher speeds, greater numbers of trucks, defective equipment, and inclines may increase traffic noise levels. The significant factors that contribute to outdoor sound propagation from source to the receiver can be described by seven main mechanisms. These mechanisms include: atmospheric absorption, ground reflection, barrier insertion loss, building attenuation, heavily wooded area attenuation, amplification caused by urban reverberation, and effects of vertical wind/temperature gradients (MERCO 2006b).

For highway projects that require noise analyses in Colorado, the accepted noise descriptor is the worst-hour Leq(h) for determining existing and future noise levels and impacts. The “worst-hour” reflects the conditions that will produce the worst traffic noise. In general, this is highest traffic volume traveling at the highest possible speed and reflects Level of Service conditions. If traffic volume continues to increase past these conditions, the traffic is forced to slow down, which in turn decreases the noise levels generated (MERCO 2006b).

To help control noise and maintain an aesthetic environment, CDOT established Noise Abatement Criteria (Table 3-47). The primary consideration is normally residential areas; however, frequent human use areas such as schools, parks, hotels, and commercial centers are also considered for evaluation. Most sensitive receivers that will be encountered on highway traffic noise analysis efforts will be categorized as category “B” receivers and are subject to the 66 dBA criterion.

Table 3-47. CDOT noise abatement criteria.

Activity Category	CDOT Leq (h), dBA[2]	Description of Activity Category
A	**56 (Exterior)**	Lands on which serenity and quiet are of extraordinary significance and serve an important public need, and where preservation of those qualities is essential if the area is to continue to serve its intended purpose
B[1]	**66 (Exterior)**	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, and hospitals
C	**71 (Exterior)**	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreational areas, Section 4(f) sites, schools, television studios, trails, and trail crossings.
D	**51 (Interior)**	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.
E[1]	**51 (Interior)**	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F.

[1]Includes undeveloped lands permitted for this activity.
[2]Hourly A-Weighted sound level reflecting a 1 dBA approach value below (more stringent) than FHWA values in 23 CFR 772.

3.15.1.5 Colorado Noise Statutes

Under the Noise Control Act of 1972, Congress directed the EPA to conduct research and implement controls of noise on a national level. In 1992, states and local agencies took over the regulation of community noise. CRS 30-15-401(1)(m) authorizes counties to regulate noise on public and private property in Colorado. Maximum permissible noise levels in Colorado are stated in CRS 25-12-103 and are implemented on the county level, as shown in the tables below. The counties in the study area where land disturbing activities and increased vehicular traffic may occur are Larimer, Weld, Morgan, and Boulder (Table 3-48 through Table 3-51).

Table 3-48. Allowable noise levels (dBA) in Larimer County.

Land Use	Maximum Noise (dBA) 7:00 a.m. – 7:00 p.m.	Maximum Noise (dBA) 7:00 p.m. – 7:00 a.m.
Residential Property or Commercial Area	55	50
Construction or Demolition Projects	80	75

Source: Larimer County Ordinance No. 97-03.
Notes: dBA = A-weighted decibel scale.

Table 3-49. Allowable noise levels (dBA) in Weld County.

Land Use	Maximum Noise (dBA) 7:00 a.m. – 9:00 p.m.	Maximum Noise (dBA) 9:00 p.m. – 7:00 a.m.
Residential Property or Commercial Area	55	50
Industrial Area or Construction Activities	80	75
Nonspecified Areas	55	50

Source: Weld County Ordinance 2008-4.
Notes: dBA = A-weighted decibel scale.

Table 3-50. Allowable noise levels (dBA) in Morgan County.

Zone	Maximum Noise (dBA) 7:00 a.m. – 7:00 p.m.	Maximum Noise (dBA) 7:00 p.m. – 7:00 a.m.
Residential	55	50
Commercial	60	55
Light Industrial	70	65
Industrial	80	75

Source: CRS 25-12-103.
Notes: dBA = A-weighted decibel scale.

Table 3-51. Allowable noise levels (dBA) in Boulder County.

Land Use	Maximum Noise (dBA) 7:00 a.m. – 7:00 p.m.	Maximum Noise (dBA) 7:00 p.m. – 7:00 a.m.[1]
Residential Property	55	50
Construction	80	75

Source: Boulder County Ordinance No. 92-28.
Notes: dBA = A-weighted decibel scale.

Vehicles operating in the public right-of-way in these counties are subject to maximum noise levels, as shown in Table 3-52 through Table 3-54.

Table 3-52. Allowable vehicular noise levels (dBA) in Larimer and Weld County public right-of-way.

Vehicle Class (GVWR)	Maximum Noise (dBA) in Speed Limit 35 mph or less Zone	Maximum Noise (dbA) in Speed Limit over 35 mph Zone
Manufacturer's gross vehicle weight rating (MGWR) greater than 10,000 pounds (4,536 kg), or any combination of vehicles towed by such motor vehicle	86	90
Any other motor vehicle or any combination of vehicles towed by any motor vehicle including, but not limited to, automobiles, motorcycles, vans, or light trucks with a gross vehicle weight rating (GVWR) less than 10,000 pounds (4,536 kg)	80	84

Source: Larimer County Ordinance No. 97-03, Weld County Ordinance 2008-4.
Notes: dBA = A-weighted decibel scale.

Table 3-53. Allowable vehicular noise levels in Morgan County public right-of-way.

Vehicle Class (GVWR)	Maximum Noise (dBA) in Speed Limit of 35 mph or less Zone	Maximum Noise (dBA) in Speed limit of more than 35 mph but less than 55 mph Zone
Any motor vehicle manufactured before January 1, 1973 with a MGWR of 6,000 pounds or more, any combination of vehicles towed by such motor vehicle, and any motorcycle other than a low-power scooter	88	90
Any motor vehicle manufactured after January 1, 1973 with a manufacturer's GVWR of 6,000 pounds or more, any combination of vehicles towed by such motor vehicle, and any motorcycle other than a low-power scooter	86	90

Source: CRS 25-12-107.
Notes: dBA = A-weighted decibel scale.

Table 3-54. Allowable vehicular noise levels in Boulder County public right-of-way[1].

Vehicle Class (GVWR)	Maximum Noise (dBA) in Speed Limit 35 mph or less Zone	Maximum Noise (dbA) in Speed Limit over 35 mph Zone
Motorcycle manufactured before 1/1/1973	82	86
Motorcycle manufactured on or after 1/1/1973	80	84
MGWR greater than 10,000 pounds (4,536 kg), or any combination of vehicles towed by such motor vehicle	86	88
All other vehicles	80	84

Source: Boulder County Ordinance No. 92-28.
Notes: dBA = A-weighted decibel scale.
[1]Sound from a vehicle being operated on private property or public property which is not a road or highway shall not exceed the following as measured on the "A" weighting scale dBA: All vehicles: 78 dBA.

3.15.1.6 Noise and Wildlife

The NISP study area is mostly rural in nature. Wildlife in the NISP affected environment is currently exposed to noise from roads, construction, and industrial and agricultural operations. Noise exposure can affect animals in several ways, including reduced threat perception and changes in breeding and foraging behavior.

3.15.2 Proposed Reservoir Sites

3.15.2.1 Glade

In the Glade Reservoir study area, U.S. 287 is an existing source of noise. Most of the remainder of the Glade Reservoir site is in a rural area and currently does not have high noise levels. The proposed U.S. 287 realignment alternatives would travel through the decommissioned Holcim Mine, and would travel along portions of existing U.S. 287. The decommissioned Holcim Mine does not have high noise levels.

3.15.2.2 Galeton

The Galeton Reservoir study area is in a rural area in or near County Roads, where noise levels are not high.

3.15.2.3 Cactus Hill

The Cactus Hill Reservoir study area is in a rural area in or near county roads, where noise levels are not high.

3.15.3 Conveyance Systems

The conveyance systems study areas are largely in rural areas, but higher noise levels can be found along highways, near agricultural and industrial operations, and in the more developed Participant study areas.

3.16 RECREATION

3.16.1 Overview

This section presents a summary of the existing recreation resources in the study areas. Recreation resources in the study areas could be affected by construction and project-related changes in streamflows and/or reservoir levels. More detailed information on recreation is presented in the 2008 Recreation Resources Report (ERO 2008g).

3.16.2 Horsetooth Reservoir

Recreation at Horsetooth Reservoir is described in Section 3.17.1 of the DEIS.

3.16.3 Flatiron Reservoir and Carter Lake

Swimming and boating are not allowed at Flatiron Reservoir, but fishing, picnicking, and camping are permitted activities. Recreation at Carter Lake is described in Section 3.17.2 of the DEIS.

3.16.4 Proposed Reservoir Sites

3.16.4.1 Glade

Recreation within the Glade study area is described in Section 3.17.4.1 of the DEIS.

3.16.4.2 Galeton

Recreation within the Galeton study area is described in Section 3.17.4.2 of the DEIS.

3.16.4.3 Cactus Hill

Recreation within the Cactus Hill study area is described in Section 3.17.4.3 of the DEIS.

3.16.5 Poudre River

New and updated information on recreation along the Poudre mainstem is presented in the sections below and on Figure 3-37 and Figure 3-38. Additional information can be found in Section 3.17.3 of the DEIS.

3.16.5.1 Boating

Downstream of the Poudre Valley Canal diversion, the Poudre River currently receives limited use by kayakers and canoers. However, local boaters occasionally paddle the lower Poudre

River through Fort Collins in kayaks or canoes. This reach of the river is also popular for tubing. The suggested minimum flow for recreation in this reach of the Poudre River through Fort Collins, including the proposed whitewater park, is 150 cfs. This is believed to be the minimum necessary to support a range of common river-based recreational experiences, including tubing, canoeing, and potential future whitewater park use. Under current conditions, the average number of days that Poudre River flows exceed 150 cfs (during the May-September recreation season) through Fort Collins (Segment B) are estimated to be as follows:

- May – 16 days
- June – 23 days
- July – 11 days
- August – 4 days
- September – 0 days

3.16.5.2 Angling

Fishing on the Poudre from the Poudre Valley Canal diversion to its confluence with the South Platte has become increasingly popular over the years. Use appears to have been increasing each year on the Poudre from Watson Lake to Lee Martinez Park, and this reach of the Poudre is within the top third of areas used by anglers in the Platte Basin (Kehmeier, pers. comm. 2011b). Fishing on the Poudre through Fort Collins has the highest use in summer and fall with slightly less use in the spring and winter (Kehmeier, pers. comm. 2011b). Wild spawn, coldwater species favored by sport anglers such as brown and rainbow trout occur in this section. The Watson Lake State Fishing Unit and the Lions Park trailhead provide access for coldwater stream fishing in the study area upstream of Fort Collins. CPW manages the Poudre River from Fort Collins downstream to the confluence with the South Platte River for native nongame fish species. The upper sections of the Poudre River are sometimes stocked with rainbow trout and rainbow/cutthroat hybrid (cutbow) trout. Most of the ponds on public lands along the Poudre are stocked with warmwater species, and receive an estimated 1,000 to 1,500 hours/acre of fishing use annually. The South Platte from Greeley to Fort Morgan is managed for native warmwater species habitat rather than recreational fishing, and is not stocked (Kehmeier, pers. comm. 2005).

3.16.5.3 Walking and Biking

A nearly continuous trail follows the Poudre River from just west of Fort Collins to Greeley. This developing regional trail corridor currently offers nonmotorized recreational opportunities including biking, walking, running, and rollerblading. The Pleasant Valley trail begins at the Watson Lake SWA and follows the Poudre River to Lions Park, where it connects with the Poudre River trail, which continues through Fort Collins, downstream to the Environmental Learning Center.

Further downstream, the Poudre River Trail continues east of I-25 for a short segment near Timnath. No trail currently exists between Timnath and Windsor. From State Highway 392 in Windsor, the trail continues to Island Grove Regional Park in Greeley. No formal visitation

studies of this portion of the trail have been conducted. Fort Collins has plans to extend the trail to the south and east, including an underpass of I-25 to meet the Timnath segment. Greeley plans to continue the trail downstream of Island Grove Park to the confluence of the South Platte River (Rudd, pers. comm. 2006); this connection has not yet been completed.

Figure 3-37. Recreation in the Cache la Poudre River Corridor (North).

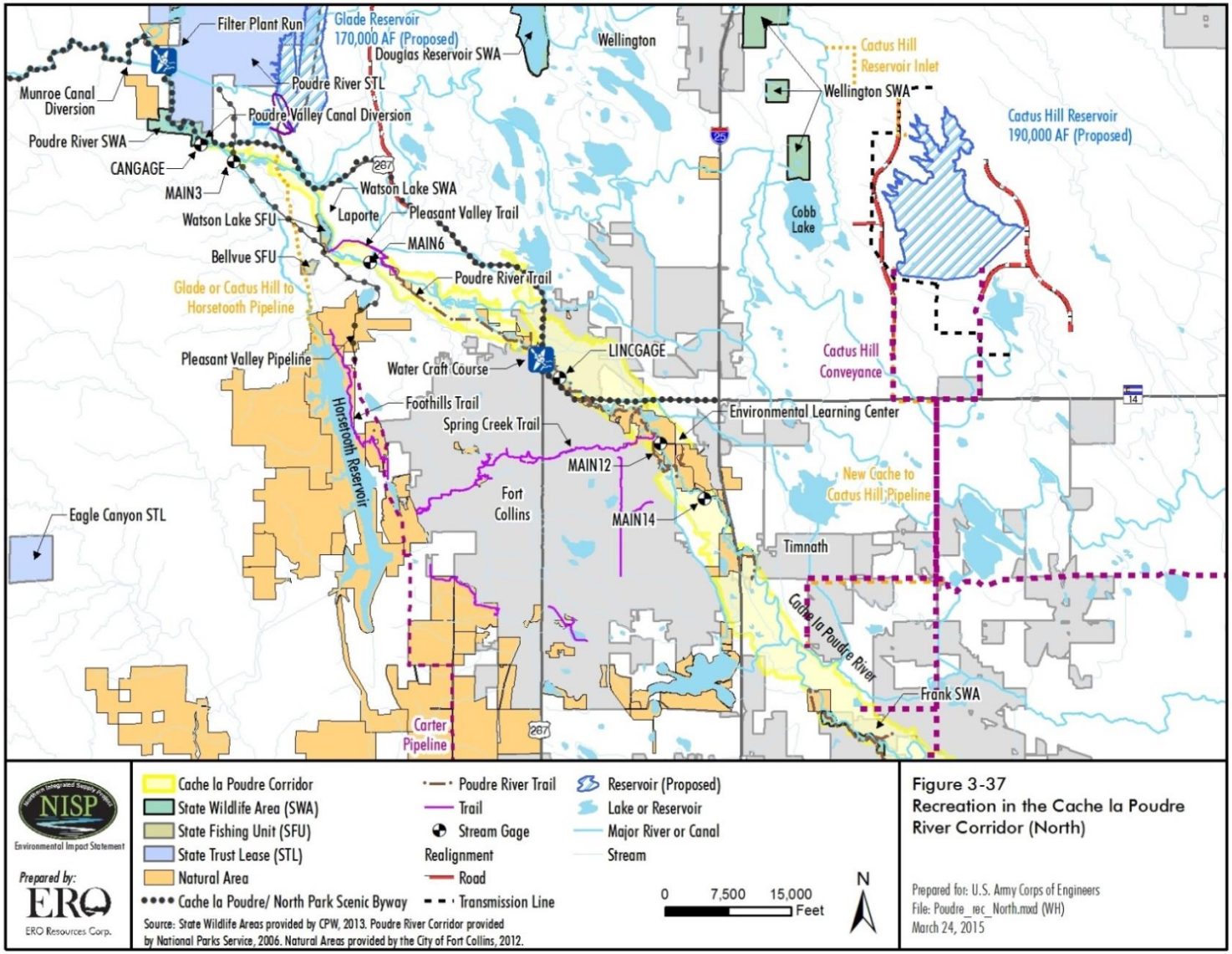
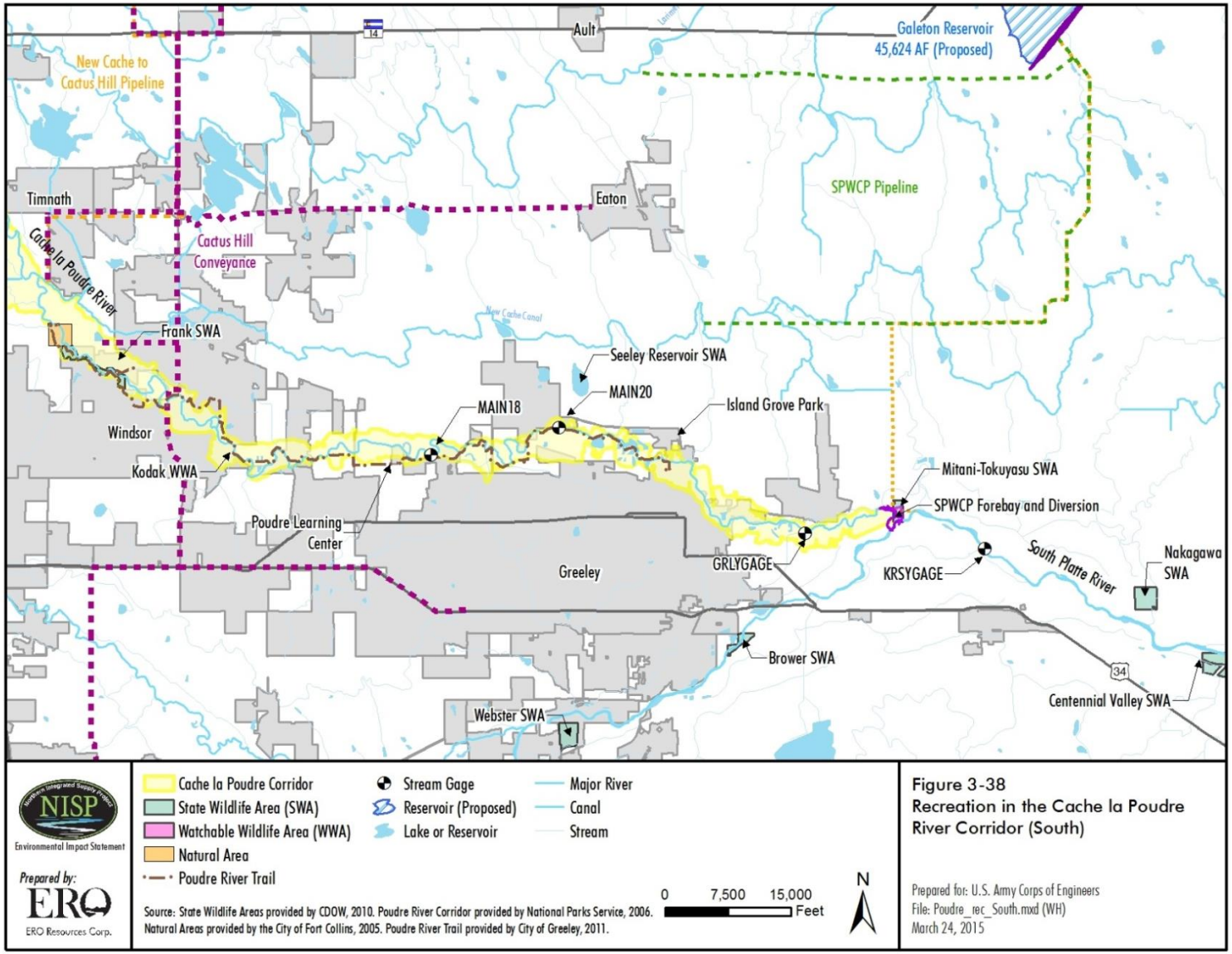


Figure 3-38. Recreation in the Cache la Poudre River Corridor (South).



3.16.6 South Platte River

Opportunities for water-based recreation along the segment of the South Platte River in the study area is more limited compared to the Poudre River due to reduced water quality associated with runoff and treated effluent discharges from neighboring towns and cities, public access, and the lack of developed trails and parks.

3.16.7 Recreation Value

Recreation within the area has an associated economic value. This value is addressed here instead of Section 3.20 Socioeconomic Resources to help place recreation and its economic value in context. As previously described, there are a multitude of recreational activities in the study area. These opportunities are available at several natural areas in Fort Collins, on trails along the Poudre River, at Horsetooth Reservoir, and other recreation resources within the study area. Estimated values for recreation were presented in the DEIS and have been updated to 2011 dollars for the SDEIS.

3.16.7.1 Horsetooth Reservoir

Table 3-55 presents visitation estimates for Horsetooth Reservoir. Using information gathered from public brochures and the Horsetooth Reservoir website (http://www.co.larimer.co.us/parks/Horsetooth.htm), the available activities at each site were determined. The estimated value per visitor day for general recreation (Table 3-55) was uniformly applied to visitation at each site because data are lacking about the levels of specific types of recreation at each site. Mountain Park, Soderberg, and Eagle's Nest were excluded from the estimate of the total recreation value of Horsetooth Reservoir, because they are associated parks and not immediately adjacent to the surface water area. By excluding these parks, the activities and recreation value associated with the reservoir can be determined.

Table 3-55. Visitation estimates for Horsetooth Reservoir.

Location	Annual Visitation	Activities Available at Location	Other Possible Activities at the Location	Estimated Value/ Visitor day*	Total Estimated Recreation Value (million)	Average Daily Visitation
Mountain Park	92,333	Excluded from analysis				250
Inlet Bay	145,663	Picnicking, camping, boating (ramp)	Fishing, canoeing etc., sightseeing, wildlife viewing	$44	$6.4	400
Soderberg	30,102	Excluded from analysis				
South Bay	194,279	Picnicking, camping, swimming, boating, scuba diving, restaurant	Fishing, floatboating, sightseeing, wildlife viewing	$44	$8.5	530
Rotary Day Use Area	89,690	Hiking, rock climbing, picnicking	Fishing, sightseeing, wildlife viewing	$44	$3.8	250
Sunrise Day Use Area	34,919	Hiking, picnicking, scuba diving	Fishing, sightseeing, wildlife viewing	$44	$1.8	100
Skyline Day Use Area	8,971	Hiking, picnicking	Fishing, sightseeing, wildlife viewing	$44	$0.4	20
Eagle's Nest	3,404	Excluded from analysis				
Satanka	66,407	Boating (ramp), picnicking	Sightseeing, wildlife viewing	$44	$2.9	180
Total 2005 Visitation**	665,768	(includes visitors from sites excluded from the analysis)				
Horsetooth Reservoir only	**539,929**				**$23.7**	

Source: Larimer County's Horsetooth District Visitation Study, 2006.
* Due to multiple recreation experiences available at each of the Horsetooth recreation areas and lack of visitation estimates by activity, general recreation value per visitor day was used to estimate the total recreation value of Horsetooth Reservoir.
** Total 2005 Visitation includes visitation at recreation sites excluded from the Horsetooth Recreation Valuation calculation.

Since the visitation estimates were made in 2005, Horsetooth Reservoir visitation has not appreciably changed due to capacity constraints. Current visitation (2011) at all sites is estimated to be 700,000, compared to the estimate of approximately 665,000 in 2005 (Reeves, pers. comm. 2011). As a result, Table 3-55 visitation estimates have not been changed in the current update, although unit day values were updated to 2011 dollars.

3.16.7.2 Carter Lake

Annual visitation at Carter Lake was not available for the DEIS. More recently, an estimate of annual visitation has been provided by Larimer County. Larimer County estimates annual Carter Lake visitation to be approximately 300,000. However, similar to Horsetooth Reservoir visitor estimates, there is no breakdown across types of recreation, so the daily value of recreation for Carter Lake is also approximated by the General Recreation value of $44.00 per visitor day. The estimated value of annual visitation is $13.2 million.

3.16.7.3 Poudre River Corridor

Descriptions of recreational resources along the Poudre River corridor are divided into three sections: the Poudre River, the Poudre River Trail, and natural areas and state wildlife areas.

The Poudre River. Portions of the Poudre River upstream of Fort Collins and through Fort Collins are currently used for rafting, kayaking, fishing, and tubing. To determine recreational value of the Poudre, the river has been divided into six segments (A through F) (Figure 3-4).

Fishing occurs along this stretch of the river; however, there are no available visitation estimates. The recreational value of the fishing would be relatively high in this stretch of the Poudre, but less than the value in more pristine areas upstream. In addition, the Watson Lake State Fishing Unit and the Lions Park trailhead provide access for coldwater fishing in this stretch of the Poudre, which also adds recreational fishing value.

Segments A and B. The Corona Report (Corona 2006) estimated 4,570 boaters annually used the Poudre River and the natural area ponds through Fort Collins. The boating visitation on the river and the natural area ponds was not separated in the Corona Report. This level of visitation was used to estimate the value of boating through Fort Collins to be $329,040 annually, as shown in Table 3-56 below. This estimate of boating value may include some tubing visitation (exact methodologies used for the survey could not be determined) that has become popular on the Poudre from Shields to Lincoln Streets in Fort Collins, but likely does not include all tubers that currently use the river in this stretch. This estimated recreation value does not include potential future value that may be created by the planned Water Craft Course currently being designed in Fort Collins because potential visitation estimates of the Water Craft Course have not yet been realized. A study by Loomis and McTiernan (2011) estimates that daily visitation to this new facility may average 173 under the current Poudre River flow regime (Loomis and McTiernan 2011).[5]

Similar to boating, the Corona Report estimated annual fishing visitation in the ponds and along the Poudre River. The visitation data does not distinguish the river fishing usage from the fishing in the ponds. In addition, there are likely a few anglers along the river that are not in a natural area, but without a formal survey there is not a method for estimating this with precision. Therefore, the estimated recreational fishing value of $1,209,000 (based on 20,840 users) likely overstates the value of fishing along this stretch of the Poudre River, because it includes fishing at the ponds. Calculation of the annual value of fishing in this stretch of the Poudre River is shown in Table 3-56.

Table 3-56. Visitation estimates for the Poudre River through Fort Collins.

	Estimated Annual Visitation	Value per Visitor Day	Total Recreation Value
Kayaking/ canoeing	4,570	$79.00	$361,000
Fishing	20,840	$58.00	$1,209,000

Source: Data collected for the Corona Report (2006).

[5] *Note: the URL link to this file provided by Save the Poudre no longer works.*

Other recreation occurs in this stretch of the river primarily associated with the Environmental Learning Center (ELC)[6], the North Aztlan Community Center, Lee Martinez Park, and natural areas. Although the Poudre River certainly contributes substantial value to each of these resources, a dollar estimate of its contribution has not been developed.

Segments C through F. Although there is boating and fishing in this stretch of the Poudre, there are no visitation estimates available. There is economic value associated with the boating and fishing that does occur, but it is likely to be much smaller than the value of boating and fishing recreation that occurs from Segments C through F due to the fewer number of users and the slow current.

The Poudre River contributes value to the recreational resources and activities in this corridor. The Poudre Learning Center, Water Valley Resort Community resources, Eastman Park, Poudre River Park, and Island Grove Park rely on the river to provide value to their recreational activities, primarily from the aesthetics it provides. The visitation at these facilities and the recreational value derived from them is currently unknown. Many of the forms of recreation resources at these sites are not entirely dependent upon the volume of river flows, as long as minimum flows are provided. These parks and facilities have many activities and amenities that do not rely on the Poudre River or the aesthetics of the river to draw visitors to the parks.

3.16.7.4 The Poudre River Trail

Segment A. The Pleasant Valley Trail, which connects to the Poudre Trail at Lions Park in Laporte, lies mostly along this stretch of the Poudre River. There are no visitation numbers available for Pleasant Valley Trail, but it can be assumed that a portion of the trail experience is related to the proximity to the Poudre River. The Pleasant Valley Trail provides recreational value to Laporte and provides connectivity to Fort Collins.

Segments A and B. Since 2006, the City of Fort Collins has used infrared counters to obtain user data on the city trail system, although there do not yet appear to be sufficient counts across days of the week, seasons, and types of use to establish a statistically robust database regarding trail usage. However, none of the relatively few counts available along the trail conducted between 2006 and 2011 indicates daily trail usage of the magnitude implied in the annual estimates from the Corona Report summarized in Table 3-57. Based on limited counts taken prior to the DEIS, and his own observations, Marshall Thornberry, the trail chief for Fort Collins, roughly estimated the number of trail users at 200 to 300 visitors per weekday and 700 to 1,000 visitors per weekend day (Thornberry, pers. comm. 2006). Raw count data through 2011 show slightly higher numbers, but Mr. Thornberry's estimates were much closer to actual visitation than the Corona Report-based estimates. If weekday visitation averages 300 and weekend visitation averages 1,000 per day, annual visitation would be about 182,300, or about 20% of the estimate attributed to the Corona Report.

[6] Annual visitation to the ELC is approximately 18,000 to 20,000 per year according to personal communication with Dr. Brett Bruyere, ELC Director. Much of the river usage is for children's learning programs and for viewing wildlife.

Given the range of these visitation estimates and lack of definitive data at this time, the Corona Report was considered an upper boundary on annual visitation, and the limited data from Fort Collins was considered a lower boundary on annual visitation. Assuming activities are proportional to visitation, the resulting lower bound on Poudre River Trail visitation is 182,300 with a resulting annual recreational value of $2.06 million. Therefore, the annual economic value associated with Poudre River Trail recreation is estimated at between $2.06 million per year and $9.86 million per year.

Because the Corona Report (Corona 2006) uses survey data for estimating usage, bicycling, hikers/walkers/joggers, skateboarders/ rollerbladers, and horseback riders visitation estimates were used and assumed to occur along the Poudre River Trail. To date, the Corona Report provides the best data on trail usage. The Corona Report estimated, using the above activities, that there are approximately 871,670 annual visits to the trail. The recreational value of this annual visitation is shown in Table 3-57 below.

Table 3-57. Value of Poudre River Trail annual visitation from downstream of Laporte through Fort Collins based on Corona Report visitation estimates.

Activity	Annual Visitation	Value per Visitor Day (2011 dollars)	Total Recreational Value (millions)	Average Daily Visitation
Bicycling	413,630	$10	$4.14	1,130
Hikers/Walkers/Joggers	436560	$10	$4.37	1,200
Skateboarders/Rollerbladers	12,640	$10	$1.26	30
Horseback Riders	8,840	$10	$0.09	20
Total Annual Visitor Days	**871,670**		**$9.86**	**2,380**

Source: Data collected for the Corona Report (Corona 2006).

It should be noted that the visitation estimate shown in Table 3-57 is a subset of visitation to the Poudre River Natural Areas, representing the portion of visitors to the natural areas who also use the trail. As a result, the visitation estimates shown for the Poudre River Trail (Table 3-57) and those shown later for the Poudre River Natural Areas (Table 3-58) are not additive.

Segments C through F. Portions of the Poudre Trail already exist in this section of the river and plans for development for complete connectivity are in place. Visitation data are not kept for the completed portions of the trail or estimated for the planned portions. In some areas of the completed and planned portions of the trail, the trail does not border the Poudre River. In areas that the trail does follow the river, it is assumed that the river contributes to the recreational experience on the trail. It is also assumed that the Poudre Trail has recreational value to the communities and counties through which it passes and will have future value from planned sections.

Natural Areas and State Wildlife Areas. There are several natural areas in Fort Collins that lie along the Poudre River (Figure 3-37). In addition, there are five state wildlife areas (SWAs) designated along the river: Watson Lake, Frank, Kodak Watchable, Mitani-Tokuyasu, and Centennial Valley. The visitation at all of these SWAs is not known. The CPW estimated the visitation at Centennial Valley SWA to be approximately 1,200 annually and at Frank SWA to be approximately 400 annually. Visitation at the other SWAs was not estimated (Mitani-

Tokuyasu is discussed under Galeton Reservoir and Forebay below). Theses SWAs all have recreational value to the region, although the value cannot be quantified due to lack of visitation data.

The CPW estimates recreational fishing for ponds and lakes associated with the Poudre River in natural areas, stocked by the Watson Rearing Unit, or that are actively managed or stocked by the CPW. The estimates are generated by using the Aquatic Characterization System and historic random stratified creel census on various waters. The characterization groups are managed with the same approach and the CPW assumes that waters being managed the same would have similar fishing pressures if they are in similar settings. The CPW estimates angler hours, but not days due to the multitude of methods for calculating the length of an angler day. Based on the characteristics of the Poudre lakes and ponds, it is estimated that there are 533 angler hours per surface acre per year. Some of the lakes and ponds associated with the Poudre River are leased by private individuals or entities, and no estimate is made for angler hours on the leased ponds or lakes.

More detailed estimates of recreation visitation at the Fort Collins natural areas are taken from the Corona Report. The report estimated there are 975,750 visitors annually to Fort Collins natural areas along the Poudre River. Table 3-58 below shows visitation by activity and the total recreational value of visitation to natural areas along the Poudre River. However, similar to the Corona-based Poudre River Trail estimates, there is some uncertainty whether the visitation estimates are excessively high in light of Fort Collins' random counts of trail usage. Given the immediate proximity and joint use nature of the trail and natural areas, it is reasonable to assume that the range of uncertainty underlying natural area usage is similar in magnitude as that for the trail. As a result, the annual economic value of the Poudre River Natural Areas may vary from approximately $2.06 million to $14.06 million, with the low end based on City observations and the high end based on the Corona Report.

Table 3-58. Value of annual visitation to Fort Collins natural areas along the Poudre River based on Corona Report visitation estimates.

Activity	Annual Visitation	Value per Visitor Day	Total Recreational Value (millions)
Bicycling	413,630	$10	$4.14
Hikers/Walkers/Joggers	436560	$10	$4.37
"Other" Visitors	78,670	$44	$3.46
Fishing	20,840	$58	$1.21
Skateboarders/Rollerbladers	12,640	$10	$0.13
Horseback Riders	8,840	$44	$0.39
Boaters	4,570	$79	$0.36
Total Annual Visitor Days	**975,750**		**$14.06**

Note: Jogging is assumed to have the same value as hiking and skateboarding/rollerblading. "Other" visitors and horseback riding are assumed to have the same value per visitor day as "other" recreation.

3.16.7.5 Proposed Reservoir Sites

Glade Reservoir. The majority of the site for the proposed Glade Reservoir is currently owned by the District, but some of the area is in the Poudre River State Trust Lands and a small portion is owned by the BLM with no public access. On the Poudre River State Trust Lands public

access is allowed for fishing and hunting during specific times of the year. Visitation for these recreation activities is not known, but it is assumed that there is some recreational value associated with the activities.

Galeton Reservoir and Forebay. The area for the proposed Galeton Reservoir is primarily privately owned and there is no public access on any portion of the site. The proposed site is bordered to the north by the administrative boundary of the Pawnee National Grassland, which also does not currently have public access, as it is private land.

The proposed Galeton forebay would be located in the Mitani-Tokuyasu SWA. Mitani-Tokuyasu has a current visitation of approximately 1,200 visitors annually, primarily for waterfowl hunting and some wildlife viewing. The approximate value of recreation at Mitani-Tokuyasu is $52,800 annually, assuming all visitors are hunting or wildlife viewing and the value per visitor-day is similar to general recreation.

Cactus Hill Reservoir. There is no known recreation that occurs at the proposed Cactus Hill Reservoir site; therefore, it is assumed that there is no recreational value at this site.

3.17 LAND USE

3.17.1 Overview

This section focuses on growth within the region as informed by comments on the DEIS. Additional information on land uses and ownership are presented in the 2008 Land Use Report (ERO 2008b) prepared for the DEIS and summarized in Sections 3.21 and 3.27.13 of the DEIS. Information on land use, growth, regional plans and ownership will be reviewed and updated, as necessary, for the FEIS.

3.17.1.1 Irrigated Agriculture

Irrigated crops in the service areas of the affected canal companies are representative of those produced in Weld County, the most productive agricultural county in the state (Colorado Agricultural Statistics 2005). Corn (grain and silage) and hay are the predominant irrigated crops in Weld County, accounting for approximately 80% of the irrigated total, as shown in Table 3-59. Irrigated wheat, barley, pinto beans, and sugar beets account for most of the remaining acreage. In addition to these field crops, onions, carrots, and other high-valued vegetable crops are also grown in Weld County and in areas served by canal companies involved in the proposed exchange. Acreages of vegetable crops tend to be small and are not published due to disclosure concerns. Crop yields for Weld County's major field crops are consistent with Statewide averages (Table 3-59).

Table 3-59. Irrigated Crops in Weld County.

Irrigated crop acreage

	2004	2005	2006	2007	2008	Average, 2004 - 2008	Proportion of Weld County total
Corn, Grain	53,600	54,000	65,700	76,000	73,400	64,540	24%
Corn, Silage	44,000	47,800	33,600	50,200	43,500	43,820	17%
Wheat	14,100	15,900	14,900	17,600	20,100	16,520	6%
Barley	13,900	9,000	8,100	6,500	8,300	9,160	3%
Pinto beans	10,300	11,900	8,400	5,300	4,300	8,040	3%
Sugarbeets	12,700	13,300	12,700	10,700	9,200	11,720	4%
All irrigated hay	99,000	101,000	101,000	122,000	128,000	110,200	42%

Irrigated crop yield per harvested acre

	Units	2004	2005	2006	2007	2008	Weld County Average, 2004 - 2008	State Average yield, 2004 - 2008
Corn, Grain	bu	166.5	176.5	172.5	178.0	168.0	172.3	177.4
Corn, Silage	ton	24.5	26.5	23.0	24.5	24.5	24.6	23.2
Wheat	bu	65.0	54.5	55.0	72.0	71.5	63.6	61.5
Barley	bu	106.0	96.5	79.0	99.0	76.0	91.3	120.7
Pinto beans	lb	2,200.0	2,100.0	2,050.0	2,210.0	2,010.0	2,114.0	2,173.0
Sugarbeets	ton	26.1	25.3	21.0	28.3	27.9	25.7	23.5
All irrigated hay	ton	4.2	4.3	4.3	4.5	4.1	4.2	3.1

3.17.1.2 Growth and Land Use within the Region

In 2010, Colorado's population was about 5.0 million. The Colorado State Demography Office projects that Colorado's population will increase to about 8.0 million by 2040 (State Demography Office 2014). The NISP Participants are located within Boulder, Larimer, Morgan, and Weld Counties in northern Colorado, with a combined population of 875,181 in 2010. These four counties represent about 17% of the total population of Colorado.

3.17.1.3 Counties

3.17.1.3.1 Boulder County

Of the four counties, Boulder County is the smallest in terms of land mass (741 square miles; 474,320 acres), but has the second largest population (294,567). Boulder County has experienced steady population growth from the 1960s with an average annual growth of 2.8% over the past 50 years (Census 1960-2010).

NISP Participants (Lafayette, Lefthand Water District, and Erie) are located in the eastern half of Boulder County. The eastern half of Boulder County hosts lush farmland, permanently protected open space, three urban centers (Cities of Boulder, Longmont, and Lafayette), several smaller towns, and residential and commercial development in the unincorporated portions of Boulder County. Once a rural farming community, Boulder County has changed significantly due to population increases and economic shifts over the last 15 to 25 years.

After growing at an average annual rate of nearly 3.5% from 1960 through 2000, population growth in Boulder County slowed substantially between 2000 and 2010 to an average annual rate of about 0.1% per year. There are several reasons for this reduction in the rate of growth in Boulder County. Much of the fast-paced residential growth for Boulder County occurred in the 1990s when population growth of the county increased almost 30%. Additionally, the City of Lafayette in Boulder County has placed growth restrictions on development so that no more than 200 units can be built per year. Despite slow growth between 2000 and 2010, the Colorado State Demography Office projects the population of Boulder County will increase by 34% and reach 396,163 residents by 2040 (State Demography Office 2014).

In the last 20 years, a substantial amount of farmland in Boulder County has been taken out of production and the size of farms has decreased. As of 2007, 137,668 acres of Boulder County were being farmed on 746 farms. While the number of farms remained fairly constant, 17,820 acres of farmland were taken out of production between 1987 and 2007. As a result, the average farm size dropped from 207 acres to 185 acres in that 20-year period (USDA-NASS 2007). Much of the agricultural land conversion was the result of new home construction. For example, in 1998 alone, 4,977 new homes were built in Boulder County (Boulder County 2000).

3.17.1.3.2 Larimer County

Larimer County is in north-central Colorado and represents the northwest corner of the NISP region. Larimer County is the seventh largest county in terms of population in Colorado. Among the four counties with NISP Participants, Larimer is the most populous and the second

largest in terms of land mass (2,640 square miles). More than 50% of Larimer County is publicly owned including Roosevelt National Forest, Rocky Mountain National Park, Colorado State Parks and Recreation Areas, Larimer County Parks, and local parks.

Between the 1970 and 2010 U.S. Censuses, the county's population more than tripled from 89,900 residents to 299,630. As a result, the population density rose to 113 people per square mile. In the 10-year period between 2000 and 2010, Larimer County's population increased by 19% (U.S. Census Bureau 2010). The Colorado State Demography Office projects that by 2040 Larimer County's population will grow by another 57% to 471,612 (State Demography Office 2014).

According to the 2007 U.S. Census of Agriculture, Larimer County had 489,819 acres of farmland as part of 1,757 farms (USDA-NASS 2007). From 1987 to 2007, Larimer County lost more than 40,000 acres of farmland (Economic Research Service 2007). Larimer County farms produced approximately $128 million in agricultural products in 2007, including about $78 million in livestock based production (primarily cattle and dairy products) (USDA Census of Agriculture 2007).

Larimer County has undertaken a variety of measures to shape and manage growth. Larimer County, Fort Collins, and Loveland have entered into Intergovernmental Agreements (IGAs) for the purpose of designating growth management areas (GMAs), cooperative planning areas (CPAs), and community influence areas. The IGAs are intended to help guide development in a cooperative, orderly manner. The Larimer County Master Plan establishes GMA boundaries where urban level services are to be located within the next 20-year planning horizon. GMAs are areas currently within or adjacent to Fort Collins, and Loveland. CPAs are those areas that are not planned for urban development and/or urban services within a city planning horizon (i.e., 20 years), but where development may have an impact on present and future city growth patterns (Larimer County Planning Division 1997).

3.17.1.3.3 Morgan County

The NISP Participants in Morgan County include Fort Morgan and Morgan County Quality Water. Morgan County is located on the eastern edge of the NISP region. Morgan County covers 1,296 square miles but has only a few incorporated communities: Fort Morgan (the county seat), and the towns of Brush, Hillrose, Log Lane Village, and Wiggins. As of the 2007 Census of Agriculture, there were 894 farms consisting of 728,092 acres of farmland.

Morgan County's population is small compared to the other counties in the NISP region. In 1970, the population was 20,105. By 2010, the population had risen to 28,159. The 2010 population represents a population density of 22 people per square mile (U.S. Census Bureau 2010). The most rapid development occurred between 1990 and 2000 with an increase of more than 5,000 residents (about 24%). From 2000 through 2010, Morgan County's population grew by less than 4%. The Colorado State Demography Office projects that by 2040 Morgan County's population will grow by about 35% to 38,029 (State Demography Office 2014).

3.17.1.3.4 Weld County

The NISP Participants located within Weld County include Central Weld County Water District, Eaton, Evans, Severance, and Windsor. Weld County is the third largest county in Colorado with a land mass of 3,999 square miles. Weld County is Colorado's leader in cattle, sugar beet, and grain production (CDA 2013). With more than $1.5 billion in farm sales in 2007, Weld County is the most productive county in Colorado in terms of value of agricultural products sold (USDA-NASS 2007).

As of 2007, Weld County had 3,921 farms consisting of 2,088,715 acres or about 6.6% of the farmland in Colorado (USDA-NASS 2007). The 2010 U.S. Census documented Weld County's population at 252,825. The population density was 63 persons per square mile (U.S. Census Bureau 2010). Weld County is one of Colorado's fastest growing counties with a 39.7% increase in population between 2000 and 2010. Weld County's population has more than doubled in the last 30 years (U.S. Census Bureau 2010). The State Demography Office projects rapid growth to continue in Weld County in the future, and forecasts the county will have 568,954 residents by 2040, an increase of 125% compared to the 2010 Census (State Demography Office 2014).

At present, Weld County's economy and population growth is at least partly driven by extensive oil and gas development activity occurring within the county. Among over 7,000 approved permits to drill oil and gas wells in Colorado in 2013-2014, more than half have been located in Weld County. Over 21,000 wells are currently operating in Weld County, about 40% of all active wells in the state. Over the past 2 years, more than 40 of approximately 70 drilling rigs operating in Colorado have been working in Weld County (COGCC 2014).

3.17.1.4 Participants

The Participants have experienced substantial growth and anticipate substantial future growth as discussed in Section 3.20.1.1.

3.17.2 Proposed Reservoir Sites

3.17.2.1 Glade Reservoir Study Area

Land use in the Glade Reservoir study area is described in Section 3.21.3.1.1 of the DEIS.

3.17.2.2 Galeton Reservoir Study Area

Land use in the Galeton Reservoir study area is described in Section 3.21.3.1.2 of the DEIS.

3.17.2.3 Cactus Hill Reservoir Study Area

Land use in the Cactus Hill Reservoir study area is described in Section 3.21.3.1.3 of the DEIS.

3.17.3 Conveyance Systems

The conveyance systems are proposed to occur primarily in rural agricultural areas and within road rights-of-way. However, some of the proposed conveyance alignments would cross open space and natural areas. The conveyance alignments will be refined for the FEIS and land use information for the conveyance alignments will be presented in the FEIS.

3.17.4 No Action Irrigated Lands

The no action irrigated lands are irrigated agricultural lands managed to produce corn, hay, and vegetables and to pasture livestock.

3.17.5 Poudre River

Land use within the Poudre River study area is primarily undeveloped floodplain that includes SWAs, natural areas, parks, open space, trails and rural agricultural lands.

3.17.6 South Platte River

Land use within the South Platte River study area is primarily undeveloped floodplain that includes SWAs and rural agricultural lands.

3.18 VISUAL RESOURCES AND AESTHETICS

3.18.1 Overview

This section addresses the existing visual qualities and aesthetics of the potential reservoir sites, conveyance system corridors, No Action Irrigated Lands, and the Poudre and South Platte River corridors. These resources may be affected by the construction of any of the reservoirs and conveyance systems or by reservoir operations. More detailed information is available in the 2008 Visual Resources Report (ERO 2008h) and Visual Resources Highway 287 Report (ERO and HLA 2008). Visual resources and aesthetics are described in Section 3.19 of the DEIS.

3.18.2 Proposed Reservoir Sites

3.18.2.1 Glade

The visual character of the Glade Reservoir study area is described in Sections 3.19.1 and 3.19.3 of the DEIS.

3.18.2.2 Galeton

The visual character of the Galeton Reservoir study area is described in Sections 3.19.1 and 3.19.2 of the DEIS.

3.18.2.3 Cactus Hill

The visual character of the Galeton Reservoir study area is described in Sections 3.19.1 and 3.19.2 of the DEIS.

3.18.3 Conveyance Systems

The conveyance systems are proposed to occur primarily in rural agricultural areas and along road rights-of-way. The scenic quality of these areas is typically low to moderate. Although most views are unobstructed, multiple artificial forms exist such as a variety of power transmission lines, wire field fences, and multiple paved and gravel roads. Most of the area in which the conveyance systems would occur also lacks variety in landforms, color, and texture.

3.18.4 No Action Irrigated Lands

The 64,200 acres of irrigated agricultural lands produce a mostly green landscape in straight long rows during the spring and summer and brown standing crops after harvest or bare tilled ground between crops. Irrigated hay fields and pastures remain green for most of the year without a defined pattern.

3.18.5 Poudre and South Platte River Corridors

The Poudre River has a largely continuous riparian corridor and water levels that fluctuate daily and seasonally as a result of natural hydrologic cycles, reservoir management, water deliveries, irrigation practices, and diversions. During high flows the river experiences whitewater conditions and during low flows boulders and bedrock may be exposed with minimal water remaining in the channel. The Poudre River is a dynamic system and visitors to the corridor experience change throughout the year. The South Platte River below the confluence with the Poudre River is relatively wide with a shallow, sandy and braided channel. Flows can fluctuate substantially seasonally and daily. The riparian corridor is dominated by plains cottonwood woodlands.

3.19 CULTURAL, HISTORICAL, AND PALEONTOLOGICAL RESOURCES

3.19.1 Overview

Cultural and historical resources are described in Section 3.18 of the DEIS. Paleontological resources are described in Section 3.27.3 of the DEIS. New information on paleontological resources within the U.S. 287 Realignment study area is presented below.

3.19.1.1 Paleontological Resources

Paleontological resources include all remains, traces, or imprints of organisms when they are (1) fossilized, (2) of paleontological interest, and (3) provide information about the history of life on earth. In response to comments on the DEIS, the Corps completed further investigations on paleontological resources within the U.S. 287 realignment corridor. More detailed information can be found in the Paleontological Technical Report: Northern Integrated Supply Project, Proposed U.S. Highway 287 Realignment (RMP 2014).

The U.S. 287 realignment study area contains six bedrock geologic units ranging in age from Permian to Cretaceous. All of these units are known to contain fossils of plants and animals in varying abundance across their distribution.

A database search for previously recorded fossil localities was conducted and none were located within the western alignment, which was selected by CDOT as the preferred realignment for U.S. 287. However, three fossil localities were recorded during a field survey of the western alignment, and numerous fossil localities have been recorded in the same geologic units that occur within the study area elsewhere in Colorado and adjacent states.

3.20 SOCIOECONOMIC RESOURCES

3.20.1 Overview

This section examines population and households; environmentally sensitive populations; race and ethnicity; income and poverty distributions; and, age of residents in the NISP Participant service areas. The information in this section has been updated since publication of the DEIS with information from the 2010 U.S. Census, the 2011 Water Supplies and Demands for Participants in the Northern Integrated Supply Project (HE 2011), and the 2015 Socioeconomics Resources Affected Environment Report (BBC and HCR 2015a). The economic and demographic portion of the affected environment discussion focuses primarily on the combined area served by all of the NISP Participants. Information on the recreation value portion of the affected environment is presented under Recreation in Section 3.16.7.

The study area for the assessment of socioeconomic issues includes the current and future water service areas of the Participants (combined service area), as well as the water service areas of the four water districts located within Boulder, Larimer, Morgan, and Weld Counties (LHWD, FCLWD, MCQWD, and CWCWD).

3.20.1.1 Population and Households

3.20.1.1.1 Population and Growth Rate

The study area had an estimated population of roughly 211,000 people as of 2010, as shown for each community in Table 3-60. The communities are generally rural in nature. The largest Participant in the analysis area is the Fort Collins-Loveland Water District service area with approximately 39,600 people, while Severance, the smallest community, has about 2,900 people. Current population estimates are based on the 2011 Water Supplies and Demands for Participants in the Northern Integrated Supply Project Report (HE 2011). These estimates were reviewed and confirmed by BBC (2011).

Table 3-60. Population in NISP study area, 2000 – 2010.

	Actual	Estimate	Estimate	Annual Compound Growth Rate
	2000	2005	2010	2000-2010
CWCWD	4,972	5,526	5,800	1.6%
Dacono	3,015	3,484	4,400	3.9%
Eaton	2,690	3,974	4,455	5.2%
Erie	6,291	14,043	19,075	11.7%
Evans	9,514	17,518	23,200	9.3%
FCLWD	23,936	35,640	39,600	5.2%
Firestone	1,908	8,265	10,000	18.0%
Fort Lupton	6,787	7,197	7,600	1.1%
Fort Morgan	11,034	11,661	11,600	0.5%
Frederick	2,262	5,893	7,500	12.7%
Lafayette	23,277	26,195	28,000	1.9%
LHWD	16,000	17,925	20,894	2.7%
MCQWD	4,973	6,249	6,700	3.0%
Severance	400	1,747	2,900	21.9%
Windsor	10,873	16,677	19,700	6.1%
Total	**127,932**	**181,994**	**211,424**	**5.2%**

Sources: BBC 2011 and HE 2011.

From 2000 to 2010, the overall average annual growth rate for the study area was 5.2%. Each community showed positive population growth over the 10-year period. Those communities with the highest compound growth rates were located in Weld County (Severance 22%, Firestone 18%, and Frederick 13%). Despite this, there are vast differences in the growth rates within the same county as well as within other small communities. For instance, Dacono and Fort Lupton, both in Weld County, had comparatively low average annual growth rates of a 3.9% and 1.1%, respectively. Fort Morgan in Morgan County had the lowest average annual rate of growth at 0.5%.

The rate of population growth in Boulder County was slower than rates in other regions as reflected by the smaller rates of change in population for Lafayette and the Lefthand Water District at average annual rates of 1.9% and 2.7%, respectively. Although these rates are relatively lower, compound growth rates of 2% and above are generally perceived as relatively rapid growth. There are several reasons for the lower rate of population growth in Boulder County. Much of the fast-paced residential growth for Boulder County occurred in the 1990s when total population growth increased almost 30% compared to a population increase of just over 1% from 2000 to 2005. Additionally, the City of Lafayette in Boulder County has placed growth restrictions on development so that no more than 200 units can be built per year.

3.20.1.1.2 Number of Households

It is estimated that there were almost 75,000 households in the study area in 2010. Nearly half of the communities (7 out of 15) in the study area have less than 3,000 households per community (Table 3-61). As a result, growth rates may appear to imply more rapid growth than the actual changes in the absolute number of new housing units.

Table 3-61. Number of households, 2000-2010.

	2000 (actual)	2010 (estimate)	Average Persons Per Household
CWCWD	1,663	2,050	2.76
Dacono	1,132	1,459	2.85
Eaton	1,065	1,621	2.69
Erie	2,280	6,301	2.88
Evans	3,402	6,294	2.94
FCLWD	8,556	15,899	2.42
Firestone	664	3,294	3.08
Frederick	896	2,950	2.94
Fort Lupton	2,132	2,391	3.09
Fort Morgan	4,085	4,000	2.78
Lafayette	9,096	9,632	2.54
LHWD	5,306	8,462	2.39
MCQWD	1,704	2,449	2.68
Severance	201	1,105	2.86
Windsor	3,692	6,732	2.75
Total/Weighted Avg	**47,754**	**74,639**	**2.67**

Sources: U.S. Census Bureau, 2010 Census.

3.20.1.1.3 Household Size

The average household size in the study area is relatively large at 2.67 persons per household (Table 3-62). Fort Lupton had the largest average household size at 3.09 people per household.

Table 3-62. Average persons per household, 2010.

Study area	2.67
U.S.	2.58
State of Colorado	2.49
Boulder County	2.39
Larimer County	2.42
Morgan County	2.68
Weld County	2.76

Source: U.S. Census Bureau, 2010 Census.

The study area household size is larger than that found in the counties overall, state (2.49 persons per household), or nationally (2.58 persons per household).

In general, nationwide household sizes are projected to get smaller over time; however Hispanic households tend to be larger than non-Hispanic households (Table 3-63). Since there is a strong presence of Hispanic households in the study area combined with a Hispanic influx in recent years, these factors may offset each other so the average household size may remain relatively consistent in the foreseeable future. Neither the Harvey Economics' water demand study, nor the various underlying studies supporting it, indicated any expected changes in future water use patterns due to changing household sizes or changing proportions of single family versus multifamily units in the study area.

Table 3-63. Average household size by ethnicity, 2010.

County	White, Non-Hispanic	Hispanic
Boulder	2.28	3.41
Larimer	2.35	3.11
Morgan	2.34	3.65
Weld	2.54	3.55

Source: U.S. Census Bureau, 2010 Census.

3.20.1.2 Environmentally Sensitive Populations in Water Service Areas

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations was issued by President Clinton on February 11, 1994. The objectives of Executive Order 12898 are to identify low-income and minority populations where proposed federal actions have disproportionately high and adverse socioeconomic environmental effects and to enable the participation of minority and low-income populations in the project planning. Environmental justice is the term used to describe fair and equitable treatment of minority and low-income populations with regard to all projects with discretionary federal action. In addition to environmental justice populations, additional under-represented populations must be identified. Within the framework of Executive Order 12898, community impact assessments are required to provide separate consideration, to investigate, analyze, and mitigate, if needed, for any segments of the population that could experience a disproportionately high and adverse effect of the proposed action. With respect to this project, those additional under-represented populations include the elderly. The rationale for including the elderly populations are the potential for higher municipal water bills associated with the project and the fixed nature of many elderly incomes. In addition, the elderly may be more isolated and could have more difficulty finding transportation to attend public meetings regarding the project.

3.20.1.3 Race and Ethnicity

Table 3-64 shows the race and ethnicity of the population in the analysis area over time. Overall, the majority of households in the study area are White and non-Hispanic. African American households constitute 1% or less of any community except Fort Morgan and Morgan County. Alternately, ethnic diversity is evident among all the communities. The greatest percentage of Hispanic households was found in Fort Lupton at 44% followed by Evans at 33%, Fort Morgan at 30%, and Dacono at 25%.

Table 3-64. Race and ethnicity of householder, comparison 2010 and 2000.

	Race			Ethnicity	
	2010			2010	2000
	White, Non-Hispanic	Black, Non-Hispanic	Other, Non-Hispanic	Hispanic	Hispanic
Dacono	71.6%	0.5%	3.1%	24.8%	21.7%
Eaton	89.2%	0.2%	2.0%	8.6%	9.9%
Erie	87.7%	0.6%	4.9%	6.8%	8.2%
Evans	63.7%	0.6%	2.3%	33.4%	30.3%
Firestone	85.2%	0.7%	2.5%	11.6%	19.5%
Frederick	86.2%	0.4%	2.9%	10.4%	14.8%
Fort Lupton	53.6%	0.3%	2.5%	43.6%	38.8%
Fort Morgan	63.5%	4.2%	2.0%	30.4%	25.5%
Lafayette	81.9%	1.0%	4.6%	12.5%	11.1%
Severance	92.1%	0.3%	1.9%	5.7%	8.0%
Windsor	90.8%	0.5%	1.9%	6.8%	8.3%
Boulder County	85.3%	0.8%	5.1%	8.9%	6.8%
Larimer County	88.7%	0.7%	3.2%	7.4%	6.1%
Morgan County	72.7%	1.9%	1.6%	23.8%	21.5%
Weld County	75.5%	0.7%	2.6%	21.2%	19.7%

Source: U.S. Census Bureau, 2000 and 2010 Census.

In Table 3-65 below, the percentage of Hispanic people for each respective county was applied to population estimates for the water districts to estimate the number of people of Hispanic origin in the water districts.

Table 3-65. Hispanic population in study area, 2010.

	Percent of Hispanic People	2010 Population (estimate)	Estimated Total Hispanic People
Dacono	35.0	4,152	1,452
Eaton	12.1	4,365	528
Erie	8.8	18,135	1,603
Evans	43.1	18,537	7,997
Firestone	16.2	10,147	1,642
Fort Lupton	55.0	7,377	4,061
Fort Morgan	43.3	11,315	4,897
Frederick	14.1	8,679	1,222
Lafayette	18.2	24,453	4,454
Severance	7.0	3,165	222
Windsor	9.0	18,644	1,676
CWCWD	28.4	5,800	1,647
FCLWD	10.6	39,600	4,198
LHWD	13.3	20,894	2,779
MCQWD	33.8	6,700	2,265
		Total	**40,642**

Source: U.S. Census Bureau, 2010 Census.

In total, the number of Hispanic people in the study area is estimated to be over 40,000, about 19% of the total population of the study area (Table 3-65). The portion of population with Hispanic ethnicity is similar to the state of Colorado (20%) but exceeds the percent found in the U.S. overall (16%).

3.20.1.4 Income

Median Household Income. The most current median household income (MHI) data available is through the American Community Survey 2005-2009 5-year estimate, which gives an average of the MHI over the time period. On the county level, Boulder County had the highest median income at roughly $65,000, whereas the lowest was Morgan County at $43,000.

As shown in Table 3-66, median household incomes are rising throughout the study area and are becoming somewhat more consistent among the regions, especially for the Front Range communities within commuting distance to the Fort Collins-Denver corridor. This trend reflects both inflation and the economic growth of this urban corridor, with relatively affluent, well-educated individuals moving into the region and "averaging-up" income levels and, in many cases, property values. This does not imply that there are fewer low income households in the area, but there are relatively more higher-income households.

Table 3-66. Median household income by community, 1999 and 2005-2009.

	1999	2005-2009	Difference	Increase
Dacono	$38,854	$43,309	$4,455	11%
Eaton	$47,314	$56,424	$9,110	19%
Erie	$77,114	$99,804	$22,690	29%
Evans	$37,158	$44,990	$7,832	21%
Firestone	$55,313	$81,821	$26,508	48%
Fort Lupton	$40,917	$50,145	$9,228	23%
Fort Morgan	$33,140	$43,917	$10,777	33%
Frederick	$55,324	$83,284	$27,960	51%
Lafayette	$56,376	$65,319	$8,943	16%
Severance	$50,625	$76,161	$25,536	50%
Windsor	$54,976	$75,267	$20,291	37%
Boulder County	$55,861	$65,040	$9,179	16%
Larimer County	$48,655	$54,755	$6,100	13%
Morgan County	$34,568	$43,317	$8,749	25%
Weld County	$42,321	$55,795	$13,474	32%

Source: U.S. Census Bureau, 2005-2009 American Community Survey.

All communities showed double-digit percentage increases in income from 2000 to 2005-2009. Frederick showed the largest percentage gain (51%) in median household income with an increase from roughly $55,000 in 1999 to over $83,000 in 2005-2009. Frederick also had the highest absolute dollar gain in median household income with about a $28,000 increase. The communities with the lowest median household income in the analysis area are Evans ($44,990), Fort Morgan ($43,917), and Dacono ($43,309). Dacono also experienced the smallest increase in median household income from 2000 to 2005-2009 (11%).

Poverty Rates. The poverty rate in the state of Colorado was 12% of the total population as of 2005-2009. Poverty rates in communities in the study area ranged broadly from 2% to 18% during the same period. Approximately 20,800 individuals, or 10% of the population in the study area, were below the poverty rate as of 2005-2009 (Table 3-67).

Table 3-67. Poverty rates and estimated persons in poverty, study area 2005-2009.

	2000	2005-2009	Estimated Number of People in Poverty
CWCWD	12.50%	13.69%	794
FCLWD	9.20%	13.74%	5,443
LHWD	9.50%	12.77%	2,668
MCQWD	12.40%	13.60%	911
Total Water Districts			**9,815**
Total Communities			**10,987**
		Total Study Area	**20,802**

Source: U.S. Census 2000 and U.S. Census Bureau, 2005-2009 American Community Survey.

Poverty rates from the Census were applied to current population of Participant communities to estimate the current number of people below the poverty line (Table 3-68). For estimates of people in poverty within the water districts, the poverty rates in the respective counties were applied to the population estimates for the water districts.

Table 3-68. Persons in poverty and poverty rates by community, 1990-2009.

	1990	2000	2003	2005-2009	2005-2009 # of People
Dacono	8.10%	6.00%	5.50%	12.79%	501
Eaton	6.20%	5.30%	3.90%	4.50%	185
Erie	8.30%	2.10%	1.50%	3.62%	552
Evans	13.00%	14.90%	9.10%	17.76%	3,242
Firestone	12.20%	7.20%	2.50%	6.67%	492
Fort Lupton	18.60%	13.30%	13.20%	15.24%	1,143
Fort Morgan	17.50%	12.90%	13.80%	10.49%	1,072
Frederick	11.70%	4.80%	2.30%	2.60%	197
Lafayette	8.40%	7.00%	6.80%	10.46%	2,619
Severance	17.90%	7.50%	4.00%	1.93%	51
Windsor	9.20%	5.60%	4.20%	5.51%	933

Sources: U.S. Census Bureau, 2005-2009 American Community Survey.

Each community demonstrated a significant drop in the levels of poverty between 1990 and 2000. However, between 2003 and 2009, poverty rates rose in every community except Fort Morgan and Severance. This increase is consistent with poverty trends across the state of Colorado as part of the recent economic downturn.

Of the estimated number of people in the community below the poverty level in 2005-2009, the communities of Lafayette, Evans, Fort Lupton, and Fort Morgan had the highest numbers totaling 8,076 people collectively – 74% of the total people below the poverty line in the study area.

A further review of income ranges in these most affected communities is provided below. In Fort Morgan, 40% had household incomes below $35,000 and nearly two-thirds (62%) had incomes less than $50,000. A similar finding is shown in Table 3-69 for household incomes in Evans and Fort Lupton, where approximately one-third of household incomes were below $35,000.

Table 3-69. Household income ranges, 2005-2009.

Household Income Distribution	Fort Morgan	Evans	Fort Lupton	Lafayette
Less than $10,000	4%	9%	6%	5%
$10,000 - $24,999	21%	17%	18%	10%
$25,000 - $34,999	15%	12%	10%	8%
$35,000 - $49,999	22%	16%	16%	16%
$50,000 - $74,999	28%	23%	23%	21%
$75,000 - $99,999	6%	15%	17%	12%
$100,000 +	6%	8%	10%	29%

Source: U.S. Census Bureau, 2005-2009 American Community Survey.

In comparison, Lafayette has a wider distribution of income. About one quarter (23%) of households have incomes below $35,000, whereas 29% have household incomes over $100,000.

3.20.1.5 Age

Median Age. The demographics shown in Table 3-70 show a wide dispersion of ages by community. The median ages range from approximately 28 (Evans) to 38 (Lafayette and Windsor) years of age in 2010.

Table 3-70. Median age by community, 2010.

Community	Median Age
Dacono	34.2
Eaton	37.3
Erie	35.8
Evans	27.9
Firestone	32.8
Fort Lupton	31.4
Fort Morgan	31.7
Frederick	34.2
Lafayette	37.6
Severance	33.6
Windsor	37.6
Boulder County	35.8
Larimer County	35.5
Morgan County	36.0
Weld County	33.1
U.S.	37.2

Source: U.S. Census Bureau, 2010 Census.

Elderly. With respect to those over the age of 65, seniors range from 9% to 25% of total householders in the study area. Table 3-71 indicates that over 20,000 householders are over 65 years of age in the Participant service areas. According to the Census, the definition of householder is the persons, or one of the people, in whose name the home is owned, being bought or rented. The portion of elderly households in the study area (9.5%) is slightly below that found in Colorado overall (10.6%). An analysis of elderly households is relevant to the NISP EIS because many of the elderly are on fixed incomes and may be impacted by changes in the cost of water.

Table 3-71. Estimated number of householders over 65 years of age, 2010.

	Percent	Number of Elderly Householders
Dacono	16.66%	243
Eaton	22.95%	372
Erie	9.76%	615
Evans	11.60%	730
Firestone	9.50%	313
Fort Lupton	16.98%	406
Fort Morgan	23.88%	955
Frederick	11.32%	334
Lafayette	13.36%	1,287
Severance	8.87%	98
Windsor	17.22%	1,159
CWCWD	17.08%	991
FCLWD	18.92%	7,493
LHWD	16.01%	3,346
MCQWD	24.87%	1,666
	Total	**20,008**

Source: U.S. Census Bureau, 2010 Census.

For estimates of elderly households within the water districts, the percent of householders 65 years and older in the respective counties were applied to household estimates for the water districts.

Poverty Rates among Elderly. Of those aged 65 or older, roughly 1,400 people in the study area are estimated to be below the poverty line (Table 3-72). This segment amounts to about 8% of the elderly population. The rate of elderly poverty was lower in the study area than in the state of Colorado (8.5%) and the nation (9.8%).

Table 3-72. Estimated number of poor elderly in study area.

	Elderly Population (65+)	Rate of Poverty for Those 65+	Number of Poor Elderly
Dacono	376	22.69%	85
Eaton	563	2.93%	17
Erie	1,030	6.78%	70
Evans	1,139	24.06%	274
Firestone	529	4.66%	25
Fort Lupton	629	9.27%	58
Fort Morgan	1,454	7.26%	106
Frederick	559	6.99%	39
Lafayette	1,969	5.74%	113
Severance	166	0.00%	0
Windsor	1,862	3.41%	63
CWCWD	556	11.16%	62
FCLWD	4,697	6.72%	316
LHWD	2,094	4.94%	104
MCQWD	943	9.01%	85
Total	**18,567**		**1,416**

Sources: U.S. Census Bureau, 2010 Census and 2005-2009 American Community Survey.
Note: Elderly population was taken from the 2010 Census and applied to poverty rates from the 2005-2009 ACS to calculate the estimate of poor elderly in 2010.

3.20.1.6 Environmentally Sensitive Populations Summary

The environmental justice assessment focused on minority and low income populations along with elderly populations, which were identified as an additional under-represented population. The portion of each of these populations represented in the study area was below the state average. However, some of the Participants serve populations with a considerably higher incidence of environmentally sensitive groups.

Nineteen percent of study area residents are Hispanic, compared with 20% of Colorado residents. The communities of Fort Lupton, Fort Morgan, and Evans had the highest portion of Hispanic residents – with more than double the state percentage in each instance.

The study area poverty rate (10%) was also lower than the state average (12%). Three quarters of the Participant residents living below the poverty level were in Evans, Lafayette, Fort Lupton and Fort Morgan. The communities with the highest poverty rates were Evans (18%), Fort Lupton (15%), and Dacono (13%).

Low income elderly households were another under-represented group of concern for this study. The portion of the elderly below the poverty line is 8% in the study area but is much higher in Dacono (23%), Evans (24%), and CWCWD (11%).

3.20.1.7 Economic Environment

This section examines employment by industrial sector, labor force, and revenues by type of industry for communities in the study area.

3.20.1.7.1 Employment by Industrial Sector

The top three employment sectors for residents in the study area are manufacturing, retail trade, and health services (Table 3-73). Manufacturing is the largest employment sector for residents in four of the Participant communities, amounting to more than 15% of employment for residents in Dacono, Fort Morgan, Firestone, and Frederick. In the communities of Eaton, Fort Lupton, and Severance, construction supports the most resident employees. The retail trade and health services sectors account for between 6% and 15% of residents in these communities.

Table 3-73. Percent of residents employed by industrial sector, 2005-2009.

	Dacono	Eaton	Erie	Evans	Firestone	Fort Lupton	Fort Morgan	Frederick	Lafayette	Severance	Windsor
Agriculture, forestry, fishing and hunting	1.1%	1.5%	0.2%	1.3%	0.0%	4.1%	2.1%	0.0%	0.3%	2.4%	1.3%
Mining, quarrying, and oil and gas extraction	0.8%	4.2%	0.5%	3.7%	0.7%	4.1%	1.6%	1.9%	0.0%	1.1%	0.5%
Construction	11.7%	16.0%	6.9%	11.0%	12.3%	15.9%	6.2%	7.6%	6.6%	14.0%	9.9%
Manufacturing	19.1%	4.2%	13.6%	9.9%	15.6%	9.9%	27.4%	15.7%	9.7%	9.3%	11.8%
Wholesale trade	4.2%	2.0%	4.7%	4.4%	5.8%	4.0%	1.0%	5.6%	3.2%	2.2%	3.9%
Retail trade	11.6%	8.6%	12.2%	11.3%	9.2%	10.5%	9.7%	15.1%	10.0%	6.4%	12.3%
Transportation and warehousing, and utilities	7.6%	11.1%	3.0%	4.2%	6.0%	8.4%	6.1%	2.9%	2.9%	4.4%	5.0%
Information	1.7%	2.7%	3.5%	2.4%	3.9%	2.1%	3.6%	1.7%	4.2%	2.0%	2.0%
Finance and insurance, and real estate and rental and leasing	5.1%	10.9%	8.7%	5.0%	5.4%	2.2%	4.9%	4.6%	6.0%	6.4%	6.4%
Professional, scientific, and management, and admin and waste management services	6.5%	10.5%	15.6%	7.2%	12.2%	6.3%	3.0%	11.6%	18.8%	9.7%	14.4%
Educational services	3.6%	5.6%	10.7%	5.9%	7.2%	4.3%	8.7%	7.1%	12.8%	13.5%	5.1%
Health care and social assistance	11.9%	11.6%	7.5%	12.9%	6.8%	7.9%	9.6%	12.6%	10.9%	11.5%	10.7%
Arts, entertainment, and recreation, and accommodation and food services:	9.6%	4.4%	6.2%	10.7%	7.7%	11.0%	6.8%	6.4%	7.3%	7.3%	6.0%
Other services (except public administration)	2.8%	3.8%	3.8%	5.1%	3.0%	4.9%	3.8%	4.2%	5.0%	6.6%	6.3%
Public administration	2.7%	3.0%	3.0%	4.8%	4.3%	4.2%	5.5%	2.7%	2.5%	3.2%	4.4%

Source: U.S. Census Bureau, 2005-2009 American Community Survey.

The previous table displayed the job sectors in which the residents of the study area work, but does not necessarily reflect the job sector distribution offered in each community. As shown in Table 3-74, approximately one third of residents in the study area traveled more than 30 minutes to work in 2005-2009. In Greeley, Fort Collins and Boulder, where residents were more likely to work locally, the percentage of people that traveled more than 30 minutes was between 18% and 20%.

Table 3-74. Travel time to work, 2005-2009.

	Less than 15 Minutes	15 to 30 Minutes	More than 30 Minutes
Dacono	7%	43%	50%
Eaton	29%	35%	37%
Erie	13%	53%	34%
Evans	33%	42%	25%
Firestone	17%	29%	54%
Fort Lupton	25%	27%	47%
Fort Morgan	76%	13%	11%
Frederick	17%	31%	52%
Lafayette	23%	45%	32%
Severance	18%	55%	27%
Windsor	31%	44%	25%
		Weighted Average	**33%**

Source: U.S. Census Bureau, 2005-2009 American Community Survey.

In terms of jobs by place of work, health services comprise over 12% of employment in the various counties while company management and utilities amount to less than 1% overall. Manufacturing and retail trade are strong sectors in each county, but job shares of other sectors vary widely among counties. For instance, Agriculture employs 13% of the labor force in Morgan County but only 1% in Boulder and Larimer Counties (Table 3-75).

Table 3-75. Percent employed by industrial sector by county, 2009.

	Boulder	Larimer	Morgan	Weld
Agriculture	1%	1%	13%	7%
Mining	0%	0%	2%	3%
Utilities	0%	0%	2%	0%
Construction	4%	9%	7%	11%
Manufacturing	9%	8%	23%	12%
Wholesale trade	3%	3%	3%	4%
Retail Trade	11%	14%	10%	11%
Transportation and warehousing	1%	2%	3%	3%
Information	6%	2%	2%	1%
Finance activities	4%	3%	3%	5%
Real estate	4%	4%	2%	3%
Professional and business services	18%	10%	2%	5%
Management of companies and enterprise	1%	0%	N/A	1%
Admin and waste	5%	7%	5%	6%
Education	3%	2%	N/A	1%
Health services	12%	13%	11%	10%
Arts	3%	3%	N/A	2%
Accommodation and food	9%	11%	7%	7%
Other services, except public administration	7%	7%	5%	7%

Source: Department of Local Affairs, 2009.

3.20.1.7.2 Labor Force

The unemployment rate for the region as a whole is below the state (8.9%) and national (9.6%) average (Table 3-76). The Greeley Metropolitan Statistical Area has the highest unemployment rate of the region and exceeds both state and national rates.

Table 3-76. Average annual employment, 2010.

Area	Labor Force	Total Employed	Total Unemployed	Unemployment Rate
Boulder	173,234	160,965	12,269	7.1%
Fort Collins-Loveland Metropolitan Statistical Area	175,823	162,765	13,058	7.4%
Fort Morgan Micropolitan Statistical Area	14,827	13,798	1,029	6.9%
Greeley Metropolitan Statistical Area	119,689	107,501	12,188	10.2%

Source: Colorado Department of Labor and Employment 2010 and Bureau of Labor Statistics 2010.

3.20.1.8 Water Rates

This section considers water rates by community, affected communities, and calculation of cost burdened populations.

3.20.1.8.1 Water Rates by Community

The following information provides a summary of current residential water rates for each of the NISP Participants. The information was derived from an analysis of NISP water rates and water use by BBC Research & Consulting. Average monthly bills were estimated based current water

rates, an assumed average residential water use of 120,000 gallons per year with 72% of water use occurring during the irrigation season (May-October). Table 3-77 shows the average monthly water bill for each Participant, as estimated by Red Oak Consulting and reported by BBC.

Average monthly water bills currently range from $32 per month to $69 per month. These fees amount to between 0.5% and 1.7% of median household incomes in the Participant communities. Under the EPA guidelines, if the water bill represents less than 2.5% of median household income (or the combined water and wastewater bill represents less than 4.5% of median household income), water supplies are deemed to be affordable (BBC and HCR 2015a). Given the approximate affordability threshold of 2.5% of median household income for water service, affordability of any additional rate increases may be of greatest concern in the communities of Fort Morgan, Fort Lupton, and Dacono (Table 3-78).

Table 3-77. 2011 Residential water rates as a percent of median household income.

	Average Monthly Water Bill	Average Annual Water Bill	Median Household Income	Water Bill as a Percent of Median Income
CWCWD	$32	$382	$55,795	0.7
Dacono	$52	$619	$43,309	1.4
Eaton	$40	$475	$56,424	0.8
Erie	$60	$720	$99,804	0.7
Evans	$42	$502	$44,990	1.1
Firestone	$39	$466	$81,821	0.6
FCLWD	$33	$394	$54,755	0.7
Ft. Lupton	$69	$830	$50,145	1.7
Ft. Morgan	$57	$678	$43,917	1.5
Frederick	$35	$422	$83,284	0.5
Lafayette	$35	$415	$65,319	0.6
LHWD	$61	$729	$65,040	1.1
MCQWD	$38	$450	$43,317	1.0
Severance	$40	$475	$76,161	0.6
Windsor	$46	$557	$75,267	0.7

Sources: Water bills based on BBC estimates. Household income based on American Community Survey, 5-year estimates, 2005-2009.

Table 3-78. Estimated number of cost-burdened households, 2006.

	Total Water and Wastewater Fees	Household Income Needed to Afford Fees at Affordability Threshold of 2%	Estimated Percent of Households at or Below needed Income for Affordability	Estimated Number of Households Currently Cost Burdened (below Affordability Level)
Fort Morgan	$658	$32,900	44%	1,830
Evans	$584	$29,200	47%	3,100
Fort Lupton	$724	$36,200	40%	1,000
			Total in Communities	**6,840**

Source: U.S. Census 2000.

3.21 HAZARDOUS MATERIALS

3.21.1 Overview

This section presents information on hazardous materials within the NISP study area. Section 3.23 of the DEIS and the 2006 Hazardous Sites Memo (ERO 2006b) describe the methodology used to identify hazardous sites within the NISP study area and the results of the review. Additional data collection and analysis of hazardous sites was accomplished for the SDEIS to address comments on the DEIS. More information is provided in the subsequent technical memos generated as part of the SDEIS, which include the 2010 Hazardous Materials Assessment Addendum (ERO 2010b) and the 2010 TCE Plume Memo (ERO 2010a).

3.21.1.1 Hazardous Sites

In addition to sites listed in Section 3.23 of the DEIS, one additional hazardous materials site has been identified since the DEIS (Table 3-79 and Figure 3-39). Two sites that have not been characterized but have the potential to have contaminated media are located within or adjacent to the proposed Glade Reservoir site (Table 3-80 and Figure 3-39).

Table 3-79. Known hazardous sites within or adjacent to the proposed reservoir sites and conveyance system study areas.

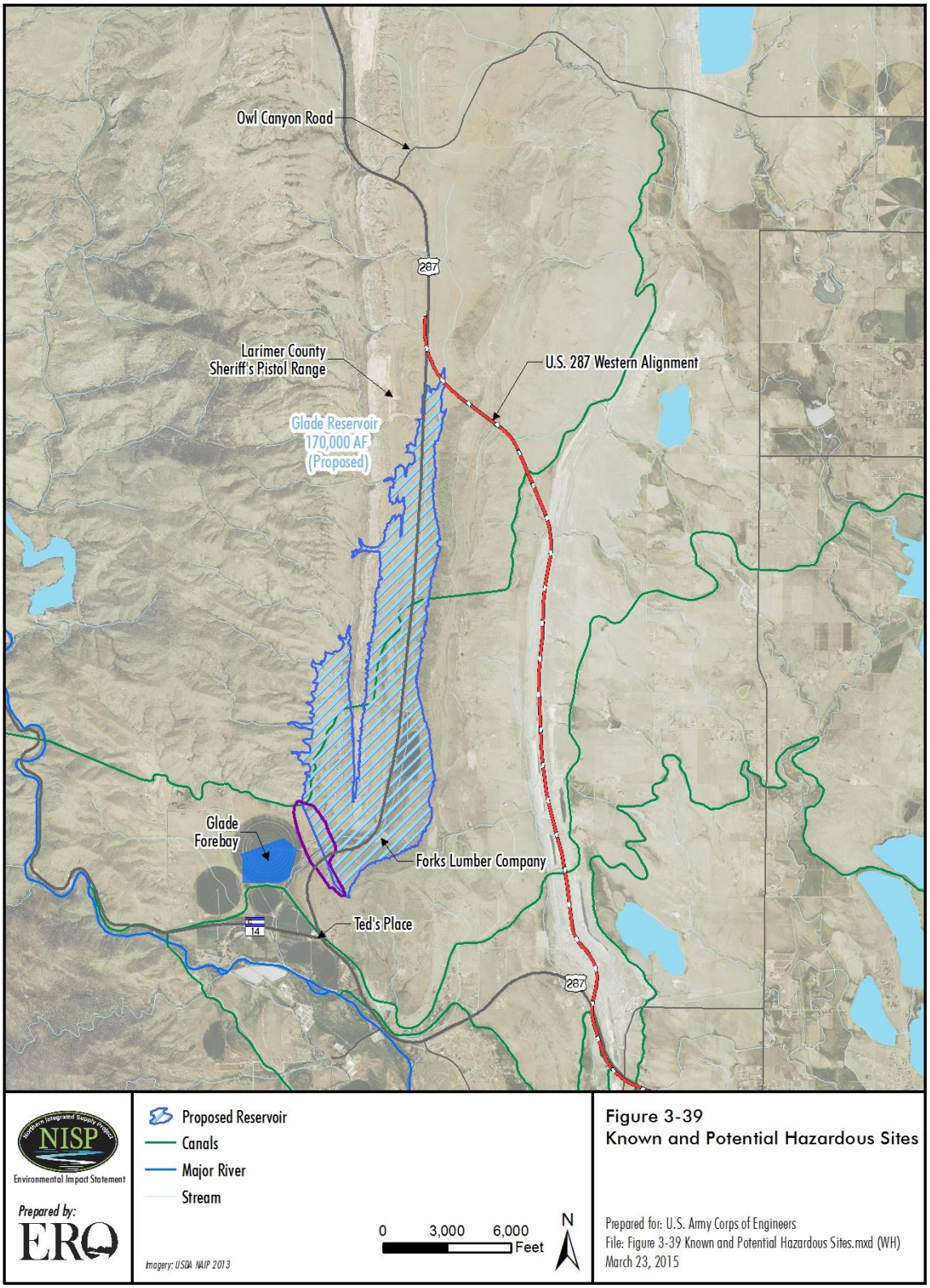
Facility	Distance / Direction	ID	Address	Facility Type
Highway 287 between Highway 14 and Owl Canyon Road	Within area of inundation by proposed Glade Reservoir	None	Highway 287	None. Four LCDHE documented fuel releases and one asphalt release.

FUDS = Former Used Defense Site, TCE = Trichloroethene, CA = Corrective Action and SQG = Small Quantity Generator, LCDHE = Larimer County Department of Health and Environment.
Note: Additional sites are provided in Table 3-33 of the DEIS.

Table 3-80. Potential hazardous sites within or adjacent to the proposed reservoir sites and conveyance system study areas.

Site	Distance / Direction	Address	Practices
Forks Lumber Company	Within area of proposed Glade Reservoir inundation	7800 Highway 287, La Porte, CO	Former on-site treatment of wood products
Larimer County Sheriff's Pistol Range	0.25 mile northwest of proposed Glade Reservoir	None	On-site lead ammunition dispensing

Figure 3-39. Known and Potential Hazardous Sites.



3.21.2 Proposed Reservoir Sites

3.21.2.1 Glade

The Highway 287 fuel and asphalt release has been assessed and remediated as appropriate and no further action has been required by the agencies overseeing the site. The proposed realignment of U.S. 287 would be designed to avoid the Holcim Mine cement kiln dust landfill.

Should the proposed Glade Reservoir be a component of a permitted action, the Forks Lumber site would be characterized during final design and remediated to applicable state standards as necessary. If the Larimer County Pistol Range continues to be used, implementation of best management practices outlined by the CDPHE would be recommended along with construction of berms to limit stormwater runoff from the range during final design.

The proposed Glade forebay would be located near the Atlas "E" Missile Site 13. A trichloroethene (TCE) release occurred from operations at the facility as discussed in Section 3.23.3.1 of the DEIS.

The Corps, Omaha District investigated the TCE-contaminated ground water plume as part of the Site Inspection conducted in 1999, the Expanded Site Inspection conducted in 2002, and the Remedial Investigation field work conducted in late 2003/early to mid-2004 to define the vertical and horizontal extent of the plume (Corps 2006).

To supplement the 2003/2004 water quality data collected for the Remedial Investigation, additional water samples were collected during fall 2008, winter 2009, spring 2009, and fall 2009. The results are provided in a technical memo prepared by ERO (ERO 2010a). The 2008/2009 sampling results indicate that the TCE plume has decreased in area since the first samples were collected. Four wells that had detected TCE concentrations above the Colorado Basic Ground Water Standards (CBGWS) in the 2003/2004 sample period are now below the CBGWS. By the end of 2009, only one well had TCE concentrations above the CBGWS (13-MW06) (ERO 2010a).

The water quality data from fall 2008, winter 2009, spring 2009, and fall 2009 indicate that the TCE concentration in WBZ-2 is continuing to decrease, probably due to natural degradation processes, and is currently below the CBGWS in all monitoring wells except one, 13-MW06. The plume has retracted in the last 5 to 6 years and no detectable TCE is currently within the footprint of the proposed forebay (Figure 3-40). As the contaminant mass continues to naturally attenuate, the plume will continue to decrease in size.

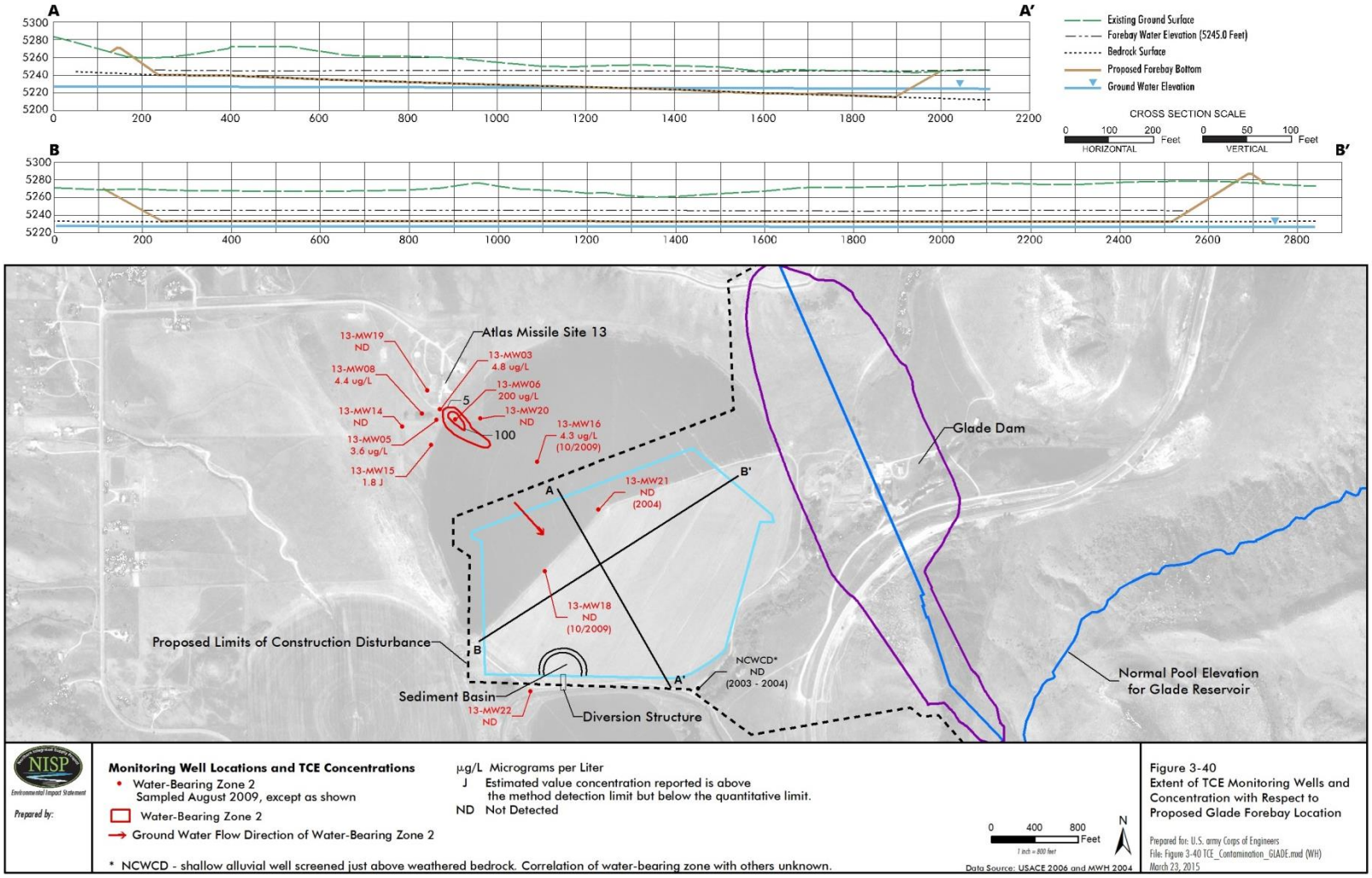
Water level data collected during the four quarters indicate that water levels vary by as much as 10 feet between seasons (ERO 2010a). Based on data from the four quarters, water levels reach their lowest level by late spring and then begin rising through the summer, remaining high through much of the winter. Although some variation was observed in the TCE concentrations, there was no discernable correlation between TCE concentration and seasonal changes in water levels, with one possible exception. Well 13-MW06 has shown the highest variability in TCE concentrations since it was first sampled in July 2002. The highest concentrations have occurred

in the fall and summer quarters, corresponding to the period of highest water levels. Because 13-MW06 is in the area where TCE was released, this observation suggests there may be residual TCE contamination that is subject to movement either by infiltrating precipitation or by the higher water levels. The apparent residual TCE mass near the source area appears to no longer affect downgradient areas. In the past, the TCE plume developed in response to the release of TCE in the source area, but currently there may not be sufficient TCE mass to affect the downgradient areas, as there are no observed corresponding increases in downgradient concentrations during or after the source area concentration increases.

After evaluation of the TCE reported concentrations, the location of the TCE plume source area, and the location and depth of the TCE plume in relationship to the proposed forebay design, the following conclusions are made:

- TCE concentrations in ground water above the CBGWS of 5 µg/L have not been detected beneath or downgradient of the proposed forebay within the second or third water bearing zones.
- TCE concentrations in ground water downgradient of the missile site are decreasing, indicating the plume is naturally attenuating and retracting. Currently, the plume appears to have retracted back to the former source area.
- A recalculation of ground water velocity using a more appropriate value for porosity indicates that the TCE plume had the potential to reach the Poudre River in the 1960s or 1970s.
- The TCE plume either reached the Poudre River in the 1960s or 1970s and has been retracting since, or the plume never reached the Poudre River because it achieved equilibrium with various degradation processes, and is currently retracting in size.
- Other than in the source area, there were no observed seasonal trends in TCE concentrations.

Figure 3-40. Extent of TCE Monitoring Wells and Concentration with Respect to Proposed Glade Forebay Location.



3.21.2.2 Galeton

Based on a review of Colorado Oil and Gas Conservation Commission (COGCC) records (2014), 31 producing oil and gas wells, 8 shut-in wells, and 11 plugged and abandoned wells are in the proposed Galeton Reservoir study area. According to COGCC inspection/incident records, four of the well sites in the proposed Galeton Reservoir study area have had remedial activities associated with a release of petroleum hydrocarbons. These incidents are described below.

Dillard AB #10-7. The Dillard AB #10-7 well site is operated by Noble Energy Production, Inc. (Noble) and is in the SW¼NW¼ of Section 10, Township 7N, Range 64W, in the middle of the proposed Galeton Reservoir pool. On November 4, 2010 about 10 barrels (420 gallons) of crude oil were spilled onto the ground surface outside of the containment berm for the well site's tank battery during transfer of oil from the tank battery to a tanker truck. About 131 cubic yards of contaminated soils were excavated and disposed at the North Weld County sanitary landfill. No ground water was encountered during the excavation. Confirmation soil sampling indicated that all soils in excess of the COGCC cleanup level of 500 milligrams/per kilogram (mg/kg) of total petroleum hydrocarbons were removed. The COGCC reported the incident was closed and no additional remedial activities were necessary in an e-mail to Noble dated December 29, 2010. The excavation pit was backfilled and the site was recontoured to the original grade.

Furrow USX AB #15-10P. The Furrow USX #AB 15-10P well site is operated by Noble and is in the NW¼SE¼ of Section 15, Township 7N, Range 64W, downgradient of the proposed Galeton Reservoir dam. According to COGCC records (2014), the well is shut-in. On February 28, 2011 about 5 barrels (210 gallons) of crude oil were spilled onto the ground surface inside of a containment berm due to oil/water separator equipment failure. About 10 cubic yards of contaminated soils were excavated and disposed at the North Weld County sanitary landfill. Confirmation soil sampling indicated that all soils in excess of the COGCC cleanup level of 500 mg/kg of total petroleum hydrocarbons were removed. The COGCC reported the incident was closed in an e-mail to Noble dated March 8, 2011.

McKay AB #02-13. The McKay AB #02-13 well site is operated by Noble and is in the SW¼SW¼ of Section 2, Township 7N, Range 64W, just outside of the proposed reservoir footprint. On November 14, 2012, during oil loading operations, about 10 barrels (420 gallons) of crude oil were spilled onto the ground surface inside of a containment berm. About 15 cubic yards of contaminated soil were excavated and disposed at the North Weld County sanitary landfill. Confirmation soil sampling indicated that all soils in excess of the COGCC cleanup level of 500 mg/kg of total petroleum hydrocarbons were removed. The COGCC reported the incident was closed in an e-mail to Noble dated January 9, 2013.

McKay AB Federal #2-14. The McKay AB #02-13 well site is operated by Noble and is in the SW¼SW¼ of Section 2, Township 7N, Range 64W, outside of the proposed reservoir footprint. On November 21, 2011, an unknown volume of crude oil leaked out of a separator onto the ground surface inside of a containment berm. About 40 cubic yards of contaminated soil were

excavated and disposed at the North Weld County sanitary landfill. Confirmation soil sampling indicated that all soils in excess of the COGCC cleanup level of 500 mg/kg of total petroleum hydrocarbons were removed. The COGCC reported the incident was closed in an e-mail to Noble dated February 3, 2012.

Inspection reports reviewed for the wells indicated either satisfactory conditions at the time of the inspections or unsatisfactory conditions due to missing signage or incomplete surface restoration after the wells were completed. None of the unsatisfactory conditions would have the potential to adversely affect the soil and or ground water at the proposed Galeton Reservoir site. The COGCC regulates fracking procedures in the State of Colorado. There are no known instances of fracking fluids reaching shallow saturated zones in the area of the proposed Galeton Reservoir.

There are no other known hazardous sites within or adjacent to the proposed Galeton Reservoir study area.

3.21.2.3 Cactus Hill

Based on a review of COGCC records (2014), one producing oil and gas well and two plugged and abandoned wells are in the proposed Cactus Hill Reservoir study area. None of the well sites have reported spill incidents.

There are no other known hazardous sites within or adjacent to the proposed Cactus Hill Reservoir study area.

3.21.3 Conveyance Systems

Based on the hydrogeologically downgradient location of the active Larimer County Landfill relative to the Carter Pipeline, no adverse impacts from the site are anticipated. The Ray Nicholson Property has been assessed and remediated as appropriate and no further action has been required by the agencies overseeing the site.

3.21.4 Poudre River

As part of comments received during the DEIS, it was recommended that the SDEIS address potential impacts to the 08HE Superfund Site (Cache la Poudre River site and referred to in the SDEIS as the Coal Tar site). The Coal Tar site is located along the south bank of the Poudre River in Fort Collins, Colorado between North College Avenue and Linden Street. The Coal Tar site is adjacent to the former manufactured gas plant, which converted coal into fuel from about 1904 to 1927, and a former landfill. The presence of coal tar and fuel-related ground water contamination has been observed at the site.

In 2005, contaminated riverbed sediments were excavated from the Poudre River as part of remediation activities for the Coal Tar site. The remediation activities also included installing an interlocking high-density polyethylene barrier wall about 700 feet in length and to a depth of

about 30 feet. A vertical hydraulic control system was installed on the bank-side of the barrier wall. The system is designed to maintain a lower ground water elevation next to the barrier wall than the water elevation in the Poudre River to prevent coal tar from seeping upwards into the river.

3.21.5 South Platte River

Based on a review of COGCC records (2014), six producing oil and gas wells are adjacent to the South Platte River from the confluence with the Poudre River down to the Kersey Gage. According to COGCC inspection/incident records, one of the well sites has had remedial activities associated with a release of petroleum hydrocarbons. This incident is described below.

Silva #1. The Silva #1 well site is operated by PDC Energy, Inc. and is in the SE¼SW¼ of Section 6, Township 5N, Range 64W, on the north side of the South Platte River downgradient of the confluence with the Poudre River. During the floods of September 2013, the tank battery at the well site was inundated and about 19 barrels (798 gallons) of produced water was released from the partially buried produced water tank. Impacted soils were not encountered beneath the tank during post-flood reclamation but about 20 yards of soil were excavated and disposed at the North Weld County sanitary landfill. COGCC reported the incident was closed in an e-mail to PDC Energy, Inc. dated August 15, 2014.

There are no other known hazardous sites within or adjacent to the South Platte River from the confluence with the Poudre River down to the Kersey Gage.

CHAPTER 4

ENVIRONMENTAL CONSEQUENCES - NISP EFFECTS

CHAPTER 4

ENVIRONMENTAL CONSEQUENCES - NISP EFFECTS

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Chapter 4. Environmental Consequences - NISP Effects

4.1 INTRODUCTION

Chapter 4 provides new and updated information on the direct and indirect effects or impacts on the environment that potentially could result from the alternatives described in Chapter 2. The information on the existing condition of the environment presented in Chapter 3 is the baseline that was used to identify potential impacts resulting from the Project.

An environmental impact is defined as any change to the environment, whether adverse or beneficial, resulting from an action taken. Impacts vary in significance from no change, or only slightly discernable change, to a full modification or elimination of the environmental condition. In accordance with 40 CFR 1502.2(b), impacts are discussed in proportion to their significance. The significance of the impact is considered in terms of context and intensity. Detailed discussions are provided for moderate to major or complex effects and brief discussions are provided for minor effects.

An impact analysis was conducted for each resource described in Chapter 3. The analysis predicts the degree to which the resources would be affected upon implementation of an action. Within each resource section in Chapter 4, a discussion of potential environmental consequences includes:

- Direct and indirect effects and their significance
- Adverse environmental effects which cannot be avoided should the proposal be implemented

Most of the substantial effects to resources are associated with project facilities (direct effects) or proposed project operations that would alter the flows in the Poudre and South Platte Rivers (indirect effects). For flow-related resources, comparisons in Chapter 4 are between CTP Current Conditions hydrology (2010) and Current Conditions with a Project Alternative, neither of which include RFFAs. Chapter 5, Cumulative Effects, provides comparisons for flow-related resources between CTP Future Conditions hydrology (2050) and Future Conditions with a Project Alternative, both of which include RFFAs.

The proposed mitigation of adverse environmental impacts is addressed in a draft Mitigation Plan prepared by the District and is included as Appendix F of the SDEIS. The plan provides proposed mitigation to offset potential project effects described in this chapter. In its ROD, the Corps will evaluate the adequacy of the proposed mitigation, as well as mitigation that may be required by CPW and CDPHE, to offset impacts to waters of the U.S. and ensure the proposed work is not contrary to the public interest.

An approved jurisdictional determination will be performed for the FEIS for waters and wetlands within proposed reservoir and associated facilities sites. The approved jurisdictional determination will follow the methods, guidance, and regulations in effect at the time of the determination. The Corps and EPA have proposed a rule defining waters of the U.S. under the Clean Water Act (76 Fed. Reg. 22188 (April 21, 2014)). If implemented as proposed, the rule could affect the jurisdictional status of some waters and wetlands within the proposed reservoir and facilities sites. Public comment on the proposed rule closed on November 14, 2014.

4.1.1 Terms Used in This Chapter

4.1.1.1 Direct and Indirect Effects

Direct impacts or effects are those that are caused by the action and occur at the same time and place as the action. Most direct effects would occur from construction of facilities (e.g., dams and pipelines) and inundation by reservoirs. Indirect effects are those that are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. The primary indirect effects for the NISP alternatives include those to resources predicted to be affected by project-related flow changes in the Poudre and South Platte Rivers, but also include the predicted economic effects of transferring agricultural water to M&I use and emission of carbon dioxide, a greenhouse gas, associated with operation of the alternatives. Estimated greenhouse gas emissions from project operations are presented in Section 4.14 Air Quality. The NISP SDEIS addresses climate change in Chapter 5 as a reasonably foreseeable condition of the future affected environment per CEQ Guidance (2010, 2014).

4.1.1.2 Effect Duration Terms

Short-term or temporary impacts typically are associated with construction activities in which the environment generally would revert to preconstruction conditions at or within a few years of construction completion (e.g., pipeline installation, noise, traffic patterns). For the Project, short-term or temporary impacts are those that would occur from the time ground-disturbing activities begin through reclamation (anticipated to be approximately 5 years), when vegetation has been re-established in construction areas such as temporary access roads, staging areas, etc. Long-term or permanent impacts are those that would occur throughout the life of the Project (e.g., reservoir inundation) or beyond (e.g., dams or the realignment of U.S. 287). The life of the Project is estimated to be a minimum of 50 years.

4.1.1.3 Intensity and Magnitude of Effect

Based on the alternatives descriptions and affected environment resource data, each resource specialist identified the types and amounts of impacts that could occur as a result of implementation of the alternatives. The potential vulnerability of each resource was considered qualitatively and/or quantitatively in predicting the intensity of impacts and was evaluated considering the following:

- *Resource significance* – A measure of formal concern for a resource through legal protection or by designation of special status.
- *Resource sensitivity* – The probable response of a particular resource to Project-related activities.
- *Resource quality* – A measure of rarity, intrinsic worth, or distinctiveness, including the local value and importance of a resource.
- *Resource quantity* – A measure of resource abundance and the amount of the resource potentially affected.

Some resource impacts are more conducive to quantification than others, such as impacts on vegetation, which can be characterized partly by measuring the area of potential ground disturbance, and air quality impacts, which can be measured against air quality standards. Other resources are difficult to quantify, such as aesthetics and visual resources, and levels of impact were based on available information and best professional judgment.

For the purposes of analysis for this Project, the intensity of impacts was described using the following terms:

- No effect: any discernable or measurable effect.
- Negligible: Effects would be at the lowest levels of detection, barely measurable, with no perceptible consequences.
- Minor: Effects result in a detectable change, but the change would be slight.
- Moderate: Effects would result in a clearly detectable change, with measurable effects.
- Major: Effects would be readily apparent with substantial consequences.

These definitions are specific to each resource, and resource-specific impact-level criteria are described in the respective sections in this chapter. Throughout this document for each resource determination, all effects are considered adverse unless otherwise stated as beneficial.

4.1.1.4 Unavoidable Adverse Impacts

Certain adverse impacts cannot be avoided with the application of mitigation measures. Implementation of any of the NISP alternatives would have unavoidable direct, adverse impacts. Unavoidable indirect impacts resulting from the alternatives could include fugitive dust and exhaust emissions from construction activities, soil and wind erosion, water quality impacts from stormwater runoff, displacement of vegetation and wildlife species, disturbance of cultural and paleontological resources, and loss of natural viewsheds.

4.1.1.5 Relationship between Short-Term Uses and Long-Term Productivity

Pursuant to NEPA regulations [40 CFR 1502.16], an EIS must consider the relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity. Short-term is defined as the construction period through final reclamation, which is assumed to take up to 5 years. Long-term is defined as the period after when the NISP would be

completed and mitigation measures are in place. For example, short-term use of the labor force could result in long-term productivity of the economic environment, including employment and tax revenue. The short-term and long-term impacts relative to each resource are described under each resource section in this chapter.

4.1.1.6 Irreversible or Irretrievable Commitment of Resources

This section describes the irreversible and irretrievable commitments of resources associated with constructing the project alternatives. NEPA [40 CFR 1502.16] requires a detailed statement describing any irreversible or irretrievable commitment of resources that would result from implementing the alternatives. An "irreversible commitment of resources" occurs when, once committed to the project components, the resource would continue to be committed throughout the life of the Project. An "irretrievable commitment of resources" refers to those resources that, once used, consumed, destroyed, or degraded during construction, operation, or decommissioning of the Project, would cause the resource to be unavailable for use by future generations. Examples of irretrievable types of resources include nonrenewable resources, such as minerals and cultural resources, as well as renewable resources that would be unavailable for the use of future generations such as loss of production, harvest, or habitat. The monetary investment by the NISP Participants is not considered to be an irreversible or irretrievable commitment of resources. If NISP is not built, the investment that would have otherwise been spent on this project could be spent elsewhere.

For NISP, the time frame for irretrievable resource commitments is the period of time that NISP remains in place or temporary facilities or disturbances remain. For example, native plant communities disturbed during construction but not inundated or covered by an impermeable surface represent an irretrievable loss of resources. In this example, the period of time between disturbance and complete revegetation represents an irretrievable loss of resources. The proposed project would require an irretrievable commitment of natural resources from direct consumption of fossil fuels and construction materials. The irreversible use of electrical energy is presented in Section 4.22. A summary of irreversible and irretrievable impacts is presented in Table 4-1.

Table 4-1. Irreversible and irretrievable commitments of resources.

Resource	Irreversible Impacts	Irretrievable Impacts	Explanation
Water Quality	No	No	Changes to water quality would not be irreversible or irretrievable.
Water Quantity	No	No	Loss of water to evaporation from the reservoirs, diversion, and consumptive use of water would reduce river flows and availability of water for other uses.
Soils	No	Yes	Loss of soil productivity due to reservoir inundation, facilities construction, and highway realignment; construction would also cause accelerated erosion.
Vegetation	No	Yes	Loss of vegetation that occurs within the facilities and roadway footprints that would be constructed.
Agriculture	Yes	Yes	Loss of agricultural land within the footprints of the facilities that would be constructed and changes in agricultural lands associated with the transfer of irrigation water.
Wildlife	Yes	Yes	Loss of wildlife habitat that occurs within the footprints of facilities that would be constructed.
Aquatics	Yes	Yes	Changes to aquatic habitat associated with reduced river flows.
Cultural Resources/ Paleontological	Yes	Yes	Loss of cultural and paleontological resources due to accidental disturbance during construction.
Land Use	Yes	No	Changes in land use associated with reservoirs and realignment of highways that would be constructed.
Construction Materials	No	Yes	Use of aggregate, water, steel, concrete, and fossil fuels for construction of facilities.
Air Quality	No	No	Changes to air quality would not be irreversible or irretrievable.
Visual	Yes	No	Degradation of scenic quality due to potential permanent changes in topography and vegetation patterns at the reservoir sites.

4.1.1.7 Natural or Depletable Resource Requirements and the Built Environment

As part of the discussion of environmental consequences, NEPA requires a discussion of natural or depletable resource requirements and conservation potential of various alternatives and mitigation measures, and design of the built environment, including reuse and conservation potential of various alternatives and mitigation measures (40 CFR 1502.16). These are discussed below, with the exception of mitigation. As part of the NISP SDEIS, the District has prepared a draft Mitigation Plan (Appendix F). The Corps will review and evaluate the District's proposed mitigation plan in light of the predicted effects. The Corps will describe the final mitigation requirements in its ROD and may incorporate mitigation required by CPW and CDPHE.

4.1.1.7.1 Natural or Depletable Resource Requirements

The alternatives are designed to meet a portion of the future water supply needs of the NISP Participants. As discussed in Section 1.2.8, the timing of the future water supply needs can be delayed (but not avoided) through water conservation. The NISP Participants have implemented water conservation programs that have been successful at conserving water (Section 1.2.7).

Water is a valuable resource that the NISP Participants will continue to conserve and look for ways to improve water conservation under any of the alternatives.

All NISP alternatives would use electrical energy to convey water. If an alternative is permitted, the District would select the type, size, and number of pumps needed to minimize energy demands and achieve maximum efficiency. The Project would be operated to optimize the energy used to pump each acre-foot of water.

All alternatives include dam construction. The design and construction of any of the dams would include maximizing the use of geologic materials (soil, aggregate, and rock) from within the footprint of the reservoir to minimize the mining of geologic materials and their import from other locations. For Alternative 2, which includes the realignment of U.S. 287, suitable rock material would be salvaged from the rock cut through the hogback for riprap at Glade Reservoir and the approach ramp for the rock cut.

4.1.1.7.2 Design of the Built Environment

All alternatives would require buildings and structures to house pumps and other equipment to operate the project. All buildings would incorporate designs to minimize energy requirements (e.g., high efficiency heating, ventilation and cooling systems, use of insulated building materials, and use of natural lighting).

4.1.2 Resource Effects Studies

Table 4-2 summarizes where information about resource effects can be found in the DEIS and SDEIS. Revisions have been made where new information is available or where comments on the DEIS warranted revisions. If a section description has not changed since the DEIS, reference to where that information can be found in the DEIS is given. If the project alternatives would not affect the resource within a given study area, that resource is not described. Information is presented on the potential effects resulting from implementation of each alternative, including the new No Action Alternative and new Alternative 4. New and updated information on resource effects within the U.S. 287 western alignment study area is provided under the Glade Reservoir subsection for each affected resource. Climate change is described in Chapter 5, Cumulative Effects, as a reasonably foreseeable future condition of the affected environment.

Table 4-2. Resource effects described in DEIS and SDEIS.

Resource	DEIS Section	SDEIS Section
Surface water	4.3	4.2
Surface water quality	4.5	4.3
Stream morphology and sediment transport	4.4	4.4
Ground water	4.7	4.5
Geology	4.8, 4.27.2	4.6
Soils	4.9, 4.27.4	4.7
Vegetation	4.10	4.8
Wetlands, riparian resources, and other waters	4.12, 4.13, 4.27.5, 4.27.6	4.9
Wildlife	4.14, 4.27.7	4.10
Special status species	4.16, 4.27.8	4.11
Aquatic biological resources	4.15	4.12
Traffic and transportation	4.20, 4.27.12	4.13
Air quality	4.25, 4.27.11	4.14
Noise	4.24, 4.27.10	4.15
Recreation	4.17	4.16
Land use	4.21, 4.27.13	4.17
Visual resources and aesthetics	4.19	4.18
Cultural, historical, and paleontological resources	4.18, 4.27.3, 4.27.9	4.19
Socioeconomic resources	4.22, 4.27.14	1.20
Hazardous materials	4.23, 4.27.15	4.21
Energy use		4.22

More detailed information is provided in the technical memos and reports produced for each resource for the DEIS and SDEIS. These studies are listed in Table 4-3 and Table 4-4. These documents are available at http://www.nwo.usace.army.mil/Missions/RegulatoryProgram/Colorado/EISNISP.aspx, and full citations are listed in Chapter 7 References.

Table 4-3. DEIS effects technical memos and reports.

Resource	DEIS Technical Memos and Reports	Citation	Abbreviated Title in SDEIS
Surface water	Water Resources Technical Report	HDR 2008	2008 Water Resources Report
Surface water quality	Water Quality Technical Report	ERO and HDR 2008	2008 Water Quality Report
Stream morphology and sediment transport	South Platte River near Kersey Stream Morphology Technical Report	ERO 2008a	2008 South Platte River Stream Morphology Report
	River Morphology and Sediment Transport Technical Report for the Cache la Poudre River	ACE 2008	2008 River Morphology Report
Ground water	Ground Water Issues –Proposed Reservoir Sites, Cache la Poudre River, and South Platte River Memorandum	ERO 2007	2007 Ground Water Memo
Geology	Glade Dam Technical Memorandum Galeton Dam Technical Memorandum Cactus Hill Dam Technical Memorandum	GEI 2006a GEI 2006b GEI 2006c	2006 Geologic Memorandums
Soils	Land Use Technical Report	ERO 2008b	2008 Land Use Report
Vegetation	Vegetation Technical Report	ERO 2008c	2008 Vegetation Report
Riparian and wetland areas	Wetlands and Other Waters Technical Report	ERO 2008d	2008 Wetland Report
	Vegetation Technical Report	ERO 2008c	2008 Vegetation Report
Wildlife	Wildlife Technical Report	ERO 2008e	2008 Wildlife Report
Special status species	Endangered Species Habitat Assessment Report	ERO 2006a	2006 Endangered Species Report
	Species of Concern Technical Report	ERO 2008f	2008 Species of Concern Report
Aquatic biological resources	Aquatic Biological Resources Technical Report	GEI 2008	2008 Aquatic Resources Report
Traffic and transportation	U.S. 287 Relocation Study	Muller 2007	2007 U.S. 287 Relocation Study
	Land Use Technical Report	ERO 2008b	2008 Land Use Report
Air quality	Air Quality Technical Report	MERCO 2006a	2006 Air Quality Report
Noise	Noise Assessment Report	MERCO 2006b	2006 Noise Report
Recreation	Recreation Resources Technical Report	ERO 2008g	2008 Recreation Report
Land use	Land Use Technical Report	ERO 2008b	2008 Land Use Report
Visual resources and aesthetics	Visual Resources Comprehensive Technical Report	ERO 2008h	2008 Visual Resources Report
	Visual Resources Technical Report for the Highway 287 Realignment Alternatives	ERO and HLA 2008	2008 Visual Resources Highway 287 Report
Cultural, historical, and paleontological resources	Cultural Resources Technical Report	WCRM 2008	2008 Cultural Resources Report
	Paleontological Technical Report	RMP 2006	2006 Paleontological Report
Socioeconomics	Socioeconomic Resources Technical Report	HDR and BBC 2008	2008 Socioeconomic Resources Report
Hazardous materials	Hazardous Sites Technical Memorandum	ERO 2006b	2006 Hazardous Sites Memo

Table 4-4. SDEIS effects technical memos and reports.

Resource	SDEIS Technical Memos and Reports	Citation	Abbreviated Title in SDEIS
Surface water	Water Resources Technical Report	CDM Smith 2014a	2014 Water Resources Report
	Final Draft Operations Plan Report	CDM Smith 2014b	2014 Operations Plan Report
Surface water quality	Draft Water Quality Effects Technical Report	ERO and Tetra Tech 2015	2015 Draft Water Quality Effects Report
	Stream Temperature and Dissolved Oxygen Analysis for NISP Supplemental EIS Summary of Current Conditions and Qualitative Anticipated Effects of NISP Alternatives	Hydros 2014a	2014 Stream Temperature and DO Analysis
	Reservoir Comparative Analysis for the NISP SDEIS Technical Memorandum	Hydros 2014b	2014 Reservoir Comparative Analysis Memo
	Water Quality Assessment Report, Phase 1	GEI 2015a	2015 Water Quality Report
	Alternatives 3 and 4 Cactus Hill Reservoir to Horsetooth Reservoir Report	ERO 2013a	2013 Alternatives 3 and 4 Cactus Hill to Horsetooth Report
	Evaluation of Water Quality and Potential Effects on Aquatic Life and Crop Production Associated with the Proposed Cactus Hill and Galeton Reservoirs Technical Report	ERO 2015a	2015 Evaluation of Water Quality for Cactus Hill and Galeton Reservoirs Report
	Horsetooth Reservoir Modeling Report	Hydros 2013	2013 Horsetooth Reservoir Modeling Report
Stream morphology and sediment transport	Stream Morphology and Sediment Transport Cache la Poudre River Mainstem Final Project Effects Report	ACE 2014	2014 Stream Morphology Effects Report
Ground water	Ground Water Effects Analysis Memorandum	ERO 2013b	2013 Ground Water Effects Memo
Geology	Oil and Gas Development at the Proposed Galeton Reservoir Site Technical Memorandum	ERO 2012c	2012 Oil and Gas Development Memo
Vegetation	Vegetation and Wetland Resources Technical Report Supplement	ERO 2015b	2015 Vegetation and Wetland Resources Supplement
Riparian and wetland areas	Wetlands and Riparian Resources Effects Technical Report for Mainstem of the Cache la Poudre River	ERO 2014d	2014 Wetlands and Riparian Resources Effects Report
	Vegetation and Wetland Resources Technical Report Supplement	ERO 2015b	2015 Vegetation and Wetland Resources Supplement
	Quantification of Impacts to Irrigation-associated Wetlands from Agricultural Lands: Methods and Results Technical Memorandum	West 2010	2010 Impacts to Irrigation-associated Wetlands Memo
Wildlife	Wildlife Technical Report Supplement	ERO 2015c	2014 Wildlife Supplement
Special status species	Species of Concern Technical Report Supplement	ERO 2015d	2015 Species of Concern Supplement

Resource	SDEIS Technical Memos and Reports	Citation	Abbreviated Title in SDEIS
Aquatic biological resources	Aquatic Biological Resources Effects Technical Report	GEI 2015b	2014 Aquatic Resources Effects Report
Air Quality	NISP Project Alternative Air Quality Analysis Technical Memorandum	GEI 2013	2013 Air Quality Analysis Memo
Noise	Noise Impact Analysis Results Northern Integrated Supply Project - U.S. 287 Relocation Study Technical Memorandum	Hankard 2014	2014 Noise Impact Assessment for U.S. 287 Memo
Recreation	Recreation Resources Technical Report Supplement	ERO 2015e	2015 Recreation Supplement
Cultural, historical, and paleontological resources	Paleontological Technical Report: Northern integrated Supply Project, Proposed U.S. Highway 287 Realignment	RMP 2014	2014 Paleontological Report
Socioeconomics	Socioeconomic Effects Technical Report	BBC and HCR 2015b	2015 Socioeconomic Effects Report
Hazardous materials	Impact of F.E. Warren Missile Site 13 TCE Plume on Construction Activities for the Proposed Glade Reservoir Forebay Memorandum	ERO 2010a	2010 TCE Plume Memo
	Hazardous Materials Assessment Addendum Memorandum	ERO 2010b	2010 Hazardous Materials Assessment Addendum
	Oil and Gas Development at the Proposed Galeton Reservoir Site Technical Memorandum	ERO 2012d	2012 Oil and Gas Development at Galeton Reservoir Memo
Energy use	GHG Emissions for NISP Alternatives Memorandum	BBC 2014	2014 GHG Emissions Memorandum

4.2 SURFACE WATER

This section describes the changes in surface water hydrology (streamflows and reservoir volumes, surface areas and elevations) that potentially could result from implementation of NISP. Surface water hydrology is the foundational resource for the evaluation of the effects to other flow-related resources. The time series data output from the Common Technical Platform (CTP) hydrologic modeling (see description below) were provided to other resource specialists for use as inputs for their models and other analytical tools used for assessing potential NISP effects. The resource specialists using these datasets contributed to reviews of the modeled streamflows, which the Corps determined were acceptable to use for the intended analytical purposes. These other flow-related resource analyses, including some aspects of water quality, river morphology, sediment transport, aquatic habitat, ground water, riparian areas, and wetlands, are documented in the technical reports listed in the Chapter 4 Introduction and other sections of Chapter 4.

The hydrologic modeling of the Poudre River and lower South Platte River Basins and modeled changes to surface water resources are described extensively in four technical memoranda and reports prepared in support of the SDEIS, as follows:

- **Technical Memorandum: Water Administration in the Cache la Poudre River Basin (CDM Smith, DiNatale, and Hydros 2011).** Hereafter referred to as the 2011 District 3 Water Administration Memo, this document provides an overview of Colorado's prior appropriation water rights system and defines many elements of the potentially affected environment for NISP, including summaries of historical streamflows at gages that are critical for water administration, transbasin imports, major irrigation diversions, and water exchanges and other operations that affect water administration in the Poudre Basin.
- **Northern Integrated Supply Project Environmental Impact Statement Common Technical Platform (CTP) Hydrologic Modeling Report (CDM Smith and DiNatale 2013).** Hereafter referred to as the 2013 CTP Modeling Report, this document explains the construction of the components of the CTP model sequence (PBN; Post-PBN Processor; Fort Collins, Greeley, North Poudre Irrigation Company [NPIC], and Tri-Districts system models; and daily disaggregation tools), and summarizes inputs, assumptions, and potential limitations of those components. The report also describes criteria and rationale for study period selection, modeling quality assurance/quality control (QA/QC) procedures, and explains the purpose of each CTP and NISP model run series. The modeling of the NISP alternatives is explained in detail in Section 7 of the modeling report.
- **NISP Operations Plan Report (CDM Smith 2014b).** Hereafter referred to as the 2014 Operations Report, this document provides an overview of estimated operational flows for the NISP action alternatives, including proposed diversions, exchanges, and pipeline deliveries. This report also summarizes storage volume, surface area, water surface elevation, and evaporation for proposed NISP reservoirs. Potential start-up and drought supplies are documented, as well as proposed flow augmentation, generally in the winter months, to help maintain minimum flows in the Poudre River through Fort Collins.

- **NISP SDEIS Water Resources Technical Report (CDM Smith 2014a).** Hereafter abbreviated as the 2014 Water Resources Report, this report presents statistical summaries of streamflows at key locations under the NISP alternatives as compared to Current Conditions and Future Conditions hydrology. The 2014 Water Resources Report also demonstrates that the existing operations and water supplies of the canals and reservoirs proposed to be integrated into NISP operations would not be negatively impacted.

The objective of this section is to summarize modeled diversions and to illustrate the modeled changes in streamflow—as compared to modeled Current Conditions hydrology—at multiple locations that are of importance to proposed NISP operations. Modeled diversions at existing irrigation structures are also summarized for those canals and reservoirs proposed to be used for NISP operations.

As stated previously, surface water hydrology is the basis for the evaluation of effects to most other flow-related resources. The tables and figures presenting modeled surface water diversions, reservoir water levels, and changes in streamflow in this chapter are mostly drawn from the 2014 Operations Report and the 2014 Water Resources Report. These tables and figures are intended to be representative examples and summaries of the types of data presentations included with much greater detail in those reports. This section *does not* include evaluation of impact intensity, but rather sets the stage for such designations in the context of the flow-related resource effects analyses that follow. The reader is encouraged to review the full technical reports to gain a more complete understanding of project operations (e.g., modeled diversions and reservoir releases) and modeled changes in Poudre River and South Platte River streamflows associated with the NISP alternatives.

In the DEIS, each action alternative included a Reclamation Contract Sub-Alternative and a Reclamation No Contract Sub-Alternative for making deliveries to the Participants. For the SDEIS, two different mechanisms for delivering water to the Participants were retained only for Alternative 2 (see Sections 2.2.6.3 and 2.5.5.2). In SDEIS technical reports such as the 2014 Operations Plan and the 2014 Water Resources Report, "Sub-Alternative" was changed to "Option." These options were then renamed as the Reclamation Action Option and the No Reclamation Action Option in the SDEIS to be more descriptive.

Modeled NISP operations are based on the best information that is currently available. It is recognized, however, that specific aspects of the project description and project operations may differ from those portrayed here and in other related technical reports prepared for the SDEIS. The NEPA analysis and subsequent permitting of NISP, if a permit is issued, are intended to allow flexibility for future adjustments in the identity of NISP Participants and their respective contract rights, and in the mechanisms for delivery of NISP water, provided those changes do not result in materially different impacts than those analyzed in the FEIS. In accordance with 40 CFR 1502.9(c)(1), the Corps will prepare supplemental NEPA documentation if: (i) the agency makes substantial changes in the proposed action that are relevant to environmental concerns; or (ii) there are substantial new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts.

Section 4.2.1 summarizes the methods and output of hydrologic modeling for NISP, data analysis, and data presentation used for surface water analyses. The No Action Alternative was evaluated under Future Conditions hydrology only, as explained in Section 4.2.2 and, therefore, diversions and analyses of surface water changes in flow for the No Action Alternative are only presented in Chapter 5. Sections 4.2.3 through 4.2.5 provide general characterization of diversions and surface water flow changes associated with the proposed NISP action alternatives (Alternatives 2 through 4) under Current Conditions hydrology and provide references to relevant figures and tables in the 2014 Operations Report and 2014 Water Resources Report. Similar results under Future Conditions hydrology are presented in Chapter 5. Section 4.2.6 describes the primary differences in operations and surface water flow changes between the NISP action alternatives.

4.2.1 Methods

The following sections summarize the methods of hydrologic modeling, data analysis, and data presentation used for NISP surface water analyses. Detailed accounts are provided in the technical reports referenced above.

4.2.1.1 Hydrologic Modeling

The purpose of the NISP alternatives modeling was to quantify the yields of the proposed action alternatives (Alternatives 2 through 4) and to estimate the potential changes to surface water resources resulting from the construction and operations of the proposed project alternatives (including the No Action Alternative [Alternative 1] and action alternatives). Proposed NISP operations and infrastructure under each action alternative were superimposed on the existing or future river system to estimate the volume of water available for the project under variable hydrologic conditions (2010 Current Conditions hydrology and 2050 Future Conditions hydrology). Diversion and exchange of water for NISP and resulting changes in streamflows were quantified through the modeling process and documented in the 2014 Operations Report and the 2014 Water Resources Report.

4.2.1.1.1 Development of the Hydrologic Models

At the direction of the Corps, the CTP was developed so that potential environmental effects to multiple flow-related resources (surface water, ground water, some aspects of water quality, geomorphology, aquatic habitat, riparian habitat, etc.) occurring as a result of proposed NISP and Halligan and Seaman Water Supply Projects (HSWSPs) implementation could be compared against consistently defined Current Conditions hydrology and Future Conditions hydrology. This directive was accomplished through the development and integration of a series of hydrologic models representing the Poudre River Basin and lower South Platte River Basin into a CTP model sequence. The hydrologic models include all major M&I and agricultural water systems and were designed to simulate Current Conditions hydrology, Future Conditions hydrology, project alternatives scenarios, and cumulative effects of the proposed project alternatives (see the 2013 CTP Modeling Report).

The CTP model sequence includes a total of eight separate model applications that are maintained either in the MODSIM or *Excel* software platforms. Each component can be categorized as a basin water allocation model, water system operations model, or pre-/post-processing tool. The CTP model sequence is executed in series to calculate streamflow and determine water systems operations for use in the assessment of the potential environmental impacts.

NISP infrastructure and operations related to the diversion, exchange, and storage of raw water to meet an aggregate NISP demand are simulated in the fourth iteration of the PBN component of the CTP model sequence (the PBNc step, which follows PBNa1, PBNa2, and PBNb). PBNc modeling applies to the three action alternatives (Alternatives 2 through 4). Post-processing analyses to further evaluate the operations required to make deliveries of raw water to the NISP Participants under the Reclamation Action Option for Alternative 2 only are documented in Section 3.1.1.2 of the 2014 Operations Report. Modeling of the No Action Alternative was accomplished by post-processing of the Future Conditions hydrology model run. Yield estimates for the No Action Alternative were initially developed by MWH (2010) and adjusted for reasonable consistency with the modeled Future Conditions headgate diversions at the Larimer-Weld Canal and the New Cache Canal.

4.2.1.1.2 Hydrologic Model Timestep and Output

Based on the analytical needs for surface water and other flow-related resources, the CTP model sequence simulations were run on a monthly time step, with an additional *Excel* spreadsheet tool executed at the end of the sequence to disaggregate final modeled monthly streamflows to estimates of daily flows. Taking the availability of supporting historical data into consideration, two study periods were selected by the Corps for CTP model sequence simulations and subsequent analyses. Both are based on the irrigation year (IY), which runs from November 1 of the preceding year through October 31 of the stated year. They are as follows:

- Monthly = IY 1950-2005 (56 years, November 1949 – October 2005)
- Daily = IY 1980-2005 (26 years, November 1, 1979 – October 31, 2005)

An analysis of historical streamflow data at the major Poudre River mainstem gages (Canyon Mouth, Lincoln Street, Boxelder, and Greeley) found that the two study periods were statistically similar. Documentation of this comparative assessment was provided in Technical Appendix 8 of the 2013 CTP Modeling Report.

Both monthly and daily streamflow data were used to illustrate the potential changes to surface water resources due to NISP. Operational flows (e.g., diversions, exchanges, pipeline deliveries, etc.) associated with the NISP action alternatives were presented in the 2014 Operations Report as monthly average flows volumetrically in units of AF or AF per month (AFM). Unless otherwise noted, those monthly average values were calculated based on 56 years of simulated data for the NISP study period encompassing IY 1950-2005, a total of 672 months. Similarly, some of the tables and figures illustrating streamflow changes in the 2014 Water Resources Report use the monthly streamflow data, presented as average volumetric flows with units of AF

over the IY 1950-2005 period. The exception is Alternative 2, which presents monthly data for only the IY 1980-2005 period (see Section 4.2.1.3).

The final output from the daily disaggregation tool for the Poudre River mainstem is a time series of daily flows at a series of specified structures, representing key points along the river with a diversion or inflow (e.g., tributary inflow or effluent discharge), using 26 years of data from IY 1980-2005. This study period contains 9,497 daily flow data points, including approximately 790 daily flow data points for each month and 26 for each calendar day (except February 29, which occurred 7 times in the IY 1980-2005 period). Estimated daily flow time series were generated at 50 locations on the Poudre River mainstem, plus the Kersey Gage on the lower South Platte River, identified as critical to various flow-related analyses (see Section 3.3.3 of the 2014 Water Resources Report). Given that these datasets are derived from the application of historical daily flow patterns to the CTP monthly final river conditions, the estimated daily flows maintain a volumetric consistency with the monthly CTP model sequence output while capturing the range of variability recorded in the historical gage measurements. The estimates of daily flows were used for the statistical analyses of the alternatives rather than as a representation of streamflow on a specific calendar day, which was not the intent of the CTP.

4.2.1.1.3 Hydrologic Model Runs Used for NISP

The CTP model sequence was employed in a series of model runs to simulate Current Conditions hydrology (2010, without proposed NISP or HSWSPs), Future Conditions hydrology (2050, without proposed NISP or HSWSPs), and project effects for the various alternatives. Potential surface water flow changes under Current Conditions hydrology are described in Sections 4.2.2 through 4.2.5. Potential surface water flow changes under Future Conditions hydrology are described in Chapter 5.

CTP Run 1 – Current Conditions Hydrology

As defined for this study, "Current Conditions" hydrology uses IY 1950 to 2005 monthly naturalized streamflows with 2010 demands, infrastructure, and operations to estimate 56 years of Poudre River streamflows under a "Current Conditions" scenario. This scenario does not include operation of the proposed NISP and HSWSPs or any other Future Conditions, including new water supply infrastructure and operations that are independent of NISP and the HSWSPs. CTP Run 1 is not intended to replicate historical hydrology and, therefore, CTP Run 1 simulation results (e.g., streamflows, diversions, and reservoir operations) should not be expected to exactly match recorded historical high flows, low flows, flood volumes, or flow rates, or other substantial hydrologic events that occurred at a particular time during the study period. Rather, based on the assumption that the variability of historical naturalized flows is representative of the expected variability of recent naturalized flows, CTP Run 1 provides an estimate of how 2010 demands and operations would have affected water rights yields and streamflows given the variability of historical water availability (i.e., naturalized flows). See Section 4.3.1 of the 2014 Water Resources Report for statistical summary plots of the estimated daily flows (minimum, maximum, median, and average) for CTP Run 1.

CTP Run 2 – Future Conditions Hydrology

"Future Conditions" hydrology, as defined for the NISP and HSWSPs EIS analyses, uses IY 1950 to 2005 monthly naturalized streamflows with projected 2050 demands (full or partial, depending on the entity), infrastructure, and operations to estimate 56 years of Poudre River streamflows under a "Future Conditions" scenario. The "Future Conditions" scenario does not include operation of the proposed NISP and HSWSPs, but does include RFFAs, which were defined for the CTP modeling to include those water supply infrastructure and operational actions that are likely to be undertaken (i.e., are "reasonably foreseeable") by water providers during the planning period for NISP and the HSWSPs, but are independent of the alternatives evaluated for NISP and the HSWSPs. RFFAs considered in the modeling are summarized in Section 1.2.6 of the 2013 CTP Modeling Report and are listed in Chapter 5. Based on the assumption that the variability of historical naturalized flows is representative of the expected variability of future naturalized flows, CTP Run 2 provides an estimate of how anticipated future 2050 demands and operations would affect water rights yields and streamflows given a repeat of historical water availability (i.e., naturalized flows). See Section 4.3.2 of the 2014 Water Resources Report for statistical summary plots of daily flows (minimum, maximum, median, and average) for CTP Run 2.

NISP Alternatives Model Runs

The NISP alternatives model runs completed for the SDEIS and for which results are presented in the SDEIS are as follows:

- NISP Run 9a – Simulates Alternative 1 (NISP No Action Alternative) with Future Conditions hydrology
- NISP Run 3a – Simulates Alternative 2 (Glade Reservoir and the SPWCP) with Current Conditions hydrology
- NISP Run 3b1 – Simulates Alternative 3 (Cactus Hill Reservoir and the SPWCP) with Current Conditions hydrology
- NISP Run 3b2 – Simulates Alternative 4 (Cactus Hill Reservoir, the SPWCP, and multiple diversion locations) with Current Conditions hydrology
- NISP Run 4a – Simulates Alternative 2 with RFFAs and Future Conditions hydrology
- NISP Run 4b1 – Simulates Alternative 3 with RFFAs and Future Conditions hydrology
- NISP Run 4b2 – Simulates Alternative 4 with RFFAs and Future Conditions hydrology
- NISP Run 5a – Simulates Alternative 2, HSWSPs, and RFFAs with Future Conditions hydrology
- NISP Run 5b1 – Simulates Alternative 3, HSWSPs, and RFFAs with Future Conditions hydrology
- NISP Run 5b2 – Simulates Alternative 4, HSWSPs, and RFFAs with Future Conditions hydrology

Both the Reclamation Action Option and the No Reclamation Action Option for Alternative 2 would include a proposed flow augmentation program, which is described in detail in Section 1.3.2.4 of the 2014 Water Resources Report and Section 8.1 of the 2014 Operations Report. A

pool of 3,600 AF would be designated in Glade Reservoir each year for release to the Poudre River during historical low flow periods between November 1 and April 30, and from September 1-September 30 (if any of the designated 3,600 AF is available at the end of April). The flow augmentation program would minimize some indirect project effects and improve winter and September streamflows through Fort Collins by providing a flow of 10 cubic feet per second (cfs) below the Larimer-Weld headgate (upstream of Martinez Park). The reach affected by flow augmentation would extend from upstream of the Larimer County Canal headgate near Laporte to the Timnath Inlet Canal headgate located on the east side of Fort Collins, a distance of about 12 river miles. The release and recapture of the augmentation flows is allowed by the District's water rights decrees proposed to be used for NISP. For NEPA analyses, it was assumed that the water would be rediverted at the Timnath headgate. The exact method to return the water to Glade Reservoir will be determined between the SDEIS and the FEIS, but possible options include water exchanges. Curtailment of streamflow augmentation releases may be required under extreme drought conditions when reservoir levels are low.

Additional post-processing of model data for Alternative 2 (NISP Runs 3a/4a) was required to account for this proposed flow augmentation program on a daily basis. For each day in the designated months (November-April and September), the augmentation flow needed to reach 10 cfs on the downstream side of the Larimer-Weld Canal headgate was calculated, and the remaining volume in the 3,600 AF designated release pool was tracked. The flow adjustment made below Larimer-Weld was then applied to other locations within the affected reach between the proposed release point (upstream of Larimer County Canal headgate) and end point (Timnath Reservoir inlet). Volumetric monthly flows in AF and monthly average flows in cfs were backcalculated from the adjusted daily flows. As a result, both monthly and daily comparative analyses presented herein for Alternative 2 are based on the period IY 1980-2005. As stated previously in Section 4.2.1.1.2, the IY 1950-2005 and 1980-2005 study periods are statistically similar; therefore, the shorter analysis timeframe still captures the range of historical streamflow variability.

4.2.1.2 Data Analysis

The following sections identify the model run comparisons used for the analysis of changes to surface water resources; describe the methods used to classify the years in the model simulation periods as hydrologically wet, average, or dry; and identify the locations at which final monthly and daily data were produced for flow-related resource analyses. The geographic scope (identification of an appropriate downstream end point) for flow-related analyses is addressed in Section 3.1.3.

4.2.1.2.1 Model Run Comparisons

In order to better understand the modeled changes in streamflow due to the proposed NISP alternatives, key comparisons were identified that highlight differences in modeled river conditions due to implementation of one alternative vs. another. This is intended to support meaningful evaluation of each NISP alternative under varying conditions. Each model comparison is defined by an alternative configuration and 2010 Current Conditions or 2050

Future Conditions hydrology. The selected model run comparisons presented in this chapter and Chapter 5 are shown in Table 4-5.

Table 4-5. NISP SDEIS model run comparisons.

Name	NISP Alternative		Hydrology	
	Alternative	Project Model Run	Scenario	Comparison Model Run
Run 9a vs. Run 2	1	9a	Future	2
Run 3a vs. Run 1	2	3a	Current	1
Run 4a vs. Run 2	2	4a	Future	2
Run 5a vs. Run 2	2	5a	Cumulative Effects	2
Run 3b1 vs. Run 1	3	3b1	Current	1
Run 4b1 vs. Run 2	3	4b1	Future	2
Run 5b1 vs. Run 2	3	5b1	Cumulative Effects	2
Run 3b2 vs. Run 1	4	3b2	Current	1
Run 4b2 vs. Run 2	4	4b2	Future	2
Run 5b2 vs. Run 2	4	5b2	Cumulative Effects	2

The comparisons for Current Conditions model runs (e.g., Run 3a vs. Run 1) are presented in this chapter. Future Conditions with NISP Alternatives comparisons (e.g., Run 4a vs. Run 2) and the additional implementation of the HSWSPs (e.g., Run 5a vs. Run 2) comparisons are summarized in Chapter 5.

4.2.1.2.2 Wet/Average/Dry Years Analysis

A percentile-based approach was developed to classify years within the study period (see Section 4.2.1.1.2) as hydrologically wet, average, or dry. This revised method—updated from the approach used for the NISP DEIS—was developed collaboratively with the other flow-related resource analysts in order to provide a reasonable and useful distribution of years across different types of hydrology and to meet specific data requirements for those analyses. Annual naturalized flows at the Canyon Gage were sorted and ranked from highest to lowest. Percentiles were calculated and used to determine wet, average, and dry years for the NISP effects analyses, as follows:

- Years with annual naturalized flows above the 75th percentile are wet
- Years between the 25th and 75th percentile are average
- Years below the 25th percentile are dry

The resulting distribution of years includes 14 wet years, 28 average years, and 14 dry years over the 56 years of IY 1950-2005. Table 4-6 identifies each year in the study period according to the classification procedure. The subset of years within the daily study period (IY 1980-2005) is identified with bold formatting. This classification represents a benchmark that was used for surface water resources and other flow-related resources in the assessment of estimated NISP impacts under Current and Future Conditions hydrology.

Table 4-6. Benchmark summary of wet, average, and dry years at Canyon Gage.

Category	Years
Wet (>75th percentile)	1957, 1961, 1965, 1971, 1973, 1978, 1979, **1980, 1983, 1984, 1986, 1995, 1997, 1999**
Average	1950, 1951, 1952, 1956, 1958, 1959, 1960, 1962, 1967, 1968, 1969, 1970, 1972, 1974, 1975, 1976, **1981, 1982, 1985, 1988, 1990, 1991, 1992, 1993, 1996, 1998, 2003, 2005**
Dry (<25th percentile)	1953, 1954, 1955, 1963, 1964, 1966, 1977, **1987, 1989, 1994, 2000, 2001, 2002, 2004**

4.2.1.2.3 Data Delivery Mile Locations for Resource Impacts Analyses

Key locations along the Poudre River were identified for NISP resource impacts analyses based on consultation with resource analysts for other flow-related resources, including water quality, aquatic habitat, and geomorphology. These locations—a total of 50 on the Poudre River mainstem, plus the Kersey Gage on the South Platte River—are shown in Table 4-7, along with an associated Data Delivery Mile (DDM) location. DDMs are used to identify the relative position along the river of each location at which data analyses are desired and are defined from upstream to downstream starting with the Munroe Canal located at river mile 0.1. For data requests on either side of a particular headgate, locations 0.05 mile upstream and downstream of the actual headgate location were used. The approximate locations of the mainstem DDMs in Table 4-7 are shown in Figure 4-1.

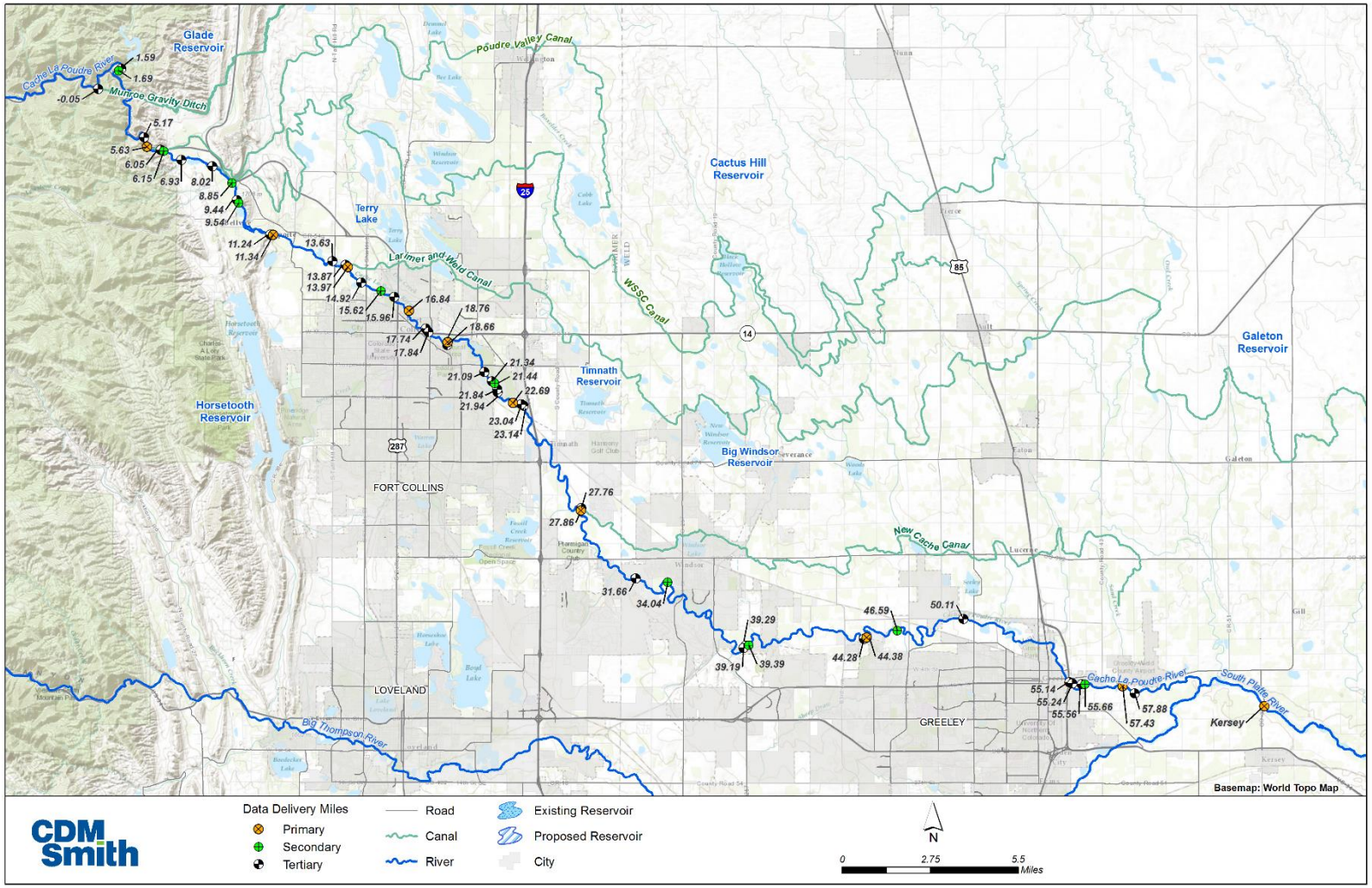
Table 4-7. DDM locations.

No.	DDM	Flow Location	Purpose of Daily Flow Estimates at this Location	Type
49	0.05	Above Munroe Canal	Provides flows above the furthest upstream major diversion on the Poudre River mainstem	Tertiary
1	1.59	Between the Munroe Canal headgate and North Fork Confluence	Provides flows in mainstem upstream of North Fork confluence	Tertiary
2	1.69	Between North Fork Confluence and Poudre Valley Canal	Provides flows on the Poudre River mainstem downstream of North Fork	Secondary
3	5.17	Between Poudre Valley Canal and the Hansen Supply Canal outlet	Provides data downstream of Poudre Valley Canal, a proposed point of diversion for NISP	Tertiary
4	5.63	Canyon Gage	Critical streamflow gage for Poudre River administration	Primary
5	6.05	Upstream of Greeley Filters Pipeline intake	Winter dry-up point, municipal intake diversion point for HSWSPs Applicant City of Greeley	Tertiary
6	6.15	Downstream of Greeley Filters Pipeline intake		Secondary
7	6.93	Between the Hansen Supply Canal outlet and the Larimer County Canal (LCC)	Daily flow estimates capture the effects of Hansen Supply Canal discharges and Pleasant Valley and Lake Canal diversions, also proposed HSWSPs exchanges	Tertiary
8	8.02	Between LCC and Little Cache	Provides data to evaluate effects of LCC diversions	Tertiary
9	8.85	2D-WAT	Graves/Watson Lake 2-D site for resource analyses	Secondary
10	9.44	Upstream of Watson Lake diversion	Irrigation season dry-up point, Watson Lake Fish Hatchery minimum flow point	Tertiary
11	9.54	Downstream of Watson Lake diversion		Secondary
13	11.24	Upstream of Little Cache/Terry Lake headgate	Winter dry-up point, NISP proposes exchanges from Terry Lake, also proposed HSWSPs exchanges.	Tertiary
14	11.34	Downstream of Little Cache/Terry Lake headgate		Primary
12	13.63	Between Little Cache and the Larimer-Weld Canal headgate	Daily flow estimates capture the effects of the South Side Ditches (Larimer No. 2, New Mercer, and Arthur) diversion in this reach. Fort Collins proposes exchanges in this reach	Tertiary
15	13.87	Upstream of Larimer-Weld Canal headgate	Winter dry-up point, NISP proposes exchanges from Larimer-Weld Canal and Big Windsor Reservoir. Fort Collins and Greeley propose exchanges in this reach.	Tertiary
16	13.97	Downstream of Larimer-Weld Canal headgate		Primary
17	14.92	Shields Street	Mid-point between Larimer-Weld Canal and Lake Canal	Tertiary
18	15.62	2D-MAR	Legacy/Martinez Park 2-D site for resource analyses	Secondary
19	15.96	Between Lake Canal and Timnath inlet	Boat Chute minimum flow point	Tertiary
20	16.84	Lincoln Street Gage	Critical streamflow gage for Poudre River administration	Primary
21	17.74	Upstream of Mulberry Wastewater Treatment Plant (WWTP) (FTC WWTP #1) discharge	Daily flow estimates capture the contribution of effluent discharges to streamflow	Tertiary
22	17.84	Downstream of Mulberry WWTP (FTC WWTP #1) discharge		Tertiary
24	18.66	Upstream of Timnath inlet headgate	Winter dry-up point, NISP proposes exchanges from Timnath Reservoir	Tertiary
25	18.76	Downstream of Timnath inlet headgate		Primary
23	21.09	Between Timnath inlet and Fossil Creek inlet	Daily flow estimates capture the effects of tributary inflows (Spring Creek and Dry Creek) and the Boxelder Ditch diversion	Tertiary
26	21.34	Upstream of Fossil Creek inlet headgate	Irrigation season and winter dry-up point	Tertiary
27	21.44	Downstream of Fossil Creek inlet headgate		Secondary

No.	DDM	Flow Location	Purpose of Daily Flow Estimates at this Location	Type
28	21.84	Upstream of Drake WWTP (FTC WWTP #2) discharge	Daily flow estimates capture the contribution of effluent discharges to streamflow, Nature Center minimum flow point	Tertiary
29	21.94	Downstream of Drake WWTP (FTC WWTP #2) discharge		Tertiary
30	22.69	Boxelder Gage	Important for Poudre River administration, captures effects of Boxelder Creek tributary inflows	Primary
31	23.04	Upstream of Boxelder Creek		Tertiary
32	23.14	Downstream of Boxelder Creek		Tertiary
33	27.76	Upstream of New Cache Canal headgate	Daily flow estimates capture the effects of New Cache Canal diversions, NISP proposes exchanges from and/or diversions at New Cache Canal	Tertiary
34	27.86	Downstream of New Cache Canal headgate		Primary
35	31.66	Between Whitney and Greeley No. 3	Daily flow estimates capture the effects of diversion and return flows in this reach	Tertiary
36	34.04	2D-WIN	Yastrow/Eastman Park 2-D site for resource analyses	Secondary
37	39.19	Upstream of Windsor WWTP	Daily flow estimates capture the contribution of effluent discharges to streamflow	Tertiary
38	39.29	Downstream of Windsor WWTP		Tertiary
39	39.39	Downstream of Kodak WWTP		Secondary
40	44.28	Upstream of Greeley No. 3 headgate	Irrigation season dry-up point	Tertiary
41	44.38	Downstream of Greeley No. 3 headgate		Primary
42	46.59	2D-GRE	Greeley 59th Avenue 2-D site for resource analyses	Secondary
50	50.11	Below Seeley Lake	Daily flow estimates capture inflows in the reach between Boyd Freeman Ditch and Ogilvy Ditch	Tertiary
43	55.14	Upstream of Greeley WWTP discharge	Daily flow estimates capture the contribution of effluent discharges to streamflow	Tertiary
44	55.24	Downstream of Greeley WWTP discharge		Tertiary
45	55.56	Upstream of Ogilvy headgate	Irrigation season dry-up point	Tertiary
46	55.66	Downstream of Ogilvy headgate		Secondary
47	57.43	Greeley Gage	Critical for Poudre River administration	Primary
48	57.88	2D-DPG	DPP Farms 2-D site for resource analyses	Tertiary
51	NA[1]	Kersey Gage	Critical streamflow gage on the South Platte River below the Poudre River confluence, NISP proposes diversions from the South Platte between the confluence and the Kersey Gage	Primary

[1] DDMs originated based on locations in the Poudre River point-flow model, which did not extend downstream to the Kersey Gage on the South Platte River. Therefore, the Kersey Gage does not have an associated DDM.

Figure 4-1. DDM Locations.



Effects to most flow-related resources were evaluated at different subsets of the 51 DDMs, based on those with the greatest relevance to a particular resource. For surface water analyses, the DDMs were classified as primary, secondary, and tertiary, as follows:

- **Primary DDMs**, of which there are 10 for surface water resources, include mainstem streamflow gages and the downstream side of diversion points directly affected by NISP operations. Select figures and tables illustrating the estimated changes in flow associated with the NISP alternatives at the primary DDMs are included in Sections 5 through 8 of the 2014 Water Resources Report; a more extensive set of comparative streamflow data presentations is included in Appendix A of the 2014 Water Resources Report.
  - DDM 5.63 = Canyon Gage (Poudre River)
  - DDM 11.34 = Downstream of Little Cache/Terry Lake headgate (Poudre River)
  - DDM 13.97 = Downstream of Larimer-Weld Canal headgate (Poudre River)
  - DDM 16.84 = Lincoln Street Gage (Poudre River)
  - DDM 18.76 = Downstream of Timnath Reservoir inlet canal headgate (Poudre River)
  - DDM 22.69 = Boxelder Gage (Poudre River)
  - DDM 27.86 = Downstream of New Cache Canal headgate (Poudre River)
  - DDM 44.38 = Downstream of Greeley No. 3 Canal headgate (Poudre River)
  - DDM 57.43 = Greeley Gage (Poudre River)
  - Kersey Gage (South Platte River) does not have an associated DDM

- **Secondary DDMs**, of which there are 10 for surface water resources, are locations that are sensitive to NISP operations, but not directly affected, including irrigation season and winter dry-up points and the study sites used for other resource analyses. Figures and tables summarizing estimated streamflow changes at secondary DDMs are provided in Appendix A of the 2014 Water Resources Report.
- **Tertiary DDMs** are those locations identified as being critical to some other flow-related resource, but not necessarily of critical importance to surface water resources. No analyses were performed at these locations for surface water, but the monthly and daily datasets provided to the resource specialists for other flow-related resources are included in Appendix B of the 2014 Water Resources Report.

4.2.1.3 Data Presentation

For each model run comparison shown in Table 4-5, a series of statistical summaries in the form of tables and figures were prepared for the Primary and Secondary DDMs. The data presentations included in Sections 5 through 8 of the 2014 Water Resources Report are described in the following sections.

4.2.1.3.1 Median Daily Flows with Confidence Intervals

Comparisons of median daily flows for the with-project run (e.g., NISP Run 3a or NISP Run 4a) vs. 2010 Current Conditions hydrology (CTP Run 1) or 2050 Future Conditions hydrology (CTP Run 2) are shown in these plots, along with 90% upper and lower confidence intervals for the CTP Run 1 or CTP Run 2 median flow. Confidence intervals measure the probability that a statistical estimation, such as a median, for a particular sample is within a certain magnitude of

the true median for the entire data set. These plots are based on estimated daily flows for IY 1980-2005. Representative examples of median daily flows with 2010 Current Conditions hydrology are shown below for Alternative 2 at the Canyon Gage (Poudre River, Figure 4-2), Alternative 3 at the Lincoln Street Gage (Poudre River, Figure 4-3), and Alternative 4 at the Kersey Gage (South Platte River, Figure 4-4).

Figure 4-2. Alternative 2 Current Conditions Median Daily Flow with 90% Upper/Lower Confidence Intervals at DDM 5.63 (Canyon Gage), IY 1980-2005.

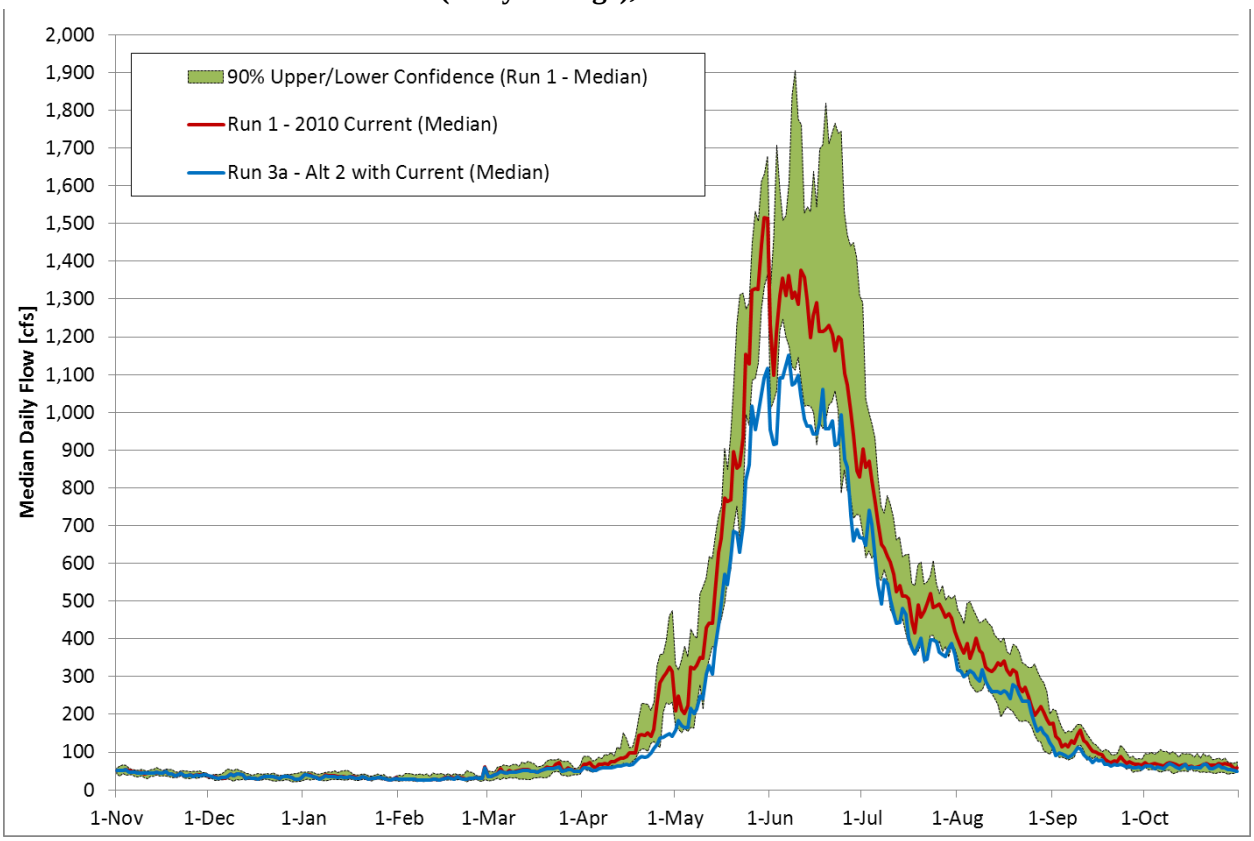


Figure 4-3. Alternative 3 Current Conditions Median Daily Flow with 90% Upper/Lower Confidence Intervals at DDM 16.84 (Lincoln Street Gage), IY 1980-2005.

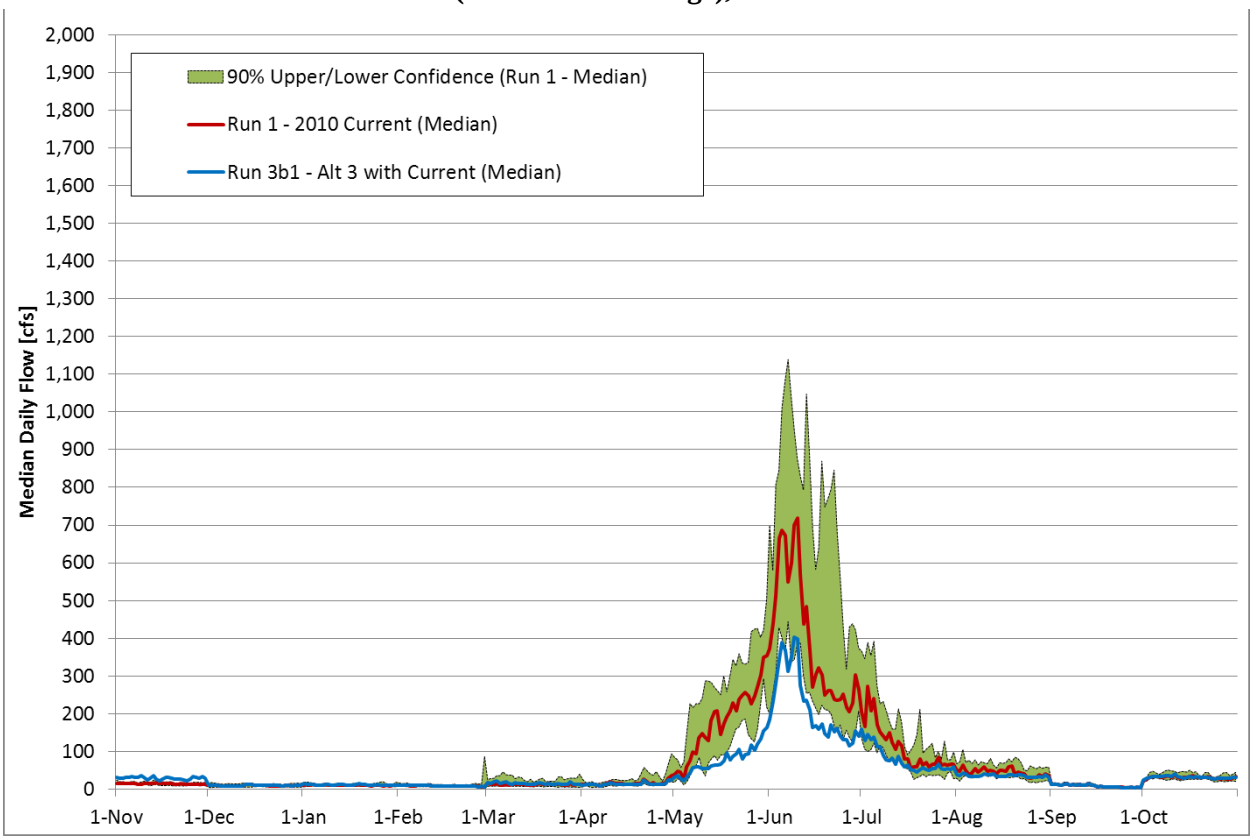
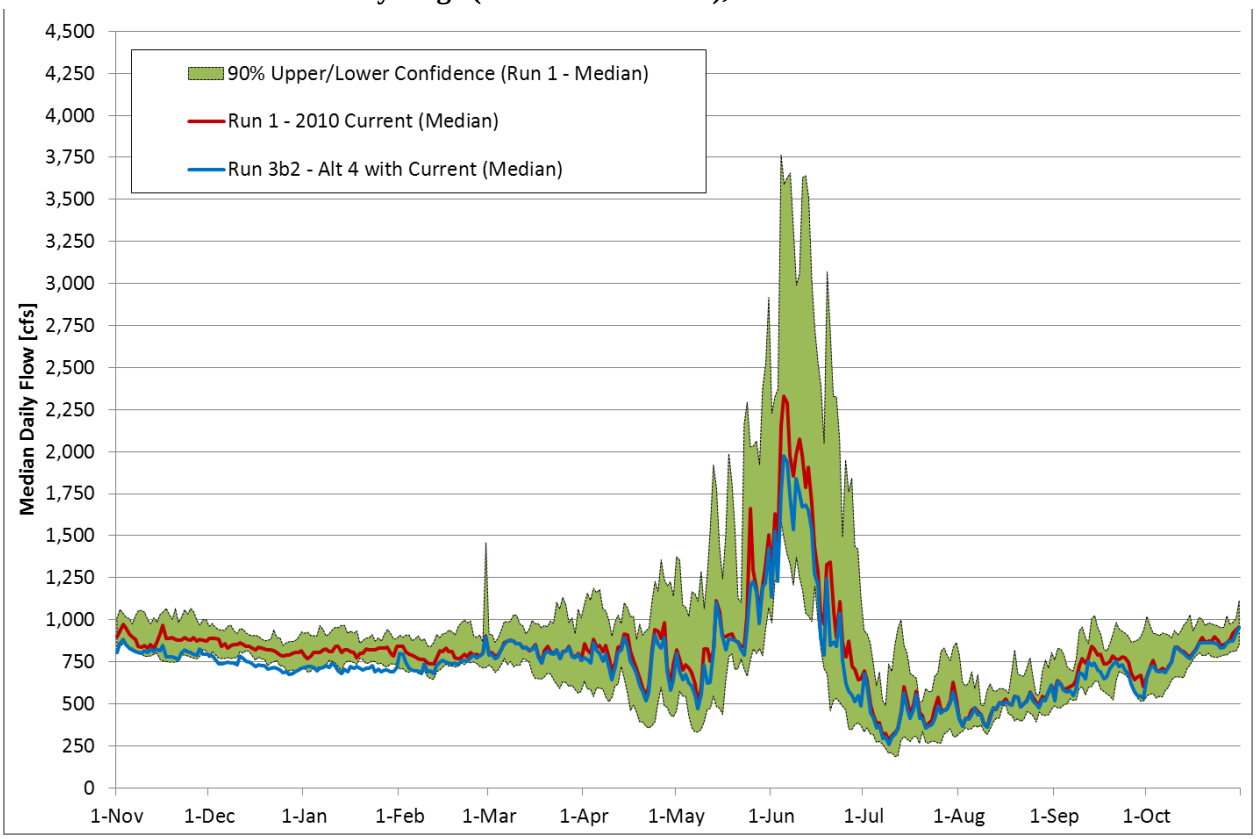


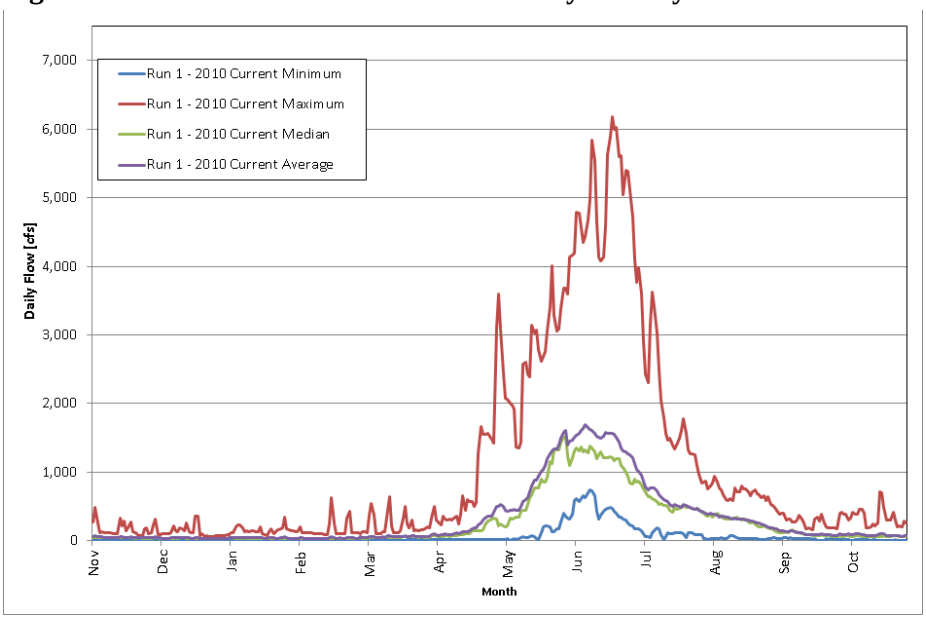
Figure 4-4. Alternative 4 Current Conditions Median Daily Flow with 90% Upper/Lower Confidence Intervals at Kersey Gage (South Platte River), IY 1980-2005.



4.2.1.3.2 Minimum, Median, Average, Maximum Time Series

Hydrographs showing minimum, median, average, and maximum streamflows are presented to provide a comparison of common statistical parameters used for hydrologic and other resource analyses. For each day in the year, the minimum, median, average, and maximum values were determined to create a single year time series. These plots are based on estimated daily flows for IY 1980-2005. A representative example (see Figure 4-5) is shown below for CTP Run 1 - 2010 Current Conditions hydrology at the Canyon Gage on the Poudre River. Similar figures were developed and presented in the 2014 Water Resources Report for CTP Run 2 – 2050 Future Conditions hydrology and for the NISP alternatives model runs.

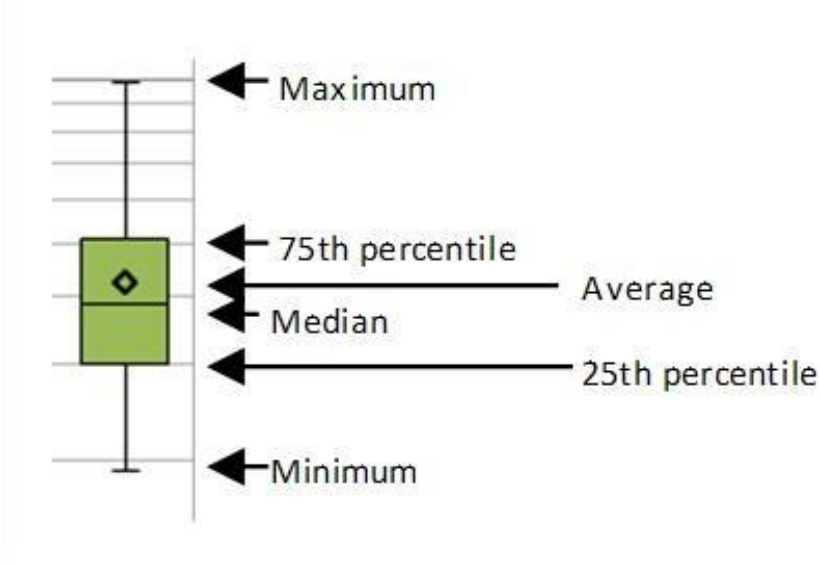
Figure 4-5. Alternative 2 Statistical Summary of Daily Flow at DDM 5.63 (Canyon Gage).



4.2.1.3.3 Box and Whiskers Plots

Box and Whiskers plots (see Figure 4-6) show a data set divided into four quartiles based on a selected percentile threshold, commonly the 25th, 50th, and 75th percentiles. The two extreme quartiles, such as the 75th and above and the 25th and below, are illustrated by a single line (the "whisker"), where the two middle quartiles are illustrated by a "box." The objective is to show a simple but meaningful distribution of a dataset's range of values.

Figure 4-6. Illustration of Box and Whiskers Concept.



The box and whiskers plots are presented with a logarithmic scale on the y-axis; due to the nature of this scale, figures for locations with very low flows (less than 1 cfs) in some months

may appear to be cut off at the bottom. Although the conceptual box and whiskers figure (Figure 4-6) illustrates the average as occurring between the median (50th percentile) and 75th percentile, some plots may show a diamond marker for the average outside of the box. This is due to the potential for a few extremely high or low monthly flows to skew the calculated average values and is the reason the median flow value was used extensively in the report. For Alternative 2, the box and whiskers plots are based on estimated monthly average flows for IY 1980-2005 to include modeling for the proposed flow augmentation plan; for Alternatives 1, 3, and 4, these plots use estimated monthly average flows for IY 1950-2005. The box and whiskers plots below the Larimer-Weld headgate provide a useful example, clearly illustrating the difference in modeled streamflows during the winter months with flow augmentation for Alternative 2 (Figure 4-7) and without flow augmentation for Alternative 3 (Figure 4-8) and Alternative 4 (Figure 4-9).

Figure 4-7. Alternative 2 Box and Whiskers at DDM 13.97 (DS LW Headgate).

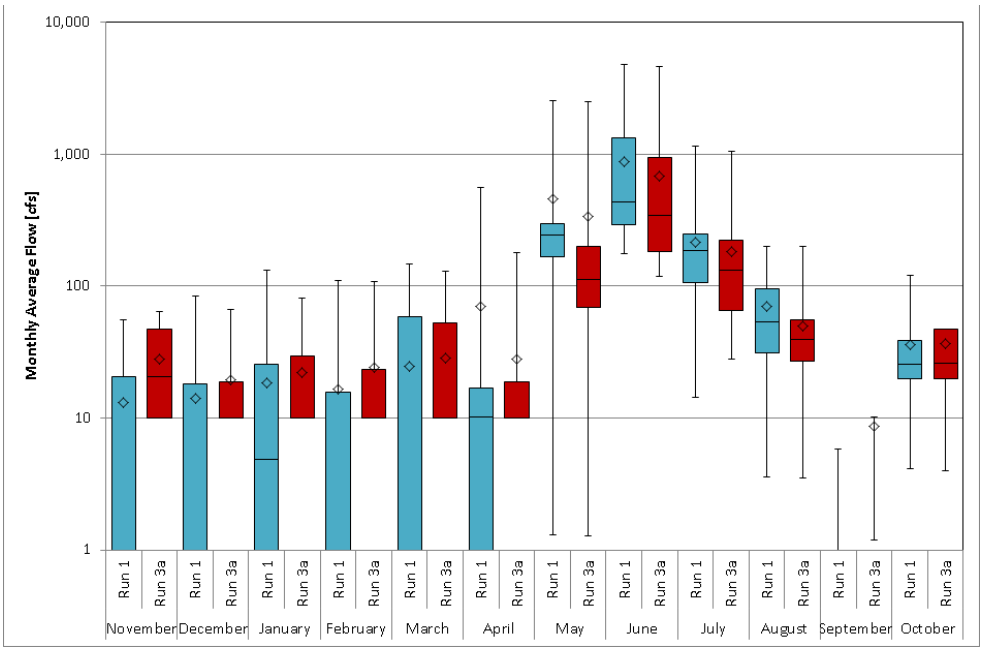


Figure 4-8. Alternative 3 Box and Whiskers at DDM 13.97 (DS LW Headgate).

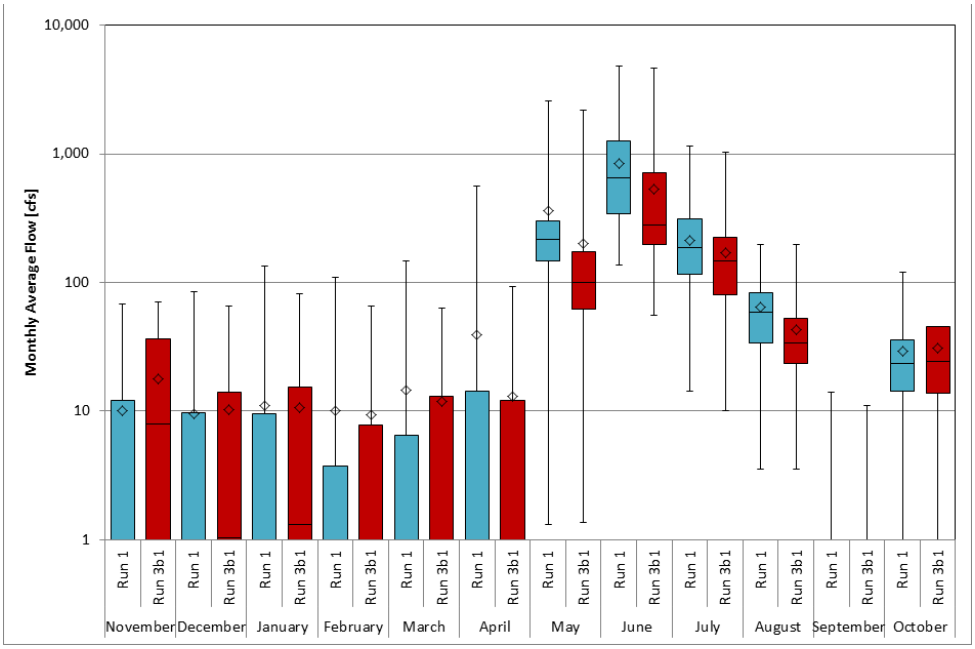
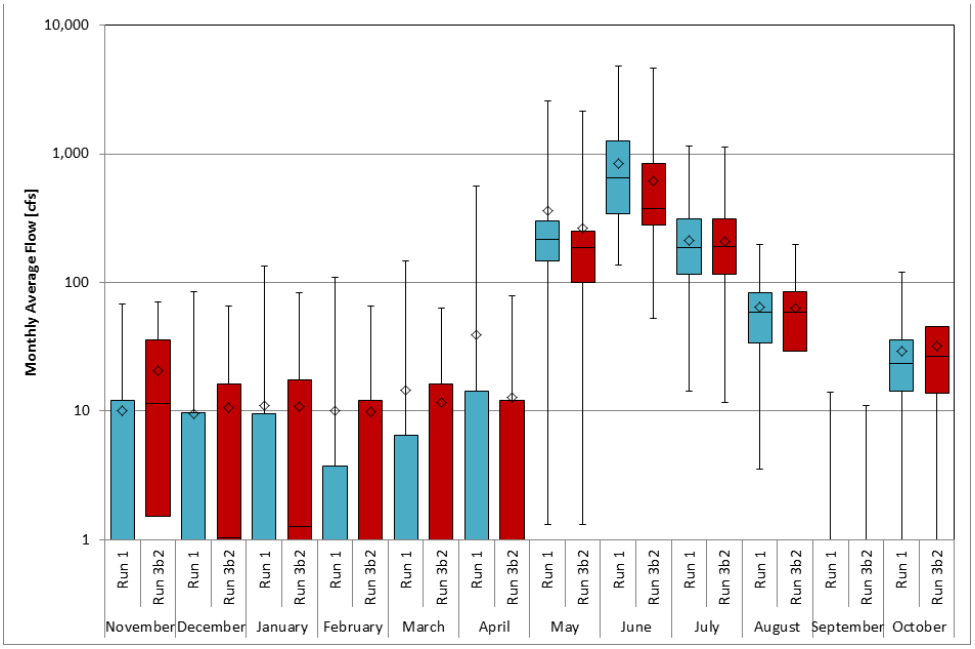


Figure 4-9. Alternative 4 Box and Whiskers at DDM 13.97 (DS LW Headgate).



4.2.1.3.4 Flow-Duration Curves

Flow-duration curves show the percentage of time that a particular flow rate is equaled or exceeded within a given data set. Flow-duration curves, which are based on estimated daily flows for IY 1980-2005, provide more detail than a Box and Whisker plot regarding distribution of a data set's values. Flow-duration curves for the downstream side of the Little Cache/Terry

Lake headgate are shown below as representative examples for Alternative 2 (Figure 4-10), Alternative 3 (Figure 4-11), and Alternative 4 (Figure 4-12).

Figure 4-10. Alternative 2 Current Conditions Daily Flow Duration Curve at DDM 11.34 (DS Little Cache/Terry Lake Headgate), IY 1980-2005.

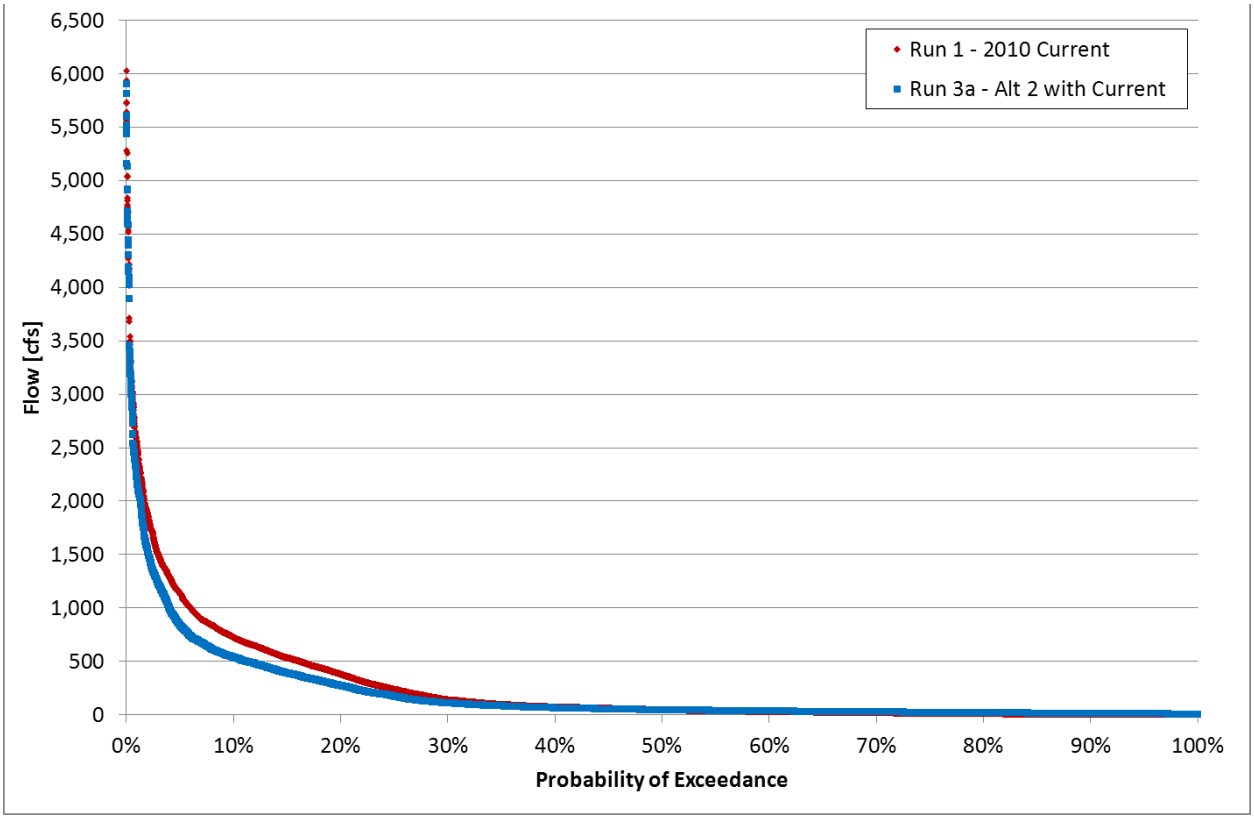


Figure 4-11. Alternative 3 Current Conditions Daily Flow Duration Curve at DDM 11.34 (DS Little Cache/Terry Lake Headgate), IY 1980-2005.

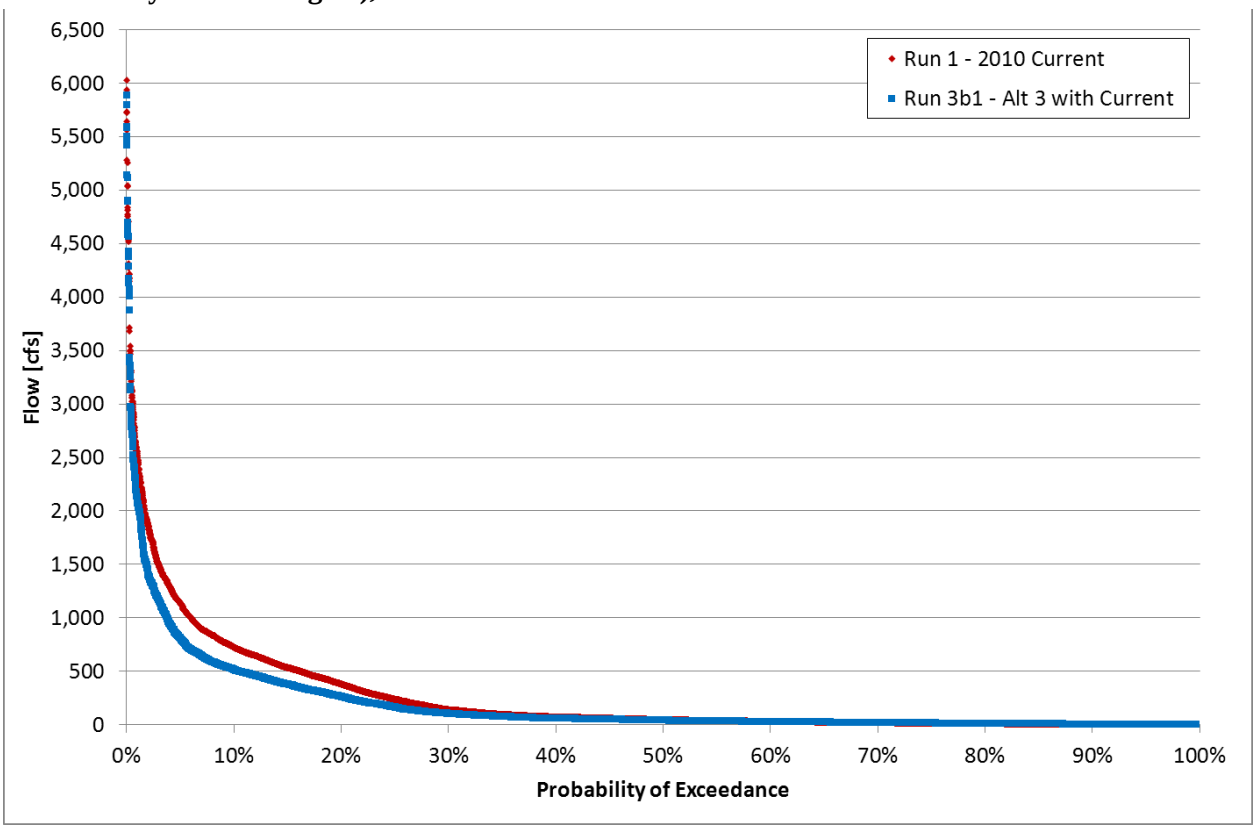
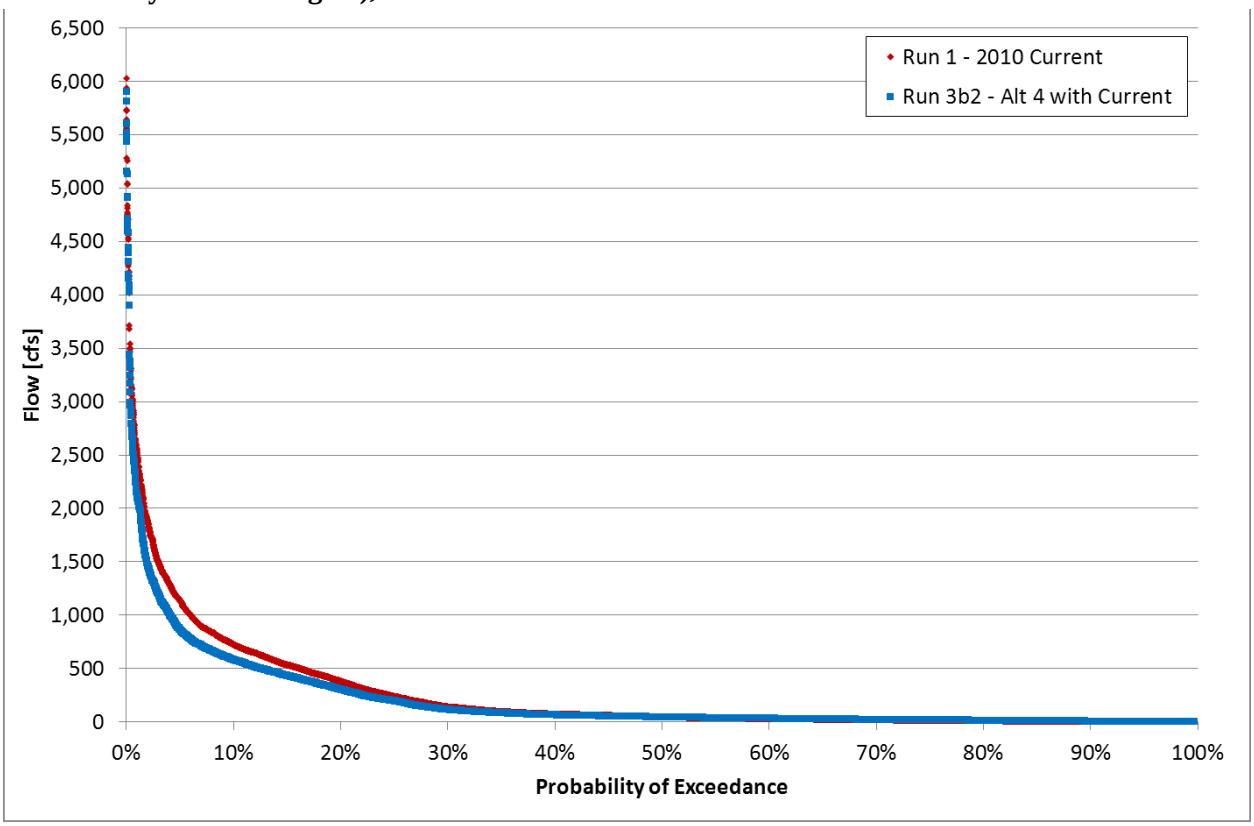


Figure 4-12. Alternative 4 Current Conditions Daily Flow Duration Curve at DDM 11.34 (DS Little Cache/Terry Lake Headgate), IY 1980-2005.



4.2.1.3.5 Wet, Average, and Dry Year Tables

Tables were prepared using monthly model data that show key statistics by month for the wet, average, and dry years. Determination of wet, average, and dry years is discussed in detail in Section 3.3.2 of the 2014 Water Resources Report. Median flows are provided in the main body of the 2014 Water Resources Report; however, similar tables that use other statistical measures including minimum, average, and maximum monthly streamflow are provided in Appendix A (file "Tables.xlsm") of the 2014 Water Resources Report for all Primary and Secondary DDMs. Representative examples of median monthly flows with 2010 Current Conditions hydrology are shown below for Alternative 2 at the Canyon Gage (Poudre River, Table 4-8), Alternative 3 at the Lincoln Street Gage (Poudre River, Table 4-9), and Alternative 4 at the Kersey Gage (South Platte River, Table 4-10). For Alternative 2, the wet, average, and dry year flows were calculated based on IY 1980-2005; for Alternatives 3 and 4, those values were calculated over IY 1950-2005.

Table 4-8. Median monthly flow at DDM 5.63 (Canyon Gage) – Alternative 2 with 2010 Current Conditions hydrology.

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Annual
2010 Current Conditions Hydrology - Run 1 (cfs)													
Wet Years, IY 1980-2005	59	44	48	42	80	251	1,194	2,192	968	468	162	102	140
Avg Years, IY 1980-2005	43	36	33	28	45	177	757	1,266	542	313	98	71	87
Dry Years, IY 1980-2005	42	28	33	29	52	96	552	830	242	170	77	47	63
All Years, IY 1950-2005	-	-	-	-	-	-	-	-	-	-	-	-	-
All Years, IY 1980-2005	48	38	39	31	53	169	792	1,266	571	313	107	67	90
NISP Alternative 2 with Current Conditions Hydrology - Run 3a (cfs)													
Wet Years, IY 1980-2005	59	42	48	41	68	133	882	1,864	963	390	119	102	111
Avg Years, IY 1980-2005	43	35	28	27	45	97	528	1,034	401	264	75	56	72
Dry Years, IY 1980-2005	42	28	34	29	52	76	466	668	272	159	65	46	59
All Years, IY 1950-2005	-	-	-	-	-	-	-	-	-	-	-	-	-
All Years, IY 1980-2005	48	38	39	31	51	88	543	1,034	442	253	87	62	75
Change in Flow (CTP Run 1 – CTP Run 3a) (cfs)													
Wet Years, IY 1980-2005	0	2	0	0	12	117	312	328	5	78	43	0	29
Avg Years, IY 1980-2005	0	2	5	1	0	80	229	232	142	49	23	15	15
Dry Years, IY 1980-2005	0	0	-2	0	0	19	87	162	-30	11	12	1	4
All Years, IY 1950-2005	-	-	-	-	-	-	-	-	-	-	-	-	-
All Years, IY 1980-2005	0	0	0	-1	2	81	249	232	129	60	20	5	15
Percent Difference													
Wet Years, IY 1980-2005	0%	4%	0%	0%	15%	47%	26%	15%	0%	17%	27%	0%	21%
Avg Years, IY 1980-2005	1%	4%	14%	5%	0%	45%	30%	18%	26%	16%	23%	20%	17%
Dry Years, IY 1980-2005	0%	1%	5%	0%	0%	20%	16%	20%	12%	6%	15%	2%	7%
All Years, IY 1950-2005	-	-	-	-	-	-	-	-	-	-	-	-	-
All Years, IY 1980-2005	0%	1%	0%	2%	3%	48%	31%	18%	23%	19%	19%	8%	17%

*Negative change in flow values indicate an increase in flow in NISP Run 3a compared to CTP Run 1.

Table 4-9. Median monthly flow at DDM 16.84 (Lincoln Street Gage) – Alternative 3 with 2010 Current Conditions hydrology.

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Annual
2010 Current Conditions Hydrology - Run 1 (cfs)													
Wet Years, IY 1950-2005	12	10	11	6	16	28	318	1,359	266	97	14	46	**34**
Avg Years, IY 1950-2005	10	10	8	7	16	24	170	585	171	42	9	38	**28**
Dry Years, IY 1950-2005	10	5	6	6	7	11	156	237	65	62	8	22	**12**
All Years, IY 1950-2005	10	8	8	7	10	21	170	585	168	61	11	34	**27**
All Years, IY 1980-2005	14	12	11	9	17	27	201	368	168	55	10	36	**28**
NISP Alternative 3 with Current Conditions Hydrology - Run 3b1 (cfs)													
Wet Years, IY 1950-2005	18	9	13	7	16	24	90	829	218	47	13	46	**32**
Avg Years, IY 1950-2005	19	12	9	7	19	17	65	240	77	31	9	36	**28**
Dry Years, IY 1950-2005	11	5	6	7	7	11	55	147	36	49	8	27	**13**
All Years, IY 1950-2005	15	8	9	7	10	17	65	198	117	36	11	34	**27**
All Years, IY 1980-2005	30	12	12	8	19	20	78	229	104	38	10	34	**30**
Change in Flow (CTP Run 1 – CTP Run 3b1) (cfs)													
Wet Years, IY 1950-2005	-5	1	-2	-1	0	4	228	529	49	50	1	0	**2**
Avg Years, IY 1950-2005	-8	-1	0	0	-2	7	105	345	94	11	0	2	**0**
Dry Years, IY 1950-2005	-2	0	0	-1	0	0	101	90	29	12	0	-5	**-1**
All Years, IY 1950-2005	-4	0	-1	0	0	4	105	387	51	24	0	1	**-1**
All Years, IY 1980-2005	-16	0	-1	0	-2	8	123	140	65	17	0	2	**-2**
Percent Difference													
Wet Years, IY 1950-2005	41%	10%	19%	17%	2%	14%	72%	39%	18%	52%	10%	1%	**6%**
Avg Years, IY 1950-2005	80%	13%	4%	2%	15%	28%	62%	59%	55%	26%	0%	5%	**0%**
Dry Years, IY 1950-2005	20%	1%	0%	10%	0%	2%	65%	38%	45%	20%	1%	24%	**10%**
All Years, IY 1950-2005	42%	3%	8%	6%	3%	18%	62%	66%	30%	40%	1%	2%	**2%**
All Years, IY 1980-2005	113%	1%	11%	3%	10%	28%	61%	38%	38%	31%	0%	6%	**6%**

*Negative change in flow values indicate an increase in flow in NISP Run 3b1 compared to CTP Run 1.
**Very large percent difference values should be reviewed with caution, as they are generally associated with very small median flow values.

Table 4-10. Median monthly flow at Kersey Gage – Alternative 4 with 2010 Current Condition hydrology.

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Annual
2010 Current Conditions Hydrology - Run 1 (cfs)													
Wet Years, IY 1950-2005	901	750	745	746	779	1,157	4,141	5,494	940	980	1,109	1,094	**1,011**
Avg Years, IY 1950-2005	795	775	752	751	708	765	990	1,813	577	533	649	764	**753**
Dry Years, IY 1950-2005	685	658	628	616	565	497	621	564	414	403	500	534	**564**
All Years, IY 1950-2005	777	741	715	724	684	761	998	1,813	579	540	671	762	**726**
All Years, IY 1980-2005	912	823	841	813	817	819	1,063	1,813	724	630	776	832	**831**
NISP Alternative 4 with Current Conditions Hydrology - Run 3b2 (cfs)													
Wet Years, IY 1950-2005	825	677	640	629	694	1,143	3,768	4,933	931	844	1,057	1,090	**941**
Avg Years, IY 1950-2005	770	706	641	655	700	778	872	1,442	551	509	580	741	**697**
Dry Years, IY 1950-2005	672	627	553	597	561	464	561	525	405	403	459	502	**532**
All Years, IY 1950-2005	753	648	636	624	665	680	907	1,600	555	519	606	741	**670**
All Years, IY 1980-2005	834	720	701	747	822	792	1,038	1,613	686	610	699	798	**760**
Change in Flow (CTP Run 1 – CTP Run 3b2) (cfs)													
Wet Years, IY 1950-2005	76	73	105	117	84	14	373	561	9	136	52	4	**69**
Avg Years, IY 1950-2005	25	69	111	96	8	-12	118	371	27	24	69	22	**55**
Dry Years, IY 1950-2005	13	30	75	19	4	33	60	40	8	0	41	32	**32**
All Years, IY 1950-2005	24	93	79	100	18	81	90	213	23	21	65	21	**56**
All Years, IY 1980-2005	79	103	139	66	-5	28	25	200	38	20	78	33	**71**
Percent Difference													
Wet Years, IY 1950-2005	8%	10%	14%	16%	11%	1%	9%	10%	1%	14%	5%	0%	**7%**
Avg Years, IY 1950-2005	3%	9%	15%	13%	1%	2%	12%	20%	5%	4%	11%	3%	**7%**
Dry Years, IY 1950-2005	2%	5%	12%	3%	1%	7%	10%	7%	2%	0%	8%	6%	**6%**
All Years, IY 1950-2005	3%	12%	11%	14%	3%	11%	9%	12%	4%	4%	10%	3%	**8%**
All Years, IY 1980-2005	9%	12%	17%	8%	1%	3%	2%	11%	5%	3%	10%	4%	**8%**

*Negative change in flow values indicate an increase in flow in NISP Run 3b2 compared to CTP Run 1.

4.2.1.3.6 Additional Surface Water Data Presentations

More extensive illustration of modeled changes in streamflows at primary and secondary DDMs under NISP Alternatives 1 through 4 can be found in Appendix A of the 2014 Water Resources Report, which includes the data presentations described above, plus the following:

- Comparative plots (e.g., NISP Run 3a vs. CTP Run 1 or NISP Run 4b2 vs. CTP Run 2) of minimum daily flows, IY 1980-2005
- Comparative plots of average daily flows, IY 1980-2005
- Comparative plots of maximum daily flows, IY 1980-2005
- Monthly flow-duration curves, which are based on IY 1980-2005 for Alternative 2; Alternatives 1, 3, and 4 are presented based on simulation data for IY 1950-2005

Additional figures were developed that superimpose modeled monthly streamflows and diversions associated with the various water supply sources. Representative examples for the 1990s are provided below at the Canyon Gage (Figure 4-13) and the Kersey Gage (Figure 4-14) for Alternative 2 with 2010 Current Conditions hydrology. As can be seen in the figure for the Canyon Gage, some amount of the modeled SPWCP exchange diversions occurred in every year of the 1990s, whereas the Grey Mountain diversions are mostly limited to the years with higher streamflows.

Figure 4-13. Canyon Gage Pre- and Post-NISP Flows with NISP Alt 2 Diversions (1990s).

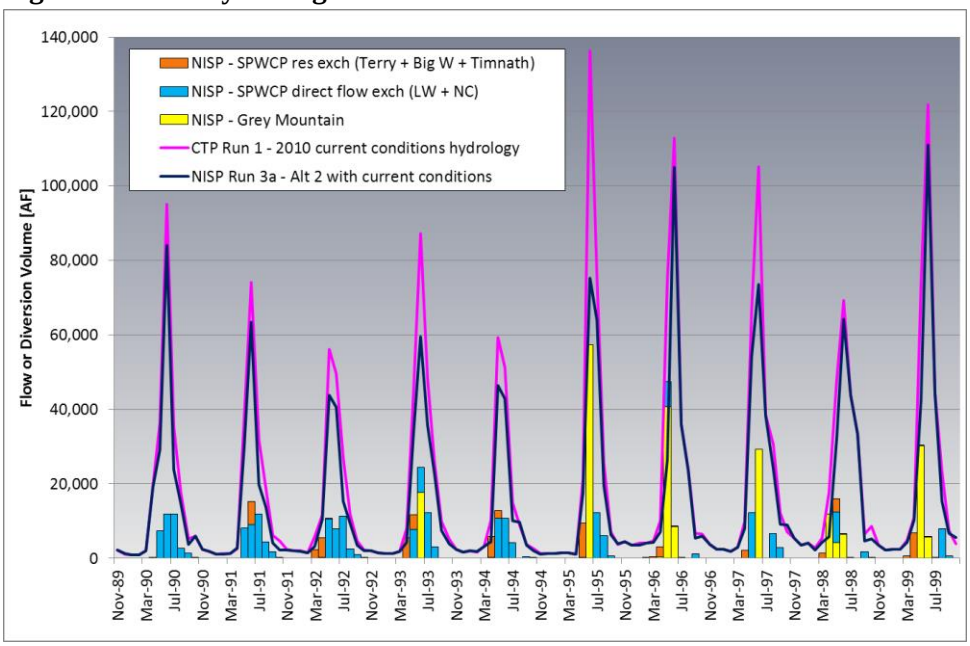
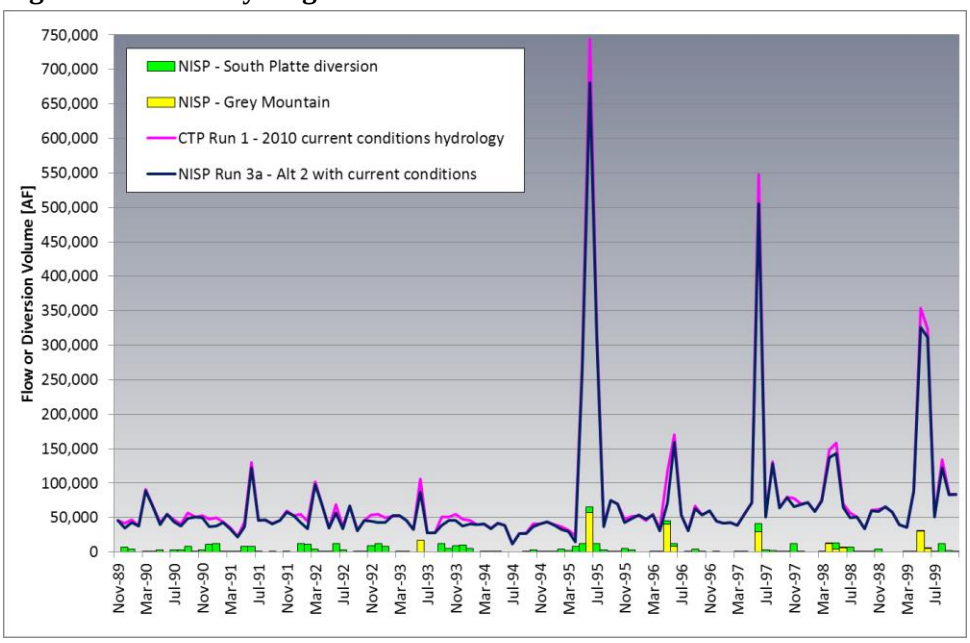


Figure 4-14 compares modeled streamflow estimates at the Kersey Gage during the 1990s, superimposed with both the modeled Grey Mountain diversions from the Poudre River and the modeled South Platte River diversions that are part of the SPWCP.

Figure 4-14. Kersey Gage Pre- and Post-NISP Flows with NISP Alt 2 Diversions (1990s).



Similar figures are provided in Appendix C of the 2014 Water Resources Report for other decades for all current and future model run comparisons at four streamflow gage locations (Canyon Gage, Lincoln Street Gage, Greeley Gage, and Kersey Gage). An additional means of illustrating the estimated changes in streamflows, the raster hydrograph, is described in Section 4.2 of the 2014 Water Resources Report and presented for all current and Future Conditions run comparisons at primary DDMs in Appendix D of the 2014 Water Resources Report.

4.2.2 No Action Alternative (Alternative 1)

As described below, the No Action Alternative was evaluated by comparison to 2050 Future Conditions hydrology only. The CTP Current Conditions hydrology (CTP Run 1) represents the Poudre River as it would exist in 2010 if historical hydrology (irrigation years 1950-2005) were to occur. CTP Run 1 includes some water supplies that will not be available in the near future, as M&I water users' demands increase and they more fully use existing water rights.

The CTP Future Conditions hydrology (CTP Run 2) reflects anticipated river conditions in 2050, to include "reasonably foreseeable future actions" proposed for water development, but not including construction of the proposed NISP or HSWSPs, which are reflected in Run Series 4 and Run Series 5, respectively. CTP Run 2 provides a realistic scenario of projected river conditions in 2050 based on anticipated water rights utilization.

If a Section 404 permit for NISP is denied, the No Action Alternative would be designed and constructed by the Participants without involvement by the District and NISP Water Activity Enterprise. Consequently, the conditional Grey Mountain water right and the SPWCP conditional water rights on the South Platte River, which are owned by the District and would be used in the action alternatives, would not be used in the No Action Alternative. The District

would continue to own these water rights and would continue to pursue development of these water rights for other uses. In the absence of NISP, the independent Participants must meet their future water demands and it is not possible to predict, with absolute certainty, the actual future response of the Participants. The No Action Alternative was determined by the Corps to be a reasonable representation of an alternative that would occur if the NISP permit was denied. It is one of several options identified by MWH in 2010. It is not known with certainty if the Participants could acquire adequate agricultural water rights to meet a firm yield of future demands.

Based on the preceding factors (uncertainty regarding Participants' response and timing of actions if NISP permit is denied and uncertainty of the availability of future water supplies) the Corps determined that the No Action Alternative would be evaluated based on a comparison to Future Conditions hydrology. With Future Conditions as a baseline, a worse case potential condition would be captured, which will inform the decision-maker and the public of what may happen if the Corps denies the permit.

4.2.3 District's Preferred Alternative (Alternative 2)

This section summarizes the modeled reservoir operations, diversions, and changes to streamflows associated with Alternative 2, the District's preferred alternative for NISP. Alternative 2 includes a Reclamation Action Option and a No Reclamation Action Option for the delivery of water to the project Participants. Model runs used in this section are as follows:

- CTP Run 1 – 2010 Current Conditions hydrology
- NISP Run 3a – Alternative 2 with 2010 Current Conditions hydrology

The following sections highlight model results that are presented in more detail in Section 3 of the 2014 Operations Report and Section 6 and Appendix A of the 2014 Water Resources Report.

4.2.3.1 Glade Reservoir

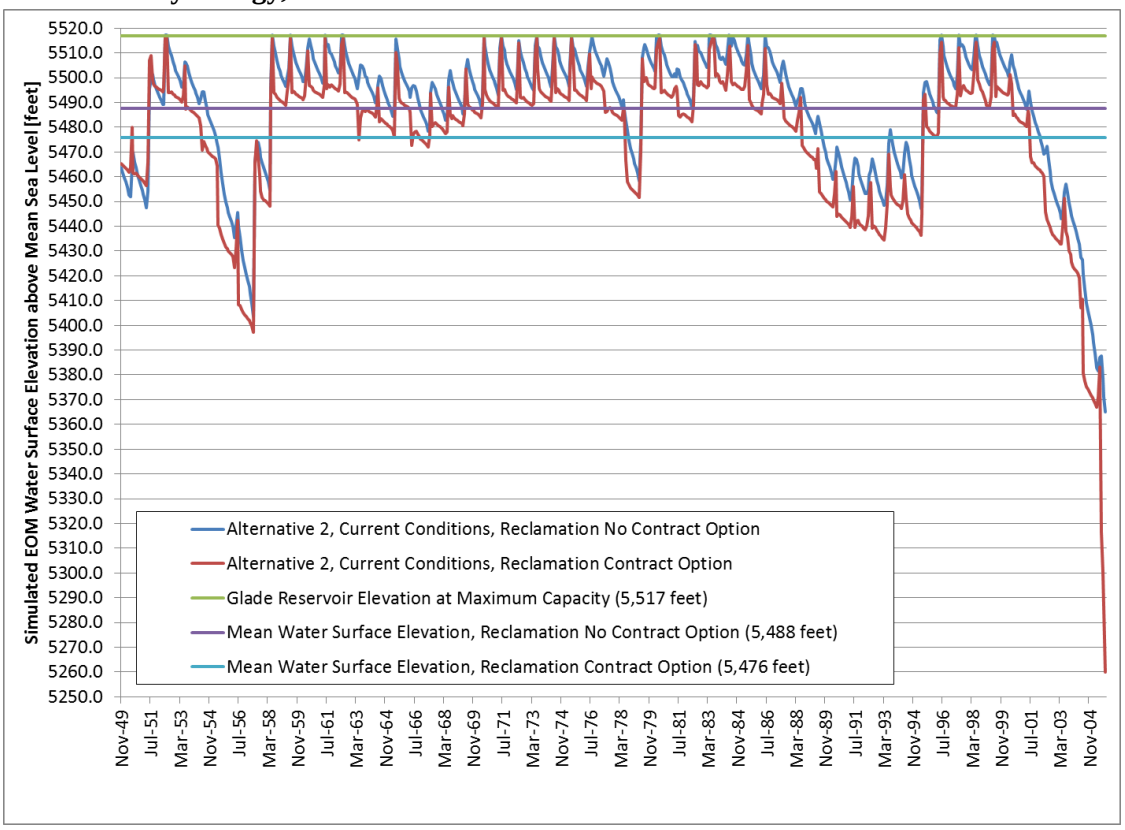
Modeled operations of the proposed Glade Reservoir under both the Reclamation Action Option and the No Reclamation Action Option for Alternative 2 are presented in Section 3.2.1 of the 2014 Operations Report. With an active storage capacity of 170,000 AF, Glade Reservoir would have an annual fill-and-drawdown cycle operating most of the time in the upper third of the storage volume. Model results show periods of extended reservoir drawdown corresponding to historical droughts in the mid-1950s, 1977, and the early 2000s, a result of the project's junior water rights rarely being in priority to divert. Extended reservoir drawdown was also shown to occur in the late-1980s and early-1990s. Time series plots of modeled Glade Reservoir end-of-month (EOM) storage volume, water surface area, evaporation, and water surface elevation are presented in the 2014 Operations Report, Section 3.2.1.3.

For the No Reclamation Action Option, the water storage volume is a modeled property. Water storage volume under the Reclamation Action Option was estimated by spreadsheet post-processing of model output. Water surface area and water surface elevation are properties

that are calculated directly from the water storage volume (see Figures 3.10 and 3.11 in the 2014 Operations Report for the relationships). Evaporation volume is a calculated property based on water surface area. Figure 4-15 is an illustrative example of the variable water surface elevation in Glade Reservoir.

Figure 4-16 reduces the full 56-year elevation time series to average monthly elevations in the wet, average, and dry years in order to illustrate typical annual fill-and-drawdown cycles. The modeled range of oscillation in the reservoir water levels is consistent with estimated inflows in the years within each hydrologic classification. All scenarios show average water level fluctuations in the range of 15 to 30 feet. Wet years exhibit the widest range from the lowest average water elevation to the highest, attributable to the Grey Mountain right being in priority and associated large inflows to storage in Glade Reservoir. The narrowest range of operation is seen in dry years, when releases would be made to meet Participant demands, but inflows would be the lowest as a result of NISP's junior water rights not being in priority very often.

Figure 4-15. Glade Reservoir EOM Water Surface Elevation, Alternative 2 with Current Conditions Hydrology, IY 1950-2005[7].



[7] Most of the figures presented throughout this surface water section were developed for the 2014 Operations Report or the 2014 Water Resources Report. Certain terminology associated with Alternative 2 delivery mechanisms was modified subsequent to the completion of those reports. At the time those reports were written, the Reclamation Action Option was called the Reclamation Contract Option, and the No Reclamation Action Option was referred to as the Reclamation No Contract Option. There were no changes to the alternative or option configurations aside from this naming convention.

Figure 4-16. Glade Reservoir Average Monthly EOM Water Surface Elevation for Wet, Average, and Dry Years, Alternative 2 with Current Conditions Hydrology, IY 1950-2005.

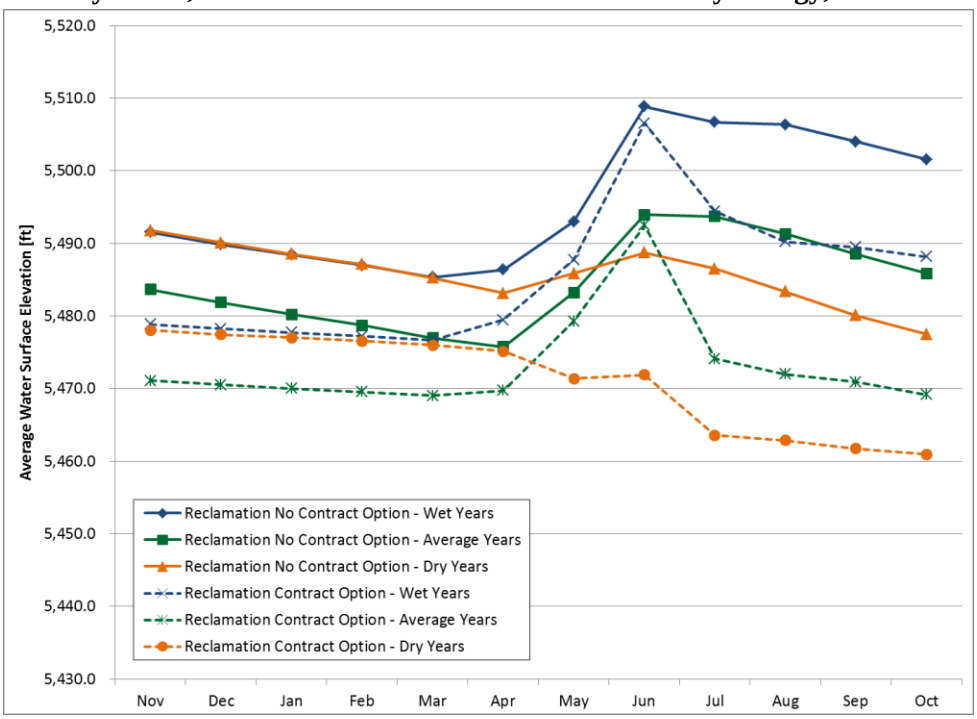


Figure 4-17 shows modeled annual and average evaporation from Glade Reservoir under Current Conditions hydrology. Table 4-11 summarizes the overall average reservoir properties as modeled with Current Conditions hydrology over the IY 1950-2005 study period.

Figure 4-17. Glade Reservoir Evaporation, Alternative 2 with Current Conditions Hydrology, IY 1950-2005.

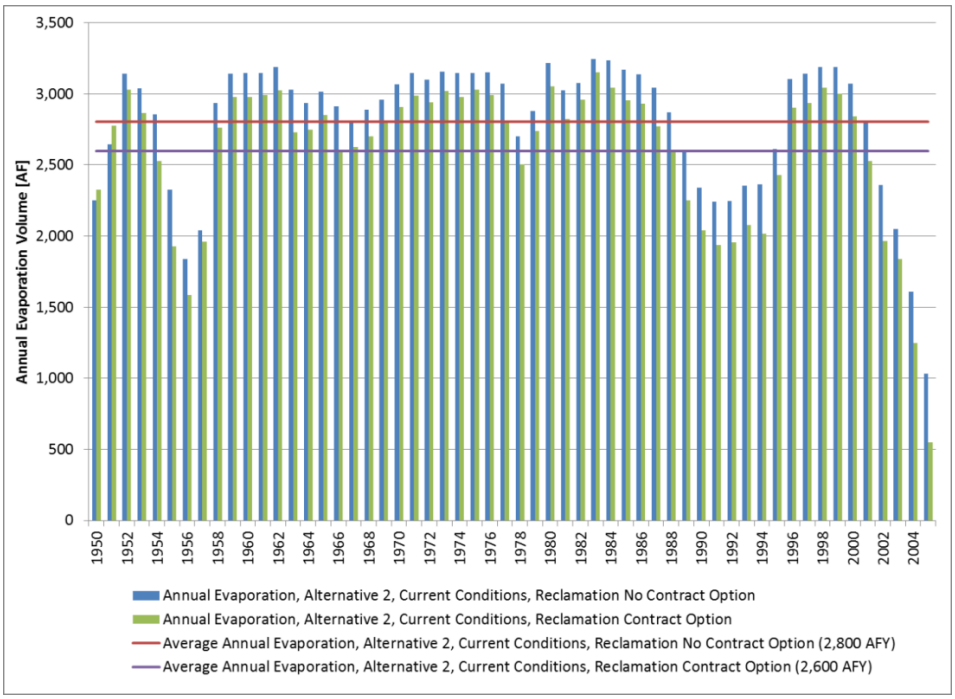


Table 4-11. Glade Reservoir properties, Alternative 2 with 2010 Current Conditions hydrology, IY 1950-2005.

Alternative 2 Scenario	Water Storage Volume [AF]	Water Surface Area [acres]	Annual Evaporation [AFY]	Water Surface Elevation [ft]	Water Depth [ft][1]
Glade Modeled Maximum	170,000	1,635	NA	5,517	257
Glade Reclamation Action Option Modeled Average	115,200	1,264	2,600	5,476	216
Glade No Reclamation Action Option Modeled Average	130,000	1,369	2,800	5,488	228

[1] Water depth based on an elevation of 5,260 feet at zero active storage.
NA=Not Applicable.

Under the Reclamation Action Option, Glade Reservoir would make releases to the Poudre River and/or the Poudre Valley Canal as part of proposed exchanges with the C-BT Project (Section 2.5.5.2.1). Releases to the river may occur in any month from April to October, but most often in July (46 times out of 56 simulated years in the IY 1950-2005 study period) and August (15 out of 56 years). These months correspond to the later irrigation season when streamflows associated with the spring runoff would diminish, NISP's junior water rights would drop out of priority and curtail diversions, but irrigation demand for supplemental water from the C-BT Project is high. Annual releases to the river range from 11,800 AF to 29,800 AF, with an average of 21,600 AFY. About 18,800 AFY or 87% of the average annual releases would occur in July and August. Glade Reservoir would release an average of about 130 AFY back to the Poudre Valley Canal to replace C-BT deliveries to the canal (see the 2014 Operations Report, Section 3.2.1.2).

In addition to these releases to the Poudre River and the Poudre Valley Canal, Glade Reservoir under the Reclamation Action Option would release an average of 10,500 AFY for direct delivery to the water treatment facilities for Participants FCLWD, Evans, Eaton, Severance, and Windsor (see the 2014 Operations Report, Section 5.1.1.1). Potential pumping from Glade Reservoir to Horsetooth Reservoir (see Section 4.2.3.3.3) would average about 400 AFY (averaged over 56 years). Total releases from storage in Glade Reservoir, excluding evaporation, seepage, and other losses would therefore be about 32,600 AFY, which can be seen in the water storage volume oscillations in Figure 3.14 of the 2014 Operations Report.

Under the No Reclamation Action Option, there would be no exchange with the C-BT Project. NISP deliveries to the Participants would be made by releases of stored water from Glade Reservoir, or by diverting water at the Poudre Valley Canal and routing it through proposed pipelines for immediate delivery to the Participants. Average annual releases from Glade Reservoir would be about 29,400 AFY, which is somewhat less than under the Reclamation Action Option and a factor contributing to overall higher water levels in Glade Reservoir under the No Reclamation Action Option.

Compared to the modeled releases for exchange with C-BT, Glade Reservoir releases for delivery to the Participants would also follow a much more regular schedule under the No Reclamation Action Option (see the 2014 Operations Report, Table 5.6). In Appendix A of the 2014 Operations Report, Figures A1 and A2 show the monthly change in water surface elevation in Glade Reservoir under the No Reclamation Action Option and the Reclamation Action Option, respectively. These figures were created to support recreation analyses for Alternative 2, specifically to understand differences in Glade Reservoir water surface levels between the Reclamation Action Option and the No Reclamation Action Option. Table 4-12 summarizes the characteristic elevation changes seen in those figures.

Table 4-12. Modeled water surface elevation changes in Glade Reservoir, Alternative 2, IY 1950-2005.

	Reservoir Inflows		Reservoir Releases/Outflows	
	Range of Positive Elevation Change	**Maximum Positive Elevation Change**	**Range of Negative Elevation Change**	**Maximum Negative Elevation Change [feet/month]**
Reclamation Action Option	0-15 feet/month	>65 feet/month	0-20 feet/month	Nearly 35 feet/month[1]
No Reclamation Action Option	0-15 feet/month	>60 feet/month	0-5 feet/month	About 9 feet/month

[1] Figure A2 of the 2014 Operations Report shows a much larger monthly drawdown (> 65 feet/month) in July 2005, near the end of the study period. This comes several years into a prolonged drought during which full Participant deliveries were modeled in all months, an unlikely scenario. As described in Section 7.1.2 of the 2014 Operations Report, operational measures would be implemented to prevent such an extreme reservoir drawdown.

Not accounted for in this analysis of Glade Reservoir water levels, but summarized in Section 4.2.1.1.3, is the proposed flow augmentation program for Alternative 2. As a result of this program, Glade Reservoir average annual releases may be up to 3,600 AFY greater, and average storage volumes may be somewhat less than described above. However, the net effect on proposed Glade Reservoir operations would be minor.

4.2.3.2 Galeton Reservoir

As described in Chapter 2, Galeton Reservoir is a component of all action alternatives. Under Alternative 2, the proposed Galeton Reservoir would be operated in the same manner for both the Reclamation Action Option and the No Reclamation Action Option (see the 2014 Operations Report, Section 3.2.2). Galeton Reservoir properties for Alternative 2 are summarized in Table 4-13 below.

Table 4-13. Galeton Reservoir properties, Alternative 2 with 2010 Current Conditions hydrology, IY 1950-2005.

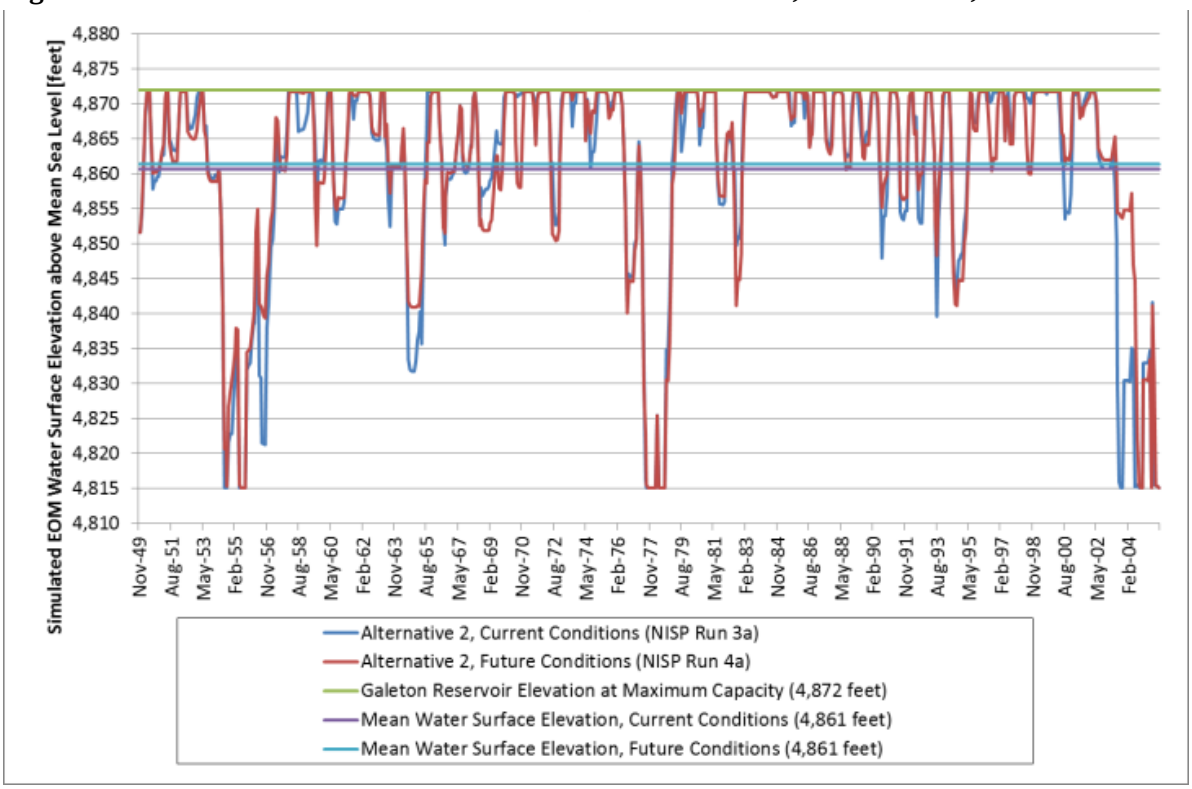
Alternative 2 Scenario	Water Storage Volume [AF]	Water Surface Area [acres]	Annual Evaporation [AFY]	Water Surface Elevation [ft]	Water Depth [ft][1]
Galeton Modeled Maximum	45,624	2,010	NA	4,872	57
Galeton Modeled Average	31,400	1,538	4,000	4,861	46

[1] Water depth based on an elevation of 4,815 feet at zero active storage.
NA=Not Applicable.

Average water storage volume in Galeton Reservoir would be about 31,400 AF under 2010 Current Conditions hydrology. However, time series plots (Figure 4-18 below and Appendix B of the 2014 Operations Report) show wide swings in Galeton Reservoir water levels. Storage would drop below 20,000 AF relatively often; during droughts such as the mid-1950s, 1977, and the early-2000s, Galeton Reservoir would be emptied of active storage[8]. This is attributable to NISP drawing more heavily on the SPWCP exchanges for water supply when the Grey Mountain right is not in priority (Section 2.5.5.2.1). Figure 4-19 shows the average monthly water surface elevation in Galeton Reservoir during wet, average, and dry years, as modeled under Current Conditions over the period IY 1950-2005. Galeton Reservoir is shown to generally follow a filling trajectory during wet years, with average and dry years showing drawdowns during the late spring and summer months (May-August). This is also consistent with the project drawing much more on the SPWCP exchanges for water supply in those years (dry years) in which the Grey Mountain right would rarely be in priority to divert from the Poudre River.

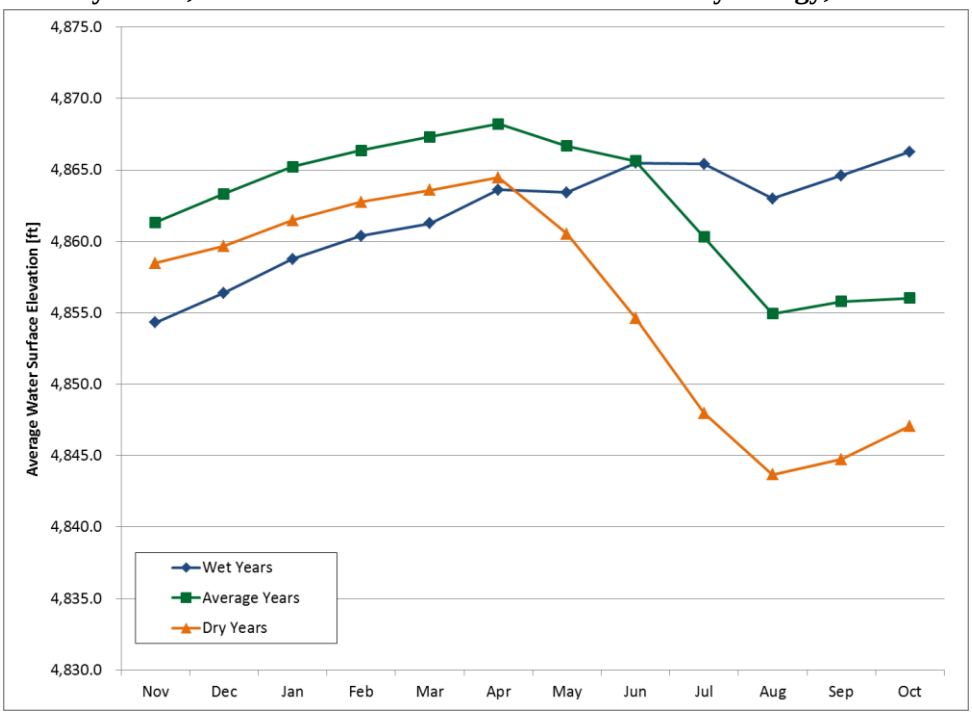
[8] Jackson Reservoir is located southeast of the proposed Galeton Reservoir site, in the lower South Platte River basin near Orchard, CO. There is at least one report of Jackson Reservoir being emptied of active storage (Denver Post, August 30, 2006, http://www.denverpost.com/rec/ci_4258620; "The reservoir is at dead-pool level and no more water is being released…"). Jackson Reservoir is managed for recreation as a Colorado State Park; however, recreation is not planned for Galeton Reservoir at this time.

Figure 4-18. Galeton Reservoir EOM Water Surface Elevation, Alternative 2, IY 1950-2005.[9]



[9] As noted previously, most of the figures presented in this surface water section were developed for the 2014 Operations Report or the 2014 Water Resources Report. Some of these figures present model results for the NISP alternatives with both 2010 Current conditions hydrology (described in this chapter of the SDEIS) and 2050 future conditions hydrology (described in SDEIS Chapter 5).

Figure 4-19. Galeton Reservoir Average Monthly EOM Water Surface Elevation for Wet, Average, and Dry Years, Alternative 2 with Current Conditions Hydrology, IY 1950-2005.



Due to its proposed plains location, Galeton Reservoir would have higher evaporation rates than at the foothills location of Glade Reservoir (see CTP Hydrologic Modeling Report, Figure 7-9 and Figure 7-21). Galeton Reservoir would be more shallow and wide with a surface area often in the 1,600 to 2,000-acre range, whereas Glade Reservoir would be deeper and narrower with a maximum surface area of 1,635 acres. Galeton Reservoir would have average annual evaporation of about 4,000 AFY.

4.2.3.3 Changes to the Operations of Existing C-BT Project Facilities

Anticipated changes to C-BT Project operations associated with Alternative 2 are described in Section 3.4 of the 2014 Operations Report. These changes to existing and ongoing operations of C-BT east slope facilities apply under the Reclamation Action Option only, which proposes to deliver an average of 29,500 AFY of NISP water to the southern and eastern Participants by exchange involving existing C-BT Project infrastructure and, potentially, a new pipeline connecting Glade Reservoir to Horsetooth Reservoir. Table 5.4 of the 2014 Operations Report shows how the combination of bypassed diversions, Glade Reservoir releases to the Poudre River and Poudre Valley Canal, and pumping from Glade Reservoir to Horsetooth Reservoir would complete the exchange to meet the demands of both NISP Participants and C-BT Project water users in the Poudre Basin. The exchanges involving existing C-BT Project infrastructure proposed under the Reclamation Action Option for Alternative 2 would result in no changes to C-BT West Slope operations; there would be no additional West Slope diversions or additional water deliveries to the East Slope through the Adams Tunnel.

4.2.3.3.1 Horsetooth Reservoir and Carter Lake

The changes to Horsetooth Reservoir and Carter Lake as a result of proposed NISP operations were modeled for the NISP DEIS. The associated documentation (Pineda and Brouwer 2006) is included with the 2014 Operations Report as Appendix C. In addition, the 2006 model results were summarized in Section 7.5.2 and Appendix G of the 2008 Water Resources Report. The modeling of Horsetooth Reservoir and Carter Lake was not updated as part of the CTP hydrologic modeling for the NISP SDEIS. Although the specific operational concept of the Reclamation Action Option was developed subsequent to the 2006 modeling, changes in operations and water levels at the two C-BT Project reservoirs are anticipated to be similar to those model results.

4.2.3.3.2 Hansen Supply Canal and Windsor Extension

Under the Reclamation Action Option for Alternative 2, Horsetooth Reservoir releases to the Poudre River and the Poudre Valley Canal via the Hansen Supply Canal and the Windsor Extension would be reduced relative to Current Conditions. Delivery of the full allotment of C-BT Project water to Poudre Basin water users would be maintained through a combination of bypassed diversions at the Poudre Valley Canal headgate (i.e., NISP junior water rights or exchanges would be in priority to divert, but the water would be left in the river to meet C-BT delivery obligations) and releases from Glade Reservoir to the Poudre River or the Poudre Valley Canal.

Comparative model results over the IY 1950-2005 study period are shown in Table 3.10 and Table 3.12 in the 2014 Operations Report. Under 2010 Current Conditions hydrology, Horsetooth Reservoir releases averaged 51,300 AFY, with 49,500 AFY released to the Poudre River and 1,800 AFY delivered to the Poudre Valley Canal via the Windsor Extension. Under NISP Alternative 2 with the Reclamation Action Option, Horsetooth Reservoir releases would be reduced to 21,900 AFY (20,200 AFY to the river and 1,700 AFY via the Windsor Extension). The volumetric reduction in Horsetooth Reservoir releases to the Poudre River (29,400 AFY) is consistent with the amount of water proposed to be released from Carter Lake (29,500 AFY) for delivery to the NISP southern and eastern Participants.

4.2.3.3.3 Glade-to-Horsetooth Pipeline (Proposed, Reclamation Action Option only)

The proposed Glade-to-Horsetooth Pipeline is described in Section 2.5.5.2.1 of Chapter 2 and Section 3.4.1 of the 2014 Operations Report. It would only be necessary to build the Glade-to-Horsetooth Pipeline under the Reclamation Action Option for Alternative 2 if C-BT deliveries to the Poudre River routinely drop below the average volume of water (29,500 AFY) that NISP would deliver to project Participants by exchange through C-BT. Specifically, this pipeline would be used to fulfill a NISP deficit to the C-BT system following years in which C-BT deliveries to the Poudre Basin are less than the 29,500 AFY of the proposed exchange (typically wetter years with lower C-BT quotas). Under 2010 Current Conditions hydrology, results based on the post-processing of model data show deficits in only 6 out of 56 years in the IY 1950-2005 study period, with deficits ranging from 340 AF to 9,700 AF with an average of 3,600 AF. Pumping from Glade Reservoir to Horsetooth Reservoir would commence in November and

continue at up to 2,000 AF per month until the deficit is repaid (see the 2014 Operations Report, Table 3.9).

4.2.3.4 River Segments

As described in Chapter 2 (Section 2.5.2.2), yield for Alternative 2 includes water derived from three water supply sources. These water supply sources are the Grey Mountain right, the SPWCP direct flow exchanges, and the SPWCP reservoir exchanges. The SPWCP exchanges include diversions on both the Poudre River and the South Platte River. A summary of the general changes to the modeled streamflows resulting from diversion and/or exchange of each water supply source is found below.

4.2.3.4.1 Poudre River

All NISP water supply sources from the Poudre River would be diverted at the Poudre Valley Canal headgate (Mile 5.12) under Alternative 2. Note that "mile" in this context and the following paragraphs refers to the actual headgate location, distinguished from the DDMs for data analysis associated with these structures, which are located 0.05 mile upstream or downstream of the physical structure location (see Table 4-7 and Figure 4-1); tertiary DDM 5.17 represents the location downstream of the Poudre Valley Canal headgate). Results of modeled diversions under the Reclamation Action Option and No Reclamation Action Option for Alternative 2 are presented in a series of tables and figures in Section 3.1.1.2 of the 2014 Operations Report. In general, modeled diversions from the Poudre River under Alternative 2 would occur primarily during the months April through October. Model results show that winter (November-March) diversions from the Poudre River by NISP would be rare. Section 7.5.1 of the 2013 CTP Modeling Report and Section 8.2 of the 2014 Operations Report describe the methods applied in the hydrologic modeling to simulate the District's operational plans to minimize diversions during the winter months.

The Grey Mountain storage right has a priority date of May 2, 1980 and was shown in the hydrologic modeling results to divert primarily in May and June of years with average to above-average streamflows (primarily from mountain snowfall). By diverting the Grey Mountain right at the Poudre Valley Canal, streamflow changes would occur at all downstream locations on the Poudre River mainstem, extending to the lower South Platte River when this water right is in priority.

Additional yield for the NISP action alternatives is proposed to come from SPWCP exchanges on direct flow water rights associated with the Larimer-Weld and New Cache Canals. Under these exchanges, water in priority for Larimer-Weld and New Cache Canals would be diverted upstream of these canals at the Poudre Valley Canal headgate under Alternative 2 instead of at the historical diversion locations at Mile 13.92 and Mile 27.81, respectively (for location reference, see Table 4-7 and Figure 4-1, which describe and map the locations 0.05 mile upstream and downstream of the headgates). These exchanges would only be possible during the irrigation season when the irrigation water rights are in priority and the ditches are diverting. Hydrologic modeling results show that operation of these exchanges would result in a reduction of streamflow between the Poudre Valley Canal and these historical diversion locations.

As part of these direct flow exchanges, Larimer-Weld and New Cache Canals would receive water from the proposed Galeton Reservoir, which would be filled by the conditional SPWCP storage right. SPWCP's point of diversion would be located below the confluence of the Poudre and South Platte Rivers but upstream of the Kersey Gage. Between the historical diversion locations and the SPWCP diversion, streamflow would not be impacted by these direct flow exchanges; however, once downstream of the SPWCP diversion, changes to the modeled streamflows are again observed when the SPWCP right is in priority.

Similar to the direct flow exchanges discussed above, additional yield would also be gained by operating storage right exchanges with Terry Lake, Big Windsor Reservoir, and Timnath Reservoir whose historical points of diversions are located near Mile 11.29 (Little Cache headgate), Mile 13.92 (Larimer-Weld headgate), and Mile 18.71 (Timnath inlet headgate), respectively. For location reference, see Table 4-7 and Figure 4-1, which describe and map the locations 0.05 mile upstream and downstream of the headgates. Water in priority for these storage rights would be diverted at the Poudre Valley Canal headgate resulting in streamflow reductions between there and the historical diversion locations. Below the Timnath Reservoir inlet headgate, there would be no changes in flow associated with the SPWCP reservoir exchange diversions at the upstream Poudre Valley Canal headgate. Changes in flow due to SPWCP diversions from the South Platte would be seen at the Kersey Gage and locations further downstream.

Table 4-14 and Table 4-15 below summarize monthly and annual diversions at the Poudre Valley Canal under the No Reclamation Action Option and the Reclamation Action Option for Alternative 2. The results shown in both tables are based on modeled annual average Poudre Valley Canal diversions of 43,300 AFY for NISP. Under the No Reclamation Action Option, all of this water would be diverted for storage or immediate delivery to Participants. HG_GLADE is the PBN link representing total Alternative 2 diversions at the Poudre Valley Canal, with an annual average diversion of 43,300 AFY. From the headgate, the modeled diversions follow different pathways in the PBN depending on the source (Grey Mountain right or SPWCP exchanges) and destination (storage in Glade or immediate delivery to the Participants). The sum of reservoir inflows (GreyMtnFill + ExchFill = 19,200 + 11,500 = 30,700 AFY) and immediate use (DirectExch = 12,600 AFY) is 43,300 AFY, matching the modeled headgate diversions.

Table 4-14. Modeled Alternative 2 diversions at the Poudre Valley Canal for storage in Glade Reservoir or immediate use, No Reclamation Action Option, IY 1950-2005.

Month	Alternative 2 with Current Conditions Hydrology (NISP Run 3a)						
	Number of Years with Simulated Diversions at Poudre Valley Canal HG_GLADE (out of 56)	Min[1] HG_ GLADE [AF]	Max[1] HG_ GLADE [AF]	Avg[1] HG_ GLADE [AF]	Avg GreyMtn Fill [AF]	Avg Exch Fill [AF]	Avg Direct Exch [AF]
November	0	0	0	0	0	0	0
December	2	0	1,300	27	0	27	0
January	1	0	3,400	61	8	53	0
February	2	0	230	7	0	7	0
March	9	0	2,300	190	56	140	0
April	30	0	24,100	2,700	1,300	1,300	48
May	54	0	56,700	12,900	5,600	4,200	3,100
June	55	0	65,000	19,000	12,100	3,300	3,600
July	49	0	12,300	4,600	110	1,700	2,700
August	40	0	10,700	2,700	0	540	2,200
September	41	0	3,000	950	0	0	960
October	23	0	3,200	200	100	93	4
Annual	—	**3,500**	**97,200**	**43,300**	**19,200**	**11,500**	**12,600**

[1] Annual average values are equal to the sum of the monthly average values. Monthly minimum and maximum values are not additive when determining annual minimums and maximums. See Section 3.1.1.2 of the 2014 Operations Report for further explanation.

For the Reclamation Action Option, post-processing data analyses separated the modeled diversions (43,300 AFY available to NISP at the Poudre Valley Canal) into three components:

(1) The water that would actually be diverted at the Poudre Valley Canal for storage in Glade Reservoir (35,100 AFY shown in the table below);
(2) Modeled diversions that would instead be bypassed as part of the proposed exchange with the C-BT Project (7,700 AFY, presented in Table 3.2 of the 2014 Operations Report); and
(3) Modeled diversions that would be bypassed to avoid spills as a result of exceeding Glade Reservoir capacity (500 AFY, presented in the 2014 Operations Report, Table 3.3).

The sum of these three components, 35,100 + 7,700 + 500 = 43,300 AFY, matching the original modeled headgate diversions; see Section 3.1.1.2 of the 2014 Operations Report for further explanation.

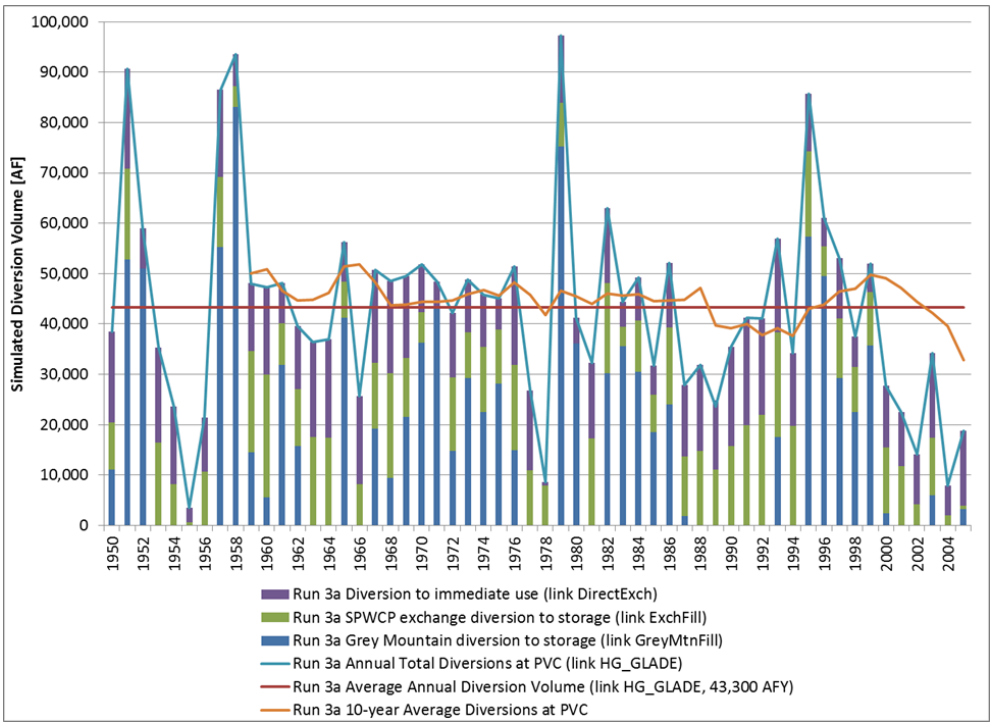
Table 4-15. Estimated Alternative 2 diversions at the Poudre Valley Canal for storage in Glade Reservoir, Reclamation Action Option, IY 1950-2005.

Month	Alternative 2 with Current Conditions Hydrology (NISP Run 3a)			
	Number of Years with Simulated Diversions at Poudre Valley Canal (out of 56)	Min [AF]	Max [AF]	Avg [AF]
November	0	0	0	0
December	2	0	1,300	27
January	1	0	3,400	61
February	2	0	230	7
March	9	0	2,300	190
April	28	0	24,100	2,600
May	46	0	56,700	11,400
June	48	0	65,000	17,400
July	9	0	12,300	810
August	31	0	8,600	1,600
September	37	0	3,000	850
October	22	0	3,200	200
Annual	**—**	**580**	**92,300**	**35,100**

Alternative 2 diversions from the Poudre River would be physically constrained to a maximum of 1,200 cfs by the enlarged capacity of the Poudre Valley Canal and the pump capacity from the Glade Forebay into Glade Reservoir. Diversion rates would rarely be this high. The maximum modeled diversion in any month under Alternative 2 is 65,000 AF (in June), which translates to an average rate of 1,092 cfs continuously for the entire month, although instantaneous diversion rates may be higher (up to the limit of 1,200 cfs).

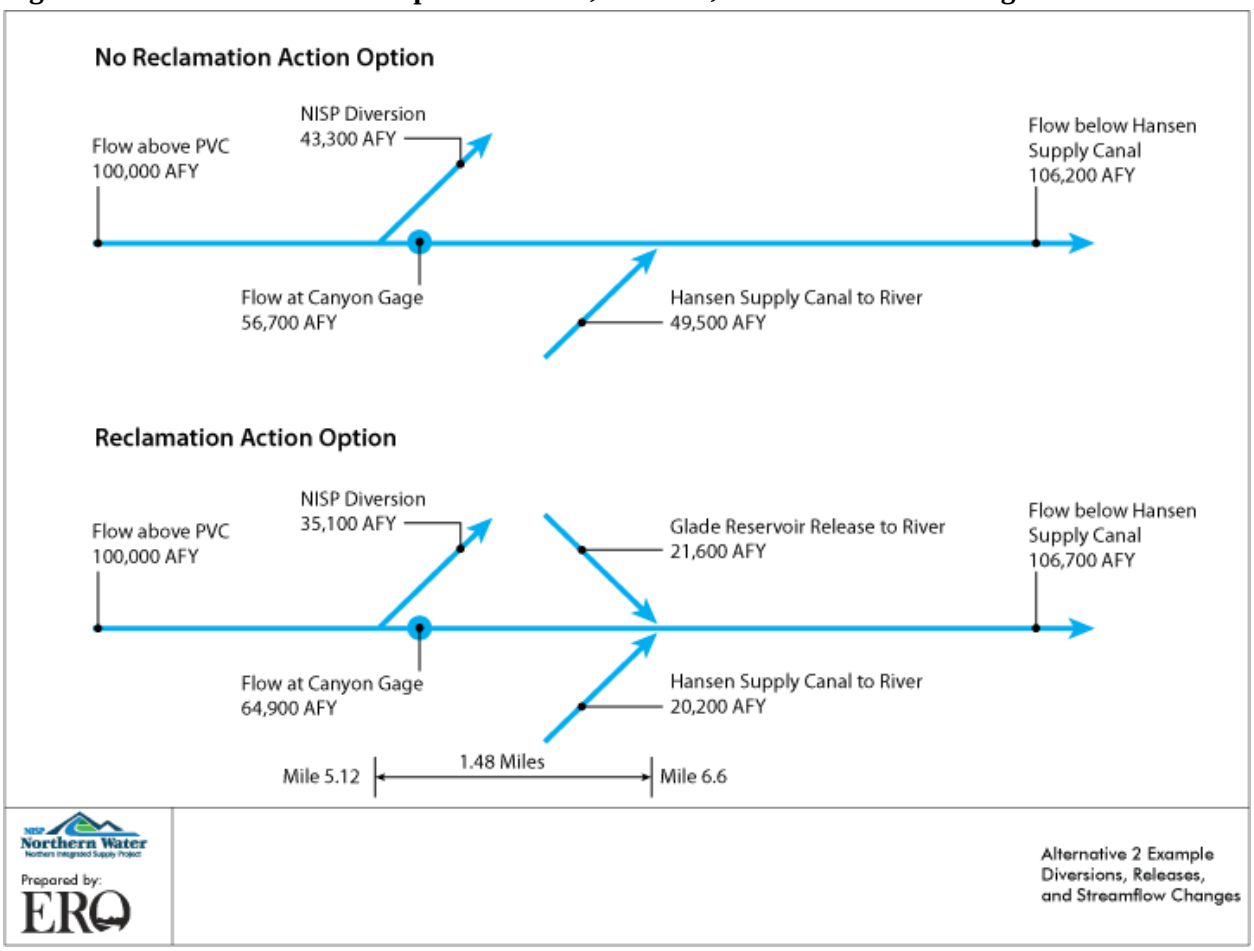
Figure 4-20 illustrates modeled Alternative 2 diversion results on an annual basis for Alternative 2 with the No Reclamation Action Option, in total and by source and destination (Grey Mountain or SPWCP exchange diversions for storage in Glade Reservoir or immediate use for delivery to the Participants). Similar results for the Reclamation Action Option are shown in the 2014 Operations Report, Figure 3.4.

Figure 4-20. Modeled Alternative Diversions at the Poudre Valley Canal for Storage or Immediate Use, with Current Conditions, No Reclamation Action Option, IY 1950-2005.



As shown above, under the No Reclamation Action Option, 100% of the 43,300 AFY modeled headgate diversions would be taken at the Poudre Valley Canal headgate. About 80% of that total volume (35,100 AFY) would be physically diverted at the Poudre Valley Canal under the Reclamation Action Option. Operated in conjunction with the Glade Reservoir releases described in Section 4.2.3.1 and the reduced Hansen Supply Canal deliveries described in Section 4.2.3.3, the net change in streamflow below the Hansen Supply Canal outfall would, on average, effectively be the same under the Reclamation Action Option as they are for the No Reclamation Action Option. This is demonstrated by the sample mass balance shown in Figure 4-21. The flow of 100,000 AFY upstream of the Poudre Valley Canal was randomly selected for the purpose of example; existing and ongoing operations not affected by NISP are not shown.

Figure 4-21. Alternative 2 Example Diversions, Releases, and Streamflow Changes.



The 500 AFY difference in streamflow below the Hansen Supply Canal (106,700 AFY vs. 106,200 AFY) is attributable to the divertible water that was bypassed by NISP at the Poudre Valley Canal headgate in the post-processing calculations for the Reclamation Action Option in order to avoid exceeding Glade Reservoir capacity. For the analysis of modeled changes in streamflow, this difference and the larger flow difference between the Poudre Valley Canal and the Hansen Supply Canal outfall (a distance of 1.48 miles) were ignored, resulting in more conservative (i.e., maximum case) streamflow results. In addition, the proposed flow augmentation program for Alternative 2 (see Section 4.2.1.1.3) would operate in a consistent manner under both the Reclamation Action Option and the No Reclamation Action Option because the infrastructure for releasing from Glade Reservoir to the Poudre River would be the same. As a result, a single set of modeled streamflows was evaluated for Alternative 2.

Modeled changes to surface water resources in the Poudre River as a result of the modeled Alternative 2 diversions were evaluated at nine locations in the 2014 Water Resources Report. Comparative figures and tables of streamflow changes under Alternative 2 with 2010 Current Conditions hydrology (i.e., Run 3a vs. Run 1) were presented in Section 6 of the 2014 Water Resources Report, as follows:

- Figures 6.1 through 6.10 (Median Daily Flows with 90% Upper/Lower Confidence Intervals)
- Figures 6.11 through 6.20 (Statistical Summary of Daily Flow – Minimum, Maximum, Median, Average)
- Figures 6.21 through 6.30 (Daily Flow-Duration Curve)
- Figures 6.31 through 6.40 (Monthly Box-and-Whiskers Plots)
- Tables 6.1 through 6.10 (Median Monthly Flow)

Representative examples of each type of figure and table were presented in Section 4.2.1.3. Raster hydrographs illustrating modeled streamflow changes under Alternative 2 with Current Conditions hydrology are presented in Appendix D of the 2014 Water Resources Report.

Canyon Gage (DDM 5.63)

The Canyon Gage is located about 0.5 mile downstream of the Poudre Valley Canal headgate and it is here that the streamflow changes resulting from Alternative 2 are first observed in the hydrologic modeling results. Water from the following sources would be diverted at the Poudre Valley Canal headgate, and corresponding changes in streamflow would be seen at the Canyon Gage:

- Grey Mountain right
- Exchange from Terry Lake
- Exchange from Larimer-Weld Canal
- Exchange from Big Windsor Reservoir
- Exchange from Timnath Reservoir
- Exchange from New Cache Canal

Expectedly, hydrologic modeling results show a reduction in streamflow at the Canyon Gage when compared to 2010 Current Conditions hydrology. The decreases in streamflow would be most substantial during the months of May and June when the Grey Mountain right is in priority and are also pronounced during other summer months when the SPWCP exchanges are in priority.

Downstream of the Canyon Gage hydrologic modeling results show a reduction in streamflow during months with Alternative 2 diversions; however, the magnitude of this reduction tapers once downstream of the Larimer-Weld Canal and New Cache Canal where the SPWCP direct flow and storage exchanges no longer affect streamflow and the Grey Mountain right results in the sole impact until just upstream of the Kersey Gage at the SPWCP diversion.

Downstream of Little Cache/Terry Lake headgate (DDM 11.34)

Water from the following sources would be diverted at the Poudre Valley Canal headgate, and corresponding changes in streamflow would be seen downstream of the Little Cache/Terry Lake headgate:

- Grey Mountain right

- Exchange from Larimer-Weld Canal
- Exchange from Big Windsor Reservoir
- Exchange from Timnath Reservoir
- Exchange from New Cache Canal

Downstream of the Little Cache/Terry Lake headgate is the first location analyzed for modeled surface water changes at which the modeled flow changes associated with the proposed flow augmentation program can be observed. Below the Little Cache headgate has historically been a winter dry-up point (see Section 2.4.1 of the 2014 Water Resources Report) associated with the filling of Terry Lake; flow augmentation may have the effect of reducing or eliminating those winter dry-up periods. Modeled winter flows for 2010 Current Conditions hydrology (CTP Run 1) drop below 10 cfs at the affected primary DDMs (downstream of Little Cache/Terry Lake, downstream of Larimer-Weld, and Lincoln Street Gage) but do not do so in the Alternative 2 (NISP Run 3a) model results. This effect can be seen clearly in the monthly box and whisker plots (see examples in Section 4.2.1.3.3, also Figures 6.32 through 6.34 of the 2014 Water Resources Report), as well as in the winter month flow increases shown for wet, average, and dry years in Tables 6.2 through 6.4 of the 2014 Water Resources Report.

Downstream of Larimer-Weld Canal headgate (DDM 13.97)

Water from the following sources would be diverted at the Poudre Valley Canal headgate, and corresponding changes in streamflow would be observable downstream of the Larimer-Weld Canal headgate:

- Grey Mountain right
- Exchange from Timnath Reservoir
- Exchange from New Cache Canal

Most modeled changes in streamflow below the Larimer-Weld Canal as a result of these diversions would occur during the summer months, particularly May and June when the Grey Mountain right is most likely to be in priority during wet and sometimes average years. Modeled changes in streamflow due to Alternative 2 diversions associated with the SPWCP direct flow exchange from Larimer-Weld and the SPWCP reservoir exchange with Big Windsor Reservoir would not be seen downstream of the Larimer-Weld headgate.

As described previously, the proposed flow augmentation program for Alternative 2 is based on meeting a flow of 10 cfs downstream of the Larimer-Weld Canal. The Larimer-Weld Canal has historically been administered as a winter dry-up point for the filling of Big Windsor Reservoir. As shown in the box-and-whisker plot for downstream of the Larimer-Weld Canal headgate (Figure 4-7 in Section 4.2.1.3.3), flows below 10 cfs between November and April would be virtually eliminated.

This effect is further demonstrated in a partial flow-duration curve for Alternative 2 with 2010 Current Conditions hydrology (Figure 8.2 in the 2014 Operations Report). The figure illustrates that, under Current Conditions hydrology and without flow augmentation, only about 55% of the

modeled daily flows immediately below the Larimer-Weld Canal headgate would exceed 10 cfs. With the proposed flow augmentation program in place under Alternative 2, flows would improve to greater than 10 cfs about 93% of the time, based on the modeled daily flows over IY 1980-2005 (see also Table 8.1 in the 2014 Operations Report).

Lincoln Street Gage (DDM 16.84)

The Lincoln Street Gage is centrally located on the reach of the Poudre River flowing through Fort Collins, not far downstream of the Martinez Park area. Water from the following sources would be diverted at the Poudre Valley Canal headgate, and corresponding changes in streamflow would be observable at the Lincoln Street Gage:

- Grey Mountain right
- Exchange from Timnath Reservoir
- Exchange from New Cache Canal

The modeled changes in streamflow as a result of the proposed flow augmentation program were also seen at the Lincoln Street Gage. In Section 6 of the 2014 Water Resources Report, Figures 6.4, 6.14, 6.24, 6.34, and Table 6.4 summarize modeled changes in streamflow at the Lincoln Street Gage under Alternative 2 with 2010 Current Conditions hydrology.

Downstream of Timnath Reservoir inlet canal headgate (DDM 18.76) and Boxelder Gage (DDM 22.69)

Based on discussions with the District, flows released from Glade Reservoir for flow augmentation purposes would be shepherded downstream and then diverted at the Timnath Reservoir Inlet Canal headgate (Timnath Inlet) on the east side of Fort Collins. The Timnath Inlet is sometimes administered as a winter dry-up point for reservoir filling (see Section 2.4.1 of the 2014 Water Resources Report). However, since the flow augmentation water is proposed to be diverted at the Timnath Inlet, winter dry-ups could still occur.

Streamflow changes observable below the Timnath Inlet and at the Boxelder Gage would be associated with upstream Grey Mountain diversions and the exchange of water from the downstream New Cache Canal headgate to the upstream Poudre Valley Canal headgate. Tables and figures illustrating modeled streamflow changes associated with Alternative 2 with 2010 Current Conditions hydrology are presented in Section 6 of the 2014 Water Resources Report.

- Downstream of Timnath Inlet: Figures 6.5, 6.15, 6.25, 6.35, and Table 6.5
- Boxelder Gage: Figures 6.6, 6.16, 6.26, 6.36, and Table 6.6

Downstream of New Cache Canal headgate (DDM 27.86), Downstream of Greeley No. 3 Canal headgate (DDM 44.38), and Greeley Gage (DDM 57.43)

The New Cache Canal headgate at Mile 27.81 is the furthest downstream location on the Poudre River at which changes in streamflow associated with any of the SPWCP direct flow or reservoir exchanges would be observed. Downstream of both the New Cache Canal and Greeley No. 3 headgates, and also at the Greeley Gage, a reach encompassing about 30 miles of the Poudre

River, the only streamflow changes attributable to Alternative 2 would be associated with Grey Mountain diversions.

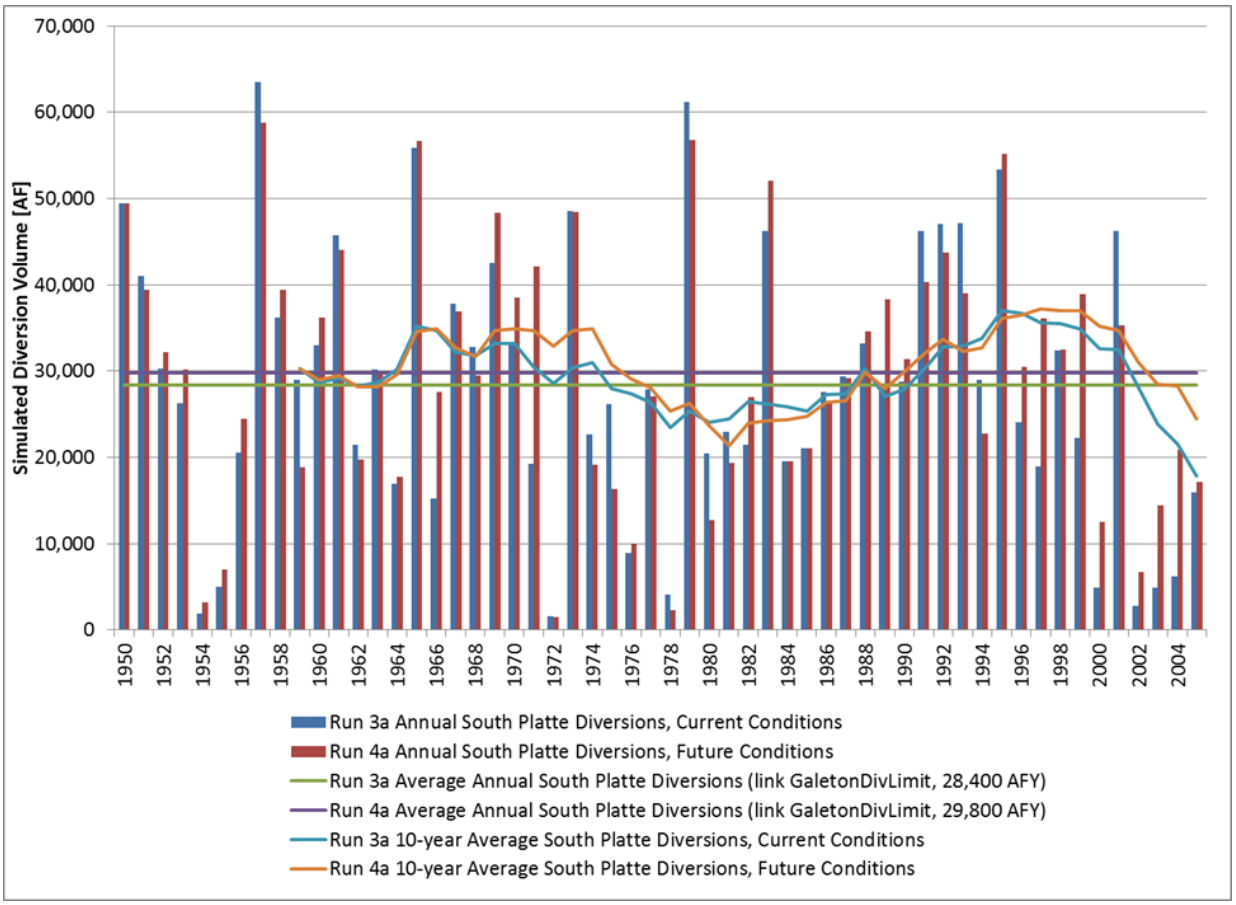
4.2.3.4.2 South Platte River

All action alternatives propose to divert water from the South Platte River as part of the SPWCP. The point of diversion would be just a short distance downstream of the confluence of the Poudre River and South Platte River. Water diverted from the South Platte River would be delivered by pipeline to storage in Galeton Reservoir or directly to the Larimer-Weld and/or New Cache Canals. Modeled Alternative 2 diversions from the South Platte River are summarized in Section 3.1.2 of the 2014 Operations Report. Table 4-16 and Figure 4-22 show results of modeled South Platte River diversions. The results show that Alternative 2 diversions from the South Platte River would occur in all months and would be limited to 200 cfs based on pipeline capacity.

Table 4-16. Estimated Alternative 2 diversions at the SPWCP South Platte River intake, IY 1950-2005.

Month	Alternative 2 with Current Conditions Hydrology (NISP Run 3a)			
	Number of Years with Simulated Diversions (out of 56)	Min [AF]	Max [AF]	Avg [AF]
November	37	0	11,900	2,300
December	26	0	12,300	2,200
January	30	0	12,300	2,700
February	23	0	11,100	1,800
March	51	0	12,300	1,600
April	53	0	11,900	1,900
May	48	0	12,300	4,000
June	42	0	11,900	4,300
July	28	0	12,300	2,000
August	19	0	12,300	1,800
September	42	0	11,900	2,900
October	42	0	5,200	830
Annual	—	**1,600**	**63,500**	**28,400**

Figure 4-22. Estimated Alternative 2 Diversions at the SPWCP South Platte River Intake, IY 1950-2005.



The Kersey Gage was identified in Section 3.1.3 as the furthest downstream site selected for detailed analysis because modeled average monthly streamflow changes from implementation of any of the action alternatives are less than 10% of the modeled Current Conditions flows in the South Platte River during all months over IY 1980-2005 (see Table 3-5, also Section 3.3.1 of the 2014 Water Resources Report). At this location, the hydrologic modeling results continue to show changes in streamflow due to the Grey Mountain diversions upstream on the Poudre River as well as additional changes to streamflow associated with the South Platte River diversions summarized above. This reduction in streamflow is similar in magnitude to that seen in the model results just downstream of the Poudre Valley Canal because (a) the surface water flow changes associated with the Grey Mountain diversions propagate to all points downstream of the Poudre Valley Canal headgate, and (b) NISP would be diverting a certain volume of water exchanged from the Larimer-Weld and New Cache canal systems on the Poudre River and replacing it with a like amount of water diverted from the South Platte River via the SPWCP.

In the 2014 Water Resources Report, Figures 6.10, 6.20, 6.30, 6.40, and Table 6.10 illustrate and summarize modeled streamflow changes at the Kersey Gage under Alternative 2 with 2010 Current Conditions hydrology. A series of figures in Appendix C of the 2014 Water Resources

Report superimpose modeled monthly diversions under Alternative 2 with the modeled pre- and post-project streamflows (see examples in Section 4.2.1.3.6).

4.2.3.5 Effects on Existing Poudre Basin Irrigation Canals and Reservoirs

As described in Chapter 2, NISP proposes several exchanges through the SPWCP, including exchanges on direct flow irrigation water rights of the Larimer-Weld and New Cache canal systems and exchanges on storage rights associated with Terry Lake, Big Windsor Reservoir, and Timnath Reservoir. The estimated diversions by NISP under these exchanges, and the corresponding SPWCP deliveries from the proposed Galeton Reservoir and/or the proposed South Platte River diversion to the canals and reservoirs, are summarized in Section 6 of the 2014 Operations Report.

Section 9 of the 2014 Water Resources Report summarizes ongoing diversions for irrigation and storage made by the Larimer-Weld and New Cache Canals and affiliated structures under 2010 Current Conditions hydrology and the NISP alternatives. Summary data tables in Sections 9.1, 9.2, and 9.3 of the 2014 Water Resources Report demonstrate that under proposed NISP operations, the combination of continued headgate diversions (consistent with historical operations) and deliveries from the SPWCP would not diminish the canal and reservoir water supplies. For Alternative 2 specifically, operations involving these facilities are anticipated to be the same under both the Reclamation Action Option and the No Reclamation Action Option.

In response to public comments on the NISP DEIS (Corps 2008) and to illustrate that NISP would not result in operational or water quantity changes at ditches not proposed to be directly involved in project operations, irrigation and storage diversions for the NPIC system (North Poudre Canal and Munroe Canal) are summarized in the 2014 Water Resources Report, Sections 9.4 and 9.5, along with those of the LCC, a part of the Water Supply and Storage Company (WSSC).

The monthly and annual average diversions/inflows for the canals and reservoirs are not expected to be exactly the same between Current Conditions hydrology and the NISP alternatives model runs. Given the complexity of the hydrologic modeling, it is reasonable to expect differences of a few percent between modeled diversions that should otherwise remain unchanged, or very nearly so, between model runs.

4.2.3.5.1 Larimer-Weld System

NISP exchanges through the SPWCP would impact several ditches and reservoirs that are operated within the Larimer-Weld irrigation system. Modeled diversions to the Poudre Valley Canal, Little Cache Canal, Terry Lake, Larimer-Weld Canal, and Big Windsor Reservoir are summarized below in upstream to downstream order. More detailed results are presented in Section 9.1 of the 2014 Water Resources Report.

Poudre Valley Canal

The Poudre Valley Canal is owned by the Windsor Reservoir and Canal Company. No lands are irrigated under the canal, which is used to fill several off-channel reservoirs that store and release

water for irrigation under the Larimer-Weld Canal. Under Alternative 2, the Poudre Valley Canal is proposed to be enlarged and improved to serve as the primary point of diversion for NISP to fill Glade Reservoir. The proposed physical and operational changes to the canal associated with NISP would not affect the current or future diversions at the Poudre Valley Canal for the purpose of delivering water to storage. Modeled annual diversions under 2010 Current Conditions hydrology averaged 9,100 AFY; with the addition of Alternative 2 to the modeling, the result was 8,900 AFY, a difference of 2%. Given the model complexities described above, this result can reasonably be described as a negligible change.

Little Cache Canal and Terry Lake

The Little Cache Canal is used to fill Terry Lake, which is proposed to be used by NISP for exchange operations. Modeled inflows to Terry Lake under Current Conditions hydrology were about 6,800 AFY. With NISP Alternative 2, the combination of continued headgate diversions and exchange water from the SPWCP would be about 7,000 AFY. The proposed exchange with Terry Lake would result in SPWCP water delivered to the Larimer-Weld Canal during the irrigation season in lieu of releases from Terry Lake. The net effect of this operation under Alternative 2 would be that higher average water levels could be maintained in Terry Lake in all months of the year (see the 2014 Water Resources Report, Figure 9.1).

Larimer-Weld Canal

NISP proposes to divert direct flow water exchanged from the Larimer-Weld Canal upstream at the Poudre Valley Canal for immediate use or diversion to storage in Glade Reservoir. In order to complete the exchange, SPWCP deliveries to Larimer-Weld would be made by pumping water from Galeton Reservoir or from the South Platte pumping station. Water supply in the Larimer-Weld Canal for ongoing irrigation would be impacted negligibly (35,700 AFY headgate diversions under Current Conditions hydrology compared to 35,800 AFY) under NISP Alternative 2. Note that this volume does not represent the full supply in the canal, just that portion of the historical headgate diversions proposed to be used in part by NISP by exchange.

Big Windsor Reservoir

Big Windsor Reservoir is filled through the Larimer-Weld Canal and is proposed to be used by NISP for exchanges in a manner similar to that proposed for Terry Lake. Net inflows to the reservoir were modeled as 9,800 AFY under both 2010 Current Conditions hydrology and NISP Alternative 2. Also similar to Terry Lake, average water levels in Big Windsor Reservoir could be higher under Alternative 2 due to NISP supplying water via the SPWCP for irrigation in place of releases from Big Windsor. The annual fill-and-drawdown cycle at Big Windsor Reservoir would maintain a pattern similar to historical operations (see the 2014 Water Resources Report, Figure 9.3).

4.2.3.5.2 New Cache Canal

Under NISP Alternative 2, the New Cache Canal is proposed to be used for SPWCP exchanges similar to the Larimer-Weld Canal. NISP would divert Poudre River water at the Poudre Valley Canal that would historically be destined for diversion downstream at the New Cache Canal headgate, just east of I-25. Through the SPWCP, NISP would deliver water to the New Cache

Canal from storage in Galeton Reservoir or directly from the South Platte River. Average annual headgate diversions under Current Conditions hydrology were modeled as 42,700 AFY. Under NISP Alternative 2, the combination of headgate diversions and water replaced by the SPWCP was modeled as 42,600 AFY, a negligible difference of 0.2%.

4.2.3.5.3 Timnath Reservoir

Timnath Reservoir is proposed to be used by NISP for exchanges similar to Terry Lake and Big Windsor Reservoir. Modeled inflows via the Timnath Inlet Canal were 6,300 AFY under 2010 Current Conditions hydrology. Under NISP Alternative 2, the combined headgate inflows and allocated water from the SPWCP was modeled as 7,500 AFY, which could result in higher reservoir water levels in all months. Model results show that the average fill-and-drawdown cycle would maintain a pattern consistent with historical operations (see the 2014 Water Resources Report, Figure 9.5).

4.2.4 Alternative 3

This section summarizes the modeled reservoir operations, diversions, and changes to streamflows due to implementation of Alternative 3. Model runs used in this section are as follows:

- CTP Run 1 – 2010 Current Conditions hydrology
- NISP Run 3b1 – Alternative 3 with 2010 Current Conditions hydrology

The following sections highlight some of the model results that are presented in more detail in Section 4 of the 2014 Operations Report and Section 7 of the 2014 Water Resources Report.

4.2.4.1 Cactus Hill Reservoir

Modeled operations of the proposed Cactus Hill Reservoir under Alternative 3 are presented in Section 4.2.1 and Appendix D of the 2014 Operations Report. Cactus Hill Reservoir would have an active storage capacity of 190,000 AF, greater than that of Glade Reservoir due to the larger surface area and plains location, which would have higher evaporation and transport losses. Similar to the operation of Glade Reservoir under the No Reclamation Action Option for Alternative 2, Cactus Hill Reservoir under Alternative 3 would have regular fill-and-drawdown cycles in most years. The physical properties of Cactus Hill Reservoir at maximum active storage and the modeled average properties of the reservoir under Alternative 3 with Current Conditions hydrology are summarized in Table 4-17 below.

Table 4-17. Cactus Hill Reservoir properties, Alternative 3 with 2010 Current Conditions hydrology, IY 1950-2005.

Alternative 3 Scenario	Water Storage Volume [AF]	Water Surface Area [acres]	Annual Evaporation [AFY]	Water Surface Elevation [ft]	Water Depth [ft][1]
Cactus Hill Modeled Maximum	190,000	3,705	NA	5,239	159
Cactus Hill Modeled Average	141,300	2,895	6,500	5,222	142

[1] Water depth based on an elevation of 5,080 feet at zero active storage.
NA=Not Applicable.

As shown in Figure 4-23, extended drawdowns of the reservoir storage are observed during the mid-1950s, late-1960s, late-1970s, and from the mid-1980s to the mid-1990s. This is attributable to modeling delivery of a full project allocation to the Participants in all years, including through drought periods in which NISP's junior water rights would rarely be in priority and would therefore produce limited reservoir inflows. Figure 4-24 shows average monthly water storage elevation in wet, average, and dry years for Cactus Hill Reservoir.

Figure 4-23. Cactus Hill Reservoir EOM Water Surface Elevation, Alternative 3, IY 1950-2005.

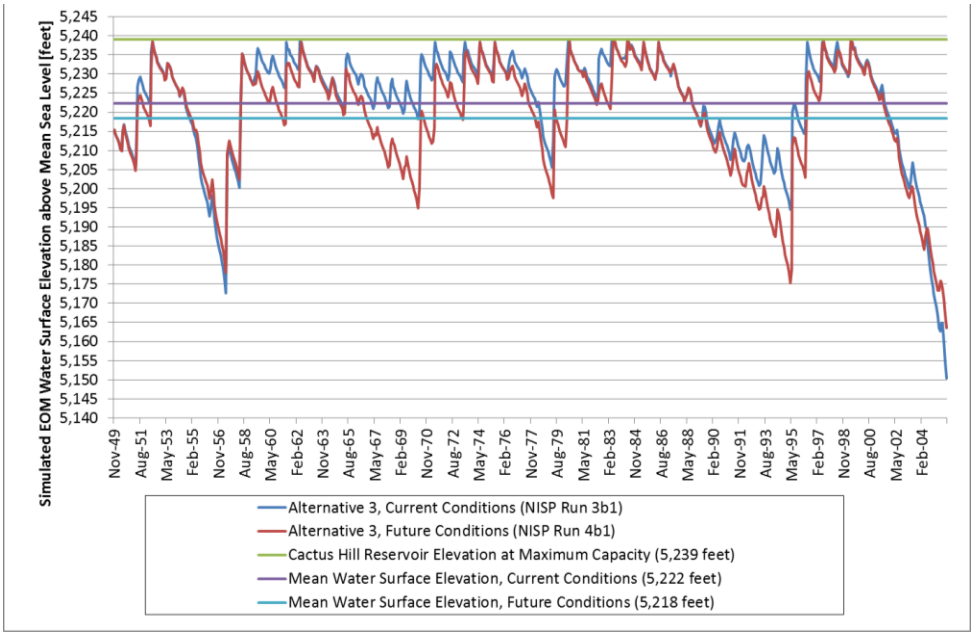
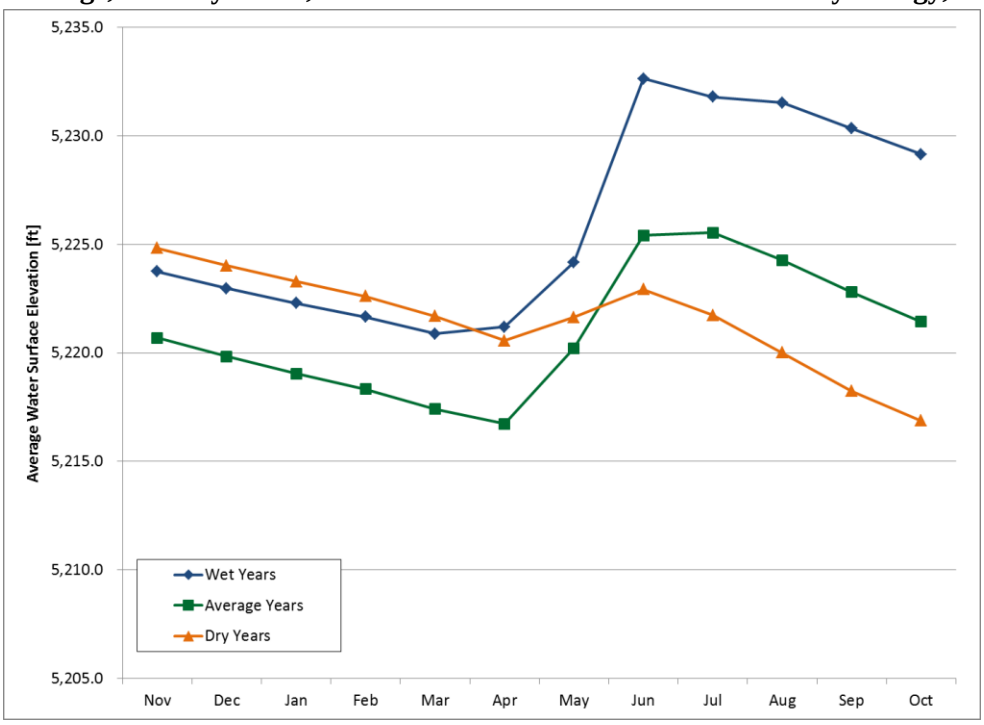
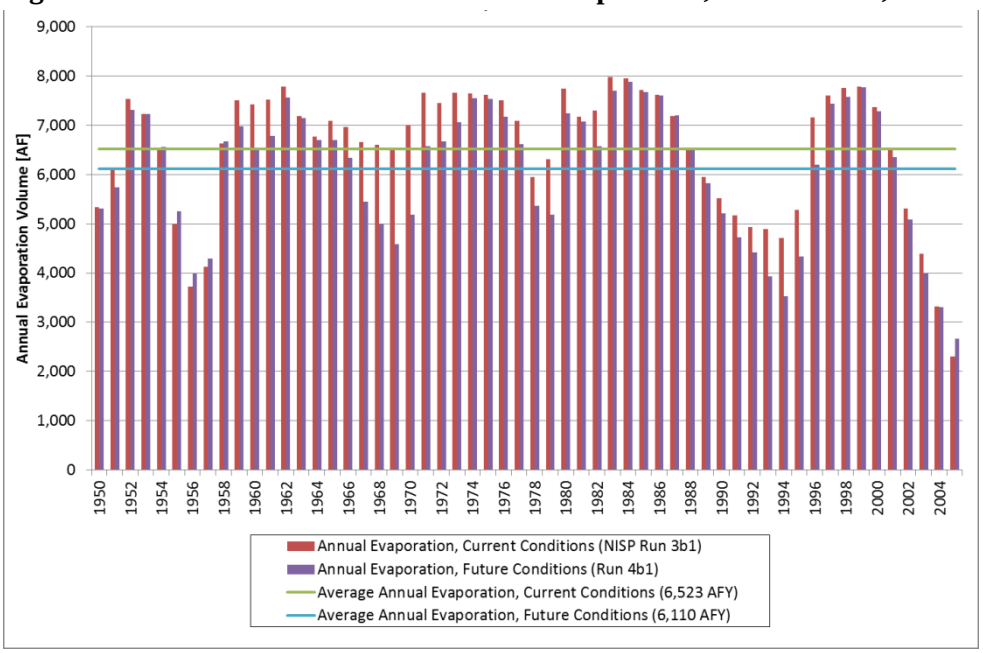


Figure 4-24. Cactus Hill Reservoir Average Monthly EOM Water Surface Elevation for Wet, Average, and Dry Years, Alternative 3 with Current Conditions Hydrology, IY 1950-2005.



All releases of water stored in Cactus Hill Reservoir for delivery to the Participants would be made through a new pipeline network (with connections to existing treatment facilities and other pipelines) described in the 2014 Operations Report, Section 4.3.1 (see Figure 4.14 of that report). Releases were assumed to follow a regular monthly distribution shown in the 2014 Operations Report, Table 5.7, hence the general regularity of annual drawdowns in Cactus Hill Reservoir. Evaporation losses from Cactus Hill Reservoir would vary with water surface area, averaging about 6,500 AFY under Current Conditions hydrology, as shown in Figure 4-25 below.

Figure 4-25. Cactus Hill Reservoir Annual Evaporation, Alternative 3, IY 1950-2005.



4.2.4.2 Galeton Reservoir

Galeton Reservoir operations under Alternative 3 would be similar to Alternative 2. The physical construction of the reservoir would be the same, with an active storage capacity of 45,624 AF. Average operational characteristics of Galeton Reservoir, modeled over the study period IY 1950-2005 under 2010 Current Conditions hydrology, are shown in Table 4-18 below.

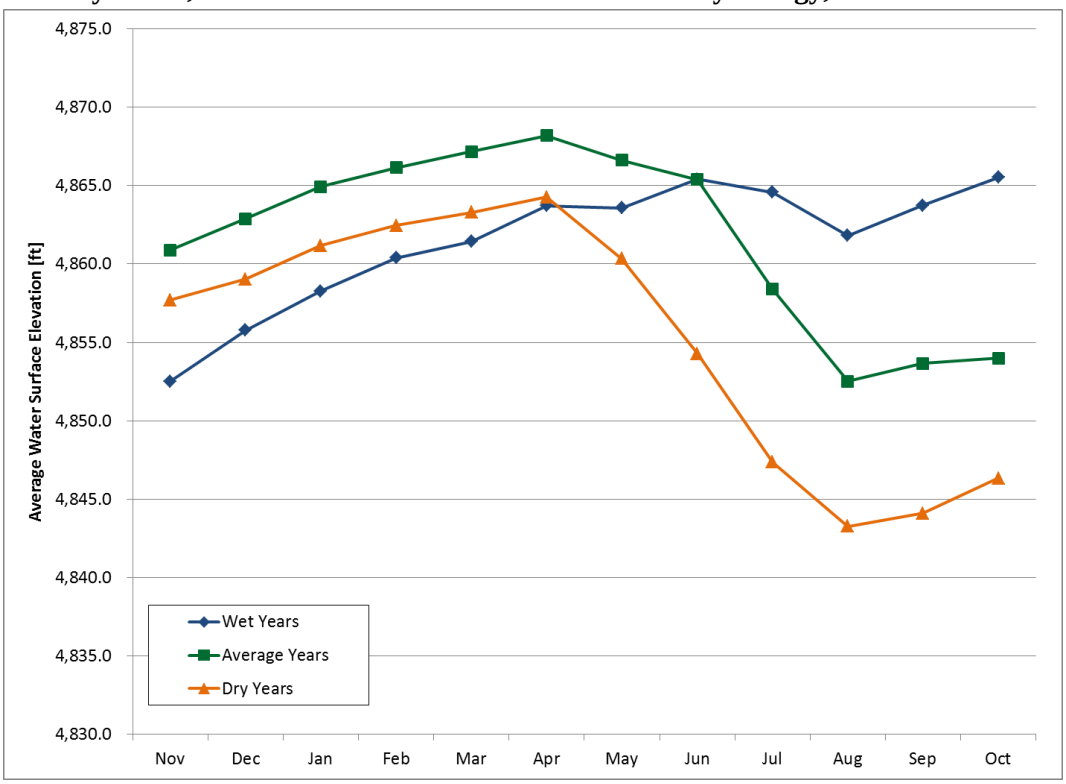
Table 4-18. Galeton Reservoir properties, Alternative 3 with 2010 Current Conditions hydrology, IY 1950-2005.

Alternative 3 Scenario	Water Storage Volume [AF]	Water Surface Area [acres]	Annual Evaporation [AFY]	Water Surface Elevation [ft]	Water Depth [ft][1]
Galeton Modeled Maximum	45,624	2,010	NA	4,872	57
Galeton Modeled Average	30,600	1,508	3,900	4,860	45

[1] Water depth based on an elevation of 4,815 feet at zero active storage.
NA=Not Applicable.

As shown in Figure 4.12 and Appendix F of the 2014 Operations Report, the water level oscillations in Galeton Reservoir under Alternative 3 would be similar to those under Alternative 2. Figure 4-26 shows the average monthly water surface elevation in Galeton Reservoir during wet, average, and dry years, as modeled for Alternative 3 with Current Conditions hydrology over the period IY 1950-2005.

Figure 4-26. Galeton Reservoir Average Monthly EOM Water Surface Elevation for Wet, Average, and Dry Years, Alternative 3 with Current Conditions Hydrology, IY 1950-2005.



4.2.4.3 River Segments

As described in Section 2.6.1, yield for Alternative 3 includes water derived from the same three water supply sources as Alternative 2. These water supply sources are the Grey Mountain right, the SPWCP direct flow exchanges, and the SPWCP reservoir exchanges. The SPWCP exchanges include diversions on both the Poudre River and the South Platte River. A summary of the general changes to the modeled streamflows resulting from diversion and/or exchange of each water supply source is found below.

4.2.4.3.1 Poudre River

The primary difference between Alternative 3 and Alternative 2 is that instead of diverting water at the Poudre Valley Canal for storage in Glade Reservoir, the Alternative 3 diversions at the Poudre Valley Canal would instead be delivered to the proposed Cactus Hill Reservoir, located further east on the plains of the Poudre Basin. This variation results in slightly higher reductions in streamflow due to increased diversions associated with a larger storage capacity at Cactus Hill (190,000 AF vs. 170,000 AF), larger water surface area of Cactus Hill, higher plains evaporation rates, and associated increase in reservoir surface evaporation. Increased system losses are also factored in due to the greater distance between the Poudre Valley Canal headgate and Cactus Hill than Glade Reservoir (nearly 30 miles of canal transit vs. about 2 miles). Alternative 3 is also differentiated from Alternative 2 because it does not include a Reclamation Action Option. Additionally, Alternative 3 does not include a flow augmentation program to improve winter

flows through Fort Collins due to the geographic location of the proposed reservoir and absence of infrastructure to make releases back to the Poudre River.

Table 4-19 shows modeled Alternative 3 diversions at the Poudre Valley Canal with Current Conditions hydrology. These diversions would be delivered to storage in Cactus Hill Reservoir or routed through the delivery pipelines for immediate use by the Participants.

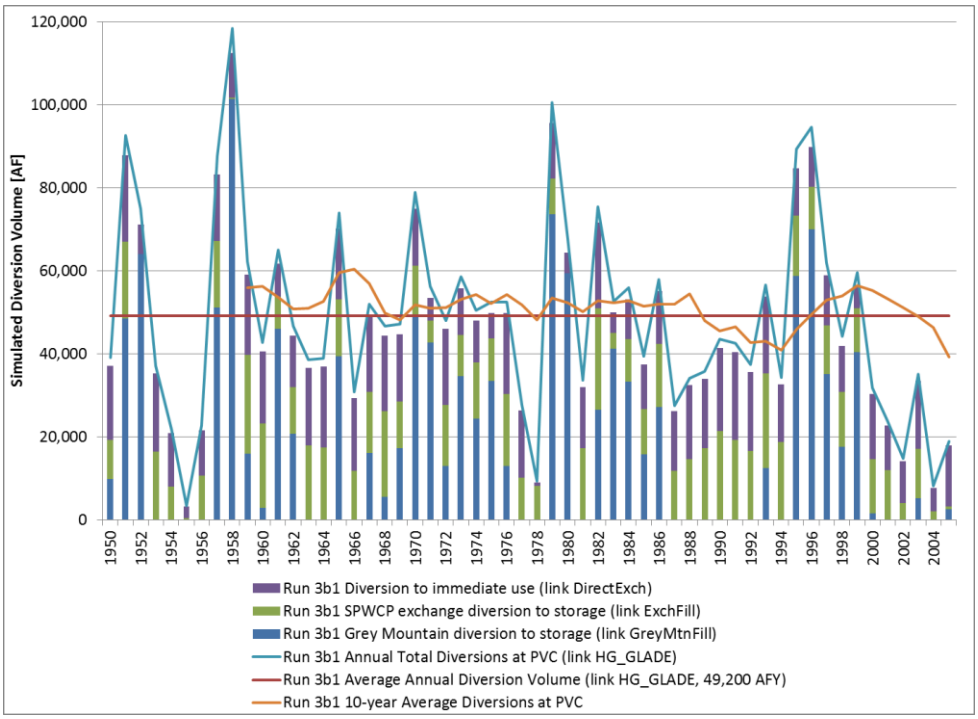
Table 4-19. Simulated Alternative 3 diversions at the Poudre Valley Canal for storage or immediate use[1], IY 1950-2005.

Month	Alternative 3 with Current Conditions Hydrology (NISP Run 3b1)						
	Number of Years with Simulated Diversions at Poudre Valley Canal HG_GLADE (out of 56)	Min HG_ GLADE [AF]	Max HG_ GLADE [AF]	Avg HG_ GLADE [AF]	Avg GreyMtn Fill [AF]	Avg Exch Fill [AF]	Avg Direct Exch [AF]
November	0	0	0	0	0	0	0
December	2	0	1,300	27	0	25	0
January	1	0	3,300	59	1	55	0
February	4	0	2,200	76	71	1	0
March	10	0	5,200	290	170	110	0
April	31	0	27,900	3,000	1,300	1,500	43
May	54	0	60,400	13,800	5,900	4,200	3,100
June	55	0	66,400	21,700	13,200	3,600	3,800
July	53	0	12,900	6,000	130	2,100	3,500
August	45	0	11,300	3,000	0	560	2,300
September	39	0	3,100	900	0	0	860
October	22	0	3,900	240	81	140	4
Annual	**—**	**3,500**	**118,300**	**49,200**	**20,900**	**12,300**	**13,500**

[1] Differences between headgate diversions (HG_GLADE) and sum of individual diversions to storage or immediate use (GreyMtnFill, ExchFill, DirectExch) attributable to channel loss applied to Poudre Valley Canal in the modeling.

Modeled average annual diversions under Alternative 3 are about 6,000 AF greater than under Alternative 2 (49,200 AFY vs. 43,300 AFY). May and June are the months with the largest modeled diversions, representing more than 72% of the average annual total. April, July, and August account for another 24% of the diversions. Figure 4-27 illustrates the annual variability in Alternative 3 diversions at the Poudre Valley Canal.

Figure 4-27. Modeled Alternative 3 Diversions at the Poudre Valley Canal for Storage or Immediate Use, with Current Conditions, IY 1950-2005.



More detailed model results for Alternative 3 diversions from the Poudre River are found in Section 4 of the 2014 Operations Report. Modeled changes to surface water resources in the Poudre River as a result of these diversions were evaluated at nine locations in the 2014 Water Resources Report. Comparative figures and tables of modeled streamflow changes under Alternative 3 with 2010 Current Conditions hydrology (i.e., Run 3b1 vs. Run 1) were presented in Section 7 of the 2014 Water Resources Report, as follows:

- Figures 7.1 through 7.10 (Median Daily Flows with 90% Upper/Lower Confidence Intervals)
- Figures 7.11 through 7.20 (Statistical Summary of Daily Flow – Minimum, Maximum, Median, Average)
- Figures 7.21 through 7.30 (Daily Flow-Duration Curve)
- Figures 7.31 through 7.40 (Monthly Box-and-Whiskers Plots)
- Tables 7.1 through 7.10 (Median Monthly Flow)

Figures superimposing modeled monthly streamflows and diversions are presented in Appendix C of the 2014 Water Resources Report. Raster hydrographs for Alternative 3 with Current Conditions hydrology are presented in Appendix D of the 2014 Water Resources Report.

As described above, Alternative 3 diversions would be made at the existing Poudre Valley Canal headgate. The Canyon Gage, located about 0.5 mile downstream, is the furthest upstream location at which the resulting modeled streamflow changes can be seen. Water from the

following sources would be diverted at the Poudre Valley Canal headgate, and corresponding changes in streamflow would be seen at the Canyon Gage:

- Grey Mountain right
- Exchange from Terry Lake
- Exchange from Larimer-Weld Canal
- Exchange from Big Windsor Reservoir
- Exchange from Timnath Reservoir
- Exchange from New Cache Canal

Expectedly, hydrologic modeling results show a reduction in streamflow at the Canyon Gage when compared to 2010 Current Conditions hydrology. The decreases in streamflow would be most substantial during the months of May and June when the Grey Mountain right is in priority and are also pronounced during other summer months when the SPWCP exchanges are in priority.

The changes in streamflow associated with diversions under the Grey Mountain right would be observed at all evaluated locations downstream because it would be a newly developed conditional right. Modeled changes in flow associated with the diversion of SPWCP exchange water upstream at the Poudre Valley Canal headgate would continue downstream to the originating headgates. For example, if NISP diverted water exchanged from Terry Lake, the changes in flow would be seen between the Poudre Valley Canal and Little Cache headgates. Likewise, diversions of water exchanged from Larimer-Weld and/or Big Windsor would result in flow reductions in the reach between the Poudre Valley Canal and the Larimer-Weld headgate, and so on downstream for Timnath Reservoir and New Cache. To see illustrations of these modeled streamflow changes, see the figures listed above and presented in Section 7 of the 2014 Water Resources Report. These figures and tables summarize the modeled streamflows under Alternative 3 with 2010 Current Conditions hydrology from upstream to downstream.

Since Alternative 3 does not include a proposed flow augmentation program, the box and whisker plots and tabulated data do not show winter flows downstream of Little Cache (DDM 11.34), downstream of the Larimer-Weld headgate (DDM 13.97), and at the Lincoln Street Gage (DDM 16.84) being maintained at or above 10 cfs in NISP Run 3b1. See examples in Section 4.2.1.3.3 above as well as Figures 7.32 to 7.34 in the 2014 Water Resources Report.

Changes in streamflow would be reduced downstream of the New Cache Canal, which is the lower terminus of the Poudre River mainstem reach affected by the proposed SPWCP direct flow and reservoir exchanges with the Larimer-Weld and New Cache canal systems and affiliates. At locations downstream of Greeley No. 3 headgate (DDM 44.38) and at the Greeley Gage (DDM 57.43), all modeled changes to surface water resources are attributable to diversions made by NISP under the Grey Mountain right.

4.2.4.3.2 South Platte River

Alternative 3 diversions from the South Platte River are shown in Table 4-20 below.

Table 4-20. Estimated Alternative 3 diversions at the SPWCP South Platte River intake, IY 1950-2005.

Month	Alternative 3 with Current Conditions Hydrology (NISP Run 3b1)			
	Number of Years with Simulated Diversions (out of 56)	Min [AF]	Max [AF]	Avg [AF]
November	36	0	11,900	2,900
December	31	0	12,300	2,600
January	30	0	12,300	3,000
February	24	0	11,100	2,100
March	51	0	12,300	1,700
April	53	0	11,900	2,100
May	48	0	12,300	4,000
June	41	0	11,900	4,400
July	28	0	12,300	2,000
August	19	0	12,300	1,700
September	42	0	11,900	2,800
October	41	0	5,200	900
Annual	**—**	**1,700**	**63,600**	**30,000**

On the South Platte River, modeled changes to surface water resources due to Alternative 3 are the result of Grey Mountain diversions upstream on the Poudre River, plus the South Platte River diversions to fill Galeton Reservoir and/or deliver replacement water directly to Larimer-Weld and New Cache. These changes are reflected in analyses of the Kersey Gage, such as those shown in Figures 7.10, 7.20, 7.30, 7.40, and Table 7.10 of the 2014 Water Resources Report.

4.2.4.4 Effects on Existing Poudre Basin Irrigation Canals and Reservoirs

Water supplies for continued irrigation under existing canals and reservoirs proposed to be integrated with NISP through diversion and exchange operations would be consistent with historical levels under Alternative 3. Operationally, these diversions and exchanges are consistent with descriptions for Alternative 2 in Section 4.2.3.5. Volumetric model results are summarized in Table 4-21 below. More detailed results are provided in Section 9 of the 2014 Water Resources Report.

Table 4-21. Modeled diversions/inflows to existing Poudre Basin irrigation canals and reservoirs, Alternative 3 vs. 2010 Current Conditions, IY 1950-2005.

Structure	Current Conditions Hydrology [AFY]	NISP Alternative 3 [AFY]
Poudre Valley Canal	9,100	8,900
Little Cache/Terry Lake	6,800	7,000
Larimer-Weld Canal	35,700	35,600
Big Windsor Reservoir	9,800	9,900
New Cache Canal	42,700	42,400
Timnath Reservoir	6,300	7,400
Total	**110,400**	**111,200**

As described in Section 4.2.3.5, the complexity of the hydrologic modeling resulted in the minor variability in the results presented in the table above. Through the proposed SPWCP exchanges under Alternative 3, the irrigation and reservoir companies' Poudre River water diverted by NISP at the Poudre Valley Canal would be fully replaced with South Platte River water and historical water supply volumes would be maintained.

4.2.5 Alternative 4

This section summarizes the modeled reservoir operations, diversions, and changes to streamflows due to implementation of Alternative 4. Alternative 4 would divert water under the Grey Mountain water right and some of the SPWCP exchanges at the Poudre Valley Canal headgate for delivery to the proposed Cactus Hill Reservoir. The SPWCP direct flow exchange associated with New Cache Canal would not be diverted at the upstream Poudre Valley Canal headgate but would instead remain in the river for diversion at the historical diversion location (New Cache Canal headgate), where it would be pumped from the canal to Cactus Hill Reservoir. Alternative 4 does not include a Reclamation Action Option or a proposed flow augmentation program. Model runs used in this section are as follows:

- CTP Run 1 – 2010 Current Conditions hydrology
- NISP Run 3b2 – Alternative 4 with 2010 Current Conditions hydrology

The following sections highlight some of the model results that are presented in more detail in Section 4 of the 2014 Operations Report and Section 8 of the 2014 Water Resources Report.

4.2.5.1 Cactus Hill Reservoir

Detailed model results for proposed Cactus Hill Reservoir operations under Alternative 4 are presented in Section 4.2.1 and Appendix E of the 2014 Operations Report. Average storage properties for Cactus Hill Reservoir under Alternative 4 with 2010 Current Conditions hydrology are listed in Table 4-22 below.

Table 4-22. Cactus Hill Reservoir properties, Alternative 4 with 2010 Current Conditions hydrology, IY 1950-2005.

Alternative 4 Scenario	Water Storage Volume [AF]	Water Surface Area [acres]	Annual Evaporation [AFY]	Water Surface Elevation [ft]	Water Depth [ft][1]
Cactus Hill Modeled Maximum	190,000	3,705	NA	5,239	159
Cactus Hill Modeled Average	142,800	2,921	6,600	5,223	143

[1] Water depth based on an elevation of 5,080 feet at zero active storage.
NA=Not Applicable.

Figure 4-28 illustrates the time series variability of water surface elevation in Cactus Hill Reservoir under Alternative 4. Figure 4-29 shows average monthly water storage elevation in

wet, average, and dry years for Cactus Hill Reservoir. Figure 4-30 shows modeled annual and average annual evaporation from Cactus Hill Reservoir.

Figure 4-28. Cactus Hill Reservoir EOM Water Surface Elevation, Alternative 4, IY 1950-2005.

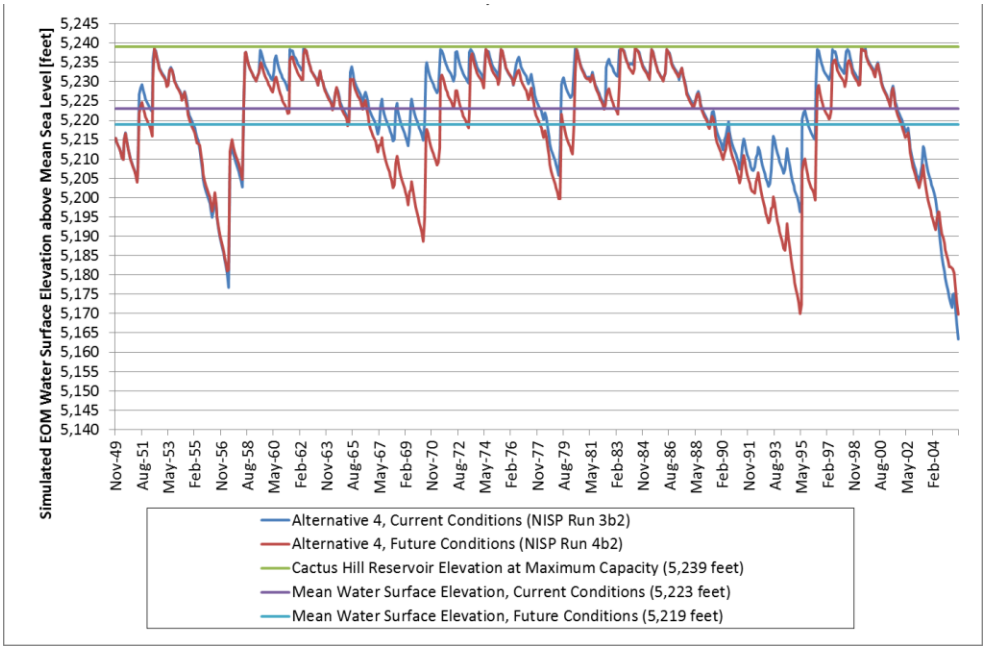


Figure 4-29. Cactus Hill Reservoir Average Monthly EOM Water Surface Elevation for Wet, Average, and Dry Years, Alternative 4 with Current Conditions Hydrology, IY 1950-2005.

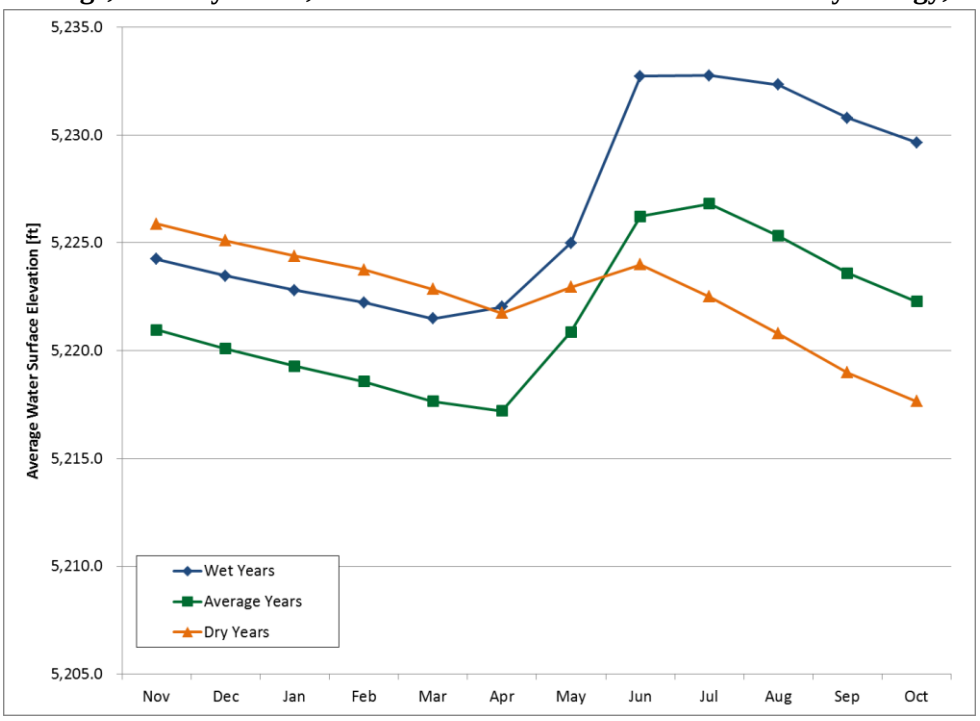
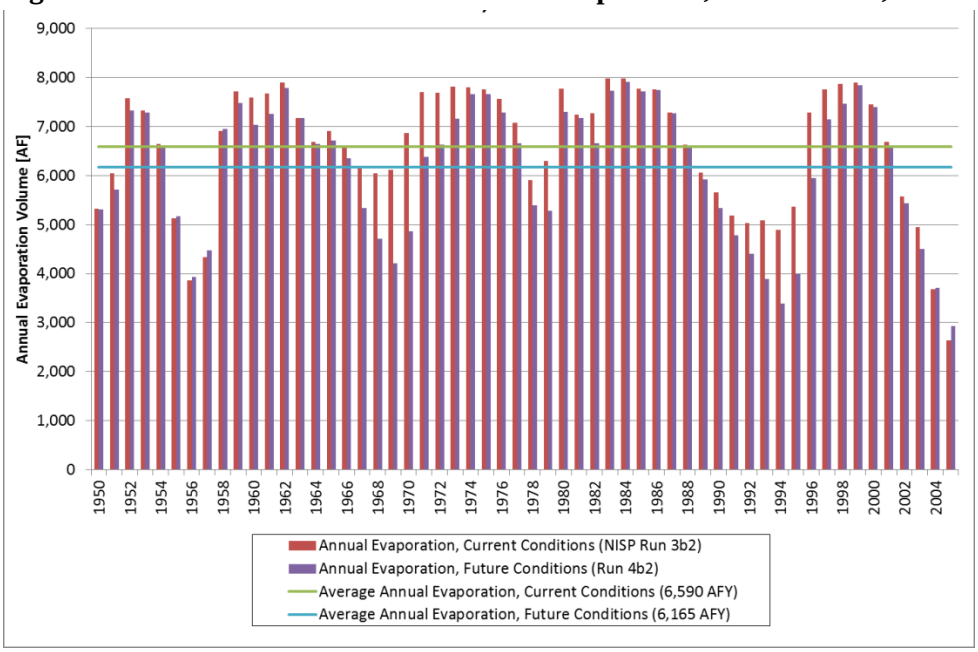


Figure 4-30. Cactus Hill Reservoir Annual Evaporation, Alternative 4, IY 1950-2005.



Releases from Cactus Hill Reservoir for delivery to the NISP Participants under Alternative 4 would be made through a new pipeline network as described in Section 4.3.1 of the 2014 Operations Report, following a monthly distribution shown in Table 5.7 of the same report.

4.2.5.2 Galeton Reservoir

Galeton Reservoir physical properties and operations under Alternative 4 would be similar to Alternatives 2 and 3. Overall average operational characteristics of Galeton Reservoir, modeled over the study period IY 1950-2005 under 2010 Current Conditions hydrology are shown in Table 4-23 below.

Table 4-23. Galeton Reservoir properties, Alternative 4 with 2010 Current Conditions hydrology, IY 1950-2005.

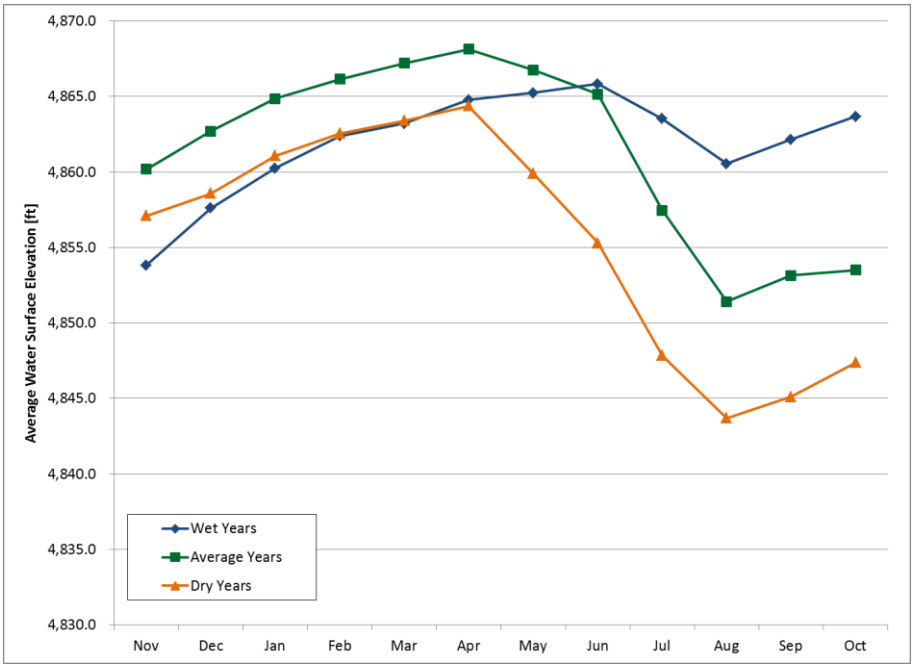
Alternative 4 Scenario	Water Storage Volume [AF]	Water Surface Area [acres]	Annual Evaporation [AFY]	Water Surface Elevation [ft]	Water Depth [ft][1]
Galeton Modeled Maximum	45,624	2,010	NA	4,872	57
Galeton Modeled Average	30,000	1,499	3,800	4,860	45

[1] Water depth based on an elevation of 4,815 at zero active storage.
NA=Not Applicable.

Further details regarding Galeton Reservoir operations under Alternative 4 are presented in Section 4.2.2 (Figure 4.13) and Appendix G of the 2014 Operations Report. Figure 4-31 shows the average monthly water surface elevation in Galeton Reservoir during wet, average, and dry

years, as modeled for Alternative 4 with Current Conditions hydrology over the period IY 1950-2005.

Figure 4-31. Galeton Reservoir Average Monthly EOM Water Surface Elevation for Wet, Average, and Dry Years, Alternative 4 with Current Conditions Hydrology, IY 1950-2005.



4.2.5.3 River Segments

Similar to Alternatives 2 and 3, yield for Alternative 4 includes water derived from three water supply sources. These water supply sources are the Grey Mountain right, the SPWCP direct flow exchanges, and the SPWCP reservoir exchanges. The SPWCP exchanges include diversions from both the Poudre River and the South Platte River. The primary difference between Alternatives 3 and 4 is the point of diversion for water exchanged from New Cache. A summary of the general changes to the modeled streamflows resulting from diversion and/or exchange of each water supply source is found below.

4.2.5.3.1 Poudre River

From an operational standpoint, the primary difference between Alternative 3 and Alternative 4 is that instead of diverting all water at the Poudre Valley Canal headgate (Mile 5.12), the SPWCP direct flow exchange water associated with New Cache would remain in the Poudre River until its historical point of diversion at the New Cache Canal headgate (Mile 27.81). Table 4-24 summarizes modeled monthly and annual diversions at the Poudre Valley Canal under Alternative 4; Table 4-25 summarizes the modeled diversions at New Cache for NISP.

Table 4-24. Simulated Alternative 4 diversions at the Poudre Valley Canal for storage or immediate use[1], IY 1950-2005.

Month	Alternative 4 with Current Conditions Hydrology (NISP Run 3b2)						
	Number of Years with Simulated Diversions at Poudre Valley Canal HG_GLADE (out of 56)	Min HG_ GLADE [AF]	Max HG_ GLADE [AF]	Avg HG_ GLADE [AF]	Avg GreyMtn Fill [AF]	Avg Exch Fill [AF]	Avg Direct Exch [AF]
November	0	0	0	0	0	0	0
December	2	0	1,300	27	3	22	0
January	2	0	3,200	58	2	53	0
February	4	0	2,500	91	85	1	0
March	10	0	5,200	300	180	100	0
April	32	0	29,900	3,400	1,400	1,800	47
May	54	0	56,500	10,600	5,500	2,700	1,900
June	55	0	61,500	17,300	12,400	1,300	2,800
July	47	0	7,600	4,800	24	0	4,600
August	25	0	5,000	950	0	0	940
September	0	0	0	0	0	0	0
October	24	0	3,800	250	100	130	4
Annual	**—**	**2,500**	**109,400**	**37,800**	**19,700**	**6,200**	**10,200**

[1] Differences between headgate diversions (HG_GLADE) and sum of individual diversions to storage or immediate use (GreyMtnFill, ExchFill, DirectExch) attributable to channel loss applied to Poudre Valley Canal in the modeling or surplus headgate diversions returned immediately to the river.

Table 4-25. Estimated Alternative 4 diversions at the New Cache Canal, IY 1950-2005.

Month	Alternative 4 with Current Conditions Hydrology (NISP Run 3b2)			
	Number of Years with Simulated Diversions (out of 56)	Min [AF]	Max [AF]	Avg [AF]
November	0	0	0	0
December	0	0	0	0
January	0	0	0	0
February	0	0	0	0
March	0	0	0	0
April	0	0	0	0
May	48	0	6,100	3,500
June	52	0	6,000	3,800
July	49	0	6,100	2,300
August	30	0	5,700	1,400
September	11	0	1,700	39
October	0	0	0	0
Annual	**—**	**5**	**20,400**	**11,000**

Modeled average annual diversions from the Poudre River under Alternative 4 with 2010 Current Conditions hydrology include 37,800 AFY at the Poudre Valley Canal and 11,000 AFY at the New Cache headgate, a total of 48,800 AFY.

More detailed model results for Alternative 4 diversions from the Poudre River are found in Section 4 of the 2014 Operations Report. Modeled changes to surface water resources in the Poudre River as a result of these diversions were evaluated at nine locations in the 2014 Water Resources Report. Comparative figures and tables of modeled streamflow changes under Alternative 4 with 2010 Current Conditions hydrology (i.e., Run 3b2 vs. Run 1) were presented in Section 8 of the 2014 Water Resources Report, as follows:

- Figures 8.1 through 8.10 (Median Daily Flows with 90% Upper/Lower Confidence Intervals)
- Figures 8.11 through 8.20 (Statistical Summary of Daily Flow – Minimum, Maximum, Median, Average)
- Figures 8.21 through 8.30 (Daily Flow-Duration Curve)
- Figures 8.31 through 8.40 (Monthly Box-and-Whiskers Plots)
- Tables 8.1 through 8.10 (Median Monthly Flow)

Figures superimposing modeled monthly streamflows and diversions are presented in Appendix C of the 2014 Water Resources Report. Raster hydrographs for Alternative 4 with Current Conditions hydrology are presented in Appendix D of the 2014 Water Resources Report.

The diversion of 11,000 AFY at the New Cache Canal headgate under Alternative 4 results in a lesser reduction in streamflow than the other action alternatives for the nearly 23-mile river reach between the Poudre Valley Canal and the New Cache Canal. The Grey Mountain right and the SPWCP exchanges with Larimer-Weld, Terry Lake, and Big Windsor Reservoir would still be diverted upstream at the Poudre Valley Canal, as reflected in the modeled streamflows at the Canyon Gage (see Figures 8.1, 8.11, 8.21, and 8.31, and Table 8.1 in the 2014 Water Resources Report).

The relative effect of leaving New Cache water in the river would be more pronounced in the Poudre River in the reach through Fort Collins between the Larimer-Weld headgate (on the northwest side of the city) and the New Cache headgate (east of I-25) because changes in streamflow would be limited to those associated with Grey Mountain diversions and upstream exchange diversions from Timnath Reservoir. See, for example, the median daily flow hydrographs in Figures 8.3 to 8.5 of the 2014 Water Resources Report.

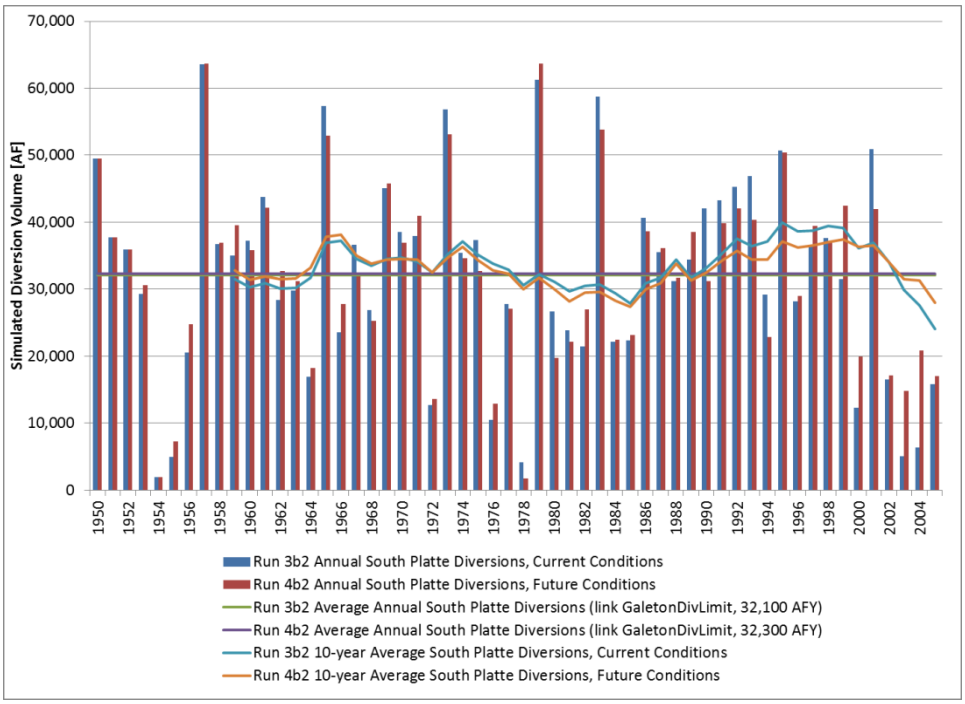
Averaged over the 5 months (May-September) in which the modeled diversions of about 11,000 AFY at New Cache would occur, about 36 cfs would be left in the affected reach. The rate would be higher for the May-July period in which the majority of diversions are concentrated. Flow-duration curves for the Lincoln Street Gage and the Boxelder Gage (Figures 8.24 and 8.26 in the 2014 Water Resources Report, respectively), based on daily flows for Alternative 4 with 2010 Current Conditions hydrology over the modeled period IY 1980-2005, show little or no change at low-flow levels. Modeled changes in flow only occur at higher flow rates at these

locations, the most visible changes having probabilities of exceedance less than 10%, and a range of flow from about 250 cfs to 1,750 cfs. These results are consistent with wet year diversions under the Grey Mountain right. Below New Cache, the only modeled changes to Poudre River flows are due to the modeled diversions upstream at the Poudre Valley Canal that are associated with the Grey Mountain right.

4.2.5.3.2 South Platte River

Alternative 4 diversions from the South Platte River are shown in Figure 4-32 below.

Figure 4-32. Estimated South Platte River Diversions, Alternative 4, IY 1950-2005.



These modeled diversions from the South Platte River below the Poudre River confluence are combined with the upstream Grey Mountain diversions, as reflected in the changes in streamflow at the Kersey Gage. Given that the magnitude of flow in the South Platte River is generally much higher than the Poudre River (roughly five times greater than flows at the Greeley Gage near the mouth of the Poudre River), the relative changes in flow would be less at the Kersey Gage than compared to Poudre River locations. Modeled streamflow changes at the Kersey Gage under Alternative 4 can be seen in Figures 8.10, 8.20, 8.30, and 8.40 and Table 8.10 in the 2014 Water Resources Report.

4.2.5.4 Effects on Existing Poudre Basin Irrigation Canals and Reservoirs

Water supplies for continued irrigation under existing canals and reservoirs proposed to be integrated with NISP through diversion and exchange operations would be consistent with historical levels under Alternative 4. Model results are summarized in Table 4-26 below. More detailed results are provided in Section 9 of the 2014 Water Resources Report.

Table 4-26. Modeled diversions/inflows to existing Poudre Basin irrigation canals and reservoirs, Alternative 4 vs. 2010 Current Conditions, IY 1950-2005.

Structure	Current Conditions Hydrology [AFY]	NISP Alternative 4 [AFY]
Poudre Valley Canal	9,100	8,800
Little Cache/Terry Lake	6,800	7,100
Larimer-Weld Canal	35,700	35,400
Big Windsor Reservoir	9,800	9,900
New Cache Canal	42,700	42,700
Timnath Reservoir	6,300	7,600
Total	**110,400**	**111,500**

As described in Section 4.2.3.5, the complexity of the hydrologic modeling resulted in the minor variability in the results presented in the table above. Through the proposed SPWCP exchanges under Alternative 4, the irrigation and reservoir companies' Poudre River water diverted by NISP at the Poudre Valley Canal would be fully replaced with South Platte River water and historical water supply volumes would be maintained.

4.2.6 Comparison of Action Alternative Changes

The preceding sections briefly recapped modeled diversions and streamflow changes resulting from the implementation of the proposed NISP action alternatives (Alternatives 2 through 4). The No Action Alternative was not evaluated by comparison to 2010 Current Conditions hydrology, as described in Section 4.2.2; results of the No Action Alternative compared to 2050 Future Conditions hydrology are presented in Chapter 5.

There are several similarities among the three action alternatives, as follows:

- All would deliver 40,000 AFY firm yield to the project Participants
- All would use the same water rights: Grey Mountain conditional storage right on the Poudre River, SPWCP diversion from the South Platte, and Poudre River exchanges with Larimer-Weld, New Cache, Terry Lake, Big Windsor Reservoir, and Timnath Reservoir
- All propose a large primary storage reservoir (170,000 AF active storage Glade Reservoir or 190,000 AF active storage Cactus Hill Reservoir) operated in conjunction with the SPWCP and Galeton Reservoir (45,624 AF active storage)

Owing to the common water rights proposed to be used for the action alternatives, the timing of diversions is relatively consistent throughout.

Due to the proximity of Glade Reservoir and the Poudre Valley Canal headgate to existing C-BT Project facilities (Horsetooth Reservoir, Hansen Supply Canal, Windsor Extension), Alternative 2 features a Reclamation Action Option and a No Reclamation Action Option. These options represent different mechanisms for delivering NISP water to the project Participants. There are accompanying variations in the timing and magnitude of inflows to and outflows from Glade Reservoir, but the net effect on Poudre River (and South Platte River) streamflows below

the Hansen Supply Canal outlet would be the same and was evaluated as such. Alternatives 3 and 4 do not include a Reclamation Action Option.

Table 4-27 summarizes modeled NISP Poudre River and South Platte River diversions under the three action alternatives. Net Poudre River diversion is the sum of the Grey Mountain and exchange diversions; however, some variation may exist due to rounding of the source values. For Alternatives 3 and 4, Poudre River diversion values were adjusted as necessary to restore the modeled channel loss of 5% in order to represent river diversion rather than Cactus Hill Reservoir inflows.

Table 4-27. Summary of modeled diversions for NISP action alternatives, 2010 Current Conditions hydrology, IY 1950-2005, in AFY.

Alternative	Poudre River				South Platte River
	Net Poudre River Diversion	Grey Mountain	SPWCP Direct Flow Exchange from Larimer-Weld and New Cache Canals	SPWCP Reservoir Exchange from Terry Lake, Big Windsor, and Timnath Reservoir	Net South Platte River Diversion
Alternative 2	43,300	19,200	19,200	4,800	28,400
Alternative 3	49,200	21,900	21,700	5,400	30,000
Alternative 4	48,800	20,600	21,700	6,500	32,000

Alternatives 3 and 4 would have greater net diversions from both the Poudre River and the South Platte River compared to Alternative 2. This is due to the need to accommodate increased transit and storage losses (i.e., seepage and evaporation) associated with Cactus Hill Reservoir, while still delivering full project firm yield to the Participants.

The amounts of Grey Mountain water and water exchanged from Larimer-Weld and New Cache Canals are similar in each of the three action alternatives. For example, under Alternative 2, NISP would divert about 19,200 AFY from each of those sources, with the balance of project yield coming from the SPWCP reservoir exchanges. Alternative 4 would divert about 1,300 AFY less Grey Mountain water than Alternative 3, but would compensate by adjusting the source mix to divert 1,100 AFY more from Terry Lake, Big Windsor, and Timnath Reservoir. Based on the model results for all three alternatives, the mix of Poudre River water supply sources would be roughly 45% from the Grey Mountain right and 55% from the SPWCP exchanges.

In addition, for all three alternatives, the modeled evaporation from Galeton Reservoir was in the range of 3,800-4,000 AFY. This is reflected in the modeled South Platte River diversions, which are all generally consistent with the sum of SPWCP exchanges plus Galeton Reservoir evaporation.

Alternatives 3 and 4 would require larger net diversions from both the Poudre River and the South Platte River; this implies that both Cactus Hill alternatives would result in greater net changes to streamflows. Other factors influencing the differences between the proposed NISP action alternatives are as follows:

- Alternative 2: Section 4.2.1.1.3 describes the proposed flow augmentation program for Alternative 2. As reported in Section 4.2.1.3.3 (see Figure 4-7), the changes to

streamflows due to flow augmentation were seen most prominently in the model results for the downstream side of the Larimer-Weld Canal headgate but were also evident in the results for downstream of the Little Cache/Terry Lake headgate and at the Lincoln Street Gage. Other resources may report results for other locations within the affected reach, such as Martinez Park.

- Alternative 3: Compared to Glade Reservoir in Alternative 2, Cactus Hill Reservoir in Alternative 3 would have a larger active storage capacity (190,000 AF vs. 170,000 AF), a larger surface area (3,705 acres vs. 1,635 acres at maximum capacity), and less depth (159 feet vs. 257 feet maximum). Overall, Cactus Hill Reservoir would be wider and shallower than Glade Reservoir. In addition, the plains location of Cactus Hill Reservoir would require delivery of water through nearly 30 miles of the Poudre Valley Canal. Compared to Alternative 2, the resulting combination of increased evaporation and transit losses would require more water to be diverted to Cactus Hill Reservoir from the Poudre River in order to meet the Participants' delivery requirements. This is reflected in larger changes in modeled streamflows at the evaluated locations on the Poudre River and South Platte River.
- Alternative 4: As described in Section 4.2.5, Alternative 4 would divert SPWCP exchange water from the New Cache Canal at the historical point of diversion (the New Cache headgate, located east of I-25) rather than diverting this water upstream at the Poudre Valley Canal headgate, as would be done under Alternatives 2 and 3. The result for streamflows would be less dewatering of the reach from the Poudre Valley Canal headgate to the New Cache headgate (about 23 miles, including through Fort Collins) relative to Alternatives 2 and 3. From the Poudre Valley Canal headgate to the Larimer-Weld headgate, there would still be reductions in flow associated with Grey Mountain diversions and the SPWCP exchanges with Larimer-Weld, Terry Lake, and Big Windsor. Below the Larimer-Weld headgate, streamflows would be reduced due to Grey Mountain diversions and the SPWCP exchange with Timnath Reservoir. Downstream of the New Cache headgate, the only differences between Alternatives 3 and 4 would be associated with the comparative amounts of Grey Mountain diversions. At the Kersey Gage, model results for Alternatives 3 and 4 show similar combined volumes of Grey Mountain diversions on the Poudre River and SPWCP diversions from the South Platte River.

Figure 4-33 through Figure 4-37 provide comparisons of the three NISP action alternatives to 2010 Current Conditions hydrology, modeled over IY 1980-2005. The figures show median daily flows at the Canyon Gage, Lincoln Street Gage, Boxelder Gage, Greeley Gage, and Kersey Gage. Table 4-28summarizes median monthly flow changes associated with the action alternatives at the same locations. The y-axis scales in the figures have been adjusted to fit the data so that more detail is visible at lower flows. As noted in Section 4.2, the objective for the Surface Water section is to present the modeled diversions, reservoir levels, and changes in streamflow. No degree of impact intensity was assigned to the model results for surface water, as the other flow-related resources were evaluated using this information as the basis for those effects analyses.

Notable observations from these figures include the following:

- The similarities of the Alternative 2 (Run 3a, blue line) and Alternative 3 (Run 3b1, purple line) flows in the Canyon Gage, Lincoln Street Gage, and Boxelder Gage plots, and of all three alternatives runs in the Greeley Gage and Kersey Gage plots, imply that the modeled changes in median daily flows due to diversions under the Grey Mountain right are similar for all NISP action alternatives. The Alternative 2 flows are often slightly higher (i.e., less flow reduction relative to 2010 Current Conditions hydrology), consistent with the lower average volume of Grey Mountain diversions under Alternative 2.
- The Alternative 4 (Run 3b2, orange line) flows at the Canyon Gage, Lincoln Street Gage, and Boxelder Gage are clearly separated from the Alternative 2 and Alternative 3 flows. This is consistent with the expected lesser reduction in median flows as a result of diverting the New Cache exchange water downstream under Alternative 4.
- At the Lincoln Street Gage, the Alternative 2 flows can be clearly seen to trend above historical from December through April and again in September. The same is true in November, although less visible due to other flow lines. This is the expected result of the proposed flow augmentation program during these historical low flow periods, providing releases to maintain 10 cfs below the Larimer-Weld headgate and benefitting the reach from above the Larimer County Canal to the Timnath Inlet Canal headgate.
- The modeled changes to median daily flows at the Kersey Gage are similar for all action alternatives, reflecting both the Grey Mountain and South Platte diversions that are similar in frequency in magnitude. Alternative 2 flows would be higher in some months (December-February, June), consistent with Alternative 2 modeling showing the lowest average diversions (both Grey Mountain and SPWCP water rights).
- Given that Grey Mountain diversions from the Poudre generally would be limited to the peak runoff months (May-June of wet years), the occurrence of modeled flow changes at the Kersey Gage illustrates that in-priority diversions from the South Platte River for storage in Galeton Reservoir could happen in any month, including through the winter. The relative changes in flow at the Kersey Gage would be much less than on the Poudre River as a percentage of the 2010 Current Conditions hydrology flows because the magnitude of flow on the South Platte River is much greater than on the tributary Poudre River.
- From the modeled streamflows presented in these figures, it appears that most of the flow-reducing changes associated with each of the proposed NISP action alternatives would be concentrated in the reach from the Poudre Valley Canal headgate to the New Cache headgate, a distance of about 23 miles, including the segment of the Poudre River traversing Fort Collins. In this reach, modeled changes in streamflow are attributable to the Grey Mountain right in combination with one or more of the SPWCP direct flow and reservoir exchanges. Downstream of New Cache on the Poudre River, modeled changes in streamflow are limited to diversions under the Grey Mountain right, which is shown on the Greeley Gage figure to have very little effect on daily median flows outside of April through June.

Figure 4-33. Current Conditions Median Daily Flow with 90% Upper/Lower Confidence Intervals at DDM 5.63 (Canyon Gage), IY 1980-2005.

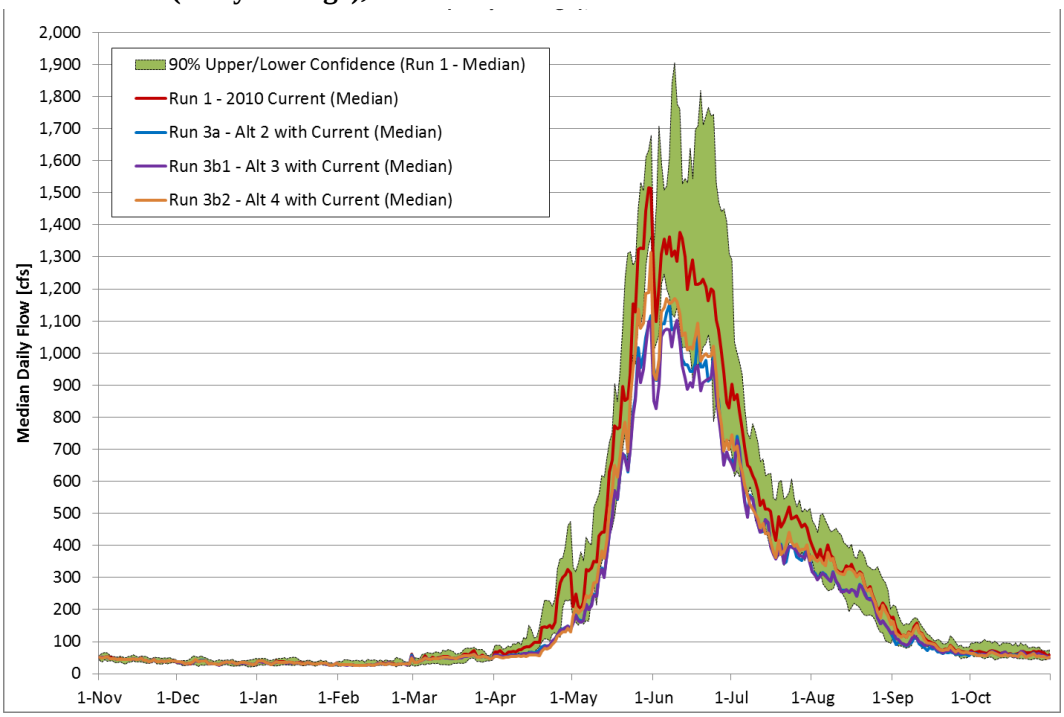


Figure 4-34. Current Conditions Median Daily Flow with 90% Upper/Lower Confidence Intervals at DDM 16.84 (Lincoln Street Gage), IY 1980-2005.

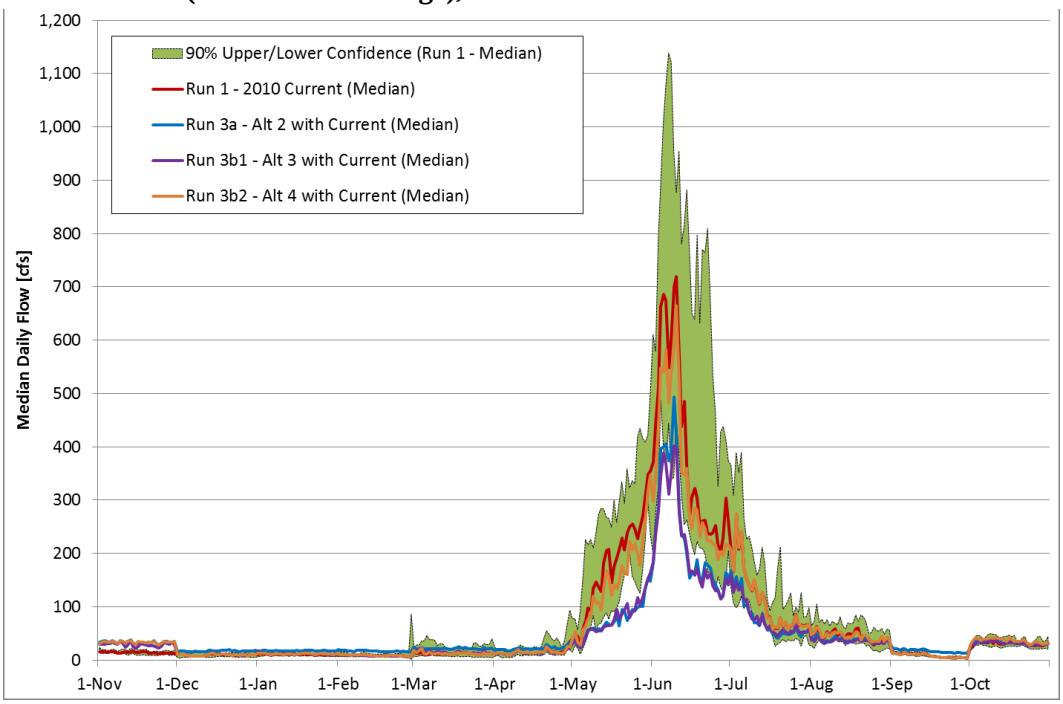


Figure 4-35. Current Conditions Median Daily Flow with 90% Upper/Lower Confidence Intervals at DDM 22.69 (Boxelder Gage), IY 1980-2005.

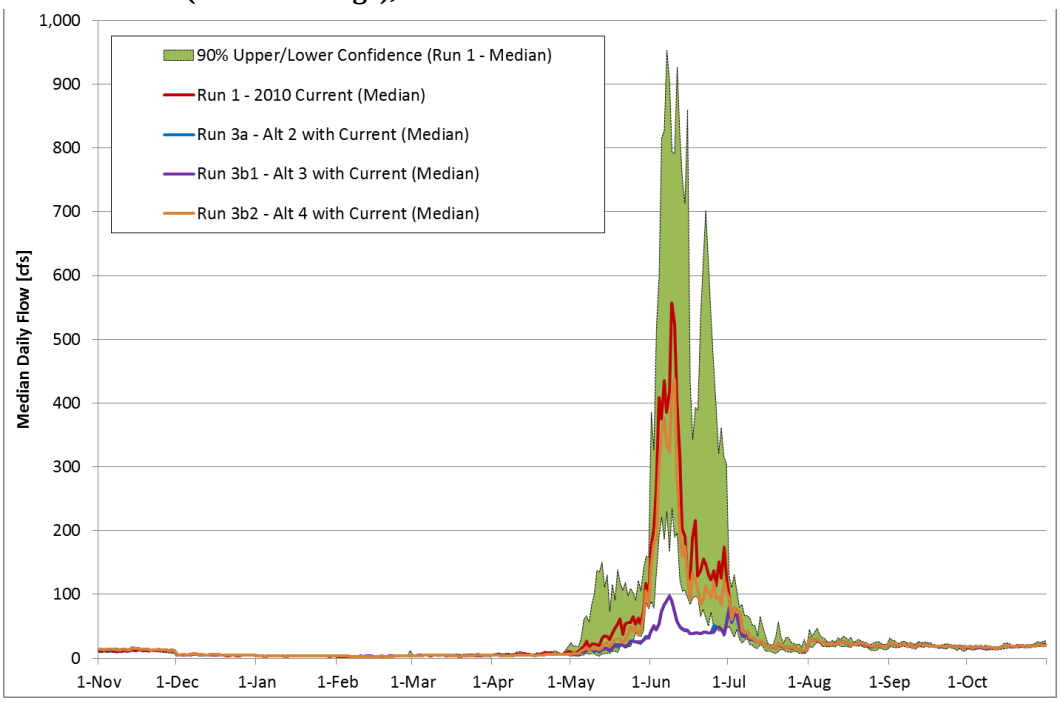


Figure 4-36. Current Conditions Median Daily Flow with 90% Upper/Lower Confidence Intervals at DDM 57.43 (Greeley Gage), IY 1980-2005.

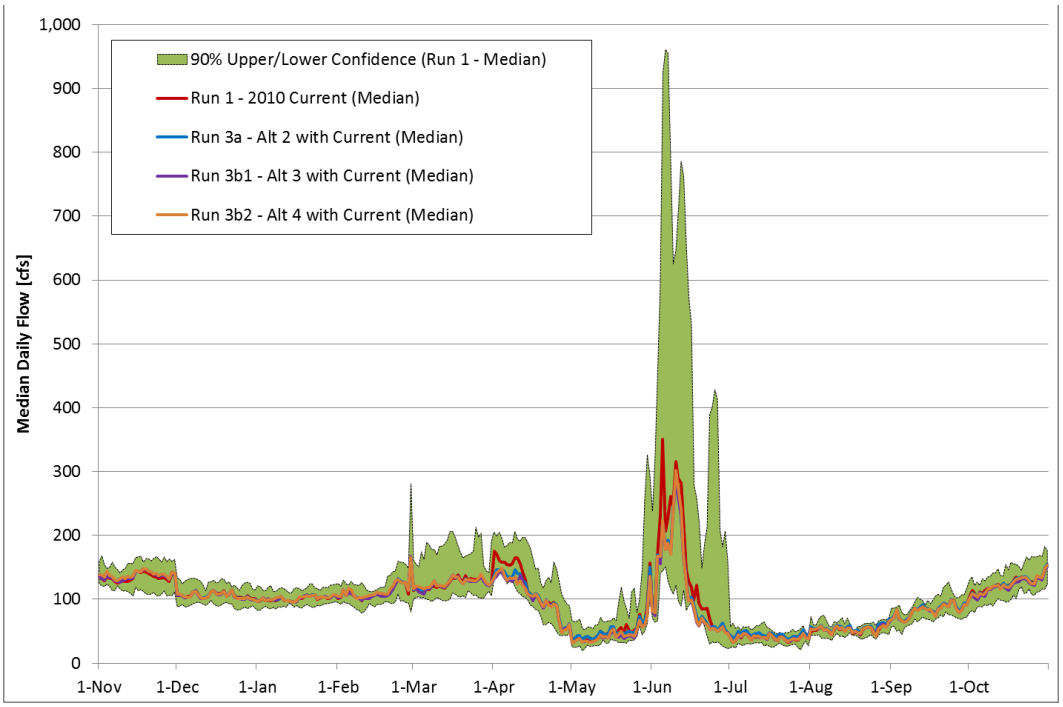


Figure 4-37. Current Conditions Median Daily Flow with 90% Upper/Lower Confidence Intervals at Kersey Gage), IY 1980-2005.

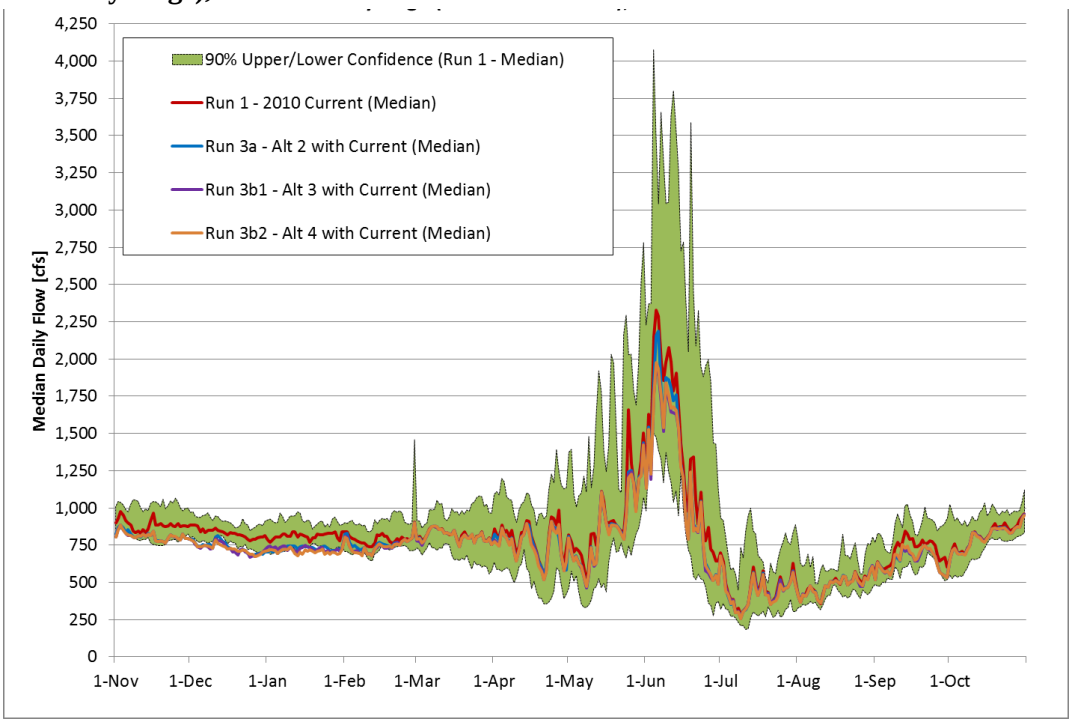


Table 4-28. Median monthly streamflow at gage locations in cfs (all years, IY 1980-2005).

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Annual
Canyon Gage (DDM 5.63)													
CTP Run 1 (2010 current)	48	38	39	31	53	169	792	1,266	571	313	107	67	90
NISP Run 3a (Alt 2)	48	38	39	31	51	88	543	1,034	442	253	87	62	75
NISP Run 3b1 (Alt 3)	48	37	39	30	50	89	528	989	438	247	92	62	74
NISP Run 3b2 (Alt 4)	48	37	39	32	51	80	623	1,074	486	309	102	56	75
Lincoln Street Gage (DDM 16.84)													
CTP Run 1 (2010 current)	14	12	11	9	17	27	201	368	168	55	10	36	28
NISP Run 3a (Alt 2)	35	18	18	18	27	29	65	275	92	40	18	35	32
NISP Run 3b1 (Alt 3)	30	12	12	8	19	20	78	229	104	38	10	34	30
NISP Run 3b2 (Alt 4)	35	12	11	9	18	21	164	338	168	57	10	38	33
Boxelder Gage (DDM 22.69)													
CTP Run 1 (2010 current)	11	5	4	3	4	8	33	238	39	28	24	20	17
NISP Run 3a (Alt 2)	13	6	4	4	4	6	16	129	29	27	24	20	15
NISP Run 3b1 (Alt 3)	13	6	4	4	4	6	16	82	33	27	24	20	15
NISP Run 3b2 (Alt 4)	13	6	4	3	4	6	29	206	39	28	24	20	17
Greeley Gage (DDM 57.43)													
CTP Run 1 (2010 current)	140	112	105	112	137	126	61	211	50	60	84	121	101
NISP Run 3a (Alt 2)	142	111	106	112	137	127	67	178	56	59	86	122	100
NISP Run 3b1 (Alt 3)	142	111	106	112	137	118	61	174	51	57	84	121	98
NISP Run 3b2 (Alt 4)	143	111	107	115	138	123	61	183	50	58	83	122	100
Kersey Gage													
CTP Run 1 (2010 current)	912	823	841	813	817	819	1,063	1,813	724	630	776	832	831
NISP Run 3a (Alt 2)	833	719	714	758	822	801	1,042	1,616	689	611	701	805	769
NISP Run 3b1 (Alt 3)	834	708	718	747	822	791	1,038	1,613	686	609	699	803	762
NISP Run 3b2 (Alt 4)	834	720	701	747	822	792	1,038	1,613	686	610	699	798	760

*Negative change in flow values indicate an increase in flow in NISP Run 3a compared to CTP Run 1.

4.3 SURFACE WATER QUALITY

This section addresses changes in surface water quality in the Poudre River, South Platte River, Horsetooth Reservoir, and the predicted water quality for each of the proposed reservoirs, as applicable for the action alternatives. The No Action Alternative was evaluated under Future Conditions hydrology only, as explained in Section 4.2.2 and, therefore, the indirect effects analyses for the No Action Alternative for the Poudre River mainstem are presented in Chapter 5.

The surface water quality analysis was revised from the DEIS based on public and agency comments on the NISP DEIS. In addition, new data were collected and several new water quality studies were conducted for the SDEIS using new water quality data and the results of the hydrologic modeling described in the Surface Water section (Section 4.2). Hydrologic data and existing water quality information was used to evaluate the potential water quality effects associated with changes in streamflow and reservoir storage, as well as the likely water quality in new reservoirs. Impacts to surface water quality reflect the indirect impacts associated with hydrologic changes to surface and ground water flow as a result of alternative actions. Possible effects to drinking water treatment plants (WTP) that rely on source water from the Poudre River or Horsetooth Reservoir were evaluated based on anticipated changes in chemical composition, including total organic carbon (TOC), at intake points. Potential effects on WWTPs were qualitatively evaluated by looking at how NISP operations might affect regulatory low flows used in setting effluent limitations. Because operation of the SPWCP under the action alternatives would impact the water quality of the Larimer-Weld Canal and New Cache Canal, changes in irrigation water quality for these canals and potential effects on crop yields were evaluated.

Primary reports and technical memorandum relied upon for the assessment of surface water quality impacts are listed below and provide additional detailed information.

- Stream Temperature and Dissolved Oxygen Analysis for NISP Supplemental Draft EIS – Summary of Current Conditions and Qualitative Anticipated Effects of NISP Alternatives (Hydros 2014a)
- Reservoir Comparative Analysis for the NISP SDEIS (Hydros 2014b)
- Northern Integrated Supply Project Supplemental Draft Environmental Impact Statement. Water Quality Assessment Report, Phase I (GEI 2015a)
- Northern Integrated Supply Project Supplemental Draft Environmental Impact Statement. Draft Water Quality Effects Technical Report (ERO and Tetra Tech 2015)

Also discussed are the potential direct effects to local water quality associated with construction related activities for dams, pipelines, canals, and other infrastructure. These primarily short-term impacts from ground disturbance, erosion, and stormwater runoff are similar in nature for all alternatives, although the magnitude of surface disturbances varies by alternative.

4.3.1 Methods

The evaluation of potential surface water quality effects for each of the alternatives used the results of output from the CTP hydrologic modeling as described in the Surface Water section (Section 4.2). Potential water quality effects were evaluated on about 51 miles of the Poudre River from the Canyon Gage downstream of the Poudre Valley Canal to the confluence with the South Platte River. South Platte River water quality was evaluated for the approximate 2.5 mile reach from the Poudre River confluence to the Kersey Gage.

Indirect effects associated with changes in streamflows are predicted to be the same for the Reclamation Action and No Reclamation Action Options. As explained in Section 4.2.3.4.1, a single set of modeled streamflows was evaluated for Alternative 2 because the net effects on streamflow below the Hansen Supply Canal outfall would, on average, effectively be the same under the Reclamation Action Option and the No Reclamation Action Option. Horsetooth Reservoir water quality was evaluated for Alternative 2, Reclamation Action Option because there would be changes in Horsetooth Reservoir storage operations with or without a pipeline from Glade Reservoir to Horsetooth Reservoir. Potential water quality in new reservoirs (Glade, Galeton, and Cactus Hill) was estimated based on source water quality, site and watershed conditions at each reservoir site, and comparisons with existing similar reservoirs where water quality data are available. Water quality parameters selected for evaluation includes those described in the Surface Water Quality Affected Environment (Section 3.3). Primary parameters of concern include temperature, dissolved oxygen, metals, and nutrients. Specific methodologies for these parameters are described in more detail below.

The results presented in the SDEIS reflect the first of two phases of water quality analysis. The first phase includes a qualitative assessment of likely changes in various water quality parameters for multiple locations within the affected environment for each of the alternatives. The intent of the first phase of analysis was to determine which water quality constituents and locations are most likely to be affected by hydrologic changes. Results of this first phase of analysis will then be used to determine which parameters can be quantitatively modeled for those locations most likely to be sensitive to hydrologic changes. The Phase I evaluation also determined locations on the Poudre and South Platte Rivers with gaps in water quality data and additional data collection was initiated in 2014 to support water quality modeling for the Poudre River in Phase II. Results of Phase II water quality modeling will be presented in the FEIS.

The intensity of water quality impacts was characterized using the following terms:

- **No effect:** no discernable or measurable effect on water quality. Water quality standards or criteria would not be exceeded.
- **Negligible:** water quality effects would be at the lowest levels of detection, barely measurable. Effects would be well below water quality standards or criteria, and would be within historical water quality conditions.
- **Minor:** water quality effects would result in a detectable change, but the change would be slight and mostly within water quality standards and historical water quality conditions.

- **Moderate:** water quality effects would result in a clearly detectable change, with measurable effects. Potential exceedances of a water quality standard or criteria are likely. Historical water quality conditions would be altered.
- **Major:** water quality effects would be readily apparent, measurable, and outside of the historical water quality condition. Frequent exceedances of a water quality standard or criteria would occur.

4.3.1.1 Reservoirs

4.3.1.1.1 Existing Reservoirs

Potential effects to Horsetooth Reservoir water quality were evaluated for the Alternative 2 Reclamation Action Option because there would be a change in reservoir operation. Reservoir operational changes would be minimal under both the No Reclamation Action Option and the Reclamation Action Option if a pipeline from Glade Reservoir to Horsetooth Reservoir is not constructed. Delivery of water from Glade Reservoir to Horsetooth Reservoir via a new pipeline could result in changes in Horsetooth Reservoir water quality under the Reclamation Action Option. Average annual (3,600 AF) and maximum annual (9,700 AF) water deliveries from Glade Reservoir to Horsetooth Reservoir were modeled to estimate a range in potential impacts for the Reclamation Action Option with a pipeline.

Water quality effects at Horsetooth Reservoir were evaluated (ERO and Tetra Tech 2015) using output from a two-dimensional hydrodynamic water quality model (Hydros 2013). The Horsetooth Reservoir model simulates observed conditions from 2005 through September 2010 for nutrient concentrations, algal growth, TOC concentrations, dissolved oxygen, and water temperature at various reservoir depths and locations, as well as outflows at Soldier Canyon Dam and the Hansen Supply Canal. Hydros modified the model slightly to allow for simulation of NISP pipeline inflow into Satanka Bay located at the north end of the reservoir. Poudre River inflow water quality was based on average stream water quality from 1972 to 2005 near the point of diversion at the Poudre Valley Canal. Poudre River average and maximum TOC values were used as input values to determine the sensitivity of the reservoir to different levels. Additional tracer-type analysis was completed to predict total dissolved solids, arsenic, copper, and selenium for a simulated time series based on the percent of water from the Glade Reservoir pipeline delivered to Horsetooth Reservoir. Because no new sources of water would be introduced into Carter Lake or Flatiron Reservoir and, with the exception of additional pumping of Pump Unit 3, the net operational changes would be very small, water quality impacts for these reservoirs are expected to be negligible and thus, no detailed analysis was conducted.

4.3.1.1.2 Proposed New Reservoirs

For Alternatives 2, 3, and 4, the water quality of Glade, Cactus Hill, and Galeton Reservoirs was predicted using a mass balance model developed for each reservoir. For the No Action Alternative, the water quality of Cactus Hill Reservoir was evaluated qualitatively because it is unknown at this time how the Participants would operate the reservoir. Estimated monthly inflows, outflows, reservoir storage volumes, surface area, and surface elevations were based on hydrologic model results for a 56-year operational period from 1949 to 2005 (CDM Smith and

DiNatale 2013). The conceptual site model for the prediction of water quality for each reservoir basin assumed a certain amount of readily available chemical mass within the reservoir basin. The readily available chemical mass from soils in the basin was assumed to leach into the reservoir water. Chemical mass also was added to the reservoir from the input water source (Poudre or South Platte Rivers) and precipitation. Further details regarding assumptions and mass balance modeling can be found in the Draft Water Quality Effects Report (ERO and Tetra Tech 2015). In addition, a comparative analysis was conducted using data from existing reservoirs with similar characteristics to the proposed new reservoirs (Hydros 2014b). Horsetooth Reservoir and Carter Lake were used to provide an indication of the likely water quality for Glade Reservoir. Jackson and Riverside Reservoirs were used to approximate likely water quality in Galeton Reservoir. No existing reservoir comparable to Cactus Hill Reservoir was identified; however, some inferences were made based on source water quality, Alternatives 3 and 4 reservoir operations, and relative comparisons with other reservoirs.

4.3.1.2 River Constituent Analysis

A qualitative water quality analysis was conducted to evaluate the effects associated with implementation of NISP alternatives. The analysis was based on changes in hydrologic conditions in the Poudre River from the canyon mouth to the Kersey Gage on the South Platte River. As described in the Affected Environment (Section 3.3), existing water quality data for the study area was compiled and analyzed to determine which parameters are likely to be sensitive to changes in hydrology and at what locations. The selected water quality sites were then paired with CTP hydrologic nodes to evaluate changes in low flow conditions at these sites for the NISP alternatives. Representative sites along the Poudre and South Platte Rivers selected for evaluation of potential effects are summarized in Table 4-29 and shown in Figure 4-38 and Figure 4-39.

Table 4-29. Representative sites for characterizing water quality effects on the Poudre River and South Platte River.

Segment / Location	River Mile	Hydrology Node
Poudre River – Segment 10		
Canyon mouth	55.8	Canyon Gage
City of Greeley Bellvue WTP Diversion	55.3	US/DS Greeley Filters Pipeline intake
Upstream of Hansen Supply Canal	54.8	US/DS Greeley Filters Pipeline intake
Shields Street in Fort Collins	46.1	Shields Street
Poudre River – Segment 11		
Lincoln Street USGS Gage	44.3	Lincoln Street Gage
Prospect St in Fort Collins	40.6	Between Timnath inlet and Fossil Creek inlet
Nature Center	40.0	US/DS Fossil Creek inlet headgate
Above Boxelder Creek	39.0	Boxelder Gage
Poudre River – Segment 12		
Harmony Road	35.6	US New Cache headgate
Larimer County Rd 5	35.3	US New Cache headgate
Downstream of Fossil Cr and New Cache Canal	32.7	US New Cache headgate
Staff Gage East of Windsor	22.7	US/DS Windsor WWTP
Below Windsor/Kodak WWTP at Hwy 257	19.6	US/DS Kodak WWTP
Farmer's Spur	13.6	2D-GRE
Upstream of City of Greeley WWTP discharge point	5.2	US/DS Greeley WWTP discharge
Fern St by USGS Gage	2.9	Greeley Gage
South Platte River – Segment 1b		
Kersey	168.4	Kersey Gage

US=Upstream; DS=Downstream.

Figure 4-38. Water Quality Sites along Segments 10 and 11 of the Poudre River.

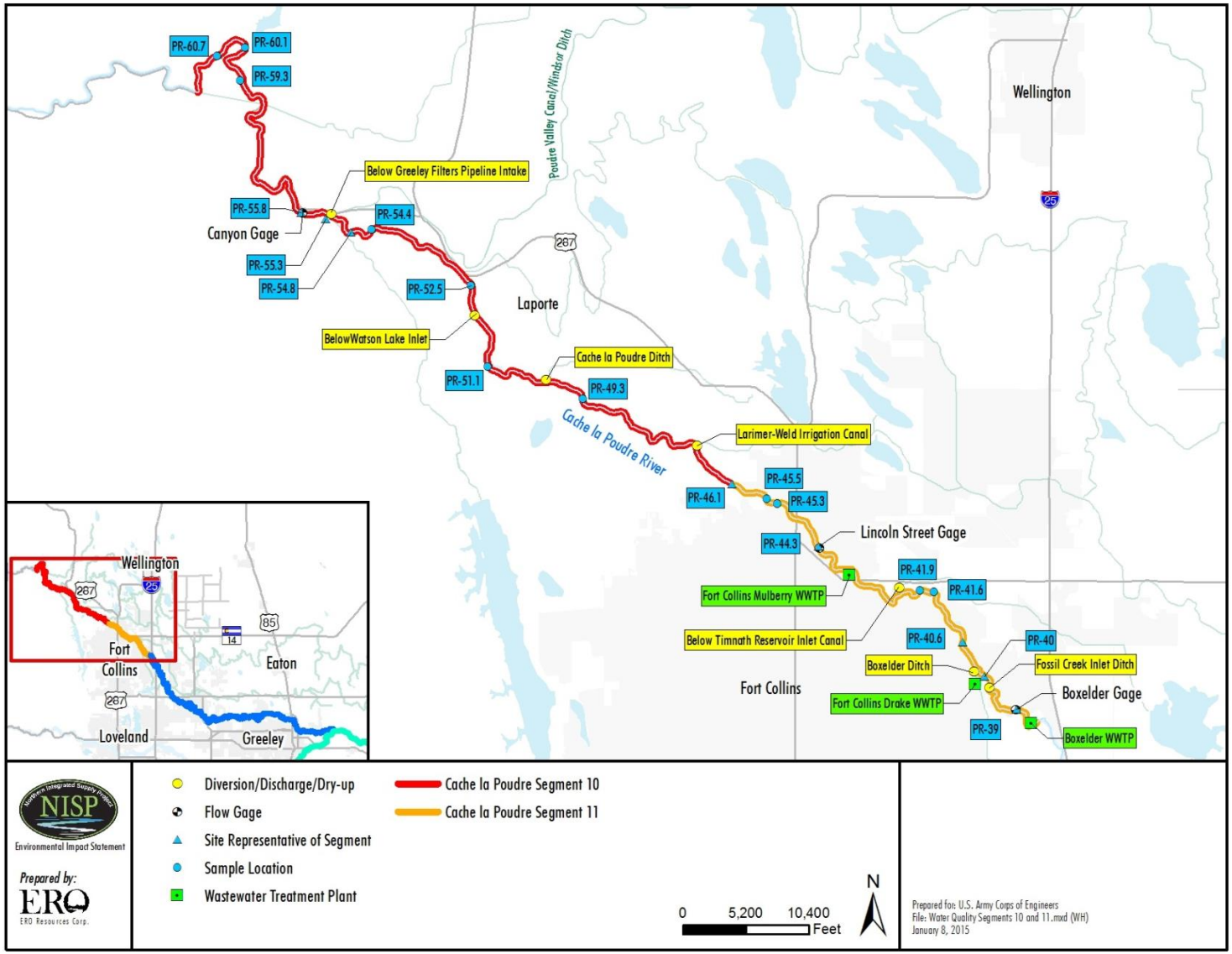
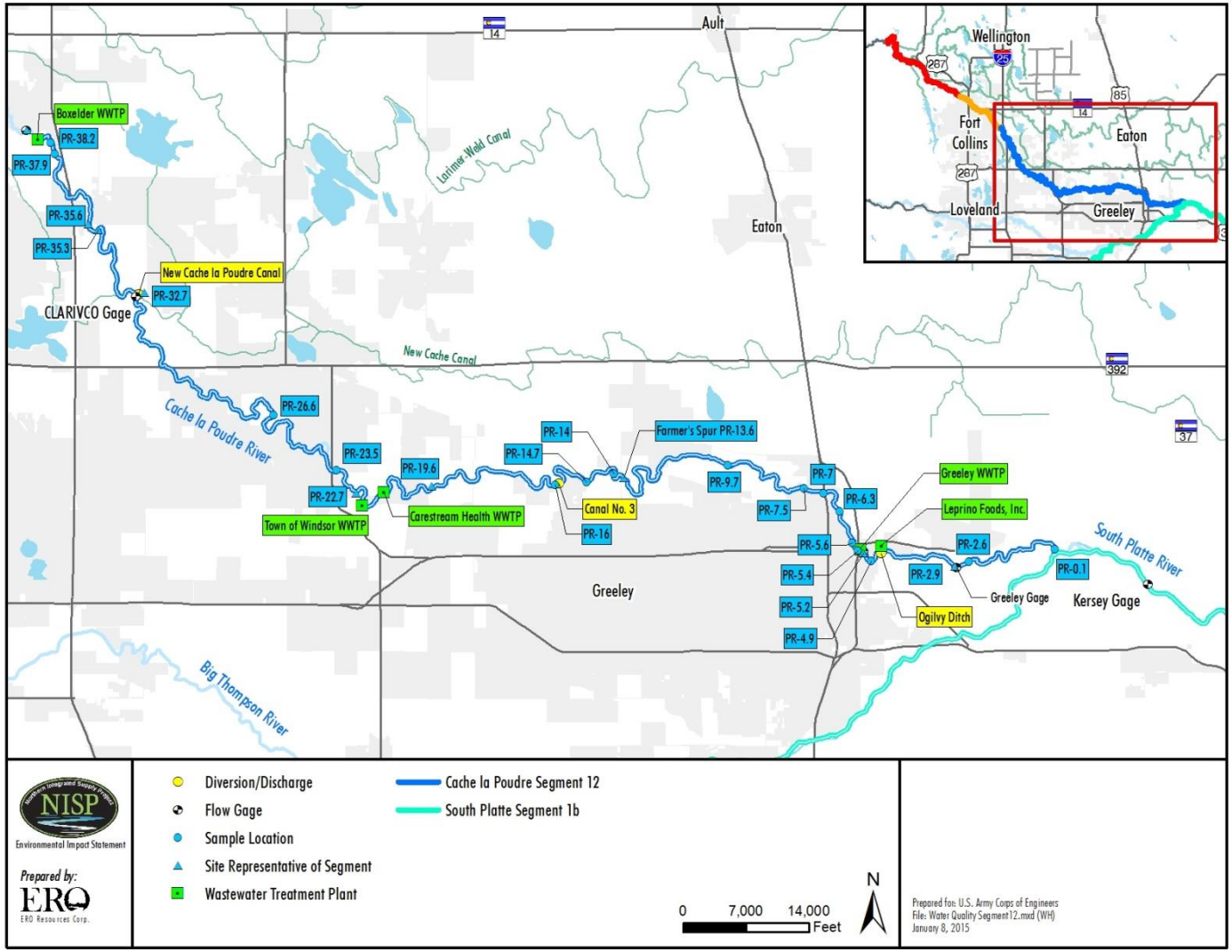


Figure 4-39. Water Quality Sites along Segment 12 of the Poudre River and Segment 1b of the South Platte River.



At key gaged streamflow locations, the concentration-flow relationships for parameters of interest were evaluated to test the relationship between parameter concentrations and changes in hydrology. While diversions would not introduce any new contaminants into the stream system or necessarily change the concentration of a parameter, diversions would affect the load and volume of the constituent. Point source hydrologic inputs and outputs to the river system from other ongoing irrigation diversions, tributary inflows, and WWTP discharges alter both the concentration and the load and thus are of concern when combined with the hydrologic changes associated with NISP operation. Ground water input to the stream system is another key variable that influences stream water quality. Ground water inputs can alter the concentration and the load in the stream; however, ground water's relative contribution to surface water flow and quality is not well defined because there is insufficient information on both alluvial flow and ground water quality along the Poudre River, especially east of I-25 to the confluence with the South Platte River.

To evaluate the concentration-flow relationship, mean daily discharge data were retrieved from each gage for the period from January 1980 to September 2014, and exceedance probabilities were calculated for the daily data. The flow concentration relationship analysis paired a measured concentration with a flow value recorded on the same day. The flow concentration scatter plot then shows the flow values based on the percentiles. Exceedance probabilities were converted to probabilities of occurrence (i.e., percentiles) to make comparisons to the 20th percentile CTP hydrology summaries more intuitive. The water quality database generally contained instantaneous flow (cfs) results for many of the sampling events at each of the water quality monitoring stations, although if a water quality result (i.e., sample event) was not paired with a flow measurement, then the daily flow record was queried for the mean daily flow datum. Each water quality flow result (i.e., sample event) was assigned a probability of occurrence based on the probability of occurrence calculated for the gaged stream data. For each parameter of interest, the measured concentrations were plotted against the probability of occurrence to characterize changes in concentrations with changes in flow. This analysis was useful in predicting parameters likely to be sensitive to changes in hydrology from the NISP alternatives.

To assist in the evaluation of potential impacts, monthly and longitudinal water quality analyses were performed on the selected parameters of interest to examine any seasonal or longitudinal trends in the data from upstream to downstream as related to point source inputs or diversions. Boxplots representing the 25th, 50th, and 75th percentiles, including the upper and lower 95% confidence intervals for each parameter with outliers were plotted either by site (longitudinal) or by month (seasonal) for each site(s) to evaluate patterns in the data. In addition, each parameter was plotted against the timeline to evaluate whether concentrations have increased, decreased, or stayed the same over time. These analyses helped to determine if there were any major discrepancies between sites within a segment with respect to data quality, point source inputs, or diversions.

The predicted changes in flow in the Poudre River and South Platte River combined with information on the seasonal concentration relationships, temporal trends analysis, and concentration flow relationships were used to qualitatively assess the potential effects on key water quality parameters.

4.3.1.3 River Temperature and Dissolved Oxygen

Median streamflow values from CTP hydrologic model runs were compared at nine locations in the Poudre River, from the Canyon Gage to the confluence with the South Platte River, and in the South Platte River at the Kersey Gage. Potential changes in stream temperature focused on the direction (increase or decrease) and timing of projected changes in flow associated with each of the alternatives at different locations. Emphasis was given to the irrigation season because this is the most sensitive period of concern for temperature and dissolved oxygen (DO) and when the majority of NISP Poudre River diversions would occur. Inflows to the rivers from tributaries, diversions, canals, WWTPs, and ground water were also considered. Results of the analysis were used to qualitatively estimate effects to Poudre and South Platte Rivers temperature and DO.

4.3.1.4 Water Treatment Plants

Potential impacts to WTP operations for entities with water intakes on the Poudre River or Horsetooth Reservoir were evaluated to determine if additional water treatment would be needed as a result of changes in water quality under the alternative actions. The Fort Collins Water Treatment Facility (FCWTF) and the Tri-Districts Soldier Canyon Filter Plant (SCFP) take raw water from Horsetooth Reservoir and thus, their operations could be affected by the Alternative 2 Reclamation Action Option. The Greeley-Bellvue WTP (Bellvue WTP), which takes water out of the Poudre River near the canyon mouth, could be affected by changes to Poudre River water quality under all alternatives, including the No Action Alternative. Operational data collected from the WTPs was used to understand existing operations and assess effects. Data included influent and effluent pH, flow rates, treatment chemical dosages, influent and effluent TOC concentrations, influent and effluent turbidities, influent and effluent alkalinities, temperature, disinfection by-product concentrations in the distribution system, filter run times, and chlorine doses and residual concentrations. The impact analysis also relied on the Horsetooth Reservoir water quality modeling results (Hydros 2013), which modeled TOC concentrations from the Hansen Supply Canal and the Soldier Canyon Dam outflow, to determine the potential impact to the three WTPs. Effects to river water quality at Greeley's raw water diversion from the Poudre River were evaluated qualitatively because water for all alternatives would be diverted about a mile upstream at the Poudre Valley Canal (Alternative 4 also would divert water downstream of Greeley's raw water diversion and the No Action Alternative would divert water at multiple locations) where water quality concentrations in the Poudre River would be very similar to concentrations at Greeley's diversion point.

4.3.1.5 Wastewater Treatment Plants

The WQCD performs a water quality assessment and develops effluent limits for WWTPs based on regulatory low flows and water quality standards for the receiving stream. Low flows are used to identify how much dilution of the wastewater effluent is available in the receiving stream under maximum case conditions. Regulatory low flows include the chronic 30-day average low flow with an average 1-in-3-year recurrence (30E3) and the acute 1-day low flow with an

average 1-in-3-year recurrence (1E3). The regulatory low flows are calculated using the DFLOW statistics program (EPA 2006) with the most recent 10 years of measured daily hydrology data, or estimated hydrology if measured data are unavailable. If the NISP alternatives alter the regulatory low flow conditions, the allowable effluent limits for WWTPs could be affected.

To qualitatively evaluate potential impacts on WWTPs, the 30-day regulatory low flows (30E3) were identified for each WWTP permittee and compared to minimum monthly flow data (November 1979 to October 2005) from the CTP hydrology model (CDM Smith and DiNatale 2013). The CTP minimum monthly average flow data were used to establish a conservative worst-case low flow scenario for each WWTP. The comparison of the minimum monthly average flow to the 30-day regulatory low flow (30E3) does not provide a direct effects comparison, yet can be used in a heuristic manner to evaluate potential effects. From a regulatory standpoint, the 30-day low flow condition occurs once every 3 years, and when placed in the context of NISP modeled hydrology, this regulatory low flow would occur approximately nine times over a 26-year period. This conservative approach is based on the minimum monthly average flow that occurs one time over a 26-year period.

The minimum monthly average flows for the CTP modeled hydrology were calculated and compared to the regulatory 30E3 low flows for each month. Where practicable, CTP nodes that correspond to gaged stream locations were used in this analysis. Measured data from these same gaged locations were also used by the state for their regulatory low flow assessment. The CTP hydrology model accounts for these various sources of flow and diversions, including tributary and ground water influences. These comparisons were performed for each NISP alternative. The regulatory 1-day low flow (1E3) using CTP daily disaggregated data were not evaluated because the CTP modeled monthly average flow conditions then imposed a daily flow pattern on these data. In order to calculate 1E3, measured daily flows must be used. Potential effects on WWTPs for all alternatives are discussed in Section 4.3.7.

4.3.1.6 Irrigation Water Quality

Water stored in the proposed Galeton Reservoir under the action alternatives would be delivered to both the Larimer-Weld and New Cache canal systems from April through October in exchange for water diverted from the Poudre River. The effects on crop yield from changes in salinity and selenium concentrations in the Larimer-Weld Canal and the New Cache Canal were evaluated quantitatively. The effects on crop growth from using irrigation water with higher salinity were evaluated by Hoffman (2012). The effects to irrigation water quality under the No Action Alternative were evaluated qualitatively because water would be conveyed by various canals, and details on these changes are not known. In addition, new diversions on existing canals would be needed under the No Action Alternative.

4.3.1.7 Construction Related Impacts to Water Quality

Construction related impacts to water quality were qualitatively evaluated based on the relative disturbance associated with implementation of each of the alternative actions.

4.3.2 Effects Common to All Alternatives

All alternatives involve water diversions from the Poudre River and new reservoir storage. The action alternatives also include water diversions from the South Platte and new storage at the proposed Galeton Reservoir. The amount, location, and timing of water diversions vary by alternative, but similar types of effects to surface water quality are anticipated from changes in hydrology. This section describes some of the key factors known to impact water quality and types of impact that would occur from NISP operations. Additional detail on specific impacts is included in the subsequent discussion for each alternative.

The 404(b)(1) Guidelines at 40 CFR 230.10(b) specify that no discharge of dredged or fill material may be permitted if it will cause or contribute to violations of any applicable State water quality standard. Therefore, in order for the proposed Project to be permitted, the District must propose measures to avoid causes or contributions specifically attributable to the Project that would result in standard violations. The disclosure of potential effects to water quality is based on the evaluation of effects without consideration of the avoidance measures proposed by the District (Appendix F).

4.3.2.1 River Constituents

All action alternatives would involve diversions from the Poudre River that would result in changes in the timing and volume of streamflow. Diversions from the South Platte River also would be common to the action alternatives and impact flows. While diversions would not affect the concentration of various constituents, they would alter the load. Diversion of surface flow alters the stream water composition downstream of the diversion. The percent of stream composition that is surface water versus ground water would likely shift and that shift has the potential to change the parameter concentration. However, the relative percent contribution of ground water to surface flows in this system is not known. The contribution of ground water is expected to be high, especially below dry-up points (Table 4-7), but it is difficult to predict how ground water influx would alter the system. The flow changes in the Poudre and South Platte Rivers expected under all action alternatives, in combination with other inputs and outputs to the system, have the potential to affect water quality in some locations and some time periods. Temperature-sensitive stream segments and months of concern are summarized in Table 4-30. Designation of temperature sensitivity is based on review of observed temperature data and existence of conditions near or exceeding relevant temperature standards.

4.3.2.2 River Temperature

Potential exceedance of temperature standards in the Poudre River and South Platte River is of concern in several locations during certain times of the year. Stream segments and months of concern are summarized in Table 4-30.

Table 4-30. Temperature sensitive locations and times for Poudre River and South Platte River stream segments.

	Poudre River			South Platte River to Kersey Gage
	Segment 10	**Segment 11**	**Segment 12**	
Location	Canyon Gage to Hansen Supply Canal, Larimer-Weld Canal to Shields St.	Reach between Fossil Creek Inlet and Boxelder Creek	Entire reach is not currently very sensitive absent major changes in ground water contributions*	Kersey Gage exhibits DM exceedances, though not highly sensitive of Poudre River inflows, which tend to be cooler in key months.
Timing	Exceeds DMs and MWATs in March (shoulder season) and July through early September	Primarily exceeds DMs July and August	Occasionally approaches temperature standards from June through September (primarily MWAT), but flow-rate sensitivity appears to be limited by significant cooler ground water inflows under current conditions.	Exceeds DM standards in July at Kersey Gage, June to Sept. downstream of Kersey.

*Current data indicate limited temperature sensitivity in this reach, due in part to the effects of inflows from cooler ground water. If major changes to ground water inflows occur due to agricultural dry-up (e.g., this is potential outcome of the No Action Alternative, depending on the final augmentation approach that would be implemented), this reach could become temperature sensitive.

A number of key factors are known to affect stream temperature, including, but not limited to:

- Flow rates
- Meteorological conditions (e.g., air temperature, solar radiation, humidity, and wind)
- Channel cross sectional geometry, grade, roughness (as they affect water depth for a given flow rate)
- Temperature of inflows (diffuse and point inflows)
- Channel shading
- Bed material (color and heat transfer properties)

NISP operations would primarily impact temperature as a result of changes in flow rates from stream diversions. Lower flow rates, particularly during the irrigation season, could result in higher stream temperatures, in the absence of changes to other key factors (above). Thus, all NISP alternatives would be expected to increase stream temperatures at times in some reaches of

the Poudre River. Additional detail on the conceptual understanding of the system and qualitative anticipated effects of NISP alternatives on stream temperature are provided in Hydros (2014a).

4.3.2.3 River Dissolved Oxygen

Reduced flows in the Poudre and South Platte Rivers have the potential to impact dissolved oxygen concentrations. Sensitive reaches are described in Table 4-31.

Table 4-31. Dissolved oxygen sensitive locations and times for Poudre River stream segments and South Platte River.

	Poudre River			South Platte River, Poudre Confluence to Kersey Gage
	Segment 10	**Segment 11**	**Segment 12**	
Location	Not highly sensitive relative to Aquatic Life Cold II standard designation	Localized areas across the entire segment may be somewhat sensitive to changes in flow rate.	Possible sensitivity in areas across the entire segment. Sensitive to inflow water sources, changes in flow rate.	Not a sensitive reach
Timing	NA	Summer months	Summer months, including nighttime response (esp. downstream portion of the segment)	NA

NA=Not Applicable.

A number of key factors are known to affect dissolved oxygen, including, but not limited to:

- Re-aeration (including effects of diversion dams)
- Stream temperature (primarily as it affects DO saturation, reaction rates [e.g., organic matter decay rates, nitrification], and biological processes [e.g., photosynthesis and respiration], and reaeration)
- Sediment oxygen demand from the streambed (the effect of which can be strongly affected by flow rate and water depth)
- Loading of organic matter and ammonia (as decomposition results in a sag in DO downstream)
- Photosynthesis (and respiration) by phytoplankton, periphyton, and macrophytes
- Concentration of DO in inflows (ground water, channelized surface and point source inflows, and distributed surface inflows)

NISP operations would primarily impact DO as a result of changes in flow rates from stream diversions. Changes in flow rate in turn affect water temperature, the impact of sediment oxygen demand, and the relative contribution of various water sources to river flows. Thus, all alternatives would have some degree of impact on DO levels in the Poudre and South Platte Rivers.

4.3.2.4 Reservoirs

All action alternatives include construction of Galeton Reservoir as part of the SPWCP with deliveries from the South Platte River. Thus, the water quality in Galeton Reservoir would be the same for all action alternatives as described in Section 4.3.5.1.3.

4.3.2.5 Irrigation Water Quality

All action alternatives include the SPWCP with releases from Galeton Reservoir to the Larimer-Weld and New Cache Canals or from direct delivery from the South Platte. Effects on irrigation water quality would be similar for all action alternatives as described in Section 4.3.4.4.

4.3.2.6 Water Treatment Plants

All alternatives have the potential to affect the intake water quality for the Greely Bellvue WTP located downstream from the Poudre Valley Canal diversion due to changes in flow under NISP operations. However, none of the alternatives would adversely impact TOC concentrations or water treatment requirements as discussed for Alternative 2 in Section 4.3.4.5, Alternative 3 in Section 4.3.5.5, and Alternative 4 in Section 4.3.6.5. Only Alternative 2 with the Reclamation Action Option has the potential to affect intake water quality for WTPs using water from Horsetooth Reservoir as described in the above referenced section.

4.3.2.7 Wastewater Treatment Plants

All action alternatives would alter flows in the Poudre River in reaches where seven permitted WWTPs are currently operating. A reduction in flow that impacts the regulatory low flow requirements for these WWTPs could affect the effluent limits and WWTP treatment requirements for discharges. Impacts on WWTPs are discussed in detail in Section 4.3.7.

4.3.2.8 Construction Related Impacts to Water Quality

All alternatives include ground disturbances for construction of dams, pipelines, roads, and other infrastructure. Ground disturbances have the potential for erosion that could lead to sedimentation of nearby water sources. Local impacts to water quality from construction disturbances and equipment operation would be addressed primarily by implementation of erosion, sediment, and pollutant control measures as regulated by the CDPHE. A Colorado Discharge Permit System (CDPS) and Stormwater Management Plan (SWMP) that includes Best Management Practices (BMPs) to reduce or eliminate possible water quality impacts would be required prior to construction for all alternatives. Water quality impacts from construction related activities would generally be short-term and minimal with implementation of a SWMP.

4.3.3 No Action Alternative (Alternative 1)

Under the No Action Alternative, the delivery of water to NISP Participants would occur from the transfer of about 45,200 AFY of agricultural water supplies from the Poudre and Big Thompson Basins. On the Poudre River, direct flow diversions would be exchanged from the Larimer-Weld Canal and the New Cache Canal upstream to the Poudre Valley Canal. Existing reservoirs would be used and a new 120,000 AF Cactus Hill Reservoir would be constructed.

4.3.3.1 Reservoirs

Under the No Action Alternative, water would be stored in the existing Big Windsor and Lone Tree Reservoirs and a new Cactus Hill Reservoir. The No Action Alternative was evaluated under Future Conditions hydrology, as explained in Section 4.2.2 and, therefore, the indirect effects analyses for reservoirs is presented in Chapter 5.

4.3.3.2 Poudre and South Platte Rivers

The No Action Alternative was evaluated under Future Conditions hydrology, as explained in Section 4.2.2 and, therefore, the indirect effects analyses for No Action Alternative for the Poudre River and South Platte Rivers are presented in Chapter 5.

4.3.3.3 Irrigation Water Quality

Under the No Action Alternative, the Participants would construct infrastructure to convey water via the Larimer-Weld Canal, New Cache Canal, and Poudre Valley Canal from different diversion points on the Poudre River and by the Home Supply Canal diverted from the Big Thompson River. Insufficient information is available at this time to predict effects to canal water quality because the exact quantity of water to be diverted by the Participants and the locations of the diversions are unknown for the No Action Alternative.

4.3.3.4 Water Treatment Plants

Potential effects to Greeley's water from the Poudre River at the canyon mouth for its Bellvue WTP are possible from diversions one mile upstream at the Poudre Valley Canal under the No Action Alternative. Because no effects on TOC concentrations at the Greeley diversion are anticipated from No Action Alternative diversions (see discussion on TOC for Alternative 2 in Section 4.3.4.5), there would be no impact to Bellvue WTP operations. The No Action Alternative would not impact Horsetooth Reservoir water quality and WTPs that take water from the reservoir.

4.3.3.5 Construction Related Impacts to Water Quality

Temporary ground disturbance on about 1,104 acres for construction of conveyance facilities and the Cactus Hill Reservoir Dam could result in erosion and possible sedimentation of nearby

streams. Impacts would generally be short-term and minor following reclamation and revegetation.

4.3.4 District's Preferred Alternative (Alternative 2)

Under Alternative 2, diversions from the Poudre River at the Poudre Valley Canal would affect water quality downstream to the Kersey Gage on the South Platte River. Construction of Glade Reservoir to store and release Poudre River diversions and Galeton Reservoir to store and release South Platte River diversions could also impact stream, irrigation canal, and reservoir water quality. The Reclamation Action Option also has the potential to affect water quality in Horsetooth Reservoir.

4.3.4.1 Projected Reservoir Water Quality

4.3.4.1.1 Glade Reservoir

Water quality in a new 170,000 AF Glade Reservoir would be driven primarily by the quality of Poudre River diversions to fill the reservoir, in-basin influences during the initial fill, and long-term reservoir operations. Water quality during initial reservoir filling would be affected by the release of nutrients and organic matter in the soil. During this period water quality may be impaired by high suspended solids, elevated nutrient concentrations, and potentially high concentrations of algae (Lewis 2003). Drawdowns and filling during reservoir operations may result in shoreline erosion and increased turbidity and sediment concentrations.

It is anticipated that Glade Reservoir would likely be classified as Aquatic Life Cold 1, due to its similarity to Horsetooth Reservoir. If a direct pipeline is constructed between Glade and a WTP, then the reservoir would qualify to have a Direct Use Water Supply sub-classification. Direct Use Water Supplies are a subclassification of the Domestic Water Supply classification for lakes and reservoirs that have a raw water supply intake directly connected to a water treatment facility. The default chlorophyll *a* interim value for Direct Use Water Supply reservoirs that need extra protection from a drinking water perspective is 5 µg/L averaged from March to November.

Predicted water quality for Glade Reservoir based on a mass balance analysis once the reservoir stabilizes following initial filling is shown in Table 4-32 (ERO and Tetra Tech 2015). Average total phosphorus concentrations are estimated to be about 0.043 mg/L, which would exceed anticipated standards. Phosphorus concentrations in the Poudre River are typically highest during peak snowmelt runoff, which is when the majority of Alternative 2 diversions would occur. Total phosphorus in the reservoir would generally decrease as a result of biomass uptake and particulate sedimentation (Lewis 2003). Average nitrogen concentrations are estimated to be 0.037 mg/L. Nitrates are typically used by phytoplankton during the growing season, when nitrate levels drop sharply.

Table 4-32. Estimated constituent concentrations in Glade Reservoir under Alternative 2 compared to anticipated standards, Carter Lake, and Horsetooth Reservoir concentrations.

Parameter	Estimated Average Concentration (mg/L)	Anticipated Standard (mg/L)	Carter Lake* (mg/L)	Horsetooth Reservoir** (mg/L)
Ammonia as N	0.013	pH/Temp Dependent	0.0038	0.0039
Dissolved Arsenic	0.0003	0.150	0.0002	0.0003
Dissolved Copper	0.003	0.0032	0.0015	0.0016
Hardness	28	--	32	29.5
Nitrate as N	0.037	10	0.029	0.045
Orthophosphate as P	0.0030	--	0.002	0.003
Total Phosphorus	0.043	0.025	0.012	0.014
Dissolved Selenium	0.0004	0.0046	0.00006	0.00008
Total Dissolved Solids	50	--	42.9	47.1
Total Kjeldahl Nitrogen	0.54	--	0.206	0.201
Total Organic Carbon	6.8	--	3.6	3.5

Source: ERO and Tetra Tech 2015.
*Average (2009-2013), Site CL-DAM1.
**Average (2009-2013), Site HT-SOL.

Based on the comparative analysis with similar reservoirs, it is likely that water quality in Glade Reservoir would be similar to the water quality in Carter Lake and Horsetooth Reservoir in many ways (Hydros 2014b). Glade and Horsetooth Reservoirs are similar in size, depth and surface area and are located at similar elevations in similar geologic and landscape settings. The hypolimnion (deeper portion of the reservoir) during stratification is likely to experience low dissolved oxygen concentrations during the summer, as currently observed in Horsetooth Reservoir. Low DO concentrations near the reservoir bottom can increase manganese concentrations to levels of concern for drinking water treatment. One key area where differences between Horsetooth and Glade Reservoir can be anticipated is the concentration of organic matter in Glade Reservoir due to elevated inflow concentrations. The fate and transport of organic matter in Glade Reservoir, however, may differ from that of Horsetooth Reservoir due to the composition of the inflowing TOC (labile versus refractory), inflow temperatures relative to the thermal structure of the reservoir, and reservoir bathymetry.

Based on the reservoir comparative analysis (Hydros 2014b), it is anticipated that Glade Reservoir over the long-term, would likely experience:

- Stratification in the summer
- Mesotrophic – oligotrophic conditions
- Periods of hypolimnetic hypoxia (low oxygen) in the summer
- Nutrient and chlorophyll *a* concentrations well within anticipated future standards
- TOC concentrations higher than those observed in Horsetooth Reservoir
- Metals concentrations within table value standards (WQCC 2013)
- Low specific conductance
- Fish consumption advisories because of mercury in fish tissue

4.3.4.1.2 Galeton Reservoir

Galeton Reservoir would receive water from a South Platte River diversion below the confluence with the Poudre River. Predicted average water quality for Galeton Reservoir based on a mass balance analysis once the reservoir stabilizes following initial filling is shown in Table 4-32 (ERO and Tetra Tech 2015).

Table 4-33. Estimated constituent concentrations in Galeton Reservoir under Alternative 2 compared to anticipated standards.

Parameter	Estimated Average Concentration (mg/L)	Anticipated Standard (mg/L)
Ammonia as N	0.71	pH / Temperature Dependent
Nitrate as N	6.7	100
Total Phosphorus	0.94	0.0.083
Dissolved Selenium	0.0035	0.0046
Total Dissolved Solids	1,099	--

Source: ERO and Tetra Tech 2015.

Based on the reservoir comparison analysis (Hydros 2014b), it is likely that Galeton Reservoir water quality would be similar to that in two nearby reservoirs, Jackson Reservoir and Riverside Reservoir. Although Galeton Reservoir would receive diversions throughout the year, Jackson and Riverside Reservoirs are filled in the fall and winter. Nutrient and chlorophyll *a* concentrations in Galeton Reservoir are likely to be well above the interim values for warm water reservoirs (total phosphorus = 83 µg/L, total nitrogen = 910 µg/L, and chlorophyll *a* = 20 µg/L). Low summer inflows in July and August may make Galeton Reservoir vulnerable to algae blooms and high chlorophyll *a* in certain years. Like some existing reservoirs receiving inflow from the lower South Platte River, summer pH values are anticipated to be high and may exceed the standard of 9.0. High pH values are often related to high chlorophyll *a* concentrations.

The depth of Galeton Reservoir may result in stratification similar to North Sterling Reservoir. Total phosphorus and total nitrogen concentrations do not vary substantially between the top and bottom of North Sterling Reservoir, although bioavailable forms (orthophosphate and ammonia) were higher at the bottom in a study by Sprague (2002). Dissolved oxygen is a concern for North Sterling Reservoir, as well as Jackson and Riverside Reservoirs, in that all three reservoirs are on the State's Monitoring and Evaluation List. Similar concerns are likely for Galeton Reservoir. Strong stratification in Galeton Reservoir could lead to increased levels of methylmercury, since it becomes bioavailable under low oxygen conditions. The evidence from comparable reservoirs; however, does not indicate mercury in fish tissue to be of great concern for Galeton Reservoir. Fish tissue mercury concentrations for both North Sterling and Jackson Reservoirs are well below the 0.3 ppm threshold[10]. No fish tissue data are available for Riverside Reservoir.

[10] Weighted mean mercury fish tissue concentrations for Jackson Reservoir are 0.06 ppm for Walleye and 0.14 ppm Wiper (Palmetto Bass). For North Sterling Reservoir, the analogous concentrations were 0.03 and 0.13 ppm.

Mass balance modeling estimates a long-term average TDS concentration of 1,099 mg/L in Galeton Reservoir. In general, relatively high TDS concentrations are predicted to occur during periods of low reservoir storage and lower TDS concentrations are predicted to occur during spring runoff when flows are high. Dissolved selenium concentrations may be elevated but are unlikely to exceed the 4.6 µg/L table value standard. Selenium concentration in Galeton Reservoir may be similar to Jackson Reservoir, which averages about 3.5 µg/L. Galeton Reservoir is not located in an area with selenium-bearing Pierre shale formations. Lower selenium concentrations are predicted to occur during periods of high inflows, and higher selenium concentrations are predicted during periods of low reservoir storage.

Based on comparisons with Jackson and Riverside Reservoirs, it is anticipated that Galeton Reservoir under Alternative 2 would experience:

- High nutrient concentrations (exceeding nutrient interim values)
- High chlorophyll *a* concentrations (exceeding nutrient interim values)
- Low clarity
- Eutrophic conditions
- Periods of hypolimnetic hypoxia in the summer
- High specific conductance
- High pH (likely exceeding the maximum standard of 9.0)
- Likely elevated selenium concentrations, but less than the table value standard

Galeton Reservoir may need to be listed on the State's 303(d) List and/or the Monitoring and Evaluation List for some of the constituents listed above (e.g., nutrients, chlorophyll *a*, and pH), due to anticipated high concentrations. With respect to mercury, there is the potential for a "spike" in mercury in fish tissue during and shortly after the filling of Galeton Reservoir, due to transitional effects. It is anticipated, however, that in the long term, mercury concentrations will not result in listing for fish tissue of fish consumption advisories. It is noted that methylmercury dynamics are very site specific and species specific.

4.3.4.1.3 Horsetooth Reservoir

Under the Reclamation Action Option, NISP operations would involve exchanges to Horsetooth Reservoir to facilitate delivery to Participants. In the event C-BT deliveries to the Poudre Basin are less than the 29,500 AFY needed to facilitate exchanges, a pipeline would be built to deliver water directly from Glade Reservoir to Horsetooth Reservoir. The Horsetooth Reservoir Model (Hydros 2013) was used to predict likely changes in reservoir quality with and without a pipeline (ERO and Tetra Tech 2015).

If no pipeline is needed to facilitate the exchanges there would be minor changes in the operation of Horsetooth Reservoir, but no direct deliveries from Glade Reservoir. Under this scenario, minor changes in reservoir operation would have limited impacts on Horsetooth Reservoir water quality. Existing ammonia concentrations in Horsetooth Reservoir are predicted to increase up to 0.13 mg/L near the bottom of Spring and Canyon Dams. Ammonia concentrations would remain well below aquatic life standards. Combined nitrite and nitrate concentrations would

increase up to about 16 µg/l at the Hansen Supply Canal and remain well below standards. The increase in phosphates concentrations would be minor at 0.025 mg/L. Chlorophyll *a* concentrations in Horsetooth Reservoir currently range from about 1 µg/L to 8 µg/L and would increase less than 0.5 µg/L. No changes in DO concentrations are predicted. TOC concentrations, which typically range from 3 to 4 mg/L would stay the same or decrease slightly. TOC concentrations would stay about the same as existing conditions.

If a pipeline is constructed from Glade Reservoir to Horsetooth Reservoir, under the Reclamation Action Option, average annual water deliveries are estimated at 3,639 AF and maximum deliveries would be 9,274 AF. Based on model results using a maximum annual pipeline delivery of 9,274 AF from Glade Reservoir to Horsetooth Reservoir, water quality changes in Horsetooth Reservoir under either delivery scenario would be similar. Piped water into Horsetooth over the year would be a small fraction of storage at any given time in the 156,000 AF reservoir. The multi-port outlet at Glade Reservoir would allow options for delivery of quality water to Horsetooth Reservoir. With pipeline delivery, ammonia, nitrate plus nitrates, chlorophyll *a*, TOC, and dissolved oxygen levels would be similar to those described for the no pipeline scenario. Phosphate concentrations would increase slightly up to 0.016 mg/L at the bottom of Spring Canyon Dam. Overall, reservoir temperature would change minimally, but occasional temperature increases of up to 1°C are modeled at the bottom of Spring and Dixon Dams. Concentrations of total dissolved solids, arsenic, copper, and selenium, although not modeled directly, are predicted to change minimally based on the volume of inflows. TDS and dissolved copper concentrations may decrease slightly and dissolved selenium may increase slightly. The largest predicted increase in TOC is about 0.5 mg/L at the bottom near Soldier Canyon and Dixon Dams.

There are no predicted exceedances of water quality standards for Horsetooth Reservoir under Alternative 2 with the Reclamation Action Option, with or without pipeline deliveries from Glade Reservoir based on modeling results. There would be no effect to Horsetooth Reservoir water quality under the Alternative 2 No Reclamation Action Option.

4.3.4.2 Poudre River

4.3.4.2.1 Flows

Alternative 2 diversions at the Poudre Valley Canal would reduce downstream flow in Segments 10, 11, and 12 (Figure 4-38 and Figure 4-39). The primary effect of Alternative 2 is the reduction of flows in the spring and summer months, April through September, although flow reductions occur throughout the year (Figure 4-40; GEI 2015a), at the Canyon Gage in the upper reach of Segment 10. At the Shields Street Gage, in the lower reach of Segment 10, flows in May, June, and July would be reduced. However, during September and the winter months flows would be slightly increased due to the Alternative 2 flow augmentation plan (Section 4.2.1.1.2) as shown at the Shields Street Gage (Figure 4-41; GEI 2015a). The augmentation flows are expected to have a beneficial effect on water quality over existing conditions because the additional flow would be characteristic of the proposed water quality conditions in Glade

Reservoir and would provide potential dilution during a period of existing low flow conditions and cool water beneficial to aquatic life in the late summer.

Figure 4-40. Comparison of the 20th Percentile and Minimum Monthly Average Flow for Current Conditions and Alternative 2 at Canyon Gage, 1980 – 2005. Error Bars Represent the 95% Confidence Interval Around the 20th Percentile.

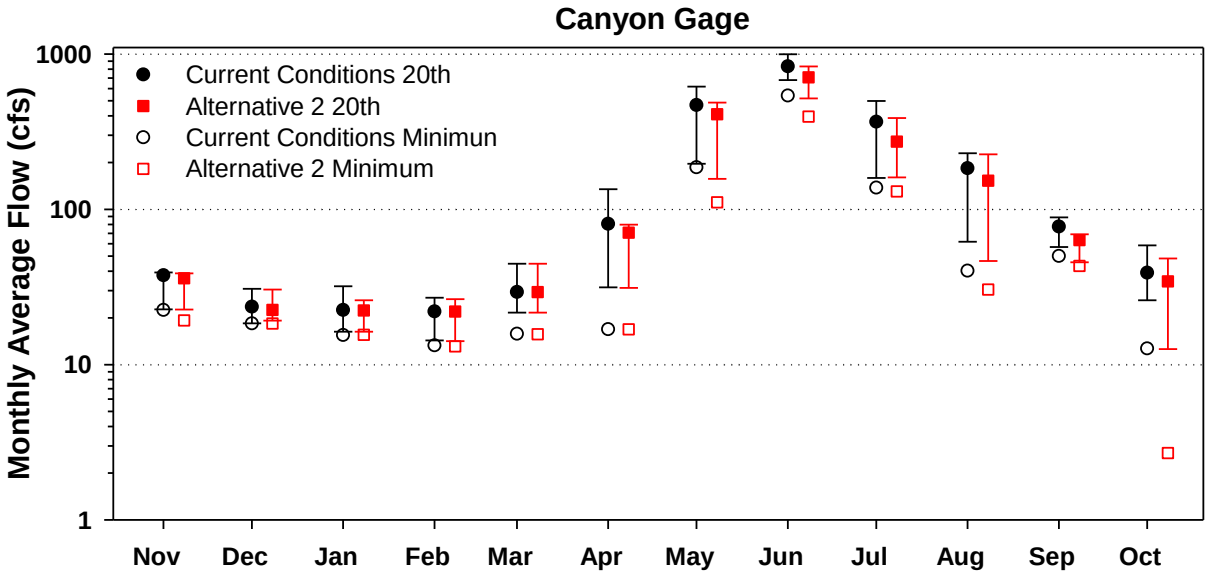
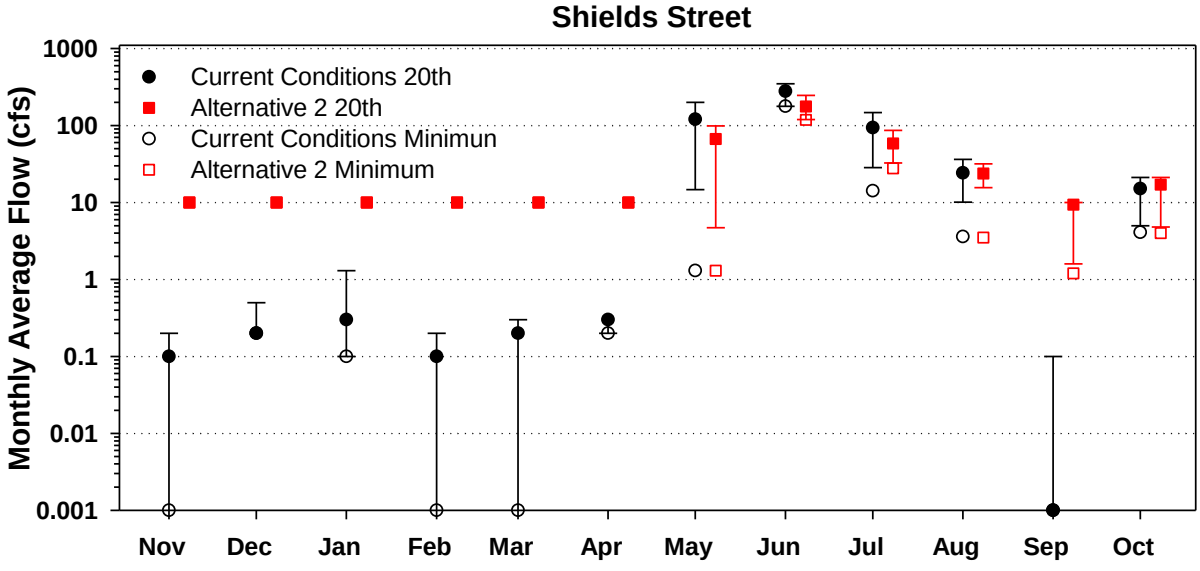


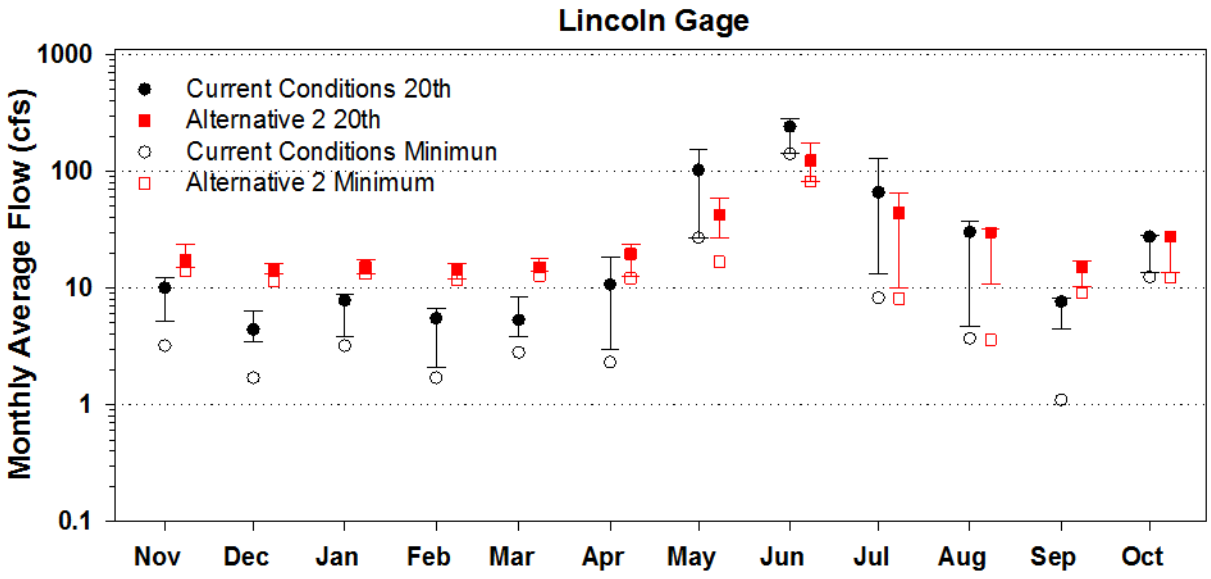
Figure 4-41. Comparison of the 20th Percentile and Minimum Monthly Average Flow for Current Conditions and Alternative 2 at Shields Street, 1980 – 2005. Error Bars Represent the 95% Confidence Interval Around the 20th Percentile.



The primary effects at the Lincoln Street Gage in the upper reaches of Segment 11 (Figure 4-42; GEI 2015a) would be a reduction of flows in spring and summer, May through July. However, in September and November through April the minimum and 20th percentile flows would be

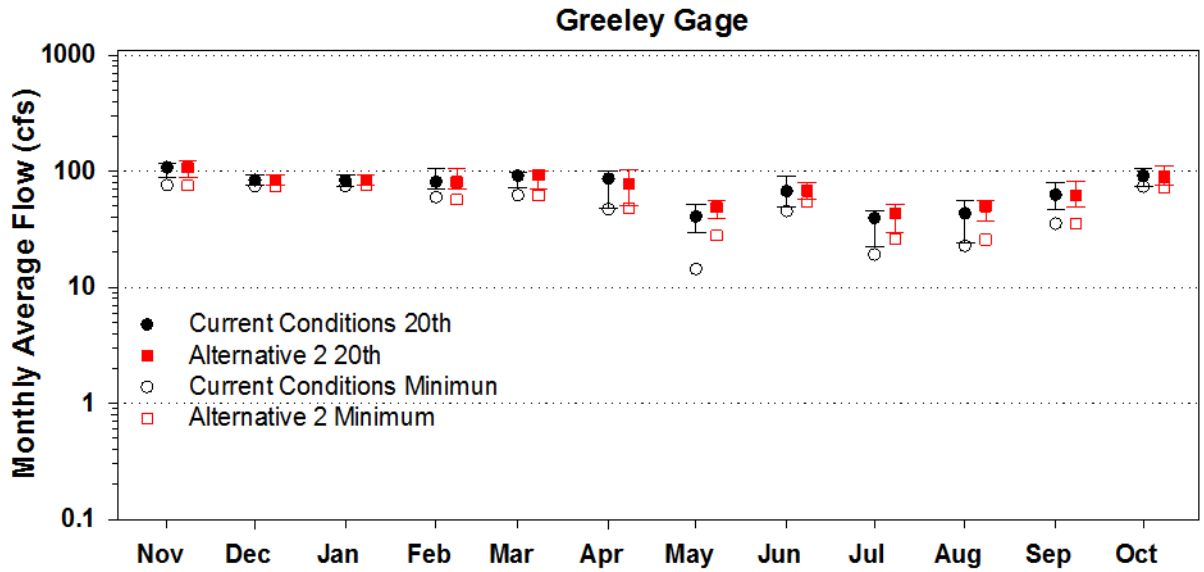
higher than existing conditions due to the proposed flow augmentation evident at the Lincoln Street Gage. In the lower reaches of Segment 11, at the Boxelder Gage, flows are reduced during May and June, with small changes for the remainder of the year.

Figure 4-42. Comparison of the 20th Percentile and Minimum Monthly Average Flow for Current Conditions and Alternative 2 at Lincoln Street Gage, 1980 – 2005. Error Bars Represent the 95% Confidence Interval Around the 20th Percentile.



In the upper reaches of Segment 12 (Figure 4-38), near the New Cache Canal, flows would be reduced in May and June, with small changes throughout the rest of the year. At the hydrology nodes near the Windsor WWTP and the Kodak WWTP (Carestream Health), effects of Alternative 2 on flows are negligible, with small decreases in the 20th percentile flow for April and October. At the hydrology node at Farmer's Spur (6 miles downstream of the Carestream Health WWTP) there is a slight decrease in flow in April; however, in May through August there are slight increases in minimum and 20th percentile flows. Flows patterns upstream of the Greeley WWTP are similar, with a decrease in April, and slight increases during the summer. In the most downstream reach of Segment 12 (the Greeley Gage), the flow pattern is similar, with a slight decrease in April and a slight increase in the summer months (Figure 4-43; GEI 2015a).

Figure 4-43. Comparison of the 20th Percentile and Minimum Monthly Average Flow for Current Conditions and Alternative 2 at Greeley Gage, 1980 – 2005. Error Bars Represent the 95% Confidence Interval Around the 20th Percentile.



4.3.4.2.2 Segment 10 Constituent Effects

The only water quality parameters that showed a relationship between concentration and flow for Segment 10 were total recoverable iron, total phosphorus, and sulfate for the full range of existing flows, except low flow conditions. Total recoverable iron and total phosphorus concentrations increased with increasing flow, but at low flow conditions near the 20th percentile concentrations are near the limits of detection. Under Alternative 2 operations exceedance of the total recoverable iron and total phosphorus water quality standards is unlikely because of the very low existing concentrations. In the lower reaches of Segment 10, the existing median recoverable iron concentration of 141 µg/L is well below the standard of 1000 µg/L and is unlikely to exceed the standard with Alternative 2 diversions. Exceedance of the interim total phosphorus standard of 0.110 mg/L is also unlikely since the 50th percentile concentration in the lower reach is currently less than half (0.05 mg/L) of the interim standard.

Sulfate showed a decrease in concentration as flow increased, therefore, a reduction in flow across the full range of conditions could potentially result in increased sulfate concentrations. The water quality standard for sulfate in Segment 10 is the drinking water standard of 250 mg/L. At the selected sites in Segment 10, the 85th percentile concentrations ranged from 6 to 72 mg/L, with a maximum concentration of 91 mg/L; therefore, exceedance of the water quality standard would not occur unless there is a nearly 300% increase in concentration. Additionally, because sulfate concentrations are lowest during the primary Alternative 2 diversion period of April through September, any increase in sulfate concentrations would likely be small.

None of the other water quality parameters of interest had strong enough concentration/flow relationships to allow any meaningful prediction of effects; therefore, the effect of Alternative 2 diversions on other inorganic and metal parameters cannot be predicted based on a

flow-concentration assessment alone and will require additional information regarding other source water contributions that may affect these parameters when analyzed in the context of a mass-balance approach in Phase II.

4.3.4.2.3 Segment 11 Constituent Effects

Dissolved iron and total recoverable iron concentrations revealed no changes with flow conditions less than the 90th percentile flow, therefore changes under low flow conditions with Alternative 2 diversions cannot be predicted based on a flow-concentration relationship alone and will require additional information regarding other source water contributions that may affect these parameters when analyzed in the context of a mass-balance approach in Phase II. The total recoverable iron standard in Segment 11 is 1,000 µg/L and the existing median concentration is 173 µg/L near the Lincoln Street Gage, which is six times less than the standard. The small changes in flow from Alternative 2 operations during low flow conditions are not expected to appreciably affect iron concentrations. Dissolved iron standards are not applicable for Segment 11 of the Poudre River as this segment does not have a water supply use classification.

Dissolved and total recoverable manganese, chloride, and sulfate concentrations all revealed decreasing concentrations along the full range of existing flow conditions. These four parameters all exhibited the greatest concentration during low flow conditions. As such, decreases in flows may increase their concentrations. There are currently no water quality standards for chloride and sulfate in Segment 11. The chronic dissolved manganese standard for aquatic life is hardness based, and when using the average hardness concentration for the selected sites in Segment 11, the dissolved manganese criteria range from 1,800 µg/L to 2,500 µg/L. The existing 85th percentile concentrations range from 48 to 60 µg/L, nearly 30 times less than the standard. It is expected that any reduction in flows from Alternative 2 diversions would have a negligible effect on dissolved manganese concentrations. The total recoverable manganese water supply standard is 200 µg/L and the existing total recoverable manganese 85th percentile concentrations ranged from 65 to 98 µg/L. Total recoverable manganese concentrations generally would be higher in March and April, but decrease in June through September, during the same time as lower flows from Alternative 2 operations are predicted. Therefore, any increases in total recoverable manganese due to decreased flow would occur when concentrations are the lowest, so effects on total recoverable manganese are expected to be negligible.

The nitrate standard in Segment 11 is 100 mg/L. The 85th percentile existing nitrate concentrations for the selected sites range from 0.3 to 1.0 mg/L. These values are considerably less than the water quality standard; therefore, any changes in flow conditions are not expected to appreciably affect nitrate concentrations. None of the other parameters of interest revealed strong relationships to the full range of flow conditions, or to low flow conditions and will require additional information regarding other source water contributions that may affect these parameters when analyzed in the context of a mass-balance approach. Dissolved copper, dissolved selenium, ammonia, and total phosphorus revealed numerous minimum detection

limits (non-detect) results across the full range of flow conditions; therefore, the concentrations for these other parameters are not expected to exceed standards under Alternative 2.

4.3.4.2.4 Segment 12 Constituent Effects

The relationship patterns for dissolved and total recoverable iron were similar to those for Segment 11, in that iron concentrations increased at higher flows that were generally in response to snowmelt or storm runoff, with highest concentrations during the summer months. In the reach of the Poudre between the Windsor and Carestream Health WWTPs and the Greeley WWTP, the median total recoverable iron concentrations are less than 10% of the standard at most of the sites. However, Site PR-5.2, which is immediately upstream of the Greeley WWTP, exceeded the standard under existing conditions by over 200%. The slight predicted increases in the 20th percentile flow during the spring and early summer at Farmer's Spur may result in an increase in the total recoverable iron concentrations at site PR-13.6. Therefore, as a result of Alternative 2 operations, total recoverable iron may exceed the water quality standard in the middle portions of Segment 12. The existing exceedance of the total recoverable iron standard immediately upstream of the Greeley WWTP is expected to continue under Alternative 2.

At the Greeley Gage, total phosphorus and ammonia concentrations were indicative of an effluent dependent stream where concentrations were the greatest at mid-range flows, which included upstream contributions for these nutrients. At low flows, concentrations slightly decreased which are likely reflective of effluent dependent conditions and increased WWTP treatment efficiency during low flows, while high flows provided a dilution effect, which also resulted in slightly lower concentrations. The chronic ammonia standard in this segment ranges from 0.181 to 0.864 mg/L, and is dependent upon temperature and pH. Based on existing conditions, the 85th percentile concentrations already exceed the standard at the majority of the selected sites. Under Alternative 2, the ammonia concentrations are not expected to appreciably change because the WWTP contributions are a dominant source of this constituent. Total phosphorus is currently exceeding the interim standard of 0.170 mg/L at all selected sites within this segment. Decreased flow from Alternative 2 may further reduce the dilution potential in this segment resulting in slightly higher total phosphorus concentrations.

Both dissolved and the total recoverable manganese concentrations reveal a slight decrease across the full range of existing flow conditions, such that the greatest concentrations are observed during low flows. The total recoverable manganese standard is 200 mg/L for Segment 12, and existing concentrations range from 89 to 142 mg/L; therefore, under Alternative 2 operations, total recoverable manganese concentrations are not expected to exceed the standard.

Dissolved copper and dissolved selenium show no discernable relationship with flow conditions. In addition, there are numerous non detect results across the full range of existing flows for dissolved copper. For selected sites along Segment 12, the dissolved copper chronic standard ranged from 19.6 to 29.3 µg/L, depending upon hardness, and the 85th percentile assessment metrics were all less than 3 µg/L. Under Alternative 2, the dissolved copper concentrations are not expected to appreciably change because this constituent is at the limits of detection in both surface water and ground water in Segment 12. The dissolved selenium chronic standard is 4.6 µg/L, although there is currently a Temporary Modification (i.e., a localized interim standard

put in place while an appropriate standard is determined) of 7.1 µg/L for Segment 12 indicating a site-specific standard may be more appropriate for this segment. The 85th percentile assessment metric was less than 4.8 µg/L for all sites upstream of the Greeley WWTP, except the site located at the Greeley Gage, which was 11.4 µg/L. Under Alternative 2, the dissolved selenium concentrations are not expected to appreciably change from existing conditions given the similar source water characteristics of ground water. Dissolved selenium concentrations in the Poudre River would continue to exceed the water quality standard in Segment 12 under Alternative 2.

4.3.4.2.5 Poudre River Temperature Effects

Projected diversions at the Poudre Valley Canal for delivery to Glade Reservoir would reduce flows in the Poudre River primarily during spring runoff from April to June. Under the Reclamation Action Option, 82% of average annual Poudre River diversions would occur during May and June (Table 4-15) (74% under No Reclamation Action Option (Table 4-14)), when stream temperatures are generally cooler and flow rates are generally higher from snowmelt runoff.

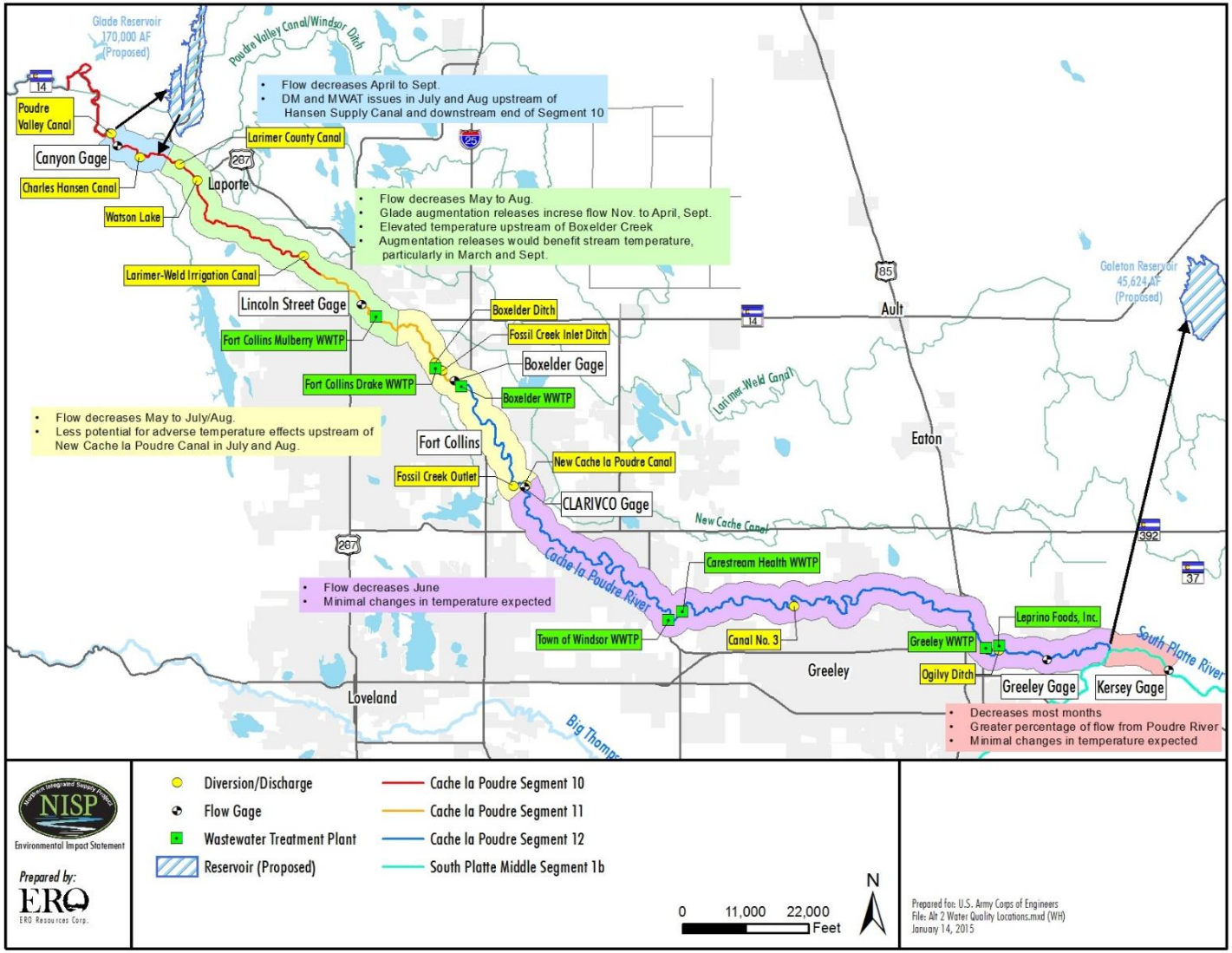
Median flow rates in the Poudre River from the Poudre Valley Canal diversion downstream to the inflow location for augmentation flows (0.37 river miles upstream of the Larimer County Canal) are expected to decrease from April through September. The upper portion of this reach (upstream of the Hansen Supply Canal) currently exhibits temperature standard excursions in March, July, and August. The anticipated reduction in the median flow rate in July and August from Alternative 2 diversions could increase the magnitude and frequency of DM and MWAT excursions upstream of the Hansen Supply Canal depending on the conditions present during the years in which July and August diversions occur.

From the inflow point of Alternative 2 augmentation flows downstream to the Timnath Reservoir Inlet, decreases in median flow rates are predicted from May through August. A reduction in flow rates would increase the magnitude and frequency of potential temperature excursions above standards in July and August at the downstream end of Segment 10. However, the 10 cfs augmentation flow releases from Glade Reservoir would have a beneficial effect on stream temperature over this reach by increasing flow rates during the low-flow months of March and September when past exceedances have occurred. Bottom release of cooler water from Glade Reservoir in September would improve the beneficial effect of augmentation releases, assuming the stratification timing pattern in Glade Reservoir would be similar to Horsetooth Reservoir. Augmentation flow release in March, which occasionally has shoulder-season temperature excursions, may or may not benefit from hypolimnetic withdrawal, depending on the timing of Glade Reservoir turnover.

Downstream of the Timnath Reservoir Inlet to the New Cache diversion in Segment 11, median flow reductions from Alternative 2 diversions would occur from May through July/August. This reduction of flow rate, combined with inflow of warmer water from upstream in July and August could elevate Poudre River temperatures in sensitive reaches upstream of Boxelder Creek and the New Cache diversion. The effect upstream of the New Cache diversion would likely be less due to the cooling effects of ground water inflow downstream of Boxelder Creek that are not expected to change.

From the New Cache diversion to the confluence with the South Platte River, decreases in median flow rates are anticipated for June. April is not considered to be a sensitive month for stream temperatures over this reach, but temperatures can approach relevant standards toward the end of June. Given the critical role of ground water return flows over this reach, which are not anticipated to change with continued irrigation of agricultural lands, warming to levels of exceedance of the temperature standard is not anticipated over this reach. Figure 4-44 summarizes changes in flow and the potential effect to stream water temperature along the Poudre and South Platte Rivers for Alternative 2.

Figure 4-44. Potential Impacts to Poudre River and South Platte River Stream Temperature from Hydrologic Changes under Alternative 2.



4.3.4.2.6 Poudre River Dissolved Oxygen Effects

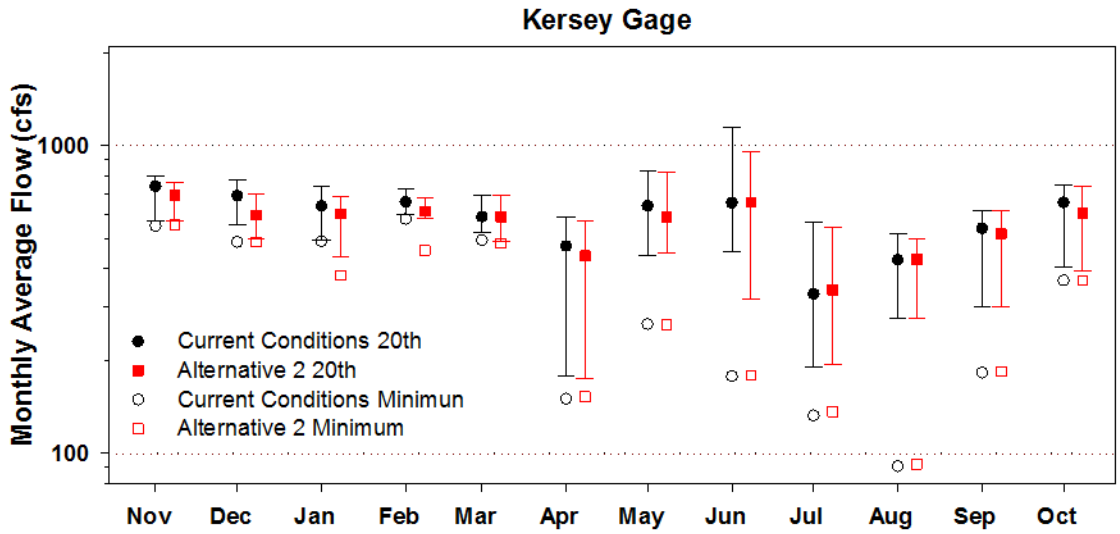
Decreased flow rates during summer months from the Canyon Gage to the New Cache diversion could adversely affect localized areas that have historically exhibited DO excursions, particularly in Segment 11. Augmentation of Poudre River flows with Glade Reservoir releases would improve DO conditions from the inflow point to the Timnath Reservoir Inlet for November through April and September. The structure for releasing water from Glade Reservoir to the Poudre River would be designed to aerate the water to increase the dissolved oxygen concentration of the water discharged to the river. The reach benefiting from augmentation flows includes the Martinez Park location, where the majority of observed historical DO excursions occurred during months when augmentation would occur.

From the New Cache diversion to the confluence with the South Platte River, decreases in median flow rates are anticipated for June. This is not considered to be a sensitive month for DO, and ground water inflow is not expected to change substantially in this reach. Thus, adverse impacts to DO concentrations in the lower Poudre are unlikely under Alternative 2.

4.3.4.3 South Platte River

The Kersey Gage on the South Platte River represents the downstream boundary for the NISP water quality analysis, and is the only site on the South Platte River within the study area with both water quality and hydrology data. The SPWCP would divert water from the South Platte River for delivery to Galeton Reservoir or canals. During winter base flow conditions, the SPWCP would on average reduce the Current Conditions 20th percentile monthly flow by approximately 8% (55 cfs) from November through February (Figure 4-45). In January and February, the minimum monthly flow would also be reduced on average by approximately 7% (35 cfs). In April and May, Alternative 2 would reduce the 20th percentile monthly flow on average by approximately 8% (42 cfs). From June through September, the NISP/SPWCP would result in little change to the flow conditions, and in October, there would be an average 8% reduction (52 cfs) in flow.

Figure 4-45. Comparison of the 20th Percentile and Minimum Monthly Average Flow for Current Conditions and Alternative 2 at Kersey Gage, South Platte River, 1980 – 2005. Error Bars Represent the 95% Confidence Interval Around the 20th Percentile.



4.3.4.3.1 Segment 1b Constituent Effects

In Segment 1b, the patterns for dissolved iron were similar to those in the Poudre River, such that iron concentrations generally increased with high flows conditions typical of snowmelt or storm runoff in the spring, with the highest concentrations observed during the summer months. The standard for dissolved iron in this segment is 300 mg/L, with an existing 85th percentile concentration of 213 mg/L. Despite the relative higher concentrations in the summer, the majority of the samples collected throughout the remaining months are well below the standard; therefore, exceedances of the standard are not expected under Alternative 2 operations.

Nutrient parameters (ammonia, nitrate, and total phosphorus) currently show a slight decrease in concentration at the highest flows (>90th percentile). Total phosphorus concentrations currently exceed the interim standard of 0.170 mg/L, with January and February revealing the highest concentrations on a seasonal basis. Therefore, decreased flow conditions during the winter months from SPWCP operation may further reduce the dilution potential in this segment resulting in slightly higher total phosphorus concentrations during the winter months. Both ammonia and nitrate concentrations are well below their respective water quality standard; therefore, SPWCP operations under Alternative 2 should have negligible effects on these parameters.

Dissolved manganese concentrations reveal a slight decrease across the full range of flow conditions, such that the greatest concentrations are observed during low flow conditions. The dissolved manganese water supply standard is 50 mg/L for Segment 1b, and the 85th percentile existing concentration is 30.6 mg/L. Under NISP/SPWCP operations, dissolved manganese concentrations are not expected to exceed the standard. Sulfate showed no relationship to flow except for a slight dilution effect at flows greater than the 90th percentile. Sulfate is currently

exceeding the water supply standard of 250 mg/L, and any decrease in flow may reduce the dilution potential resulting in slightly higher sulfate concentrations under Alternative 2.

Dissolved copper and dissolved selenium show no discernable relationship with flow conditions, although data are limited. The existing 85th percentile assessment metric for dissolved copper (3.4 µg/L) is a factor of 10 less than the chronic standard, therefore, under Alternative 2, dissolved copper is not expected to exceed the standard. The dissolved selenium chronic standard is 4.6 µg/L, and the existing 85th percentile assessment metric is 3.21 µg/L. Based on the available data, the dissolved selenium concentrations would likely change from existing conditions and may approach the standard under Alternative 2 operations; although insufficient data upstream of the confluence with the Poudre River limits the assessment.

4.3.4.3.2 Segment 1b Temperature Effects

Median monthly flow rates in the South Platte River at the Kersey Gage would decrease from November through February, May, June, and September. Of these months, only June currently exhibits values approaching the DM temperature standard at this location (values occasionally observed within one degree and one value above the DM standard historically in June). Reduced flow rates would result in some additional warming, but the relative decrease in median flow during these months) is relatively small (12% reduction in median flows), considering typical flow rates at this time (median flow rates of 1,400 cfs in June). The temperature of water entering from the Poudre River is not expected to change substantially. Thus, no increased frequency of temperature standard exceedances is anticipated on the South Platte River.

4.3.4.3.3 Segment 1b Dissolved Oxygen Effects

Reduced flow rates are anticipated in the South Platte due to the SPWCP; however, as discussed for temperature, the relative decrease in median flow rate is relatively small, considering typical flow rates at this time. Considering the long-term South Platte DO record, and expected changes in flow, DO excursions on the South Platte associated with Alternative 2 are unlikely.

4.3.4.4 Effects on Larimer-Weld and New Cache Canals Water Quality and Crop Yield

As part of the SPWCP, water stored in the proposed Galeton Reservoir would be delivered to both the Larimer-Weld and New Cache canal systems from April through October in exchange for water diverted from the Poudre River. Based on model results for Alternative 2 (CDM Smith 2014a), exchanges with the Larimer-Weld and New Cache Canals would result in a monthly Galeton Reservoir release to each canal ranging from 0 to 6,149 AF. Galeton Reservoir releases would constitute from 0% to 100% of the water supply in the Larimer-Weld Canal and 0% to 69% of the water supply for the New Cache Canal. Other water sources to the canals include direct flow diversions, releases from multiple off-channel reservoirs, and exchanges on native rights and C-BT water but the impact of these were not modeled. Assuming only the percentage of Galeton Reservoir release relative to water supply for the canal, releases to the Larimer-Weld Canal would constitute an average of 47% during August, the month where nine times during the 56-year modeling period the release would constitute 100% of the water supply. Under the same assumptions, releases to the New Cache Canal would constitute an average of 41% during May, the month with the highest number of times during the 56-year modeling period where the

Galeton release would constitute between 51 and 69% of the water supply. On average during the growing season (May through September), Galeton releases would constitute 20% of the water supply for the Larimer-Weld Canal and 17% of the water supply for the New Cache Canal. For individual growing seasons modeled during the 56-year period for New Cache Canal, there would be 7 years where the average percent of water supply from Galeton releases would be greater than 25% for the year with the highest percentage being 39%. For individual growing seasons modeled during the 56-year period for Larimer-Weld Canal, there would be 19 years where the average percent of water supply from Galeton releases would be greater than 25% for the year with the highest percentage being 41%.

Galeton Reservoir water is expected to have a similar selenium concentration and a higher salinity concentration than the receiving canal waters. However, the initial selenium and salinity concentrations during initial reservoir filling would be greater than the concentrations measured in the receiving canals for the first several years of operation. Long-term dissolved selenium concentration in the canals is predicted to be 5 µg/L with an initial maximum between 20 and 90 µg/L. The long-term predicted selenium concentration would be less than the selenium Colorado agricultural use standard of 20 µg/L (CDPHE 2013).

The average predicted salinity, measured as the total dissolved solids (TDS) concentration, in the proposed Galeton Reservoir is 914 mg/L, while the Larimer-Weld Canal average TDS is 261 mg/L and the New Cache Canal average TDS is 434 mg/L. Although water in the proposed Galeton Reservoir would have a similar TDS concentration to that of other off-stream reservoirs used for supply of irrigation water, agricultural fields using water from the Larimer-Weld and New Cache Canals downgradient of the Galeton exchange locations would receive irrigation water with a higher TDS concentration than is currently being received. The actual increase in TDS of the canal water during a given month would depend on the volume diverted, the delivery point into the canal, and the time of delivery, as well as other deliveries from storage reservoirs that supply the canals.

The SPWCP water delivery system would be designed to allow the release of diverted water directly to the canals to reduce pumping demands on the system. When direct delivery is used, the TDS would be lower than if the water was first stored in Galeton Reservoir. The direct delivery of low-salinity water would reduce the dilution effect the water would have on the salinity in Galeton Reservoir, which would result in the potential delivery of water with higher than predicted average salinity in later months. Although TDS concentrations in water delivered to the canals would vary, the net effect would be an increase in the amount of salts delivered over the course of the growing season.

Changes in the salinity and selenium concentrations in the Larimer-Weld and New Cache Canals have the potential to impact the yield of crops irrigated by these canals. The effects on crop growth of using higher salinity water were evaluated quantitatively by Hoffman (2012). The 2012 Hoffman study evaluated the impacts of SPWCP on crop yields under different mixes of SPWCP water (water either stored in Galeton or directly diverted from the South Platte River) and canal water. Assuming a conversion factor of 700 to calculate TDS from electrical

conductivity, Hoffman's evaluation was based on a TDS of 910 mg/L for the supply water and 259 mg/L and 455 mg/L for the Larimer-Weld and New Cache Canals, respectively.

The long-term predicted Galeton Reservoir TDS (914 mg/L) is the same as the SPWCP value used by Hoffman (2012). Regarding crop yield reductions, Hoffman's (2012) evaluation used various mixing ratios of source and receiving waters that approximate Future Conditions. Hoffman (2012) concluded that with a ratio of 25% SPWCP water and 75% canal water, no crop yield losses would occur under average rainfall conditions. If a ratio of 50% SPWCP water and 50% canal water is assumed, Hoffman (2012) predicted no crop yield losses for the Larimer-Weld Canal and slight yield reductions for beans (3% yield loss for gravity irrigation systems and no yield loss for center pivot systems) and carrots (2% yield loss for gravity irrigation systems and no yield loss for center pivot systems) for the New Cache Canal. If a ratio of 100% SPWCP water is assumed for Larimer-Weld Canal, Hoffman (2012) concluded that under average rainfall, yield losses are predicted for beans (10% yield loss for gravity irrigation systems and 7% yield loss for center pivot systems), carrots (7% yield loss for gravity irrigation systems and 5% yield loss for center pivot systems), lettuce (3% yield loss for gravity irrigation systems and 1% yield loss for center pivot systems), and onions (5% yield loss for gravity irrigation systems and 3% yield loss for center pivot systems). Under the scenario of drought conditions without rainfall, Hoffman (2012) concluded crop yield losses for beans (4% for New Cache and no loss for Larimer-Weld), and carrots (3% for New Cache and no loss for Larimer-Weld), for a ratio of 25% SPWCP water and 75% canal water and crop yield losses for beans (9% for New Cache and 5% for Larimer-Weld), carrots (7% for New Cache and 4% for Larimer-Weld), lettuce (3% for New Cache and no loss for Larimer-Weld), and onions (4% for New Cache and 1% for Larimer-Weld) for a ratio of 50% SPWCP water and 50% canal water. Yield loss calculations for 75 or 100% SPWCP water under drought conditions were not performed by Hoffman (2012).

Assuming a ratio of about 25% SPWCP water and 75% canal water, which corresponds to roughly the average percentage of SPWCP water to each canal over the entire growing season, no effect on crop yield is predicted for farmlands served by either the Larimer-Weld Canal or New Cache Canal. Assuming a ratio of about 50% SPWCP water and 50% canal water which corresponds to the 7 years where SPWCP would constitute between 26 and 39% of New Cache Canal supply water, minor effects on bean and carrot crop yield are predicted for the farmlands using gravity irrigation systems and no effect on crop yield is predicted for farmlands using center pivot systems. Assuming a ratio of about 50% SPWCP water and 50% canal water, which corresponds to the 19 years where SPWCP would constitute between 26 and 41% of Larimer-Weld Canal supply water, no effect on crop yield is predicted for the farmlands using either gravity or central pivot irrigation systems. During drought years when it is assumed no rainfall would occur during the growing season, minor effects on beans, carrots, lettuce and onions are predicted for farmlands served by the New Cache Canal and minor effects on beans, carrots and onions are predicted for farmlands served by the Larimer-Weld Canal. Socioeconomics (Section 4.20.3.3.2) discusses the potential economic impact of reductions in crop yield from increased salinity with operation of the SPWCP. The assessment of potential effects to crop yields does not consider any mitigation that may be proposed by the District (Appendix F).

4.3.4.5 Effects on Water Treatment Plant Operations

Potential effects to WTP operations from changes in input water quality may occur at two locations: where the City of Greeley diverts water from the Poudre River at the canyon mouth for its Bellvue WTP and at Horsetooth Reservoir where the Fort Collins WTP and the Tri-Districts Soldier Canyon Filter Plant take water from the reservoir. Under Alternative 2, TOC concentration and other relevant water quality parameters in the river at Greeley's diversion point are not expected to change and thus, no impact to Greeley's WTP operations are anticipated. Under the Reclamation Action Option, water from Glade Reservoir may be piped to Horsetooth Reservoir, so potential changes could occur to the water quality of Horsetooth Reservoir water used by the two WTPs.

There are no regulatory limits on TOC concentrations in treated drinking water; however, the EPA's Stage 1 Disinfectants and Disinfection Byproducts Rule (Stage 1 DBPR), which governs WTPs that use conventional treatment for surface water, mandates that a certain percentage of influent TOC needs to be removed in the treatment process, depending on source water TOC concentration, and source water alkalinity (Table 4-34). Higher TOC concentrations in the raw water source could require WTPs to use higher coagulant and other chemical dosages to achieve compliance with Stage 1 DBPR, and thus impact the operating costs of the WTPs. The potential impacts of the Reclamation Action Option to WTP operation focused on analyses of modeled TOC concentrations in the Horsetooth Reservoir under various scenarios.

Table 4-34. TOC removal requirements for surface water systems using conventional filtration treatment.

Source Water TOC (mg/L)	Source Water Alkalinity (mg/L as $CaCO_3$)		
	≤ 60	**> 60 to 120**	**> 120**
> 2.0 to 4.0	35%	25%	15%
> 4.0 to 8.0	45%	35%	25%
> 8.0	50%	40%	30%

The Horsetooth Reservoir water quality model (Hydros 2013) was used to evaluate changes in TOC concentrations for the Reclamation Action Option (ERO and Tetra Tech 2015). The model was used to estimate changes in TOC concentrations in the Soldier Canyon outflow, which would be the raw water supply to the Fort Collins and Tri-Districts WTPs. The model was also used to estimate changes in TOC concentrations in the Hansen Supply Canal outflow, which is the raw water supply to the Greeley WTP. TOC measurements encompass all types of organic carbon molecules, some types of which are removed more readily by coagulation processes used at WTPs compared to other types of organic molecules. For purposes of this analysis, it was assumed that the types of TOC in Horsetooth Reservoir would be similar to the types of TOC anticipated for Glade Reservoir.

The model results for the Reclamation Action Option with and without a pipeline from Glade Reservoir to Horsetooth Reservoir are provided in Table 4-35. For the with pipeline scenario,

two different volumes were modeled and two TOC concentrations (predicted average and maximum) for Glade Reservoir were used.

Table 4-35. Average modeled TOC concentrations in Horsetooth Reservoir for the Alternative 2 Reclamation Action Option under Current Conditions hydrology.

Modeling Scenario	Modeled Time Period	Pipeline Volume (AF)	Modeled Average and Maximum TOC Concentrations in Pipeline (mg/L)	Soldier Canyon Outflow Avg. TOC (mg/L)	Hansen Supply Canal Avg. TOC (mg/L)
Existing conditions	Jan. 2005 – Sep. 2010	—	—	3.23	3.28
No pipeline		—	—	3.15	3.17
Existing conditions	Nov. 2009 – Dec. 2009 for pipeline inflow	—	—	3.40 [1]	3.78 [2]
Average pipeline volume, **average** Glade TOC concentration		3,639	6.7	3.32 [1]	3.45 [2]
Average pipeline volume, **maximum** Glade TOC concentration		3,639	7.6	3.36 [1]	3.47 [2]
Existing conditions	Nov. 2009 – March 2010 for pipeline inflow	—	—	3.40 [1]	3.78 [2]
Maximum pipeline volume, **average** Glade TOC concentration		9,724	6.7	3.44 [1]	3.59 [2]
Maximum pipeline volume, **maximum** Glade TOC concentration		9,724	7.6	3.52 [1]	3.65 [2]

[1] Although the modeled pipeline inflow periods varied for the different Reclamation Action Option scenarios, all modeled results showed an influx of contents from the pipeline (Glade Reservoir water) into the Soldier Canyon Outflow starting on November 3, 2009 through September 30, 2010. Therefore, all average TOC concentrations for the Soldier Canyon Outflow were calculated using modeled TOC concentrations from November 3, 2009 to September 30, 2010, including the existing conditions average TOC concentrations for comparison.

[2] Although the modeled pipeline inflow periods varied for the different Reclamation Action Option scenarios, all modeled results showed an influx of contents from the pipeline (Glade Reservoir water) in the Hansen Supply Canal starting on May 2, 2010 through September 30, 2010. Therefore, all average TOC concentrations for the Hansen Supply Canal for the Reclamation Action Option scenarios were calculated using modeled TOC concentrations from May 2, 2010 to September 30, 2010, including the existing conditions average TOC concentrations for comparison.

Table 4-35 shows that for the Soldier Canyon Outflow, which supplies Horsetooth Reservoir water to the Fort Collins and Tri Districts WTPs, average TOC concentrations are predicted to be higher under the Reclamation Action Option for the maximum pipeline volume. However, even for the highest average predicted TOC concentration of 3.52 mg/L in the Soldier Canyon outflow, this would be only 3.5% higher than the baseline average TOC concentration of 3.40 mg/L. For the Hansen Supply Canal, which supplies water to the Bellvue WTP, all modeled scenarios for the Reclamation Action Option show lower average TOC concentrations than for existing conditions. TOC concentrations are predicted to be lower with no pipeline from Glade Reservoir and under many of the pipeline scenarios because with implementation of NISP there would be a longer hydraulic residence time in Horsetooth Reservoir due to changes in operations of Horsetooth Reservoir and TOC was modeled to decay in the reservoir. Under

normal WTP operations, an overall average increase in influent TOC concentrations of 3.5% or less would not require increasing coagulant and other chemical dosages to meet percent TOC removal requirements or to maintain treated water quality.

Another possible effect that higher TOC concentrations in Horsetooth Reservoir water can have on WTP operations is to cause the required TOC removal percentages to become higher due to higher influent TOC concentrations. For example, if the influent TOC concentration in Horsetooth Reservoir water increased to greater than 4.0 mg/L, and the WTP was only using Horsetooth Reservoir water as its raw water supply, then the required TOC removal percentage would increase from 35% to 45% for water with less than 60 mg/L alkalinity as $CaCO_3$ (Table 4-34). In the November 2009 to September 2010 period in which input from Glade Reservoir to Horsetooth Reservoir was modeled for TOC concentrations, there were no times when the TOC concentration exceeded 4.0 mg/L in the Soldier Canyon outflow. Modeling showed three days in September 2010 in which the TOC concentration was 4.01 mg/L in the Hansen Supply Canal outflow; the existing conditions TOC concentrations during the same time period were up to 4.14 mg/L. It is anticipated that none of the Alternative 2 Reclamation Action Option scenarios would affect either the required chemical dosages for TOC removal or the treated water quality in the WTPs that use Horsetooth Reservoir water.

Disinfection byproducts form in drinking water during a reaction of a disinfectant (such as chlorine) with naturally present organic matter, and can be harmful to human health. Increases in TOC concentrations of up to 3.5% under the Reclamation Action Option would not be expected to increase disinfection byproduct concentrations. Besides TOC removal, many other factors determine whether treated water can achieve disinfection byproduct concentrations that are below water quality standards. The concentrations of these contaminants in the distribution system also depend on temperature, residence times, and chlorine residual concentrations and on the types of organic carbon remaining in the water after treatment. Because the Reclamation Action Option would not affect these other factors or substantially increase TOC concentrations, no measurable effects to disinfection byproduct concentrations are predicted.

As described in the previous section on Glade Reservoir water quality, inflow of water with elevated organic matter concentrations is likely to result in higher TOC concentrations in releases from the reservoir or direct deliveries to WTPs than observed at Horsetooth Reservoir. Concentrations in the reservoir would depend on a number of variables including the composition of the inflowing TOC, inflow temperature relative to the thermal structure of the reservoir, and reservoir bathymetry.

4.3.4.6 Construction Related Impacts to Water Quality

Temporary ground disturbance on about 889 acres under the No Reclamation Action Option and 742 acres under the Reclamation Action Option for construction of conveyance facilities and Glade and Galeton Reservoir Dams could result in erosion and possible sedimentation of nearby streams. Impacts would generally be short-term and minor following reclamation and revegetation.

4.3.5 Alternative 3

Under Alternative 3, diversions from the Poudre River at the Poudre Valley Canal would affect water quality downstream to the Kersey Gage on the South Platte River. Diversions would be larger than Alternative 2 because of greater transit and evaporation losses. A 190,000 AF Cactus Hill Reservoir would be used to store Poudre River diversions and Galeton Reservoir would store South Platte River diversions. Water quality in these new reservoirs would be affected by source water quality and operations. There would be no effect on Horsetooth Reservoir water quality because Alternative 3 would not use Horsetooth to store or transmit NISP water.

4.3.5.1 Projected Reservoir Water Quality

4.3.5.1.1 Existing Reservoirs

No existing reservoirs would be used for water storage under Alternative 3, so there would be no effects to the water quality of existing reservoirs.

4.3.5.1.2 Cactus Hill Reservoir

Cactus Hill Reservoir would be constructed off-channel on agricultural land in Weld County. The 190,000 AF reservoir would receive water via the Poudre Valley Canal. Cactus Hill would likely be classified as Aquatic Life Warm 1 or 2. Because there would be a direct pipeline from the reservoir to water treatment facilities, the reservoir would qualify to have a Direct Use Water Supply (DUWS) sub-classification. The default chlorophyll *a* interim value for DUWS reservoirs that need extra protection from a drinking water perspective is 5 µg/L averaged from March to November.

Poudre River water quality at the Poudre Valley Canal is generally good (Table 4-36); however, there is a high potential for water quality degradation from nonpoint sources along the approximate 30-mile open canal leading to Cactus Hill Reservoir. Clay or concrete lining of the canal is anticipated, which is likely to reduce loading in the canal during conveyance to the reservoir. Another factor that would affect water quality in the reservoir occurs during initial filling. During the first few years of operation, reservoir water quality would be influenced by metals, nutrients, and organic matter stored within the soil that would leach into the reservoir as it fills. Over time, the addition and withdrawal of water from the reservoir removes the initial chemical mass and the water quality of the reservoir would be similar to the water entering the reservoir.

Table 4-36. Poudre River water quality at Poudre Valley Canal.

Water Quality Constituent	Median	Minimum	Maximum
Dissolved Oxygen (mg/L)	8.9	6.3	12.7
Specific Conductance (uS/cm)	55	6	185
Total Phosphorus (µg/L)	20	5	260
Ortho-phosphate (µg/L)	2	1	30.5
Total Nitrogen (µg/L)	310	143	3,567
Nitrate + Nitrite (µg/L)	8	1	953
Total Organic Carbon (mg/L)	5	2	9.1
Total Suspended Solids (mg/L)	9	1	265
Copper, Diss(µg/L)	1	0.41	2.2
Copper, Tot Rec (µg/L)	1	0.5	11
Arsenic, Diss (µg/L)	0.377	0.134	0.536
Selenium, Diss, (µg/L)	0.11	0.05	0.37

Source: District 2013.

Mass balance modeling was used to evaluate the likely water quality of Cactus Hill Reservoir receiving water from the Poudre Valley Canal diversion of the Poudre River (ERO and Tetra Tech 2015). The mass balance assumed that the Poudre Valley Canal is lined and that there is no substantial loading of metals, nutrients, or other constituents during conveyance. Table 4-37 shows the modeled average concentration for several constituents in Cactus Hill Reservoir.

Table 4-37. Modeled average Cactus Hill Reservoir water quality under Alternative 3 compared to anticipated standards.

Parameter	Estimated Mass Balance Average Concentration (mg/L)	Anticipated Standard (mg/L)
Ammonia as N	0.014 – 0.015	pH/Temp Dependent
Dissolved Arsenic	0.0003	0.150
Dissolved Copper	0.004	0.0293*
Hardness	30 – 33	--
Nitrate as N	0.042 – 0.046	100
Orthophosphate as P	0.0034 – 0.0038	--
Total Phosphorus	0.048 – 0.049	0.083
Dissolved Selenium	0.001 – 0.002	0.0046
Total Dissolved Solids	80 – 87	--
Total Kjeldahl Nitrogen	0.60 – 0.061	--
Total Organic Carbon	7.5	--

Source: ERO 2013a.
*Based on assumed hardness similar to Jackson Reservoir (400 mg/L).
Note: First number in range assumes leached layer thickness of 1 foot; second number assumes a leach area thickness of 6 feet. If no range provided, then predicted values are the same under both conditions.

Based on its location and depth, Cactus Hill Reservoir is expected to stratify during the summer and experience hypoxia in the hypolimnion. It is estimated that on average, when the reservoir is stratified, the hypolimnion volume would be about 50% of the reservoir content. This is similar to existing Front Range reservoirs, where low hypolimnetic DO concentrations near the bottom are commonly observed. Thus, it is likely that sediment-water interactions induced by low DO concentrations, such as internal loading nutrients and mobilization of metals, would also occur in Cactus Hill Reservoir. In years when there is little to no outflow from the reservoir (57% of the time), the potential for large algae blooms increases.

Cactus Hill Reservoir is expected to have lower water quality than Glade Reservoir in Alternative 2 and higher water quality than Cactus Hill Reservoir in Alternative 4, which would divert some Poudre River water lower on the river at the New Cache Canal. Cactus Hill Reservoir would have higher water quality than Galeton Reservoir.

4.3.5.1.3 Galeton Reservoir

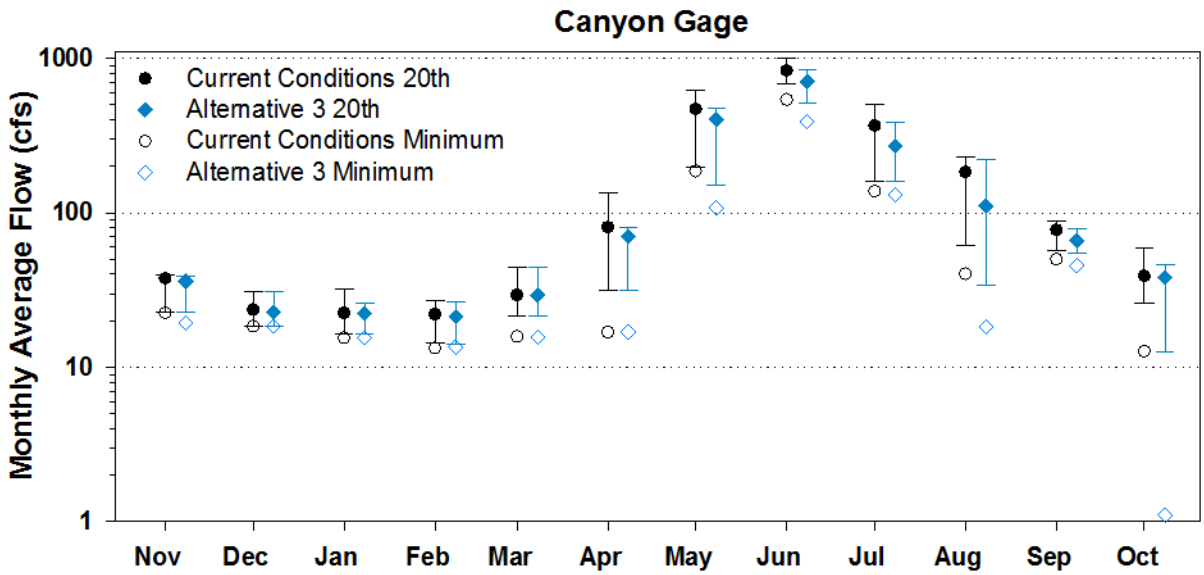
Galeton Reservoir would operate in the same manner as described for Alternative 2 with similar water quality effects, although it would be less vulnerable to higher chlorophyll *a* blooms in certain years with minimal flowthrough when there would be minimal outflows from the reservoir (Hydros 2014b).

4.3.5.2 Poudre River

4.3.5.2.1 Flows

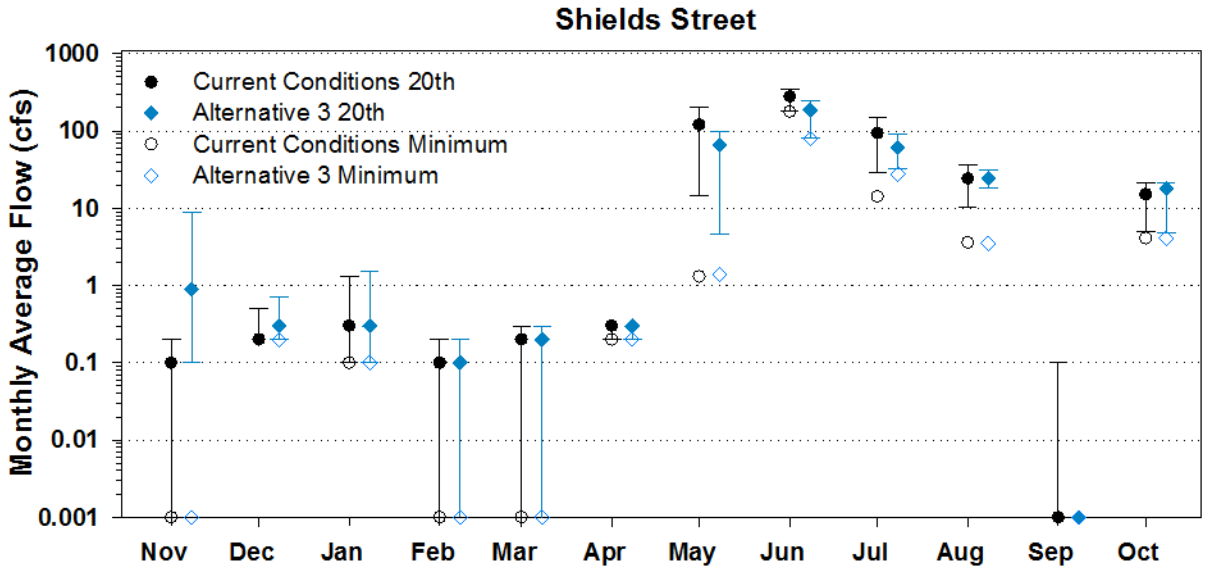
Water would be diverted from the mainstem primarily during the high flow months of May and June under Alternative 3. At the Canyon Gage (Figure 4-38), Alternative 3 would result in hydrology very similar to Alternative 2 (Figure 4-46; GEI 2015a). During the winter, the change in the 20th percentile monthly flows would decrease by approximately 0% to 13%, which represents up to an 11 cfs reduction (March) in modeled flows. In April, May, and June, the 20th percentile would decrease by 13%, 14%, and 15%, respectively, and would represent approximately an 11 cfs, 67 cfs, and 128 cfs reduction in flow. During the summer months of July, August, and September, the 20th percentile monthly flows would decrease by 26%, 40%, and 14%, respectively, and would represent approximately a 97 cfs, 73 cfs, and 11 cfs reduction in flow. In October, the 20th percentile shows a 3% (1 cfs) decrease in flow, although the minimum monthly decreases substantially. The minimum flows represent modeled conditions that may be observed 1 out of 26 years, which is less than 4% of the time.

Figure 4-46. Comparison of the 20th Percentile and Minimum Monthly Average Flow for Current Conditions and Alternative 3 at Canyon Gage, 1980 – 2005. Error Bars Represent the 95% Confidence Interval Around the 20th Percentile.



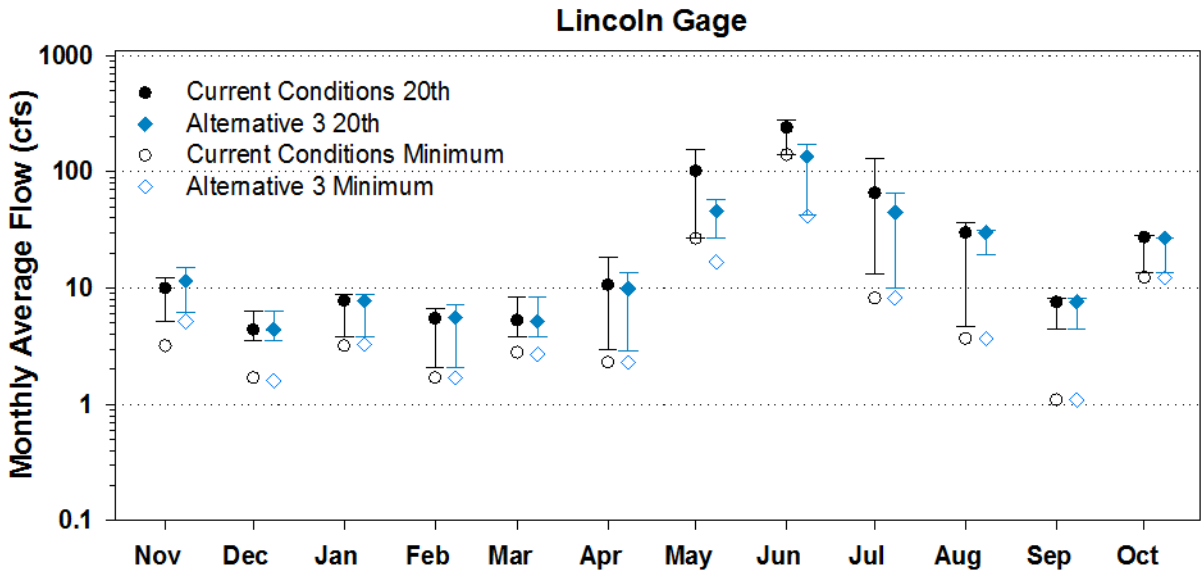
In the lower portion of Segment 10 and upper portion of Segment 11 flows would be less in both the winter and in September with Alternative 3 as compared to Alternative 2 because flow augmentation is not a part of this alternative. The Shields Street hydrology node represents the downstream boundary of Segment 10 and under Alternative 3 this location highlights the lack of winter flow augmentation (Figure 4-47; GEI 2015a). Under Alternative 3, the 20th percentile monthly flow for May, June, and July would be reduced by 38%, which corresponds to a 54 cfs, 91 cfs, and 34 cfs reduction in flow.

Figure 4-47. Comparison of the 20th Percentile and Minimum Monthly Average Flow for Current Conditions and Alternative 3 at Shields Street, 1980 – 2005. Error Bars Represent the 95% Confidence Interval Around the 20th Percentile.



At the Lincoln Street Gage, the absence of the winter augmentation flows would result in 20th percentile monthly flows ranging from 4.4 to 11.5 cfs from November through April, which is a negligible change from Current Conditions (Figure 4-48; GEI 2015a). The minimum flows would remain nearly identical to Current Conditions, except for November, which shows a 64% increase or 2 cfs. From May through July, reduced spring runoff flows would decrease the 20th percentile flow by 55%, 44%, and 32%, respectively.

Figure 4-48. Comparison of the 20th Percentile and Minimum Monthly Average Flow for Current Conditions and Alternative 3 at Lincoln Street Gage, 1980 – 2005. Error Bars Represent the 95% Confidence Interval Around the 20th Percentile.



At the Boxelder Gage, the 20th percentile and minimum monthly flows would be nearly identical to Alternative 2 conditions because the 10 cfs winter augmentation flow would be re-diverted at Timnath Reservoir Canal. The hydrological conditions further downstream of the Boxelder Gage to the Greeley Gage would be nearly identical to Alternative 2.

4.3.5.2.2 Segment 10 Constituent Effects

In the lower reaches of Segment 10, the total recoverable iron standard is 1,000 µg/L, and the existing median concentration is 141 µg/L. During the Alternative 3 operational months of May and June, the total recoverable iron concentrations are their greatest during the year, which is indicative of watershed snowmelt runoff rather than point sources. From an operational standpoint, a decrease in flow during these months is not expected to substantively increase total recoverable iron concentrations in Segment 10. Total recoverable iron concentrations are also not expected to substantively increase during other months of the year, because Alternative 3 operations would be limited.

Dissolved and total recoverable manganese concentrations show no relationship with flow, perhaps due to the low sample size. However, total recoverable manganese concentrations do exhibit a seasonal pattern such that concentrations are the lowest during the summer months and highest during the winter/spring. The agricultural manganese standard is 200 mg/L, and the

existing 50th percentile concentration is 22 mg/L in Segment 10. Thus, manganese concentrations may increase as a result of Alternative 3 operations, but concentrations are not expected to exceed the agricultural water quality standard.

Both dissolved copper and dissolved selenium show no relationship to flow because of the low sample size, which includes many non-detect results. The 85th percentile concentrations for dissolved copper range from 1.20 µg/L to 1.70 µg/L, and the chronic hardness based standards range from 3.15 µg/L to 10.4 µg/L. The 85th percentile concentrations for dissolved selenium range from 0.039 µg/L to 0.500 µg/L, and the chronic standard is 4.6 µg/L. Dissolved copper concentrations increase in June, July, and August, but this pattern is likely a result of copper-based herbicides that are applied during these months. Dissolved selenium concentrations show no discernable seasonal pattern. Based on the available data, Alternative 3 would not substantively change the selenium concentrations in the lower portion of Segment 10 given other source water characteristics in Segment 10.

Both ammonia and nitrate concentrations show no relationship with flow, nor a seasonal pattern. There are numerous non-detect results reported across the full range of flow conditions. Based on the available data, Alternative 3 would not substantively affect ammonia or nitrate concentrations in Segment 10 given the constituents are currently at the limits of detection.

Total phosphorus concentrations show a slight increase with increasing flow, although there are many <non-detect results reported across the full range of flows. The interim total phosphorus standard in Segment 10 is 0.110 mg/L, and the 50th percentile concentration in the lower reach is 0.016 mg/L, which is approximately seven times less than the interim standard. Alternative 3 is not expected to affect the assessment metric for total phosphorus.

Both chloride and sulfate concentrations show a distinct seasonal pattern such that concentrations are the lowest during the summer months. Chloride and sulfate concentrations may increase during Alternative 3 operational months; however, a change in the low end concentrations is not expected to change the assessment metrics or exceed their respective water quality standard.

4.3.5.2.3 Segment 11 Constituent Effects

In the upper reaches of Segment 11, the total recoverable iron standard is 1,000 µg/L, and the existing median concentration is 173 µg/L. During the Alternative 3 operational months of May and June, the total recoverable iron concentrations are greatest during the year, which is indicative of watershed snowmelt runoff rather than point sources. From an operational standpoint, a decrease in flow during these months is not expected to substantively increase total recoverable iron concentrations in Segment 11. It would take an approximately 6-fold increase in concentration before the iron standard was exceeded. Total recoverable iron concentrations are also not expected to substantively increase during other months of the year when base flow conditions exist and concentrations are at their lowest point.

Dissolved and total recoverable manganese concentrations exhibit a slight decrease in concentrations across the full ranges of flow conditions, and do not reveal strong seasonal patterns as compared to iron. This indicates that the source for manganese is relatively consistent over the year, but that as flows increase there may be a dilution effect. Total

recoverable manganese concentrations are typically the greatest during low flow conditions. The agricultural manganese standard is 200 mg/L, and the existing 50th percentile concentration ranges from 29 to 47 mg/L in Segment 11. Based on this information, manganese concentrations may increase as a result of Alternative 3, but concentrations are not expected to exceed the agricultural water quality standard.

Both dissolved copper and dissolved selenium show no discernable relationship to the full range of flow conditions observed in Segment 11, and there are numerous non-detect results across the full range of flow conditions. The 85th percentile concentrations for each parameter are less than their respective water quality standards. Dissolved copper also shows no seasonal pattern; however, dissolved selenium concentrations show a distinct seasonal pattern. Selenium concentrations are the lowest during June, July, and August, which may indicate that flow conditions do affect selenium concentrations, although they are not readily discernable in the concentration-flow relationship for the selected sites. Alternative 3 may affect selenium concentrations in the upper portion of Segment 11, but would not appreciably affect the 85th percentile assessment metric because concentrations are the lowest during the Alternative 3 operational months.

Nitrate concentrations reveal a relationship with low flow conditions, such that at flows less than the 20th percentile, concentrations begin to increase; however, these concentrations are orders of magnitude less than the 100 mg/L standard. Nitrate concentrations also show a strong seasonal pattern indicating concentrations are the lowest during late spring and early summer, which could be a function of flow conditions, but is more likely tied to nitrate attenuation, either biotic or abiotic, in the stream channel (Ranalli and Macalady 2010). Based on this information, Alternative 3 is not expected to affect nitrate concentrations in the context of water quality standards.

Both ammonia and total phosphorus concentrations do not show a relationship with flow or a seasonal pattern. The interim total phosphorus standard in Segment 10 is 0.110 mg/L, and the 50th percentile concentration in the lower reach is 0.05 mg/L, which is approximately two times less than the interim nutrient value. While the ammonia standards vary with changing temperature and pH, existing concentrations are considerably less than their comparable standards. Alternative 3 is not expected to affect the assessment metrics for these parameters.

Both chloride and sulfate concentrations decrease as flow increases in the upper portion of Segment 11, and both show a distinct seasonal pattern such that concentrations are the lowest during the months of May through October. Under Alternative 3, chloride and sulfate concentrations may increase during the operational months; however, a change in the low end concentrations is not expected to change the assessment metrics or exceed their respective water quality standard.

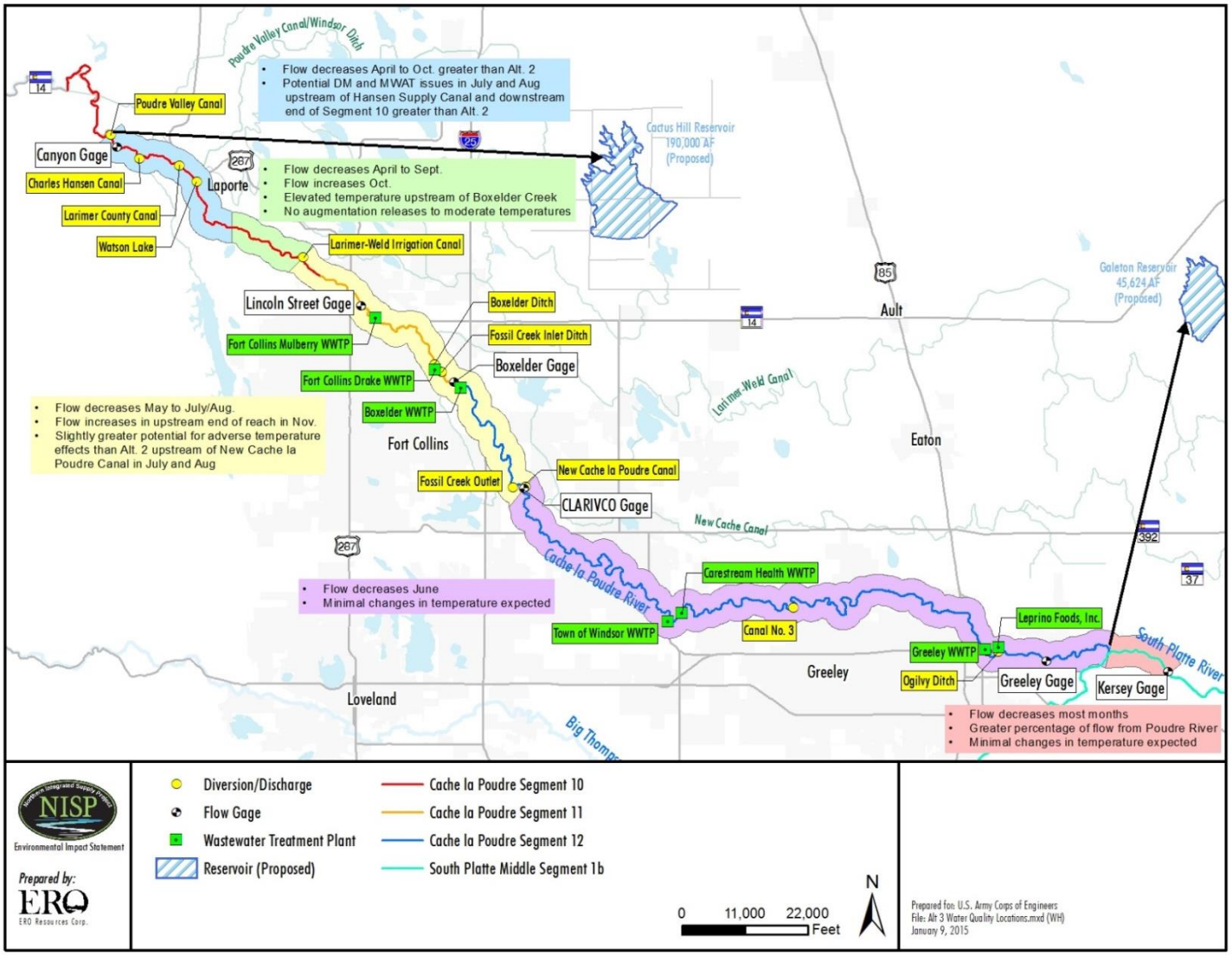
4.3.5.2.4 Segment 12 Constituent Effects

Under Alternative 3, the hydrological conditions in Segment 12 would be nearly identical to conditions described for Alternative 2; therefore, the potential effects on water quality conditions are expected to be very similar to those as described in Section 4.3.4.2.4.

4.3.5.2.5 Poudre River Temperature Effects

Poudre Valley Canal diversions to Cactus Hill Reservoir would likely exacerbate and expand DM and MWAT temperature issues in March, July, August, and September upstream of the Hansen Supply Canal and at the downstream end of Segment 10. Effects in July and August could extend to upstream of Boxelder Creek. The effect upstream of the New Cache diversion would likely be less due to the cooling effects of ground water inflow downstream of Boxelder Creek that are not expected to change. Minimal temperature effects are anticipated for the reach from the New Cache diversion to the confluence with the South Platte River. Potential adverse effects from Alternative 3 on stream temperatures would generally be similar to or greater that those identified for Alternative 2, due to greater flow diversions at the Poudre Valley Canal and the lack of streamflow augmentation in March and September. Figure 4-49 summarizes CTP simulated changes in median irrigation season flow rates and the potential effect to stream water temperature along the Poudre and South Platte Rivers.

Figure 4-49. Potential Impacts to Poudre River and South Platte River Stream Temperature from Hydrologic Changes under Alternative 3.



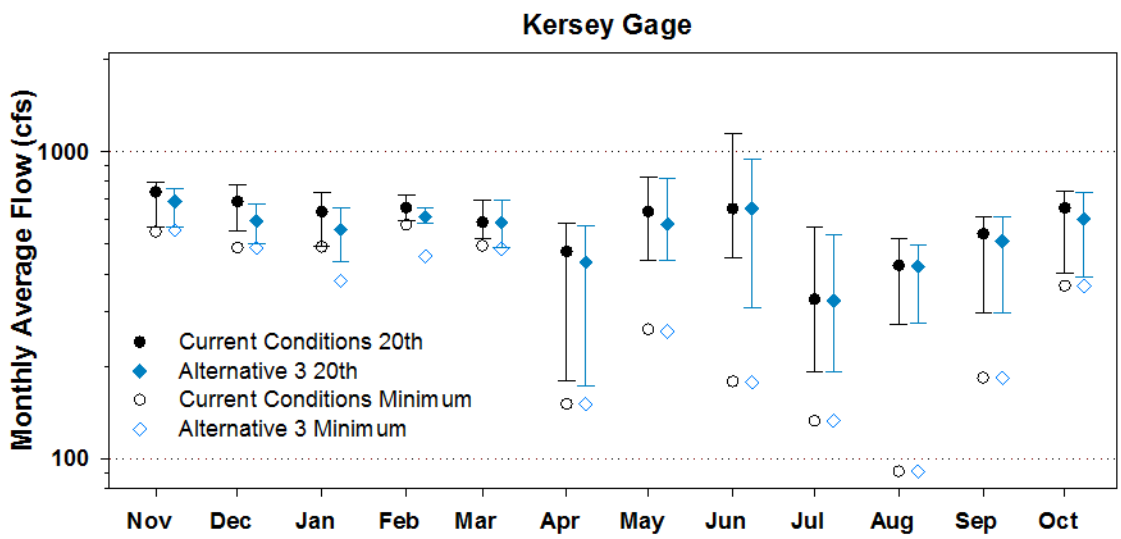
4.3.5.2.6 Poudre River Dissolved Oxygen Effects

Decreased flow rates during summer months from the Canyon Gage to the New Cache diversion could adversely affect localized areas that have historically exhibited DO excursions, particularly in Segment 11. Minimal effects to DO are anticipated for the reach from the New Cache diversion to the confluence with the South Platte River because this is not a sensitive reach for DO and ground water inflow is not expected to change substantially. The potential for increased frequency or magnitude of conditions below the DO standard under Alternative 3 is expected to be greater than that identified for Alternative 2 as a result of greater flow diversions at the Poudre Valley Canal.

4.3.5.3 South Platte River

Under Alternative 3, the NISP/SPWCP operations would result in nearly identical low flow conditions as observed for Alternative 2. From October through February, Alternative 3 would reduce the Current Conditions 20th percentile flow by approximately 8% or 54 cfs (Figure 4-50; GEI 2015a). In April and May, Alternative 3 would reduce the 20th percentile monthly flow by approximately 8% or 42 cfs. The minimum monthly flows in January and February would be reduced by approximately 22% or 116 cfs, while all other months would show negligible differences (≤5 cfs).

Figure 4-50. Comparison of the 20th Percentile and Minimum Monthly Average Flow for Current Conditions and Alternative 3 at Kersey Gage, South Platte River, 1980 – 2005. Error Bars Represent the 95% Confidence Interval Around the 20th Percentile.



4.3.5.3.1 Segment 1b Constituent Effects

Under Alternative 3, the hydrological conditions in Segment 1b would be nearly identical to conditions described for Alternative 2, therefore, the potential effects on water quality conditions is expected to be very similar to those as described in Section 4.3.4.3.

4.3.5.3.2 Segment 1b Temperature Effects

Similar to Alternative 2, minimal temperature effects are anticipated for the South Platte River for Alternative 3.

4.3.5.3.3 Segment 1b Dissolved Oxygen Effects

Minimal DO effects are anticipated for the South Platte River for Alternative 3, for the reasons noted in the discussion for Alternative 2.

4.3.5.4 Effects on Larimer-Weld and New Cache Canals Water Quality and Crop Yield

Since Galeton Reservoir and the SPWCP would be operated in the same manner as Alternative 2, Alternative 3 would have similar effects in terms of increasing the salinity of water supplied to participating irrigators within the Larimer-Weld and New Cache irrigation systems and impacts on crop yield.

4.3.5.5 Effects on Water Treatment Plants

Diversions for Alternative 3 are not expected to change the TOC concentration in the Poudre River at Greeley's Bellvue WTP diversion point. Potential changes to other water quality parameters in the Poudre River from Alternative 3 diversions are also not expected to affect Greeley's WTP operations. Under Alternative 3, water would not be piped to Horsetooth Reservoir, so WTPs using Horsetooth Reservoir water would not be affected. However, direct delivery from Cactus Hill Reservoir to a Participant WTP could require additional treatment for TOC depending on the quality of the source water to Cactus Hill, lake processes that affect TOC, and the time of the year.

4.3.5.6 Construction Related Impacts to Water Quality

Temporary ground disturbance on about 1,259 acres for construction of conveyance facilities and the Cactus Hill and Galeton Reservoir Dams could result in erosion and possible sedimentation of nearby streams. Impacts would generally be short-term and minor following reclamation and revegetation.

4.3.6 Alternative 4

Under Alternative 4, water quality effects on the Poudre River would occur downstream from the Poudre Valley Canal and New Cache Canal diversions. Combined diversions would be larger than Alternative 2 because of greater transit and evaporation losses. Cactus Hill Reservoir would be used to store Poudre River diversions and Galeton Reservoir would store South Platte River diversions. Water quality in these new reservoirs would be affected by source water quality and operations. There would be no effect on Horsetooth Reservoir water quality because Alternative 4 would not use Horsetooth to store or transmit NISP water.

4.3.6.1 Projected Reservoir Water Quality

4.3.6.1.1 Existing Reservoirs

No existing reservoirs would be used for water storage under Alternative 4, so there would be no effects to the water quality of existing reservoirs.

4.3.6.1.2 Cactus Hill Reservoir

Cactus Hill Reservoir under Alternative 4 would be at the same location as Alternative 3, but the 190,000 AF reservoir would receive water from both the Poudre Valley Canal and a diversion at the existing New Cache Canal, which diverts water from the Poudre River downstream from Fort Collins and the Fossil Creek confluence in Segment 12. Poudre River water quality at the New Cache Canal diversion is lower than at the Poudre Valley Canal diversion site used for filling Cactus Hill Reservoir under Alternative 3 (Table 4-38).

Table 4-38. Poudre River water quality at New Cache Canal.

Water Quality Constituent	Median	Minimum	Maximum
Dissolved Oxygen (mg/L)	7.9	3.7	14.8
Specific Conductance (uS/cm)	827	194	1,692
Total Phosphorus (µg/L)	65.2	88	1,639
Total Nitrogen (µg/L)	1,742	410	5,118
Nitrate + Nitrite (µg/L)	760	160	3,650
Dissolved Organic Carbon (mg/L)	8.2	4.6	25.7
Total Suspended Solids (mg/L)	18	3	529
Copper, Diss(µg/L)	1.3	0.25	5
Copper, Tot Rec (µg/L)	2.2	1.9	2.4
Arsenic, Diss (µg/L)	1.01	0.53	2.32
Selenium, Diss, (µg/L)	1.42	0.25	3.84

Source: District 2013.

Mass balance modeling of likely water quality in Cactus Hill Reservoir was conducted assuming no degradation in water quality during conveyance as the Poudre Valley Canal would be lined (ERO and Tetra Tech 2015). Table 4-39 indicates modeled water quality in Cactus Hill Reservoir.

Stratification during the summer is likely to result in low dissolved oxygen concentrations at the bottom of the reservoir. The reservoir is expected to be vulnerable to higher algae blooms in July and August when little or no outflow is expected. This is anticipated to occur in 68% of years simulated. Initial water quality in Cactus Hill Reservoir also would be lower during initial filling as described for Alternative 3. Source water quality to Cactus Hill would be lower under Alternative 4 compared to Alternative 3 due to some of the water being diverted lower on the river, thus water quality in the reservoir is anticipated to be lower. Elevated TOC concentrations under Alternative 4 may cause water treatment concerns, depending on the time of year and blending with other sources of water. Cactus Hill Reservoir would qualify as a direct use water supply and would more than likely not be in attainment of a possible 5 µg/L chlorophyll *a* standard (average March to November).

Table 4-39. Modeled average Cactus Hill Reservoir water quality under Alternative 4 compared to anticipated standards.

Parameter	Estimated Mass Balance Average Concentration (mg/L)	Anticipated Standard (mg/L)
Ammonia as N	0.048	pH/Temp Dependent
Dissolved Arsenic	0.0004	0.150
Dissolved Copper	0.003	0.0293*
Hardness	82 – 85	--
Nitrate as N	0.12 – 0.13	100
Orthophosphate as P	0.013	--
Total Phosphorus	0.070 - 0.071	0.083
Dissolved Selenium	0.001 – 0.002	0.0046
Total Dissolved Solids	177 – 183	--
Total Kjeldahl Nitrogen	0.73 – 0.74	--
Total Organic Carbon	8.1 – 8.2	--

Source: ERO and Tetra Tech 2015.
*Based on assumed hardness similar to Jackson Reservoir (400 mg/L).
Note: First number in range assumes leached layer thickness of 1 foot; second number assumes a leach area thickness of 6 feet. If no range provided, then predicted values are the same under both conditions.

4.3.6.1.3 Galeton Reservoir

Galeton Reservoir would operate in the same manner as described for Alternative 2 with similar water quality effects, although it would be less vulnerable to higher chlorophyll *a* blooms in certain years with minimal flowthrough when there would be minimal outflows from the reservoir (Hydros 2014b).

4.3.6.2 Poudre River

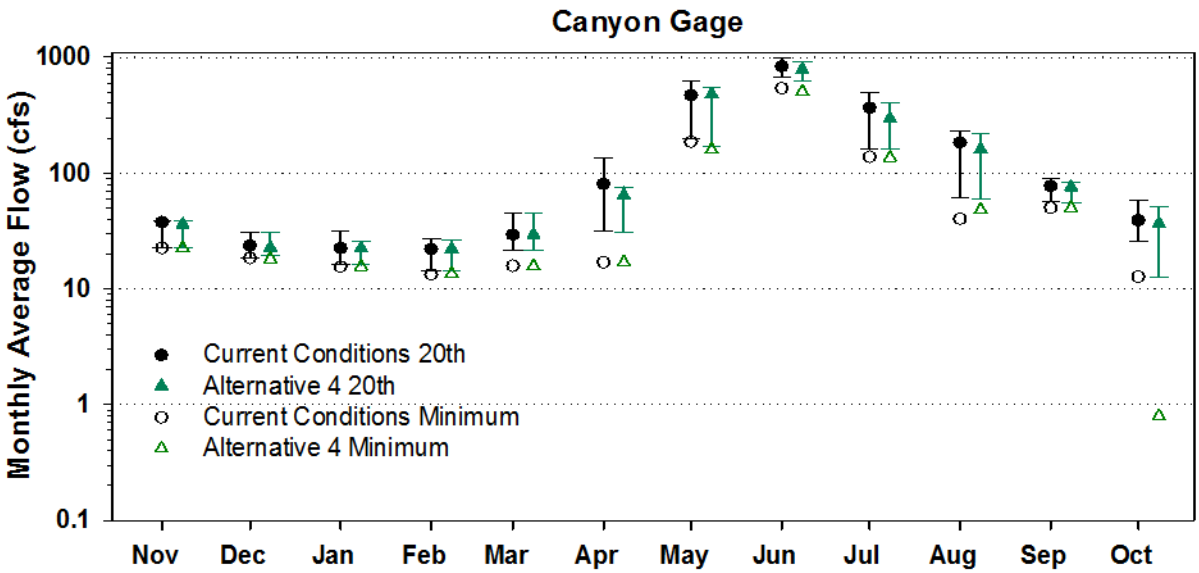
4.3.6.2.1 Flows

Under Alternative 4, approximately 75% of the water would be diverted from the mainstem at the Poudre Valley Canal, the same location as the other alternatives, but approximately 25% of the water would be diverted at the New Cache Canal east of I-25 and east of Fort Collins. Relative to Alternatives 2 and 3, this would allow more water to flow through the Fort Collins area before being diverted. Alternative 4 would result in different flows in Segments 10 and 11, as well as the upper portion of Segment 12 above the New Cache Canal when compared to Alternatives 2 and 3. Alternative 4 would result in reduced spring runoff flows and a shorter high flow season throughout Segment 10 and a portion of Segment 11 of the Poudre River. However, the reductions in spring flows would be less than for Alternatives 2 and 3.

Under Alternative 4, the 20th percentile and minimum monthly flows from November through March would remain unchanged in Segment 10. The diversions in April and May would result in a 20% decrease (17 cfs) and 2% increase (9 cfs) in the 20th percentile flow at the Canyon Gage (Figure 4-51; GEI 2015a). The minimum monthly flow would remain unchanged in April, yet decrease approximately 15% (27 cfs) in May. In June, July, and August, the 20th percentile flow

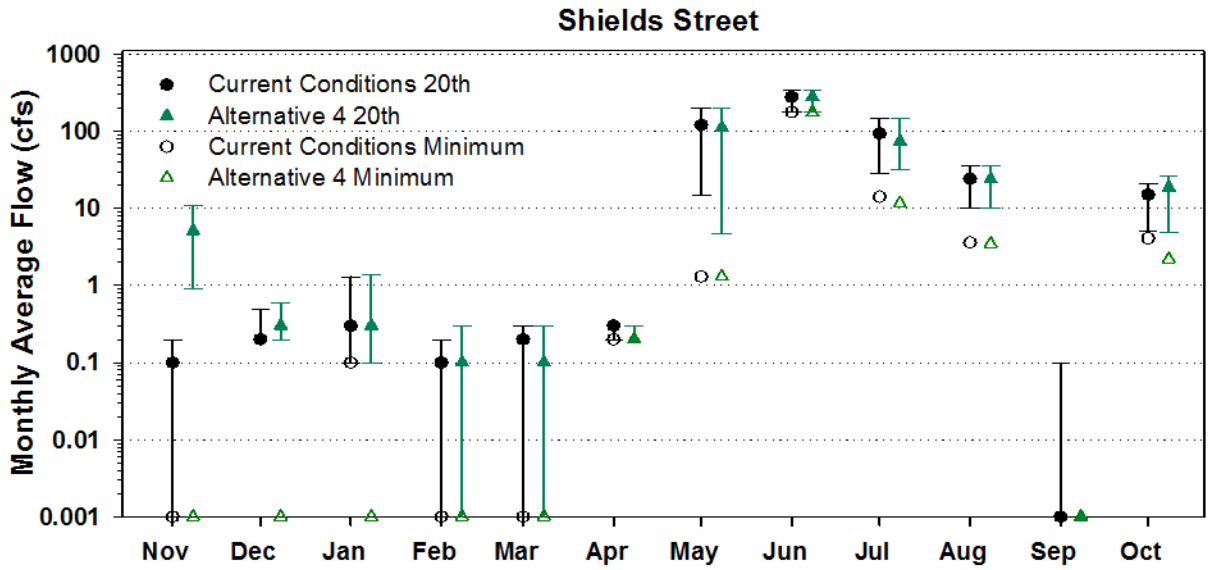
would decrease by 6%, 20%, and 13%, respectively, which corresponds to a reduction in flow of 52 cfs, 72 cfs, and 24 cfs. The minimum flows would generally remain unchanged although the minimum would increase slightly (20%) in August. In September and October, the 20th percentile flow would show negligible changes from Current Conditions, although the minimum flow in October may substantially decrease by 12 cfs (93%).

Figure 4-51. Comparison of the 20th Percentile and Minimum Monthly Average Flow for Current Conditions and Alternative 4 at Canyon Gage, 1980 – 2005. Error Bars Represent the 95% Confidence Interval Around the 20th Percentile.



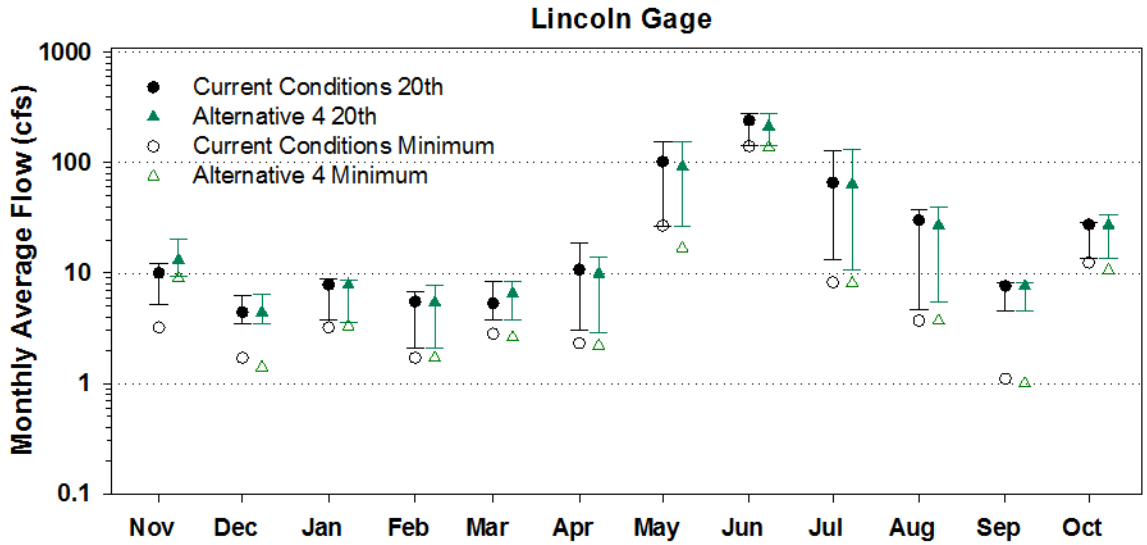
At the Shields Street hydrology node, Alternative 4 would result in negligible changes (≤1 cfs) to the 20th percentile monthly flow during the winter, except for a minor increase in November of 5 cfs. In May, June, and July the 20th percentile flows would result in a reduction of approximately 10% (Figure 4-52; GEI 2015a). In August and September, the 20th percentile and minimum monthly flow conditions would remain unchanged from Current Conditions. In October, there would be a slight increase in the 20th percentile flow of approximately 24% (4 cfs).

Figure 4-52. Comparison of the 20th Percentile and Minimum Monthly Average Flow for Current Conditions and Alternative 4 at Shields Street, 1980 – 2005. Error Bars Represent the 95% Confidence Interval Around the 20th Percentile.



Under Alternative 4, the absence of the winter augmentation flows would result in 20th percentile monthly flows ranging from 4.4 to 13.1 cfs from November through April, which is a negligible change from Current Conditions (Figure 4-53; GEI 2015a). The minimum flows would remain nearly identical to Current Conditions, except for November, which shows a 182% increase or 9 cfs. From May through July, Alternative 4 would result in negligible changes to the 20th percentile flows. The 20th percentile and minimum monthly flow conditions in August, September, and October would result in negligible changes of approximately 4% (1 cfs) decrease in flows.

Figure 4-53. Comparison of the 20th Percentile and Minimum Monthly Average Flow for Current Conditions and Alternative 4 at the Lincoln Street Gage, 1980 – 2005. Error Bars Represent the 95% Confidence Interval Around the 20th Percentile.



At the Boxelder CTP hydrology node, Alternative 4 would result in negligible changes to the 20th percentile and minimum monthly flows as compared to Current Conditions. Upstream of the Greeley WWTP and Greeley Gage changes in the 20th percentile and minimum monthly flows would be nearly identical to changes in flow conditions as discussed for Alternative 2.

4.3.6.2.2 Segment 10 Constituent Effects

Changes in water quality conditions for Segment 10 are expected to be very similar to those described for Alternative 3, even though the 20th percentile flow conditions under Alternative 4 in the downstream reach would be greater during the operational months of May (69%), June (48%), and July (22%). From an operational standpoint, the transfer of water occurs at multiple diversion locations under Alternative 4 thus the 20th percentile flow conditions are greater in Segment 10 because many of these transfers occur further downstream. Under Alternative 4 at Shields Street, the 20th percentile flows during May, June, and July (i.e., 75 – 280 cfs) are greater than flow conditions under Alternative 3 (i.e., 60 – 190 cfs), but given the relative magnitude of the flows under both alternatives and the fact that streamflow would not be from a new source, the water quality conditions during the May-July period are expected to be very similar to those described in Alternative 3. During the remaining months of the year, the 20th percentile flow conditions should remain nearly identical to Current Conditions; therefore, water quality conditions are not expected to change during non-operating months.

4.3.6.2.3 Segment 11 Constituent Effects

Under Alternative 4, changes in water quality conditions in Segment 11 are expected to be very similar to those described for Alternative 2 and Alternative 3. The slightly higher 20th percentile flow as compared to other alternatives during the May – July period is due to the transfer of water occurring at multiple diversions as well as via the SPWCP. This is likely to have a negligible improvement in water quality in Segment 11, with overall negligible to minor impacts to constituents in Segment 11.

4.3.6.2.4 Segment 12 Constituent Effects

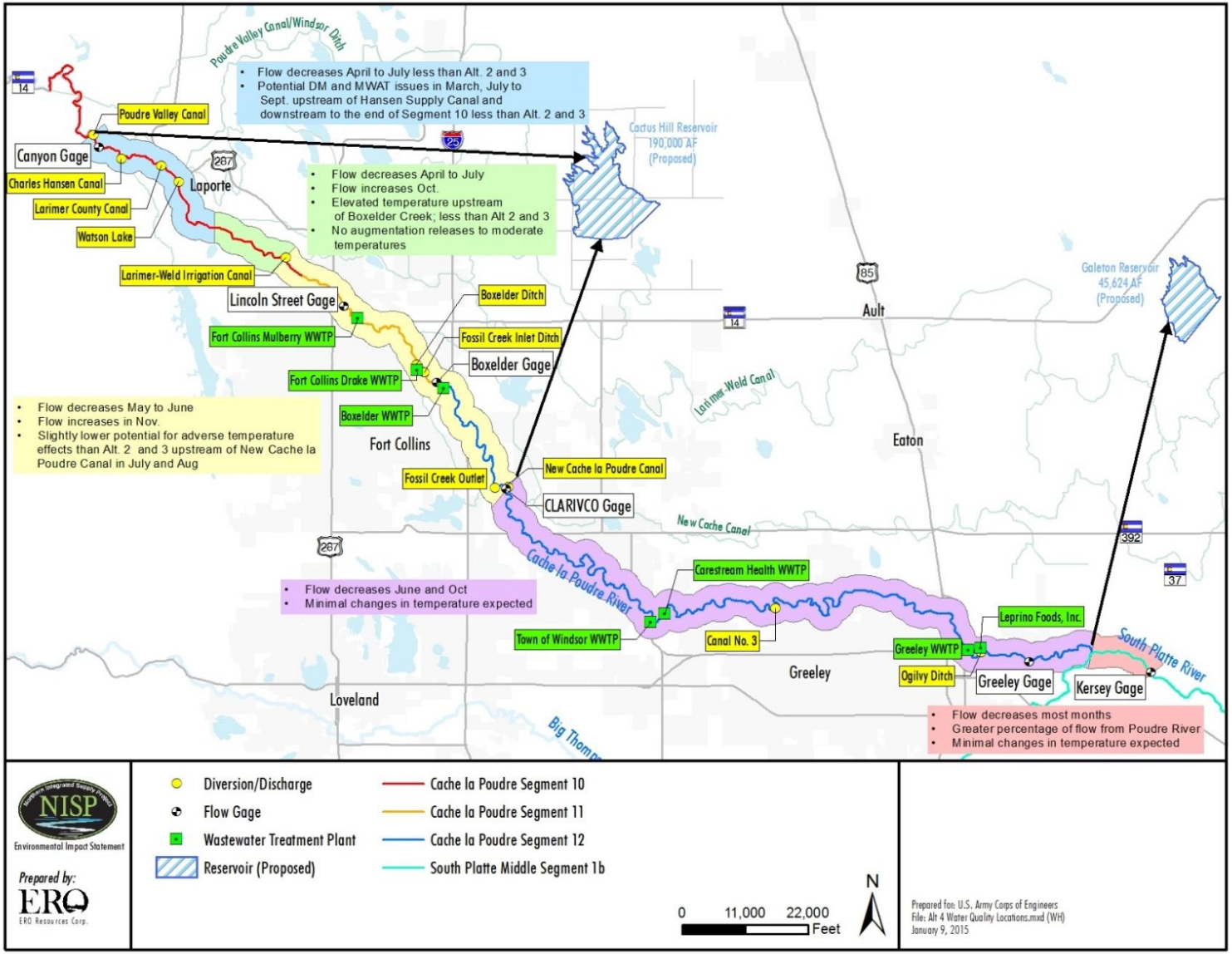
The increase in the 20th percentile flow as compared to other alternatives during the May – July period is due to the transfer of water occurring at multiple diversions as well as via the SPWCP. This increase in flow is likely to have negligible effects on the water quality conditions upstream of the New Cache Canal, where a substantial amount of flow is diverted under Alternative 4. Downstream of the New Cache Canal the hydrology and water quality conditions should be very similar for Alternatives 2, 3, and 4. Overall constituent water quality effects are likely to be minor to moderate in Segment 12.

4.3.6.2.5 Poudre River Temperature Effects

Adverse effects on Poudre River temperatures under Alternative 4 would generally be similar to those of Alternative 3, but less in the upper reaches (from the Poudre Valley Canal to the New Cache diversion) because diversions would be less at the Poudre Valley Canal. Poudre Valley Canal diversions to Cactus Hill Reservoir could likely exacerbate and expand DM and MWAT temperature issues in March, July, August, and September upstream of the Hansen Supply Canal and at the downstream end of Segment 10. Effects in July and August would also be possible just upstream of Boxelder Creek (Segment 11), but they would likely be less than those

anticipated for Alternative 3 due to lower upstream diversion volumes. Potential adverse temperature effects in July and August from the Canyon Gage to Boxelder Creek would also be less than those anticipated for Alternative 2, due to lower diversions from the Poudre Valley Canal. Minimal temperature effects are anticipated for the reach from the New Cache diversion to the confluence with the South Platte River. Figure 4-54 summarizes CTP-simulated changes in median irrigation-season flow rates and the potential effect to stream water temperature along the Poudre and South Platte Rivers for Alternative 4.

Figure 4-54. Potential Impacts to Poudre River and South Platte River Stream Temperature from Hydrologic Changes under Alternative 4.



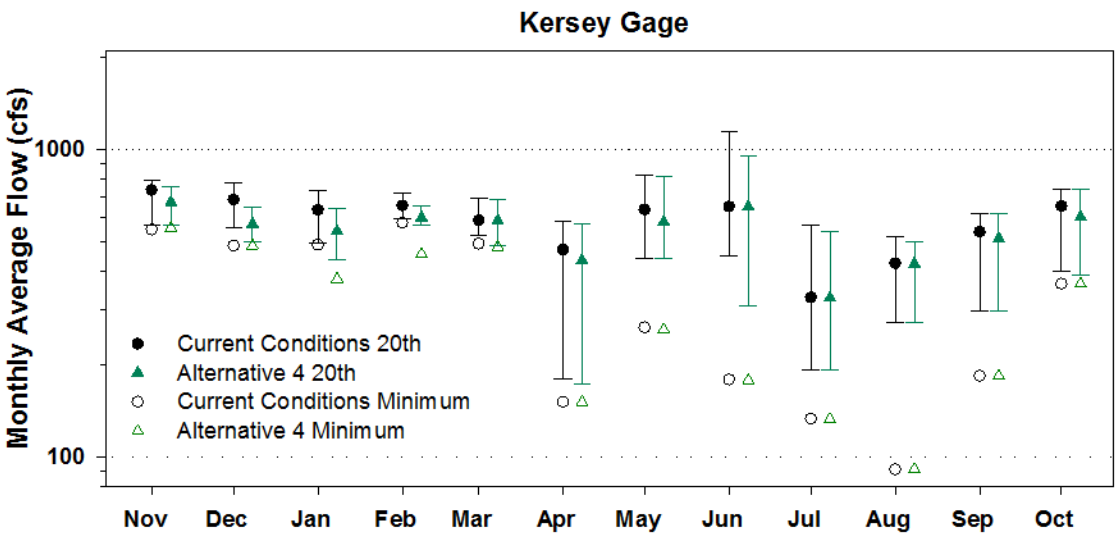
4.3.6.2.6 Poudre River Dissolved Oxygen Effects

Adverse effects from Alternative 4 on DO would generally be similar to those of Alternative 3, but lesser in the upper reaches (from the Poudre Valley Canal to the New Cache diversion) due to lower diversions at the Poudre Valley Canal. Minimal DO effects are anticipated for the reach from the New Cache diversion to the confluence with the South Platte River.

4.3.6.3 South Platte River

Under Alternative 4, the NISP/SPWCP operations would result in similar low flow conditions as observed for Alternatives 2 and 3. The slight difference between Alternative 4 and the other alternatives is that NISP/SPWCP would increase the diversions from November through February by approximately 15-20 cfs depending upon the month (Figure 4-55). During the remaining months of the year, Alternative 4 would result in no change from conditions described for the other alternatives. No change would occur to the minimum monthly flows when compared to the other alternatives.

Figure 4-55. Comparison of the 20th Percentile and Minimum Monthly Average Flow for Current Conditions and Alternative 4 at Kersey Gage, South Platte River, 1980 – 2005. Error Bars Represent the 95% Confidence Interval Around the 20th Percentile.



4.3.6.3.1 South Platte River Constituents Effects

Under Alternative 4, changes in water quality conditions in Segment 1b of the South Platte River are expected to be very similar to those described for Alternative 2. The additional decrease in flow by 15 to 20 cfs during the winter months is likely to have negligible effects on the water quality conditions.

4.3.6.3.2 South Platte River Temperature Effects

Similar to Alternative 2, minimal temperature effects are anticipated for the South Platte River for Alternative 4.

4.3.6.3.3 South Platte River Dissolved Oxygen Effects

Minimal DO effects are anticipated for the South Platte River for Alternative 4, for reasons noted in the discussion for Alternative 2.

4.3.6.4 Effects on Larimer-Weld and New Cache Canals Water Quality and Crop Yield

Alternative 4 includes the construction of Galeton Reservoir and operation of the SPWCP in a similar manner as Alternatives 2 and 3. Consequently, this alternative would have similar effects in terms of increasing the salinity of water supplied to participating irrigators within the Larimer-Weld and New Cache irrigation systems and impacts on crop yield.

4.3.6.5 Effects on Water Treatment Plants

Diversions for Alternative 4 are not expected to change the TOC concentration in the Poudre River at Greeley's Bellvue WTP diversion point. Potential changes to other water quality parameters in the Poudre River from Alternative 4 diversions are also not expected to affect Greeley's WTP operations. No water would be piped to Horsetooth Reservoir, so WTPs using Horsetooth Reservoir water would not be affected. However, direct delivery from Cactus Hill Reservoir to a Participant WTP could require additional treatment for TOC depending on the quality of the source water to Cactus Hill, lake processes that affect TOC, and the time of the year.

4.3.6.6 Construction Related Impacts to Water Quality

Temporary ground disturbance on about 1,319 acres for construction of conveyance facilities and the Cactus Hill and Galeton Reservoir Dams could result in erosion and possible sedimentation of nearby streams. Impacts would generally be short-term and minor following reclamation and revegetation.

4.3.7 Effects of All Action Alternatives on Wastewater Treatment Plants

This evaluation focuses on the potential effects of the NISP alternatives on CDPS permittees in Segments 10, 11, and 12 of the Poudre River, with special consideration to the seven permitted wastewater treatment plants. These WWTPs include: Fort Collins Mulberry, Fort Collins Drake, Boxelder, Windsor, Carestream Health (Kodak), Greeley, and Leprino Foods (Figure 4-38 and Figure 4-39). To protect regulatory low flows, the alternatives would divert water only when the minimum flow criteria are met for the following locations:

- Watson Lake Fish Hatchery
  - 50 cfs summer (April 15-October 14)
  - 25 cfs winter (October 15-April 14)

- Fort Collins boat chute
  - 30 cfs (May 1-August 31)
  - 5 cfs (September 1-April 30)

- Fort Collins Nature Center
  - 30 cfs (May 1-August 31)
  - 5 cfs, with all river flows between 5 cfs and 25 cfs to be shared equally between Fort Collins and the City of Thornton, and Fort Collins is entitled to no more than 15 cfs (September 1-April 30)

Due to the constraints posed by the fish hatchery and recreational water rights, NISP would only divert water during times of sufficient flows and therefore should not affect the regulatory low flows imposed on the WWTPs in Segments 10 and 11. However, under Current Conditions hydrology there may be conditions where the regulatory low flows are currently not attained. During these cases, NISP alternatives would result in negligible change to these conditions, except for the augmentation program under Alternative 2. The Alternative 2 augmentation plan would benefit regulatory low flows by increasing flows (~10 cfs) during November through April and September. By protecting the regulatory low flows within Segments 10 and 11, the regulatory low flows should also be protected in Segment 12, although there are no specific water rights or operations designated for protection in Segment 12.

Potential effects to each of the WWTPs on the Poudre River for the action alternatives are described below.

4.3.7.1 City of Fort Collins Mulberry Wastewater Treatment Facility

Given the CTP Current Conditions hydrology, the minimum monthly flow based on 26 years of modeled data is currently less than the 30E3 chronic low flow for the months of July, August, September, and December (Table 4-40), ranging from 0.5 cfs to 2.8 cfs less than the permit amount. While this evaluation does not provide a direct one-to-one comparison to the regulatory chronic low flows, it does provide some insight into the existing hydrology issues that may occur. During May and June, the primary operating months for NISP, the regulatory chronic low flows would not be affected. For the months that indicate potential issues under Current Conditions hydrology, Alternatives 2, 3, and 4 would have either a negligible or no effect on minimum monthly flows, except for Alternative 2, which would have a benefit by increasing low flows. Under Alternative 2, the flow augmentation program would increase the November through April and September low flow conditions and maintain flow at approximately 10 cfs or slightly above depending upon existing conditions.

Table 4-40. Mulberry WWTP 30E3 regulatory low flow and PR 44.3, Lincoln Street Gage minimum monthly average flow (shaded cells indicate values below the 30E3 chronic low flow).

Month	30E3 Chronic Low Flow (cfs)	PR 44.3, Lincoln Street Gage Minimum Monthly Average Flow (cfs)			
		Current Conditions	Alternative 2	Alternative 3	Alternative 4
January	1.5	3.2	13.2	3.3	3.3
February	1.5	1.7	11.7	1.7	1.7
March	1.5	2.8	12.7	2.7	2.6
April	1.5	2.3	12.1	2.3	2.2
May	1.8	26.8	16.8	16.8	16.8
June	14.0	140.5	81.5	41.7	137.7
July	11.0	8.2	8.1	8.2	8.1
August	4.8	3.7	3.6	3.7	3.7
September	2.2	1.1	9.0	1.1	1.0
October	2.2	12.4	12.3	12.4	10.6
November	2.2	3.2	13.9	5.2	9.0
December	2.2	1.7	11.4	1.6	1.4

4.3.7.2 City of Fort Collins Drake Wastewater Treatment Plant

The Fort Collins Drake facility has a design capacity of 23 million gallons per day (mgd) and is located near the downstream reach of Segment 11 (Figure 4-38). The Drake Facility is permitted to discharge either to the Poudre River or to Fossil Creek Ditch, which then flows to Fossil Creek Reservoir. Only the Poudre outfall would be directly affected by NISP. However, the outflows from Fossil Creek Reservoir eventually flow into the Poudre River, just upstream of the New Cache Canal. The USGS Boxelder Gage and estimated seepage rates were used to synthesize the regulatory low flow record for the Mulberry WWTP (CDPHE 2008, CO-0026425).

Given the CTP Current Conditions hydrology, the minimum monthly flow for July is currently less than the 30E3 chronic low flow (Figure 4-52). The difference between the Current Conditions minimum monthly flow and the 30E3 chronic low flow is 0.3 cfs and indicates a dry-up period based on modeled hydrology. During May and June, the primary operating months for NISP, the regulatory chronic lows flow would not be affected. Modeled hydrology for NISP Alternatives 2, 3, and 4 also show that the minimum monthly flow expected to occur in July over a 26-year period is zero (i.e., dry-up) which is the same as Current Conditions. Under Alternative 2, the flow augmentation program would not increase low flows upstream of the Drake Outfall, because the augmented flows would be recaptured at the Timnath Reservoir Canal headgate, which is approximately 2.4 miles upstream of the outlet. However, Alternative 2, as structured to minimize effects on the water right for the Fort Collins Nature Center, is expected to also be protective of the CDPS regulatory low flows for the Drake WWTP, which is immediately upstream.

Table 4-41. Drake WWTP 30E3 regulatory low flow and PR 40.0, Upstream Fossil Creek inlet minimum monthly average flows (shaded cells indicate values below the 30E3 chronic low flow).

Month	30E3 Chronic Low Flow (cfs)	PR 40.0, Upstream of Fossil Creek Inlet Minimum Monthly Average Flow (cfs)			
		Current Conditions	Alternative 2	Alternative 3	Alternative 4
January	0.1	1.3	1.3	1.3	1.3
February	0.1	0.9	0.9	0.9	0.9
March	0.1	2.2	2.2	2.2	2.2
April	0.1	8.0	7.9	8.0	7.9
May	0.1	20.1	33.1	33.1	33.1
June	0.3	158.4	95.5	59.6	157.2
July	0.3	0.0	0.0	0.0	0.0
August	0.1	4.0	5.8	9.0	0.4
September	0.1	2.1	2.2	2.1	2.1
October	0.1	3.0	6.3	6.3	7.4
November	0.1	4.1	4.1	4.1	4.1
December	0.1	1.9	1.9	1.9	1.7

4.3.7.3 Boxelder Sanitation District Wastewater Treatment Plant

The Boxelder facility has a design capacity of 2.34 mgd and discharges to Boxelder Creek; however, the discharge point is only 0.03 miles upstream of the confluence with the Poudre River at the top of Segment 12. Therefore, instream standards for both Boxelder Creek and the Poudre River are considered in their permit (CDPHE 2008, CO-0020478).

The WQCD calculated the low flows in the Poudre River immediately downstream of the confluence with Boxelder Creek by accounting for low flows in Boxelder Creek, the seepage characteristics of the Poudre River, and measured flow at the USGS Boxelder Gage for 1996 to 2006. The WQCD estimated low flow conditions in Boxelder Creek, upstream of the WWTP, based on measured low flow conditions and not a continuous gage record. The regulatory low flows represent chronic flow conditions in the Poudre River and Boxelder Creek without the hydrology inputs from the Drake and Boxelder WWTPs (CDPHE 2008, CO-0020478).

Given the two sources of chronic low flow conditions as defined by the WQCD (Boxelder Creek and Poudre River immediately downstream of the confluence with Boxelder Creek) the Boxelder Creek low flows were subtracted from the Poudre River downstream of the confluence low flows to estimate a chronic low flow condition upstream of the confluence. This provided a similar point in reference on the Poudre River for comparison with CTP modeled hydrology absent Boxelder WWTP hydrology inputs.

Based on the CTP Current Conditions hydrology, the regulatory chronic lows flows (30E3) indicate a concern with flow conditions during the winter months (January through April) and possibly in August (Figure 4-53). However, flows under the NISP alternatives would not differ

substantially from Current Conditions, and would therefore, not affect the minimum monthly flows during these months with exception of possibly Alternative 4, when minimum monthly flows are predicted to be slightly above both the regulatory chronic low flow and Current Conditions. Given the differences (<1 cfs) in modeling low flow conditions, the potential for NISP Alternatives to adversely affect the chronic low flow conditions for the Boxelder WWTP is negligible.

Table 4-42. Boxelder WWTP 30E3 regulatory low flow and PR 38.7 upstream Boxelder Creek minimum monthly average flows (shaded cells indicate values below the 30E3 chronic low flow).

Month	30E3 Chronic Low Flow (cfs)	PR 38.7, Upstream of Boxelder Creek Minimum Monthly Average Flow (cfs)			
		Current Conditions	Alternative 2	Alternative 3	Alternative 4
January	2.5	2.0	2.0	2.0	2.0
February	2.0	1.6	1.6	1.4	1.6
March	2.5	1.7	1.5	1.5	1.7
April	2.7	2.6	2.6	2.6	2.6
May	4.3	10.2	6.7	6.7	6.7
June	13.0	29.0	19.0	16.7	28.7
July	14.9	16.3	16.4	15.6	19.3
August	12.9	11.9	11.8	11.3	13.4
September	10.6	11.5	11.4	10.9	13.0
October	2.7	7.0	7.1	6.6	8.2
November	1.6	4.8	4.8	4.6	6.0
December	1.6	2.5	2.5	2.5	2.7

4.3.7.4 Town of Windsor Wastewater Treatment Plant

The Windsor facility is located near the middle of Segment 12, and has a design capacity of 2.8 mgd. The WQCD calculated the low flows in the Poudre River immediately upstream of the Windsor WWTP based on the Staff Gage located 0.25 miles upstream of the facility and takes into account the historical contributions of the Law Ditch prior to 1999.

Based on the CTP Current Conditions hydrology, there is a substantial portion of the year where chronic low flow conditions are not being achieved upstream of the Windsor WWTP (Table 4-43). For the months of April through September, the minimum monthly flows are substantially less (i.e., 9 to 22 cfs) than the 30E3 chronic low flow conditions. Even the Current Conditions 20th percentile flows for May through September are substantially less than the regulatory chronic low flows. Regardless of these Current Conditions issues, the three alternatives show little to no change with respect to Current Conditions. Given the differences in modeling approaches for estimating flows for regulatory assessment purposes or for modeling NISP alternatives, these low flow differences should not be interpreted as a direct comparison and need further evaluation before potential effects to the CDPS permit can be thoroughly assessed.

Table 4-43. Windsor WWTP 30E3 regulatory low flow and PR 22.7 upstream Windsor WWTP minimum monthly average flows (shaded cells indicate values below the 30E3 chronic low flow).

Month	30E3 Chronic Low Flow (cfs)	PR 22.7, Upstream of Windsor WWTP Minimum Monthly Average Flow (cfs)			
		Current Conditions	Alternative 2	Alternative 3	Alternative 4
January	17.8	24.2	24.4	24.4	24.5
February	20.0	18.5	18.5	18.5	18.5
March	17.8	19.9	19.1	18.6	19.8
April	17.8	9.3	8.7	8.7	8.6
May	19.0	8.0	8.0	8.0	8.0
June	31.0	8.8	8.8	8.8	8.8
July	31.0	11.1	11.1	11.1	11.1
August	32.0	10.8	10.8	10.8	10.8
September	32.0	10.0	10.0	9.8	9.5
October	25.0	26.0	26.0	25.9	26.1
November	17.8	18.9	18.9	18.9	18.9
December	17.8	22.0	22.0	22.0	22.1

4.3.7.5 Carestream Health WWTP

The Carestream Health WWTP discharges to a ditch system that enters the Poudre River approximately 0.85 miles downstream of the Windsor WWTP, and has a design capacity of 1.8 mgd. The WQCD calculated the low flows in the Poudre River immediately upstream of the Carestream Health WWTP based on the Staff Gage located 1.1 miles upstream of the facility and takes into account the historical contributions of the ditch system as well as ground water seepage to the Poudre River that occurs in this reach.

Similar to the conditions upstream of the Windsor WWTP, there is a substantial portion of the year where chronic low flow conditions are not being achieved upstream of the Carestream Health WWTP (Table 4-44). For the months of April through September, the minimum monthly flows are substantially less (i.e., 10 to 26 cfs) than the 30E3 chronic low flow conditions, and for February, March, and October the minimum monthly average flows are slightly less (<3 cfs) than the regulatory chronic low flow. Even the Current Conditions 20th percentile flows for May through September are substantially less than the regulatory chronic low flows. Regardless of these Current Conditions issues, the three action alternatives show little to no change with respect to Current Conditions, except for Alternatives 2 and 3 for the month of March which are also less than the regulatory low flows. Given the differences in modeling approaches for estimating flows for regulatory assessment purposes or for modeling NISP alternatives, these low flow differences should not be interpreted as a direct comparison and need further evaluation before potential effects to the CDPS permit can be thoroughly assessed.

Table 4-44. Carestream Health WWTP 30E3 regulatory low flow and PR 22.5, downstream of Windsor WWTP minimum monthly average flows (shaded cells indicate values below the 30E3 chronic low flow).

Month	30E3 Chronic Low Flow (cfs)	PR 22.5, Downstream of the Windsor WWTP Minimum Monthly Average Flow (cfs)			
		Current Conditions	Alternative 2	Alternative 3	Alternative 4
January	20.1	25.6	25.8	25.8	25.8
February	23.0	19.8	19.8	19.8	19.8
March	20.9	21.2	20.5	19.9	21.2
April	20.4	10.7	10.1	10.1	10.0
May	24.8	9.6	9.6	9.6	9.6
June	37.6	10.9	10.9	10.9	10.9
July	38.4	13.2	13.2	13.2	13.2
August	39.0	12.9	12.9	12.9	12.9
September	37.6	11.9	11.9	11.7	11.4
October	29.1	27.7	27.6	27.6	27.8
November	20	20.3	20.3	20.3	20.3
December	16	23.4	23.4	23.4	23.5

4.3.7.6 City of Greeley Water Pollution Control Facility

The Greeley facility is located near the bottom of Segment 12, and has a design capacity of 14.7 mgd. The Greeley facility has three separate outfall tiers based on average "monthly" flow for a single month, and each tier has a separate set of effluent limits. If the average "monthly" flow is less than 10 mgd, limits for Outfall 001A apply, if flow is between 10 and 12 mgd, Outfall 001B limits apply, and if flow is between 12 and 14.7 mgd, Outfall 001C limits apply.

The WQCD calculated the low flows in the Poudre River immediately upstream of the Greeley WWTP based on the hydrological record (1999-2009) from the USGS Greeley Gage which was adjusted for discharges from the Greeley WWTP, from the Western Sugar Company, and the return flow from the Greeley #3 Ditch, then the diversions by the Ogilvy Ditch were added to the adjusted flows. Because the Leprino Foods WWTP is immediately downstream of the Greeley WWTP, the regulatory low flows are also applicable to the Leprino Foods WWTP.

Based on Current Conditions hydrology, the minimum monthly flows are less than regulatory low flows for the months of January, February, and April (Table 4-45). The differences observed between modeled Current Conditions and the regulatory lows flows is negligible for January; however the differences appear to be greater for the months of February and April (~13 cfs). The NISP alternatives do not substantively change the Current Conditions and therefore are not expected to affect the CDPS permitted low-flow conditions.

Table 4-45. City of Greeley WWTP and Leprino Foods WWTP 30E3 regulatory low flow and PR 5.2, upstream Greeley WWTP minimum monthly average flows (shaded cells indicate values below the 30E3 chronic low flow).

Month	30E3 Chronic Low Flow (cfs)	PR 5.2, Upstream Greely WWTP Minimum Monthly Average Flow (cfs)			
		Current Conditions	Alternative 2	Alternative 3	Alternative 4
January	45	44.5	44.7	44.7	44.8
February	50	37.5	34.7	34.7	45.3
March	32	38.1	38.1	38.1	38.0
April	29	15.9	18.2	16.1	14.6
May	29	37.2	44.6	37.2	37.2
June	42	54.2	62.9	54.2	54.2
July	45	57.7	61.7	55.1	57.7
August	25	38.2	39.6	38.1	44.5
September	25	41.2	41.1	40.7	40.4
October	25	46.7	46.1	45.0	45.3
November	25	46.4	45.9	46.4	46.3
December	43	43.7	43.7	43.7	43.8

4.3.8 Unavoidable Adverse Impacts

Additional stream diversions from the Poudre River under all alternatives would result in lower flows below the Poudre Valley Canal. The impact of lower flows may result in unavoidable adverse impacts to stream temperature, DO concentration, and inorganic and organic constituent concentrations in some reaches at different times. Changes in Horsetooth Reservoir operations under Alternative 2 with the Reclamation Action Option would result in minor effects on Horsetooth Reservoir water quality, but no exceedances of water quality standards are expected. Operation of Galeton Reservoir under the SPWCP would have unavoidable adverse impacts on irrigation water quality in the Larimer-Weld Canal and New Cache Canal under the action alternatives. Mitigation measures as described in Appendix F are expected to reduce adverse impacts, but some unavoidable impacts are possible.

4.3.9 Impact Summary

4.3.9.1 Poudre and South Platte River Constituents

Overall, within each segment of the Poudre and South Platte Rivers, the potential for exceedances of water quality standards for each of the alternatives were similar. Alternative 2 would have fewer anticipated impacts because diversions would be less than Alternatives 3 and 4, and the augmentation releases from Glade Reservoir would have a beneficial effect in some months. A summary of the potential for exceedance of water quality standards in each segment is provided in the tables below (Table 4-47, Table 4-48, and Table 4-49). The “low,” “medium,” and “high” designations are based on the current water quality conditions and how near they are

to the current standards. A low rating indicates that it is unlikely that the parameter would exceed water quality standards under the given alternative. Medium indicates that current water quality is approaching the standard and changes in flow associated with the alternative could result in standard exceedances. Parameters with a high rating are likely to continue exceeding the standard and the alternative could contribute to a greater magnitude and/or frequency of standard exceedance. The Section 404(b)(1) Guidelines at 40 CFR 230.10(b) specify that no discharge of dredged or fill material may be permitted if it will cause or contribute to violations of any applicable State water quality standard. Therefore, in order for the proposed Project to be permitted, the District must propose measures to avoid causes or contributions specifically attributable to the Project that would result in standard violations. The disclosure of potential effects to water quality is based on the evaluation of effects without consideration of the avoidance measures proposed by the District (Appendix F). The only parameters with "high" potential for exceeding water quality standards under any of the alternatives are those parameters that are already exceeding standards in Segments 11 and 12 of the Poudre River, and Segment 1b of the South Platte River.

Table 4-46. Potential for exceedance of water quality standards in Segment 10 of the Poudre River.

Parameter	Alternative 2	Alternative 3	Alternative 4
Chloride	Low	Low	Low
Copper	Medium	Medium	Medium
Iron (Trec)	Low	Low	Low
Iron (D)	Low	Low	Low
Manganese (Trec)	Low	Low	Low
Manganese (D)	Medium	Medium	Medium
Ammonia	Low	Low	Low
Nitrate	Low	Low	Low
Total Phosphorus	Low	Low	Low
Selenium	Low	Low	Low
Sulfate	Low	Low	Low

Table 4-47. Potential for exceedance of water quality standards in Segment 11 of the Poudre River.

Parameter	Alternative 2	Alternative 3	Alternative 4
Copper	Low	Low	Low
Iron (Trec)	Low	Low	Low
Iron (D)	Low	Low	Low
Manganese (D)	Low	Low	Low
Ammonia	Low	Low	Low
Nitrate	Low	Low	Low
Total Phosphorus	Medium	Medium	Medium
Selenium	High*	High*	High*

*Water Quality Standard exceeded under Current Conditions in one reach above Boxelder Creek.

Table 4-48. Potential for exceedance of water quality standards in Segment 12 of the Poudre River.

Parameter	Alternative 2	Alternative 3	Alternative 4
Copper	Low	Low	Low
Iron (Trec)	High*	High*	High*
Manganese (D)	Low	Low	Low
Ammonia	High*	High*	High*
Nitrate	Low	Low	Low
Total Phosphorus	High*	High*	High*
Selenium	High*	High*	High*

*Water Quality Standard exceeded under Current Conditions.

Table 4-49. Potential for exceedance of water quality standards in Segment 1b of the South Platte River.

Parameter	Alternative 2	Alternative 3	Alternative 4
Chloride	Low	Low	Low
Copper	Low	Low	Low
Iron (Trec)	High*	High*	High*
Iron (D)	Low	Low	Low
Manganese (D)	Medium	Medium	Medium
Ammonia	Medium	Medium	Medium
Nitrate	Low	Low	Low
Total Phosphorus	High*	High*	High*
Selenium	Low	Low	Low
Sulfate	High*	High*	High*

*Water Quality Standard exceeded under Current Conditions.

4.3.9.2 Poudre and South Platte River Temperature

In the study area, only the Poudre River Segment 10 is included on the State's 303(d) list for non-attainment of temperature standards. Historical data indicates excursions of standards in Segment 10 (DM and MWAT), Segment 11 (primarily DM), and the South Platte (primarily MWAT). Segment 12 data indicates historical peak season MWAT values that approach the standard in several years, though DM values tend to be further below the standard. All action alternatives would have the potential to cause further exceedances of temperature standards in some locations and some years as summarized below.

- Due to increased diversions at the Poudre Valley Canal, adverse effects on stream temperature are possible in sensitive reaches of Segment 10 and Segment 11, potentially including key months of July and August.
- Generally, the anticipated adverse effects on stream temperature for Alternative 2 are expected to be less than those for Alternative 3 and greater than those for Alternative 4.

- The streamflow augmentation program included in Alternative 2 would increase flow rates in parts of Segments 10 and 11 (from 0.37 miles upstream of the Larimer County Canal to the Timnath Inlet headgate) to values greater than those in Current Conditions, providing a net temperature benefit in this reach in key months of March and September.

4.3.9.3 Poudre and South Platte River Dissolved Oxygen

None of the Poudre River or South Platte River segments in the focus area are on the 303(d) List for DO. A review of available DO data revealed some excursions in Segments 10, 11, and 12 of the Poudre River, with very few excursions observed in the recent 5 years of record. Excursions tend to occur in summer months, but some winter excursions have been observed. No excursions of DO standards have been observed in the long record at the two stations in the focus reach of the South Platte. NISP action alternatives are anticipated to have negligible to minor effects on river DO concentrations as summarized below.

- Alternative 2 diversions at the Poudre Valley Canal could exacerbate occasionally observed DO issues in July and August in Segment 11. However, augmentation flows would likely provide a DO benefit during any times of low flow from November through April and in September. Planned aeration of releases from Glade Reservoir should also help maintain DO concentrations within standards.
- Effects of Alternative 3 on DO would generally be similar to but greater than those identified for Alternative 2, due to greater flow diversions at the Poudre Valley Canal and the lack of streamflow augmentation. Any adverse effects would be primarily in Segment 11.
- Adverse effects from Alternative 4 on DO in Segment 11 would generally be similar to, but less than, those identified for Alternative 2 and Alternative 3.

4.3.9.4 Reservoirs

Glade Reservoir would be constructed only under Alternative 2 and is anticipated to have water quality similar to Horsetooth Reservoir, although TOC concentrations may be higher. Periods of low dissolved oxygen near the bottom are likely in the summer. Metal concentrations are likely to be within standards. Fish consumption advisories are likely because of mercury in fish tissues. In Alternative 2, with the Reclamation Action Option, minor effects on Horsetooth Reservoir water quality and no exceedances of water quality standards are expected.

Galeton Reservoir would be constructed in all action alternatives. Nutrient and chlorophyll *a* concentrations are likely to exceed interim value standards. Specific conductance, pH, and selenium concentrations are likely to be high. Low DO concentrations near the bottom are expected in the summer. It is anticipated that mercury concentrations would not result in listings for fish tissue or fish consumption advisories.

Cactus Hill Reservoir would be constructed under Alternatives 1, 3, and 4. Water quality in Cactus Hill would be lower than Glade Reservoir, but better than Galeton Reservoir. Water quality would be slightly lower under Alternative 4 because a portion of the water would come

from the New Cache Canal, which has lower water quality than diversions at the upstream Poudre Valley Canal.

4.3.9.5 Larimer-Weld and New Cache Canals and Crop Yield

As part of the SPWCP, water stored in the proposed Galeton Reservoir would be delivered to both the Larimer-Weld and New Cache canal systems from April to October in exchange for water diverted from the Poudre River. Elevated salinity and selenium concentrations in Galeton Reservoir releases to the canals are expected to result in a decrease in crop yields where the water is used for irrigation. Economic effects of reduced crop yields are discussed in Socioeconomics (Section 4.20.3.3.2).

4.3.9.6 Water Treatment Plants

Under all alternatives, no adverse impact to water quality in the Poudre River is anticipated that would affect treatment requirements at the City of Greely's Bellvue WTP. Under Alternative 2 with the Reclamation Action Option, small changes in Horsetooth Reservoir water quality at the Soldier Canyon outflow are predicted. TOC concentrations are estimated to be slightly higher, but not to a level that would require increasing the level of treatment at the Fort Collins or Tri-District's WTP.

4.3.9.7 Wastewater Treatment Plants

There are negligible differences between the regulatory 30-day low flow (30E3) and Current Conditions minimum monthly flow for the Fort Collins Mulberry WWTP, Fort Collins Drake WWTP, Boxelder WWTP, Greeley WWTP, and Leprino Foods WWTP. For the Fort Collins Mulberry WWTP, the differences (<3 cfs) between flow metrics occurred for the months of July, August, September, and December, although most of the NISP alternatives would not result in changes to the Current Conditions minimum monthly flows during these months. The one exception is for Alternative 2, when the augmentation plan would increase the minimum flow conditions in September as well as during the winter months. Alternative 2 would provide a net benefit to the low flow conditions in the Poudre River just upstream of the Fort Collins Mulberry WWTP. For the Fort Collins Drake WWTP (discharge to Poudre River), Current Conditions hydrology appears to meet the regulatory low flow requirements with exception to when the river may dry-up in July. Alternative 2 would not affect the regulatory low flows for the Fort Collins Drake WWTP. The analysis for the Boxelder WWTP shows negligible differences (≤1.6 cfs) between the Current Conditions minimum monthly flows and the regulatory low flows with differences occurring in January, February, March, April and August. The NISP alternatives would not appreciably change the Current Conditions low flows and would not affect the regulatory low flows for the Boxelder WWTP. The analysis for the Greeley and Leprino Foods WWTPs indicate that Current Conditions minimum monthly flow meets the regulatory low flow conditions for most of the year, except for January, February, and April. In February and April, there is a substantial difference in flow (approximately 13 cfs less) when Current Conditions is

compared to the regulatory chronic low flow condition (30E3). The NISP alternatives would not appreciably change the minimum monthly flow when compared to Current Conditions for these months, and thus the minimum monthly flows for each alternative is predicted to still be less than the regulatory low flow during some months.

The analysis for the Windsor and Carestream Health WWTPs indicates that Current Conditions likely do not meet regulatory low flows for either facility for a major portion of the year, April through August. During these months, the Current Conditions minimum monthly flow is substantially less than the regulatory low flows (≤26 cfs). However, the NISP alternatives would not appreciably change the Current Conditions minimum flow conditions. It is apparent that the assumptions for estimating regulatory low flows and the assumptions in the CTP Hydrology Model do not necessarily correspond well for these two facilities, and result in major differences. Therefore, these differences need to be explored further before conclusions about effects to regulatory low flow conditions can be determined.

When these differences in low flow conditions are placed in the context of Alternative 2, and plans to divert water only when the minimum flow criteria is met for Watson Lake Fish Hatchery, Fort Collins Boat Chute, and the Fort Collins Nature Center, Alternative 2 would not affect the CDPS regulatory 30-day (30E3) low flow conditions for any of the WWTPs in the study area.

4.3.9.8 Effects Determination

Table 4-50 provides a summary of the anticipated effects to surface water quality for each of the alternatives at different locations in the study area. The District's proposed Mitigation Plan (Appendix F) will be reviewed by the Corps to make a preliminary determination if water quality degradation can be avoided or minimized. However, the final determination by the Corps will be made after taking into account the results of Phase II water quality modeling, input from the WQCD through the 401 certification process and antidegradation review and review of the final mitigation plan prepared by the District.

Table 4-50. Surface water quality effects determination summary.

Study Area	Alternative 2		Alternative 3	Alternative 4
	Reclamation Action Option	No Reclamation Action		
Horsetooth Reservoir	Negligible	No effect	No effect	No effect
Carter Lake	Negligible	No effect	No effect	No effect
Glade Reservoir	[1]	[1]	NA	NA
Galeton Reservoir	[2]	[2]	[2]	[2]
Cactus Hill Reservoir	NA	NA	[3]	[3]
Poudre R. – Seg. 10				
Temperature	Minor/Moderate	Minor/Moderate	Minor/Moderate	Minor/Moderate
DO	Minor	Minor	Minor	Negligible/Minor
Nutrients	Negligible	Negligible	Negligible	Negligible
Inorganics/metals	Negligible/Minor	Negligible/Minor	Negligible/Minor	Negligible/Minor
Poudre R. Seg. 11				
Temperature	Minor	Minor	Minor	Negligible/Minor
DO	Minor	Minor	Minor	Minor
Nutrients	Negligible/Minor	Negligible/Minor	Negligible/Minor	Negligible/Minor
Inorganics/metals	Negligible/Minor	Negligible/Minor	Negligible/Minor	Negligible/Minor
Poudre R. Seg. 12[4]				
Temperature	Negligible/Minor	Negligible/Minor	Negligible/Minor	Negligible/Minor
DO	Negligible	Negligible	Negligible	Negligible
Nutrients	Moderate	Moderate	Moderate	Moderate
Inorganics/metals	Minor/Moderate	Minor/Moderate	Minor/Moderate	Minor/Moderate
South Platte River[5]				
Temperature	Negligible/Minor	Negligible/Minor	Negligible/Minor	Negligible/Minor
DO	Negligible	Negligible	Negligible	Negligible
Nutrients	Minor/Moderate	Minor/Moderate	Minor/Moderate	Minor/Moderate
Inorganics/metals	Minor/Moderate	Minor/Moderate	Minor/Moderate	Minor/Moderate
Larimer-Weld and New Cache Canal / Crop Yield	Minor/Moderate	Minor/Moderate	Minor/Moderate	Minor/Moderate
WTP	Negligible/Minor	Negligible/Minor	Negligible/Minor	Negligible/Minor
WWTP	Negligible/Minor	Negligible/Minor	Negligible/Minor	Negligible/Minor

[1] Glade Reservoir would be a new reservoir with water quality similar to Horsetooth Reservoir and Carter Lake.
[2] Galeton Reservoir would be a new reservoir with water quality similar to Jackson and Riverside reservoirs.
[3] Cactus Hill would be a new reservoir with water quality somewhere between Glade and Galeton Reservoirs.
[4] Ammonia, total phosphorus, and selenium are exceeding water quality standards under existing conditions.
[5] Iron, total phosphorus, and sulfate are exceeding water quality standards under existing conditions.
NA = Not a component of the alternative.

4.3.10 401 Certification Process and Antidegradation Review

The WQCC is responsible for issuing Water Quality Certifications under Section 401 of the CWA for projects or actions that are applicable to the provisions of the Colorado 401 Certification Regulation (WQCC Regulation #82: 5 CCR 1002-82). A CWA §401 Water Quality Certification is required for any federal license or permit that is issued to construct or operate a facility, which may result in any fill or discharge into the navigable waters of the United States. The WQCD will initiate an antidegradation review process to determine if the action (regulated activity requiring water quality certification or discharge permit) would significantly degrade the quality of state surface waters, with respect to adopted narrative or

numeric standards. The antidegradation review applies to regulated activities with water quality impacts to surface water that have not been designated as outstanding waters or use-protected waters. These waters are considered "reviewable waters." As stated in Section 31.8(3)(c) of WQCC Regulation #31: 5 CCR 1002-31:

> "The significance determination will be based on the chronic numeric standard and flow for the pollutant of concern except for those pollutants which have only acute numeric standards in which case the acute standard and flow will be used. This significance determination shall be made with respect to the net effect of the new or increased water quality impacts of the proposed regulated activity, taking into account any environmental benefits resulting from the regulated activity and any water quality enhancement or mitigation measures impacting the segment or segments under review, if such measures are incorporated with the proposed regulated activity."

The 401 certification process is a permitting requirement separate from NEPA compliance. 401 certification and antidegradation review will be required for any permitted alternative prior to construction. To facilitate the 401 permitting process, additional water quality modeling will be conducted for the FEIS in coordination with the WQCD and the EPA using WQCD protocols. The intent of this effort is to use the results of the water quality analysis conducted for 401 certification in the FEIS and thus, minimize any duplication of effort.

4.4 STREAM MORPHOLOGY AND SEDIMENT TRANSPORT

This section summarizes the predicted potential effects of the NISP alternatives on stream morphology and sediment transport as compared to Current Conditions. Additional studies and impact assessments for stream morphology and sediment transport for the Poudre River mainstem were undertaken for this SDEIS based on comments on the NISP DEIS. These new studies are described in Section 3.4 and the 2013 Stream Morphology Baseline Report (ACE 2013). New baseline and effects technical reports were prepared using new and revised information and the CTP hydrology. Detailed information on effects can be found in the 2014 Stream Morphology Effects Report (ACE 2014). The effects report presents results and interpretations for river morphology and sediment transport using the same analyses that were described in the 2013 Stream Morphology Baseline Report (ACE 2013). The analyses that form the basis of effects assessment are listed in Table 4-51. As discussed in the 2013 Stream Morphology Baseline Report, there is no deterministic analysis that can provide an unequivocal description of future river morphology and sediment transport under each of the alternatives. Instead, based on the range of analyses listed in Table 4-51, the predicted river response is presented and discussed in light of the current trajectory of river condition presented in Section 3.4.2.

In overview, the trajectory of the river is expected to continue under Current Conditions hydrology as the result of ongoing channel contraction, fining of surficial material, and loss of channel complexity. These predicted changes in river condition are a fluvial response to historical and contemporary physical and hydrologic changes to the river, floodplain, and watershed. Based largely on an observational model of response to Current Conditions hydrology, the trends that were identified in the 2013 Stream Morphology Baseline Report (ACE 2013) are expected to be more severe downstream of I-25 than upstream of I-25 because:

- Sediment supply in the size fractions relevant for deposition is more limited upstream of I-25 than downstream
- Biogeomorphic processes involving vegetation establishment on benches and bars prevail more downstream of I-25 compared to upstream

The analyses presented in this section focuses on potential indirect impacts to river morphology and sediment transport associated with streamflow changes and presents comparisons between the Current Conditions hydrology and each alternative. The discussion of effects focuses on sediment transport because it was the focus of comments on the DEIS. No comments were received on the DEIS regarding stream morphology or sediment transport on the South Platte River; therefore, no new studies or analysis were done on these subjects for the SDEIS for the South Platte River. Section 4.4.1 of the DEIS and the 2008 South Platte River Stream Morphology Report (ERO 2008a) describe effects to the South Platte River.

Table 4-51. Analyses and results presented in detail in the 2014 Stream Morphology Effects Report (ACE 2014).

Hydrology
General Statistics (Annual, Monthly, Seasonal)
Flow Duration Curves/Histograms
Exceedance Discharges (1, 2, 5, 10, 25, 50, 75, 95, and 100%)
Annual Maximum Flood Discharge (2-, 10- and 25-Year) w/ confidence intervals
Spells Analysis for Movement of Bed Material
Spells Analysis for Vegetation Impacts
Hydraulics
Duration of Flow for Movement of Bed Material
Duration of Flow for Flushing of Fines
Total Work on Channel Boundary along River
Total Work on Channel Boundary above Incipient Motion
Sediment Transport
Annual Sediment Transport Potential (using SIAM)
Transport Potential by Size Fraction over Flow Range (using SIAM)

River morphology and sediment transport would not be impacted by construction activities at Glade, Galeton, or Cactus Hill Reservoirs or within the conveyance systems study areas, therefore Project impacts to river morphology and sediment transport associated with these alternative components were not evaluated.

4.4.1 Methods

The methods used to provide the results for each alternative are described in detail in the 2013 Stream Morphology Baseline Report (ACE 2013). The effects analyses repeat the analyses described in the 2013 Stream Morphology Baseline Report for each of the modeled daily flow data sets. The results of these analyses were used to generate comparisons relative to Current Conditions for channel hydraulics, geomorphology and sediment transport. For each alternative, the CTP hydrologic modeling (CDM Smith and DiNatale 2013) produced a 26-year time series (November 1, 1979 through October 31, 2005; irrigation years [IY] 1980-2005) of estimated daily streamflows on the Poudre River to demonstrate the potential effects of proposed alternative operations and infrastructure. The flow series were used to assess river hydrology and hydraulics for each scenario and then to analyze initiation of motion characteristics, channel morphology, and sediment transport behavior for each cross section and reach in the Poudre River from the Munroe Canal to the confluence with the South Platte River as described in detail in the 2013 Stream Morphology Baseline Report. A HEC-RAS model was used to calculate hydraulic conditions at 428 cross sections over approximately 60 miles of the Poudre River for flows representing the following conditions:

- Flow intervals: a range of flows between 200 and 10,000 cfs selected to characterize flow conditions across the flow range;

- Representative flows: the 2%, 20%, and 50% exceedance flows; and
- Flood flows: the 2-year, 5-year, and 25-year floods for each study reach.

A flood frequency analysis was undertaken on the 26-year period of modeled daily flows. The flood frequency analysis considers the likelihood that a flood peak would occur or be exceeded in any year. It does not take into account flow duration. The analysis should not be compared with other flood frequency analyses for the river that are undertaken for a different purpose and based on much longer periods of record covering a wider range of flood peaks. The 26-year period of modeling means that confidence intervals for the rarer floods in this analysis are very wide.

As described in Section 3.1 of the 2013 Stream Morphology Baseline Report, the mainstem was divided into seven reaches of similar geomorphic and sediment transport characteristics, such that within each reach, response to change is expected to be similar (Table 4-52). An increased resolution (compared to the DEIS) was applied to the mainstem reach within the City of Fort Collins to allow impacts to be discriminated at a finer scale in this area of interest. Effects on each of these reaches are discussed in detail in the 2014 Stream Morphology Effects Technical Report (ACE 2014). For ease of description and summarizing the predicted effects in the SDEIS, the mainstem is divided into upstream of where I-25 crosses the Poudre River and downstream. The Laporte, Fort Collins, and upper portion of the Timnath reaches are located upstream of I-25 and the remaining reaches are located downstream of I-25. Adopting a fixed descriptive boundary such as I-25 is more of a convenience than a reality. The episodic nature of erosion and deposition processes demands a transition zone between the two types of river response and the boundary demarcating observable deposition is predicted to move upstream and downstream depending on recent history of flows and the particle size, quantity, and rate of sediment supply. Based on observations, I-25 approximately marks this transition.

Table 4-52. Breakdown of study area into seven study reaches.

Study Reach Name	Upstream Limit
Laporte Reach	Munroe Canal
Fort Collins	Larimer-Weld Canal
Timnath Reach	Fossil Creek Inlet
Windsor Reach	Whitney Ditch
Greeley Upstream Reach	Jones Ditch
Greeley Channelized Reach	Colorado and Southern Railroad
Greeley Downstream Reach	Greeley Gage

The concept of space for time substitution was used to aid interpretation by recognizing that change occurs through both time and through space. Contemporaneous observations at different locations on the mainstem can represent changes to be expected at a single location through time. Examples of channel contraction already occurring were examined to provide insight into the likelihood and nature of similar impacts elsewhere along the mainstem.

The following terms were used to describe potential effects to stream morphology and sediment transport:

- Negligible: The effect would be at the lowest levels of detection, barely measureable, with no perceptible consequences.
- Minor: The action might result in a detectable change, but the change would be slight.
- Moderate: The action could result in a clearly detectable change, with measurable effects.
- Major: The action could result in readily apparent effects with substantial consequences.

4.4.2 No Action Alternative (Alternative 1)

4.4.2.1 Poudre River

The No Action Alternative was evaluated under Future Conditions hydrology only, as explained in Section 4.2.2 and, therefore, river morphology and sediment transport effects analyses for the No Action Alternative are only presented in Chapter 5.

4.4.2.2 South Platte River

No new studies or analysis was done for the SDEIS for the South Platte River. Section 4.4.1 of the DEIS and the 2008 South Platte River Stream Morphology Report (ERO 2008a) describe effects to the South Platte River. The No Action Alternative was revised for the SDEIS. The No Action Alternative for the SDEIS would on average reduce flows on the South Platte River by less than 10% and is not predicted to affect channel morphology or sediment transport on the South Platte River and is further discussed in Chapter 5.

4.4.3 District's Preferred Alternative (Alternative 2)

4.4.3.1 Poudre River

The effects assessment of Alternative 2 uses Current Conditions hydrology (Run 1) compared to hydrology Run 3a. Assessments of the effects of Alternative 2 compared to the Current Conditions confirm an amplified trajectory of the river conditions reflected in continuing channel contraction, fining of surficial material, and loss of channel complexity.

4.4.3.1.1 Flows and Flooding

There are predicted large changes in flow frequency throughout the mainstem as a result of Alternative 2. Changes would be variable reflecting the complex interactions of diversions, transfers, and returns at different locations. Considering the mainstem as a whole, changes to flows would be greatest during the high flow period – late spring to early summer. Taken over the whole year, the 1%, 2%, and 5% flows are predicted to be affected by a reduction of 20% to 35% in duration and magnitude at different places in the system. Lower flows (10% flow, 25% flow) would be impacted more upstream of I-25 than downstream. Widespread 20% to 35% predicted reductions in flows around the 1% to 5% flow range may have an impact on channel forming discharges and channel morphology. Implications for the likelihood and magnitude of

possible channel contraction, fining of surficial material, and loss of hydraulic and morphologic complexity are discussed below under Sediment Transport.

Upstream of I-25

Laporte Reach. Flood flows are predicted to be reduced. The 1%, 2%, and 5% exceedance flows (less frequent flood flows) would be affected by a reduction of 11% to 26%. Lower, more frequently occurring flood flows (10% flow, 25% flow) are predicted to be reduced by 16% to 28%, a slightly greater reduction than the less frequently occurring flood flows. For the 26-year period of record, 15 flushing events under Current Conditions lasting for 132 days in total would become 10 flushing events under Alternative 2 lasting for 94 days in total.

Fort Collins and Upper Timnath Reaches. There is a predicted 20% to 35% reduction in flow duration at or above 1,000 cfs, as well as a 20% to 40% reduction in the duration of flows in the interval from 140 cfs to 1,000 cfs. The predicted impact is greatest on 5% to 10% exceedance flows, which would be reduced by 35% to 45%. The reduced duration of both high flows and low flows leads to decreased flow variability with increased duration of moderate flows, particularly flows in the 7 to 20 cfs range. Winter low flows through Fort Collins would increase by as much as 35% as a result of the proposed flow augmentation plan. A 19% to 36% reduction in the magnitude of the 2-year flood is predicted for the Fort Collins and upper Timnath reaches, but this reduction lessens for larger floods so that the reduction in the 25-year flood is predicted to be 10% or less in Fort Collins. For the 26-year period of record, 23 flushing events under Current Conditions lasting for 325 days in total would become 16 flushing events under Alternative 2 lasting for 222 days in total.

Downstream of I-25

Timnath, Windsor, Greeley Upstream, Greeley Channelized, and Greeley Reaches. Impact is predicted to be greatest on 5% exceedance flows, which would be reduced by 25% to 42%. For the 26-year period of record, 18 flushing events under Current Conditions lasting for 292 days in total become 19 flushing events under Alternative 2 lasting for 218 days in total.

The impact on floods up to the 25-year flood is predicted to be reasonably uniform, with the 2-year, 10-year, and 25-year flood peaks all reducing between 16% and 21%. The impact of Alternative 2 on floods larger than these (e.g., the 100-year flood) cannot be reliably estimated with the 26-year existing modeled data set (see Section 4.4.1 Methods). The reduction in flood frequency correlates with reductions in flow durations and reflects increased diversions from the river by Alternative 2. Predicted reductions in the frequency of occurrence of high flows have the potential to cause morphologic change through reduced sediment mobility. These implications are discussed below under Sediment Transport.

The 2013 Stream Morphology Baseline Report concluded that the ongoing trend associated with channel contraction downstream of I-25 would likely lead to an increase in overbank flooding. The 2014 Stream Morphology Effects Report suggests that the predicted effect of the trend of channel contraction on flooding is balanced to some extent by the decreased frequency of flooding at each recurrence interval associated with project diversions. However, larger flood events (such as the 100-year flood), would be less affected by this decrease in flood frequency.

Additionally, while project alternatives could provide positive benefits in the reduction of flooding, there is no certainty that the diversions would occur during a flooding event.

It is likely that the acceleration of channel contraction would lead to an increased frequency of flooding. The magnitude of the predicted increase in flooding frequency would be dependent on location (e.g., in some areas overbank flooding occurs during the 5-year to 10-year flood event) and would be site specific. The majority of the channel downstream of I-25 has a bankfull capacity ranging from 2,000 cfs to less than 5,000 cfs (for comparison, the 100-year discharge downstream of I-25 ranges from 10,000 cfs to 17,000 cfs).

The channel contraction at any given location may represent a small portion of the overall conveyance capacity relative to the magnitude of the 100-year flood. For example, the lost conveyance due to channel contraction may represent 500 cfs or less. The additional overbank flooding associated with 500 cfs would likely result in increases in flood stage that are hardly discernable but would occur. Relative to floodplain ratings or values, the increase in flooding would not change the floodplain rating (zone designation) within existing flood prone areas, but may increase the limits of this flood zone. Increases in floodplain stage can affect insurable structures and may adversely affect the cost of flood insurance.

4.4.3.1.2 Sediment Transport

Upstream of I-25

Under Current Conditions hydrology, the contemporary armor layer and the general absence of available sands and fine gravels in the riverbed attest that the majority of this finer material that enters the reaches upstream of I-25 is soon transported through without long-term deposition. There is little evidence of progressive accumulation of medium or coarse gravels or cobbles in the reach despite the historical reductions in the flow regime and the depositional environments that exist upstream of the numerous diversion structures. These contemporary observations led to the conclusion in the 2013 Stream Morphology Baseline Report that the reaches upstream of I-25 are supply limited – flows are generally able to transport all incoming material (sands and gravels) through the reaches without deposition. Under these conditions, a reduction in sediment transport potential is predicted to not cause a substantial change in the channel unless a threshold is reached whereby upstream (or in-channel) sediment supply exceeds sediment transport potential, or vegetation effects start to dominate. Temporary instances of excess sediment supply may occur locally during flow events that capture adjacent gravel pits, remove a diversion structure, result in channel relocation or mass failure of channel banks, or supply fine sediment following a fire and subsequent hillslope erosion in the upstream watershed.

Laporte Reach. The predicted reduction in sediment transport potential at high flows suggests an ongoing tendency toward channel contraction by deposition in response to Alternative 2. Likewise, the slight shift in the peak of the sediment potential distribution curve suggests a lower effective discharge for Alternative 2 compared to Current Conditions, which implies a trend toward a smaller channel.

Channel contraction is predicted to only occur if there is sufficient material in transport that is available to be deposited. Initiation of motion and sediment transport analyses show that

medium gravel is the size of bed material that is near the point of motion in this reach at around the effective discharge for Alternative 2. It is therefore concluded that while there is a tendency towards channel contraction in this reach it is predicted to only occur at a rate that is dictated by the availability of material in transport of around medium gravel size or greater.

Given the history of hydrologic change in the river, the 2013 Stream Morphology Baseline Report documented Current Conditions and current bed material gradations that give an indication that the rate of adjustment would be slow. The 2013 Stream Morphology Baseline Report also presented the finding that the channel in this reach is already subject to contraction as the result of historical changes in flow regime. It showed that the effective discharge for Current Conditions indicated an expected channel capacity of around 1,000 cfs under Current Conditions hydrology but channel capacity was generally much higher. It was concluded that the trend toward channel contraction was constrained by a lack of material (of around medium gravel size) available to deposit in the reach. The same constraint would apply to any trend of channel contraction in this reach that is attributable to Alternative 2. The Current Conditions analyses have suggested that the channel has barely responded to the historical changes in flow regime over the last two centuries. Any change attributable to Alternative 2 is predicted to be similarly constrained by lack of sediment supply.

Fort Collins and Upper Timnath Reaches. The 2013 Stream Morphology Baseline Report suggested that there is also a depositional trend in this reach, but lack of available sediment constrains the depositional response. The 2013 Stream Morphology Baseline Report presented analyses that proposed an effective discharge in this reach of about 2,000 cfs. This compares with estimates of current channel capacity in the reach averaging about 6,000 cfs.

Throughout most of this reach, the effects analyses predict an effective discharge of 2,000 cfs for Alternative 2 – unchanged from the Current Conditions hydrology. It is concluded that unless the quantity or size distribution of available sediment changes, channel capacity is predicted to be similar under Alternative 2. This does not mean there would be no change from the present. The current channel is still undergoing slow adjustment in response to historical changes in the flow regime. Any change attributable to the Alternative 2 would be incremental to that existing response.

Under Alternative 2, it is possible that the reduced incidence of flows around the current 1- and 2-year flood level would increase the likelihood that colonizing vegetation can become established before it is scoured out by subsequent high flows. Channel contraction can then be driven by vegetation in the absence of abundant sediment.

There is a special case that applies to the reach between Coy Ditch and Lemay Avenue. In this reach, hydraulic conditions allow sediment to be moved at low flows and provide a secondary peak in the sediment potential distribution curve at around 25 cfs. Lack of available sediment would preclude a systematic response to this secondary peak and it is predicted that the peak at 2,000 cfs would prevail, although channel contraction may occur from time to time in response to pulses of sediment or dry periods, and there may be a tendency for the river to develop a smaller benched channel within the larger cross section.

Downstream of I-25

Downstream of I-25 the model based on observation of Current Conditions predicts that the response would be greater than upstream of I-25. Starting at around I-25 and continuing downstream to Greeley, the contemporary state of the river channel is evidence that there is net deposition of sands and fine gravels as presented in the 2013 Stream Morphology Baseline Report. For any of the available bed material size fractions, a further reduction in sediment transport potential of 8% to 18% is predicted to further reduce the duration of periods when transport exceeds or balances supply. The reduction in transport potential for gravels only is predicted to be between about 18% and 24%, indicating more impact to the transport of gravels than sands. The result would be expected to reinforce the current net depositional trend. There would continue to be occasions when some of the material that enters a reach from upstream would not be transported and would deposit in the lee of obstructions, downstream of bars and islands, and on channel margins. The frequency and duration of these occasions are predicted to increase under Alternative 2.

Deposition is episodic. Within the net depositional trend, there are periods when sand and fine gravels build up in the channel and other periods when, at least at some sections, sediment is removed again. Even with the reduced sediment transport potential, the model that derives from the observed response indicates that the processes are not continuous or even uni-directional. Change is predicted to be episodic in response to variations in water flow and sediment flux and changes in the rate of colonization and the persistence of in-channel vegetation. There would be periods when the channel is essentially static, periods when deposition is the dominant process, and other periods when transport exceeds supply and previously deposited material is removed. Furthermore, deposition would not be uniform in space. The loci of maximum deposition are predicted to move within the reach in response to variability in flow and sediment supply. Despite the episodic nature of the process, the net effect of a further reduction in sediment transport potential is predicted to reinforce the current process of channel contraction in this reach.

Timnath, Windsor, Greeley Upstream, Greeley Channelized, and Greeley Reaches. The predicted effects on these reaches are described together to reduce repetition because the effects of reduced flows on sediment transport in the reaches downstream of I-25 are similar. The 2013 Stream Morphology Baseline Report described strong depositional trends at many locations downstream of I-25 and attributed them to reduced sediment transport potential resulting from historical changes to the flow regime. Vegetation has also been implicated in the persistence of sediment deposits.

Under Alternative 2, the minor peak in the distribution of sediment transport potential at 40 to 110 cfs becomes more dominant and it is likely that renewed channel contraction would occur at some locations for extended periods, as the channel adjusts toward that low flow. Channel contraction in response to Alternative 2 would occur as an extension of the processes already underway by deposition on bars, islands, riffles, and channel margins.

The second peak in the curve (at about 2,000 cfs) suggests the possibility of a two-stage channel (one where a benched low flow channel establishes within a larger cross section), or a channel

that oscillates between the larger and smaller channel in response to the most recent history of flows. It is important to note that the sediment transport potential analysis takes no account of the effect of in-channel vegetation. Recent history suggests that as sediment accumulates in the channel in this reach, vegetation would colonize and stabilize the deposits such that channel contraction that might otherwise be temporary becomes an enduring characteristic.

At many locations, channel capacity is already at or below 2,000 cfs. Further contraction is likely at these sections in response to Alternative 2, and a compound channel with capacities as low as 40 to 110 cfs may form by deposition of benches within the larger channel.

Based on the modeled flow record for this reach, the 2-year flood is estimated at 650 to 1,120 cfs under Current Conditions and 530 to 920 cfs under Alternative 2. The effect of the trend of channel contraction on flooding would be balanced to some extent by the decreased frequency of flooding at this recurrence interval. However, larger floods (greater than the 25-year flood) would less affected by Alternative 2, and channel contraction is predicted to continue to have adverse consequences for flooding for these events.

The complexity of in-channel morphologic features is already low in the reaches downstream of I-25 as the result of sand deposition smothering the bed and reducing the magnitude and frequency of pool and riffle sequences. Further channel contraction under Alternative 2 is predicted to exacerbate this condition. Although channel contraction is predicted to lead to floodplain engagement at lower flows, and this could have ecological benefits, the frequency of flows around the current 2-year to 5-year flood would also be reduced.

The rate of change in channel morphology cannot be directly predicted by these analyses. However, predictions can be made based on the history of channel change through the reach. Investigations for the 2013 Stream Morphology Baseline Report concluded that the river downstream of I-25 had crossed a bio-geomorphic threshold and is on a trajectory leading to a shallower and narrower channel. While the net response over several years is expected to reveal a trend toward a shallower and narrower channel, the response at any time depends on the relative location and the recent hydrologic history. For example, observations following the 2013 flood suggest that some previously deposited sand in the Timnath and Windsor reaches was mobilized only to deposit further downstream in the Windsor and Greeley Reaches.

Alternative 2 would likely exaggerate and extend these contemporary changes in channel morphology. Nevertheless, the rate of change is probably dominated by the rate of sediment supply. The rate of sediment supply from upstream of I-25 and from local catchments is not sensitive to the hydrologic changes under Alternative 2 so it is likely that the rate of change below I-25 would not be sensitive to the changes either. The best prediction of the rate of change under Alternative 2 is a continuation of current rates.

4.4.3.2 South Platte River

No new studies or analysis were done for the SDEIS for the South Platte River. Section 4.4.1 of the DEIS and the 2008 South Platte River Stream Morphology Report (ERO 2008a) describe effects to the South Platte River.

4.4.4 Alternative 3

4.4.4.1 Poudre River

Alternative 3 would divert on average about 5,500 to 6,000 AFY more water from the Poudre River than Alternative 2 to compensate for increased reservoir evaporation from Cactus Hill Reservoir and conveyance loss. Additionally, Alternative 3 does not include the Poudre River flow augmentation program that is proposed under Alternative 2.

The effects assessment of Alternative 3 uses Current Conditions hydrology (Run 1) compared to CTP hydrology Run 3b1. The assessments of the effects of Alternative 3 compared to the Current Conditions confirm an amplified trajectory of the river conditions reflected in continuing channel contraction, fining of surficial material, and loss of channel complexity.

4.4.4.1.1 Flows and Flooding

The amount of time the river flows at or above about 1,000 cfs at almost all hydrologic nodes downstream of the Munroe Canal is predicted to be reduced between 30% and 40%. Taken over the whole year, the 1%, 2%, and 5% flows would be affected by a reduction of 15% to 55% in duration and magnitude at different locations along the mainstem. Lower flows (10% flow, 25% flow) are predicted to be more affected upstream of I-25 than downstream. Widespread 15% to 55% reductions in flows around the 1% to 5% exceedance flow range may have an impact on channel forming discharges and channel morphology as discussed below.

Upstream of I-25

Laporte Reach. The 1%, 2%, and 5% flows would affected by a reduction of 15% to 29%. Lower flows (10% flow, 25% flow) are predicted to be reduced by 18% to 32%. For the 26-year period of record, 15 flushing events under Current Conditions lasting for 132 days in total would become 11 flushing events under Alternative 3 lasting for 82 days in total.

Fort Collins and Upper Timnath Reaches. The 1%, 2%, and 5% flows would affected by a reduction of 17% to 55%. Lower flows (10% flow, 25% flow) are predicted to be reduced by 12% to 43%. For the 26-year period of record, 23 flushing events under Current Conditions lasting for 325 days in total would become 18 flushing events under Alternative 3 lasting for 205 days in total.

Downstream of I-25

Timnath, Windsor, Greeley Upstream, Greeley Channelized, and Greeley Reaches. Impact is predicted to be greatest on 5% exceedance flows, which are reduced by 30% to 45%. It is likely that the acceleration of channel contraction would lead to an increased frequency of flooding as described in Section 4.4.3.1.1 For the 26-year period of record, 18 flushing events under Current Conditions lasting for 292 days in total become 16 flushing events under Alternative 3 lasting for 197 days in total.

The impact on floods up to the 25-year flood is predicted to be reasonably uniform, with the 2-year, 10-year, and 25-year flood peaks all reducing between 19% and 25%. The impact of Alternative 3 on floods larger than these (e.g., the 100-year flood) cannot be reliably estimated

with the 26-year existing modeled data set (see Section 4.4.1 Methods). The reduction in flood frequency correlates with reductions in flow durations and reflects increased diversions from the river by Alternative 3. Predicted reductions in the frequency of occurrence of high flows have the potential to cause morphologic change through reduced sediment mobility. These implications are discussed below under Sediment Transport.

The 2013 Stream Morphology Baseline Report concluded that the ongoing trend associated with channel contraction downstream of I-25 would likely lead to an increase in overbank flooding. The 2014 Stream Morphology Effects Report suggests that the predicted effect of the trend of channel contraction on flooding is balanced to some extent by the decreased frequency of flooding at each recurrence interval associated with project diversions. However, larger flood events (such as the 100-year flood), would be less affected by this decrease in flood frequency. Additionally, while project alternatives could provide positive benefits in the reduction of flooding, there is no certainty that the diversions would occur during a flooding event.

It is likely that the acceleration of channel contraction would lead to an increased frequency of flooding. The magnitude of the predicted increase in flooding frequency would be dependent on location (e.g., in some areas overbank flooding occurs during the 5-year to 10-year flood event) and would be site specific. The majority of the channel downstream of I-25 has a bankfull capacity ranging from 2,000 cfs to less than 5,000 cfs (for comparison, the 100-year discharge downstream of I-25 ranges from 10,000 cfs to 17,000 cfs).

The channel contraction at any given location may represent a small portion of the overall conveyance capacity relative to the magnitude of the 100-year flood. For example, the lost conveyance due to channel contraction may represent 500 cfs or less. The additional overbank flooding associated with 500 cfs would likely result in increases in flood stage that are hardly discernable but would occur. Relative to floodplain ratings or values, the increase in flooding would not change the floodplain rating (zone designation) within existing flood prone areas, but may increase the limits of this flood zone. Increases in floodplain stage can affect insurable structures and may adversely affect the cost of flood insurance.

4.4.4.1.2 Sediment Transport

The following describes how the increased diversions under Alternative 3 are predicted to affect sediment transport but does not repeat the general effects description in Section 4.4.3.1.2. All action alternatives would reduce flows on the mainstem of the Poudre River. Section 4.4.3.1.2 describes the effects of reduced flows on sediment transport, channel contraction and loss of channel complexity on the mainstem of the Poudre River upstream and downstream of I-25 for which Alternative 3 would have similar effects.

Upstream of I-25

For Alternative 3, sediment transport potential is predicted to be reduced through the mainstem generally by around 16% to 37% upstream of I-25. Bed material moves at 28% of the cross sections under both Current Conditions and Alternative 3. Under Alternative 3, 223 cross sections (55%) show a change from Current Conditions in duration of flows that flush fines. For the reaches upstream of I-25, a reduction by as much as 40% in flushing flow duration is

predicted at certain cross sections. Where the supply of material that makes up the bed is limited, such as in the Fort Collins and Laporte Reaches, reduced movement of bed material under Alternative 3 is likely to lead to lower rates of change of in-channel bars, islands, benches, and channel form. Upstream of I-25, a reduction in sediment transport potential is predicted to not cause a substantial change in the channel unless a threshold is reached whereby upstream (or in-channel) sediment supply exceeds sediment transport potential, or vegetation effects start to dominate. Temporary instances of excess sediment supply may occur locally during flow events that capture adjacent gravel pits, remove a diversion structure, result in channel relocation or mass failure of channel banks, or supply fine sediment following a fire and subsequent hillslope erosion in the upstream watershed.

Laporte Reach. For the 26-year period of record, 15 flushing events under Current Conditions lasting for 132 days in total would become 11 flushing events under Alternative 3 lasting for 82 days in total.

Fort Collins and Upper Timnath Reaches. For the 26-year period of record, 23 flushing events under Current Conditions lasting for 325 days in total would become 18 flushing events under Alternative 3 lasting for 205 days in total.

Downstream of I-25

For Alternative 3, sediment transport potential is predicted to be reduced through the mainstem generally by around by 12% to 23% downstream of I-25. Bed material is predicted to move at 60% of the cross sections under both Current Conditions and Alternative 3. The duration of flows that move bed material is predicted to be reduced at these sections by up to 40%.

Timnath, Windsor, Greeley Upstream, Greeley Channelized, and Greeley Reaches. The lower Timnath reach is predicted to have the greatest reduction in the 1%, 2%, and 5% flows. These flows would be affected by a reduction of 17% to 45%. Lower flows (10% flow, 25% flow) are predicted to be reduced by 2% to 24%. The Windsor reach is predicted to have the greatest change in flushing events. For the 26-year period of record, 18 flushing events under Current Conditions lasting for 292 days in total become 16 flushing events under Alternative 3 lasting for 197 days in total.

4.4.4.2 South Platte River

No new studies or analysis were done for the SDEIS for the South Platte River. Section 4.4.1 of the DEIS and the 2008 South Platte River Stream Morphology Report (ERO 2008a) describe effects to the South Platte River.

4.4.5 Alternative 4

4.4.5.1 Poudre River

Alternative 4 is designed to allow some flow to pass through the Fort Collins area and be diverted lower on the river at the New Cache Canal headgate. Relative to the other action

alternatives, with Alternative 4, more water would remain in the mainstem between the Poudre Valley Canal and the New Cache Canal before it is diverted for exchanges. Like Alternative 3, Alternative 4 would divert on average about 5,500 to 6,000 AFY more water from the Poudre River than Alternative 2 to compensate for increased reservoir evaporation from Cactus Hill Reservoir and conveyance loss. Additionally, Alternative 4 does not include the Poudre River flow augmentation program that is proposed under Alternative 2.

The effects assessment of Alternative 4 uses Current Conditions hydrology (Run 1) compared to CTP hydrology Run 3b1. The assessments of the effects of Alternative 4 compared to the Current Conditions confirm an amplified trajectory of the river conditions reflected in continuing channel contraction, fining of surficial material, and loss of channel complexity.

4.4.5.1.1 Flows and Flooding

The amount of time the river flows at or above about 1,000 cfs at almost all hydrologic nodes downstream of the Munroe Canal is predicted to be reduced between 30% and 40%. Taken over the whole year, the 1%, 2%, and 5% flows are predicted to be affected by a reduction of 12% to 43% in duration and magnitude at different locations along the mainstem. Lower flows (10% flow) are predicted to be more affected upstream of I-25 than downstream. Widespread 15% to 55% reductions in flows around the 1% to 5% exceedance flow range may have an impact on channel forming discharges and channel morphology as discussed below.

Upstream of I-25

Laporte Reach. The 1%, 2%, and 5% flows would be affected by a reduction of 12% to 24%. Lower flows (10% flow, 25% flow) are predicted to be reduced by 12% to 20%. For the 26-year period of record, 15 flushing events under Current Conditions lasting for 132 days in total would become 11 flushing events under Alternative 4 lasting for 88 days in total.

Fort Collins and Upper Timnath Reaches. The 1%, 2%, and 5% flows would be affected by a reduction of 13% to 39%. Lower flows (10% flow, 25% flow) are predicted to be reduced by 5% to 20%. For the 26-year period of record, 23 flushing events under Current Conditions lasting for 325 days in total would become 20 flushing events under Alternative 4 lasting for 231 days in total.

Downstream of I-25

Timnath, Windsor, Greeley Upstream, Greeley Channelized, and Greeley Reaches. The lower Timnath reach is predicted to have the greatest reduction in the 1%, 2%, and 5% flows. These flows would be affected by a reduction of 14% to 43%. Lower flows (10% flow, 25% flow) are predicted to be reduced by 1% to 23%. It is likely that the acceleration of channel contraction would lead to an increased frequency of flooding as described in Section 4.4.3.1.1. For the 26-year period of record, 18 flushing events under Current Conditions lasting for 292 days in total become 17 flushing events under Alternative 4 lasting for 217 days in total.

The impact on floods up to the 25-year flood is predicted to be reasonably uniform, with the 2-year, 10-year, and 25-year flood peaks all reducing between 17% and 23%. The impact of Alternative 4 on floods larger than these (e.g., the 100-year flood) cannot be reliably estimated

with the 26-year existing modeled data set (see Section 4.3.1 Methods). The reduction in flood frequency correlates with reductions in flow durations and reflects increased diversions from the river by Alternative 4. Predicted reductions in the frequency of occurrence of high flows have the potential to cause morphologic change through reduced sediment mobility. These implications are discussed below under Sediment Transport.

The 2013 Stream Morphology Baseline Report concluded that the ongoing trend associated with channel contraction downstream of I-25 would likely lead to an increase in overbank flooding. The 2014 Stream Morphology Effects Report suggests that the predicted effect of the trend of channel contraction on flooding is balanced to some extent by the decreased frequency of flooding at each recurrence interval associated with project diversions. However, larger flood events (such as the 100-year flood) would be less affected by this decrease in flood frequency. Additionally, while project alternatives could provide positive benefits in the reduction of flooding, there is no certainty that the diversions would occur during a flooding event.

It is likely that the acceleration of channel contraction would lead to an increased frequency of flooding. The magnitude of the predicted increase in flooding frequency would be dependent on location (e.g., in some areas overbank flooding occurs during the 5-year to 10-year flood event) and would be site specific. The majority of the channel downstream of I-25 has a bankfull capacity ranging from 2,000 cfs to less than 5,000 cfs (for comparison, the 100-year discharge downstream of I-25 ranges from 10,000 cfs to 17,000 cfs).

The channel contraction at any given location may represent a small portion of the overall conveyance capacity relative to the magnitude of the 100-year flood. For example, the lost conveyance due to channel contraction may represent 500 cfs or less. The additional overbank flooding associated with 500 cfs would likely result in increases in flood stage that are hardly discernable but would occur. Relative to floodplain ratings or values, the increase in flooding would not change the floodplain rating (zone designation) within existing flood prone areas, but may increase the limits of this flood zone. Increases in floodplain stage can affect insurable structures and may adversely affect the cost of flood insurance.

4.4.5.1.2 Sediment Transport

The following describes how the increased diversions under Alternative 4 would affect sediment transport, but does not repeat the general effects description in Section 4.4.3.1.2. All action alternatives would reduce flows on the mainstem of the Poudre River. Section 4.4.3.1.2 describes the effects of reduced flows on sediment transport, channel contraction and loss of channel complexity on the mainstem of the Poudre River upstream and downstream of I-25 for which Alternative 4 would have similar effects.

Upstream of I-25

For Alternative 4, sediment transport potential is predicted to be reduced through the mainstem generally by around 12% to 26% upstream of I-25. Bed material moves at 28% of the cross sections under both Current Conditions and Alternative 4. Under Alternative 4, 223 cross sections (55%) show a change from Current Conditions in duration of flows that flush fines. For the reaches upstream of I-25, a reduction by as much as 40% in flushing flow duration is

predicted at certain cross sections. Where the supply of material that makes up the bed is limited, such as in the Fort Collins and Laporte Reaches, reduced movement of bed material under Alternative 4 is likely to lead to lower rates of change of in-channel bars, islands, benches, and channel form. Upstream of I-25, a reduction in sediment transport potential is predicted to not cause a substantial change in the channel unless a threshold is reached whereby upstream (or in-channel) sediment supply exceeds sediment transport potential, or vegetation effects start to dominate. Instances of excess sediment supply may occur locally during flow events that capture adjacent gravel pits, remove a diversion structure, result in channel relocation or mass failure of channel banks, or supply fine sediment following a fire and subsequent hillslope erosion in the upstream watershed.

Laporte Reach. For the 26-year period of record, 15 flushing events under Current Conditions lasting for 132 days in total would become 11 flushing events under Alternative 4 lasting for 88 days in total.

Fort Collins and Upper Timnath Reaches. For the 26-year period of record, 23 flushing events under Current Conditions lasting for 325 days in total would become 20 flushing events under Alternative 4 lasting for 231 days in total.

Downstream of I-25

For Alternative 4, sediment transport potential is predicted to be reduced through the mainstem generally by around 11% to 20% downstream of I-25. Bed material is predicted to move at 60% of the cross sections under both Current Conditions and Alternative 4. The duration of flows that move bed material is predicted to be reduced at these sections by up to 40%.

Timnath, Windsor, Greeley Upstream, Greeley Channelized, and Greeley Reaches. For the 26-year period of record, 18 flushing events under Current Conditions lasting for 292 days in total for the Windsor reach would become 17 flushing events under Alternative 4 lasting for 217 days in total.

4.4.5.2 South Platte River

No new studies or analysis were done for the SDEIS for the South Platte River. Section 4.4.1 of the DEIS and the 2008 South Platte River Stream Morphology Report (ERO 2008a) describe effects to the South Platte River.

4.4.6 Unavoidable Adverse Impacts

Investigations for the 2013 Stream Morphology Baseline Report concluded that the mainstem downstream of I-25 had crossed a bio-geomorphic threshold and is on a trajectory leading to a shallower and narrower channel. Implementation of any of the action alternatives has the potential to reinforce the current net depositional trend on the mainstem of the Poudre River downstream of I-25. There would continue to be occasions when some of the material that enters a reach from upstream would not be transported and would deposit in the lee of obstructions, downstream of bars and islands, and on channel margins. The frequency and

duration of these occasions are predicted to increase under all action alternatives. The complexity of in-channel morphologic features is already low in the reaches downstream of I-25 as the result of sand deposition smothering the bed and reducing the magnitude and frequency of pool and riffle sequences. Further channel contraction under the action alternatives is predicted to exacerbate this condition. The effect of the existing trend of channel contraction on flooding would be balanced to some extent by the decreased frequency of flooding due to diversions associated with the alternatives. However, larger floods (greater than the 25-year flood) would less affected by the action alternatives, and channel contraction is predicted to continue to have adverse consequences for flooding for these events.

The District's proposed mitigation will be reviewed by the Corps to determine whether unavoidable adverse impacts would remain with the implementation of the District's proposed mitigation.

4.4.7 Impact Summary

4.4.7.1 Poudre River

Table 4-53 summarizes the predicted effects for Alternatives 2, 3, and 4 for the mainstem of the Poudre River.

Table 4-53. River morphology and sediment transport effects comparison for NISP action alternatives for the Poudre River mainstem.

Potential Effect	Alternative 2 Compared to Current Conditions	Alternative 3 Compared to Current Conditions	Alternative 4 Compared to Current Conditions
	Run 1 vs. Run 3a	**Run 1 vs. Run 3b1**	**Run 1 vs. Run 3b2**
Change in Flow Regime	Mean flow would be reduced by 20%-30% from mid-April to mid-July. The duration of flows at or above 1,000 cfs would be reduced by 30% to 35% throughout. The 2% flow is reduced by 10% up to 30%. Alternative 2 is predicted to reduce the 10-year flood peak generally less than 20%. *Laporte Reach*: The 1%, 2%, and 5% exceedance flows would be affected by a reduction of 11% to 26%. Lower flows (10% flow, 25% flow) are predicted to be reduced by 16% to 28%. *Fort Collins Reach*: Winter low flows through Fort Collins would increase by as much as 35% as a result of the proposed flow augmentation plan. The 1%,	Mean flow would be reduced by 20%-35% from mid-April to mid-July. The duration of flows at or above 1,000 cfs is reduced by 30% to 40% throughout. The 2% flow is reduced by 15% to 37%. Alternative 3 is predicted to reduce the 10-year flood peak up to 26%. *Laporte Reach:* The 1%, 2%, and 5% flows would be affected by a reduction of 15% to 29%. Lower flows (10% flow, 25% flow) are predicted to be reduced by 18% to 32%. *Fort Collins Reach:* The 1%, 2%, and 5% flows would be affected by a reduction of 17% to 55%. Lower flows (10% flow, 25% flow) are predicted to be reduced by 12% to 43%.	Mean flow would be reduced by 20%-25% from mid-April to mid-July. The duration of flows at or above 1,000 cfs is reduced by 20% to 30% throughout. The 2% flow is reduced by 12% to 30% throughout the system. Alternative 4 is predicted to reduce the 10-year flood peak up to 23%. *Laporte Reach:* The 1%, 2%, and 5% flows would be affected by a reduction of 12% to 24%. Lower flows (10% flow, 25% flow) are predicted to be reduced by 12% to 20%. *Fort Collins Reach:* For moderate flows in Fort Collins the impact is less than the other action alternatives because some of the exchange water is

Potential Effect	Alternative 2 Compared to Current Conditions	Alternative 3 Compared to Current Conditions	Alternative 4 Compared to Current Conditions
	Run 1 vs. Run 3a	**Run 1 vs. Run 3b1**	**Run 1 vs. Run 3b2**
	2%, and 5% flows would be affected by a reduction of 13% to 47%. Lower flows (10% flow, 25% flow) are predicted to be reduced by 12% to 41%. A 19% to 36% reduction in the magnitude of the 2-year flood is predicted for the Fort Collins and upper Timnath reaches, but this reduction lessens for larger floods so that the reduction in the 25-year flood is predicted to be 10% or less in Fort Collins. *Timnath, Windsor, Greeley Upstream, Greeley Channelized, and Greeley Reaches:* Impact is predicted to be greatest on 5% exceedance flows, which are reduced by 25% to 42%. The impact on floods up to the 25-year flood is predicted to be reasonably uniform, with the 2-year, 10-year, and 25-year flood peaks all reducing between 16% and 21%.	*Timnath, Windsor, Greeley Upstream, Greeley Channelized, and Greeley Reaches:* Impact is predicted to be greatest on 5% exceedance flows, which are predicted to be reduced by 30% to 45%. The impact on floods up to the 25-year flood is predicted to be reasonably uniform, with the 2-year, 10-year, and 25-year flood peaks all reducing between 19% and 25%.	diverted downstream of Fort Collins. The 1%, 2%, and 5% flows would be affected by a reduction of 13% to 39%. Lower flows (10% flow, 25% flow) are predicted to be reduced by 5% to 20%. *Timnath, Windsor, Greeley Upstream, Greeley Channelized, and Greeley Reaches:* Impact is predicted to be greatest on 5% exceedance flows, which are predicted to be reduced by 14% to 43%. The impact on floods up to the 25-year flood is predicted to be reasonably uniform, with the 2-year, 10-year, and 25-year flood peaks all reducing between 17% and 23%.

Potential Effect	Alternative 2 Compared to Current Conditions	Alternative 3 Compared to Current Conditions	Alternative 4 Compared to Current Conditions
	Run 1 vs. Run 3a	**Run 1 vs. Run 3b1**	**Run 1 vs. Run 3b2**
Fining of Surficial Material	At 55% of the cross sections, the duration of flows that would flush fine material from the riverbed is predicted to be reduced by as much as 30% to 40%. For the remaining 45% of the cross sections, there is either no flushing or no change in the duration of flushing flows. *Laporte Reach:* For the 26-year period of record, 15 flushing events under Current Conditions lasting for 132 days in total would become 10 flushing events lasting for 94 days in total. *Fort Collins Reach:* For the 26-year period of record, 23 flushing events under Current Conditions lasting for 325 days in total would become 16 flushing events lasting for 222 days in total. *Timnath, Windsor, Greeley Upstream, Greeley Channelized, and Greeley Reaches:* For the 26-year period of record, 18 flushing events under Current Conditions lasting for 292 days in total for the Windsor reach would become 19 flushing events lasting for 218 days in total.	At 55% of the cross sections, the duration of flows that flush fines is predicted to be reduced by up to 40%. For the remaining 45% of the cross sections, there is either no flushing or no change in the duration of flushing flows. *Laporte Reach:* For the 26-year period of record, 15 flushing events under Current Conditions lasting for 132 days in total would become 11 flushing events lasting for 82 days in total. *Fort Collins Reach:* For the 26-year period of record, 23 flushing events under Current Conditions lasting for 325 days in total would become 18 flushing events lasting for 205 days in total. *Timnath, Windsor, Greeley Upstream, Greeley Channelized, and Greeley Reaches:* For the 26-year period of record, 18 flushing events under Current Conditions lasting for 292 days in total for the Windsor reach would become 16 flushing events lasting for 197 days in total.	At 55% of the cross sections, the duration of flows that flush fines is predicted to be reduced by up to 40%. For the remaining 45% of the cross sections, there is either no flushing or no change in the duration of flushing flows. *Laporte Reach:* For the 26-year period of record, 15 flushing events under Current Conditions lasting for 132 days in total would become 11 flushing events lasting for 88 days in total. *Fort Collins Reach:* For the 26-year period of record, 23 flushing events under Current Conditions lasting for 325 days in total would become 20 flushing events lasting for 231 days in total. *Timnath, Windsor, Greeley Upstream, Greeley Channelized, and Greeley Reaches:* For the 26-year period of record, 18 flushing events under Current Conditions lasting for 292 days in total for the Windsor reach would become 17 flushing events lasting for 217 days in total.
Loss of Morphologic Complexity	The duration of bed material movement is predicted to be reduced by an average of 21% and up to 40% in some locations. The temporal variability of habitats is predicted to be reduced throughout. Spatial variability is predicted to be reduced downstream of I-25. *Laporte Reach:* Analyses indicate that the channel has barely responded to the historical changes in flow regime over the last two centuries. Any change attributable to Alternative 2	The duration of bed material movement is predicted to be reduced by an average of 26% and as much as 40% in some locations. Temporal variability of habitats is predicted to be reduced throughout. Spatial variability is predicted to be reduced downstream of I-25. *Laporte Reach:* Similar to Alternative 2. *Fort Collins Reach:* Similar to Alternative 2. *Timnath, Windsor, Greeley Upstream, Greeley Channelized, and Greeley*	The duration of bed material movement is predicted to be reduced by an average of 24% and as much as 40% in some locations. Temporal variability of habitats is predicted to be reduced throughout. Spatial variability is predicted to be reduced downstream of I-25. *Laporte Reach:* Similar to Alternative 2. *Fort Collins Reach:* Similar to Alternative 2. *Timnath, Windsor, Greeley Upstream, Greeley Channelized, and Greeley*

Potential Effect	Alternative 2 Compared to Current Conditions	Alternative 3 Compared to Current Conditions	Alternative 4 Compared to Current Conditions
	Run 1 vs. Run 3a	**Run 1 vs. Run 3b1**	**Run 1 vs. Run 3b2**
	is predicted to be similarly constrained by lack of sediment supply. *Fort Collins Reach:* The effects analyses predict an effective discharge of 2,000 cfs for Alternative 2 – unchanged from the Current Conditions hydrology. Channel capacity is predicted to be similar under Alternative 2 unless the quantity or size distribution of available sediment changes. The current channel is still undergoing slow adjustment in response to historical changes in the flow regime. Any change attributable to Alternative 2 would be incremental to that existing response. *Timnath, Windsor, Greeley Upstream, Greeley Channelized, and Greeley Reaches:* The complexity of in-channel morphologic features is already low in the reaches downstream of I-25 as the result of sand deposition smothering the bed and reducing the magnitude and frequency of pool and riffle sequences. Further channel contraction under Alternative 2 is predicted to exacerbate this condition.	*Reaches:* Similar to Alternative 2.	*Reaches:* Similar to Alternative 2.
Channel Contraction	Sediment transport potential is predicted to be reduced throughout the river. The capability of the river to move bed material is reduced between 12% and 31% upstream of I-25 and 8% to 18% downstream of I-25. There is predicted to be a propensity toward channel contraction throughout the system, but this is predicted to be mainly realized downstream of I-25 where there would be	Sediment transport potential is predicted to be reduced throughout the river. The capability of the river to move bed material is reduced between 16% and 37% upstream of I-25 and 12% to 33% downstream of I-25. There is predicted to be a propensity toward channel contraction throughout the system but this is predicted to be mainly realized downstream of I-25 where there would be	Sediment transport potential is predicted to be reduced throughout the river. The capability of the river to move bed material is reduced between 12% and 26% upstream of I-25 and 11% to 20% downstream of I-25. There is predicted to be a propensity toward channel contraction throughout the system but this would be mainly realized downstream of I-25 where there would be

Potential Effect	Alternative 2 Compared to Current Conditions	Alternative 3 Compared to Current Conditions	Alternative 4 Compared to Current Conditions
	Run 1 vs. Run 3a	**Run 1 vs. Run 3b1**	**Run 1 vs. Run 3b2**
	material of the relevant size fraction available for deposition and bio-geomorphic feedback loops are predicted to prevail. It is likely that the acceleration of channel contraction would lead to an increased frequency of flooding downstream of 1-25. *Laporte Reach:* Channel capacity under Alternative 2 is predicted to be similar to Current Conditions unless the quantity or size distribution of available sediment changes. *Fort Collins Reach:* Channel capacity under Alternative 2 is predicted to be similar under Current Conditions unless the quantity or size distribution of available sediment changes. *Timnath Reach:* Channel contraction in response to Alternative 2 would occur as an extension of the processes already underway by deposition on bars, islands, riffles, and channel margins.	material of the relevant size fraction available for deposition and bio-geomorphic feedback loops are predicted to prevail. It is likely that the acceleration of channel contraction would lead to an increased frequency of flooding downstream of 1-25. *Laporte Reach:* Similar to Alternative 2. *Fort Collins Reach:* Similar to Alternative 2. *Timnath, Windsor, Greeley Upstream, Greeley Channelized, and Greeley Reaches:* Similar to Alternative 2.	material of the relevant size fraction available for deposition and bio-geomorphic feedback loops are predicted to prevail. It is likely that the acceleration of channel contraction would lead to an increased frequency of flooding downstream of 1-25. *Laporte Reach:* Similar to Alternative 2. *Fort Collins Reach:* Similar to Alternative 2. *Timnath, Windsor, Greeley Upstream, Greeley Channelized, and Greeley Reaches:* Similar to Alternative 2.
Determination of Effects	Effects of Alternative 2 on geomorphology and sediment transport may result in a detectable change that is considered to be ***minor*** in the reaches upstream of I-25. Downstream of I-25 Alternative 2 effects may result in a clear detectable change that is considered to be ***moderate***.	Effects of Alternative 3 on geomorphology and sediment transport are considered to be ***minor*** in the reaches upstream of I-25. Downstream of I-25 Alternative 3 effects are considered to be ***moderate***.	Effects of Alternative 4 on geomorphology and sediment transport are considered to be ***minor*** in the reaches upstream of I-25. Downstream of I-25 Alternative 4 effects are considered to be ***moderate***.

4.4.7.2 South Platte River

It is unlikely that implementation of any of the action alternatives would affect the morphology of the South Platte River downstream of the confluence with the Poudre River. No new studies or analysis were done for the SDEIS for the South Platte River. Section 4.4.1 of the DEIS concluded that channel-forming flows (1.5-year peak flows of 3,858 cfs) would occur or be exceeded about 3% of the time. Under the action alternatives, flows of this magnitude would occur less than 1% of the time. High flows of up to about 24,200 cfs were modeled to occur under baseline conditions; flows exceeding about 22,600 cfs would not occur under the action alternatives. Scouring flows equivalent to the 25-year peak flows would continue to occur in the South Platte River under the alternatives.

4.4.7.3 Comparison of Alternatives

All alternatives would reduce flows in the mainstem of the Poudre River. Alternatives 3 and 4 would divert on average about 5,500 to 6,000 AFY more water from the Poudre River than Alternative 2 to compensate for increased reservoir evaporation from Cactus Hill Reservoir and conveyance loss. Alternative 4 is designed to allow some flow to pass through the Fort Collins area and be diverted lower on the river at the New Cache Canal headgate. Relative to the other action alternatives, with Alternative 4, more water would remain in the mainstem between the Poudre Valley Canal and the New Cache Canal before it is diverted for exchanges. Alternatives 3 and 4 would not include the Poudre River flow augmentation program that is proposed under Alternative 2. These differences in the action alternatives would result in some differences in predicted effects on channel morphology and sediment transport as described in Table 4-53 and shown below. All action alternatives are predicted to contribute to the existing trend of channel contraction, loss of channel complexity, and increased flooding downstream of I-25. Figure 4-56, Figure 4-57, and Figure 4-58 compare the alternatives for the percent change in 2% exceedance discharge, the percent change in 10-year flood frequency discharge and the percent change in total annual sediment transport potential, respectively.

Figure 4-56. Percent Change in 2% Exceedance Discharge.

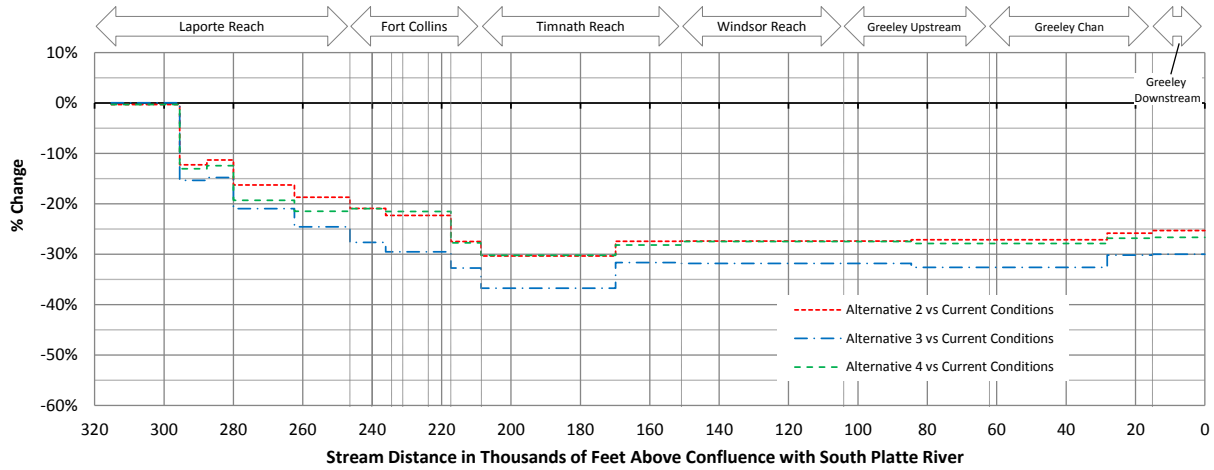


Figure 4-57. Percent Change in 10-Year Flood Frequency Discharge.

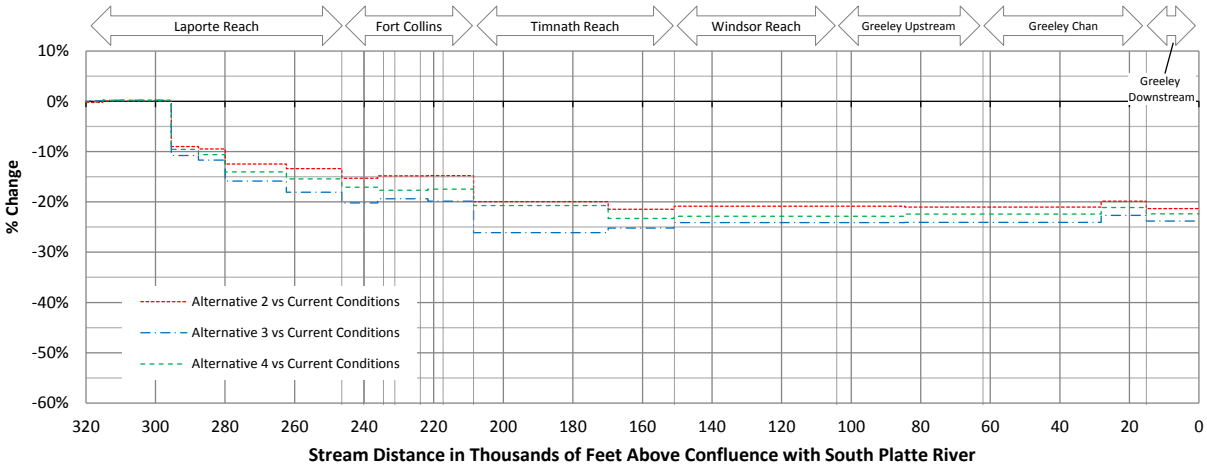
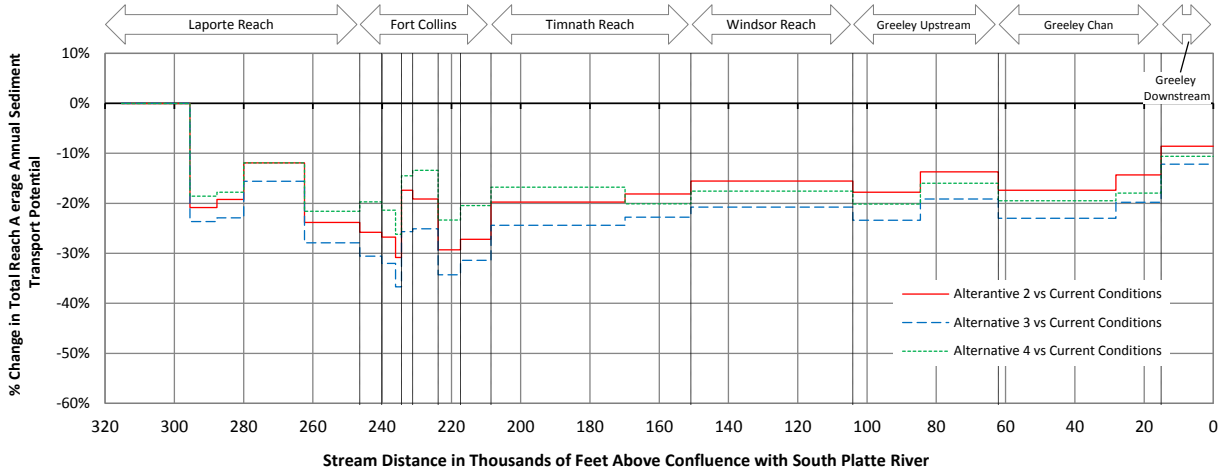


Figure 4-58. Percent Change in Total Annual Sediment Transport Potential.



4.5 GROUND WATER

This section provides information on the predicted effects of the alternatives on ground water resources at the proposed reservoir sites and along the Poudre and South Platte Rivers. More detailed information on the analysis for the Poudre River is presented in the 2013 Ground Water Effects Memo (ERO 2013b). Similar to surface water, information on the predicted changes in ground water levels were used by resource scientists to predict effects to various resources. The role of ground water as it relates to other resources is addressed in Section 4.2 Surface Water Quality and Section 4.9 Wetlands, Riparian Resources, and Other Waters.

4.5.1 Methods

The ground water analysis for the proposed reservoir sites is based on information on the geology and ground water resources, such as GEI (2006a, 2006b, and 2006c) and ERO (2007). In addition to existing information, ground water monitoring wells were installed within the footprint of the proposed Galeton Reservoir, sampled to determine the existing water quality, and tested to determine aquifer characteristics (ERO 2013a).

As part of additional studies performed for the SDEIS, a hydrologic investigation of the mainstem of the Poudre River was conducted from 2009 through 2011. The data collected during the hydrologic investigation are the basis for evaluating how the alternatives may change alluvial ground water levels. These studies included the installation and monitoring of six transects of piezometers at the six Poudre River study sites (Figure 3-26). The 2012 Ground Water Report (ERO 2012b) provides details for the six transects that were established along the Poudre River, data collection methods, and discussion and interpretation of the results. The ground water monitoring was used to establish the relationship between alluvial ground water and surface water, monitor changes in ground water levels at various river stages, and provide hydrologic data to be used for evaluating potential impacts to riparian communities. The results of the monitoring were used to generalize the likely response of ground water levels within each river segment to changes in river flow and stage associated with the NISP alternatives. The geology and hydrogeology of the river alluvium is highly variable within each river segment. Monitoring of ground water at the study sites captured that variability. Because of this variability, the ground water monitoring at the study sites should be considered as a whole, representing the range of responses of ground water to changes in river flow.

This analysis uses existing data presented in the 2012 Ground Water Report (ERO 2012b) and predicted stage changes from the CTP hydrologic model to predict how ground water levels would be reduced as a function of reduction in river stage and distance from the river for each of the action alternatives. The assessment of how predicted reductions in Poudre River flows associated with the action alternatives are estimated to reduce ground water levels along the Poudre River focused on the brief and infrequent predicted maximum reductions in river stage representing a maximum effect scenario. This approach was taken because most of the reductions in river stage are predicted to be 0.5 feet or less (Appendix A of the 2014 Wetland and Riparian Resources Effects Report) and therefore would have only minor reductions on

associated alluvial ground water levels. A maximum effect scenario was of interest because alluvial ground water levels can influence cottonwood woodlands and reductions in ground water levels below the annual water table low (Section 4.3.1 of the 2014 Wetland and Riparian Resources Effects Report).

Changes in river flows were predicted by comparing modeled Current Conditions hydrology to project hydrology for each of the action alternatives. Weekly changes in river stage were determined to be suitable for estimating changes in ground water levels because ground water levels tend to fluctuate less than surface water levels, the monitoring increment for most of the ground water monitoring wells was a week or greater, and the predicted changes to ground water levels were focused on longer term trends that have the potential to affect cottonwood woodlands.

Predicted change in water surface elevation (or stage) at each of the six study sites on a weekly average basis was computed using daily disaggregated model flows and hydraulic modeling. Detailed topographic data generated as part of the 2-dimensional hydraulic modeling (ACE 2011) was used to develop a 1-dimensional HEC-RAS hydraulic model of each of the six study sites. The HEC-RAS hydraulic modeling was used to develop a relationship between stage and discharge at one selected transect located within each study site. Daily disaggregated flows were used to compute weekly average discharge (average of daily flows over a 7-day period) for each week in the 26-year period of record (a total of 1,357 weeks). Weekly average flows were computed for Current Conditions and each action alternative. Weekly average stage was then computed by applying the relationship between stage and discharge to the computed weekly average flows. The predicted change in weekly average stage, for each week in the 26-year period of record, was then determined by comparing the weekly average stage for each action alternative with the weekly average stage computed under Current Conditions.

The predicted changes in water surface elevation were computed using the CTP hydrologic model and have the same uncertainties as those associated with the hydrologic modeling (CDM Smith and DiNatale 2013). Using the largest predicted stage reduction at each study site is a conservative estimate (an estimate of the maximum effect) that reduces the concern that effects were underestimated.

Using the largest predicted stage reduction at each study site for each of the action alternatives, and river stage-ground water level relationships developed for each monitoring well, graphs were constructed with predicted ground water level declines at each well at the study site. The graphs show the predicted reduction in depth to ground water as a function of distance from the river for all action alternatives (ERO 2013b).

Large rising or falling river stage time segments from the stage data measured at each of the six ground water monitoring transects were selected from the 2-year dataset presented in the 2012 Ground Water Report and compared with measured ground water level changes at each of the ground water monitoring wells for the same time period to develop river stage-ground water level relationships. During the same time segment, the measured ground water level change in a piezometer was compared to the stage change and reported as a percentage of the total river stage change. For example, if the stage reduction was 1 foot and the ground water level reduction was

0.5 foot for the same time segment, the result was reported as 50% for that piezometer. This process was followed for each of the piezometers within a given transect, resulting in percentage change in ground water level at each piezometer for increasing distance from the river. Ground water level changes as percentages were then plotted vs. distance from the river.

As described in the 2013 Ground Water Effects Memo, this analysis could not be performed on river segments D and E because the ground water levels are controlled by nearby ponds (Eastman Park study site) and a river meander (59th Avenue study site), and there is not a good correlation between ground water levels and distance from the river at these locations.

4.5.2 No Action Alternative (Alternative 1)

4.5.2.1 Cactus Hill Reservoir Site

Ground water resources for Cactus Hill Reservoir were discussed in Section 4.7.4 of the DEIS.

4.5.2.2 Poudre River

The No Action Alternative was evaluated under Future Conditions hydrology only, as explained in Section 4.2.2 and, therefore, the assessment of how the No Action Alternative is predicted to reduce ground water levels is presented in Chapter 5.

4.5.2.3 South Platte River

The No Action Alternative was evaluated under Future Conditions hydrology, as explained in Section 4.2.2. The No Action Alternative for the South Platte River from the confluence with the Poudre down to the Kersey Gage Poudre River mainstem are presented in Chapter 5.

4.5.2.4 No Action Irrigated Lands

Under the No Action Alternative, the NISP Participants would rely on transfers of irrigated agricultural water rights to provide their future water supply. Agricultural ditch transfers are projected to result in the “dry up” (i.e., revegetated or converted to dryland farming) of 64,200 irrigated acres. The No Action Alternative would result in a large percentage reduction in irrigated land in the Poudre River Basin (Figure 2-1), which would likely result in a large percentage reduction in the current ground water return flows to the Poudre River, particularly during the mid to late summer, and possibly into the fall. The reduction of irrigated acres in two irrigation districts (Larimer and Weld Irrigation Company and New Cache Irrigation Company) would be about 60% (Figure 2-1). This reduction in ground water flow assumes that the volume of irrigation water classified as non-consumptive would be delivered back to the river via one or more discharge points and would not pass through the ground water system. The current return flows via ground water have not been quantified. The dry up of irrigated land may result in the flattening of the hydraulic gradient between the river and adjacent lands, due to the reduction in ground water flow or flux towards the Poudre River.

4.5.3 District's Preferred Alternative (Alternative 2)

4.5.3.1 Reservoir Sites

4.5.3.1.1 Glade Reservoir

Effects to ground water resources at Glade Reservoir are discussed in Section 4.7.2 of the DEIS. Additional ground water samples were collected near and within the TCE plume near the Glade Reservoir site during the fall and winter quarters of 2008, and spring through fall quarters of 2009 for the SDEIS and to supplement the 2003/2004 water quality data. Ground water level data collected during the four quarters indicated that water levels vary by as much as 10 feet between seasons. Based on data from the four quarters, water levels reach their lowest level by late spring and then begin rising through the summer, remaining high through much of the winter. Although there are large variations within ground water levels in the area throughout the year, the residual TCE mass near the source area appears to no longer affect downgradient areas, which is where the Glade forebay would be located. The 2008/2009 sampling results indicate that the TCE plume has retracted so that there is currently no detectable TCE within the footprint of the proposed Glade Reservoir forebay. As the contaminant mass continues to naturally attenuate, the plume will continue to decrease in size. Additional information on the TCE plume near the proposed Glade Reservoir forebay is provided in Section 4.21.3.1.1 of the Hazardous Materials section.

4.5.3.1.2 Galeton Reservoir

Information on effects to ground water at Galeton Reservoir is presented in Section 4.7.3 of the DEIS. Subsequent to the DEIS, there has been drilling for oil and gas production at the Galeton Reservoir site. The oil and gas development and any potential effects to ground water quality are addressed in the 2012 Oil and Gas Development Memo (ERO 2012c) and in Section 4.21.3.1.2.

Comments on the DEIS questioned how Galeton Reservoir might affect selenium and salinity concentrations in ground water in the vicinity of the proposed reservoir or surface waters downgradient of the proposed Galeton Reservoir. As part of the SDEIS, additional ground water studies were undertaken to respond to these comments (ERO 2015a). These studies determined that ground water selenium concentrations measured within the footprint of the proposed Galeton Reservoir (3.33 to 4.58 µg/L) are within the range of dissolved selenium concentrations for the water that would be stored in the reservoir as measured at the South Platte River at Kersey (<1 to 80 µg/L) and the analogous existing Jackson Reservoir (< 1 to 5.7 µg/L). As the proposed Galeton Reservoir would mature and organic-rich sediments accumulate, they would help to remove selenium from reservoir water that seeps into the underlying water-bearing zone (ERO 2015a). Salinity impacts to ground water from the proposed Galeton Reservoir would not be expected due to the higher TDS concentrations in ground water measured at Galeton (2,750 to 5,560 mg/L) compared to that predicted in the reservoir water (1,085 mg/L). The closest major downgradient surface water from the proposed Galeton Reservoir is the South Platte River, located 15 miles away. The time for ground water to travel from the proposed Galeton Reservoir to the South Platte River is estimated to be about 20,000 years due to the distance between the two waterbodies and the composition of the geologic materials through which the ground water

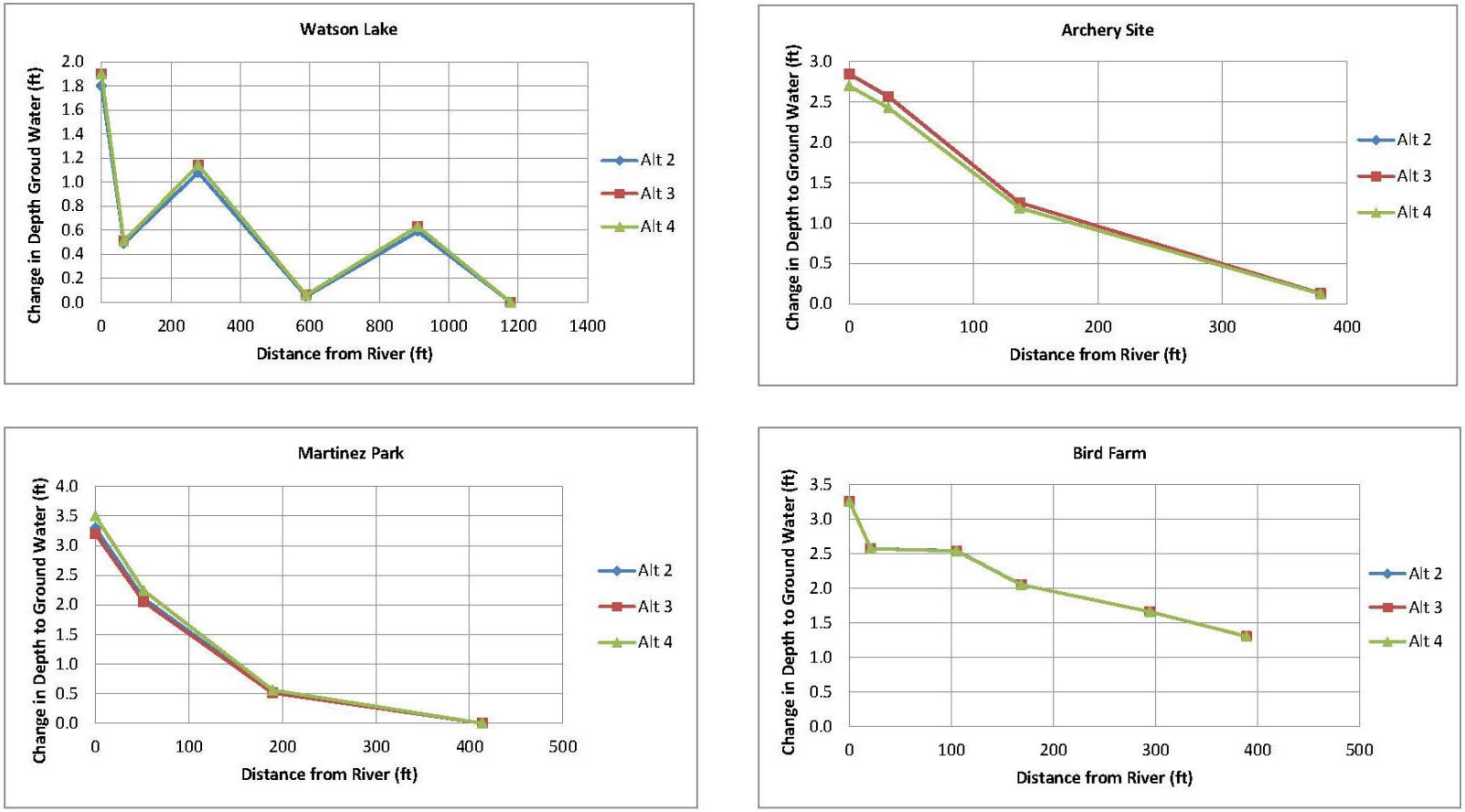
would travel. Because no selenium or salinity impacts are predicted to occur to the ground water underlying Galeton Reservoir, no impacts are predicted to occur to the South Platte River from ground water at the Galeton Reservoir site.

4.5.3.2 Poudre River

Predicted changes in stream water quality that would occur along the mainstem during the typical high flow periods of May and June may also occur in alluvial ground water. However, as a result of chemical and biochemical interactions between ground water and the geological materials through which it flows, ground water contains a wide variety of dissolved inorganic chemical constituents at various concentrations (Freeze and Cherry 1979). Changes to ground water quality as a result of changes in stream water quality due to the NISP alternatives would be temporary and may not be separable from the existing variability in ground water quality. During periods of low flow (such as July and August), the river alluvium gains water from irrigation supported alluvial ground water that moves from farm fields toward the river channel. Any predicted changes in river water quality during low river flows would likely not have an effect on alluvial ground water quality.

For the four river segments that were analyzed (A, B, C, and F), the predicted reductions in maximum river stage would range from about 1.8 feet to 3.0 feet. Water levels in alluvial ground water monitoring wells located within tens of feet of the river would be at about the same elevation as river stage. At a distance of about 50 feet from the river, the effect of reductions in maximum river stage on ground water levels would decrease with greater distance from the river. Figure 4-59 compares estimated ground water level reductions with distance from the river for each of the action alternatives at four of the study sites based on predicted maximum reduction in river stage.

Figure 4-59. Predicted Ground Water Level Reductions vs. Distance from the Poudre River Based on Maximum River Stage Reductions.



The predicted declines in ground water levels presented in Figure 4-59 are for a maximum-case situation that may occur typically once in 26 years, as predicted by the CTP hydrologic modeling. More frequently, the predicted reductions in river stage range from 0 to 1 foot, and less frequently, reductions range between 1 and 2 feet, depending on location and alternative (Attachment 1 of the 2013 Ground Water Effects Memo). With predicted stage reductions of 1 to 2 feet, ground water level reductions in the alluvium in the vicinity of the river would be less than what is predicted in Figure 4-59 and would not likely be discernible by alluvial well owners, given the range of natural variability in water levels. Alluvial wells located hundreds of feet from the river would not be affected, even during the estimated maximum effect scenario.

As Figure 4-59 demonstrates, there would be little difference between the alternatives in ground water level reductions associated with predicted maximum river stage reductions. This lack of difference between the alternatives occurs for several reasons:

- The differences in flow regimes between the alternatives result in minor differences in water surface elevation.
- The flow augmentation program under Alternative 2 would add water during the winter when flows (and river stage) are low, and would add a few inches at most to river stage. The predicted maximum river stage declines are measured in feet when the river is at high flow.
- The relationship between ground water levels and river stage decreases with greater distance from the river.

4.5.3.2.1 Poudre River Segments

Segment A. The maximum predicted river stage reduction for Segment A would be less of a reduction than is predicted for the other study sites (Figure 4-59). At the Watson Lake study site (representative of Segment A), a maximum reduction in river stage of about 2 feet is estimated to result in a 0.5 foot decline in ground water levels at about 50 feet from the river and a 0 foot decline in ground water levels 600 feet from the river. The Watson Lake study site differs from the other study sites in that buried river channels coincide with 2 of the monitoring wells about 280 feet and 900 feet from the river. The effect of these buried channels can be seen on Figure 4-59 where predicted ground water level reductions are out of character with distance from the river and neighboring monitoring wells.

Segment B. The greatest reduction in flows and maximum reduction in river stage are predicted to occur in Segment B; however, the reductions in ground water levels decrease in a relatively short distance from the river (Figure 4-59). At the Martinez Park study site (representative of Segment B), a maximum reduction in river stage of about 3.5 feet is estimated to result in a 2.0 feet decline in ground water levels at about 50 feet from the river, a 0.5 foot decline in ground water levels at about 200 feet, and a 0 foot decline in ground water levels at about 400 feet from the river.

Segment C. Unlike most of the other study sites, at the Archery Site (representative of Segment C) there are greater predicted differences among the action alternatives in predicted reductions to ground water levels (Figure 4-59). Under Alternative 2, a maximum reduction in river stage of

about 2.6 feet is estimated to result in a 2.4 feet decline in ground water levels at about 50 feet from the river, a 1.6 feet decline in ground water levels at about 100 feet, and a 0 foot decline in ground water levels at about 375 feet from the river. Similar to Segment B, the reductions in ground water levels decrease in a relatively short distance from the river (Figure 4-59).

Segment D. The Eastman Park study site represents conditions where ground water levels correspond to river stage, particularly in the wells closest to the river. The five monitoring wells are completely within the alluvial system. Ground water levels are controlled by the river and nearby ponds and there is not a good correlation between ground water levels and distance from the river.

Segment E. The 59th Avenue study site represents conditions where the relationship between river stage and ground water levels can seasonally reverse, where ground water levels are controlled by a river meander, and there is not a good correlation between ground water levels and distance from the river. For much of the year, ground water flows across the interior of the river meander from the upstream side to the downstream side. However, at times (such as during the spring), ground water appears to flow into the meander from outside of the river area, recharging both the alluvium within the meander and eventually the river.

Segment F. At the Bird Farm study site (representative of Segment F), a maximum reduction in river stage of about 3.25 feet is estimated to result in about a 2.5 feet decline in ground water levels at about 50 feet to 100 feet from the river, and about a 1.3 foot decline in ground water levels at about 400 feet from the river. The reductions in ground water levels decrease in a relatively short distance from the river, and then would level off for the next 50 feet, then decline to about 1.3 feet within about 400 feet of the river (Figure 4-59).

4.5.3.3 South Platte River

Alternative 2 would on an average annual basis reduce flows on the South Platte River by less than 10% and the stage reductions are predicted to be small (up to 0.33 feet). Given the minor reductions in flow and stage, it is unlikely that there would be measurable changes to alluvial ground water along the South Platte River associated with Alternative 2.

There could be slight changes in water quality in the South Platte River due to increased surface water diversions under the NISP alternatives. Because the changes in surface water quality are predicted to be slight, any changes in alluvial water quality may not be measurable or be distinguishable from natural water quality variability in the alluvium.

4.5.4 Alternative 3

4.5.4.1 Reservoir Sites

4.5.4.1.1 Cactus Hill Reservoir

Effects on ground water resources associated with Cactus Hill Reservoir were discussed in Section 4.4.2.1 of the DEIS.

4.5.4.1.2 Galeton Reservoir Site

The effects on ground water associated with Galeton Reservoir are the same as Alternative 2 and are discussed in Section S.7.4.1.2.

4.5.4.2 Poudre River

The predicted effects to water quality and general discussion of river stage and ground water levels discussed for Alternative 2 also apply to Alternative 3. As discussed under Alternative 2 (Section S.7.4.2), there would be little predicted difference between the action alternatives in ground water level reductions associated with maximum river stage reductions, with the exception of Segment C as described below.

Segment A. The ground water level reductions associated with the predicted maximum river stage reduction would be the same as described for Alternative 2.

Segment B. The ground water level reductions associated with the predicted maximum river stage reduction would be the same as described for Alternative 2.

Segment C. At the Archery Site (representative of Segment C) there are greater differences observed among the action alternatives in predicted reductions to ground water levels (Figure 4-59). Alternative 3 is predicted to have a slightly greater reduction in maximum river stage reduction and corresponding reduction in ground water levels than Alternatives 2 and 4 at this location. A maximum reduction in river stage of about 3 feet is estimated to result in a 2.5 feet decline in ground water levels at about 50 feet from the river, a 1.75 foot decline in ground water levels at about 100 feet, and a 0 foot decline in ground water levels at about 375 feet from the river. Similar to Segment B, the reductions in ground water levels decrease in a relatively short distance from the river (Figure 4-59).

Segment D. The Eastman Park study site represents conditions where ground water levels correspond to river stage, particularly in the wells closest to the river. The five monitoring wells are completely within the alluvial system. Ground water levels are controlled by the river and nearby ponds and there is not a good correlation between ground water levels and distance from the river.

Segment E. The 59th Avenue study site represents conditions where the relationship between river stage and ground water levels can seasonally reverse, where ground water levels are controlled by a river meander, and there is not a good correlation between ground water levels and distance from the river. For much of the year, ground water flows across the interior of the river meander from the upstream side to the downstream side. However, at times (such as during the spring), ground water appears to flow into the meander from outside of the river area, recharging both the alluvium within the meander and eventually the river.

Segment F. The predicted ground water level reductions associated with the predicted maximum river stage reduction would be the same as described for Alternative 2.

4.5.4.3 South Platte River

Alternative 3 would on average reduce flows on the South Platte River by less than 10% and the stage reductions are predicted to be small (up to 0.33 feet). Given the minor reductions in flow and stage, it is unlikely that there would be measurable changes to alluvial ground water along the South Platte River associated with Alternative 2.

There could be slight changes in water quality in the South Platte River due to increased surface water diversions under the NISP alternatives. The predicted slight changes in surface water quality may not measurably affect alluvial water quality or be separable from natural water quality variability in the alluvium.

4.5.5 Alternative 4

4.5.5.1 Reservoir Sites

4.5.5.1.1 Cactus Hill Reservoir

Effects on ground water resources at Cactus Hill Reservoir were described in Section 4.7.4 of the DEIS.

4.5.5.1.2 Galeton Reservoir

The effects on ground water at Galeton Reservoir are the same as Alternative 2 (Section S.7.4.1.2) and were described in Section 4.7.3 of the DEIS.

4.5.5.2 Poudre River

The predicted effects to water quality and general discussion of river stage and ground water levels discussed for Alternative 2 also apply to Alternative 4. As discussed under Alternative 2 (Section S.7.4.2), there would be little predicted difference between the action alternatives in ground water level reductions associated with maximum river stage reductions, with the exception of Segment C as described below.

Segment A. The ground water level reductions associated with the predicted maximum river stage reduction would be the same as described for Alternative 2.

Segment B. The ground water level reductions associated with the predicted maximum river stage reduction would be the same as described for Alternative 2.

Segment C. At the Archery Site (representative of Segment C) there are greater differences observed among the action alternatives in predicted reductions to ground water levels (Figure 4-59). Alternative 4 is predicted to have a slightly greater reduction in maximum river stage reduction and corresponding reduction in ground water levels at this location than Alternative 2, but less than Alternative 3. A maximum reduction in river stage of about 2.8 feet is estimated to result in about a 2.5 feet decline in ground water levels at about 50 feet from the river, a 1.6 feet decline in ground water levels at about 100 feet, and a 0 foot decline in ground water levels at

about 375 feet from the river. Similar to Segment B, the reductions in ground water levels decrease in a relatively short distance from the river (Figure 4-59).

Segment D. The Eastman Park study site represents conditions where ground water levels correspond to river stage, particularly in the wells closest to the river. The five monitoring wells are completely within the alluvial system. As discussed above, ground water levels are controlled by the river and nearby ponds and there is not a good correlation between ground water levels and distance from the river.

Segment E. The 59th Avenue study site represents conditions where the relationship between river stage and ground water levels can seasonally reverse. For much of the year, ground water flows across the interior of the river meander from the upstream side to the downstream side. However, at times (such as during the spring), ground water appears to flow into the meander from outside of the river area, recharging both the alluvium within the meander and eventually the river. As discussed above, the 59th Avenue study site represents conditions where ground water levels are controlled by a river meander and there is not a good correlation between ground water levels and distance from the river.

Segment F. The predicted ground water level reductions associated with the predicted maximum river stage reduction would be the same as described for Alternative 2.

4.5.5.3 South Platte River

Alternative 4 would on average reduce flows on the South Platte River by less than 10% and the stage reductions are predicted to be small (up to 0.33 feet). Given the minor reductions in flow and stage, it is unlikely that there would be measurable changes to alluvial ground water along the South Platte River associated with Alternative 2.

There could be slight changes in water quality in the South Platte River due to increased surface water diversions under the NISP alternatives. The predicted slight changes in surface water quality may not measurably affect alluvial water quality or be separable from natural water quality variability in the alluvium.

4.5.6 Unavoidable Adverse Impacts

The predicted reductions in alluvial ground water levels are relatively small compared to the natural variability of ground water levels and the reductions would be relatively short-lived. Indirect effects associated with the predicted reductions in ground water levels are addressed for those resources in Section 4.3 Water Quality and Section 4.9 Wetlands, Riparian Resources, and Other Waters. There are no predicted unavoidable adverse impacts to ground water resources or users associated with any of the alternatives.

4.5.7 Impact Summary

As discussed above, reductions in alluvial ground water levels were used to predict resource effects and are addressed in those sections of the SDEIS. The predicted reductions to ground water levels in the alluvium would be similar for all action alternatives. Within 50 feet of the river, ground water level differences between the alternatives would be a maximum of about 0.5 feet. The differences in predicted reductions in ground water levels between alternatives would decrease as a function of distance from the river (Figure 4-59).

4.6 GEOLOGY

This section summarizes the predicted potential geologic effects of the NISP alternatives. No additional studies were conducted for geology for the SDEIS. More detailed information is available in the 2006 Geologic Memorandums (GEI 2006a, 2006b, 2006c).

4.6.1 Methods

The methods for analyzing effects related to geology are described in Section 4.8.1 of the DEIS

The following terms were used to describe potential effects to geologic resources:

- Negligible: The effect would be at the lowest levels of detection, barely measureable, with no perceptible consequences.
- Minor: The action might result in a detectable change, but the change would be slight.
- Moderate: The action could result in a clearly detectable change, with measurable effects.
- Major: The action could result in readily apparent effects with substantial consequences.

4.6.2 No Action Alternative (Alternative 1)

4.6.2.1 Cactus Hill Reservoir Site

The geologic effects for the Cactus Hill Reservoir, as described in Section 4.8.2 of the DEIS, would be associated with ground-disturbing construction activities. Moderate direct impacts to geologic resources include the loss of mineral resources such as sand, gravel, and bedrock that would be used as borrow material for dam construction. In addition, there would be a partial loss of unmined gravel and rock resources due to reservoir inundation. The majority of the aggregate required to construct the dam would be excavated onsite within the reservoir area. Minor indirect, permanent effects would include reservoir rim instability, landslides, rock fall, and erosion due to project operations. According to the preliminary geologic assessment, no geologic features including faults, seismic hazards, and mineral resources (not including oil and gas resources) were identified at the site that would preclude construction of the dam and appurtenant facilities (GEI 2006c). The site would be thoroughly characterized prior to final design to clarify geologic and geotechnical design considerations.

4.6.2.2 Conveyance Systems

The geologic effects for the No Action Alternative conveyance systems would be associated with ground-disturbing activities for pipeline installation and associated facility construction. These effects would be minor compared to the scale of the larger disturbances associated with reservoir construction.

4.6.2.3 Poudre River

Flow changes to the Poudre River would have no impact on geology along the Poudre River under the No Action Alternative.

4.6.2.4 South Platte River

Flow changes to the South Platte River would have no impact on geology along the South Platte River under the No Action Alternative.

4.6.3 District's Preferred Alternative (Alternative 2)

4.6.3.1 Reservoir Sites

4.6.3.1.1 Glade Reservoir

Similar to the effects at the Cactus Hill Reservoir site under the No Action Alternative, the potential moderate direct impacts to geologic resources at the Glade Reservoir site would include the loss of mineral resources such as sand, gravel, and bedrock that would be used as borrow material for dam construction. There also would be a partial loss of unmined gravel and rock resources due to reservoir inundation. The majority of the aggregate required to construct the dam would be excavated onsite within the reservoir area. Minor indirect, permanent effects would include reservoir rim instability, landslides, rock fall, and erosion due to project operations.

The geologic effects for the Glade Reservoir site related to inactive faults in the area and the potential for reservoir seepage were discussed in Section 4.8.3 of the DEIS.

The potential for karst features (solution cavities) in the Lower Ingleside Formation, which has been mapped in the lower right abutment area of the proposed Glade Reservoir Dam, would be evaluated by future geotechnical studies for the reservoir. Mitigation of solution cavities would be addressed in the final design, including a grouting program and other foundation treatment precautions.

The USGS has created a map that displays areas of equal seismic hazard that are defined by the probability of having a certain level of ground shaking, or horizontal acceleration, during an earthquake (USGS 2014). The map shows levels of ground shaking that have a 2% chance of being exceeded in a 50-year period. The data are presented as peak acceleration values in %g (percentage of g, where g is acceleration due to gravity, or 9.8 meters/second^2).

The analysis area is in a region with low to moderate peak acceleration values of 0.10g to 0.14g and the seismic hazard impact to the Glade Reservoir Dam would be minor. Final design of the dam and any appurtenant facilities would be done in accordance with applicable Colorado dam safety criteria, to include current seismic stability standards.

U.S. 287. The geologic effects for the U.S. 287 realignment were described in Section 4.8.4 of the DEIS. The U.S. 287 realignment would require rock excavation and cut slopes through a

hogback structure composed of sandstones and claystones of the Lytle and Morrison formations. This would result in a permanent loss of bedrock material in a unique geologic structure, which is considered a moderate effect because the cut would be clearly detectable.

4.6.3.1.2 Galeton Reservoir

The geologic effects for the Galeton Reservoir, as described in Section 4.8.2 of the DEIS, would be associated with ground-disturbing construction activities similar to those described under the Cactus Hill and Glade Reservoir sites and would be moderate because most of the geologic disturbance would occur onsite within the reservoir area, resulting in localized effects to geologic resources which are abundant within the region. Minor potential indirect effects could include reservoir rim instability, landslides, rock fall, and erosion due to project operations. According to the preliminary geologic assessment, no geologic features including faults, seismic hazards, and mineral resources (not including oil and gas resources) were identified at the site that would preclude construction of the dam and appurtenant facilities, (GEI 2006b). The site would be thoroughly characterized prior to final design to clarify geologic and geotechnical design considerations.

4.6.3.2 Conveyance Systems

The geologic effects for the Alternative 2 conveyance systems, as described in Section 4.8.2 of the DEIS, would be associated with ground-disturbing construction activities and would be a minor effect because the effects would be limited to small corridors of disturbance and once construction was completed would be relatively undetectable.

4.6.3.3 Poudre River

Flow changes to the Poudre River would have no impact on geology along the Poudre River under Alternative 2.

4.6.3.4 South Platte River

Flow changes to the South Platte River would have no impact on geology along the South Platte River under Alternative 2.

4.6.4 Alternative 3

4.6.4.1 Reservoir Sites

4.6.4.1.1 Cactus Hill Reservoir

The geologic effects associated with Cactus Hill Reservoir are the same as the No Action Alternative and are described in Section 4.6.2.1. There would be a moderate effect on geologic resources associated with construction of the reservoir as previously described.

4.6.4.1.2 Galeton Reservoir

The geologic effects associated with Galeton Reservoir are the same as Alternative 2 and are described in Section 4.6.3.1.2. There would be a moderate effect on geologic resources associated with construction of the reservoir as previously described.

4.6.4.2 Conveyance Systems

The geologic effects for the Alternative 3 conveyance systems, as described in Section 4.8.2 of the DEIS, would be associated with ground-disturbing construction activities and would be minor as previously described.

4.6.4.3 Poudre River

Flow changes to the Poudre River would have no impact on geology along the Poudre River under Alternative 3.

4.6.4.4 South Platte River

Flow changes to the South Platte River would have no impact on geology along the South Platte River under Alternative 3.

4.6.5 Alternative 4

4.6.5.1 Reservoir Sites

4.6.5.1.1 Cactus Hill Reservoir

The geologic effects associated with Cactus Hill Reservoir are the same as the No Action Alternative and are described in Section 4.6.2.1. There would be a moderate effect on geologic resources associated with construction of the reservoir as previously described.

4.6.5.1.2 Galeton Reservoir

The geologic effects associated with Galeton Reservoir are the same as Alternative 2 and are described in Section 4.6.3.1.2. There would be a moderate effect on geologic resources associated with construction of the reservoir as previously described.

4.6.5.2 Conveyance Systems

The geologic effects for the Alternative 4 conveyance systems, as described in Section 4.8.2 of the DEIS, would be associated with ground-disturbing construction activities and would be minor as previously described.

4.6.5.3 Poudre River

Flow changes to the Poudre River would have no impact on geology along the Poudre River under Alternative 4.

4.6.5.4 South Platte River

Flow changes to the South Platte River would have no impact on geology along the South Platte River under Alternative 4.

4.6.6 Unavoidable Adverse Impacts

There would be an unavoidable loss of geologic resources (i.e., bedrock and sand and gravel deposits) and alteration of topography associated with the use of borrows materials for construction of the dams and installation of the conveyance systems infrastructure.

4.6.7 Impact Summary

All alternatives would be affected by site geology and would impact geologic resources (Table 4-54). Additional geotechnical studies would be performed for final design of any alternative permitted. In order to address potential geologic effects on proposed project facilities, standard engineering practices would be incorporated into project facility designs.

Table 4-54. Geology effects determinations.

Study Area	Alternative 1	Alternative 2 Reclamation Action Option	Alternative 2 No Reclamation Action Option	Alternative 3	Alternative 4
Glade Reservoir	NA	Moderate	Moderate	NA	NA
U.S. 287 Realignment	NA	Moderate	Moderate	NA	NA
Glade Infrastructure	NA	Minor	Minor	NA	NA
Galeton Reservoir	NA	Moderate	Moderate	Moderate	Moderate
Galeton Infrastructure	NA	Minor	Minor	Minor	Minor
Cactus Hill Reservoir	Moderate	NA	NA	Moderate	Moderate
Cactus Hill Infrastructure	Minor	NA	NA	Minor	Minor
Conveyance Systems	Minor	Minor	Minor	Minor	Minor
No Action Irrigated Lands	No effect	NA	NA	NA	NA
Poudre River	No effect	No effect	No effect	No effect	No effect
South Platte River	No effect	No effect	No effect	No effect	No effect

NA = Not a component of the alternative.

4.7 SOILS

This section summarizes the predicted potential effects of the NISP alternatives on Prime and Unique Farmlands and soil erodibility. Prime farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, fiber, forage, oilseed, and other agricultural crops with minimum inputs of fuel, fertilizer, pesticides, and labor, and without intolerable soil erosions [7 USC 4201(c)(1)(a)]. Unique farmland is land other than prime farmlands that is used for the production of specific high-value food and fiber crops such as citrus, tree nuts, olives, cranberries, fruits, and vegetables [7 USC 4201(c)(1)(b)]. As of September 2014, the NRCS estimated that Weld County had 740,628 acres of Prime Farmland and that Larimer County had 204,777 acres of Prime Farmland. No Unique Farmlands are located in the alternatives study areas.

The Farmland Protection Policy Act (FPPA) [7 CFR 658] is intended to minimize the impact Federal programs have on the unnecessary and irreversible conversion of farmland to nonagricultural uses. It does not authorize the Federal Government to regulate the use of private or nonfederal land or in any way affect the property rights of owners. Projects are subject to FPPA requirements if they may irreversibly convert farmland (directly or indirectly) to nonagricultural use and are completed by a Federal agency or with assistance from a Federal agency. Federal permitting and licensing are activities that are not subject to the FPPA.

NISP would not be a federally funded or assisted project; therefore impacts to Prime and Unique farmland were not evaluated under the FPPA. However, impacts to Prime and Unique farmland are evaluated in the EIS under NEPA as a natural or depletable resource [40 CFR 1502.16(f)] and as a Corps public interest review factor [33 CFR 320.4(a)(1)].

No additional studies were conducted for soils for the SDEIS although new analysis on soil erodibility is presented. More detailed information on soils is presented in the 2008 Land Use Report (ERO 2008b). Effects were updated for the SDEIS using the current reservoir sizes and conveyance system alignments for each alternative. Prime Farmland would not be affected by changes in streamflow; therefore, effects for the Poudre and South Platte Rivers study areas were not evaluated.

4.7.1 Methods

The methods for analyzing Prime Farmland effects are described in Section 4.9.1 of the DEIS. The intensity of effects for each alternative is correlated to the acreage of Prime Farmland that is predicted to be permanently impacted compared to the total acreage of Prime Farmland in Larimer and Weld Counties, as follows: no effect - no impact to prime farmland; negligible – effects would be temporary and the disturbed lands would be restored to preconstruction conditions with no loss of Prime Farmland; minor – less than 1% of Prime Farmland within Larimer County or Weld County would be impacted; moderate – 1% to 10% of Prime Farmland within Larimer County or Weld County would be impacted; and major – greater than 10% of Prime Farmland within Larimer County or Weld County would be impacted. Within the NISP study area, the designation of Prime Farmland indicates Prime Farmland only if irrigated.

Data to assess susceptibility to wind and water erosion in the analysis area were obtained from the NRCS (2014). The soil erodibility factor Kw was used to assess the susceptibility of surface soils within the analysis area to water erosion. The wind erodibility group (WEG) was used to assess the susceptibility of soils within the analysis area to wind erosion. Values for Kw and WEG were placed in one of three categories: low, moderate and high susceptibility to erosion. The project components used to calculate areas of high susceptibility to erosion included those in which areas of soil would be disturbed and exposed, such as areas exposed during reservoir construction until the reservoir was filled, areas of temporary disturbance around the reservoirs and pump stations, temporary roads, and pipelines.

4.7.2 No Action Alternative (Alternative 1)

4.7.2.1 Cactus Hill Reservoir

Inundation by the 120,000 AF Cactus Hill Reservoir would permanently affect 313.5 acres of Prime Farmland and infrastructure for the reservoir site, including the dam, proposed roads, and powerline poles, would permanently affect 54.2 acres of Prime Farmland. The reservoir site would permanently affect a total of 367.7 acres of Prime Farmland, or 0.05% of all Prime Farmland in Weld County, which is a minor impact. Construction of the reservoir and infrastructure would temporarily affect 85.6 acres of Prime Farmland and would expose 118 acres of soil highly susceptible to water erosion and 118 acres of soil highly susceptible to wind erosion until the reservoir was filled.

4.7.2.2 Conveyance Systems

Conveyance systems, including pump stations and water treatment plants, would permanently affect 9.4 acres of Prime Farmland, which would be a minor impact. Construction of the conveyance systems would temporarily affect 558.6 acres of Prime Farmland.

The No Action Alternative would have 209 acres highly susceptible to water erosion and 345 acres highly susceptible to wind erosion from temporary impacts along pipelines, access roads, and other temporary construction disturbances.

4.7.2.3 Poudre River

Flow changes to the Poudre River would have no impact on Prime Farmland along the Poudre River under the No Action Alternative.

4.7.2.4 South Platte River

Flow changes to the South Platte River would have no impact on Prime Farmland along the South Platte River under the No Action Alternative.

4.7.2.5 No Action Irrigated Lands

The No Action Alternative contains Prime Farmland only if it is irrigated. Within the No Action Irrigated Lands, 64,200 acres could be converted from irrigated agriculture to dry land with the removal of irrigation. By not irrigating this land, between 1% and 10% of the total Prime Farmland in Larimer and Weld Counties would no longer be soils classified as Prime Farmland, which would be considered a moderate impact.

4.7.3 District's Preferred Alternative (Alternative 2)

4.7.3.1 Reservoir Sites

4.7.3.1.1 Glade Reservoir

Inundation by the 170,000 AF Glade Reservoir would permanently affect 540.9 acres of Prime Farmland and infrastructure for the reservoir site, including the dam and proposed roads, would permanently affect 24.2 acres of Prime Farmland. The reservoir site would permanently affect a total of 565.1 acres of Prime Farmland, or 0.3% of all Prime Farmland in Larimer County, which is a minor impact. 31.4 acres of Prime Farmland would be temporarily affected by construction of the reservoir and infrastructure.

Construction of Glade Reservoir under Alternative 2 for both the Reclamation Action Option and the No Reclamation Action Option would expose 65 acres of soils highly susceptible to water erosion and 1,300 acres highly susceptible to wind erosion until the reservoir was filled.

U.S. 287. The U.S. 287 realignment would have a minor impact on Prime Farmland with permanent effects on 30.4 acres, or 0.01% of all Prime Farmland in Larimer County. Construction of the U.S. 287 realignment would temporarily affect 15.4 acres of Prime Farmland.

4.7.3.1.2 Galeton Reservoir

Inundation by the 45,624 AF Galeton Reservoir would permanently affect 76.9 acres of Prime Farmland and infrastructure for the reservoir site, including the dam and forebay dikes and facilities, would permanently affect 12.8 acres of Prime Farmland. The reservoir site would permanently affect a total of 367.7 acres of Prime Farmland, or 0.01% of all Prime Farmland in Weld County, which is a minor impact. Construction of the reservoir and infrastructure would temporarily affect 16.2 acres of Prime Farmland.

Construction of Galeton Reservoir under Alternative 2 for both the Reclamation Action Option and the No Reclamation Action Option would expose 16 acres of soils highly susceptible to water erosion and 702 acres highly susceptible to wind erosion until the reservoir was filled.

4.7.3.2 Conveyance Systems

Conveyance systems, including pump stations and pipelines, would permanently affect 0.6 acre of Prime Farmland under the Reclamation Action Option and 0.5 acre of Prime Farmland under the No Reclamation Action Option, both of which are considered minor impacts. Construction

of the conveyance systems would temporarily affect 169.1 acres of Prime Farmland under the Reclamation Action Option and 206.2 acres of Prime Farmland under the No Reclamation Action Option.

The Alternative 2 Reclamation Action Option would have 46 acres of soils highly susceptible to water erosion and 346 acres of soils highly susceptible to wind erosion from temporary impacts along pipelines, access roads, and other temporary construction disturbances. The No Reclamation Action Option would have 67 acres of soils highly susceptible to water erosion and 421 acres highly susceptible to wind erosion from temporary impacts along pipelines, access roads, and other temporary construction disturbances.

4.7.3.3 Poudre River

Flow changes to the Poudre River would have no impact on Prime Farmland along the Poudre River under Alternative 2.

4.7.3.4 South Platte River

Flow changes to the South Platte River would have no impact on Prime Farmland along the South Platte River under Action Alternative 2.

4.7.4 Alternative 3

4.7.4.1 Reservoir Sites

4.7.4.1.1 Cactus Hill Reservoir

Inundation by the 190,000 AF Cactus Hill Reservoir would permanently affect 620.1 acres of Prime Farmland and infrastructure for the reservoir site, including the dam, proposed roads, and powerline poles, would permanently affect 81.7 acres of Prime Farmland. The reservoir site would permanently affect a total of 367.7 acres of Prime Farmland, or 0.09% of all Prime Farmland in Weld County, which is a minor impact. Construction of the reservoir and infrastructure would temporarily affect 34.0 acres of Prime Farmland and would expose 118 acres of soils highly susceptible to water erosion and 219 acres highly susceptible to wind erosion until the reservoir was filled.

4.7.4.1.2 Galeton Reservoir

Inundation by the Galeton Reservoir would permanently affect 76.9 acres of Prime Farmland and infrastructure for the reservoir site, including the dam and forebay dikes and facilities, would permanently affect 12.8 acres of Prime Farmland. The reservoir site would permanently affect a total of 367.7 acres of Prime Farmland, or 0.01% of all Prime Farmland in Weld County, which is a minor impact. Construction of the reservoir and infrastructure under Alternative 3 would temporarily affect 16.2 acres of Prime Farmland and would expose 16 acres of soils highly susceptible to water erosion and 702 acres highly susceptible to wind erosion until the reservoir was filled.

4.7.4.2 Conveyance Systems

Conveyance system pump stations would permanently affect 2.5 acres of Prime Farmland, which is considered a minor impact. Construction of the conveyance systems would temporarily affect 532.5 acres of Prime Farmland.

Under Alternative 3, 167 acres would be highly susceptible to water erosion and 398 acres would be highly susceptible to wind erosion from temporary impacts along pipelines, access roads, and other temporary construction disturbances.

4.7.4.3 Poudre River

Flow changes to the Poudre River would have no impact on Prime Farmland along the Poudre River under Alternative 3.

4.7.4.4 South Platte River

Flow changes to the South Platte River would have no impact on Prime Farmland along the South Platte River under Action Alternative 3.

4.7.5 Alternative 4

4.7.5.1 Reservoir Sites

4.7.5.1.1 Cactus Hill Reservoir

The Cactus Hill Reservoir site under Alternative 4 would have the same effect on Prime Farmland and soils highly susceptible to erosion as under Alternative 3.

4.7.5.1.2 Galeton Reservoir

The Galeton Reservoir site under Alternative 4 would have the same effect on Prime Farmland and soils highly susceptible to erosion as under Alternative 3.

4.7.5.2 Conveyance Systems

Conveyance system pump stations would permanently affect 3.0 acres of Prime Farmland, which is considered a minor impact. Construction of the conveyance systems would temporarily affect 573.5 acres of Prime Farmland.

Under Alternative 4, 173 acres would be highly susceptible to water erosion and 415 acres would be highly susceptible to wind erosion from temporary impacts along pipelines, access roads, and other temporary construction disturbances.

4.7.5.3 Poudre River

Flow changes to the Poudre River would have no impact on Prime Farmland along the Poudre River under Alternative 4.

4.7.5.4 South Platte River

Flow changes to the South Platte River would have no impact on Prime Farmland along the South Platte River under Action Alternative 4.

4.7.6 Unavoidable Adverse Impacts

All alternatives would result in unavoidable adverse impacts on Prime Farmland from the construction of reservoirs, dams, and infrastructure.

In all alternatives, some loss of soil material from wind and water erosion would be likely during construction and until disturbed areas are revegetated. Best Management Practices would be implemented to minimize soil loss. Operation of the reservoirs would result in shoreline erosion associated with fluctuating water levels.

4.7.7 Impact Summary

Table 4-55 below shows the permanent effects in acres on Prime Farmland by the components of each Alternative. The permanent effects on Prime Farmland would be greatest for the No Action Alternative because irrigation would be removed from 64,200 acres of irrigated land. While the total acreage cannot be determined because the exact location of the dry up is not known, it is likely that more than 9,447 acres (or 1% of the total acres of Prime Farmland in Larimer and Weld Counties) of Prime Farmland would be lost, which would be considered a moderate impact. The loss could be substantially higher. The level of permanent impacts to Prime Farmlands for all action alternatives would be minor, considering the impacts would be less than 1% of all Prime Farmland in Larimer and Weld Counties. Alternatives 3 and 4 would have greater permanent effects on Prime Farmland than Alternative 2 because of the higher number of acres at Cactus Hill Reservoir compared to Glade Reservoir. The permanent effects on Prime Farmland for conveyance systems would be slightly more for the No Action Alternative. There would be no permanent effects on Prime Farmland due to flow changes in the Poudre and South Platte Rivers under all alternatives.

Table 4-56 presents the permanent effects determinations for impacts to Prime Farmland by Alternative and component.

Table 4-55. Prime Farmland permanent effects in acres.

Study Area	Alternative 1	Alternative 2 Reclamation Action Option	Alternative 2 No Reclamation Action Option	Alternative 3	Alternative 4
Glade Reservoir	NA	540.9	540.9	NA	NA
U.S. 287 Realignment	NA	30.4	30.4	NA	NA
Glade Infrastructure	NA	24.2	24.2	NA	NA
Galeton Reservoir	NA	76.9	76.9	76.9	76.9
Galeton Infrastructure	NA	12.8	12.8	12.8	12.8
Cactus Hill Reservoir	313.5	NA	NA	620.1	620.1
Cactus Hill Infrastructure	54.2	NA	NA	81.7	81.7
Conveyance Systems	9.4	0.6	0.5	2.5	3.0
Poudre River	None	None	None	None	None
South Platte River	None	None	None	None	None
Total acres	**377.1[1]**	**685.8**	**685.7**	**794.0**	**794.5**

NA = Not a component of the alternative.
[1]Total does not include acreage potentially lost due to removal of irrigation from currently irrigated Prime Farmlands.

Table 4-56. Prime Farmland permanent effects determinations.

Study Area	Alternative 1	Alternative 2 Reclamation Action Option	Alternative 2 No Reclamation Action Option	Alternative 3	Alternative 4
Glade Reservoir	NA	Minor	Minor	NA	NA
U.S. 287 Realignment	NA	Minor	Minor	NA	NA
Glade Infrastructure	NA	Minor	Minor	NA	NA
Galeton Reservoir	NA	Minor	Minor	Minor	Minor
Galeton Infrastructure	NA	Minor	Minor	Minor	Minor
Cactus Hill Reservoir	Minor	NA	NA	Minor	Minor
Cactus Hill Infrastructure	Minor	NA	NA	Minor	Minor
Conveyance Systems	Minor	Minor	Minor	Minor	Minor
No Action Irrigated Lands	Moderate[1]	NA	NA	NA	NA
Poudre River	No effect	No effect	No effect	No effect	No effect
South Platte River	No effect	No effect	No effect	No effect	No effect

NA = Not a component of the alternative.
[1]Prime Farmland effects for the No Action Irrigated Lands is considered moderate (i.e., between 1% and 10% of the total Prime Farmland in Larimer and Weld Counties) because of the likelihood of being greater than 9,447 acres of impact. The exact acreage cannot be determined at this time because the exact location of dry up is not known.

Table 4-57 shows the temporary effects in acres on Prime Farmland by the components of each Alternative. The temporary effects on Prime Farmland would be greater for the No Action

Alternative and Alternatives 3 and 4 because more Prime Farmland occurs in those conveyance systems compared to Alternative 2.

Table 4-57. Prime Farmland temporary effects in acres.

Study Area	Alternative 1	Alternative 2 Reclamation Action Option	Alternative 2 No Reclamation Action Option	Alternative 3	Alternative 4
Glade Reservoir	NA	31.4	31.4	NA	NA
Galeton Reservoir	NA	16.2	16.2	16.2	16.2
Cactus Hill Reservoir[1]	85.6	NA	NA	34.0	34.0
U.S. 287 Realignment	NA	15.4	15.4	NA	NA
Conveyance Systems	558.6	169.1	206.2	532.5	573.5
Poudre River	None	None	None	None	None
South Platte River	None	None	None	None	None
Total acres	**644.2**	**232.1**	**269.2**	**582.7**	**623.7**

NA = Not a component of the alternative.
[1]The temporary effects on soils at Cactus Hill Reservoir would be greater for the No Action Alternative than for Alternatives 3 and 4 because the dam would be oriented differently creating more temporary impacts below the dam.

Table 4-58 shows the number of acres in each Alternative that are highly susceptibility to water and wind erosion. Generally, alternatives that would result in less surface disturbance would have a lower potential for soil erosion, such as the No Action Alternative, Alternative 3, and Alternative 4. The No Action Alternative would have the fewest number of acres with a high susceptibility to soil erosion. Alternative 2 No Reclamation Option would have the greatest number of acres with a high susceptibility to soil erosion.

Table 4-58. Areas of high susceptibility to soil erosion in acres.

Alternative	High Susceptibility To		Total
	Water Erosion	Wind Erosion	
Alternative 1 No Action	327	463	790
Alternative 2 Reclamation Action Option	126	2,348	2,474
Alternative 2 No Reclamation Action Option	148	2,423	2,571
Alternative 3	302	1,318	1,620
Alternative 4	307	1,336	1,643

4.8 VEGETATION

This section summarizes the predicted potential effect of the NISP alternatives on vegetation resources. No additional studies were conducted for vegetation resources for the SDEIS; however, new analysis based on updated information and revised study area boundaries was conducted and is presented. Revised information on wetlands and vegetation is presented in the 2015 Vegetation and Wetland Resources Supplement (ERO 2015b), which supplements the 2008 Vegetation Report (ERO 2008c). This section also addresses the effects the NISP alternatives would have on noxious weed distribution. Sensitive plant communities tracked by the Colorado Natural Heritage Program (CNHP) are discussed in this section but individual sensitive plant species are discussed in Section 4.11. Direct effects on wetlands, generally effects that would occur at construction sites due to ground disturbing activities or inundation at reservoir and forebay sites, are included in the total vegetation acreage impacts described in this section and summarized in Table 4-59. However, detailed descriptions of direct effects to wetlands for each alternative are contained in the Wetlands, Riparian Resources, and Other Waters section of this chapter (Section 4.9). Section 4.9 also includes wetland and riparian resources that would be indirectly affected by changes in streamflow on the Poudre and South Platte Rivers study areas and the lining of the Poudre Valley Canal.

Both permanent and temporary impacts to vegetation would occur. Permanent impacts include loss or permanent modification of vegetation communities due to replacement by NISP facilities and unvegetated areas. All alternatives would result in short-term or temporary impacts to vegetation from construction of reservoirs, dams, spillways, roads, pipeline installation, and other facilities. All areas with temporary impacts would be revegetated following construction according to reclamation plans approved by the Corps.

4.8.1 Methods

Methods used to assess vegetation resources are described in Section 4.10.1 of the DEIS and Section 4 of the 2008 Vegetation Report (ERO 2008c). Vegetation cover types and wetland data used for the 2008 Vegetation Report and the 2008 Wetland Report were used to determine effects based on new alternatives and study area boundaries. For newly proposed pipeline alignments, vegetation and wetland resources were mapped using remote sensing. For ditches, an average 2-foot-wide fringe of wetlands on both banks was assumed for the mapping, which is a typical width of wetland fringe along ditches in the Front Range based on past field observations and professional judgment. The effects on vegetation and wetlands were determined using geographic information systems (GIS) analysis with the SDEIS impact boundaries.

The inundation effects for reservoirs were estimated based on the normal high pool elevation and not the probable maximum flood (PMF). The PMF is the largest flood event that could conceivably occur at a particular location based on a probable maximum precipitation event, which is the most severe precipitation event that could occur over a drainage basin.

Vegetation and wetland effects, which could be either adverse or beneficial, are considered negligible, minor, moderate, or major. Negligible effects would be at the lowest levels of detection, barely measurable, with no perceptible consequences. Minor effects might result in a detectable change, but the change would be slight. Minor is used when the benefits or impacts would be short-term, occur at low levels, and/or are not likely to have a long-term noticeable effect on vegetation, including wetlands. Minor effects include temporary impacts during construction. Moderate effects would result in a clearly detectable change, with measureable effects. Moderate is used when beneficial or adverse effects would be noticeable, and the existing vegetation including wetlands would likely be replaced by a different vegetation type. Moderate also includes losses of low- or moderate-quality vegetation types, such as disturbed areas and introduced vegetation. Moderate effects typically are long-term. Major effects would result in readily apparent effects with substantial consequences. Major is used when impacts on large areas of native vegetation would occur. Major effects typically are long-term. The term no effect is used when there would be no changes from existing conditions.

4.8.2 No Action Alternative (Alternative 1)

4.8.2.1 Cactus Hill Reservoir Site

Most of the permanent vegetation effects would occur as a result of inundation at the Cactus Hill Reservoir site (ERO 2015b). The reservoir would permanently inundate 2,367.2 acres of vegetation. The reservoir dam, facilities, access road, and powerline realignment would permanently affect another 227.5 acres of vegetation, for a total permanent loss of 2,594.5 acres of vegetation. Most of the permanent effects are on Upland Mixed Grasslands (1,547.3 acres), Upland Native Grasslands (615.6 acres), and Agricultural Lands (238.6 acres). During construction of the reservoir, about 323.5 acres of vegetation resources would be temporarily affected. This vegetation would be cleared to create suitable areas for construction equipment and staging areas. Most of the temporary effect would be on Upland Mixed Grasslands (230.0 acres).

The combined permanent loss and temporary effect on vegetation at the Cactus Hill Reservoir site would be a major effect. Even though these vegetation types are common in the region, the magnitude of effect would be great.

No sensitive plant communities tracked by CNHP would be affected at the Cactus Hill Reservoir Site.

The existing cover of noxious weeds would decrease throughout the area of inundation for the reservoir but areas of temporary construction disturbance would be suitable for noxious weeds colonization. Species expected to colonize disturbed areas prior to reclamation, or if reclamation did not occur include Canada thistle, common mullein, cheatgrass, field bindweed, musk thistle, and bull thistle, and potentially other noxious weed species. Periods of prolonged low water levels at Cactus Hill Reservoir would allow for noxious weeds to colonize the drawdown area.

Typically, these are localized infestations of weeds, which would not spread further than the reservoir shorelines.

4.8.2.2 Conveyance Systems

Conveyance systems include the pipeline alignments, pump stations, and water treatment plants. Permanent effects from the conveyance systems (14.4 acres) would occur as the result of construction of pump stations and water treatment plants. Construction of the conveyance systems would temporarily affect 780.4 acres of vegetation resources (ERO 2015b). The conveyance systems would result in a minor effect on vegetation because most of the effects are temporary and permanent effects occur at a low level.

The CNHP tracks the Shortgrass Prairie community as State Imperiled (provisionally ranked as S2 pending further documentation by CNHP). This community may occur along some of the pipeline alignments. The CNHP does not have any element occurrences of this community within any of the proposed pipeline alignments, but surveys would be conducted prior to final design so that potential effects are avoided.

The 780.4 acres that would be temporarily disturbed by conveyance systems would be suitable habitat for the colonization of noxious weeds. Species such as Canada thistle, common mullein, cheatgrass, bindweed, musk thistle, redstem filaree, and diffuse knapweed would be expected to readily colonize newly disturbed areas prior to reclamation, or if reclamation did not occur.

4.8.2.3 No Action Irrigated Lands

The removal of irrigation would affect about 64,200 acres of Agricultural Lands, which would likely be converted to uplands with a mix of species. The removal of irrigation would have an indirect effect on wetlands supported by irrigation that is addressed in Section 4.9. The removal of irrigation from the 64,200 acres has the potential to substantially increase the distribution and cover of noxious weeds depending on how the lands would be managed and how weeds would be controlled following the removal of irrigation. Canada thistle, bull thistles, common mullein, common teasel, knapweed, field bindweed, hoary cress, and several others would be expected to colonize areas that would be dried up. The removal of irrigation and conversion of up to 64,200 acres of irrigated crop land to dry uplands would be a major effect on Agricultural Lands due to the magnitude of resource change.

4.8.3 District's Preferred Alternative (Alternative 2)

4.8.3.1 Reservoir Sites

4.8.3.1.1 Glade Reservoir

The permanent and temporary effects on vegetation at Glade Reservoir and the U.S. 287 realignment study areas are the same under the Reclamation Action and No Reclamation Action Options (Reclamation Options). The reservoir would permanently inundate 1,581.3 acres of

vegetation and permanently affect 207.0 acres from construction of the forebay, dam, access roads, spillway and other facilities. The greatest effects would be on Upland Native Grasslands (829.8 acres), Upland Native Shrublands (430.3 acres), and Agricultural Lands (162.4 acres) (ERO 2015b). The reservoir and dam would permanently affect 19.7 acres of Mesic Native Woodlands and 28.6 acres of Mesic Mixed Shrublands, vegetation types that are considered of moderate to high quality. At Glade Reservoir, 188.0 acres of Upland Native Shrublands that are CNHP-tracked Foothills Shrublands (S2S3) community would be permanently inundated. Construction of the Glade Reservoir, forebay, and access roads would temporarily affect 156.9 acres of vegetation with the greatest effects on Agricultural Lands and Upland Native Shrublands. These areas would be cleared of vegetation to create suitable areas for construction vehicles and staging areas.

U.S. 287. The realignment of U.S. 287 would result in the permanent loss of 144.4 acres and the temporary effect on 122.4 acres of vegetation. The greatest permanent loss would be to previously disturbed areas (45.9 acres of Revegetated Areas and 17.4 acres of Disturbed Areas) and on Upland Native Grasslands (47.0 acres).

The effects on vegetation from Glade Reservoir and U.S. 287 realignment are considered major because of the magnitude of permanent loss.

Noxious weeds would be expected to colonize the 279.3 acres of temporarily disturbed areas from the construction of Glade Reservoir and U.S. 287 realignment. Noxious weed cover in the reservoir area would be inundated and reduced. Species that would be likely to colonize the newly disturbed sites prior to reclamation, or if reclamation did not occur include Canada thistle, bull, thistle, common mullein, teasel, Dalmatian toadflax, cheatgrass, field bindweed, musk thistle, and redstem filaree. Periods of prolonged low water levels at Galeton Reservoir would allow for noxious weeds to colonize the drawdown area. Typically, these are localized infestations of weeds, which would not spread further than the reservoir shorelines.

4.8.3.1.2 Galeton Reservoir

Effects on vegetation at the Galeton Reservoir site would be the same for both Reclamation Options. Galeton Reservoir and forebay would permanently inundate 1,852.1 acres of vegetation with the greatest effect on Upland Native Grassland (1,373.0 acres). The Galeton Reservoir Dam, forebay and other facilities would permanently affect 96.8 acres of vegetation. Activities associated with constructing the Galeton Reservoir Dam, forebay, and access roads would temporarily affect 155.8 acres of vegetation, with most of the effects on Upland Mixed Grasslands (97.2 acres), Upland Introduced Grasslands (31.0 acres), and Agricultural Lands (20.9 acres). The permanent and temporary effects on vegetation at Galeton Reservoir would be major because of the magnitude of long-term effect on native grasslands and other vegetation types. If the probable maximum flood were to occur at Galeton Reservoir, a portion of the Pawnee National Grasslands would be temporarily inundated. In the unlikely event that a probable maximum flood event occurs in the future, it would result in a negligible effect on the Pawnee National Grasslands because no permanent loss of vegetation would be expected since floodwaters would recede after the event.

No sensitive plant communities tracked by the CNHP would be affected at the Galeton Reservoir site.

Noxious weeds would be reduced in the area inundated by the reservoir but could colonize the 155.8 acres of temporarily affected area. Species that would be likely to colonize the newly disturbed sites prior to reclamation, or if reclamation did not occur include Canada thistle, bull, thistle, common mullein, teasel, cheatgrass, field bindweed, musk thistle, and redstem filaree. Periods of prolonged low water levels at Galeton Reservoir would allow for noxious weeds to colonize the drawdown area. Typically, these are localized infestations of weeds, which would not spread further than the reservoir shorelines.

4.8.3.2 Conveyance Systems

The vegetation effects for the Reclamation Action Option and No Reclamation Action Option are different for the conveyance systems because of the additional pipeline length for the Carter Pipeline in the No Reclamation Action Option. Conveyance systems include the pipeline alignments and pump stations. Under the Reclamation Action Option, permanent effects on vegetation from pump stations and pipelines would be 1.1 acres, with 1.6 acres affected under the No Reclamation Action Option. The conveyance systems would temporarily affect 278.9 acres of vegetation resources under the Reclamation Action Option and 434.2 acres under the No Reclamation Action Option (ERO 2015b). The conveyance systems would result in a minor effect on vegetation because most of the effects would be temporary and permanent effects would occur at a low level.

The areas temporarily disturbed by conveyance systems would be suitable habitat for the colonization of noxious weeds. The potential for weed colonization is greater for the No Reclamation Action Option because of the greater temporary disturbance.

The CNHP-tracked Xeric Tallgrass Prairie community (S2) is reported to occur near the Carter Pipeline; however, the presence of this community type could not be verified during field investigations for the DEIS because of lack of access to the Carter Pipeline study area due to private property ownership. Surveys would be conducted prior to final design. The CNHP-tracked Shortgrass Prairie (provisionally ranked as S2 pending further documentation by CNHP) may occur along some of the pipeline alignments. The CNHP does not have any element occurrences of this community within any of the pipeline alignments, but surveys would be conducted prior to final design so that potential effects would be avoided.

4.8.3.2.1 Poudre Valley Canal

Under both Reclamation Options the existing Poudre Valley Canal would be lined from the outtake on the Poudre River to Glade Reservoir, a distance of about 2.5 miles, which would permanently affect 12.2 acres of upland vegetation. The permanent effects would occur within a 30-foot-wide buffer of the canal and may be reduced during final design. Areas outside of the canal would likely be revegetated with grasses. An estimated 5.5 acres of the Poudre Valley Canal would be affected by the lining. The effects on vegetation from lining this reach of the

Poudre Valley Canal would be minor because the areas would likely be revegetated. Indirect effects on wetlands from the lining of the Poudre Valley Canal are discussed in Section 4.9.

4.8.3.2.2 Munroe Canal

Construction of Glade Reservoir would require relocation of a portion of the existing Munroe Canal. The relocation of the Munroe Canal would permanently affect 28.8 acres of upland vegetation under the Reclamation Action Option and 19.1 acres of vegetation under the No Reclamation Action Option.

4.8.4 Alternative 3

4.8.4.1 Reservoir Sites

4.8.4.1.1 Cactus Hill Reservoir

The permanent effects on vegetation at Cactus Hill Reservoir are greater under Alternative 3 than under the No Action Alternative because of the larger reservoir size (190,000 AF vs. 120,000 AF). Most of the permanent vegetation effects (3,866.1 acres) would occur as a result of inundation at the Cactus Hill Reservoir site (ERO 2015b). Another 308.3 acres of vegetation would be permanently affected by the reservoir dam, facilities, access road, and powerline realignment. During construction of the reservoir, about 189.7 acres of vegetation resources would be temporarily affected. The greatest effects would be on Upland Mixed Grasslands (1,960.8 acres), Upland Native Grasslands (815.9 acres), and Agricultural Lands (509.2 acres) (ERO 2015b). The reservoir and dam would permanently affect 4.8 acres of Mesic Mixed Woodlands that are considered of moderate quality. Temporary effects at Cactus Hill Reservoir would occur within a 250 feet disturbance boundary south of the dam from access roads and the Cactus Hill inlet pipeline and pump station and would temporarily affect 189.7 acres of vegetation, with the greatest effects on Upland Mixed Grasslands and Agricultural Lands.

The permanent loss of 3,557.8 acres and temporary effect on 189.7 acres of vegetation at the Cactus Hill Reservoir would be a major effect. Even though these vegetation types are common in the region, the magnitude of effect is great.

The effects on sensitive plant communities under Alternative 3 are the same as those described for the No Action Alternative in Section 4.8.2.1. The cover of noxious weeds would decrease throughout the area of inundation for the reservoir but areas of temporary construction disturbance would be suitable for noxious weeds colonization. Species that would be likely to colonize the newly disturbed sites prior to reclamation, or if reclamation did not occur include Canada thistle, bull, thistle, common mullein, teasel, cheatgrass, field bindweed, musk thistle, and redstem filaree. Periods of prolonged low water levels at Cactus Hill Reservoir would allow for noxious weeds to colonize the drawdown area. Typically, these are localized infestations of weeds, which would not spread further than the reservoir shorelines.

4.8.4.1.2 Galeton Reservoir

The effects on vegetation at the Galeton Reservoir site would be the same as Alternative 2 described in Section 4.8.3.1.2.

4.8.4.2 Conveyance Systems

Permanent effects on vegetation from constructing the conveyance systems (2.5 acres) would occur as the result of construction of pump stations associated with the pipelines. The conveyance systems would temporarily affect 913.7 acres of vegetation (ERO 2015b). The effects of the conveyance systems would be a minor effect on vegetation because most of the effects would be temporary and permanent effects would occur at a low level.

The 913.7 acres that would be temporarily disturbed by conveyance systems would be suitable habitat for the colonization of noxious weeds. Species that would be likely to colonize the newly disturbed sites prior to reclamation, or if reclamation did not occur include Canada thistle, bull, thistle, common mullein, teasel, cheatgrass, field bindweed, musk thistle, and redstem filaree.

The CNHP-tracked Shortgrass Prairie (provisionally ranked as S2 pending further documentation by CNHP) may occur along some of the pipeline alignments. The CNHP does not have any element occurrences of this community within any of the pipeline alignments, but surveys would be conducted prior to final design so that potential effects are avoided.

4.8.4.2.1 Poudre Valley Canal

The existing Poudre Valley Canal would be lined from the outtake from the Poudre River to the Cactus Hill Reservoir, a distance of about 24 miles. The permanent effects on vegetation were estimated within a 30-foot buffer of the canal and may be reduced during final design. About 88.4 acres of vegetation could be affected by construction activities needed to line the canal within the 30-foot buffer. Most effects would be on Upland Mixed Grasslands and Agricultural Lands. Areas affected by construction would likely be revegetated with native grasses and the estimate of permanent loss is conservative. An estimated 84.7 acres of the existing Poudre Valley Canal would be affected by the lining. Indirect effects on wetlands from the lining of the Poudre Valley Canal are discussed in Section 4.9.

4.8.5 Alternative 4

4.8.5.1 Reservoir Sites

4.8.5.1.1 Cactus Hill Reservoir

The effects on vegetation at the Cactus Hill Reservoir site would be the same as Alternative 3 described in Section 4.8.4.1.

4.8.5.1.2 Galeton Reservoir

The effects on vegetation at the Galeton Reservoir site would be the same as Alternative 2 described in Section 4.8.3.1.2.

4.8.5.2 Conveyance Systems

The permanent effects on vegetation for Alternatives 3 and 4 would be similar. Because Alternative 4 has the New Cache to Cactus Hill Pipeline, which does not occur in Alternative 3, it would have additional temporary effects from pipeline construction and require an additional

pump station, resulting in 0.5 acre of additional permanent effects on vegetation for a total of 3.0 acre of impacts on vegetation. Alternative 4 would have 973.7 acres of temporary effects on vegetation from construction of the pipelines and pump stations. The combined permanent and temporary effect would be minor because most areas would be revegetated and effects would be short-term.

The effects on vegetation from lining the existing Poudre Valley Canal would be the same as for Alternative 3 described in Section 4.8.4.2.1.

The CNHP-tracked Shortgrass Prairie (CNHP-tracked as State Imperiled – provisionally ranked as S2 pending further documentation by CNHP) may occur along some of the pipeline alignments. The CNHP does not have any element occurrences of this community within any of the pipeline alignments, but surveys would be conducted prior to final design so that effects are avoided.

4.8.6 Unavoidable Adverse Impacts

All alternatives would cause unavoidable adverse impacts on vegetation resources from inundation by reservoirs and other permanent and temporary losses of vegetation. Alternative 2 would also cause the unavoidable loss of 188.0 acres of the CNHP-ranked S2S3 Foothills Shrubland community that occurs in the Glade Reservoir study area. Even if revegetated, the post-disturbance communities would be different following construction completion. The NISP alternatives would unavoidably create favorable conditions for the establishment of noxious weeds as a result of construction and reservoir water elevation fluctuations.

4.8.7 Impact Summary

All alternatives would have major effects on vegetation because of the total permanent loss of vegetation from inundation of reservoirs and other project components (Table 4-60). No Action Alternative would have the least permanent loss from reservoirs because only one reservoir would be constructed instead of two as in Alternatives 2, 3, and 4, but the dry up of irrigated lands would result in a greater effect on vegetation than the additional reservoir in the action alternatives. Alternative 2 would cause the loss of 188.0 acres of the CNHP-ranked S2S3 Foothills Shrubland community that occurs in the Glade Reservoir study area. Alternative 2 would also have the greatest effect on Mesic Mixed Shrublands and Mesic Mixed Woodlands, both of moderate to high quality habitat types. Other CNHP-ranked vegetation communities possibly associated with conveyance systems would be avoided during final design and after surveys confirm their location. Alternatives 3 and 4 have similar overall effects on vegetation and impact more acres of vegetation compared to Alternative 2 and the No Action Alternative (Table 4-59).

Table 4-59. Direct effects on vegetation cover types, other land use types, wetlands, and other waters by alternative.

Vegetation Type	Habitat Quality[1]	Alternative 1		Alternative 2 Reclamation Action		Alternative 2 No Reclamation Action		Alternative 3		Alternative 4	
		Permanent[2] (acre)	Temporary[3] (acre)	Permanent[2] (acre)	Temporary[3] (acre)	Permanent[2] (acre)	Temporary[3] (acre)	Permanent[2] (acre)	Temporary[3] (acre)	Permanent[2] (acre)	Temporary[3] (acre)
Upland Native Grasslands	Moderate	615.6	60.1	2,276.1	68.0	2,276.1	110.2	2,225.6	30.1	2,225.6	30.1
Upland Mixed Grasslands	Low	1,547.8	252.4	248.5	194.0	248.5	211.2	2,452.1	307.7	2,452.6	322.0
Upland Introduced Grasslands	Low	0.0	0.0	125.0	32.3	125.0	52.5	122.8	31.0	122.8	31.0
Mesic Native Grasslands	Moderate	0.6	11.2	55.3	5.5	55.3	5.5	16.3	7.3	16.3	7.3
Mesic Mixed Grasslands	Low	125.8	8.1	219.3	8.1	219.3	8.1	307.7	14.8	307.7	15.4
Upland Native Shrublands	Moderate	0.0	0.0	453.1	73.4	453.6	90.6	0.2	4.1	0.2	4.1
Mesic Native Shrublands	Moderate to high	0.0	0.3	28.6	0.0	28.6	0.0	0.1	0.7	0.1	0.7
Mesic Mixed Shrublands	Moderate	0.0	1.2	55.7	0.0	55.7	0.0	0.0	0.2	0.0	0.2
Upland Native Woodlands	Moderate to high	0.0	0.0	0.5	0.3	0.5	1.2	0.0	0.0	0.0	0.0
Mesic Mixed Woodlands	Moderate to high	4.2	13.8	28.2	8.4	28.2	8.9	16.3	15.0	16.3	15.0
Agricultural Lands	Low	251.1	503.2	238.2	262.0	238.2	280.4	649.6	623.0	649.6	655.9
Revegetated Areas	Low	0.0	0.0	45.9	72.0	45.9	72.0	0.3	0.0	0.3	0.0
Disturbed Areas	Low	31.1	13.3	76.1	6.8	76.1	3.7	77.5	5.4	77.5	7.0
Landscaped Areas	Low to moderate	1.0	224.1	0.0	4.0	0.0	34.0	4.1	201.2	4.1	211.7
Palustrine Emergent Wetlands	Moderate to high	31.8	13.9	44.1	7.6	44.1	8.5	33.6	15.4	33.6	15.5
Palustrine Scrub-Shrub Wetlands	Moderate to high	0	2.3	0.3	0.5	0.3	1.7	0.1	3.2	0.1	3.2
Total Direct Effects on Vegetation		**2,609.0**	**1,103.9**	**3,894.9**	**742.9**	**3,895.4**	**888.5**	**5,906.3**	**1,259.1**	**5,906.8**	**1,319.1**

[1]Habitat quality is based on ERO field reviews for habitats within the NISP study areas for the 2008 Vegetation Report and is based on best professional judgment.

[2]Permanent effects include reservoir and dam footprints, forebays, pump stations, associated facilities, pipeline connections to the reservoir, and realigned roads.

[3]Temporary effects are from the removal of vegetation around the dam, reservoirs, pump stations, realigned roads, and other facilities; access roads; borrow areas; staging areas; and pipelines that would be restored following construction. Grasslands and wetlands would take 1 to 5 years to become well established; shrublands and woodlands would likely take greater than 5 years to become well established.

Table 4-60. Vegetation direct effects determination.

Study Area	Alternative 1	Alternative 2 Reclamation Action Option	Alternative 2 No Reclamation Action Option	Alternative 3	Alternative 4
Glade Reservoir	NA	Major	Major	NA	NA
U.S. 287	NA	Major	Major	NA	NA
Galeton Reservoir	NA	Major	Major	Major	Major
Cactus Hill Reservoir	Major	NA	NA	Major	Major
Conveyance Systems	Minor	Minor	Minor	Minor	Minor
No Action Irrigated Lands	Major	NA	NA	NA	NA
Poudre Valley Canal	No effect	Minor	Minor	Major	Major
Poudre River	No effect	No effect	No effect	No effect	No effect
South Platte River	No effect	No effect	No effect	No effect	No effect

NA = Not a component of the alternative.

4.9 WETLANDS, RIPARIAN RESOURCES, AND OTHER WATERS

4.9.1 Overview

This section summarizes the predicted effects of the NISP alternatives on wetland and riparian resources. The alternatives have the potential to directly affect wetland and riparian resources through the construction of facilities and inundation associated with reservoirs and indirectly by changing flows associated with diversions and exchanges on the Poudre and South Platte Rivers, the transfer of water from irrigated lands, and lining of the Poudre Valley Canal. Comments on the DEIS expressed concern that predicted changes in flows on the Poudre River associated with the NISP alternatives would affect riparian and wetland resources, particularly the cottonwood woodlands along the Poudre River mainstem by reduced inundation and/or declines in alluvial ground water levels. Studies for the SDEIS collected data on river stage, ground water, and inundation at the Poudre River study sites to determine the potential for predicted changes in Poudre River flows to affect wetland and riparian resources, particularly cottonwood woodlands. The indirect effects assessment in this section focuses on cottonwood woodlands and cottonwood recruitment along the mainstem because this was the topic of many comments on the NISP DEIS and because recruitment is an important variable in determining the long-term viability and composition of the woody riparian community along the mainstem. Section 3.9 describes these studies. Additional detail on the studies and effects assessment can be found in the 2012 Wetlands and Riparian Resources Baseline Report (ERO 2012d) and the 2014 Wetlands and Riparian Resources Effects Report (ERO 2014d).

4.9.1.1 Resource Trajectory

To understand the future predicted effects attributable to the alternatives, one must understand changes that are currently occurring in the resource that will be manifested in the future with or without the alternatives (i.e., the resource trajectory). This is particularly important for a resource such as woody vegetation that can change gradually over many years. In overview, the trajectory of the Poudre River mainstem is expected to continue under Current Conditions hydrology as the result of ongoing channel contraction, fining of surficial material, and loss of channel complexity. These predicted changes in river condition are a fluvial response to historical and contemporary physical and hydrologic changes to the river, floodplain, and watershed (Section 4.4). Similarly, the trajectory of the wetland and riparian resources along the mainstem has been affected by historical and contemporary physical and hydrologic changes that have established a trajectory that is expected to continue under Current Conditions hydrology.

The 2012 Wetlands and Riparian Resources Baseline Report (ERO 2012d) suggests that the plains cottonwood woodlands along the mainstem are not self-sustaining and are likely to not be a dominant component of the future riparian woodland composition along the mainstem. The dominant older plains cottonwood woodlands represent relict conditions (of a less confined river)

while the increasing frequency of green ash and Siberian elm suggests the forest may be transforming to a new forest composition altogether (Shanahan 2011).

The combination of flood flows that are no longer effective in establishing large new stands of plains cottonwoods, extensive stands of smooth brome and reed canarygrass that compete with cottonwood seedlings, and nonnative woody vegetation that is establishing at rates equal to or greater than plains cottonwoods establish a trajectory for a future mainstem riparian corridor that will likely be very different from the past and current riparian corridor. As the stands of plains cottonwoods mature and die, they will not likely be readily replaced at current densities and distribution, and the woody vegetation that replaces the plains cottonwoods will likely be a mix of cottonwoods and nonnative woody vegetation (e.g., green ash).

This predicted trajectory for the plains cottonwood woodland may not be the same for the upper portions of the mainstem that are dominated by narrowleaf cottonwood. Once established, narrowleaf cottonwood (unlike plains cottonwood) can spread extensively by establishing new shoots from its root system.

The following changes in the distribution and composition of the wetland and riparian communities associated with the mainstem are likely to occur in the future, with or without implementation of any of the NISP alternatives:

- The recruitment of plains cottonwoods will not keep pace with the maturation and decline of existing plains cottonwood stands along the mainstem.
- Nonnative woody vegetation (e.g., green ash, box elder, Russian olive, and Siberian elm) will increase in composition and distribution in the plant communities along the mainstem. In the future, plains cottonwoods will likely not dominate the riparian woodlands along the mainstem.
- Where currently established, narrowleaf cottonwoods may expand along the mainstem due to less competition from plains cottonwoods and the ability of narrowleaf cottonwoods to spread rhizomateously once established.
- The wetland and riparian plant communities along the mainstem will likely gradually shift to plant communities with species adapted to a drier environment and less tolerant of or dependent on flooding or shallow ground water levels.
- Reed canarygrass will likely continue to colonize areas of the formerly active channel downstream of I-25 as the channel in this portion of the river continues to aggrade and narrow with accumulated sediment.

The exception to this trajectory is stands of young plains cottonwoods that establish along the shores of ponds along the mainstem. The shorelines of these ponds provide suitable conditions for the establishment of extensive plains cottonwood stands.

4.9.2 Methods

Two levels of impact assessment were performed: 1) direct effects (effects associated with construction and inundation) and 2) indirect effects (effects associated with changes in

streamflows, the transfer of irrigation water, and lining the Poudre Valley Canal). For the assessment of direct effects, the proposed facilities (e.g., dams, reservoirs, roads, and pipelines) for each alternative were compared with the mapping of wetland and riparian resources. The high water elevation of each proposed reservoir was used to estimate impacts associated with inundation.

Effects to wetlands, riparian areas, and other waters, were determined to be negligible, minor, moderate, or major. Negligible effects were predicted to be at the lowest levels of detection, barely measurable, with no perceptible consequences. Minor effects might result in a detectable change, but the change would be slight. Minor is used when the benefits or impacts would be short-term, occur at low levels, and/or are not likely to have a long-term noticeable effect on wetlands, riparian areas, and other waters. Minor effects include temporary impacts during construction. Moderate effects would result in a clearly detectable change, with measureable effects. Moderate is used when beneficial or adverse effects would be noticeable, and the existing wetlands, riparian resources, or other waters would likely be lost. Moderate effects typically are long-term. Major effects would result in readily apparent effects with substantial consequences. Major is used when permanent impacts on large areas (greater than 10 acres) of wetlands, riparian areas, or other waters would occur. The term no impact is used when there are no expected changes from existing conditions.

For the assessment of indirect effects, first the trajectory of the riparian and wetland resources along the Poudre River was estimated to determine context for how changes in streamflow would potentially affect the future of the resources. The trajectory was determined by collecting and analyzing data on vegetation communities, nonnative species, and the recruitment and size distribution of woody vegetation at the six Poudre River study sites (Section 3.9.5.2). The assessment of indirect effects focused on changes in the frequency of inundation and changes in ground water levels of wetland and riparian resources along the Poudre River and post-flood reviews of these resources. The analyses that form the basis of the indirect effects assessment are:

- Poudre River riparian and wetland vegetation mapping
- Poudre River study site vegetation mapping
- Vegetation trends (nonnative species, recruitment of woody vegetation, and size class distribution of woody vegetation)
- Historical trends in riparian resources
- Wetland functional assessment
- Alluvial ground water levels
- Water sources other than the Poudre River
- Inundation of riparian and wetland resources
- Post-flood reviews (2012, 2011, and 2013)

Changes in river flows were predicted using the CTP hydrology modeling by comparing various model runs (Current Conditions hydrology compared to the NISP action alternatives with

Current Conditions hydrology). Information on the CTP model can be found in the 2013 Hydrologic Modeling Report (CDM Smith and DiNatale 2013).

4.9.2.1 Impact Thresholds

4.9.2.1.1 Poudre River Stage

Predicted changes to river stage were derived from site-specific relationships to river flow. Impact thresholds were established for each of the indirect effects assessments. Changes in river stage were used to estimate effects on herbaceous wetland vegetation along the banks of the mainstem. The weekly average river stage was predicted for each of the action alternatives at each of the Poudre River study sites. Appendix A of the 2014 Wetland and Riparian Resources Effects Report provides a listing of these river stages.

These weekly average river stages were reviewed for changes in river stage of 0.5 foot or greater during the growing season. For the purposes of this review, the growing season was defined as May 1 through September 30. A threshold of 0.5-foot decline in river stage was used to determine potential effects on herbaceous and shrub wetlands. Herbaceous wetlands are potentially the most sensitive communities to declines in alluvial ground water levels. The Corps' technical standard for wetland hydrology is that the wetland site is inundated (flooded or ponded) or the water table is 12 inches or less below the soil surface for 14 or more consecutive days during the growing season at a minimum frequency of 5 years in 10 (50% or higher probability) (Corps 2005). Assuming an average midpoint of 0.5 foot for ground water levels for wetlands, a decline of less than 0.5 foot in ground water levels would still meet the threshold for wetland hydrology. It was assumed that there would be a direct relationship between a change in river stage (elevation) and alluvial ground water levels for wetland and riparian communities bordering the mainstem.

All Poudre River study sites are predicted to have at least 2 consecutive weeks of stage change of 0.5 foot or less during the growing season under all alternatives and often multiple weeks of no stage change, indicating that wetland hydrology per the Corps' technical standard would be maintained for existing wetlands under all alternatives. Despite all sites retaining wetland hydrology, prolonged stage declines (>4 weeks) of 0.5 foot or greater were reviewed to assess the potential for adverse effects on wetland and riparian vegetation. The review of weekly average stage data for each alternative focused on:

- Number of years in the period of record where weekly average river stages during the growing season declined by 0.5 foot or greater for at least 4 consecutive weeks and/or 6 weeks total (i.e., not consecutive)
- Number of weeks for the period of record where weekly average river stages during the growing season declined by 0.5 foot or greater; there are 546 weeks in the period of record that occur between May 1 and September 30
- Percentage of weeks for the period of record where weekly average river stages during the growing season declined by 0.5 foot or greater

Prolonged declines of 4 consecutive weeks or more could potentially stress shallowly rooted vegetation associated with shallow ground water levels such as is found in wetlands that occur near the banks of the Poudre River. A decline of 6 weeks over the 22-week growing season could also stress wetland vegetation. Declines of 0.5 foot or greater for more than 10% of the period of record were used to identify alternatives and river segments as areas of greater potential for impacts associated with river stage declines. At 10% or less, the effect would be negligible because 10% represents an average of 2 weeks during each year of the growing season and the Corps' technical standard for wetland hydrology is that the wetland site is inundated (flooded or ponded) or the water table is 12 inches or less below the soil surface for 14 or more consecutive days during the growing season (Corps 2005). A stage decline of 2 weeks and corresponding water table decline would not result in measurable effects on herbaceous or shrub wetlands. Nineteen percent or higher represents an average of about 4 weeks of the growing season, which was identified as the impact threshold to determine a year with substantial declines. Shallowly rooted vegetation could be affected by 4 weeks of water table declines, but most of the effects would be in the form of temporary water stress of plants. Many types of wetlands in the West experience periods of drought and water stress each growing season but are resilient when supportive hydrologic conditions return.

Stage declines of this magnitude during the growing season are predicted to result in a shift in species at wetlands dominated by obligate wetland species (i.e., cattail and threesquare bulrush) to those that tolerate greater fluctuations in river stage such as reed canarygrass. Since most wetlands along the banks of the mainstem are dominated by reed canarygrass and sandbar willow, two species that can tolerate a range of ground water levels, effects are predicted to be minor and likely not perceptible along Segment B. Ground water and river stage relationships were used to predict changes in ground water levels. The relationship between river stage and ground water levels diminishes with distance from the river (ERO 2012b). Based on these ground water and river stage relationships, the 2014 Wetlands and Riparian Resources Effects Report describes why riparian and wetland vegetation within 0 to 100 feet of the river is potentially more vulnerable to reductions in river stage associated with operations that result in declines in ground water levels during the growing season.

4.9.2.1.2 Alluvial Ground Water

Information on ground water is presented in Section 4.5. The annual floodplain water table low, a critical elevation for cottonwood trees which is often controlled by mid- to late-summer river base flow stage elevation (Cooper et al. 2003), was assessed to determine potential impacts to cottonwood woodlands. Predicted changes in ground water levels were compared with the observed annual water table low during the growing season. The maximum predicted stage change/ground water levels were used to assess potential effects on cottonwood woodlands. Declines in river stage of 2 feet or greater during the growing season would occur infrequently (0% to 3% of the period of record) and typically would be short lived (i.e., most of these declines would occur for less than 4 consecutive weeks). These relatively large (2 feet to 5.28 feet) but infrequent declines in river stage were evaluated to determine their potential effect on alluvial ground water levels that provide hydrological support for riparian cottonwood woodlands along the mainstem.

4.9.2.1.3 Inundation

The assessment of effects associated with predicted changes in inundation focused on cottonwood woodlands. A total of 49 points (elevations), distributed across 13 riparian vegetation transects at the 6 study sites were evaluated for the Current Conditions modeled flow compared with the modeled flow for each alternative at which the point first became inundated, the number of times (spells or frequency) the point was inundated for the period of record, and the duration of that inundation. The analysis points were selected to represent key elevations (low points and high points), vegetation cover types, and a variety of distances from the river within the riparian zone. Cross sections of these locations are presented in Appendix A of the 2014 Wetland and Riparian Resources Effects Report (ERO 2014d). The majority of the points evaluated were located in riparian woodland vegetation cover types dominated by plains cottonwoods because this is the most common riparian woodland along the mainstem.

For the purposes of the effects analysis, cottonwood woodland sites predicted to be inundated in at least 13 years (half of the years of the period of record) under Current Conditions were assumed to receive some amount of hydrological support from inundation based on the Corps' technical standard for wetland hydrology that the site is inundated (flooded or ponded) or the water table is 12 inches or less below the soil surface for 14 or more consecutive days during the growing season at a minimum frequency of 5 years in 10 (>50% probability) (Corps 2005).

4.9.2.1.4 Wetland Functions

The wetland functional assessment performed for the DEIS was replaced using the Functional Assessment of Colorado Wetlands (FACWet) method that was adopted by the Corps' Denver Regulatory Office as the standard for wetland functional assessment subsequent to the DEIS. The effects on functions of wetlands at the Poudre River study sites were assessed based on the changes to the scores for Current Conditions (Section 3.9.1.1) compared with the predicted effects of the NISP alternatives on water source, water distribution, water outflow, geomorphology, and water and soil chemical environment. The functions of wetlands were determined based on the number of outside stressors that affect the normal functioning of a wetland based on the nine fundamental variables following Johnson et al. (2010).

From the variable scores, functional capacity indices are calculated, which relate the variable scores to the following seven key functions performed by wetlands:

- Support of characteristic wildlife habitat
- Support of characteristic fish/aquatic habitat
- Flood attenuation
- Short- and long-term water storage
- Nutrient/toxicant removal
- Sediment retention/shoreline stabilization
- Production export and food chain support

Once the functional capacity indices for the above functions were determined, a composite functional capacity index score was derived by totaling the functional capacity indices of the functions and dividing by the number of functions scored.

4.9.3 No Action Alternative (Alternative 1)

A total of 250.6 acres of wetlands would be lost, and 16.2 acres of wetlands would be temporarily affected by the No Action Alternative associated with the transfer of irrigation from agricultural lands and construction of Cactus Hill Reservoir, associated facilities, and conveyance systems (Table 4-61). The 2014 Vegetation and Wetlands Resources Report lists in detail effects by wetland and water type and alternative facility. A total of 4.2 acres of riparian woodland vegetation would be permanently impacted and a total of 15.3 acres of riparian woodland and shrubland vegetation would be temporarily impacted by the construction of the No Action Alternative. More detail on the effects of the No Action Alternative on vegetation cover types for each alternative component is in Section 6.0 of the 2015 Vegetation and Wetland Resources Supplement.

Table 4-61. Estimated effects on wetlands and other waters for the No Action Alternative.

Feature/Action	Wetlands		Waters[1]	
	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)
Direct Effects				
Cactus Hill Reservoir	31.8	11.2	6.4	1.5
Conveyance Systems	0.0	5.0	0.1	15.8
Indirect Effects				
Removal of Irrigation from Agricultural Lands	218.6	0.0	0.0	0.0
Total	**250.6**	**16.2**	**6.5**	**17.3**

[1]Includes: ponds, lakes, creeks, streams, ditches, and canals (does not include riparian resources).

4.9.3.1 Cactus Hill Reservoir

Impacts on wetlands and other waters associated with the construction of Cactus Hill Reservoir include the dam, inundation from the reservoir, access roads, pump stations, and associated facilities. An estimated 30.4 acres of palustrine emergent wetlands would be lost from inundation by the reservoir. These wetlands have a FACWet composite functional capacity index score ranging from 0.67 (functioning impaired) to 0.70 (functioning) (Section 3.9.2.3). The functional variable scores, functional capacity index scores, and composite functional capacity indices scores for individual wetlands are presented in Table 5 of the 2014 Vegetation and Wetlands Report. Cactus Hill Reservoir wetlands would be lost by inundation for the No Action Alternative. Functions provided by wetlands at Cactus Hill Reservoir that would be lost are shoreline stabilization and production export/food chain support. The open water of the reservoir would provide greater functions than the impacted wetlands for the following functions: support of characteristic fish/aquatic habitat, flood attenuation, short- and long-term

water storage, nutrient/toxicant removal, and sediment retention. The reservoir would also provide support of characteristic wildlife habitat but for species dependent on open water rather than herbaceous wetlands.

4.9.3.2 Conveyance Systems

The pipelines for conveyance are proposed to be buried and would result in an estimated 5.0 acres of temporary effects on wetlands and 15.8 estimated effects on other waters.

4.9.3.3 No Action Irrigated Lands

Comments on the DEIS regarding the approach to estimating impacts on wetlands associated with the transfer of irrigation water informed development of a new approach for the SDEIS to estimate the amount of wetlands that would be lost due to transfer of water from irrigated agricultural lands (WEST 2010). The new approach for the SDEIS used a systematic sampling design to evaluate about 20% (192 square miles) of the 960-square-mile agricultural transfer lands study area and estimate the percentage of irrigation-induced wetlands within the irrigated agricultural transfer lands of the No Action Alternative study area. Based on this evaluation, about 0.34% of the agricultural transfer lands have palustrine emergent (PEM) wetlands supported by irrigation and about 0.00053% of the lands have palustrine scrub-shrub wetlands supported by irrigation. The transfer of irrigation water from these lands would cause an estimated loss of 218.6 acres of wetlands, assuming an estimated average of 0.0034 acre of PEM wetlands and 0.0000053 acre of palustrine scrub-shrub wetlands per acre of irrigated land (WEST 2010).

4.9.3.4 Poudre River

The No Action Alternative was evaluated under Future Conditions hydrology only, as explained in Section 4.2.2 and, therefore, the indirect effects analyses for the No Action Alternative for the Poudre River mainstem are presented in Chapter 5.

4.9.3.5 South Platte River

The No Action Alternative was evaluated under Future Conditions hydrology, as explained in Section 4.2.2 and, therefore, the indirect effects analyses for the No Action Alternative for the South Platte River from the confluence with the Poudre down to the Kersey Gage are presented in Chapter 5.

4.9.4 Indirect Effects Common to Action Alternatives

The action alternatives would reduce flows in the Poudre River that would affect alluvial ground water levels and inundation along the mainstem of the Poudre River. The following information is common to the assessment of indirect potential flow-related effects for all action alternatives.

Alluvial Ground Water Levels. Changes in river stage during the growing season were used to predict changes in ground water levels that could indirectly affect shallowly rooted herbaceous wetland vegetation bordering the mainstem and the more deeply rooted woody riparian vegetation. The most common riparian vegetation cover type along the Poudre River is woodlands dominated by plains cottonwood (ERO 2012d). Monitoring wells at sites dominated by plains cottonwoods typically had depths to ground water during the growing season ranging from about 2 feet in June to about 5 feet, and to almost 7 feet, by late September (Table 4-70). Ground water depths were typically observed to be at their deepest during the end of the growing season in August and September.

The effects of a decline in river stage on alluvial ground water levels greater than about 100 feet from the river are predicted to be generally less than the 0.5-foot impact threshold. This is because the majority of predicted declines in river stage are in the range of 0.5 to 1.0 feet, and the relationship between river stage and ground water levels lessens substantially with distances from the river of greater than 100 feet.

Based on the 2009 through 2011 monitoring of ground water wells located within the cottonwood woodlands at the six Poudre River study sites, it was determined that the deepest annual water table depth during the growing season for the cottonwood woodlands along the mainstem is about 6.85 feet.

Table 4-70 in Section 4.9.9 summarizes the predicted depths to the alluvial ground water level for the action alternatives. None of the declines in ground water levels within the cottonwood woodlands are predicted to be greater than 2.5 feet below the deepest annual water table depth during the growing season. Effects on the cottonwoods associated with declines in river stage of 2 feet or greater are predicted to be limited to periodic short-lived stresses because these estimated declines in alluvial ground water levels are predicted to occur infrequently (i.e., not predicted to be sustained) and are generally predicted to occur in May at the beginning of the growing season when soil moisture conditions are typically favorable for supporting cottonwoods without dependence on shallow ground water levels. Although cottonwoods are phreatophytes, their shallower root systems can also primarily use soil water even when ground water is available (Williams and Cooper 2005).

Inundation. Flooding and inundation can influence wetland and riparian resources and provide a variety of ecological processes. Inundation under Current Conditions hydrology of wetland and riparian resources along the mainstem at the six Poudre River study sites is presented in Table 3-32 (Section 3.9.5.6). Table 3-32 indicates the number of years of inundation for the period of record for different vegetation cover types at the six Poudre River study sites under Current Conditions hydrology. Table 4-71 in Section 4.9.9 summarizes the estimated difference in the number of years of inundation for each action alternative compared to Current Conditions. Additional information on inundation including duration and number of events for the six Poudre River study sites is presented in the 2014 Wetlands and Riparian Resources Effects Report and the results of the Spells Analysis can be found in Appendix B of the report (ERO 2014d).

Inundation has the potential to provide supportive hydrology for wetland and riparian vegetation; however, inundation of many of the locations within the Poudre River study sites under Current Conditions occurs infrequently.

As shown in Table 4-71, woody vegetation cover types, primarily those dominated by plains cottonwood that are inundated infrequently by higher flows (2,000 cfs or higher), would have the greatest reduction in years with inundation events. This effect is due to NISP's Grey Mountain water rights would be in priority more frequently in wet years with larger flows. However, these are also the cover types and elevations that are inundated in less than half of the years in the period of record with Current Conditions hydrology (i.e., sites unlikely to receive hydrologic support from the infrequent inundation).

For all action alternatives, the riparian and wetland locations inundated in more than half of the years under Current Conditions hydrology, and thus potentially more dependent on frequent inundation, are not predicted to have a substantial decrease in the number of years in which inundation occurs.

Sites between the high infrequent flows and low frequent flows (e.g., EPT3.2, 59T1.2, 59T3a.2, 59T3a.3, 59T3a.4, 59T3b.3, 59T3b.4, and BFT3.4), with a minimum inundation flow ranging from about 580 to 1,900 cfs, would have minor changes in inundation frequency under the NISP action alternatives. These changes would range from no reductions in inundation at half of the sites to reductions in inundations of 2 or 3 years at the remaining sites. These mid-range flows occur frequently, are well above the base flows, and range from about one-third to slightly greater than the average annual peak flow.

Predicted changes in inundation associated with operations would accelerate and/or reinforce the trajectory previously described for the riparian plains cottonwood woodlands, but are not predicted to have a substantial effect or result in a major change to cottonwood woodlands along the Poudre River, or substantially change the resource trajectory as discussed in greater detail in the 2014 Wetlands and Riparian Resources Effects Report (ERO 2014d).

Inundation is also associated with a variety of other ecological processes including:

- Creating open, bare substrate for the establishment of riparian and wetland vegetation
- Flushing of salts and pollutants from the flooded area
- Adding sediments, nutrients, and pollutants to the flooded areas
- Export of nutrients to downstream reaches (food chain support)
- Recharge of the soil moisture of flooded areas
- Enhanced decomposition in flooded areas
- Short-term recharge of the alluvial ground water
- Effects on the distribution and composition of vegetation

Reductions in inundation would potentially have some level of effect on these functions or the frequency at which these functions are provided.

Post-Flood Reviews. Flooding on the Poudre River mainstem in 2010, 2011, and 2013 provided the opportunity to review how flood flows and inundation affect wetland and riparian resources. Post-flood reviews of the mainstem determined that most of the vegetation and riverbanks of the reaches reviewed appeared to be unaffected by the floods. There were isolated instances of uprooted plant material along the riverbanks and on islands and bars, but these effects were limited to the active channel and riverbanks. The locations of these areas affected by the floods were relatively infrequent and typically occurred where channel instability had been noted in the past. These minor post-flood changes within the channel contribute to channel complexity, but had little effect on the broader riparian community along the mainstem. The study sites reviewed had observable signs of inundation throughout much of the sites. There were no observable effects on vegetation from the inundation outside of the active channel or stream banks other than the flattening of herbaceous vegetation and the accumulation and piling of woody debris.

In general, it appeared that the floods had little effect on bars and banks with the exception of isolated undercutting of some steep banks on outside bends and deposition of sediments on banks and bars, which continues the current trend of aggradation and vegetation encroachment at these sites. It appears the root mass of the well-vegetated bars and banks protected against widespread erosion for flows of this magnitude. Flows of this magnitude did not create substantial areas of either newly deposited sediments or eroded areas beyond the active channel and riverbanks that could provide potential suitable substrate for colonization by riparian vegetation. The floods in early June of 2010 and 2011 occurred during the normal time for peak flows that can facilitate the establishment of new cottonwood stands. Very few areas of post-flood cottonwood seedlings were observed and the few areas of cottonwood seedlings that were observed occurred within and adjacent to the active channel where the cottonwood seedlings are vulnerable to inundation, channel erosion, and aggradation.

The 2013 Stream Morphology Baseline Report concluded that the ongoing trend associated with channel contraction downstream of I-25 would likely lead to an increase in overbank flooding. The 2014 Stream Morphology Effects Report suggests that the predicted effect of the trend of channel contraction on flooding is balanced to some extent by the decreased frequency of flooding at each recurrence interval associated with project diversions. However, larger flood events (such as the 100-year flood) would be less affected by this decrease in flood frequency. Additionally, while project alternatives could provide positive benefits in the reduction of flooding, there is no certainty that the diversions would occur during a flooding event. Although channel contraction is predicted to lead to floodplain engagement at lower flows, which could have ecological benefits, the frequency of flows around the current 2-year to 5-year flood would also be reduced.

Wetland Functions. Wetland functional assessments using the FACWet assessment procedure were performed for each of the representative Poudre River study sites for depressional and riverine wetlands. Table 4-72 summarizes how the alternatives are predicted to change the functional capacity index score for depressional wetlands and Table 4-73 summarizes how the alternatives are predicted to change the functional capacity index score for riverine wetlands. Table 4-72 and Table 4-73 are in Section 4.9.9 at the end of this section. The largest potential effect on functions is predicted to be to riverine wetlands that are within about 100 feet of the

Poudre River channel. The NISP action alternatives could change the functions of riverine wetlands by altering river stage, inundation, ground water levels, water quality, and geomorphology. Generally, the changes in the composite functional capacity index score for depressional wetlands remained the same as existing conditions, with slight decreases in functions for riverine wetlands. However, slight changes in variable scores caused riverine wetland functions at several of the study sites to go from functioning to functioning impaired (Table 4-73). Most of the functional capacity index scores for riverine wetlands were already on the lower end of the functioning scale, resulting in small changes of a few variables (i.e., 0.01) to decrease the sites to functioning impaired.

4.9.5 District's Preferred Alternative (Alternative 2)

Alternative 2 includes a No Reclamation Action Option and Reclamation Action Option as described in Section 2.5.5. Direct effects due to construction of Glade and Galeton Reservoirs, associated facilities, and conveyance systems would result in a total of 44.4 acres of wetlands lost and 10.2 acres of wetlands temporarily affected by Alternative 2 under the No Reclamation Action Option. A total of 44.4 acres of wetlands would be lost and 8.1 acres of wetlands would be temporarily affected by direct effects of the Reclamation Action Option (Table 4-62). The 2015 Vegetation and Wetland Resources Supplement lists in detail effects by wetland and water type and alternative facility.

A total of 112.5 acres of riparian vegetation would be permanently impacted and a total of 8.4 acres of riparian vegetation would be temporarily impacted by construction of Alternative 2 No Reclamation Action Option. A total of 112.5 acres of riparian vegetation would be permanently impacted and a total of 8.9 acres of riparian vegetation would be temporarily impacted by construction of the Alternative 2 Reclamation Action Option. More detail on the effects of Alternative 2 on vegetation cover types for each alternative component can be found in Section 6.0 of the 2015 Vegetation and Wetland Resources Supplement.

The operation of Alternative 2 (both Reclamation options), is predicted to indirectly affect about 9 acres of near-bank wetlands in Segment B of the Poudre River mainstem due to reduced flows as described under River Stage. Unquantified potential indirect effects are discussed below under Poudre River.

Table 4-62. Estimated effects on wetlands and other waters for Alternative 2.

Facility	No Reclamation Action				Reclamation Action			
	Wetlands		Waters		Wetlands		Waters[1]	
	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)
Direct Effects								
Glade Reservoir	41.6	3.8	6.1	0.1	41.6	3.8	6.1	0.1
U.S. 287	2.5	0.1	0.6	0.4	2.5	0.1	0.6	0.4
Conveyance Systems	0.0	5.7	5.5	2.3	0.0	3.6	5.5	2.3
Galeton Reservoir	0.3	0.6	0.2	1.1	0.3	0.6	0.2	0.1
Indirect Effects								
Segment B[2]	9.0	0.0	0.0	0.0	9.0	0.0	0.0	0.0
Total	**53.4**	**10.2**	**12.4**	**3.9**	**53.4**	**8.1**	**12.4**	**2.9**

[1]Includes: ponds, lakes, creeks, streams, ditches, and canals (does not include riparian resources).
[2]A shift to species that tolerate greater fluctuations in river stage declines is predicted for wetlands dominated by obligate wetland species within 100 feet of the riverbanks due to predicted reductions in ground water levels. There are an estimated 9 acres of wetlands potentially sensitive to such ground water declines in Segment B.

4.9.5.1 Reservoir Sites

4.9.5.1.1 Glade Reservoir

Impacts on wetlands and other waters associated with the construction of Glade Reservoir include the Glade Dam, Glade forebay, inundation from the reservoir, access roads, and associated facilities. The 41.6 acres of wetlands estimated to be lost are PEM wetlands; 41.3 acres of which would be inundated by the reservoir or occur within the footprint of the dam. Permanent impacts on wetlands would not differ between the Reclamation Action Options. The wetlands associated with the Glade Reservoir site have a FACWet composite functional capacity index score ranging from 0.69 (functioning impaired) to 0.93 (reference standard) (Section 3.9.2.2). The functional variable scores, functional capacity index scores, and composite functional capacity indices scores for individual wetlands are presented in Table 5 of the 2015 Vegetation and Wetland Resources Supplement. Wetlands would either be lost by inundation or by the placement of fill for the dam and other facilities. Functions provided by Glade Reservoir wetlands that would be lost are shoreline stabilization and production export/food chain support. Many functions, including support of characteristic fish/aquatic habitat, flood attenuation, short- and long-term water storage, nutrient/toxicant removal, and sediment retention would be greater for the new aquatic resource created by the reservoir than for the wetlands that would be impacted. The reservoir would also provide support of characteristic wildlife habitat for species dependent on open water.

U.S. 287. The construction of Glade Reservoir would require the realignment of U.S. 287, which would result in an estimated 2.5 acres of permanent impacts on wetlands. The composite functional capacity index scores of wetlands in the U.S. 287 realignment study area ranged from 0.76 (functioning) to 0.94 (reference standard). Functions of wetlands within the U.S. 287

realignment would be completely lost by the placement of fill. Functions lost include support of characteristic wildlife habitat, support of characteristic fish/aquatic habitat, flood attenuation, short- and long-term water storage, nutrient/toxicant removal, sediment retention/shoreline stabilization, and production export/food chain support.

4.9.5.1.2 Galeton Reservoir

Impacts on wetlands and other waters associated with the construction of Galeton Reservoir include the dam, forebay, diversion on the South Platte River, inundation from the reservoir, access roads, and associated facilities. The 0.3 acre of wetlands estimated to be lost is PEM wetland, 0.2 acre of which would be inundated by the reservoir or occurs within the footprint of the dam. The few wetlands that occur at the Galeton Reservoir site have a FACWet composite functional capacity index score of 0.82 (functioning) for all wetlands. These wetlands would be inundated and would no longer provide shoreline stabilization and production export/food chain support. Many functions, including support of characteristic fish/aquatic habitat, flood attenuation, short- and long-term water storage, nutrient/toxicant removal, and sediment retention would be greater for the new aquatic resource created by the reservoir than for the wetlands that would be impacted. The reservoir would also provide support of characteristic wildlife habitat for species dependent on open water.

4.9.5.2 Conveyance Systems

Proposed conveyance would vary by Reclamation option (Section 2.5). Conveyance associated with the No Reclamation Action Option is estimated to temporarily impact 5.7 acres of wetlands, and conveyance associated with the Reclamation Action Option is estimated to temporarily impact 3.7 acres of wetlands.

4.9.5.3 Poudre River

The indirect effects assessment of Alternative 2 uses Current Conditions hydrology compared to hydrology Run 3a. Changes in flows have the potential to affect wetland and riparian resources through changes in shallow alluvial ground water levels and or periodic inundation that support these resources and provide other ecological services. The assessment of indirect effects focuses on changes to river stage, alluvial ground water levels, and inundation of riparian and wetland resources along the mainstem. Indirect effects associated with changes in streamflows are predicted to be the same for the Reclamation Action and No Reclamation Action Options. As explained in Section 4.1.3.4.1, a single set of modeled streamflows was evaluated for Alternative 2 because the net effects on streamflow below the Hansen Supply Canal outfall would, on average, effectively be the same under the Reclamation Action Option and the No Reclamation Action Option.

The trajectory previously described for the mainstem riparian resources (Section 4.9.1.1) is predicted to continue with or without the NISP alternatives. Changes in flows associated with Alternative 2 would accelerate and/or reinforce the trajectory but is unlikely to affect existing stands of mature trees. It is challenging to predict the degree to which acceleration of the current

trajectory might occur because of the prolonged time over which the trajectory is predicted to occur and the many variables that could affect timing of the trajectory. However, further reductions in flow in the mainstem would reinforce the current trajectory.

4.9.5.3.1 River Stage

Changes in river stage during the growing season were used to predict indirect effects on shallowly rooted herbaceous wetland vegetation bordering the mainstem that is supported, at least in part, by water levels (river stage) in the river. For all but the Martinez Park study site (representative of Segment B), the predicted percentage of the period of record with a decline of 0.5 foot or greater is 10% or less (Table 4-63). A decline of 10% or less was identified as having negligible effects on wetland and riparian vegetation (Section 4.9.2.1).

Table 4-63. Summary of weekly average stage declines of 0.5 foot or greater during the growing season for Alternative 2 compared to Current Conditions.

Study Site - Segment	Years of Consecutive Declines[1] (Number of Years)	Number of Weeks[2]	Percentage of Record
Watson Lake – Segment A	1982, 1995, 1996 (3 years)	23	4
Martinez Park – Segment B	1981, 1982, 1986, 1993, 1995, 1996, 1997, 1999 (8 years)	104	19
Archery Site – Segment C	1982, 1993, 1995, 1996, 1997, 1999 (6 years)	55	10
Eastman Park – Segment D	1982, 1986, 1993, 1995, 1996, 1997, 1998, 1999, 2000 (9 years)	53	10
59th Avenue – Segment E	1982, 1996, 1999, 2000 (4 years)	44	8
Bird Farm – Segment F	1986, 1993, 1996, 1997, 1998, 1999 (6 years)	40	7

[1] Years of consecutive declines are years in the period of record with at least four consecutive weeks during the growing season (May 1 through September 30) of weekly average river stage declines of 0.5 foot or greater or a total of 6 weeks of declines of 0.5 foot or greater.

[2] Number of weeks with a decline of 0.5 foot or greater for the period of record during the growing season. There are 546 weeks during the growing season for the period of record.

Segment A. Relative to the other segments, the predicted frequency of declines in river stage for Segment A are estimated to have the least potential effect on near-bank herbaceous wetland vegetation. The Watson Lake study site, representative of Segment A, is predicted to have the fewest number of years (3) of at least 4 consecutive weeks during the growing season of weekly average river stage declines of 0.5 foot or greater or a total of 6 weeks of declines of 0.5 foot or greater. It is also predicted to have the lowest percentage of record (4%) of weekly average stage declines of 0.5 foot or greater during the growing season (Table 4-63). As discussed above, the predicted percentage of the period of record with a decline of 0.5 foot in river stage of 10% or less during the growing season was identified as having negligible effects on wetland and riparian vegetation.

Segment B. Relative to the other segments, predicted frequency of declines in river stage for Segment B are estimated to have the greatest potential effect on near-bank herbaceous wetland vegetation. The Martinez Park study site, representative of Segment B, would have the greatest

number of weeks (104) and 19% of the period of record with a decline of 0.5 foot or greater during the growing season (Table 4-63).

Segment C. Relative to the other segments, predicted declines in river stage for Segment C are estimated to occur more frequently than in Segment A, but less frequently than Segment B and are similar to Segment D. The Archery Site, representative of Segment C, would have 55 weeks and 10% of the period of record with a decline of 0.5 foot or greater during the growing season (Table 4-63). The predicted percentage of the period of record with a decline of 0.5 foot in river stage of 10% or less during the growing season was identified as having negligible effects on wetland and riparian vegetation.

Segment D. The effects of reduced river stage in Segment D are similar to those predicted for Segment C. The Eastman Park study site, representative of Segment D, would have 53 weeks and 10% of the with a decline of 0.5 during the growing season (Table 4-63). The predicted percentage of the period of record with a decline of 0.5 foot in river stage of 10% or less during the growing season was identified as having negligible effects on wetland and riparian vegetation.

Segment E. Relative to the other segments, the effects of reduced river stage in Segment E and Segment F are similar. The 59th Avenue study site, representative of Segment E, would have 44 weeks and 8% of the period of record with a decline of 0.5 foot or greater during the growing season (Table 4-63). Segment E is predicted to have 4 years of at least 4 consecutive weeks during the growing season of weekly average river stage declines of 0.5 foot or greater or a total of 6 weeks of declines of 0.5 foot or greater – the fewest next to Segment A. The predicted percentage of the period of record with a decline of 0.5 foot in river stage of 10% or less during the growing season was identified as having negligible effects on wetland and riparian vegetation.

Segment F. The predicted effects of reduced river stage in Segment F are similar to Segment E (Table 4-63). The predicted percentage of the period of record with a decline of 0.5 foot in river stage of 10% or less during the growing season was identified as having negligible effects on wetland and riparian vegetation.

4.9.5.3.2 Riparian Vegetation and Alluvial Ground Water

In general, the deepest observed and predicted annual water table depths during the growing season tend to increase in a downstream direction (the exception being Segment C at the Archery Site). Segment A has the shallowest and Segment F has the deepest observed annual water table depth during the growing season (Table 4-70). The greatest predicted declines in alluvial ground water levels below the deepest observed annual water table depth during the growing season associated with cottonwood woodlands for Alternative 2 are predicted to infrequently occur at the Archery Site (Segment C) at monitoring well A3 (-2.47 feet) and at the Bird Farm study site (Segment F) at monitoring well D5 (-2.48 feet). These infrequent declines are estimated to have negligible to minor effects as described below.

Segment A. Relative to the other segments, predicted maximum depth to ground water within the monitored cottonwood woodland locations at the Watson Lake study site, representative of Segment A, are estimated to be the shallowest. Under Alternative 2, the maximum ground water depths in monitoring wells within the cottonwood woodlands are predicted to be about 2.82 feet (September) to 3.14 feet (May) below the surface (Table 4-70). These estimated changes in the maximum depth to ground water are not predicted to adversely impact the cottonwood woodlands along Segment A because the changes are well within the observed range of maximum ground water depths of 2.79 feet to 6.85 feet for cottonwoods during the growing season along the mainstem (Table 4-70).

Segment B. Under Alternative 2, the maximum ground water depths in monitoring wells within the cottonwood woodlands are predicted to be about 4.82 feet (September) to 7.17 feet (May) below the surface (Table 4-70). These estimated changes in the maximum depth to ground water are not predicted to adversely impact the cottonwood woodlands along Segment B because the changes are very close to being within the observed range of maximum ground water depths of 2.79 feet to 6.85 feet for cottonwoods during the growing season along the mainstem. The maximum predicted ground water depth of 7.17 feet in May would occur at the beginning of the growing season when soil moisture conditions are typically favorable for supporting cottonwoods without dependence on shallow ground water levels.

Segment C. Under Alternative 2, the maximum ground water depths in monitoring wells within the cottonwood woodlands at the Archery Site, representative of Segment C, are predicted to be about 8.08 feet to 8.52 feet below the surface in May (Table 4-70). This would be about 1.9 feet to 2.5 feet below the maximum ground water depths observed during the growing season at these monitoring wells and about 1.7 feet below the maximum ground water depth observed for cottonwoods during the growing season along the mainstem. Effects on cottonwood woodlands are predicted to be minor in Segment C due to short-term increases in maximum ground water depths. As discussed above, minor effects on the cottonwoods associated with declines in river stage of 2 feet or greater are predicted to be limited to periodic short-lived stresses because these estimated declines in alluvial ground water levels are predicted to occur infrequently. Additionally, the infrequently occurring maximum predicted ground water depth of 8.52 feet in May would occur at the beginning of the growing season when soil moisture conditions are typically favorable for supporting cottonwoods without dependence on shallow ground water levels.

Segment D. Under Alternative 2, the maximum ground water depths in monitoring wells within the cottonwood woodlands at the Eastman Park study site, representative of Segment D, are predicted to infrequently reach depths of about 5.52 feet in September to 8.77 feet below the surface in May (Table 4-70). This would be about 0.3 feet to 1.9 feet below the maximum ground water depths observed during the growing season at these monitoring wells and about 1.9 feet below the maximum ground water depth observed for cottonwoods during the growing season along the mainstem. Effects on cottonwood woodlands are predicted to be minor in Segment D due to short-term increases in maximum ground water depths. As discussed above, minor effects on the cottonwoods associated with declines in river stage of 2 feet or greater are

predicted to be limited to periodic short-lived stresses because these estimated declines in alluvial ground water levels are predicted to occur infrequently.

Segment E. Under Alternative 2, the maximum ground water depths in monitoring wells within the cottonwood woodlands at the 59th Avenue study site, representative of Segment E, are predicted to infrequently reach depths of about 6.21 feet to about 7.68 feet below the surface (Table 4-70). This would be about 0.0 feet to 2.1 feet below the maximum ground water depths observed during the growing season at these monitoring wells and about 0.8 feet below the maximum ground water depth observed for cottonwoods during the growing season along the mainstem. Effects are predicted to be minor in Segment E on cottonwood woodlands due to short-term increases in maximum ground water depths. As discussed above, minor effects on the cottonwoods associated with declines in river stage of 2 feet or greater are predicted to be limited to periodic short-lived stresses because these estimated declines in alluvial ground water levels are predicted to occur infrequently.

Segment F. Relative to the other segments, Segment F is predicted to have the deepest maximum ground water depth in a monitoring well within a cottonwood woodland location. Monitoring well D5 is predicted to infrequently have a maximum ground water depth of 9.32 feet in May. Additionally, monitoring well D4 is predicted to infrequently have a maximum ground water depth of 7.36 feet in May. This would be about 1.8 feet to 2.5 feet below the maximum ground water depths observed during the growing season at these monitoring wells and a maximum of about 2.5 feet below the maximum ground water depth observed for cottonwoods during the growing season along the mainstem. Effects are predicted to be minor in Segment F on cottonwood woodlands due to short-term increases in maximum ground water depths. As discussed above, minor effects on the cottonwoods associated with declines in river stage of 2 feet or greater are predicted to be limited to periodic short-lived stresses because these estimated declines in alluvial ground water levels are predicted to occur infrequently.

4.9.5.3.3 Inundation

Under Alternative 2, the number of years that riparian and wetland resources along the mainstem would be inundated over the period of record is predicted to be reduced by 0 to 5 years (Table 4-71). The greatest estimated reduction in years of inundation is predicted to occur at the Martinez Park study site (transect points LMT2.1, 2.2, and 2.3); Eastman Park study site (transect points EPT2.2, 2.3, 2.4, 2.5, and EPT3.1); 59th Avenue study site (transect point 59T3a.5); and Bird Farm study site (transect point BFT3.1). However, inundation at these locations under Current Conditions is not predicted to occur with enough frequency (at least 50% of the years in the period of record) to provide a reliable source of hydrologic support. Under Alternative 2, inundation of these 10 locations is predicted to decrease from 10 to 11 years under Current Conditions to 5 to 6 years.

Eight vegetated points (points mapped as open water excluded) for the Spells Analysis were estimated to have at least one inundation event in 13 or more years during the period of record (Table 4-71). These riparian and wetland vegetation locations were identified as being inundated with enough frequency under Current Conditions to potentially be dependent to some degree on inundation for hydrologic support. These locations (WLT1.2 and 1.3, AT2.2, EPT2.1, 59T1.3,

3a.1, and 3b.1, and BFT3.3) are inundated by the more frequently occurring lower flows ranging from about 160 to 580 cfs. Alternative 2 is predicted to reduce these frequently inundated locations by 0 to 3 years (Table 4-71). These minor reductions in years of inundation are not predicted to adversely affect these wetland and riparian resources because these elevations are predicted to continue to be inundated in at least half of the years of the period of record.

The following discussion on predicted changes to inundation under Alternative 2 for the Poudre River segments focuses on potential effects on cottonwood woodlands. Herbaceous near-bank riparian resources and wetlands are addressed under River Stage. Predicted reductions in inundation are estimated to have negligible effects on established cottonwood woodlands as discussed below. Table 4-71 summarizes the differences in number of years locations are inundated for the action alternatives in Section 4.9.9.

Segment A. The narrowleaf cottonwood woodland locations within the Watson Lake study site, representative of Segment A, have minimum inundation flows of about 1,500 to 3,000 cfs (Table 4-71). Under Current Conditions, these locations would be inundated in about 7 to 17 years of the period of record. As discussed above, locations inundated in at least half of the years of the period of record under Current Conditions were assumed to receive some amount of hydrological support from inundation. Only one cottonwood woodland location at the Watson Lake study site is predicted to be inundated in at least half of the years of the period of record. The inundation under Alternative 2 at this location is predicted to be reduced by 1 year, resulting in inundation that would still occur in greater than half of the years of the period of record. Under Alternative 2, the predicted effects of reduced inundation are estimated to have a negligible effect on cottonwood woodlands in Segment A because all but one cottonwood location are not inundated with enough frequency to provide consistent hydrological support, and the cottonwood woodland location that is inundated with enough frequency for hydrologic support is predicted to continue with enough frequency of inundation to maintain hydrologic support comparable to Current Conditions.

Segment B. The plains cottonwood woodland locations within the Martinez Park study site, representative of Segment B, have minimum inundation flows of about 2,000 to 3,200 cfs (Table 4-71). Under Current Conditions, these locations would be inundated in about 4 to 11 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 1 to 5 years at these locations. None of these locations would be inundated in more than half of the years of the period of record under Current Conditions. Under Alternative 2, the estimated reduction in inundation is predicted to have a negligible effect on cottonwood woodlands in Segment B because under Current Conditions, the cottonwood woodlands are not inundated with enough frequency to provide consistent hydrologic support.

Segment C. The plains cottonwood woodland locations within the Archery Site, representative of Segment C, have minimum inundation flows of about 1,900 to 4,000 cfs (Table 4-71). Under Current Conditions, these locations would be inundated in about 10 to 11 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 1 to 4 years at these locations. None of these locations would be inundated in more than half of the years of the period of record under Current Conditions. Under Alternative 2, the reduction in

inundation is predicted to have a negligible effect on cottonwood woodlands in Segment C because the cottonwood woodlands are not inundated under Current Conditions with enough frequency to provide consistent hydrologic support.

Segment D. The plains cottonwood woodland locations within the Eastman Park study site, representative of Segment D, have minimum inundation flows of about 1,900 to 2,200 cfs (Table 4-71). Under Current Conditions, these locations would be inundated in about 10 to 11 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 3 to 5 years at these locations. None of these locations would be inundated in more than half of the years of the period of record under Current Conditions. Under Alternative 2, the reduction in inundation is predicted to have a negligible effect on cottonwood woodlands in Segment D because under Current Conditions, the cottonwood woodlands are not inundated with enough frequency to provide consistent hydrologic support.

Segment E. The plains cottonwood woodland locations within the 59th Avenue study site, representative of Segment E, have minimum inundation flows of about 580 to 4,000 cfs (Table 4-71). Under Current Conditions, these locations would be inundated in about 3 to 15 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 0 to 5 years at these locations. Only one cottonwood woodland location at the 59th Avenue study site is predicted to be inundated in more than half of the years of the period of record. The inundation under Alternative 2 at this location is predicted to be reduced by 2 years, resulting in inundation that would still occur in about half of the years of the period of record. Under Alternative 2, the predicted effects of reduced inundation are estimated to have negligible effects on cottonwood woodlands in Segment E because all but one cottonwood location is not inundated with enough frequency to provide consistent hydrological support. The cottonwood woodland location that is inundated with enough frequency under Current Conditions is predicted to continue with enough frequency under Current Conditions of inundation to maintain hydrologic support comparable to Current Conditions.

Segment F. The plains cottonwood woodland locations within the Bird Farm study site, representative of Segment F, have minimum inundation flows of about 1,500 to 2,200 cfs (Table 4-71). Under Current Conditions, these locations would be inundated in about 11 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 0 to 5 years at these locations. None of these locations would be inundated in more than half of the years of the period of record under Current Conditions. Under Alternative 2, the reduction in inundation is predicted to have a negligible effect on cottonwood woodlands in Segment F because under Current Conditions, the cottonwood woodlands are not inundated with enough frequency to provide consistent hydrologic support.

4.9.5.3.4 Vegetation Communities and Nonnative Species

Vegetation studies for the SDEIS included collecting and analyzing data on vegetation communities, nonnative species, and the recruitment and size distribution of woody vegetation at the Poudre River study sites. This information was used to develop trends and a trajectory for wetland and riparian resources along the mainstem as well as estimate how predicted changes in

the frequency and duration of inundation and ground water levels during the growing season could affect the composition and distribution of plant communities along the mainstem.

As discussed above, the current trajectory for the plant communities bordering the mainstem involves less inundation. Less inundation combined with potential changes in tree canopy cover and potentially greater recreational use of the mainstem riparian plant communities (e.g., social trails and access for fishing, wading, and tubing) would likely lead to the increased presence and distribution of nonnative vegetation in the plant communities along the mainstem. This predicted increase in nonnative species does not attempt to account for programs that may be implemented by land managers to reduce the presence and distribution of nonnative vegetation along the mainstem or new nonnative species that may be introduced to the area. As discussed above, reed canarygrass is expected to increase its distribution downstream of I-25.

4.9.5.3.5 Wetland Functions

Alternative 2 is predicted to slightly lower the composite functional score in Segment E for depressional wetlands and is predicted to slightly lower all composite functional scores for riverine wetlands. For depressional wetlands in Segment E, the slight decrease in function of support of characteristic fish/aquatic habitat, flood attenuation, and short- and long-term water storage would be imperceptible and would be a negligible effect on the overall function of the wetlands.

Alternative 2 is predicted to lower the composite functional score of the riverine wetlands in Segments A, B, D, and E from functioning to functioning impaired, which would be a minor effect because the change in composite functional scores are typically based on a small change in one or more variables that contribute to the composite functional score, and the functions would not change substantially even though the classification would change Segments A, B, D, and E. For riverine wetlands in all segments, slight decreases in the score for functions of support of characteristic fish/aquatic habitat, flood attenuation, short- and long-term water storage, nutrient/toxicant removal, sediment retention/shoreline stabilization, and production export/food chain support would cause a slight decrease in overall function of riverine wetlands, a minor effect.

4.9.5.4 South Platte River

No new studies or analyses were performed for the SDEIS for the South Platte River. Alternative 2 would on an average annual basis reduce flows on the South Platte River by less than 10% and the stage reductions are predicted to be small (up to 0.33 feet). Given the minor reductions in flow and stage, Alternative 2 is not predicted to affect wetland and riparian resources along the South Platte River.

4.9.6 Alternative 3

A total of 89.7 acres of permanent wetland impacts and 18.6 acres of temporary wetland impacts are estimated to occur due to the construction and operation of Alternative 3 (Table 4-64). Of the 89.7 acres of permanent impacts, 33.7 acres are direct impacts associated with the

construction of Alternative 3. The proposed lining of the Poudre Valley Canal is estimated to indirectly affect about 47 acres of wetlands. The operation of Alternative 3 is predicted to indirectly affect about 9 acres of near-bank wetlands in Segment B of the Poudre River mainstem due to reduced flows as described under River Stage. Unquantified potential indirect effects are discussed below under Poudre River.

The 2015 Vegetation and Wetland Resources Supplement lists in detail effects by wetland and water type and alternative facility. A total of 16.4 acres of riparian vegetation would be permanently impacted and a total of 15.9 acres of riparian vegetation would be temporarily impacted by the direct effects of the construction of Alternative 3. More detail on the effects of Alternative 3 on vegetation cover types for each alternative component is presented in Section 6.0 of the 2015 Vegetation and Wetland Resources Supplement.

Table 4-64. Estimated direct effects on wetlands and other waters for Alternative 3.

Facility	Wetlands		Waters[1]	
	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)
Direct Effects				
Cactus Hill Reservoir	32.0	10.1	6.9	1.1
Conveyance Systems	1.4	7.9	85.1	10.1
Galeton Reservoir	0.3	0.6	0.2	1.1
Indirect Effects				
Segment B[2]	9.0	0.0	0.0	0.0
Poudre Valley Canal Lining	47.0	0.0	0.0	0.0
Total	**89.7**	**18.6**	**92.2**	**12.3**

[1]Includes: ponds, lakes, creeks, streams, ditches, and canals (does not include riparian resources).
[2]A shift to species that tolerate greater fluctuations in river stage declines is predicted for wetlands dominated by obligate wetland species within 100 feet of the riverbanks due to predicted reductions in ground water levels. There are an estimated 9 acres of wetlands potentially sensitive to such ground water declines in Segment B.

4.9.6.1 Reservoir Sites

4.9.6.1.1 Cactus Hill Reservoir

Impacts on wetlands and other waters associated with construction of Cactus Hill Reservoir include the Cactus Hill Reservoir Dam, inundation from the reservoir, access roads, and associated facilities. The 32.0 acres of wetlands estimated to be lost are PEM wetlands. These wetlands have a FACWet composite functional capacity index score ranging from 0.67 (functioning impaired) to 0.70 (functioning) (Section 3.9.2.2). The functional variable scores, functional capacity index scores, and composite functional capacity indices scores for individual wetlands are presented in Table 5 of the 2015 Vegetation and Wetland Resources Supplement. Wetlands would either be lost by inundation or by the placement of fill for the dam and other facilities. Functions provided by wetlands at Cactus Hill Reservoir that would be lost are shoreline stabilization and production export/food chain support. The open water of the reservoir would provide greater functions than the impacted wetlands; these functions include support of

characteristic fish/aquatic habitat, flood attenuation, short- and long-term water storage, nutrient/toxicant removal, and sediment retention. The reservoir would also provide support of characteristic wildlife habitat but for species dependent on open water rather than herbaceous wetlands.

4.9.6.1.2 Galeton Reservoir

Impacts to wetlands and waters associated with Galeton Reservoir are the same as presented for Alternative 2 (Section 4.9.5.1.2).

4.9.6.2 Conveyance Systems

Pipelines for conveyance are proposed to be buried and would result in an estimated 7.9 acres of temporary effects on wetlands and 10.1 acres of temporary effects on other waters.

4.9.6.2.1 Poudre Valley Canal

The 85.1 acres of estimated permanent direct impacts on ditches, canals, ponds, and lakes and 1.4 acres of permanent direct impacts on PEM wetlands are associated with the lining of the Poudre Valley Canal. Lining the Poudre Valley Canal is estimated to additionally indirectly affect approximately 47 acres of wetlands. Most of the wetland effects would be on PEM Wetlands (33 acres) with 14 acres of palustrine scrub-shrub wetlands likely to be affected. These effects were calculated based on proximity of the wetland to the canal, if the wetlands were downgradient from the canal, and if other hydrological sources are likely to be present. For wetlands adjacent and downgradient to the Poudre Valley Canal with no apparent hydrological source other than the canal (based on aerial photographs and National Hydrography Data), it was assumed that the supportive hydrology to these wetlands would be lost and, therefore, the wetlands would be lost. These wetlands were counted as permanent indirect effects. For wetlands not adjacent to the canal with other observable sources of supportive hydrology, such as streams and reservoirs, it was assumed that loss of the canal seepage may reduce the supportive hydrology but would not result in a loss of wetlands. Wetlands higher than the canal were assumed to not be impacted by the proposed lining of the Poudre Valley Canal.

4.9.6.3 Poudre River

The indirect effects assessment of Alternative 3 uses Current Conditions hydrology compared to CTP hydrology Run 3b1. Alternative 3 would divert on average about 5,500 to 6,000 AFY more water from the Poudre River than Alternative 2 to compensate for increased reservoir evaporation from Cactus Hill Reservoir and conveyance loss. Additionally, Alternative 3 does not include the Poudre River flow augmentation program that is proposed under Alternative 2.

4.9.6.3.1 River Stage

Changes in river stage during the growing season were used to predict indirect effects on shallowly rooted herbaceous wetland vegetation bordering the mainstem that is supported, at least in part, by water levels (river stage) in the river. For the study sites representative of Segments A, E, and F, the predicted percentage of the period of record with a decline of 0.5 foot or greater is 10% or less (Table 4-65). A decline of 10% or less was identified as having

negligible effects on wetland and riparian vegetation (Section 4.9.2.1). The study sites representing Segments C and D are predicted to have declines of 12 and 11%, respectively, of the period of record with a decline of 0.5 foot or greater. Some sites would experience declines of 0.5 foot or greater for slightly more than 10% of the period of record; however these occurrence would be infrequent and an adverse effect is not predicted. These percentages, slightly greater than 10%, represent an average of 2 to 2.5 weeks of decline during the growing season, which is not estimated to have a measurable long-term effect on shallowly rooted wetland vegetation.

Alternative 3 is predicted to have weekly average river stage declines of 0.5 foot or greater during the growing season of 21% of the period of record at the Martinez Park study site. This level of decline in river stage is predicted to result in a shift in species at wetlands dominated by obligate wetland species (e.g., cattail and threesquare bulrush) to those that tolerate greater fluctuations in river stage such as reed canarygrass. Since most wetlands along the banks of the mainstem are dominated by reed canarygrass and sandbar willow, two species that can tolerate a range of ground water levels, effects are predicted to be minor and likely not perceptible along Segment B. An estimated 9 acres of vegetation classes are potentially sensitive to declines in the ground water table within Segment B within 100 feet of the riverbanks.

Table 4-65. Summary of weekly average stage declines of 0.5 foot or greater during the growing season for Alternative 3 compared to Current Conditions.

Study Site - Segment	Years of Consecutive Declines[1] (Number of Years)	Number of Weeks[2]	Percentage of Record
Watson Lake – Segment A	1982, 1995, 1996, 1997 (4 years)	31	6
Martinez Park – Segment B	1982, 1985, 1986, 1993, 1995, 1996, 1997, 1999 (8 years)	116	21
Archery Site – Segment C	1982, 1985, 1986, 1993, 1994, 1995, 1996, 1997, 1998, 1999 (10 years)	68	12
Eastman Park – Segment D	1982, 1986, 1993, 1995, 1996, 1997, 1998, 1999, 2000 (9 years)	62	11
59th Avenue – Segment E	1982, 1996, 1997, 1998, 1999, 2000 (6 years)	54	10
Bird Farm – Segment F	1986, 1993, 1996, 1997, 1998, 1999 (6 years)	46	8

[1] Years of consecutive declines are years in the period of record with at least 4 consecutive weeks during the growing season (May 1 through September 30) of weekly average river stage declines of 0.5 foot or greater or a total of 6 weeks of declines of 0.5 foot or greater.

[2] Number of weeks with a decline of 0.5 foot or greater for the period of record during the growing season. There are 546 weeks during the growing season for the period of record.

Segment A. Relative to the other segments**,** the predicted frequency of declines in river stage for Segment A are estimated to have the least potential effect on near-bank herbaceous wetland vegetation. The Watson Lake study site, representative of Segment A, is predicted to have the fewest number of years (4) of at least 4 consecutive weeks during the growing season of weekly average river stage declines of 0.5 foot or greater or a total of 6 weeks of declines of 0.5 foot or greater. It is also predicted to have the lowest percentage of record (6) of weekly average stage

declines of 0.5 foot or greater during the growing season (Table 4-65). As discussed above, the predicted percentage of the period of record with a decline of 0.5 foot in river stage of 10% or less during the growing season was identified as having negligible effects on wetland and riparian vegetation.

Segment B. Relative to the other segments, predicted frequency of declines in river stage for Segment B are estimated to have the greatest potential effect on near-bank herbaceous wetland vegetation. The Martinez Park study site, representative of Segment B, would have the greatest number of weeks (116) and 21% of the period of record with a decline of 0.5 foot or greater during the growing season (Table 4-65). As discussed above, this level of decline in river stage is predicted to result in a shift in species at wetlands dominated by obligate wetland species to those that tolerate greater fluctuations in river stage.

Segment C. Relative to the other segments, predicted declines in river stage for Segment C are estimated to occur more frequently than in Segment A, but less frequently than Segment B. The Archery Site, representative of Segment C, would have 68 weeks and 12% of the period of record with a decline of 0.5 foot or greater during the growing season (Table 4-65). As discussed above, sites with a decline of slightly greater than 10% of the period of record represent an average of 2 to 2.5 weeks of decline during the growing season, which is not estimated to have a measurable long-term effect on shallowly rooted wetland vegetation.

Segment D. The effects of reduced river stage in Segment D are similar to those predicted for Segment C. The Eastman Park study site, representative of Segment D, would have 62 weeks and 11% of the period of record with a decline of 0.5 foot or greater during the growing season (Table 4-65).

Segment E. Relative to the other segments, the effects of reduced river stage in Segment E and Segment F are similar. The 59th Avenue study site, representative of Segment E, would have 54 weeks and 10% of the period of record with a decline of 0.5 foot or greater during the growing season (Table 4-65). Segments E and F are predicted to have 6 years of at least 4 consecutive weeks during the growing season of weekly average river stage declines of 0.5 foot or greater or a total of 6 weeks of declines of 0.5 foot or greater – the fewest next to Segment A. As discussed above, the predicted percentage of the period of record with a decline of 0.5 foot in river stage of 10% or less during the growing season was identified as having negligible effects on wetland and riparian vegetation.

Segment F. The predicted effects of reduced river stage in Segments E and F are similar. The predicted percentage of the period of record with a decline of 0.5 foot in river stage of 10% or less during the growing season was identified as having negligible effects on wetland and riparian vegetation.

4.9.6.3.2 Alluvial Ground Water

Table 4-70 summarizes the predicted maximum depth to ground water during the growing season for the action alternatives. Under Alternative 3, the greatest predicted declines in alluvial ground water levels below the deepest observed annual water table depth during the growing season for cottonwood are predicted to infrequently occur at the Archery Site (Segment C) at

monitoring well A3 (-2.47 feet) and at the Bird Farm study site (Segment F) at monitoring well D5 (-2.48 feet). For the reasons discussed in Section 4.9.2.1, these infrequent declines are estimated to have negligible to minor effects on the cottonwood woodlands, depending on the river segment as presented below.

In general, the deepest observed and predicted annual water table depth during the growing season tends to increase in a downstream direction (the exception being Segment C at the Archery Site). Segment A has the shallowest and Segment F has the deepest observed annual water table depth during the growing season (Table 4-70).

Poudre River Segments. The descriptions of the maximum predicted ground water depths in monitoring wells within the cottonwood woodlands under Alternative 3 are predicted to be the same as Alternative 2 (Table 4-70).

Segment A. Relative to the other segments, predicted maximum depth to ground water within the monitored cottonwood woodland locations at the Watson Lake study site, representative of Segment A, are estimated to be the shallowest. Under Alternative 3, the maximum ground water depths in monitoring wells within the cottonwood woodlands are predicted to be about 2.82 feet (September) to 3.14 feet (May) below the surface (Table 4-70). These estimated changes in the maximum depth to ground water are not predicted to adversely impact the cottonwood woodlands along Segment A because the changes are well within the observed range of maximum ground water depths of 2.79 feet to 6.85 feet for cottonwoods during the growing season along the mainstem (Table 4-70).

Segment B. Under Alternative 3, the maximum ground water depths in monitoring wells within the cottonwood woodlands are predicted to be about 4.82 feet (September) to 7.13 feet (May) below the surface (Table 4-70). These estimated changes in the maximum depth to ground water are not predicted to adversely impact the cottonwood woodlands along Segment B because the changes are very close to being within the observed range of maximum ground water depths of 2.79 feet to 6.85 feet for cottonwoods during the growing season along the mainstem. The maximum predicted ground water depth of 7.13 feet in May would occur at the beginning of the growing season when soil moisture conditions are typically favorable for supporting cottonwoods without dependence on shallow ground water levels.

Segment C. Under Alternative 3, the maximum ground water depths in monitoring wells within the cottonwood woodlands at the Archery Site, representative of Segment C, are predicted to be about 8.08 feet to 8.52 feet below the surface in May (Table 4-70). This would be about 1.9 feet to 2.5 feet below the maximum ground water depths observed during the growing season at these monitoring wells and about 1.7 feet below the maximum ground water depth observed for cottonwoods during the growing season along the mainstem. Effects on cottonwood woodlands are predicted to be minor in Segment C due to short-term increases in maximum ground water depths. As discussed above, minor effects on the cottonwoods associated with declines in river stage of 2 feet or greater are predicted to be limited to periodic short-lived stresses because these estimated declines in alluvial ground water levels are predicted to occur infrequently. Additionally, the infrequently occurring maximum predicted ground water depth of 8.52 feet in May would occur at the beginning of the growing season when soil moisture conditions are

typically favorable for supporting cottonwoods without dependence on shallow ground water levels.

Segment D. Under Alternative 3, the maximum ground water depths in monitoring wells within the cottonwood woodlands at the Eastman Park study site, representative of Segment D, are predicted to infrequently reach depths of about 5.52 feet in September to 8.77 feet below the surface in May (Table 4-70). This would be about 0.3 feet to 1.9 feet below the maximum ground water depths observed during the growing season at these monitoring wells and about 1.9 feet below the maximum ground water depth observed for cottonwoods during the growing season along the mainstem. Effects on cottonwood woodlands are predicted to be minor in Segment D due to short-term increases in maximum ground water depths. As discussed above, minor effects on the cottonwoods associated with declines in river stage of 2 feet or greater are predicted to be limited to periodic short-lived stresses because these estimated declines in alluvial ground water levels are predicted to occur infrequently.

Segment E. Under Alternative 3, the maximum ground water depths in monitoring wells within the cottonwood woodlands at the 59th Avenue study site, representative of Segment E, are predicted to infrequently reach depths of about 6.23 feet to about 7.68 feet below the surface (Table 4-70). This would be about 0.0 feet to 2.1 feet below the maximum ground water depths observed during the growing season at these monitoring wells and about 0.8 feet below the maximum ground water depth observed for cottonwoods during the growing season along the mainstem. Effects are predicted to be minor in Segment E on cottonwood woodlands due to short-term increases in maximum ground water depths. As discussed above, minor effects on the cottonwoods associated with declines in river stage of 2 feet or greater are predicted to be limited to periodic short-lived stresses because these estimated declines in alluvial ground water levels are predicted to occur infrequently.

Segment F. Relative to the other segments, Segment F is predicted to have the deepest maximum ground water depth in a monitoring well within a cottonwood woodland location. Monitoring well D5 is predicted to infrequently have a maximum ground water depth of 9.32 feet in May. Additionally, monitoring well D4 is predicted to infrequently have a maximum ground water depth of 7.36 feet in May. This would be about 1.8 feet to 2.5 feet below the maximum ground water depths observed during the growing season at these monitoring wells and a maximum of about 2.5 feet below the maximum ground water depth observed for cottonwoods during the growing season along the mainstem. Effects are predicted to be minor in Segment F on cottonwood woodlands due to short-term increases in maximum ground water depths. As discussed above, minor effects on the cottonwoods associated with declines in river stage of 2 feet or greater are predicted to be limited to periodic short-lived stresses because these estimated declines in alluvial ground water levels are predicted to occur infrequently.

4.9.6.3.3 Inundation

Predicted changes in inundation associated with Alternative 3 would accelerate and/or reinforce the trajectory previously described for the riparian plains cottonwood woodlands, but are not predicted to have a substantial effect or result in a substantial change to established plains cottonwood woodlands along the Poudre River, or substantially change the established resource

trajectory as discussed in greater detail in the 2013 Wetland and Riparian Resources Effects Report.

Under Alternative 3, the number of years that riparian and wetland resources along the mainstem would be inundated over the period of record is predicted to be reduced by 0 to 6 years (Table 4-71). The greatest estimated reduction in years of inundation is predicted to occur at the Watson Lake study site (transect point WLT2.3); the Martinez Park study site (transect points LMT2.1, 2.2, and 2.3); the Archery Site (transect point AT1.2); the Eastman Park study site (transect points EPT2.2, 2.3, 2.4, 2.5, and EPT3.1); the 59th Avenue study site (transect point 59T3a.5); and the Bird Farm study site (transect points BFT3.1 and 3.2). However, inundation at these locations under Current Conditions is not predicted to occur with enough frequency (at least 50% of the years in the period of record) to provide a reliable source of hydrologic support. Under Alternative 3, inundation of these 13 locations is predicted to decrease from 10 to 11 years under Current Conditions to 5 to 6 years.

Eight vegetated points (points mapped as open water excluded) for the Spells Analysis were estimated to have at least one inundation event in 13 or more years during the 27-year period of record (Table 4-71). These riparian and wetland vegetation locations were identified as being inundated with enough frequency under Current Conditions to potentially be dependent to some degree on inundation for hydrologic support. These locations (WLT1.2 and 1.3, AT2.2, EPT2.1, 59T1.3, 3a.1, and 3b.1, and BFT3.3) are inundated by the more frequently occurring lower flows ranging from about 160 to 580 cfs. Alternative 3 is predicted to reduce these frequently inundated locations by 0 to 3 years (Table 4-71). These minor reductions in years of inundation are not predicted to adversely affect these wetland and riparian resources.

The following discussion on predicted changes to inundation for the Poudre River segments focuses on potential effects on cottonwood woodlands. Herbaceous near-bank riparian resources and wetlands are addressed under River Stage. Under Alternative 3, predicted reductions in inundation are estimated to have negligible to moderate effects on established cottonwood woodlands as discussed below. Table 4-71 summarizes the differences in number of years locations are inundated for the action alternatives in Section 4.9.9.

Segment A. The narrowleaf cottonwood woodland locations within the Watson Lake study site, representative of Segment A, have minimum inundation flows of about 1,500 to 3,000 cfs (Table 4-71). Under Current Conditions, these locations would be inundated in about 7 to 17 years of the period of record. As discussed above, locations inundated in at least half of the years of the period of record were assumed to receive some amount of hydrological support from inundation. Only one cottonwood woodland location at the Watson Lake study site is predicted to be inundated in at least half of the years of the period of record. The inundation under Alternative 3 at this location is predicted to be reduced by 1 year, resulting in inundation that would still occur in greater than half of the years of the period of record. Under Alternative 3, the predicted effects of reduced inundation are estimated to have a negligible effect on cottonwood woodlands in Segment A because under Current Conditions, all but one cottonwood location are not inundated with enough frequency to provide consistent hydrological support. The cottonwood woodland location that is inundated under Current Conditions with enough frequency for

hydrologic support is predicted to continue to maintain hydrologic support comparable to Current Conditions.

Segment B. The plains cottonwood woodland locations within the Martinez Park study site, representative of Segment B, have minimum inundation flows of about 2,000 to 3,200 cfs (Table 4-71). Under Current Conditions, these locations would be inundated in about 4 to 11 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 2 to 6 years at these locations. None of these locations would be inundated in more than half of the years of the period of record under Current Conditions. Under Alternative 3, the reduction in inundation is predicted to have a negligible effect on cottonwood woodlands in Segment B because under Current Conditions, the cottonwood woodlands are not inundated with enough frequency to provide consistent hydrologic support.

Segment C. The plains cottonwood woodland locations within the Archery Site, representative of Segment C, have minimum inundation flows of about 1,900 to 4,000 cfs (Table 4-71). Under Current Conditions, these locations would be inundated in about 10 to 11 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 1 to 5 years at these locations. None of these locations would be inundated in more than half of the years of the period of record under Current Conditions. Under Alternative 3, the estimated reduction in inundation is predicted to have a negligible effect on cottonwood woodlands in Segment C because under Current Conditions, the cottonwood woodlands are not inundated with enough frequency to provide consistent hydrologic support.

Segment D. The plains cottonwood woodland locations within the Eastman Park study site, representative of Segment D, have minimum inundation flows of about 1,900 to 2,200 cfs (Table 4-71). Under Current Conditions, these locations would be inundated in about 10 to 11 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 3 to 5 years at these locations. None of these locations would be inundated in more than half of the years of the period of record under Current Conditions. Under Alternative 3, the estimated reduction in inundation is predicted to have a negligible effect on cottonwood woodlands in Segment D because under Current Conditions, the cottonwood woodlands are not inundated with enough frequency to provide consistent hydrologic support.

Segment E. The plains cottonwood woodland locations within the 59th Avenue study site, representative of Segment E, have minimum inundation flows of about 580 to 4,000 cfs (Table 4-71). Under Current Conditions, these locations would be inundated in about 3 to 15 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 0 to 5 years at these locations. Only one cottonwood woodland location at the 59th Avenue study site is predicted to be inundated in more than half of the years of the period of record. The inundation under Alternative 3 at this location is predicted to be reduced by 3 years, resulting in inundation that would occur in a little less than half of the years of the period of record. This reduction in inundation would reduce the frequency of inundation of cottonwood woodland at this location to a degree that it is no longer supportive. To the degree that the cottonwood woodland at this location is dependent on relatively frequent inundation, the reduced inundation would be a moderate impact (i.e., likely reduce the vigor of the stand). Under

Alternative 3, the predicted effects of reduced inundation are estimated to have a negligible effect on most of the cottonwood woodlands in Segment E. However, stands that are inundated at the more frequently occurring low flows of about 580 cfs are likely to be moderately impacted by a reduced number of years of inundation.

Segment F. The plains cottonwood woodland locations within the Bird Farm study site, representative of Segment F, have minimum inundation flows of about 1,500 to 2,200 cfs (Table 4-71). Under Current Conditions, these locations would be inundated in about 11 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 0 to 5 years at these locations. None of these locations would be inundated in more than half of the years of the period of record under Current Conditions. Under Alternative 3, the estimated reduction in inundation is predicted to have a negligible effect on cottonwood woodlands in Segment F because under Current Conditions, the cottonwood woodlands are not inundated with enough frequency to provide consistent hydrologic support.

4.9.6.3.4 Vegetation Communities and Nonnative Species

Vegetation studies for the SDEIS included collecting and analyzing data on vegetation communities, nonnative species, and the recruitment and size distribution of woody vegetation at the Poudre River study sites. This information was used to develop trends and a trajectory for wetland and riparian resources along the mainstem as well as estimate how predicted changes in the frequency and duration of inundation and ground water levels during the growing season could affect the composition and distribution of plant communities along the mainstem.

The trajectory previously described for the mainstem riparian resources (Section 4.9.1.1) is predicted to continue with or without the NISP alternatives. Changes in flows associated with Alternative 3 would accelerate and /or reinforce the trajectory, but is unlikely to affect existing stands of mature trees. This trajectory would likely lead to the increased presence and distribution of nonnative vegetation in the plant communities along the mainstem, including an expected increase in the distribution of reed canarygrass downstream of I-25. Section 4.9.9 provides a summary of the anticipated effects on the vegetation communities along the mainstem associated with this trajectory.

4.9.6.3.5 Wetland Functions

Alternative 3 is predicted to slightly lower the composite functional score in Segment E for depressional wetlands (Table 4-72) and is predicted to slightly lower all composite functional scores for riverine wetlands (Table 4-73). For depressional wetlands in Segment E, the slight decrease in function of support of characteristic fish/aquatic habitat, flood attenuation, and short- and long-term water storage would be imperceptible and would be a negligible effect on the overall function of the wetlands. Alternative 3 is predicted to lower the composite functional score of the riverine wetlands in Segments A, B, D, and E from functioning to functioning impaired, which would be a minor effect because the change in composite functional scores are typically based on a small change in one or more variables that contribute to the composite functional score, and the functions would not change substantially even though the classification would change Segments A, B, D, and E. For riverine wetlands in all segments, slight decreases in the score for functions of support of characteristic fish/aquatic habitat, flood attenuation,

short- and long-term water storage, nutrient/toxicant removal, sediment retention/shoreline stabilization, and production export/food chain support would cause a slight decrease in overall function of riverine wetlands, a minor effect.

4.9.6.4 South Platte River

No new studies or analyses were performed for the SDEIS for the South Platte River. Alternative 2 would on an average annual basis reduce flows on the South Platte River by less than 10% and the stage reductions are predicted to be small (up to 0.33 feet). Given the minor reductions in flow and stage, Alternative 3 is not predicted to affect wetland and riparian resources along the South Platte River.

4.9.7 Alternative 4

A total of 80.7 acres of permanent wetland impacts and 18.7 acres of temporary wetland impacts are estimated to occur due to the construction and operation of Alternative 4 (Table 4-66). Of the 80.7 acres of permanent impacts, 33.7 acres are direct impacts associated with the construction of Alternative 4. The proposed lining of the Poudre Valley Canal is estimated to indirectly affect about 47 acres of wetlands.

The 2015 Vegetation and Wetland Resources Supplement lists in detail effects by wetland and water type and alternative facility. A total of 16.4 acres of riparian vegetation would be permanently impacted and a total of 15.9 acres of riparian vegetation would be temporarily impacted by the direct effects of the construction of Alternative 4. More detail on the effects of Alternative 4 on vegetation cover types for each alternative component is in Section 6.0 of the 2014 Vegetation and Wetlands Resources Report.

Table 4-66. Estimated effects on wetlands and other waters for Alternative 4.

Facility	Wetlands		Waters[1]	
	Permanent (acres)	Temporary (acres)	Permanent (acres)	Temporary (acres)
Direct Effects				
Cactus Hill Reservoir	32.0	10.1	6.9	1.1
Conveyance Systems	1.4	8.0	85.1	10.2
Galeton Reservoir	0.3	0.6	0.2	1.1
Indirect Effects				
Poudre Valley Canal Lining	47.0	0.0	0.0	0.0
Total	**80.7**	**18.7**	**92.2**	**12.4**

[1]Includes: ponds, lakes, creeks, streams, ditches, and canals (does not include riparian resources).

4.9.7.1 Reservoir Sites

4.9.7.1.1 Cactus Hill Reservoir

Impacts on wetlands and other waters associated with construction of Cactus Hill Reservoir include the Cactus Hill Dam, inundation from the reservoir, access roads, and associated facilities. The 32.0 acres of wetlands estimated to be lost are PEM wetlands. These wetlands have a FACWet composite functional capacity index score ranging from 0.67 (functioning impaired) to 0.70 (functioning) (Section 3.9.2.2). The functional variable scores, functional capacity index scores, and composite functional capacity index scores for individual wetlands are presented in Table 5 of the 2014 Vegetation and Wetlands Technical Report Supplement. Wetlands would either be lost by inundation or by the placement of fill for the dam and other facilities. Functions provided by wetlands at Cactus Hill Reservoir that would be lost are shoreline stabilization and production export/food chain support. The open water of the reservoir would provide greater functions than the impacted wetlands; these functions include support of characteristic fish/aquatic habitat, flood attenuation, short- and long-term water storage, nutrient/toxicant removal, and sediment retention. The reservoir would also provide support of characteristic wildlife habitat but for species dependent on open water rather than herbaceous wetlands.

4.9.7.1.2 Galeton Reservoir

Impacts on wetlands and waters associated with Galeton Reservoir are the same as presented for Alternative 2 (Section 4.9.5.1.2).

4.9.7.2 Conveyance Systems

Pipelines for conveyance are proposed to be buried and would result in an estimated 8.0 acres of temporary effects on wetlands and 10.2 acres of temporary effects on waters.

4.9.7.2.1 Poudre Valley Canal

The 85.1 acres of estimated permanent impacts on ditches, canals, ponds, and lakes and 1.4 acres of permanent impacts on PEM wetlands are associated with the lining of the Poudre Valley Canal. The indirect effects on wetlands from lining of the Poudre Valley Canal are the same as Alternative 3 described in Section 4.9.6.2.1.

4.9.7.3 Poudre River

The indirect effects assessment of Alternative 4 uses Current Conditions hydrology compared to hydrology Run 3b2. Alternative 4 is designed to allow some flow to pass through the Fort Collins area and be diverted lower on the river at the New Cache Canal headgate. Relative to the other action alternatives, under Alternative 4, more water would remain in the mainstem between the Poudre Valley Canal and New Cache Canal before it is diverted for exchanges. Like Alternative 3, Alternative 4 would divert on average 5,500 to 6,000 AFY more water from the Poudre River than Alternative 2 to compensate for increased reservoir evaporation from Cactus Hill Reservoir and conveyance loss. Additionally, Alternative 4 does not include the Poudre River flow augmentation program that is proposed under Alternative 2.

4.9.7.3.1 River Stage

Changes in river stage during the growing season were used to predict indirect effects on shallowly rooted herbaceous wetland vegetation bordering the mainstem that is supported, at least in part, by water levels (river stage) in the river. For all study sites, the predicted percentage of the period of record with a decline of 0.5 foot or greater is 10% or less (Table 4-67). A decline of 10% or less was identified as having negligible effects on wetland and riparian vegetation (Section 4.9.2.1.1).

Table 4-67. Summary of weekly average stage declines of 0.5 foot or greater during the growing season for Alternative 4 compared to Current Conditions.

Study Site - Segment	Years of Consecutive Declines[1] (Number of Years)	Number of Weeks[2]	Percentage of Record
Watson Lake – Segment A	1982, 1995, 1996 (3 years)	23	4
Martinez Park – Segment B	1986, 1993, 1995, 1996, 1997, 1999 (6 years)	44	8
Archery Site – Segment C	1982, 1993, 1995, 1996, 1997, 1999 (6 years)	38	7
Eastman Park – Segment D	1982, 1986, 1993, 1996, 1997, 1998, 1999, 2000 (8 years)	56	10
59th Avenue -Segment E	1982, 1993, 1996, 1998, 1999, 2000 (6 years)	49	9
Bird Farm – Segment F	1986, 1993, 1995, 1996, 1997, 1998, 1999 (7 years)	45	8

[1] Years of consecutive declines are years in the period of record with at least 4 consecutive weeks during the growing season (May 1 through September 30) of weekly average river stage declines of 0.5 foot or greater or a total of 6 weeks of declines of 0.5 foot or greater.

[2] Number of weeks with a decline of 0.5 foot or greater for the period of record during the growing season. There are 546 weeks during the growing season for the period of record.

Segment A. Relative to the other segments, the predicted frequency of declines in river stage for Segment A are estimated to have the least potential effect on near-bank herbaceous wetland vegetation. The Watson Lake study site, representative of Segment A, is predicted to have the fewest number of years (3) of at least 4 consecutive weeks during the growing season of weekly average river stage declines of 0.5 foot or greater or a total of 6 weeks of declines of 0.5 foot or greater. It is also predicted to have the lowest percentage of record (4%) of weekly average stage declines of 0.5 foot or greater during the growing season (Table 4-67). As discussed above, the predicted percentage of the period of record with a decline of 0.5 foot in river stage of 10% or less during the growing season was identified as having negligible effects on wetland and riparian vegetation.

Segment B. Predicted declines in river stage for Segment B are estimated to occur more frequently than in Segment A, and are relatively similar to the other segments downstream of Segment B. The Martinez Park study site, representative of Segment B, would have 44 weeks and 8% of the period of record with a decline of 0.5 foot or greater during the growing season (Table 4-67). The predicted percentage of the period of record with a decline of 0.5 foot in river

stage of 10% or less during the growing season was identified as having negligible effects on wetland and riparian vegetation.

Segment C. Predicted declines in river stage for Segment C are estimated to occur more frequently than in Segment A, but less frequently than Segment B. The Archery Site, representative of Segment C, would have 38 weeks and 7% of the period of record with a decline of 0.5 foot or greater during the growing season (Table 4-67). The predicted percentage of the period of record with a decline of 0.5 foot in river stage of 10% or less during the growing season was identified as having negligible effects on wetland and riparian vegetation.

Segment D. Relative to the other segments, the predicted effects of reduced river stage in Segment D would be the greatest. The Eastman Park study site, representative of Segment D, would have 56 weeks and 10% of the period of record with a decline of 0.5 foot or greater during the growing season (Table 4-67). The predicted percentage of the period of record with a decline of 0.5 foot in river stage of 10% or less during the growing season was identified as having negligible effects on wetland and riparian vegetation.

Segment E. The predicted effects of reduced river stage in Segment E and Segment F are similar. The 59th Avenue study site, representative of Segment E, would have 49 weeks and 9% of the period of record with a decline of 0.5 foot or greater during the growing season (Table 4-67). Segments E and F are predicted to have 6 years and 7 years, respectively, of at least 4 consecutive weeks during the growing season of weekly average river stage declines of 0.5 foot or greater or a total of 6 weeks of declines of 0.5 foot or greater – the fewest next to Segment A. As discussed above, the predicted percentage of the period of record with a decline of 0.5 foot in river stage of 10% or less during the growing season was identified as having negligible effects on wetland and riparian vegetation.

Segment F. The predicted effects of reduced river stage in Segments E and F are similar. The predicted percentage of the period of record with a decline of 0.5 foot in river stage of 10% or less during the growing season was identified as having negligible effects on wetland and riparian vegetation.

4.9.7.3.2 Alluvial Ground Water

Table 4-70 summarizes the predicted maximum depth to ground water during the growing season for the action alternatives (Section 4.9.9). Under Alternative 4, the greatest predicted declines in alluvial ground water levels below the deepest observed annual water table depth during the growing season for cottonwood woodlands are predicted to occur at the Archery Site (Segment C) at monitoring well A3 (-2.30 feet) and at the Bird Farm study site (Segment F) at monitoring well D5 (-2.48 feet). For the reasons discussed in Section 4.9.5.3.3, these infrequent declines are estimated to have negligible to minor effects on the cottonwood woodlands.

In general, the deepest observed and predicted annual water table depth during the growing season tends to increase in a downstream direction (the exception being Segment C at the Archery Site). Segment A has the shallowest and Segment F has the deepest observed annual water table depth during the growing season (Table 4-70). Under Alternative 4, predicted maximum depth to ground water for monitoring wells within the cottonwood woodlands is

similar to the predicted maximum depths for Alternatives 2 and 3. Predicted changes in maximum ground water depth under Alternative 4 in Segments A, B, and C are slightly less than those predicted under Alternatives 2 and 3 and are described below.

Segment A. Relative to the other segments, predicted maximum depth to ground water within the monitored cottonwood woodland locations at the Watson Lake study site, representative of Segment A, are estimated to be the shallowest. Under Alternative 4, the maximum ground water depths in monitoring wells within the cottonwood woodlands are predicted to infrequently occur at about 2.81 feet (September) to 3.06 feet (May) below the surface (Table 4-70). These estimated changes in the maximum depth to ground water are not predicted to adversely impact the cottonwood woodlands along Segment A because the changes are well within the observed range of maximum ground water depths of 2.79 feet to 6.85 feet for cottonwoods during the growing season along the mainstem.

Segment B. Under Alternative 4, the maximum ground water depths in monitoring wells within the cottonwood woodlands are predicted to infrequently occur at about 4.82 feet (September) to 6.93 feet (May) below the surface (Table 4-70). These estimated changes in the maximum depth to ground water are not predicted to adversely impact the cottonwood woodlands along Segment B because the changes are very close to being within the observed range of maximum ground water depths of 2.79 feet to 6.85 feet for cottonwoods during the growing season along the mainstem. The maximum predicted ground water depth of 6.93 feet in May would occur at the beginning of the growing season when soil moisture conditions are typically favorable for supporting cottonwoods without dependence on shallow ground water levels.

Segment C. Under Alternative 4, the maximum ground water depths in monitoring wells within the cottonwood woodlands at the Archery Site, representative of Segment C, are predicted to infrequently occur at about 7.95 feet to 8.35 feet below the surface in May (Table 4-70). This would be about 1.9 feet to 2.3 feet below the maximum ground water depths observed during the growing season at these monitoring wells and about 1.5 feet below the maximum ground water depth observed for cottonwoods during the growing season along the mainstem. Effects on cottonwood woodlands are predicted to be minor in Segment C due to short-term increases in maximum ground water depths. As discussed above, effects on the cottonwoods associated with declines in river stage of 2 feet or greater are predicted to be limited to periodic short-lived stresses because these estimated declines in alluvial ground water levels are predicted to occur infrequently. Additionally, the maximum predicted ground water depth of 8.35 feet in May would occur infrequently at the beginning of the growing season when soil moisture conditions are typically favorable for supporting cottonwoods without dependence on shallow ground water levels.

Segment D. The effects of reduced river stage in Segment D are similar to those predicted for Segment C. The Eastman Park study site, representative of Segment D, would have 62 weeks and 11% of the period of record with a decline of 0.5 foot or greater during the growing season (Table 4-70).

Segment E. Relative to the other segments, the effects of reduced river stage in Segment E and Segment F are similar. The 59th Avenue study site, representative of Segment E, would have

54 weeks and 10% of the period of record with a decline of 0.5 foot or greater during the growing season (Table 4-70). Segments E and F are predicted to have 6 years of at least 4 consecutive weeks during the growing season of weekly average river stage declines of 0.5 foot or greater or a total of 6 weeks of declines of 0.5 foot or greater – the fewest next to Segment A. As discussed above, the predicted percentage of the period of record with a decline of 0.5 foot in river stage of 10% or less during the growing season was identified as having negligible effects on wetland and riparian vegetation.

Segment F. The predicted effects of reduced river stage in Segments E and F are similar. The predicted percentage of the period of record with a decline of 0.5 foot in river stage of 10% or less during the growing season was identified as having negligible effects on wetland and riparian vegetation.

4.9.7.3.3 Inundation

Predicted changes in inundation associated with Alternative 4 would accelerate and/or reinforce the well-established trajectory previously described for the riparian plains cottonwood woodlands, but are not predicted to have a substantial effect or result in a substantial change to established cottonwood woodlands along the Poudre River, or substantially change the established resource trajectory as discussed in greater detail in the 2013 Wetland and Riparian Resources Effects Report.

Under Alternative 4, the number of years that riparian and wetland resources along the mainstem would be inundated over the period of record is predicted to be reduced by 0 to 6 years (Table 4-71). The greatest estimated reduction in years of inundation is predicted to occur at the Martinez Park study site (transect points LMT2.1, 2.2, and 2.3); the Eastman Park study site (transect points EPT2.2, 2.3, 2.4, 2.5, and EPT3.1); the 59th Avenue study site (transect points 59T3a.5 and 3b.2); and the Bird Farm study site (transect point BFT3.1). However, inundation at these locations under Current Conditions is not predicted to occur with enough frequency (at least 50% of the years in the period of record) to provide a reliable source of hydrologic support. Under Alternative 4, inundation of these 11 locations is predicted to decrease from 10 to 11 years under Current Conditions to 4 to 6 years.

Eight vegetated points (points mapped as open water excluded) for the Spells Analysis were estimated to have at least one inundation event in 13 or more years during the period of record (Table 4-66). These riparian and wetland vegetation locations were identified as being inundated with enough frequency under Current Conditions to potentially be dependent to some degree on inundation for hydrologic support. These locations (WLT1.2 and 1.3, AT2.2, EPT2.1, 59T1.3, 3a.1 and 3b.1, and BFT3.3) are inundated by the more frequently occurring lower flows ranging from about 160 to 580 cfs. Alternative 4 is predicted to reduce these frequently inundated locations by 0 to 2 years (Table 4-66).

The following discussion on predicted changes to inundation for the Poudre River segments focuses on potential effects on cottonwood woodlands. Herbaceous near-bank riparian resources and wetlands are addressed under River Stage. Under Alternative 4, predicted reductions in inundation are estimated to have negligible effects on established cottonwood woodlands as

discussed below. Table 4-71 summarizes the differences in number of years locations are inundated for the action alternatives in Section 4.9.9.

Segment A. The narrowleaf cottonwood woodland locations within the Watson Lake study site, representative of Segment A, have minimum inundation flows of about 1,500 to 3,000 cfs (Table 4-71). Under Current Conditions, these locations would be inundated in about 7 to 17 years of the period of record. As discussed above, locations inundated in at least half of the years of the period of record were assumed to receive some amount of hydrological support from inundation. Only one cottonwood woodland location at the Watson Lake study site is predicted to be inundated in more than half of the years of the period of record. The inundation under Alternative 4 at this location is predicted to not be reduced. Under Alternative 4, the predicted effects of reduced inundation are estimated to have a negligible effect on cottonwood woodlands in Segment A because under Current Conditions, all but one cottonwood location are not inundated with enough frequency to provide consistent hydrological support, and the cottonwood woodland location that is inundated with enough frequency for hydrologic support is predicted to continue to maintain hydrologic support comparable to Current Conditions.

Segment B. The plains cottonwood woodland locations within the Martinez Park study site, representative of Segment B, have minimum inundation flows of about 2,000 to 3,200 cfs (Table 4-71). Under Current Conditions, these locations would be inundated in about 4 to 11 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 1 to 6 years at these locations. None of these locations would be inundated in more than half of the years of the period of record under Current Conditions. Under Alternative 4, the reduction in inundation is predicted to have a negligible effect on cottonwood woodlands in Segment B because under Current Conditions, the cottonwood woodlands are not inundated with enough frequency to provide consistent hydrologic support.

Segment C. The plains cottonwood woodland locations within the Archery Site, representative of Segment C, have minimum inundation flows of about 1,900 to 4,000 cfs (Table 4-71). Under Current Conditions, these locations would be inundated in about 10 to 11 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 1 to 4 years at these locations. None of these locations would be inundated in more than half of the years of the period of record under Current Conditions. Under Alternative 4, the reduction in inundation is predicted to have a negligible effect on cottonwood woodlands in Segment C because the cottonwood woodlands are not inundated with enough frequency to provide consistent hydrologic support.

Segment D. The plains cottonwood woodland locations within the Eastman Park study site, representative of Segment D, have minimum inundation flows of about 1,900 to 2,200 cfs (Table 4-71). Under Current Conditions, these locations would be inundated in about 10 to 11 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 4 to 6 years at these locations. None of these locations would be inundated in more than half of the years of the period of record under Current Conditions. Under Alternative 4, the reduction in inundation is predicted to have a negligible effect on cottonwood woodlands in

Segment D because under Current Conditions, the cottonwood woodlands are not inundated with enough frequency to provide consistent hydrologic support.

Segment E. The plains cottonwood woodland locations within the 59th Avenue study site, representative of Segment E, have minimum inundation flows of about 580 to 4,000 cfs (Table 4-71). Under Current Conditions, these locations would be inundated in about 3 to 15 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 0 to 5 years at these locations. Only one cottonwood woodland location at the 59th Avenue study site is predicted to be inundated in over half of the years of the period of record. The inundation under Alternative 4 at this location is predicted to be reduced by 2 years, resulting in inundation that would still occur in about half of the years of the period of record. Under Alternative 4, the predicted effects of reduced inundation are estimated to have negligible effects on cottonwood woodlands in Segment E because under Current Conditions, all but one cottonwood location are not inundated with enough frequency to provide consistent hydrological support, and the cottonwood woodland location that is inundated with enough frequency for hydrologic support is predicted to continue to maintain hydrologic support comparable to Current Conditions.

Segment F. The plains cottonwood woodland locations within the Bird Farm study site, representative of Segment F, have minimum inundation flows of about 1,500 to 2,200 cfs (Table 4-71). Under Current Conditions, these locations would be inundated in about 11 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 1 to 5 years at these locations. None of these locations would be inundated in more than half of the years of the period of record under Current Conditions. Under Alternative 4, the estimated reduction in inundation is predicted to have a negligible effect on cottonwood woodlands in Segment F because under Current Conditions, the cottonwood woodlands are not inundated with enough frequency to provide consistent hydrologic support.

4.9.7.3.4 Vegetation Communities and Nonnative Species

Vegetation studies for the SDEIS included collecting and analyzing data on vegetation communities, nonnative species, and the recruitment and size distribution of woody vegetation at the Poudre River study sites. This information was used to develop trends and a trajectory for wetland and riparian resources along the mainstem as well as estimate how predicted changes in the frequency and duration of inundation and ground water levels during the growing season could affect the composition and distribution of plant communities along the mainstem.

The trajectory previously described for the mainstem riparian resources (Section 4.9.1.1) is predicted to continue with or without the NISP alternatives. Changes in flows associated with Alternative 4 would reinforce the well-established trajectory, but is unlikely to affect existing stands of mature trees. This trajectory would likely lead to the increased presence and distribution of nonnative vegetation in the plant communities along the mainstem, including an expected increase in the distribution of reed canarygrass downstream of I-25. Section 4.9.5.3.1 provides a summary of the anticipated effects on the vegetation communities along the mainstem associated with this trajectory.

4.9.7.3.5 Wetland Functions

Alternative 4 is predicted to slightly lower the composite functional score in Segment E for depressional wetlands (Table 4-72) and is predicted to slightly lower all composite functional scores for riverine wetlands (Table 4-73). For depressional wetlands in Segment E, the slight decrease in function of support of characteristic fish/aquatic habitat, flood attenuation, and short- and long-term water storage would be imperceptible and would be a negligible effect on the overall function of the wetlands. Alternative 4 is predicted to lower the composite functional score of the riverine wetlands in Segments A, B, D, and E from functioning to functioning impaired, which would be a minor effect because the change in composite functional scores are typically based on a small change in one or more variables that contribute to the composite functional score, and the functions would not change substantially even though the classification would change Segments A, B, D, and E. For riverine wetlands in all segments, slight decreases in the score for functions of support of characteristic fish/aquatic habitat, flood attenuation, short- and long-term water storage, nutrient/toxicant removal, sediment retention/shoreline stabilization, and production export/food chain support would cause a slight decrease in overall function of riverine wetlands, a minor effect.

4.9.7.4 South Platte River

No new studies or analyses were performed for the SDEIS for the South Platte River. Alternative 2 would on an average annual basis reduce flows on the South Platte River by less than 10% and the stage reductions are predicted to be small (up to 0.33 feet). Given the minor reductions in flow and stage, Alternative 4 is not predicted to affect wetland and riparian resources along the South Platte River.

4.9.8 Unavoidable Adverse Impacts

All alternatives would have unavoidable direct effects on wetlands and waters associated with the construction of facilities and inundation from reservoirs. These direct effects vary by alternative and would result in the loss of wetlands, waters, and the functions they perform (Section 4.9.9).

The No Action Alternative would have the unavoidable indirect adverse impact of transferring irrigation water from 64,200 acres of irrigated lands, resulting in the indirect loss of an estimated 218.6 acres of wetlands. Alternatives 3 and 4 would have the unavoidable indirect adverse impact to 47 acres of wetlands associated with lining the Poudre Valley Canal.

Investigations for the 2013 Stream Morphology Baseline Report concluded that the mainstem downstream of I-25 had crossed a biogeomorphic threshold and is on a trajectory leading to a shallower and narrower channel including a continuing biogeomorphic feedback cycle of vegetation encroachment by reed canarygrass. Investigations for the 2014 Wetlands and Riparian Resources Effects Report also predicted a shift to species that tolerate greater fluctuations in river stage declines in Segment B for wetlands dominated by obligate wetland species within 100 feet of the riverbanks due to predicted reductions in ground water levels.

The 2012 Wetlands and Riparian Resources Baseline Report concluded that the mainstem had crossed a biologic threshold that limits the recruitment of plains cottonwood and is in the process of altering the composition of the riparian woodlands. Implementation of any of the action alternatives has the potential to accelerate and/or reinforce these existing trajectories projected to result in a future riparian community that will differ from the current community in its vegetation composition.

4.9.9 Impact Summary

Table 4-68. Summary of unmitigated effects on wetlands and waters.

	Alternative 1		Alternative 2 Reclamation Action		Alternative 2 No Reclamation Action		Alternative 3		Alternative 4	
	Perm.	**Temp.**	**Perm.**	**Temp.**	**Perm.**	**Temp.**	**Perm.**	**Temp.**	**Perm.**	**Temp.**
Direct Effects										
Wetlands	31.8	16.2	44.4	3.9	44.4	10.2	33.7	18.6	33.7	18.7
Waters[1]	6.5	17.3	12.4	2.9	12.4	3.9	92.2	12.3	92.2	12.4
Indirect Effects										
Wetlands	218.6	0.0	9.0[2]	0.0	9.0[2]	0.0	56.0[2]	0.0	47.0	0.0
Waters[1]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**257.1**	**33.5**	**65.8**	**6.8**	**65.8**	**14.1**	**181.9**	**30.9**	**172.9**	**31.1**
Effect Determination	**Major**	**Minor**	**Major**	**Minor**	**Major**	**Minor**	**Major**	**Minor**	**Major**	**Minor**

[1]Includes: ponds, lakes, creeks, streams, ditches, and canals (does not include riparian resources).

[2]A shift to species that tolerate greater fluctuations in river stage declines is predicted for wetlands dominated by obligate wetland species within 100 feet of the Poudre River due to predicted reductions in ground water levels. There are an estimated 9 acres of wetlands potentially sensitive to such ground water declines in Segment B under Alternatives 2 and 3.

Table 4-69. Summary of flow-related indirect effects on mainstem wetland and riparian resources.

Predicted Changes to Hydrology and Effects on Resource	Alternative 2 (Reclamation Action and No Reclamation Action)	Alternative 3	Alternative 4
River Stage River stage is affected by flow and channel morphology. Changes in river flows would alter river stage. The assessment of effects associated with changes in river stage focused on near-bank herbaceous wetlands.	Would frequently decrease river stage by 0.5 to 1.0 foot during the growing season. Negligible effect for all segments except Segment B; supportive hydrology would still likely occur. Moderate effects for Segment B; decline in river stage is predicted to result in a shift in species at wetlands dominated by obligate wetland species to those that tolerate greater fluctuations in river stage such as reed canarygrass.	Similar to the effects described for Alternative 2; the timing and magnitude of stage reductions would be similar to Alternative 2.	Would frequently decrease river stage by 0.5 to 1.0 foot during the growing season. River Segments A and B are predicted to have fewer declines in river stage compared with Alternatives 2 and 3. Negligible effects as supportive hydrology would still likely occur in all segments.
Alluvial Ground Water Levels Alluvial ground water levels closely match river stage in locations close to the river. The relationship between river stage and ground water levels decreases with distance from the river. Declines in ground water levels focused on predicted declines below the observed maximum ground water depths during the growing season for cottonwood woodlands.	Negligible effects on Segments A, B, and F. Minor effects on cottonwood woodlands in Segments C, D, and E associated with infrequent short-lived declines below the observed maximum ground water depths during the growing season.	Similar to the effects described for Alternative 2; the timing and magnitude of stage reductions are similar to Alternative 2 and declines in alluvial ground water levels are based on reductions in stage. Declines in ground water levels are predicted to be slightly more frequent than under Alternative 2 due to increased diversions required for Cactus Hill Reservoir. Negligible effects on Segments A, B, and F. Minor effects on cottonwood woodlands in Segments C, D, and E associated with infrequent short-lived declines below the observed maximum ground water depths during the growing season.	Similar to Alternatives 2 and 3, except fewer declines in ground water levels are predicted in Segments A and B due to shifting some diversions to downstream of Fort Collins. Negligible effects on cottonwood woodlands in all segments.

Predicted Changes to Hydrology and Effects on Resource	Alternative 2 (Reclamation Action and No Reclamation Action)	Alternative 3	Alternative 4
Inundation Frequent moderate flooding would no longer occur along the mainstem. All alternatives are predicted to further reduce inundation. The assessment of reduced flooding focused on the maintenance of cottonwood woodlands.	Cottonwood woodlands inundated in at least half of the years of the period of record would still be inundated at a similar frequency. Mainstem plant communities associated with frequent flooding are predicted to continue to be inundated.	Declines in inundation are predicted to be slightly more frequent than Alternative 2 due to increased diversions required for Cactus Hill Reservoir. Reduced inundation is predicted to have a moderate effect on some cottonwood stands in Segment E that are predicted to be inundated in at least half of the years during the period of record because the frequency of inundation would be reduced to less than half of the years.	Similar to Alternatives 2 and 3 except fewer declines in inundation frequency are predicted in Segments A and B due to shifting some diversions to downstream of Fort Collins.
Vegetation Communities The plains cottonwood woodlands appear to be on a trajectory that would eventually lead to their decline. Nonnative woody vegetation (e.g., green ash, Russian olive, and Siberian elm) are predicted to increase. In the future, plains cottonwoods would likely not dominate the riparian woodlands along the mainstem. Reed canarygrass is predicted to continue to colonize areas of the formerly active channel downstream of I-25. All alternatives are predicted to further reduce inundation.	Changes in flows associated with Alternative 2 are predicted to reinforce the trajectory. Minor effect; trajectory would continue with or without alternative but may be accelerated.	Minor effect; trajectory would continue with or without alternative but may be accelerated.	Minor effect; trajectory would continue with or without alternative but may be accelerated.

Predicted Changes to Hydrology and Effects on Resource	Alternative 2 (Reclamation Action and No Reclamation Action)	Alternative 3	Alternative 4
Nonnative Species Reed canarygrass has colonized areas of the formerly active channel downstream of I-25 as the channel in this portion of the river continues to aggrade and narrow with accumulated sediment. The current trajectory of less inundation, combined with potential changes in tree canopy cover and potentially greater recreational use of the mainstem riparian plant communities, would likely lead to the increased presence and distribution of nonnative vegetation.	Changes in flows associated with Alternative 2 are predicted to accelerate and/or reinforce the well-established trajectory. Minor effect; trajectory would continue with or without alternative.	Minor effect; trajectory would continue with or without alternative.	Minor effect; trajectory would continue with or without alternative.
Recruitment of Woody Riparian Vegetation Green ash, narrowleaf cottonwood, plains cottonwood, box elder, and possibly Russian olive are currently an important component of the regenerating riparian forest. The current woodland overstory, typically dominated by plains cottonwood, would likely become characterized by a greater mix of these tree species in the future.	Changes in flows associated with Alternative 2 are predicted to accelerate and/or reinforce the well-established trajectory. Minor effect; trajectory would continue with or without alternative.	Minor effect; trajectory would continue with or without alternative.	Minor effect; trajectory would continue with or without alternative.
Wetland Functions – Depressional Wetlands All Poudre River study site depressional wetlands are functioning under all alternatives with Segment F ranking the highest and Segment B ranking the lowest. Negligible effects would occur to the functions and services of depressional wetlands for any of the alternatives.	Little predicted change in function; negligible effect.	Little predicted change in function; negligible effect.	Little predicted change in function; negligible effect.

Predicted Changes to Hydrology and Effects on Resource	Alternative 2 (Reclamation Action and No Reclamation Action)	Alternative 3	Alternative 4
Wetland Functions – Riverine Wetlands	Negligible to minor effect. Wetland functions for riverine wetlands would decline to functioning impaired except for Segment F, which would remain as functioning. Functional rankings for existing conditions were on the lower end of the functioning category; therefore, small changes in the scoring would result in a change to functioning impaired.	Negligible to minor effect; similar to Alternative 2.	Negligible to minor effect; wetland functions for riverine wetlands would remain as functioning except for Segment C, which previously was functioning impaired and Segment E, which would decline to functioning impaired.
Other Flood-Related Functions Inundation is also associated with a variety of ecological processes including flushing salts, creating bare substrate for the establishment of riparian vegetation, recharging soil moisture, and exporting nutrients.	Moderate effect; inundation would occur less often under Alternative 2 and this would reinforce the well-established trajectory for the mainstem riparian corridor and floodplain, which includes a reduction of functions associated with inundation.	Moderate effect; similar to Alternative 2 because of reduced inundation.	Moderate effect; similar to Alternative 2 because of reduced inundation.

Details regarding the summary presented above on the indirect effects on functions of depressional and riverine wetlands from Poudre River flow changes are presented in Appendix C of the 2014 Wetlands and Riparian Resources Effects Report.

All alternatives would cause a loss of wetlands and waters. The No Action Alternative is predicted to have the greatest loss of wetlands and waters (256.9 acres), 218.6 acres of which are associated with the transfer of water from 64,200 acres of irrigated agricultural lands. Alternative 2 is predicted to have the least permanent impact to wetlands and waters (74.8 acres). Alternatives 3 and 4 are predicted to permanently impact 228 and 172 acres of wetlands and waters, respectively, 133.5 acres of which are associated with the lining of the Poudre Valley Canal to convey water to Cactus Hill Reservoir.

All action alternatives would cause reductions in flows and river stage of the mainstem, which are predicted to accelerate and/or reinforce the well-established trajectory for riparian and wetland resources along the mainstem. Figure 4-60, Figure 4-61, and Figure 4-62 (from the 2014 Wetlands and Riparian Resources Effects Report) compare river stage decline for the action alternatives. At most locations, Alternative 3 has the greatest predicted declines in river stage.

Alternative 3 consistently has a greater number of weeks and percentage of the period of record with a decline in ground water levels of 0.5 foot or greater. For river Segments A, B, and C, Alternative 4 consistently has the fewest number of weeks and percentage of the period of record with a decline in ground water levels of 0.5 foot or greater. Alternative 4 would have less of a predicted effect on ground water levels compared to the other action alternatives in Segments B and C, but would have a greater effect than Alternative 2 in Segments D, E, and F. Table 4-70 compares the maximum observed depth and predicted depths to ground water levels for the alternatives.

The action alternatives vary slightly in terms of the predicted number of years in which inundation of wetland and riparian areas are estimated to occur. Alternative 3 generally decreases the number of years of inundation by about 1 more year during the period of record for many of the Poudre River study site transects compared with Alternative 2. This slight decrease in the estimated number of years of inundation with Alternative 3 is because Alternative 3 would divert on average about 5,000 AFY to 6,000 AFY more from the Poudre River than Alternative 2. While Alternative 4 is similar to Alternatives 2 and 3, in some locations (e.g., Segment A), Alternative 4 has slightly fewer years of reduced inundation than Alternative 2 and slightly greater years of reduced inundation than Alternative 3. In most segments, the years of reduced inundation associated with Alternative 4 are similar to Alternative 3. Table 4-71 compares the difference in number of years inundated for a variety of elevations and vegetation cover types at the Poudre River study sites.

Figure 4-60. Number of Years of Consecutive River Stage Declines for the Alternatives Compared to Current Conditions (Run 1 vs. Run 3 Series).

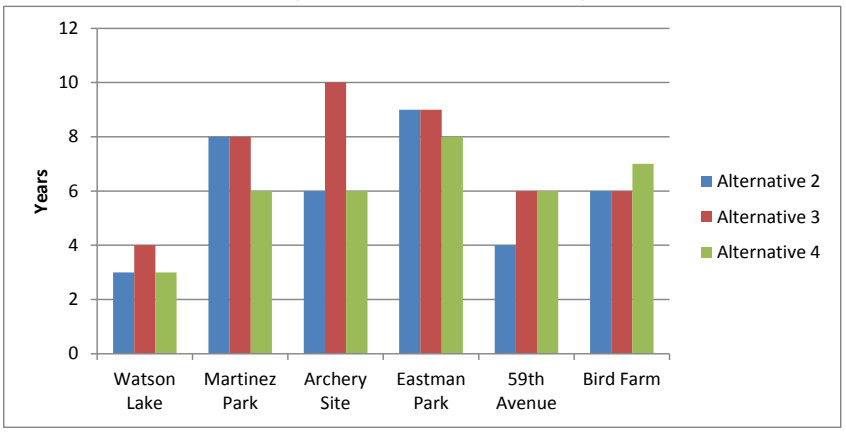


Figure 4-61. Number of Weeks with a River Stage Decline of 0.5 Foot or Greater for the Period of Record for the Alternatives Compared to Current Conditions (Run 1 vs. Run 3 Series).

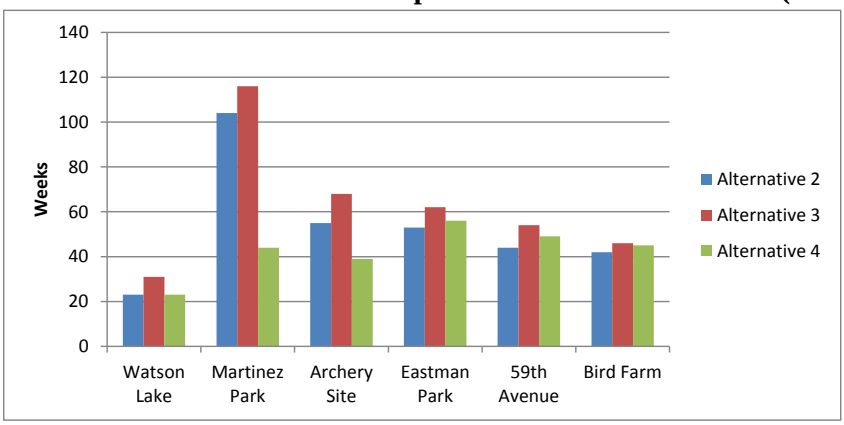


Figure 4-62. Percentage of Record of Number of Weeks with a River Stage Decline of 0.5 Foot or Greater for the Period of Record for the Alternatives Compared to Current Conditions (Run 1 vs. Run 3 Series).

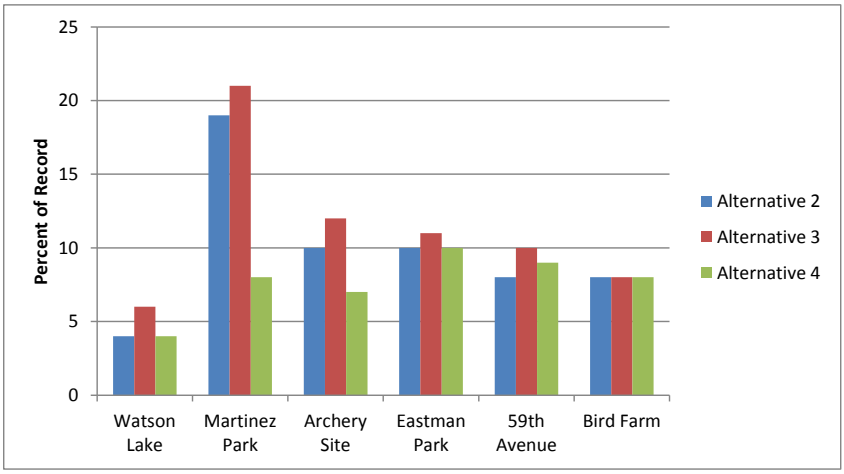


Table 4-70. Maximum current depth and predicted depths to ground water levels.

Monitoring Well	Watson Lake		Martinez Park			Archery Site		Eastman Park				59th Avenue			Bird Farm	
	G3	G5	L1	L4	L5	A3	A4	Y2	Y3	Y4	Y5	59-1	59-2	59-3	D4	D5
Maximum depth to ground water during the growing season[1]																
May	2.11	2.44	4.44	5.04	3.47	5.95	6.08	4.83	5.19	6.01	6.29	4.30	3.97	4.41	4.83	6.40
June	2.11	1.98	3.83	3.94	1.92	4.47	4.55	4.22	4.32	4.77	5.41	NA	NA	5.32	**5.59**	NA
July	2.46	2.55	4.70	5.13	3.70	5.66	5.94	5.31	5.76	6.70	6.75	5.24	6.11	5.86	5.15	6.63
August	2.37	2.49	4.91	5.71	4.26	6.04	6.22	5.44	5.86	**6.79**	6.82	**5.63**	**6.20**	**6.32**	5.38	**6.84**
September	**2.79**	**2.95**	**5.29**	**6.04**	**4.78**	**6.05**	**6.22**	**5.52**	**5.92**	**6.79**	**6.85**	5.54	6.02	6.25	5.26	6.83
Alternative 2 - Maximum predicted ground water depth																
May	2.32	**3.14**	4.44	**7.17**	3.96	**8.52**	**8.08**	4.83	5.19	**7.07**	**8.77**	**7.68**	5.45	6.40	**7.36**	**9.32**
June	2.32	2.66	3.83	5.54	2.29	6.79	6.36	4.22	4.32	5.50	7.13	NA	NA	**6.86**	7.15	NA
July	2.53	2.77	4.70	5.68	3.83	5.98	6.19	5.31	5.76	6.78	6.95	5.45	6.20	5.98	5.37	6.88
August	2.41	2.64	4.91	6.65	4.48	6.14	6.30	5.44	5.86	6.80	6.85	5.65	**6.21**	6.33	5.40	6.87
September	**2.82**	3.04	**5.29**	6.22	**4.82**	6.11	6.27	**5.52**	**5.92**	6.83	6.93	5.70	6.09	6.34	5.36	6.95
Alternative 3 - Maximum predicted ground water depth																
May	2.32	**3.14**	4.44	**7.13**	3.95	**8.52**	**8.08**	4.83	5.19	**7.07**	**8.77**	**7.68**	5.45	6.40	**7.36**	**9.32**
June	2.33	2.72	3.83	5.62	2.31	6.79	6.36	4.22	4.32	5.50	7.13	NA	NA	**6.86**	7.15	NA
July	2.53	2.79	4.70	5.71	3.83	6.64	6.70	5.31	5.76	6.80	6.99	5.50	**6.23**	6.02	5.42	6.94
August	2.42	2.65	4.91	6.62	4.47	6.14	6.30	5.44	5.86	6.80	6.85	5.67	6.22	6.34	5.46	6.93
September	**2.82**	3.04	**5.29**	6.22	**4.82**	6.10	6.26	**5.52**	**5.92**	6.83	6.93	5.71	6.09	6.35	5.36	6.95
Alternative 4 - Maximum predicted ground water depth																
May	2.30	**3.06**	4.44	**6.93**	3.91	**8.35**	**7.95**	4.83	5.19	**7.07**	**8.77**	**7.68**	5.45	6.40	**7.36**	**9.32**
June	2.32	2.67	3.83	5.32	2.24	6.79	6.36	4.22	4.32	5.50	7.13	NA	NA	**6.86**	7.15	NA
July	2.49	2.67	4.70	5.37	3.76	5.71	5.98	5.31	5.76	6.79	6.96	5.35	6.16	5.93	5.27	6.77
August	2.39	2.55	4.91	6.73	4.50	6.09	6.26	5.44	5.86	6.80	6.85	5.68	**6.22**	6.35	5.43	6.89
September	**2.81**	3.03	**5.29**	6.22	**4.82**	6.11	6.27	**5.52**	**5.92**	6.85	6.98	5.70	6.09	6.34	5.36	6.95

[1]Growing season is estimated to be May 1 through September 30; ground water levels were collected in 2009.
Data were collected weekly through the growing season, except for 59th Avenue and Bird Farm sites (maximum ground water levels for Wells 59-3 and D4 for June were obtained from datalogger data).
2010 and 2011 data were collected twice during the growing season for each year: May 11, 2010, July 27, 2010, May 20, 2011, and August 24, 2011.
NA= Not applicable because ground water levels were not measured at those wells for June for any of the years collected.
Bold values are the deepest observed or predicted maximum water table depths during the growing season based on the data collected.

Table 4-71. Difference in number of years inundated for existing conditions.

Study Site Transect Point	Elevation NGVD (ft)	Approx. Distance from River-bank (ft)	Vegetation Cover Type[1]	Minimum Inundation Flow (cfs)	No. of Years Inundated - Existing Conditions (Run 1)	Change in No. of Years Inundated with Alternative 2 (Run 3a-Run 1)	Change in No. of Years Inundated with Alternative 3 (Run 3b1-Run 1)	Change in No. of Years Inundated with Alternative 4 (Run 3b2-Run 1)
Watson Lake (Segment A)								
Transect 1								
WLT1.1	5,143.18	210	NA	3,000	7	-3	-4	-2
WLT1.2	5,140.93	75	NC/MG W	1,500	17	-1	-1	0
WLT1.3	5,139.10	10	RC H	800	26	0	0	0
WLT1.4	5,141.70	205	BE-NC/ROD W	3,000	7	-3	-4	-2
WLT1.5	5,141.32	500	AM[RC] H	3,000	7	-3	-4	-2
Transect 2								
WLT2.1	5,137.65	50	BE-NC/ROD W	2,500	9	-3	-4	-3
WLT2.2	5,135.85	350	BE-NC/ROD W	3,000	7	-3	-4	-2
WLT2.3	5,133.65	450	AM[RC] H	2,300	11	-4	-5	-3
Martinez Park (Segment B)								
Transect 2								
LMT2.1	4,971.81	375	RO W	2,000	11	-5	-6	-6
LMT2.2	4,969.95	30	RC H	2,000	11	-5	-6	-6
LMT2.3	4,971.52	5	PC/SB W	2,000	11	-5	-6	-6
LMT2.4	4,965.25	140	OW	40	26	0	0	0
LMT2.5	4,972.45	180	PC/SW W	3,000	5	-1	-2	-1
LMT2.6	4,970.47	250	PC/SB W	3,000	5	-1	-2	-1
Transect 3								
LMT3.1	4,969.11	90	UG	2,500	7	-3	-3	-3
LMT3.2	4,969.03	40	PC/SW W	3,200	4	-2	-3	-2
LMT3.3	4,967.66	140	PC/SB W	3,200	4	-2	-3	-2
LMT3.4	4,969.22	190	PC/SB W	3,200	4	-2	-3	-2
Archery Site (Segment C)								
Transect 1								
AT1.1	4,859.15	65	PC/PC-S W	4,000	2	-1	-1	-1
AT1.2	4,857.28	100	PC-(PW)/SW[RC] W	1,900	10	-4	-5	-4
Transect 2								
AT2.1	4,857.06	25	PC/SB W	2,500	7	-3	-3	-2
AT2.2	4,853.46	40	SW/MG-[RC] S	100	26	0	0	0
AT2.3	4,851.38	50	OW	10	26	0	0	0
AT2.4	4,858.67	15	UG	4,600	1	0	0	0
Eastman Park (Segment D)								
Transect 2								
EPT2.1	4,760.65	40	SW/MG-[RC] S	330	16	-3	-3	-1
EPT2.2	4,767.01	70	PC/SB W	2,200	10	-5	-5	-5
EPT2.3	4,765.91	225	PC/SB W	2,200	10	-5	-5	-5
EPT2.4	4,766.83	275	PC/SB W	2,100	10	-5	-5	-5
EPT2.5	4,764.55	675	PC/SB W	2,100	10	-5	-5	-5
Transect 3								
EPT3.1	4,760.54	305	PC/SB W	2,100	10	-5	-5	-6
EPT3.2	4,762.18	40	PC/SB W	1,900	11	-3	-3	-4

Study Site Transect Point	Elevation NGVD (ft)	Approx. Distance from River-bank (ft)	Vegetation Cover Type[1]	Minimum Inundation Flow (cfs)	No. of Years Inundated - Existing Conditions (Run 1)	Change in No. of Years Inundated with Alternative 2 (Run 3a-Run 1)	Change in No. of Years Inundated with Alternative 3 (Run 3b1-Run 1)	Change in No. of Years Inundated with Alternative 4 (Run 3b2-Run 1)
59th Avenue (Segment E)								
Transect 1								
59T1.1	4,694.35	145	PC/SB W	4,000	3	-2	-2	-1
59T1.2	4,692.97	5	PC/SB W	980	11	0	0	0
59T1.3	4,686.93	10	RC H	160	25	-3	-4	-1
59T1.4	4,694.00	5	PC/SB W	2,300	9	-4	-4	-4
Transect 3a								
59T3a,1	4,687.76	280	PC/SB W	580	15	-2	-3	-2
59T3a.2	4,691.19	230	PC/SB W	1,900	11	-4	-3	-4
59T3a.3	4,691.62	5	PC/SB W	1,900	11	-4	-3	-4
59T3a.4	4,688.31	35	RC H	1,820	11	-4	-3	-3
59T3a.5	4,691.89	5	PC/SB W	2,100	11	-5	-6	-5
Transect 3b								
59T3b.1	4,689.84	70	UG	580	15	-2	-3	-2
59T3b.2	4,692.68	10	PC/SB W	2,000	11	-4	-4	-5
59T3b.3	4,689.97	125	PC/SB W	850	11	0	0	0
59T3b.4	4,689.27	150	PC/SB W	850	11	0	0	0
Bird Farm (Segment F)								
Transect 2								
BF2.1	4,612.98	155	PC/SB W	1,500	11	0	-2	-1
Transect 3								
BFT3.1	4,608.70	160	PC-(PW)/SW-[RC] W	2,200	11	-5	-5	-5
BFT3.2	4,608.95	5	UG	2,300	10	-4	-5	-4
BFT3.3	4,606.12	30	SW/MG-[RC] S	520	18	-1	0	-1
BFT3.4	4,607.80	360	PC/SB W	1,500	11	0	-2	-1

[1] AM[RC] H - American Mannagrass[Reed Canarygrass] Herbaceous; BE-NC/ROD W - Boxelder-Narrowleaf Cottonwood/Red-Osier Dogwood Woodlands; NA – Not Applicable; NC/MG W -Narrowleaf Cottonwood/Mesic Graminoid Woodlands; OW – Open Water; PC-(PW)/SW[RC] W - Plains Cottonwood-(Peachleaf Willow)/Sandbar Willow/[Reed Canarygrass] Woodland; PC/PC-S W - Plains Cottonwood/Prairie Cordgrass-Sedge Woodland; PC/SB W - Plains Cottonwood/Smooth Brome Woodland; PC/SW W - Plains Cottonwood/Slender Wheatgrass Woodland; RC H -Reed Canarygrass Herbaceous; RO W - Russian Olive Woodland; SW/MG-[RC] S - Sandbar Willow/Mesic Graminoid-[Reed Canarygrass] Shrubland; UG – Upland Grassland; NGVD - National Geodetic Vertical Datum.

Table 4-72. Composite FACWet functional capacity index score for depressional wetlands.

Poudre River Study Site	Segment	Existing Conditions	Alternative 2	Alternative 3	Alternative 4
Watson Lake	A	0.72	0.72	0.72	0.72
Martinez Park	B	0.70	0.70	0.70	0.70
Archery Site	C	0.72	0.72	0.72	0.72
Eastman Park	D	0.73	0.73	0.73	0.73
59th Avenue	E	0.76	0.75	0.75	0.75
Bird Farm	F	0.77	0.77	0.77	0.77

1.0 to 0.9 – Reference Standard; <0.9 to 0.8 – Highly Functioning; <0.8 to 0.7 – Functioning; <0.7 to 0.6 – Functioning Impaired; <0.6 – Nonfunctioning.

Table 4-73. Composite FACWet functional capacity index score for riverine wetlands.

Poudre River Study Site	Segment	Existing Conditions	Alternative 2	Alternative 3	Alternative 4
Watson Lake	A	0.71	0.69	0.69	0.69
Martinez Park	B	0.71	0.69	0.69	0.70
Archery Site	C	0.69	0.67	0.67	0.68
Eastman Park	D	0.70	0.69	0.68	0.69
59th Avenue	E	0.70	0.68	0.68	0.68
Bird Farm	F	0.73	0.71	0.71	0.71

1.0 to 0.9 – Reference Standard; <0.9 to 0.8 – Highly Functioning; <0.8 to 0.7 – Functioning; <0.7 to 0.6 – Functioning Impaired; <0.6 – Nonfunctioning.

4.10 WILDLIFE

This section provides information on the potential effects of the alternatives on wildlife resources within the study areas and replaces Section 4-14 of the DEIS. No additional studies were conducted on wildlife resources for the SDEIS, although new analyses based on updated information and revised study areas are presented. Revised information is presented for potential indirect effects on wildlife associated with indirect effects on Poudre River riparian vegetation (ERO 2014d) and the 2015 Aquatic Resources Effects Report (GEI 2015b). For the SDEIS, potential local impacts on big game species were determined. All impacts on big game were evaluated in the DEIS at a regional scale (Game Management Unit or GMU). Because regional effects of all alternatives on big game would be negligible (<1% of habitat available within each GMU would be affected) and none of the alternatives would likely have a noticeable effect on big game populations or sex ratios at a regional scale, local impacts could be more meaningful and are discussed in the analysis of big game effects. There is no standard criterion for defining effects at a "local" scale or population. This analysis uses a ¼-mile buffer to define local effects on big game populations based on professional judgment and the concept of limiting factors. A limiting factor is a resource or environment (e.g., winter range) that most limits the growth, abundance, or distribution of an individual or population. Thus, the analysis assumes that the most profound effects on a limiting environment would occur within close proximity (¼ mile) of the project component. Information on wildlife resources are described in Section 4 of the 2008 Wildlife Report (ERO 2008e) and updated in the 2015 Wildlife Supplement (ERO 2015c).

Potential effects on wildlife include the direct effects on wildlife and wildlife habitat associated with proposed project facilities, such as reservoirs and associated structures, roads, pipelines, and canals. Indirect impacts, both temporary and permanent, such as those that might occur due to noise or visual disturbance, are described. Permanent effects include reservoir and dam footprints, forebay, pump stations, associated facilities, pipeline connections to the reservoir, and realigned roads. Temporary effects include removal of vegetation around the dam, reservoirs, pump stations, realigned roads, and other facilities; access roads; borrow areas; staging areas; and pipelines that would be restored following construction. Permanent effects on aquatic habitat are from the placement of permanent fill; temporary effects are areas where pre-construction contours and drainage would be restored after construction.

4.10.1 Methods

Methods used to assess wildlife resources are described in Section 4.14.1 in the DEIS, and Section 4 of the 2008 Wildlife Report (ERO 2008e). Wildlife resources were identified in the study areas based on field observations, remote sensing using aerial photography, and from published reports and database searches, specifically the CPW wildlife database (CPW 2013). Effects on wildlife include benefits, or positive effects, resulting from the alternatives, as well as impacts, which are negative. Effects to wildlife are described as negligible, minor, moderate, or major based on the following criteria. Negligible effects would be at the lowest levels of detection, barely measurable, with no perceptible consequences. Minor effects might result in a detectable change, but the change would be slight. Minor is used when the benefits or impacts

would be short-term, occur at low levels, and are not likely to have a long-term noticeable effect on wildlife. Minor effects include temporary impacts during construction. Moderate is used when impacts to wildlife would affect individuals or small groups of wildlife, but would not affect populations or large areas of wildlife habitat. Major is used when impacts to large populations or large areas of wildlife habitat would occur. Major effects typically are long-term. The term no impact is used when there are no changes to existing conditions from the alternatives. Methods for evaluating effects on wildlife are described in the 2015 Wildlife Supplement (ERO 2015c).

Big game habitat is mapped by CPW by seasonal use and ranges that frequently overlap. For example, CPW maps big game winter range, winter concentration areas, and severe winter range; each range is a subset of the previous range, depending on the severity of the winter. Winter range is where 90% of the individuals are located during an average of 5 winters out of 10 from the first heavy snowfall to spring green-up. A winter concentration area is that part of the winter range of a species where densities are at least 200% greater than the surrounding winter range density. Severe winter range is where 90% of the individuals are located in the 2 worst winters out of 10.

Because winter range classifications overlap, alternatives with the greatest effect on winter range would also have a corresponding greater effect on winter concentration areas and severe winter range. All alternatives would have a minor permanent effect on severe winter ranges (<4% of available range at a local scale) for most big game species, and the analysis focuses on the larger winter range and winter concentration areas for comparative effects among alternatives for elk, mule deer, and pronghorn. The analysis on white-tailed deer focuses on winter range because winter range and winter concentration areas closely overlap in the study areas and alternative impacts are very similar within these two seasonal habitats.

Loss of a small percentage (<10%) of winter ranges at a local scale could affect some individuals, but is not likely to reduce the overall survival of individuals. The loss of a greater percentage of winter ranges could have progressively increasing effects on individual survival at the local scale. Based on this information, the direct effects on big game from each of the alternatives were characterized as follows:

- Negligible – no measurable (<1%) or perceptible consequence to the winter ranges
- Minor – effects are localized, with impacts on winter ranges between 1 and 10%
- Moderate – effects are localized, with impacts on winter ranges between 11 and 20%
- Major – effects are regional or localized with impacts on winter range greater than 20%

4.10.2 No Action Alternative (Alternative 1)

Wildlife habitat would be impacted under the No Action Alternative by construction and inundation of Cactus Hill reservoir, construction of the conveyance system, dry-up of irrigated lands, and decreased water flows in the Poudre River. Direct impacts to wildlife would result from loss or degradation of habitat, mortality from ground-disturbing activities, and from vegetation clearing and inundation of natural habitat. Indirect impacts consist of displacement of

wildlife by noise and disturbance resulting from on-site construction, and transport of materials and people. Temporary displacement could result in increased mortality from vehicle collisions and increased resource competition. Table 4-74 summarizes the direct effects on wildlife habitat that are predicted to occur under the No Action Alternative.

Table 4-74. Direct effects (acres of habitat) of the No Action Alternative on wildlife.

Habitat Type	Permanent	Temporary
Big game habitat		
Elk overall range	0	25
Elk winter range	0	0
Elk winter concentration area	0	0
Mule deer winter range	2,602	466
Mule deer winter concentration area	1,635	186
Pronghorn winter range	220	41
Pronghorn winter concentration area	0	0
White-tailed deer winter range	2,602	405
Wetlands, riparian, and aquatic habitat		
Aquatic habitat[1]	6	17
Riparian (mesic mixed woodlands)	4	14
Wetland–agricultural transfers (dry-up)	218	0
Wetlands	32	16
Other habitat types		
Great blue heron nesting area	<1	2
Native grassland (upland and mesic)	616	71
Other grasslands	1,674	260
Upland native shrublands	0	0
Other shrublands	0	2
Agricultural lands	251	503

[1]Aquatic habitats include lakes, ponds, creeks, streams, ditches, and canals as described in the 2008 Vegetation Report (ERO 2008c) and updated in the 2015 Vegetation and Wetland Resources Supplement (ERO 2015b).

4.10.2.1 Cactus Hill Reservoir

4.10.2.1.1 Big Game

Under the No Action Alternative, most of the permanent effects on big game habitat would occur as a result of construction of Cactus Hill Reservoir. Cactus Hill Reservoir is within the overall ranges of mule deer, white-tailed deer, and pronghorn and these ranges would be slightly reduced by construction of the reservoir (Appendix B in ERO 2015c). The effects on big game seasonal habitat are provided in Table 4-74 and Appendix B of the 2015 Wildlife Supplement (ERO 2015c).

Although direct loss of big game habitat would be negligible or inconsequential at a regional scale, the effects could be consequential at a more local scale and could severely reduce or eliminate locally important seasonal cover or forage resources, displace animals from locally limited resources, or disrupt important movement patterns. The direct loss of mule deer, pronghorn and white-tailed deer winter range represents about 18, 13, and 20%, respectively, of

these habitats at the local scale, which would be moderate effects. The direct loss of mule deer winter concentration area would be 33% at a local scale, a major effect.

4.10.2.1.2 Migratory Birds and Raptors

Birds associated with affected vegetation types described in the 2008 Vegetation Report (ERO 2008c) and the 2015 Vegetation and Wetland Resources Supplement (ERO 2015b) would be directly affected by the No Action Alternative through the loss of nesting, migratory, winter, and year-round habitat and the potential destruction of nests. Under the No Action Alternative, permanent effects on birds would be greatest for species associated with grassland and agricultural habitats, such as ground-nesting songbirds and raptors. The greatest effects on ground-nesting birds and other species associated with native grassland habitats would occur as a result of construction of Cactus Hill Reservoir. Native vegetation generally provides higher quality wildlife habitat and greater biodiversity because it is often less disturbed and has fewer introduced species. About 69% of the permanent effects on vegetation from the No Action Alternative would consist of Agricultural Lands or mixed and introduced grasslands, rather than native grasslands. The loss of these habitat types would be a moderate effect on migratory birds associated with grassland habitats because individuals would be displaced but the No Action Alternative would be unlikely to affect the overall populations of species because the habitat lost is a small percent of the overall habitat available in the region.

The No Action Alternative would result in the permanent direct loss of about 32 acres of wetlands providing potential habitat for bird species associated with wetland habitats and about 11 acres of wetlands would be temporarily lost (ERO 2015b). About 4 acres of riparian woodlands would be permanently lost and 14 acres would be temporarily affected. However, Cactus Hill Reservoir would provide new open water habitat for waterfowl as well as foraging habitat for bald eagle and osprey. Newly created shorelines would provide new habitat for shore birds. The additional open water and shore habitat would be a beneficial effect for migratory birds that use those habitats. Cactus Hill Reservoir would also provide a new substrate for macroinvertebrate breeding and population growth in the area around Cactus Hill Reservoir. This would have an indirect beneficial effect on birds that feed on macroinvertebrates. The effects on migratory birds associated with wetlands, riparian, and aquatic habitats would be minor because of the abundant habitat available below the reservoir at Black Hollow Reservoir and the creation of new wetlands and aquatic habitat associated with Cactus Hill Reservoir.

Direct impacts to raptors could occur during construction from disturbance from human activity around an active raptor nest. Depending on several factors such as species, the type of activity, topography, and individual sensitivity, disturbance could result in loss of eggs or young from nest abandonment. If construction begins after the start of the nesting season (generally March 15 to July 31), construction activity may remove trees with active nests or cause abandonment of active nests in the vicinity of construction, resulting in loss of eggs or young. Destruction of an active nest or activities that result in nest failure would be a violation of the Migratory Bird Treaty Act.

4.10.2.1.3 Reptiles and Amphibians

Reptiles and amphibians occurring in the affected vegetation types described in the 2008 Vegetation Report and the 2015 Vegetation and Wetland Resources Supplement would be directly affected by the No Action Alternative through the loss of habitat. Mortality of adults, eggs, or tadpoles could also occur during construction of Cactus Hill Reservoir, pipelines, and other project components. The effects on grasslands and agricultural areas that provide habitat for reptiles, some toad species, and on wetlands and riparian woodlands that support both reptiles and amphibians would be the same as described for migratory birds. The greatest effects on reptile and amphibian species associated with grassland habitats would occur as a result of construction of Cactus Hill Reservoir. The No Action Alternative would result in the loss of about 2,290 acres of grassland habitat, including 616 acres of Native Grassland. The loss of these habitat types would be a moderate effect on reptiles associated with grassland habitats because individuals would be displaced but the No Action Alternative would be unlikely to affect the overall populations of species because the habitat lost is a small percent of the overall habitat available in the region.

The open water habitat created with the construction of Cactus Hill Reservoir would provide some new habitat for amphibians but the habitat would likely be low quality because establishment of persistent wetland vegetation is typically prevented by fluctuations of reservoir levels. Open water habitat would be a beneficial effect for amphibians. The effects on amphibians associated with wetlands, riparian, and aquatic habitats at the Cactus Hill study area would be minor because of the abundant habitat available below the reservoir at Black Hollow Reservoir and the creation of new wetlands and aquatic habitat associated with Cactus Hill Reservoir.

4.10.2.1.4 Other Wildlife Species

Small and large mammals associated with affected vegetation types described in the 2008 Vegetation Report and the 2015 Vegetation and Wetland Resources Supplement would be directly affected by the No Action Alternative through the loss of habitat. Mortality of individuals of smaller, less mobile species could also occur during construction of reservoirs, pipelines, and other project components.

Effects on wildlife habitat from the No Action Alternative would be similar to those described above for migratory birds. Permanent effects on wildlife resulting from the No Action Alternative would be greatest on grassland and agricultural habitats, which support high densities of ground squirrels, rabbits, foxes, badgers, coyotes, and other mammals. New reservoirs would provide habitat and additional sources of water for various wildlife such as muskrat and beaver.

4.10.2.2 Conveyance Systems

Conveyance systems include the pipeline alignments, pump stations, and water treatment plants. The pipeline routes would follow existing roads where possible, and primarily traverse agricultural areas and grasslands. The pipeline routes would cross riparian areas, wetlands, and waters that provide habitat for a variety of wildlife species. Pipelines and pump stations for the No Action Alternative would permanently impact about 0.5 acre of a great blue heron nesting

area and temporarily impact about 1 acre of nesting area. These impacts would occur along the edge of the 500-meter nest buffer and would likely be minor. Most other impacts to wildlife habitat associated with the pipelines would be temporary; however, pump stations and other structures necessary to distribute water would result in minor permanent impacts. Because wildlife is dynamic and can move or shift use areas to avoid human disturbance, effects were analyzed on a broader landscape scale and conveyance system impacts are similar to the reservoir impacts described above.

Pipelines, roads, and other linear facilities can create barriers to wildlife movements and fragment habitat. No wildlife migration corridors would be crossed by conveyance systems and pipelines would be buried underground and revegetated. Effects of the conveyance system on wildlife movement would be negligible to minor because most of the effects are temporary.

4.10.2.3 No Action Irrigated Lands

About 64,200 acres of irrigated agricultural land would be dried up as a result of the No Action Alternative. Methods for estimating losses of irrigated wetlands resulting from the dry up of agricultural lands are described in WEST (2010). An estimated 218 acres of irrigated wetlands would dry up as a result of the No Action Alternative. The agricultural wetlands that would be dried up generally provide low- to moderate-quality habitat as they are supported by flood irrigation and are often subjected to tilling and other disturbances. Losses of irrigated cropland and wetlands, as well as open water habitat, would affect wildlife, although most of the species associated with these habitats are disturbance-tolerant generalist species. Wildlife most likely to be affected by the loss of cropland and other agricultural land include species that may use these areas for foraging or cover such as the raccoon, ring-necked pheasant, and Canada goose. Wildlife potentially affected by the loss of irrigated wetlands includes the Woodhouse's toad, a variety of water fowl, and other migratory bird species. Although irrigation canals and ditches are periodically cleared or dredged, the loss of open water habitat could affect species such as the snapping turtle, northern water snake, and mallard. Dry up could consist of either reestablishing native vegetation on the acreages involved, conversion to nonnative weedy habitat, or conversion of farming practices to the production of dry-land crops such as winter wheat. Areas revegetated to upland grassland habitat would provide habitat for grassland-associated wildlife, which would be a beneficial effect for these species.

4.10.2.4 Poudre River

Assessment of potential impacts to wildlife is based on the effects and trends described for other resources, which could affect wildlife and wildlife habitat, and does not rely directly on the comparison of hydrologic modeling for wildlife. Effects on wetland and riparian vegetation that provide habitat for migratory birds, amphibians, reptiles, and other wildlife are analyzed in the Wetlands and Riparian Resources Effects Report (ERO 2014d). The analysis found that under all alternatives, plains cottonwoods would likely continue to decline along the mainstem of the Poudre River, while nonnative species such as green ash, box elder, Siberian elm, Russian olive,

and reed canarygrass would persist or increase. Corresponding changes in wildlife communities described in detail in the 2015 Wildlife Supplement (ERO 2015c) would include:

- A decrease in the abundance of roosting/nesting/breeding opportunities for riparian wildlife
- A shift in wildlife species composition
- A decreased abundance of suitable nesting and roosting habitat for colonial birds (herons and egrets) and raptors

The No Action Alternative was evaluated under Future Conditions hydrology, as explained in Section 4.2.2 and, therefore, the indirect effects analyses for the No Action Alternative for the Poudre River mainstem are presented in Chapter 5.

4.10.2.5 South Platte River

Section 4.12.4 of the DEIS concluded that reductions in South Platte River flows associated with the alternatives are estimated to be relatively minor and would not adversely affect the supportive hydrology for wetlands along the South Platte River. The No Action Alternative was revised for the SDEIS. The No Action Alternative was evaluated under Future Conditions hydrology, as explained in Section 4.2.2. The No Action Alternative for the South Platte River from the confluence with the Poudre down to the Kersey Gage Poudre River mainstem are presented in Chapter 5.

4.10.3 District's Preferred Alternative (Alternative 2)

Wildlife habitat would be impacted under Alternative 2 by construction and inundation of Glade and Galeton Reservoirs, construction of the conveyance system, and decreased water flows in the Poudre and South Platte Rivers. Direct impacts to wildlife would result from loss or degradation of habitat, mortality from ground-disturbing activities, and from vegetation clearing and inundation of natural habitat. Indirect impacts consist of displacement of wildlife by noise and disturbance resulting from on-site construction and transport of materials and people. Temporary displacement could result in increased mortality from vehicle collisions and increased resource competition. Table 4-75 summarizes the direct effects on wildlife habitat that are predicted to occur under Alternative 2.

Table 4-75 Direct effects (acres of habitat) of Alternative 2 on wildlife.

Habitat Type	Reclamation Action		No Reclamation Action	
	Permanent	Temporary	Permanent	Temporary
Big game				
Elk overall range	2,043	386	2,043	456
Elk winter range	186	101	196	167
Elk winter concentration area	124	75	124	74
Mule deer winter range	3,789	647	3,789	746
Mule deer winter concentration area	70	152	70	231
Pronghorn winter range	2,256	295	2,256	295
Pronghorn winter concentration area	1,928	204	1,928	204
White-tailed deer winter range	416	192	416	181
Wetlands, riparian, and aquatic habitat				
Wetlands	44	8	44	10
Riparian (mesic mixed woodlands)	29	9	28	10
Aquatic habitat[3]	12	6	12	4
Other habitat types				
Great blue heron nesting area	0	0	0	2
Native grassland (upland and mesic)	2,331	74	2,331	116
Other grasslands	593	234	593	272
Upland native shrublands	453	73	454	91
Other shrublands	84	0	84	0
Agricultural lands	238	262	238	280

4.10.3.1 Reservoir Sites and U.S. 287

4.10.3.1.1 Big Game

Big game, including elk, mule deer, white-tailed deer, and pronghorn, would lose habitat due to permanent and temporary impacts associated with reservoir construction and inundation. Under Alternative 2, most of the permanent effects on big game habitat would occur as a result of construction of the two reservoirs as described in Section 6.3.1 of the 2008 Wildlife Report and 2015 Wildlife Supplement. Glade Reservoir would be located at the eastern edge of a residential elk population area, where elk could be present at any time during the year. Winter range and winter concentration habitat for big game is also present within the Alternative 2 study area. The effects on all big game seasonal habitats are provided in Table 4-73 and Appendix B of the 2015 Wildlife Supplement.

Elk overall range includes the area east of U.S. 287 and abuts the western edge of the Fort Collins and Laporte urban areas. Alternative 2 is the only alternative with substantial effects on elk overall range, primarily because of the location of Glade Reservoir. Under the Reclamation Action Option, 2,043 acres of elk overall range, representing 18% of the local habitat, would be permanently lost, of which 1,882 acres would be lost at Glade Reservoir (Appendix B in ERO 2015c). About 124 acres of an elk winter concentration area, representing about 13% of local habitat available, would be permanently affected by Glade Reservoir and 75 acres would be

temporarily affected. Slight differences in effects on elk habitat occur under the No Reclamation Action Option (Appendix B in ERO 2015c).

Under the Reclamation Action Option, about 3,789 acres of mule deer winter range, representing about 16% of the local habitat, would be permanently affected with 1,882 acres occurring at Glade Reservoir and 1,928 acres occurring at Galeton Reservoir. About 70 acres of mule deer winter concentration habitat would be permanently affected, including 59 acres at Glade Reservoir or <2% of the local habitat. About 152 acres of a mule deer winter concentration area and 647 acres of mule deer winter range would be temporarily affected by the loss of vegetation during construction of project facilities, access roads, and staging areas. Mule deer permanent effects are the same under the No Reclamation Action but the temporary effects are slightly higher (Appendix B in ERO 2015c).

Under both the Reclamation Action and No Reclamation Action Options, about 2,256 acres of pronghorn winter range and 1,938 acres of a pronghorn winter concentration area would be permanently lost (Table 4-75), mostly at Galeton Reservoir (Appendix B in ERO 2015c). This represents about 25% and 31% of the local availability of these habitats, respectively.

Under the Reclamation Action Option, about 416 acres (8% of the local habitat) of white-tailed deer winter range, mostly at Glade Reservoir, would be permanently affected by reservoir construction and inundation and an additional 100 acres would be temporarily affected. The permanent white-tailed deer effects are the same under both Reclamation options, while the temporary effects of the Reclamation Action Option are slightly higher.

Although direct loss of big game habitat would be negligible or inconsequential at a regional scale, the effects could be consequential at a local scale. Major and moderate effects could reduce or eliminate locally important seasonal cover or forage resources, displace animals from locally limited resources, or disrupt important movement patterns. Both the Reclamation Action and No Reclamation Action Options would have major local effects on pronghorn winter range and winter concentration areas, moderate local effects on elk winter concentration areas and mule deer winter range, and minor effects on mule deer winter concentration areas. Both options would also have moderate local effects on elk overall range.

U.S. 287 would be realigned under both Alternative 2 Reclamation options. Subsequent to the DEIS, CDOT selected the western alignment as their preferred alternative. Topography in the Glade Reservoir area forms a natural funnel that directs the east-west seasonal movements of both mule deer and elk through a relatively narrow passage through the hogbacks. Because current east-west movements of deer and elk may shift north and/or south as a result of the construction of Glade Reservoir, the U.S. 287 realignment could result in increased risk of big game/vehicle collisions, although the realigned U.S. 287 would shift to the eastern fringe of the mapped elk overall range. The realignment could also disrupt north-south movements of deer and elk where they cross the hogbacks east of the current U.S. 287.

4.10.3.1.2 Migratory Birds and Raptors

Under Alternative 2, most of the effects on migratory bird habitat would occur as a result of construction of Glade and Galeton Reservoirs, resulting in the loss of wetlands, open water and

stream habitat, shrublands, and grasslands. Effects on migratory birds and raptors are described in the 2008 Wildlife Report (ERO 2008e) and updated in the 2015 Wildlife Supplements (ERO 2015c) due to the increase in size of the proposed Galeton Reservoir from 40,000 AF to 45,624 AF.

Clearing of vegetation during reservoir site preparation has the potential to remove trees with stick nests used by hawks or cavity nests used by owls. All raptors are protected under the Migratory Bird Treaty Act, and removal or destruction of an active nest would be a violation of the act. Impacts would be avoided or minimized by use of pre-construction surveys to identify active nests in the Project footprint. If nests are found in the construction area, they would be removed during the non-breeding season when they are not being actively used. Removal of inactive nests during vegetation clearing would have no direct impacts on raptors, but could affect use of breeding territories during the next breeding season. Some species, such as red-tailed hawk, typically have multiple nests within their territory, and breeding would likely occur at one of the alternate nests. Other species often build or use new nests each year, such as great-horned owl and Cooper's hawk, and loss of an old nest site would have no effect. Impacts would be greatest for species that have high nest fidelity and that use the same nest for many years, such as bald eagle and osprey.

Direct impacts could occur during construction from disturbance from human activity around an active raptor nest. Depending on several factors such as species, the type of activity, topography, and individual sensitivity, disturbance could result in loss of eggs or young from nest abandonment. If construction begins after the start of the nesting season (generally March 15 to July 31), construction activity may remove trees with active nests or cause abandonment of active nests in the vicinity of construction, resulting in loss of eggs or young. Destruction of an active nest or activities that result in nest failure would be a violation of the Migratory Bird Treaty Act.

Under both the Reclamation Action and the No Reclamation Action Options, birds associated with wetlands, riparian, and open water habitat would be affected by the permanent loss of about 42 acres of wetlands, 22 acres of riparian woodlands, and 6 acres of aquatic habitat. Effects on riparian woodlands and aquatic habitat have been reduced since the DEIS by correcting inundation effects at the Galeton forebay. Implementation of either option would temporarily disturb less than 10 acres of wetlands, riparian woodlands, and aquatic habitat. Birds associated with shrub and grassland habitats would be affected by the permanent loss of about 537 acres of shrublands and 2,256 acres of grassland habitat, including 2,331 acres of native grasslands under both options. No effects on great blue heron nesting areas would occur under the Reclamation Action Option, but the No Reclamation Option would result in the temporary loss of 2 acres near the edge of a great blue heron nesting area (500 meters around a known active or inactive nest site) during construction.

Glade and Galeton Reservoirs would provide new open water habitat for water fowl, as well as foraging habitat for bald eagles, kingfisher, osprey, and other fish-eating birds. Newly created shorelines would provide new habitat for shore birds. The additional open water and shore habitat would be a beneficial effect for migratory birds that use those habitats. Glade and

Galeton Reservoirs would also provide a new substrate for macroinvertebrate breeding, which would increase the numbers in the area around these reservoirs. This would have an indirect beneficial effect on birds that feed on macroinvertebrates.

Effects on migratory birds would be similar under both Reclamation options (ERO 2015c). Permanent and temporary effects on migratory birds would be moderate for species associated with grassland habitats and minor for species associated with wetlands, riparian and aquatic habitats because of the habitat available below Glade Reservoir and the creation of new wetlands and aquatic habitat associated with both reservoirs.

4.10.3.1.3 Reptiles and Amphibians

Reptiles and amphibians occurring in the Alternative 2 study area would be directly affected by Alternative 2 through the loss of habitat. Effects on reptiles and amphibians are described in the 2008 Wildlife Report and updated in the 2015 Wildlife Supplement due to the increase in size of the proposed Galeton Reservoir from 40,000 AF to 45,624 AF.

Under the Reclamation Action Option, effects on amphibians would occur from the permanent loss of 42 acres of wetlands and 6 acres of aquatic habitat. About 4 acres of wetlands would be temporarily disturbed. Reptiles associated with shrub habitat would be affected by the permanent loss of 537 acres and temporary disturbance of 73 acres of shrub habitat. Reptiles and amphibians associated with grassland habitat would be affected by the permanent loss of 2,924 acres and temporary loss of 308 acres of grasslands.

Under the No Reclamation Option, permanent effects on amphibians and reptiles from the permanent loss of wetlands, aquatic habitat, shrublands, and grasslands would be the same as under the Reclamation Action Option. About 10 acres of wetlands and 4 acres of aquatic habitat would be temporarily disturbed. Reptiles associated with shrub and cliff habitat would be affected by the temporary disturbance of 91 acres of shrub habitat. Reptiles and amphibians associated with grassland habitat would be affected by the temporary disturbance of 388 acres of grasslands.

The open water habitat created with the construction of Glade and Galeton Reservoirs would provide some new habitat for amphibians, but it would likely be low quality because of the lack of persistent wetland vegetation. Open water habitat would be a beneficial effect for amphibians.

Effects on reptiles and amphibians would be similar under both Reclamation options (ERO 2015c). Permanent and temporary effects would be moderate for species associated with grassland habitats and minor for species associated with wetlands, riparian and aquatic habitats because of the habitat available below Glade Reservoir and the creation of new wetlands and aquatic habitat associated with both reservoirs.

4.10.3.1.4 Other Wildlife Species

Mammals such as squirrels, rabbits, foxes, badgers, coyotes, raccoons, several species of bats, and other mammals occurring in the Alternative 2 study area would be directly affected by Alternative 2 through the loss of habitat. Effects on other wildlife species are described in Section 6.3.4 of the 2008 Wildlife Report (ERO 2008e) and updated in 2015 (ERO 2015c) due to the increase in size of the proposed Galeton Reservoir from 40,000 AF to 45,624 AF.

Effects on wildlife habitat from Alternative 2 would be similar to those described above for migratory birds. Permanent effects on wildlife resulting from Alternative 2 would be greatest on grassland and agricultural habitats, which support high densities of ground squirrels, rabbits, foxes, badgers, coyotes, and other mammals. New reservoirs would provide habitat and additional sources of water for various wildlife such as muskrat and beaver.

4.10.3.1 Conveyance Systems

Because wildlife is dynamic and can move or shift use areas to avoid human disturbance, effects were analyzed on a broad landscape scale and conveyance system impacts would be similar to reservoir impacts described above. However, pipelines, road and other linear facilities can create barriers to wildlife movements and fragment habitat. No wildlife migration corridors would be crossed by conveyance systems and pipelines would be buried underground and revegetated. Effects of the conveyance system on wildlife movement would be negligible to minor because most of the effects would be temporary.

4.10.3.2 Poudre and South Platte Rivers

Reduced spring river flows would likely affect the overall abundance of wildlife but would not alter species composition and distribution. The effects of Alternative 2 on the Poudre and South Platte Rivers are based on general predicted trends for wetlands, riparian, and aquatic habitats that are expected to occur with or without implementation of any of the NISP alternatives. Predicted declines in alluvial ground water levels in Segment B under Alternative 2 are likely to affect about 9 acres of riparian and wetland plant communities that are shallowly rooted, are associated with shallow alluvial ground water levels, and occur close to the riverbank where changes in river stage have a one-to-one relationship with alluvial ground water levels (ERO 2014d). A predicted shift in species composition favoring plant species adapted to greater fluctuations in ground water levels could result in slight habitat changes in Segment B for the common garter snake, northern leopard frog, smoky-eyed brown butterfly, two-spotted skipper and other wildlife that may use these habitats. The predicted changes in vegetation would occur slowly over a long period of time and would likely be negligible and imperceptible given the dynamics of riparian areas. Wildlife using these habitats typically use a wide range of aquatic, wetlands, and riparian habitats and would likely adapt to the new habitat conditions that currently occur within the riparian areas of the rivers. Effects on the common gartersnake, northern leopard frog, smoky-eyed brown butterfly, two-spotted skipper are addressed in Section 4.11.

4.10.4 Alternative 3

Wildlife habitat would be impacted under Alternative 3 by construction and inundation of Cactus Hill and Galeton Reservoirs, construction of the conveyance system, lining the Poudre Valley Canal, and decreased water flows in the Poudre and South Platte Rivers. Direct impacts to wildlife would result from loss or degradation of habitat, mortality from ground-disturbing

activities, and from vegetation clearing and inundation of natural habitat. Indirect impacts consist of displacement of wildlife by noise and disturbance resulting from on-site construction and transport of materials and people. Temporary displacement could result in increased mortality from vehicle collisions and increased resource competition. Table 4-76 summarizes the direct effects on wildlife habitat that are predicted to occur under Alternative 3.

Table 4-76. Direct effects (acres of habitat) of Alternative 3 on wildlife.

Habitat Type	Permanent	Temporary
Big game habitat		
Elk overall range	46	35
Elk winter range	10	15
Elk winter concentration area	0	0
Mule deer winter range	5,687	534
Mule deer winter concentration area	2,332	146
Pronghorn winter range	2,317	234
Pronghorn winter concentration area	1,928	204
White-tailed deer winter range	3,929	284
Wetlands, riparian, and aquatic habitat		
Wetlands	34	19
Riparian (mesic mixed woodlands)	16	15
Aquatic habitat	92	12
Other habitat types		
Great blue heron nesting area	0	2
Native grassland (upland and mesic)	2,242	37
Other grasslands	2,883	354
Upland native shrublands	0	4
Other shrublands	0	1
Agricultural lands	649	623

4.10.4.1 Reservoir Sites

4.10.4.1.1 Big Game Species

Under Alternative 3, most of the permanent effects on big game habitat would occur as a result of construction of Cactus Hill Reservoir and Galeton Reservoir, and are described in the 2015 Wildlife Supplement (ERO 2015c). Effects on big game habitat have been updated due to the increase in size of the proposed Galeton Reservoir from 40,000 AF to 45,624 AF, increase in the size of Cactus Hill Reservoir from 180,000 AF to 190,000 AF, and updates to CPW's wildlife database (CPW 2013) since 2008.

Under Alternative 3, there would be permanent effects on 46 acres of elk overall range (<2% of local habitat), 10 acres of winter range (<1% of local habitat), and no effect on winter concentration areas. Temporary effects on elk overall range and winter range would be 35 and 15 acres, respectively. About 5,687 acres of mule deer winter range would be permanently lost with 3,873 acres occurring at the Cactus Hill Reservoir and 1,722 acres occurring at Galeton Reservoir; 534 acres would be temporarily disturbed. This represents a 23% of local habitat loss, a major effect. About 2,321 acres of a mule deer winter concentration area would be

permanently lost at Cactus Hill Reservoir (28% of local habitat). Temporary effects on a mule deer winter concentration area would be 146 acres and winter range would be 534 acres.

About 2,317 acres of pronghorn winter range would be permanently lost (1,928 acres at Galeton Reservoir) and 234 acres would be temporarily disturbed. The permanent loss of pronghorn winter range would be about 27% of local habitat. About 1,928 acres of a winter concentration area would be permanently affected, all at Galeton Reservoir and about 204 acres of a winter concentration area would be temporarily affected at Galeton. The permanent loss of pronghorn winter concentration area would be about 31% of the local habitat. About 3,929 acres of white-tailed deer winter range, all at Cactus Hill Reservoir, would be permanently affected (25% at a local scale) and about 284 acres would be temporarily affected.

Alternative 3 would have minor effects on local elk overall range, negligible effects on local elk winter range, and major local effects on mule deer winter range and winter concentration areas, pronghorn winter range and winter concentration areas, and white-tailed deer winter range. These major local effects on winter range and winter concentration areas could severely reduce or eliminate locally important winter cover or forage resources, displace animals from locally limited resources, or disrupt important movement patterns.

4.10.4.1.2 Migratory Birds and Raptors

Under Alternative 3, most of the effects on migratory bird and raptor habitat would occur as a result of construction of Cactus Hill Reservoir and Galeton Reservoir, resulting in effects on wetlands, open water and stream habitat, shrublands, and grasslands. Effects on migratory birds and raptors under Alternative 3 are described in Section 6.4.2 of the 2008 Wildlife Report (ERO 2008e) and were updated in the 2015 Wildlife Supplement due to the increase in the size of the proposed Galeton Reservoir from 40,000 AF to 45,624 AF and increase in the size of Cactus Hill Reservoir from 180,000 AF to 190,000 AF.

As described under Alternative 2, direct impacts to raptors could occur during construction from disturbance from human activity around an active raptor nest. Depending on several factors such as species, the type of activity, topography, and individual sensitivity, disturbance could result in loss of eggs or young from nest abandonment. If construction begins after the start of the nesting season (generally March 15 to July 31), construction activity may remove trees with active nests or cause abandonment of active nests in the vicinity of construction, resulting in loss of eggs or young. Destruction of an active nest or activities that result in nest failure would be a violation of the Migratory Bird Treaty Act.

Birds associated with wetlands, riparian, and open water habitat would be affected by the permanent loss of about 81 acres of wetlands (34 acres from direct from fill in wetlands and 47 acres from indirect loss of wetland hydrology and vegetation downgradient of the Poudre Valley Canal), 16 acres of riparian woodlands, and 7 acres of aquatic habitat. About 11 acres of wetlands, 15 acres of riparian woodlands, and 2 acres of aquatic habitat would be temporarily disturbed. Alternative 3 would result in the temporary disturbance of 2 acres of great blue heron nesting area (individual trees or groups of trees containing nest platforms and a buffer zone extending 500 meters around a known active or inactive nest site). No permanent effects on great blue heron nesting areas would occur under Alternative 3.

Birds associated with shrub habitat would be affected by the temporary disturbance of 5 acres of shrublands. Less than 1 acre of shrublands would be permanently affected. Ground-nesting birds would be affected by the permanent loss of about 5,124 acres of grassland habitat, including 2,242 acres of native grasslands. About 391 acres of grasslands would be temporarily disturbed.

Cactus Hill and Galeton Reservoirs would provide new open water habitat for water fowl, as well as foraging habitat for bald eagles and osprey. Newly created shorelines would provide new habitat for shore birds. The additional open water and shore habitat would be a beneficial effect for migratory birds that use those habitats. Cactus Hill and Galeton Reservoirs would also provide a new substrate for macroinvertebrate breeding, which would increase the numbers in the area around these reservoirs. This would have an indirect beneficial effect on birds that feed on macroinvertebrates.

Permanent and temporary effects of Alternative 3 on migratory birds would be moderate for species associated with grassland habitats and minor for species associated with wetlands, riparian, and aquatic habitats because of the habitat available below Cactus Hill Reservoir and the creation of new wetlands and aquatic habitat associated with both Cactus Hill and Galeton Reservoirs.

4.10.4.1.3 Reptiles and Amphibians

Reptiles and amphibians in the Alternative 3 study area would be directly affected through the loss of habitat. Effects on reptiles and amphibians under Alternative 3 are described in Section 6.4.3 of the 2008 Wildlife Report and were updated in the 2015 Wildlife Supplement due to the increase in size of the proposed Galeton Reservoir from 40,000 AF to 45,624 AF and Cactus Hill Reservoir from 180,000 AF to 190,000 AF.

Effects on amphibians would occur from the permanent loss of 81 acres of wetlands from direct placement of fill and loss of hydrology downgradient of the Poudre Valley Canal and 92 acres of aquatic habitat. Most of the aquatic habitat loss would be from lining the Poudre Valley Canal and the loss of aquatic soils, vegetation, and macroinvertebrates that support amphibians. About 19 acres of wetlands and 12 acres of aquatic habitat would be temporarily disturbed. Reptiles and amphibians associated with grassland habitat would be affected by the permanent loss of 5,124 acres and the temporary disturbance of 391 acres of grasslands.

The open water habitat created with the construction of Cactus Hill and Galeton Reservoirs would provide some new habitat for amphibians, but it would likely be low quality because fluctuations of reservoir levels prevent persistent wetland vegetation from establishing. Open water habitat would be a beneficial effect for amphibians. Permanent and temporary effects of Alternative 3 on reptiles and amphibians would be moderate for species associated with grassland habitats and minor for species associated with wetlands, riparian, and aquatic habitats because of the habitat available below Cactus Hill Reservoir and the creation of new wetlands and aquatic habitat associated with both Cactus Hill and Galeton Reservoirs.

4.10.4.1.4 Other Wildlife Species

Mammals such as squirrels, rabbits, foxes, badgers, coyotes, raccoons, several species of bats, and other mammals occurring in the Alternative 3 study area would be directly affected through the loss of habitat. Effects on other wildlife species are described in Section 6.4.4 of the 2008 Wildlife Report (ERO 2008e) and were updated in the 2015 Wildlife Supplement due to the increase in size of the proposed Galeton Reservoir from 40,000 AF to 45,624 AF and Cactus Hill Reservoir from 180,000 AF to 190,000 AF.

Permanent effects on wildlife species occurring in grasslands would result from the permanent loss of 5,124 acres of native and other grasslands. About 391 acres of grasslands would be temporarily disturbed. Permanent effects on wildlife associated with riparian and wetland habitat would result from the permanent loss of 6 acres of riparian woodland habitat and 81 acres of wetlands. About 19 acres of wetlands and 25 acres of riparian habitat would be temporarily disturbed. Shrubland-associated wildlife species would be affected by the temporary disturbance of 5 acres of shrublands. No shrublands would be permanently lost.

4.10.4.2 Conveyance Systems

Because wildlife are dynamic and can move or shift use areas to avoid human disturbance, effects were analyzed on a broader landscape scale and conveyance system impacts are similar to reservoir impacts above. Conveyance systems under Alternative 3 would permanently affect 1.4 acres of wetland habitat and 85 acres of aquatic habitat, mostly associated with lining the Poudre Valley Canal. Alternative 3 would also temporarily affect 1 acre of wetlands and 10 acres of aquatic habitat. Reptiles associated with shrubland habitat would be affected by the temporary disturbance of 5 acres of shrub habitat. No shrublands would be permanently affected under Alternative 3. Because of the loss of 85 acres of aquatic habitat from lining the Poudre Valley Canal, the combined effects would be a major effect on reptiles and amphibians because of the loss of a substantial amount of habitat.

Pipelines, roads, and other linear facilities can create barriers to wildlife movements and fragment habitat. No wildlife migration corridors would be crossed by conveyance systems and pipelines would be buried underground and revegetated. Effects of the conveyance system on wildlife movement would be negligible to minor because most of the effects would be temporary and wildlife movement would resume after construction.

4.10.4.3 Poudre and South Platte Rivers

The effects of Alternative 3 on the Poudre and South Platte Rivers would be similar to those described for Alternative 2 because changes in flow would maintain or amplify the current trajectory of vegetation changes but the changes still would be gradual and over a long period. A predicted shift in species composition favoring plant species adapted to greater fluctuations in ground water levels could result in slight habitat changes in about 9 acres of near-bank wetlands in Segment B that provide habitat for the common garter snake, northern leopard frog,

smoky-eyed brown butterfly, two-spotted skipper and other wildlife that may use these habitats. These effects are discussed in Section 4.10.3.2 and Section 4.11.

4.10.5 Alternative 4

Wildlife habitat would be impacted under Alternative 4 by construction and inundation of Cactus Hill and Galeton Reservoirs, construction of the conveyance system, lining the Poudre Valley Canal, and decreased water flows in the Poudre and South Platte Rivers. Direct impacts to wildlife would result from loss or degradation of habitat, mortality from ground-disturbing activities, and from vegetation clearing and inundation of natural habitat. Indirect impacts consist of displacement of wildlife by noise and disturbance resulting from on-site construction and transport of materials and people. Temporary displacement could result in increased mortality from vehicle collisions and increased resource competition. Table 4-77 summarizes the direct effects on wildlife habitat that are predicted to occur under Alternative 4.

Table 4-77. Direct effects (acres of habitat) of Alternative 4 on wildlife.

Habitat Type	Permanent	Temporary
Big game habitat		
Elk overall range	46	35
Elk winter range	10	15
Elk winter concentration area	0	0
Mule deer winter range	5,688	567
Mule deer winter concentration area	2,332	146
Pronghorn winter range	2,317	234
Pronghorn winter concentration area	1,928	204
White-tailed deer winter range	3,929	284
Wetlands, riparian, and aquatic habitat		
Wetlands	34	19
Riparian (mesic mixed woodlands)	16	15
Aquatic habitat	92	12
Other wildlife habitat		
Great blue heron nesting area	0	2
Native grassland (upland and mesic)	2,242	37
Other grasslands	2,883	368
Upland native shrublands	0	4
Other shrublands	0	1
Agricultural lands	650	656

4.10.5.1 Reservoir Sites

4.10.5.1.1 Big Game Species

Permanent effects on big game species under Alternative 4 would be similar to those for Alternative 3.

4.10.5.1.2 Migratory Birds and Raptors, Reptiles and Amphibians, and Other Wildlife Species

In general, permanent and temporary effects on migratory birds and raptors, reptiles and amphibians, and other wildlife species would be similar under Alternative 4 as under Alternative 3.

4.10.5.2 Conveyance Systems

The permanent effects of Alternative 4 conveyance systems on wildlife would be similar to those for Alternative 3. Temporary effects on mule deer and white-tailed deer winter range would be slightly greater (33 and 28 acres, respectively) because Alternative 4 includes construction of the New Cache to Cactus Hill Pipeline, which would not be included in Alternative 3. Temporary effects on species found in grasslands would be slightly greater because of construction of the New Cache to Cactus Hill Pipeline. Beneficial effects would be similar as those for Alternative 3.

4.10.5.3 Poudre and South Platte Rivers

Effects of Alternative 4 on the Poudre and South Platte Rivers would be negligible because changes in flows are not expected to result in changes to wetland and riparian habitats. Changes in flow would maintain the current trajectory of vegetation changes but the changes would be gradual and over a long period.

4.10.6 Unavoidable Adverse Impacts

All alternatives would result in unavoidable adverse loss and fragmentation of habitat for big game, migratory birds and raptors, reptiles, amphibians, and other wildlife species from habitat loss resulting from construction of reservoirs, dams, and infrastructure.

In all alternatives, temporary displacement of wildlife during construction and temporary barriers to wildlife movement from construction activities would occur. Disturbed areas would not function as wildlife habitat until disturbed areas are revegetated. All alternatives would unavoidably cause disturbance to existing vegetation in temporarily affected areas, but habitat values can be restored through successful revegetation. It would also result in unavoidable increase in the potential for noxious weed invasions, but degradation of habitat can be avoided by weed control. All Action Alternatives would create new lake habitat, shoreline, and lakeshore wetland habitat.

4.10.7 Impact Summary

A comparative summary of effects on big game species is provided in Table 4-78 and Table 4-79. Permanent effects on elk overall range and elk winter concentration areas would be greatest for Alternative 2, under either Reclamation Action Option, because of the construction of Glade Reservoir and relocation of U.S. 287 that would occur within elk habitats. Alternative 2 could

affect between 14 and 18% of elk overall range and 11% to 13% of elk winter concentration areas at a local scale. Reservoir construction under the other alternatives would be farther east and outside of most elk habitat.

Effects on mule deer winter concentration areas would be greatest for Alternatives 1, 3, and 4 (29% to 33% loss at local scale), although the total acres of winter range lost would be greatest for Alternatives 3 and 4. All alternatives range between 16 and 23% loss of winter range. The No Action Alternative would have the least permanent effect on pronghorn winter habitats whereas Alternatives 2, 3, and 4 would have the same or very similar local effects with 25% to 27% loss of winter range and about 31% loss winter concentration habitat. Alternative 2 would result in the least permanent loss of white-tailed deer winter range.

Because current east-west movements of deer and elk may shift north and/or south as a result of the construction of Glade Reservoir, the U.S. 287 realignment could result in increased risk of big game/vehicle collisions, although the realigned U.S. 287 would shift to the eastern fringe of the mapped elk overall range. The realignment could also disrupt north-south movements of deer and elk where they cross the hogbacks east of the current U.S. 287.

A comparative summary of effects on wildlife and wildlife habitat in general is provided in Table 4-80. All alternatives would result in reduced flows in the Poudre River downstream of the Poudre Valley Canal diversion, especially during high-flow periods. As described in the 2015 Wildlife Supplement (ERO 2015c), the flow reductions are not expected to cause losses of riparian and wetland habitat. However, a reduction in the infrequently occurring overbank flows may affect the periodic disturbance of the riparian zone that can aid in creating new habitat for riparian vegetation establishment and rejuvenation of the riparian zone. Flow changes are expected to be less for the No Action Alternative (ERO 2014d).

These reduced flows would not likely affect the overall species composition of the fish community, but would affect the relative abundance of species within the river (GEI 2015b). These potential effects are further described in Section 4.12. Change in the relative size of the fish within the fish community would have a corresponding change in the fish-eating bird community. The presence of alternative prey resources in lakes and ponds along the river corridor would likely moderate some of these effects. The change in relative abundance and distribution of fish eating birds would be a minor effect for all action alternatives, and negligible to minor effect for the No Action Alternative. Minor effects on macroinvertebrates described in the 2014 Aquatic Resources Effects Report would have a minor effect on bird species that feed on macroinvertebrates under all alternatives (ERO 2015c).

Permanent loss of wildlife habitat that supports migratory birds and raptors, reptiles and amphibians, and other wildlife would result from inundation, construction of permanent facilities, road realignments, and agricultural dry-up. Wetlands and riparian areas in the arid west, including Colorado, are some of the most limited habitats, yet support many more species of native birds and in greater numbers than surrounding grassland or shrubland communities (Knopf and Samson 1994). Because of this importance, effects to these two habitats are typically greater than comparative effects to other habitat types. The No Action Alternative would permanently affect 250 acres of wetlands resulting in a major effect due to agricultural

dry-up. The effects on wetlands would be three to six times greater for the No Action Alternative than the action alternatives (Table 4-80). Alternative 2 would have the greatest effect on riparian habitat, although the effect would be minor compared to the availability of this habitat type in the study area. In addition, all action alternatives are likely to create additional, albeit lower quality riparian habitat surrounding the reservoirs. The No Action Alternative would have a negligible effect on riparian habitat.

The No Action Alternative and Alternative 2 (both Reclamation options) would have minor effects to aquatic habitat. Alternatives 3 and 4 would have moderate effects on aquatic habitat, impacting nearly 8 times (92 acres) the habitat than the other alternatives due to lining the Poudre Valley Canal and eliminating soil substrate and vegetation that supports aquatic life that provides food for aquatic mammals, waterbirds, and shorebirds. Grassland habitats, both native and other, are the most abundant habitat types within the study area. The greatest overall acreage of impacts for all alternatives would occur in grasslands; however, in comparison to the overall availability of these habitats effects would be minor to moderate. The No Action Alternative would affect the least amount of native grassland (616 acres) resulting in a minor effect. All action alternatives would have a moderate effect on native grasslands affecting about four times more habitat than the No Action Alternative. Alternative 2 (both Reclamation options) would have a minor effect on other grasslands, whereas the No Action Alternative and Alternatives 3 and 4 would have a moderate effect.

The No Action Alternative and Alternatives 3 and 4 would have no effect on upland native shrublands and other shrublands. Alternative 2 (both options) would have a moderate effect on shrublands compared to the availability of this habitat type and given the importance of shrubs to wildlife for providing food and cover. As discussed above, the No Action Alternative would have a major effect on agricultural lands. All action alternatives would have a minor effect on agricultural lands, although Alternatives 3 and 4 would affect more than double the agricultural lands as Alternative 2.

Table 4-78. Direct effects on big game habitat by alternative.

Big Game Habitat	Effect on Wildlife Habitat (acres)							
	Alternative 1		Alternative 2 (Reclamation Action)		Alternative 2 (No Reclamation Action)		Alternatives 3 and 4[1]	
	Permanent[2]	Temporary[3]	Permanent[2]	Temporary[3]	Permanent[2]	Temporary[3]	Permanent[2]	Temporary[3]
Elk overall range	0	25	2,043	386	2,043	456	46	35
Elk winter range	0	0	186	101	196	167	10	15
Elk winter concentration area	0	0	124	75	124	74	0	0
Mule deer winter range	2,602	446	3,789	647	3,789	746	5,687	534 (567)
Mule deer winter concentration area	1,635	186	70	152	70	231	2,332	146
Pronghorn winter range	220	41	2,256	295	2,256	295	2,317	234
Pronghorn winter concentration area	0	0	1,928	204	1,928	204	1,928	204
White-tailed deer winter range	2,602	405	416	192	416	181	3,929	284

[1]Effects on big game ranges under Alternatives 3 and 4 are very similar, varying less than 2% between the alternatives. Effects shown are for Alternative 3 with any variance for Alternative 4 in parentheses. Variances of 1 acre or less are not shown.

[2]Permanent effects include reservoir and dam footprints, forebay, pump stations, associated facilities, pipeline connections to the reservoir, and realigned roads.

[3]Temporary effects include the removal of vegetation around the dam, reservoirs, pump stations, realigned roads, and other facilities; access roads; borrow areas; staging areas; and pipelines that would be restored following construction. Grasslands would take 1 to 5 years to become well established; shrublands and woodlands would likely take greater than 5 years to become well established.

Table 4-79. Summary of effects determination on big game from the NISP alternatives.

Habitat Type	Alternative 1	Alternative 2 – Reclamation Action	Alternative 2 – No Reclamation Action	Alternative 3	Alternative 4
All big game - Regional	Negligible	Negligible	Negligible	Negligible	Negligible
Elk overall range - Local	No effect	Moderate	Moderate	Negligible	Negligible
Elk winter range - Local	No effect	Moderate	Moderate	Negligible	Negligible
Elk winter concentration - Local	No effect	Moderate	Moderate	No effect	No effect
Mule deer winter range - Local	Moderate	Moderate	Moderate	Major	Major
Mule deer winter concentration - Local	Major	Negligible	Negligible	Major	Major
Pronghorn winter range - Local	Moderate	Major	Major	Major	Major
Pronghorn winter concentration - Local	No effect	Major	Major	Major	Major
White-tailed deer winter range - Local	Moderate	Minor	Minor	Major	Major

Table 4-80. Summary of effects (in acres) on wildlife habitat from the NISP alternatives[1].

Wildlife Habitat	Alternative 1	Alternative 2 – Reclamation Action	Alternative 2 – No Reclamation Action	Alternative 3	Alternative 4
Great blue heron nesting area[2]	>1 (2)	0 (0)	0 (2)	0 (2)	0 (2)
Wetlands	250 (16)	44 (8)	44 (10)	81 (19)	81 (19)
Riparian	4 (14)	29 (9)	28 (10)	16 (15)	16 (15)
Aquatic habitat	6 (17)	12 (6)	12 (4)	92 (12)	92 (12)
Native grassland	616 (71)	2,331 (74)	2,331 (116)	2,242 (37)	2,242 (37)
Other grasslands	1,674 (26)	598 (234)	593 (272)	2,283 (354)	2,283 (368)
Upland native shrublands	0 (0)	453 (73)	454 (91)	0 (4)	0 (4)
Other shrublands	0 (2)	84 (0)	84 (0)	0 (1)	0 (1)
Agricultural lands	251 (503)	238 (262)	238 (280)	649 (623)	650 (56)

[1] Temporary effects in parentheses.
[2] Based on the percentage of impact acres compared to overall acreage within the 500-meter nest buffer.

4.11 SPECIAL STATUS SPECIES

This section provides information on the potential effects of the alternatives on special status species within the study areas and replaces Section 4-16 of the DEIS. No additional studies were conducted on special status species or their habitat for the SDEIS, although new analyses based on updated information and revised alternatives and study areas are presented. Revised information is presented for potential indirect effects to species associated with the Poudre River riparian corridor based on updated CTP hydrologic modeling and on modeling of habitat availability (WUA) for fish species associated with the mainstem based on the 2015 Aquatic Resources Effects Report (GEI 2015b).

Potential effects on special status species include the direct effects on wildlife and wildlife habitat associated with proposed project facilities, such as reservoirs and associated structures, roads, pipelines, and canals. Indirect impacts, both temporary and permanent, such as those that might occur due to noise or visual disturbance, are described. Permanent effects include loss of habitat from reservoir and dam construction, forebay, pump stations, associated facilities, pipeline connections to the reservoir, and realigned roads. Temporary effects include habitat impacts from vegetation removal around the dam, reservoirs, pump stations, realigned roads, and other facilities; access roads; borrow areas; staging areas; and pipelines that would be restored following construction. Permanent effects on aquatic habitat are from the placement of permanent fill; temporary effects are areas where pre-construction contours and drainage would be restored after construction. Indirect effects include permanent and temporary displacement of species from suitable habitat by construction of permanent facilities and human activities during construction and operation of those facilities.

4.11.1 Methods

Methods used to analyze effects on special status species are described in Section 4 of the 2008 Species of Concern Report (ERO 2008f) and 2015 Species of Concern Supplement (ERO 2015d). Species of concern are federally listed threatened and endangered species; state-listed threatened, endangered, and species of concern; and species ranked as vulnerable or imperiled in Colorado by the CNHP. Plant species ranked S1 (critically imperiled) or S2 (imperiled) by CNHP are addressed in this section. No CNHP-ranked S3 (vulnerable) species have habitat within the NISP study areas and therefore they are not discussed. Plant community types that meet or potentially meet the description of plant communities listed by the CNHP as S1 or S2 in Colorado are described in the 2015 Vegetation and Wetland Resources Supplement and are described in the vegetation section of this SDEIS (Section 4.8). Effects calculations were updated for this section based on updates to the CPW Wildlife database (CPW 2013), CNHP updates (CNHP 2014), and changes to the alternatives. Species identified in the 2015 Species of Concern Supplements having no habitat within the study areas were not evaluated in this SDEIS. Federally listed species with potential habitat in the study areas were included in the effects analysis (Table 3-28) and include Preble's meadow jumping mouse, Colorado butterfly plant and

Ute ladies'-tresses orchid. Federally listed threatened, endangered, proposed, or candidate species that do not have the potential to occur in any of the study areas or are unlikely to occur in the study areas due to a lack of suitable habitat include Canada lynx, Mexican spotted owl, black-footed ferret, and Arapahoe snowfly. Federally listed species potentially affected by depletions to the South Platte River were addressed in the Biological Assessment and Biological Opinion (DEIS, Appendix B). The Corps will prepare a Supplemental Biological Assessment that addresses changes to the District's Preferred Alternative that could have effects on federally listed threatened or endangered species and their designated critical habitat and will reinitiate consultation with the USFWS under Section 7 of the Endangered Species Act. These actions will take place prior to issuance of the FEIS or a ROD.

Potential effects were evaluated for the loss or disturbance of habitat and potential for affecting species population, viability, distribution, travel, and reproduction. Findings on the potential effects on federally listed species were based on the determination language used by the USFWS (1998). Possible determinations include:

No effect — the proposed action would not affect listed species or designated critical habitat.

Is not likely to adversely affect — the effect on listed species is expected to be discountable, insignificant, or completely beneficial.

Likely to adversely affect — the action would have a direct or indirect adverse effect to listed species as a result of the proposed action, or its interrelated or interdependent actions; and the effect is not discountable, insignificant, or beneficial.

Permanent impacts associated with the proposed Glade, Galeton, and Cactus Hill Reservoirs include reservoirs, dams, forebays, permanent access roads, and pump stations. A 20-foot disturbance zone is assumed for pipeline impacts, which would be temporary in most cases. Direct impacts for the U.S. 287 realignment study area were calculated based on a 100-foot width for permanent surface impacts and 150-foot width for temporary surface impacts.

Potential indirect effects on special status species in the Poudre River study area were updated based on predicted effects on riparian and wetland vegetation.

The effects analysis for state special status species includes only species that have been recently observed in the study areas. As described in the 2008 Species of Concern Report and 2014 Species of Concern Supplement, the effects analysis for state species of concern includes only those that have been observed from 2000 to present at the study areas. Three species ranked by the CNHP as either S1 or S2 have been observed at City of Fort Collins Natural Areas along the Poudre River: the smokey-eyed brown butterfly, two-spotted skipper, and American currant. These species were not observed in the study areas during field surveys from 2004 to 2006; however, they are included in the discussion of potential effects of changes in streamflow in the Poudre River because their potential habitat occurs in riparian areas.

Effects to special status species are described as negligible, minor, moderate, or major based on the following criteria. Negligible effects would be at the lowest levels of detection, barely measurable, with no perceptible consequences. Minor is used when the impacts would be at low levels and may not have a noticeable effect on special status species or their populations. Minor

effects include temporary impacts during construction. Minor effects typically are short-term. Moderate is used when impacts to special status species would affect individuals or small groups of special status species, but would not affect populations or large areas of habitat. Major is used when impacts to populations or large areas of special status species habitat would occur. Major effects typically are long-term. The term no impact is used when there are no changes to existing conditions from the alternatives.

4.11.2 No Action Alternative (Alternative 1)

Special status species habitat could be impacted under the No Action Alternative by construction and inundation of Cactus Hill Reservoir, construction of the conveyance system, dry-up of irrigated lands, and decreased water flows in the South Platte and Poudre Rivers. Direct impacts to wildlife would result from loss or degradation of habitat, mortality from ground-disturbing activities, and from vegetation clearing and inundation of natural habitat. Indirect impacts consist of displacement of wildlife by noise and disturbance resulting from on-site construction, dry-up of irrigated lands, and transport of materials and people. Permanent effects include reservoir and dam footprints, forebay, pump stations, associated facilities, pipeline connections to the reservoir, and realigned roads.

Temporary displacement could result in increased mortality from vehicle collisions and increased resource competition. Temporary effects include construction effects for dam, reservoirs, pump stations, realigned roads, and other facilities; access roads; borrow areas; and pipelines. Table 4-81 summarizes the direct effects on special status species habitat that are predicted to occur under the No Action Alternative.

Table 4-81. Total effects (acres of habitat) of the No Action Alternative on special status species.

Habitat Type	Permanent			Temporary		
	Reservoir and Roads	Conveyance	Total	Reservoir and Roads	Conveyance	Total
Preble's occupied habitat	0	0	0	0	5	5
Bald eagle nest buffer	9	0	9	33	8	41
Bald eagle winter concentration area	0	1	1	6	62	68
Black-tailed prairie dog colony	65	0	65	0	6	6
Swift fox overall range	2,306	0	2,306	106	0	106
Wetlands (common gartersnake and northern leopard frog habitat)	32	0	32	11	5	16
Aquatic habitat (common gartersnake and northern leopard frog habitat)	6	<1	6+	1	16	17
Riparian woodland habitat (common gartersnake habitat)	4	0	4	12	2	14
Habitat Type	**Permanent**			**Temporary**		
	Irrigated Land Dry-up			**Irrigated Land Dry-up**		
Agricultural transfers wetlands (common gartersnake and northern leopard frog habitat)	218			0		

4.11.2.1 Cactus Hill Reservoir

4.11.2.1.1 Federally Listed Threatened and Endangered Species

Preble's Meadow Jumping Mouse

No known populations or habitat of Preble's would be affected by Cactus Hill Reservoir.

Colorado Butterfly Plant

No known populations of Colorado butterfly plant occur in any of the study areas (ERO 2008f, 2014c). No populations were found during surveys conducted prior to the 2008 Species of Concern Report (ERO 2008f).

Ute Ladies'-Tresses Orchid

Potential Ute ladies'-tresses orchid habitat in the study areas is described in Section 6.4.1 of the 2008 Species of Concern Report (ERO 2008f). No known populations of Ute ladies'-tresses orchid occur in the Cactus Hill Reservoir or Poudre Valley Canal study areas, or at locations of proposed access roads.

4.11.2.1.2 State Species of Concern

Bald Eagle

The No Action Alternative would result in the permanent loss of 9 acres and temporary disturbance of 33 acres of bald eagle nest buffer (areas within 0.5 mile of a bald eagle nest) from construction of Cactus Hill Reservoir and associated facilities, including realignment of Weld County Road (WCR) 19. The noise and vibration from the operation of the pump station at Cactus Hill Reservoir would be mitigated by building design and any noise from construction would not be a long-term effect. Bald eagles and human disturbances are increasing along the Colorado Front Range and any eagles attracted to the reservoir, in any season, would likely be tolerant of human disturbances such as noise, vibration, traffic, and light pollution.

Temporary effects on bald eagle winter concentration areas would be 6 acres and would result from realignment of WCR 19. About 65 acres of black-tailed prairie dog colonies that could potentially provide foraging habitat for bald eagles also would be permanently lost under this alternative from inundation of Cactus Hill Reservoir.

The permanent and temporary loss of habitat would be a minor effect on bald eagles because impacts would be less than 10% of eagle habitats (nest buffer and winter concentration area) available within the Cactus Hill study area and there is other habitat in the area for bald eagles to use. Construction of Cactus Hill Reservoir would provide habitat for fish, waterfowl, and other bald eagle prey species. The reservoir would likely become a new bald eagle winter concentration area and the availability of fish and waterfowl as prey would offset the losses of prairie dogs as a prey resource resulting in a minor benefit to eagles. The types of effects on bald eagles and their habitat are discussed in Section 6.4.1 of the 2008 Species of Concern Report (ERO 2008f).

4.11.2.1.3 Black-tailed Prairie Dog

The No Action Alternative would result in the permanent loss of about 65 acres of black-tailed prairie dog habitat from construction of Cactus Hill Reservoir. The types of direct and indirect effects on black-tailed prairie dogs are described in Section 6.4.2 of the 2008 Species of Concern Report (ERO 2008f). In addition to being considered a Colorado species of special concern, these colonies provide nesting habitat for other species of concern such as burrowing owl and mountain plover and foraging habitat for ferruginous hawk. The overall effect on black-tailed prairie dogs is expected to be moderate because inundation of the reservoir would result in complete loss of some small prairie dog colonies but would not substantially affect the overall prairie dog population in the study area.

4.11.2.1.4 Swift Fox

The No Action Alternative would result in the permanent loss of about 2,306 acres of swift fox overall range. An additional 106 acres of swift fox overall range would be temporarily affected. Nearly all of these effects would result from construction of Cactus Hill Reservoir. The types of direct and indirect effects on swift fox are described in Section 6.4.2 of the 2008 Species of Concern Report. A home range is the area over which an animal or group of animals regularly travels in search of food or mates, and is roughly equal to the area needed by a breeding pair.

Home range studies for swift fox studies conducted in Colorado found that the average home range of swift fox ranges between 1,878 and 6,177 (Stephens and Anderson 2005). Based on these studies the permanent loss of 2,306 acres of swift fox overall range would potentially impact between 0.4 and 1.2 swift fox home ranges/pair (ERO 2015d). Although not likely to have a substantial effect on the local swift fox population, this would have a moderate effect on a large area (2,306 acres) of habitat.

4.11.2.1.5 Burrowing Owl

Because burrowing owl habitat essentially overlaps black-tailed prairie dog habitat, the effects on burrowing owl habitat from the No Action Alternative would be similar to those described for the black-tailed prairie dog. However, these would be the maximum effects on burrowing owl habitat as it is unlikely that all prairie dog colonies are occupied by burrowing owls. There is no minimum or average size of a prairie dog town needed to support burrowing owls. Burrowing owl home range and nesting density is more dependent on habitat variables such as prey abundance nest burrow availability, and clear views for predator detection (Poulin et al. 2011). Because burrowing owls are semi-colonial and can nest in close proximity to each other if suitable habitat is present, the loss of a potential 65 acres of burrowing owl habitat from the construction of Cactus Hill Reservoir would be a moderate effect on burrowing owl habitat and could displace several pair of breeding owls.

4.11.2.1.6 Common Gartersnake

The types of potential effects on common gartersnake are described in Section 6.4.2 of the 2008 Species of Concern Report. Under the No Action Alternative, effects on the common gartersnake would occur from the permanent loss of 32 acres of wetlands, 6 acres of aquatic habitat, and 4 acres of riparian habitat. About 16 acres of wetlands, 17 acres of aquatic habitat, and 14 acres of riparian woodland habitat would be temporarily disturbed during construction and would be restored when construction ceased. These effects on common gartersnake habitat would be minor because of the abundant habitat available below the reservoir at Black Hollow Reservoir and the creation of new wetlands and aquatic habitat associated with Cactus Hill Reservoir.

4.11.2.1.7 Northern Leopard Frog

Effects on the northern leopard frog from the No Action Alternative would be the same as those described for common gartersnake. The effects on northern leopard frog would be minor because of the abundant habitat available below the reservoir at Black Hollow Reservoir and the creation of new wetlands and aquatic habitat associated with Cactus Hill Reservoir.

4.11.2.1.8 Bell's Twinpod

No suitable habitat for Bell's twinpod or existing populations would be affected by Cactus Hill reservoir and there would be no effect on Bell's twinpod.

4.11.2.2 Conveyance Systems

Conveyance systems include the pipeline alignments, pump stations, and water treatment plants. Although wildlife are dynamic and can move or shift use areas to avoid human disturbance,

special status species are generally defined as species with low abundance or patchy distributions and effects to a relatively small area of habitat can have noticeable effects on local populations.

4.11.2.2.1 Federally Listed Threatened and Endangered Species

The No Action Alternative may affect, but is not likely to adversely affect Preble's because there would be no permanent effects and only about 5 acres of temporary effect on Preble's habitat from the construction of the South Water Treatment Plant to Central Weld County Water District Pipeline near the Little Thompson River. Impacts to Preble's would be avoided and minimized through project design and implementation. Additional mitigation actions such as seasonal restrictions and habitat restoration and creation would be implemented as part of project design.

Potential habitat for Ute ladies'-tresses orchid and Colorado butterfly plant may occur where the No Action Alternative conveyance pipelines cross the active floodplain of permanent drainages. Pipelines crossing streams and rivers are proposed to be bored or tunneled under rivers and streams for the No Action Alternative. Habitat assessments or surveys for Ute ladies'-tresses orchid and the Colorado butterfly plant in areas crossed by the No Action Alternative pipelines would be conducted prior to construction, and any potential effects on populations would be avoided. There would be no effect on Ute ladies'-tresses orchid and Colorado butterfly plant because project design and preconstruction surveys would avoid populations.

4.11.2.2.2 State Species of Concern

The No Action Alternative conveyance systems would result in the permanent loss of 1 acre of bald eagle winter concentration area from construction of pump stations and pipelines (ERO 2015d). The indirect effects of noise and vibration from the operation of pump stations would be mitigated by building design and any noise from construction would not be a long-term effect. These effects to bald eagles would be negligible due to the small amount of permanent impacts. Construction of pipelines would result in temporary disturbances of 8 acres along the edge of a bald eagle nest buffer and 62 acres of bald eagle winter concentration area. These effects would be minor because impacts would be temporary and less than 10% of the habitat available.

About 6 acres of black-tailed prairie dog colonies would be temporarily affected by construction of pipelines under the No Action Alternative. In addition to being considered a Colorado species of special concern, these colonies provide nesting habitat for other species of concern such as burrowing owl and mountain plover and foraging habitat for ferruginous hawk. Effects would be negligible assuming that preconstruction surveys and temporal restrictions per CPW guidelines would avoid impacts to burrowing owls, mountain plover, ferruginous hawk, and other sensitive migratory bird species. All effects to prairie dogs and other associated species of concern would be temporary and minor for construction of the conveyance system. Effects to swift fox would be negligible because effects would be temporary and occur on less than 1% of the available habitat in the study area.

Under the No Action Alternative, there would be no effect on Bell's twinpod. Suitable habitat for Bell's twinpod or existing populations would not be affected by the No Action Alternative. Although suitable Bell's twinpod habitat is near the Poudre Valley Canal, under the No Action Alternative, the Poudre Valley Canal would not be lined and habitat would not be disturbed.

4.11.2.3 Poudre and South Platte Rivers

Section 6.1 of the 2015 Species of Concern Supplement (ERO 2015d) describes effects on riparian habitat along the Poudre and South Platte Rivers and resulting effects on species of concern. Operation of the NISP alternatives could potentially indirectly affect wetland and riparian resources along the mainstem by affecting river flows. The No Action Alternative was evaluated under Future Conditions hydrology only, as explained in Section 4.2.2 and, therefore, the indirect effects analyses for No Action Alternative for the Poudre River mainstem are presented in Chapter 5.

4.11.2.3.1 Federally Listed Threatened and Endangered Species

Preble's Meadow Jumping Mouse

Preble's occurs in shrub wetlands dominated by sandbar willow. Willow-dominated communities are less sensitive to river stage declines than herbaceous communities are because they are more deeply rooted (ERO 2014d). The No Action Alternative was evaluated under Future Conditions hydrology only, as explained in Section 4.2.2 and, therefore, the indirect effects analyses for No Action Alternative for the Poudre River mainstem are presented in Chapter 5.

Colorado Butterfly Plant

No known populations of Colorado butterfly plant occur along the mainstem. Potential habitat is unlikely to occur in the Poudre River floodplain as described in the 2008 Species of Concern Report. For these reasons, the Colorado butterfly plant is unlikely to be affected by any changes in flows on the mainstem of the Poudre River resulting from operation of the No Action Alternative.

Ute Ladies'-tresses Orchid

No known populations of Ute ladies'-tresses orchid occur along the mainstem. Potential habitat is unlikely to occur in the Poudre River floodplain as described in the 2008 Species of Concern Report. For these reasons, the Ute ladies'-tresses orchid is unlikely to be affected by any changes in flows on the mainstem resulting from operation of the No Action Alternative.

4.11.2.3.2 State Sensitive Species

Bald Eagle

Bald eagles occurring along the riparian corridor of the Poudre River could be affected by changes in the vegetation community as tree species preferred for roosting and nesting are replaced by less desirable species (ERO 2015d). These changes in the vegetation community would occur regardless of whether the No Action Alternative is implemented or not, but operation of the No Action Alternative would contribute to the changes. The effects on bald eagles are predicted to be negligible and likely not perceptible because the changes to the riparian overstory would be gradual and happen over a long period.

Common Gartersnake

Common gartersnakes likely occur in aquatic and riparian habitats along the mainstem. Predicted declines in alluvial ground water levels under the No Action Alternative are likely to affect riparian and wetland plant communities that are shallowly rooted, associated with shallow alluvial ground water levels, and occur close to the riverbank where changes in river stage have a one-to-one relationship with alluvial ground water levels (ERO 2014d). Declines in alluvial ground water levels within these potentially sensitive plant communities could result in the following:

- Water stress of wetland species with no measurable long-term effect
- Shifts in wetland plant species composition toward drier species (e.g., a shift from obligate to facultative wetland species)
- Increases in plant species (native and nonnative) adapted to greater fluctuations in ground water levels

These changes, in turn, could result in effects on the common gartersnake from changes to habitat. Common gartersnakes are adapted to a wide range of aquatic, wetlands, and riparian habitats and would likely adapt to the new habitat conditions. The effects on the common gartersnake from changes in vegetation would occur over a long period of time and would likely be negligible and imperceptible.

Northern Leopard Frog

Northern leopard frogs potentially occur within shallow backwaters along the mainstem and within associated wetlands. Potential changes in vegetation along the mainstem, as described above for common gartersnake, would also affect northern leopard frog. A shift from wetland plant species and increases in plant species adapted to greater fluctuations in ground water levels could result in a decline in habitat quality for northern leopard frogs for a portion of their life cycle. Northern leopard frogs occur across a broad area of geographic, ecological, and elevational range in Colorado (Hammerson 1999). In Colorado lowland areas, declining populations of leopard frog are often associated with increasingly abundant bullfrogs (Hammerson 1999) and any changes in vegetation and flows that benefit bullfrogs would likely affect leopard frogs. However, the effects would occur over a long period of time and because bullfrogs are already abundant and widely distributed along the Poudre River the effects would likely be negligible and imperceptible.

Smokey-eyed Brown Butterfly, Two-spotted Skipper, and American Currant

Potential habitat for the smokey-eyed brown butterfly, two-spotted skipper, and American currant occurs in riparian areas along the mainstem. These species occur in habitat similar to the common gartersnake and northern leopard frog and the effects would be the same as for those species. The effects would occur over a long period of time and would likely be negligible and imperceptible because vegetation changes would be gradual over a long period of time.

Brassy Minnow, Common Shiner, and Iowa Darter

Brassy minnow and common shiner were commonly collected in the study area through the 1980's. Brassy minnow recently has been collected in very low numbers but common shiner is

likely not currently present. The declines in both species are due to changes in channel morphology, specifically channelization and fragmentation due to migration barriers at diversions. Flow related impacts are not anticipated as changes in flow with the No Action Alternative would not affect the causes of these species' declines (channelization and fragmentation from migration barriers). Iowa darter is present in the study area and recently has been collected in low numbers. The modeling of habitat availability for the Iowa darter indicates there would be negligible changes in WUA metrics with the changes in flow and negligible impacts for this species in the mainstem with the No Action Alternative based on the results in the 2015 Aquatic Resources Effects Report (GEI 2015b).

4.11.2.4 No Action Irrigated Lands

In addition to the direct effects from project components described above, about 64,200 acres of irrigated agricultural land would be dried up as a result of the No Action Alternative. The type and magnitude of effects of agricultural dry-up would be similar to those described in the wildlife section (Section 4.10). An estimated 218 acres of irrigated wetlands would dry up as a result of the No Action Alternative. The irrigated land that would be dried up generally provides low-quality habitat because it is supported by flood irrigation and is often subjected to dredging, tilling, and other disturbances. However, it is possible that losses of irrigated cropland and wetlands, as well as open water habitat, could affect some species of concern, such as northern leopard frog. The common garter snake is seldom found away from a reliable water source or isolated ponds (Hammerson 1999) and is unlikely to occur in irrigated fields because of the irregular supply of irrigation water. Effects to most species of concern from agricultural dry-up would be minor because of the low quality of habitat that would be lost. Leopard frogs do occur in flood irrigated fields and agricultural dry-up could have a major effect on northern leopard frog habitat. Irrigated habitats potentially dried up as a result of the No Action Alternative are subjected to frequent disturbance and are unlikely to support Preble's, Colorado butterfly plant, or Ute ladies'-tresses orchid.

Agricultural lands dried up as a result of the No Action Alternative would have requirements imposed by water court to convert the lands removed from irrigation to dry land farming or to revegetate the lands to a self-sustaining vegetation cover. Much of the formally irrigated area would probably be replaced by areas revegetated to upland grassland habitat, potentially providing habitat for grassland-associated species of concern, such as black-tailed prairie dog, swift fox, burrowing owl, chestnut-collared longspur, ferruginous hawk, long-billed curlew, McCown's longspur, mountain plover, and Rhesus skipper. Conversion of irrigated agricultural lands to more native grasslands would likely provide habitat for songbirds and small mammals increasing the prey available to bald eagles and other predatory sensitive species. These benefits would occur slowly and are estimated to be negligible to minor (ERO 2015d).

4.11.3 District's Preferred Alternative (Alternative 2)

Detailed information on the direct and indirect effects of Alternative 2 is provided in Section 6.3 of the 2008 Species of Concern Report and Section 6.4 of the 2015 Species of Concern

Supplement. Table 4-82 summarizes the direct effects on special status species habitat that would result from Alternative 2 with the Reclamation Action and No Reclamation Action Options.

Table 4-82. Direct effects (acres of habitat) of Alternative 2 on special status species.

Habitat Type	Permanent					Temporary				
	Glade	Galeton	U.S. 287	Conveyance	Total	Glade	Galeton	U.S. 287	Conveyance	Total
Reclamation Action										
Preble's occupied habitat	53	0	0	1[1]	54	16	0	0	12	28
Bald eagle nest buffer	0	0	0	0	0	0	0	0	4	4
Bald eagle winter concentration area	0	21	0	0	21	0	12	0	1	13
Prairie dog colony	16	248	2	0	267	0	0	0	0	0
Swift fox overall range	0	1,928	0	1	1,929	0	145	0	69	214
Bell's twinpod locations	0	0	29	0	29	0	0	45	0	45
Wetlands (common gartersnake and northern leopard frog habitat)	42	<1	2	0	44	4	<1	<1	4	8
Aquatic habitat (common gartersnake and northern leopard frog habitat)	6	<1	<1	5	11	<1	<1	<1	2	3
Riparian woodland habitat (common gartersnake habitat)	20	<1	1	7[1]	28	4	2	<1	2	8
No Reclamation Action										
Preble's occupied habitat	53	0	0	1[1]	54	16	0	0	9	25
Bald eagle nest buffer	0	0	0	0	0	0	0	0	4	4
Bald eagle winter concentration area	0	21	0	0	21	0	12	0	1	13
Prairie dog colony	16	248	2	0	267	0	0	0	8	8
Swift fox overall range	0	1,928	0	1	1,929	0	145	0	69	214
Bell's twinpod locations	0	0	29	0	29	0	0	45	0	45
Wetlands (common gartersnake and northern leopard frog habitat)	42	<1	2	0	44	4	<1	<1	6	10
Aquatic habitat (common gartersnake and northern leopard frog habitat)	6	<1	<1	5	12	<1	1	<1	2	4
Riparian woodland habitat (common gartersnake habitat)	20	<1	1	7[1]	28	4	2	<1	3	9

[1]Permanent effects are due to lining the Poudre Valley Canal.

4.11.3.1 Glade Reservoir

4.11.3.1.1 Federally Listed Threatened and Endangered Species

Preble's Meadow Jumping Mouse

Alternative 2 would result in the permanent loss of about 53 acres of occupied Preble's habitat from construction and inundation of Glade Reservoir under the Reclamation Action and No Reclamation Action Options. An additional 16 acres of Preble's habitat would be temporarily affected under the Reclamation Action Option and the No Reclamation Action Option. Impacts to Preble's would be avoided and minimized through project design and implementation. Additional mitigation actions such as seasonal restrictions and habitat restoration and creation would be implemented as part of the project design. Based on these avoidance, minimization, and mitigation activities, the October 5, 2007 Biological Opinion issued by the USFWS found that the Proposed Action is not likely to jeopardize the continued existence of Preble's (DEIS, Appendix B).

Colorado Butterfly Plant

No known populations of Colorado butterfly plant occur in any of the study areas. No populations were found during surveys conducted prior to the 2008 Species of Concern Report (ERO 2008f). Potential habitat was identified in the Glade and U.S. 287 study areas, and the USFWS has requested that these areas and other potential habitat be resurveyed twice before any construction would occur (USFWS 2007). Alternative 2 is not likely to adversely affect the Colorado butterfly plant.

Ute Ladies'-Tresses Orchid

No known populations of Ute ladies'-tresses orchid occur in any of the study areas. No populations were found during surveys conducted prior to the 2008 Species of Concern Report (ERO 2008f). Potential habitat was identified in the Glade and U.S. 287 study areas, and the USFWS has requested that these areas and other potential habitat be resurveyed twice before any construction would occur (USFWS 2007). Alternative 2 is not likely to adversely affect Ute ladies'-tresses orchid.

4.11.3.1.2 State Species of Concern

Bald Eagle

Construction of Glade Reservoir would have no effect on bald eagle nest sites, winter roosts, or winter concentration areas under either Reclamation option. Bald eagles are attracted to reservoirs for nesting, wintering, and feeding. Reservoirs typically support fish, waterfowl, and other prey species, and often support riparian woodlands along the reservoir banks that provide nesting and roosting opportunities for bald eagles (Bryan et al. 1996). Bald eagles would likely be attracted to Glade Reservoir and the forebay in both summer and winter resulting in a minor benefit to eagles.

Black-tailed Prairie Dog

Construction and inundation of Glade Reservoir would result in the permanent loss of about 16 acres and no temporary loss of prairie dog habitat under either Reclamation option. The types of direct and indirect effects on black-tailed prairie dogs are described in Section 6.3.2 of the 2008 Species of Concern Report. Inundation of Glade Reservoir under Alternative 2 would have a minor effect on black-tailed prairie dog because the permanent loss of 16 acres of prairie dog colonies would impact individuals and a small colony of prairie dogs, but would not have a noticeable effect on populations within the study area.

Swift Fox

Inundation of Glade Reservoir under Alternative 2 would have no direct or indirect effects on swift fox.

Burrowing Owl

Because burrowing owl habitat essentially overlaps prairie dog habitat, the effects on burrowing owl habitat from inundation by Glade Reservoir under Alternative 2 would be similar as those described for the prairie dog. However, burrowing owls are typically not attracted to prairie dog colonies near the Colorado Front Range and valleys of the hogbacks (COBBAII 2014). Effects on burrowing owl under Alternative 2 would be negligible because of the limited acreage of suitable burrowing owl habitat and the unlikelihood of owls nesting in the study area.

Common Gartersnake

The types of potential effects on the common gartersnake are described in Section 6.3.2 of the 2008 Species of Concern Report. Both Reclamation options under Alternative 2 would result in the permanent loss of 42 acres of wetlands, 6 acres of aquatic habitat, and 20 acres of riparian woodland habitat. Most of these permanent effects would occur in the southernmost portion of the Glade Reservoir study area, although most of these habitats are either unsuitable for the common gartersnake or seasonally unavailable due to the absence of permanent water. Temporary effects of Alternative 2 would be similar under both Reclamation options: 4 acres of wetlands, <1 acre of aquatic habitat, and 4 acres of riparian woodland habitat during construction. The temporary impacts would be restored at the end of construction. These permanent and temporary losses of common gartersnake habitat would be minor because of the amount of habitat available below the reservoir and the creation of new wetlands and aquatic habitat associated with Glade Reservoir.

Northern Leopard Frog

Effects on the northern leopard frog from Alternative 2 would be similar to those described for the common gartersnake under both Reclamation options. The permanent and temporary loss of northern leopard frog habitat would be minor because of the ephemeral nature of many of the wetlands and the amount of habitat available below the reservoir. In Colorado lowland areas declining populations of leopard frog are often associated with increasingly abundant bullfrogs (Hammerson 1999) and any changes in vegetation and flows that benefit bullfrogs would likely

affect leopard frogs. The loss of wetland and aquatic habitats would be partially offset by the construction of Glade Reservoir and the forebay.

Bell's Twinpod

Construction and inundation of Glade Reservoir under Alternative 2 would have no effect on Bell's twinpod because suitable habitat is not present and no known populations would be impacted.

4.11.3.2 U.S. 287 Realignment

4.11.3.2.1 Federally Listed Threatened and Endangered Species

U.S. 287 would be realigned under both Alternative 2 Reclamation options. Subsequent to the DEIS, CDOT selected the western alignment as its preferred alternative. There is no Preble's habitat within the U.S. 287 study area and the only federally listed threatened and endangered species potentially occurring in the study areas or potentially affected by the U.S. 287 realignment are Ute ladies'-tresses orchid and Colorado butterfly plant (ERO 2015d).

Colorado Butterfly Plant

Potential Colorado butterfly plant habitat in the study areas is described in Section 6.3.1 of the 2008 Species of Concern Report (ERO 2008f). No known populations of Colorado butterfly plant occur in any of the study areas. No populations were found during surveys conducted prior to the 2008 Species of Concern Report. Potential habitat was identified in the U.S. 287 study area, and the USFWS has requested that these areas and other potential habitat be resurveyed twice before any construction would occur (USFWS 2007). The realignment of U.S. 287 is not likely to adversely affect the Colorado butterfly plant.

Ute Ladies'-Tresses Orchid

Potential Ute ladies'-tresses orchid habitat in the study areas is described in Section 6.3.1 of the 2008 Species of Concern Report (ERO 2008f). No known populations of Ute ladies'-tresses orchid occur in any of the study areas. No populations were found during surveys conducted prior to the 2008 Species of Concern Report. Potential habitat was identified in the U.S. 287 study area, and the USFWS has requested that these areas and other potential habitat be resurveyed twice before any construction would occur (USFWS 2007). The realignment of U.S. 287 is not likely to adversely affect Ute ladies'-tresses orchid.

4.11.3.2.2 State Species of Concern

The only state species of concern potentially occurring in the study area or potentially affected by the realignment of U.S. 287 are prairie dog and Bell's twinpod. Approximately 29 acres of Bell's twinpod habitat would be permanently lost and approximately 45 acres of Bell's twinpod habitat would be temporarily affected by the construction of the U.S. 287 realignment, which would be a major effect.

About 2 acres of prairie dog colony would be permanently affected by construction of the U.S. 287 realignment. The effects on prairie dogs are predicted to be negligible because of other nearby available habitat, which could be occupied.

4.11.3.3 Galeton Reservoir

4.11.3.3.1 Federally Listed Threatened and Endangered Species

There is no habitat for federally listed species and construction and inundation of Galeton Reservoir under Alternative 2 would have no effect on Preble's, Colorado butterfly plant, or Ute ladies'-tresses orchid.

4.11.3.3.2 State Species of Concern

Bald Eagle

Construction of Galeton Reservoir and forebay would result in the permanent loss of 21 acres of bald eagle winter concentration area under either Reclamation option. Temporary effects on bald eagle winter concentration areas would be 12 acres and would be the same under the Reclamation Action and No Reclamation Action Options. About 248 acres of prairie dog colonies that could potentially provide foraging habitat for bald eagles also would be permanently lost from construction and inundation of Galeton Reservoir and would be the same for both Reclamation options. The permanent and temporary loss of habitat would be a minor effect on bald eagles because impacts would be to less than 10% of eagle habitats (nest buffer and winter concentration area) available within the Galeton study area and there is other habitat in the area for bald eagles to use.

Bald eagles are attracted to reservoirs for nesting, wintering, and feeding. Reservoirs typically support fish, waterfowl, and other prey species, and often support riparian woodlands along the reservoir banks that provide nesting and roosting opportunities for bald eagles (Bryan et al. 1996). Bald eagles would likely be attracted to Galeton Reservoir in both summer and winter resulting in a minor benefit to eagles.

Black-tailed Prairie Dog

Alternative 2 would result in the permanent loss of about 248 acres of prairie dog habitat under either Reclamation option from construction of Galeton Reservoir, which is common to all action alternatives. No prairie dog colonies would be temporarily affected under either Reclamation option. The types of direct and indirect effects on black-tailed prairie dogs are described in Section 6.3.2 of the 2008 Species of Concern Report. The overall effect on black-tailed prairie dogs is expected to be moderate because inundation by Galeton Reservoir would result in complete loss of a medium-sized (248-acre) prairie dog colony but would not substantially affect the overall prairie dog population in the study area.

Swift Fox

Alternative 2 would result in the permanent loss of about 1,928 acres of swift fox overall range. An additional 144 acres of swift fox overall range would be temporarily affected. Nearly all of these effects would result from construction of Galeton Reservoir, which is common to all action

alternatives. The permanent loss of 1,928 acres of swift fox overall range would potentially impact between 0.3 and 1.0 swift fox home range/pair (Stephens and Anderson 2005) as described in the 2015 Species of Concern Supplement. Although not likely to have a substantial effect on the local swift fox population, this would have a moderate effect on a large area (1,928 acres) of habitat. Permanent and temporary effects would be the same under the Reclamation Action Option and the No Reclamation Action Option. The types of direct and indirect effects on swift fox are described in Section 6.3.2 of the 2008 Species of Concern Report.

Burrowing Owl

Because burrowing owl habitat essentially overlaps prairie dog habitat, the effects on burrowing owl habitat from Alternative 2 for Galeton Reservoir would be similar as those described for the prairie dog. However, these would be the maximum effects on burrowing owl habitat as it is unlikely that all prairie dog colonies are occupied by burrowing owls. Because burrowing owls are semi-colonial and can nest in close proximity to each other if suitable habitat is present (Poulin et al. 2011), the loss of a potential 248 acres of burrowing owl habitat from the construction of Galeton Reservoir would be a moderate effect on burrowing owl habitat and could displace several pair of breeding owls.

Other State Sensitive Species

There is very little (<1 acre) wetland, riparian, or aquatic habitat available for the common gartersnake or northern leopard frog and construction and inundation of Galeton Reservoir would have a negligible effect on these species.

4.11.3.4 Conveyance Systems

Conveyance systems include the pipeline alignments, pump stations, and water treatment plants. Although wildlife are dynamic and can move or shift use areas to avoid human disturbance, because special status species are generally defined as species with low abundance or patchy distributions, effects to a relatively small area of habitat can have noticeable effects to local populations.

Conveyance systems under Alternative 2 could potentially cross areas of potential Preble's habitat. The southern portions of the Carter Pipeline under the No Reclamation Action Option would temporarily affect 9 acres of habitat, and the Glade to Horsetooth pipeline under the Reclamation Action Option would temporarily affect 7 acres of habitat. While the temporary effects of pipeline alignments under either Reclamation option may affect, but are not likely to adversely affect Preble's habitat, Alternative 2 as a whole is likely to adversely affect Preble's. Based on avoidance, minimization, and mitigation activities, the October 5, 2007 Biological Opinion issued by the USFWS found that the Proposed Action is not likely to jeopardize the continued existence of Preble's (DEIS, Appendix B). Conveyance systems under Alternative 2 would not affect any potential habitat for Colorado butterfly plant or Ute ladies'-tresses orchid and would have no effect on these species.

Both Reclamation options under Alternative 2 would result in no permanent loss of bald eagle nest buffer (areas within ½ mile of a bald eagle nest) but would have temporary disturbance to about 4 acres of bald eagle nest buffer. Both Reclamation options would temporarily affect about 1 acre of bald eagle winter concentration area from construction of pipelines near the nest at the Greeley Bellvue Water Treatment Facility. Both Reclamation options would also temporarily affect 69 acres of overall swift fox range. These effects would be negligible to bald eagles and swift fox because they would be temporary and occur on less than 1% of the habitat available in the Alternative 2 study area.

About 8 acres of black-tailed prairie dog colonies would be temporarily affected by construction of pipelines and pump stations under the No Reclamation Action Option. These colonies provide nesting habitat for other species of concern such as burrowing owl and mountain plover and foraging habitat for ferruginous hawk. Effects would be negligible assuming that preconstruction surveys and temporal restrictions per CPW guidelines would avoid impacts to burrowing owls, mountain plover, ferruginous hawk, and other sensitive migratory bird species. All effects on prairie dogs and other associated species of concern would be temporary and minor for construction of the conveyance system.

Temporary effects on potential Bell's twinpod habitat may occur in the Carter Pipeline alignment in the shale outcrops east and south of Horsetooth Reservoir. If the No Reclamation Action Option is constructed, surveys for Bell's twinpod would be conducted in the Carter Pipeline alignment prior to construction.

4.11.3.5 Poudre River

Section 6.4 of the 2015 Species of Concern Supplement describes effects on riparian habitat along the Poudre and South Platte Rivers and predicted effects on species of concern. Operation of the NISP alternatives could potentially indirectly affect wetland and riparian resources along the mainstem by affecting river flows. The analysis in the 2014 Wetlands and Riparian Resources Effects Report (ERO 2014d) found that under the alternatives, plains cottonwoods would likely continue to decline along the mainstem because of the current trajectory of decline from past actions, while nonnative species such as green ash, box elder, Siberian elm, Russian olive, and reed canarygrass would persist or increase. Under Alternative 2, predicted changes in river stage would, over time, cause a shift in species at wetlands dominated by obligate wetland species to species that tolerate greater fluctuations in river stage in about 9 acres in Segment B.

4.11.3.5.1 Federally Listed Threatened and Endangered Species

Preble's Meadow Jumping Mouse

Preble's occurs in shrub wetlands dominated by sandbar willow. Willow-dominated communities are less sensitive to river stage declines than herbaceous communities are because they are more deeply rooted (ERO 2014d). Suitable Preble's habitat is present along the mainstem, and occupied habitat is present upstream of Watson Lake. Changes in streamflow along the Poudre are not expected to adversely affect woody riparian vegetation, and effects on Preble's habitat are not predicted from operation of Alternative 2.

Colorado Butterfly Plant

No known populations of Colorado butterfly plant occur along the mainstem. Potential habitat is unlikely to occur in the Poudre River floodplain as described in the 2008 Species of Concern Report (ERO 2008f). For these reasons, the Colorado butterfly plant is unlikely to be affected by predicted changes to wetlands in Segment B of the mainstem from the operation of Alternative 2.

Ute Ladies'-tresses Orchid

No known populations of Ute ladies'-tresses orchid occur along the mainstem. Potential habitat is unlikely to occur in the Poudre River floodplain as described in the 2008 Species of Concern Report (ERO 2008f). For these reasons, the Ute ladies'-tresses orchid is unlikely to be affected by predicted changes to wetlands in Segment B of the mainstem from the operation of Alternative 2.

4.11.3.5.2 State Species of Concern

Bald Eagle

Bald eagles occurring along the riparian corridor of the mainstem could be affected by changes in the riparian tree species preferred for roosting and nesting if the trees are replaced by less desirable species (ERO 2015d). These changes in the riparian tree species would occur regardless of whether Alternative 2 is implemented or not, but operation of Alternative 2 would contribute to the changes. The effects on bald eagles are predicted to be negligible and likely not perceptible because changes to the overstory would occur slowly over time.

Common Gartersnake

Common gartersnakes likely occur in aquatic and riparian habitats along the mainstem. Predicted declines in alluvial ground water levels under Alternative 2 are likely to affect riparian and wetland plant communities that are shallowly rooted, associated with shallow alluvial ground water levels, and occur close to the riverbank where changes in river stage have a one-to-one relationship with alluvial ground water levels (ERO 2014d). Declines in alluvial ground water levels within these potentially sensitive plant communities could result in the following:

- Water stress of wetland species with no measurable long-term effect
- Shifts in wetland plant species composition toward drier species (e.g., a shift from obligate to facultative wetland species)
- Increases in plant species (native and nonnative) adapted to greater fluctuations in ground water levels

These changes, in turn, could result in effects on the common gartersnake from changes to habitat. Common gartersnakes are adapted to a wide range of aquatic, wetlands, and riparian habitats and would likely adapt to the new habitat conditions. The effects on the common gartersnake from changes in vegetation would occur over a long period of time and would likely be negligible and imperceptible.

Northern Leopard Frog

Northern leopard frogs potentially occur within shallow backwaters along the mainstem and within associated wetlands. Changes in vegetation along the mainstem, as described above for common gartersnake, would also affect northern leopard frog. A shift from wetland plant species and increases in plant species adapted to greater fluctuations in ground water levels could result in a decline in habitat quality for northern leopard frogs for a portion of their life cycle. Northern leopard frogs occur across a broad area of geographic, ecological and elevational range in Colorado (Hammerson 1999). In Colorado lowland areas declining populations of leopard frog are often associated with increasingly abundant bullfrogs (Hammerson 1999) and any changes in vegetation and flows that benefit bullfrogs would likely affect leopard frogs. However, the effects would occur over a long period of time and would likely be negligible and imperceptible.

Smokey-eyed Brown Butterfly, Two-spotted Skipper, and American Currant

Potential habitat for the smokey-eyed brown butterfly, two-spotted skipper, and American currant occurs in riparian areas along the mainstem. These species occur in habitat similar to the common gartersnake and northern leopard frog and the effects would be the same as for those species. The effects would occur gradually over a long period of time and would likely be negligible and imperceptible.

Brassy Minnow, Common Shiner, and Iowa Darter

Brassy minnow and common shiner were commonly collected in the study area through the 1980's. Brassy minnow recently has been collected in very low numbers but common shiner is likely not currently present. The declines in both species are due to changes in channel morphology, specifically channelization and fragmentation due to migration barriers at diversions (Section 3.12.1.2.1). Flow related impacts are not anticipated as changes in flow with Alternative 2 would not affect the causes of these species' declines (channelization and fragmentation from migration barriers). Iowa darter is present in the study area and recently has been collected in low numbers. The modeling of habitat availability (WUA) for the Iowa darter indicates negligible changes in WUA metrics and negligible impacts for this species in most segments of the mainstem with Alternative 2 based on the 2015 Aquatic Resources Effects Report (GEI 2015b). In the section near Fort Collins (Segment B), the augmented low flows would have a moderate beneficial impact for the Iowa darter based on increases in minimum and average habitat availability (WUA values) in almost all years.

4.11.3.6 Platte River Depletions

Federally listed species potentially affected by depletions to the Platte River System were addressed in the 2007 Biological Assessment and Biological Opinion (DEIS, Appendix B) for the District's preferred alternative. Prior to issuance of the FEIS or a ROD, the Corps will reinitiate consultation with the USFWS regarding South Platte River depletions.

4.11.4 Alternative 3

Detailed information on the direct and indirect effects of Alternative 3 is provided in Section 6.4 of the 2008 Species of Concern Report and Section 6.5 of the 2015 Species of Concern Supplement. Table 4-83 summarizes the direct effects on special status species habitat that would result from Alternative 3.

Table 4-83. Overall direct effects (acres of habitat) of Alternative 3 on special status species.

Habitat Type	Permanent[1]				Temporary			
	Cactus Hill	Galeton	Conveyance	Total	Cactus Hill	Galeton	Conveyance	Total
Preble's occupied habitat	0	0	0	0	0	0	1	1
Bald eagle nest buffer	10	0	3	13	32	0	10	41
Bald eagle winter concentration area	0	21	0	21	6	12	61	79
Prairie dog colony	65	248	0	313	0	0	2	2
Swift fox overall range	3,319	1,928	1	5,248	39	145	93	277
Bell's twinpod (small patches)	0	0	1	1	0	0	0	0
Bell's twinpod (large patches)	0	0	<1	0	0	0	0	0
Wetlands (common gartersnake and northern leopard frog habitat)	32	<1	1	34	10	<1	8	19
Aquatic habitat (common gartersnake and northern leopard frog habitat)	7	<1	85	92	1	1	10	12
Riparian woodland habitat (common gartersnake habitat)	6	<1	10	16	9	2	4	15

[1]Lining the Poudre Valley Canal is predicted to permanently affect 47 acres of wetlands located downgradient of the canal.

4.11.4.1 Cactus Hill Reservoir

Generally the effects on special status species at Cactus Hill Reservoir are greater under Alternative 3 than in the No Action Alternative because of the larger reservoir size (190,000 AF vs. 120,000 AF). Most of the permanent vegetation effects would occur as a result of inundation at the Cactus Hill Reservoir site.

4.11.4.1.1 Federally Listed Threatened and Endangered Species

Preble's Meadow Jumping Mouse

Due to a lack of suitable habitat, Alternative 3 would not result in the permanent loss of occupied Preble's habitat from construction of Cactus Hill. About an acre of the Poudre Valley Canal is Preble's habitat but temporary effects on Preble's habitat along the canal would be avoided or minimized. The construction and inundation of Cactus Hill Reservoir would have no effect on Preble's.

Colorado Butterfly Plant

Potential Colorado butterfly plant habitat in the study areas is described in Section 6.4.1 of the 2008 Species of Concern Report (ERO 2008f). No known populations of Colorado butterfly plant occur in any of the study areas. No populations were found during surveys conducted prior to the 2008 Species of Concern Report. The construction and inundation of Cactus Hill Reservoir would have no effect on Colorado butterfly plant.

Ute Ladies'-Tresses Orchid

Potential Ute ladies'-tresses orchid habitat in the study areas is described in Section 6.4.1 of the 2008 Species of Concern Report. No known populations of Ute ladies'-tresses orchid occur at the Cactus Hill Reservoir site. No populations were found during surveys conducted prior to the 2008 Species of Concern Report. The construction and inundation of Cactus Hill Reservoir would have no effect on Ute ladies'-tresses orchid.

4.11.4.1.2 State Species of Concern

Bald Eagle

Alternative 3 would result in the permanent loss of 10 acres and temporary disturbance of 32 acres of bald eagle nest buffer (areas within ½ mile of a bald eagle nest) from construction of Cactus Hill Reservoir and associated facilities, including realignment of WCR 19. Construction of Cactus Hill Reservoir also would result in the temporary disturbance of 6 acres of bald eagle winter concentration area. The noise and vibration from the operation of the pump station at Cactus Hill Reservoir would be mitigated by building design and any noise from construction would not be a long-term effect. About 65 acres of prairie dog colonies that could potentially provide foraging habitat for bald eagles also would be permanently lost. The permanent and temporary loss of habitat would be a minor effect on bald eagles because impacts would be to less than 10% of eagle habitats (nest buffer and winter concentration area) available in the Cactus Hill study area and there is other habitat in the area for bald eagles to use. Construction of Cactus Hill Reservoir would provide habitat for fish, waterfowl and other bald eagle prey species. The reservoir would likely become a new bald eagle winter concentration area and the availability of fish and waterfowl as prey would offset the losses of prairie dogs as prey resources resulting in a minor benefit to eagles.

Black-tailed Prairie Dog

Alternative 3 would result in the permanent loss of about 65 acres of black-tailed prairie dog habitat from the inundation of Cactus Hill Reservoir. The types of direct and indirect effects on black-tailed prairie dogs are described in Section 6.4.2 of the 2008 Species of Concern Report (ERO 2008f). The overall effect on black-tailed prairie dogs is expected to be moderate because inundation of the reservoir would result in complete loss of some small prairie dog colonies, but would not substantially affect the overall prairie dog population in the Cactus Hill Reservoir study area.

Swift Fox

Alternative 3 would result in the permanent loss of about 3,319 acres of swift fox overall range. An additional 39 acres of swift fox overall range would be temporarily affected from construction and inundation of Cactus Hill Reservoir. The permanent loss of 3,319 acres of swift fox overall range would impact between 0.5 and 1.8 swift fox home ranges/pairs (ERO 2015d). Although not likely to have a substantial effect on the local swift fox population, this would have a moderate effect on a large area (3,319 acres) of habitat.

Burrowing Owl

Because burrowing owl habitat essentially overlaps prairie dog habitat, effects on burrowing owls from Alternative 3 would be similar as those described for the black-tailed prairie dog. However, these would be the maximum effects on burrowing owl habitat as it is unlikely that all prairie dog colonies are occupied by burrowing owls. The loss of 65 acres of burrowing owl habitat from the construction of Cactus Hill Reservoir would be a moderate effect on potential burrowing owl habitat.

Common Gartersnake

The types of potential effects on the common gartersnake are described in Section 6.4.2 of the 2008 Species of Concern Report (ERO 2008f). Effects on the common gartersnake would occur from the permanent loss of 31 acres of wetlands, 7 acres of aquatic habitat, and 6 acres of riparian habitat. About 10 acres of wetlands, 1 acre of aquatic habitat, and 9 acres of riparian woodland habitat would be temporarily disturbed during construction and would be restored when construction ceased. Another 47 acres of wetlands are predicted to be affected by the lining of the Poudre Valley Canal. These effects on common gartersnake habitat would be minor because of the abundant habitat available below the reservoir at Black Hollow Reservoir and the creation of new wetlands and aquatic habitat associated with Cactus Hill Reservoir.

Northern Leopard Frog

Effects on the northern leopard frog from construction and inundation of Cactus Hill Reservoir under Alternative 3 would be the same as those described for the common gartersnake. The effects on northern leopard frog would be minor because of the abundant habitat available below the reservoir at Black Hollow Reservoir and the creation of new wetlands and aquatic habitat associated with Cactus Hill Reservoir.

Bell's Twinpod

No suitable habitat for Bell's twinpod or existing populations would be affected by Cactus Hill reservoir and there would be no effect on Bell's twinpod.

4.11.4.2 Galeton Reservoir

Galeton Reservoir and its associated facilities are common to all action alternatives. The predicted effects on special status species associated with the construction and operation of Galeton Reservoir and associated facilities are discussed in Section 4.11.3.3.

4.11.4.3 Conveyance Systems

4.11.4.3.1 Federally listed Threatened and Endangered Species

Less than 1 acre of Preble's habitat would be temporarily affected by modifications to the Poudre Valley Canal. Although unlikely, potential Preble's habitat could occur in other wetlands or riparian areas crossed by pipelines, roads, or other components that would be constructed under Alternative 3. Because temporary impacts to Preble's habitat would occur, Alternative 3 may affect but is not likely to adversely affect Preble's because the extent of the impacts would be small and temporary.

Although no known populations of Colorado butterfly plant or Ute ladies'-tresses orchid occur in any of the study areas, potential habitat could occur where the Galeton conveyance pipelines cross the active floodplain of permanent drainages. Because potential habitat is present, but no known populations occur within the study area, Alternative 3 is unlikely to adversely affect Colorado butterfly plant or Ute ladies'-tresses orchid.

4.11.4.3.2 State Sensitive Species

Conveyance pipelines would temporarily affect about 61 acres of bald eagle winter concentration area, 2 acres of prairie dog colonies, and 93 acres of swift fox overall range. These effects would be minor because the effects would be temporary and would not have a noticeable effect on the species.

4.11.4.4 Poudre River

Section 6.1 of the 2015 Species of Concern Supplement (ERO 2015d) describes effects on riparian habitat along the Poudre and South Platte Rivers and resulting effects on species of concern. The operation of Alternative 3 is predicted to have similar effects on species of concern as those previously described for Alternative 2.

Brassy Minnow, Common Shiner, and Iowa Darter

Brassy minnow recently has been collected in very low numbers but common shiner is likely not currently present. Flow related impacts are not anticipated as changes in flow with Alternative 3 would not affect the causes of these species' declines (channelization and fragmentation due to migration barriers at diversions). Iowa darter is present in the study area and recently has been collected in low numbers. The modeling of habitat availability (WUA) for the Iowa darter indicates negligible changes in WUA metrics and negligible impacts for this species in the mainstem with Alternative 3 based on the 2015 Aquatic Resources Effects Report (GEI 2015b).

4.11.4.5 Platte River Depletions

Federally listed species potentially affected by depletions to the Platte River System were addressed in the 2007 Biological Assessment and resultant Biological Opinion (DEIS, Appendix B) for the District's preferred alternative, Alternative 2. If, due to permit denial by the Corps or a decision by the District to change their preferred alternative, the Corps would reinitiate

consultation with the USFWS under Section 7 of the Endangered Species Act on the new alternative.

4.11.5 Alternative 4

Detailed information on the direct and indirect effects of Alternative 4 is provided in Section 6.6 of the 2015 Species of Concern Supplement (ERO 2015d). Table 4-84 summarizes the direct effects on special status species habitat that would result from Alternative 4.

Table 4-84. Overall direct effects (acres of habitat) of Alternative 4 on special status species.

Habitat Type	Permanent[1]				Temporary			
	Cactus Hill	Galeton	Conveyance	Total	Cactus Hill	Galeton	Conveyance	Total
Preble's occupied habitat	0	0	0	0	0	0	1	1
Bald eagle nest buffer	10	0	3	13	32	0	10	41
Bald eagle winter concentration area	0	21	0	21	6	12	64	82
Prairie dog colony	65	248	0	313	0	0	2	2
Swift fox overall range	3,319	1,928	1	5,248	39	145	93	277
Bell's twinpod (small patches)	0	0	1	1	0	0	0	0
Bell's twinpod (large patches)	0	0	<1	0	0	0	0	0
Wetlands (common gartersnake and northern leopard frog habitat)	32	<1	1	34	10	<1	8	19
Aquatic habitat (common gartersnake and northern leopard frog habitat)	7	<1	85	92	1	1	10	12
Riparian woodland habitat (common gartersnake habitat)	6	<1	10	16	9	2	4	15

[1]Lining the Poudre Valley Canal is predicted to permanently affect 47 acres of wetlands located downgradient of the canal.

The effects of Alternative 4 on special status species, both federal and state, would be similar to those for Alternative 3. Permanent effects would be similar for reservoirs, conveyance systems, and the Poudre and South Platte Rivers, and temporary effects vary less than 1 acre for all species except for bald eagle for which Alternative 4 would have an additional 3 acres of temporary effects on winter concentration areas. The effects determinations for all special status species are the same as Alternative 3.

4.11.6 Unavoidable Adverse Impacts

Construction of Glade Reservoir under Alternative 2 is likely to adversely affect Preble's. All alternatives would result in unavoidable adverse loss and fragmentation of habitat for federal and state special status species from habitat loss resulting from inundation of reservoirs, and construction of dams, conveyance systems, and other infrastructure. Changes in river flows in

the South Platte and Poudre Rivers may affect, but would not likely adversely affect Preble's, Colorado butterfly plant, and Ute ladies'-tresses orchid.

All alternatives would temporarily displace special status species during construction. All alternatives would unavoidably cause disturbance to existing vegetation in temporarily affected areas, but habitat values can be restored through successful revegetation. All alternatives would create new lake habitat, shoreline, and lakeshore wetland habitat that would offset some habitat loss for bald eagle, common gartersnake, and northern leopard frog.

4.11.7 Impact Summary

Table 4-85. Summary of effects on special status species habitat from the NISP alternatives.

Wildlife Habitat	Alternative 1	Alternative 2 – Reclamation Action	Alternative 2 – No Reclamation Action	Alternative 3	Alternative 4
Preble's meadow jumping mouse	May Affect, Not Likely to Adversely Affect	May Affect, but not likely to jeopardize the continued existence	May Affect, but not likely to jeopardize the continued existence	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Colorado butterfly plant	No Effect	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Ute ladies'-tresses orchid	No Effect	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Bald eagle nest buffer	Minor	Negligible	Negligible	Minor	Minor
Bald eagle winter concentration area	Minor Adverse Effect, Minor Benefit	Minor Adverse Effect, Minor Benefit	Minor Adverse Effect, Minor Benefit	Minor Adverse Effect, Minor Benefit	Minor Adverse Effect, Minor Benefit
Black-tailed prairie dog colony	Moderate	Moderate	Moderate	Moderate	Moderate
Swift fox overall range	Moderate	Moderate	Moderate	Moderate	Moderate
Burrowing owl habitat	Moderate	Moderate	Moderate	Moderate	Moderate
Wetlands (common gartersnake and northern leopard frog habitat)	Minor	Minor	Minor	Minor	Minor
Aquatic habitat (common gartersnake and northern leopard frog habitat)	Minor	Minor	Minor	Minor	Minor
Riparian woodland habitat (common gartersnake habitat)	Minor	Minor	Minor	Minor	Minor
Bell's twinpod locations	No Effect	Minor	Minor	Negligible	Negligible
Agricultural transfers wetlands (common gartersnake and northern leopard frog habitat)	Major	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Brassy minnow and common shiner	No effect	No effect	No effect	No effect	No effect
Iowa darter	Negligible	Negligible except Segment B, which would be moderate beneficial	Negligible except Segment B, which would be moderate beneficial	Negligible	Negligible

4.12 AQUATIC BIOLOGICAL RESOURCES

This section summarizes the predicted potential aquatic biological resources effects of the NISP alternatives. Fish, benthic invertebrate, periphyton, and aquatic plant communities and their habitat represent the components of the aquatic environment of interest for the project. Based on public comments received during scoping and in response to the DEIS and discussions with state and federal agencies, this assumption is appropriate. The analysis focused on the suitability of the habitat to support higher or lower number and abundance of species of fish, invertebrates, and periphyton and plants or to change the composition of the communities for each alternative.

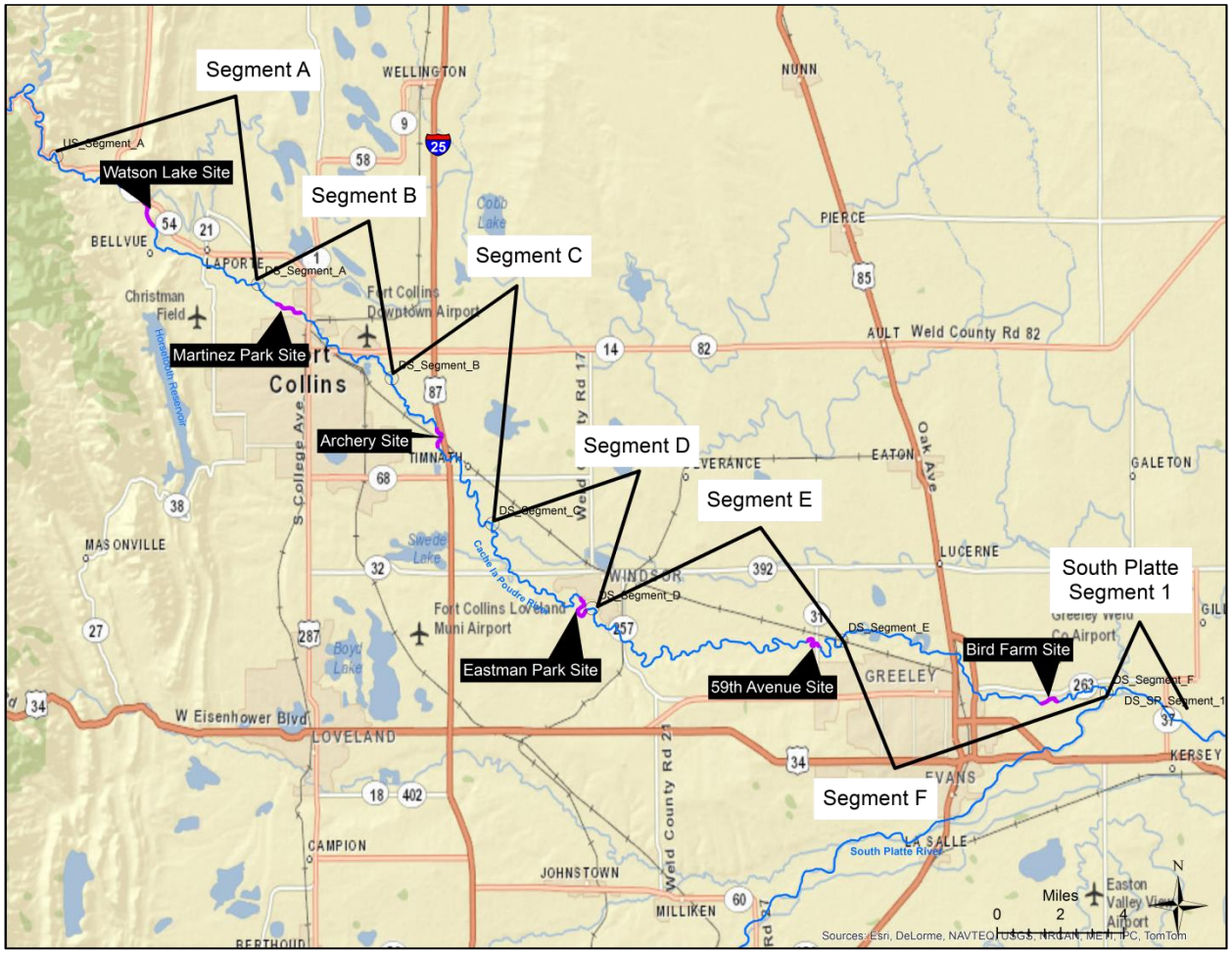
Because flow changes can affect habitat and the riffle-pool complexes used by aquatic organisms, project effects are evaluated by measuring changes in available habitat. Fish habitat availability was compared between Current Conditions and each project alternative. In addition, the suitability of a stream to support aquatic resources is also influenced by water quality, geomorphology, and riparian vegetation, so these components of the aquatic environment evaluated in other sections of the SDEIS are also included in the analysis to determine if potential changes resulting from the alternatives would be expected to affect populations of fish, benthic invertebrates, periphyton, and plants.

4.12.1 Methods

The methods for predicting impacts are described in detail in the 2015 Aquatic Resources Effects Report (GEI 2015b). Three types of analyses were used to assess the potential impacts of the alternatives in the mainstem. For the first type of analysis, two-dimensional hydrodynamic (2-D) fish habitat modeling was used to simulate the relationship between habitat availability and flow in segments of the mainstem and the South Platte River (Figure 4-63) for specific species and life stages of fish that are known to currently inhabit the drainage as explained in the 2013 Aquatic Resources Baseline Report (GEI 2013). This approach is based on the concepts used in the Instream Flow Incremental Methodology (IFIM) and the Physical Habitat Simulation System (PHABSIM) (Bovee 1982; Bovee et al. 1994). The second type of analysis used the 2-D hydraulic data to simulate the availability and spatial arrangement of shallow, slow current velocity (SSCV) habitat that is required for spawning and rearing habitat by many of the warmwater fish present in the study area. The third type of analysis evaluated specific hydrologic metrics in order to summarize potential changes in flow that might be relevant to fish, invertebrates, and plants. Qualitative evaluations of the effects of changes to other resource areas were also considered in the impact evaluation. Those findings are described in the 2014 Stream Morphology Effects Report (ACE 2014), 2015 Water Quality Report (GEI 2015a) including the 2014 Stream Temperature and DO Analysis (Hydros 2014a), and 2014 Wetlands and Riparian Resources Effects Report (ERO 2014d). In the absence of a quantitative means of analysis of the changes to the various resources, professional judgment, based on available information in the scientific literature, was used to evaluate relative impacts. For macroinvertebrates, periphyton, and aquatic plants, professional judgment was used to evaluate

impacts based on changes in flow, water quality, sediment, and channel morphology. Colorado macroinvertebrate multimetric index (MMI) scores are used by the WQCD to assess attainment of the aquatic life use in streams. Therefore, changes in MMI scores with the alternatives and associated aquatic life use designations are predicted using professional judgment.

Figure 4-63. Segments A through F and 2-D Hydraulic Modeling Sites on the Poudre River Mainstem and Segment 1 on the South Platte River.



Fish habitat modeling was conducted for specific segments of the mainstem and South Platte River as described in the 2013 CTP Aquatic Resources Baseline Report (GEI 2013); impacts analyses results presented in this section are summarized for these segments (Figure 4-63). The six segments of the mainstem are labeled from upstream to downstream as Segment A through Segment F (GEI 2013). A single segment of the South Platte River immediately downstream from the confluence with the mainstem was modeled, and was designated Segment 1.

Final impacts were determined on a segment-by-segment basis for each alternative. Impacts were determined by taking into account the effects to all separate components of the aquatic community evaluated in each segment. The overall impact was categorized as negligible, minor, moderate, or major according to professional judgment by taking into account the individual impacts to the components of the aquatic environment based on the magnitude of the changes,

the risk of crossing an ecological threshold, the changes in habitat availability for other species and life stages in that segment, and the predicted changes to other relevant aspects such as water quality, temperature, channel geomorphology, sedimentation, and riparian vegetation.

For the proposed new reservoirs, the quality of the recreational fishery in the reservoirs was predicted as described in the 2015 Aquatic Resources Effects Report (GEI 2015b) and incorporates findings detailed in the 2014 Reservoir Comparative Analysis Memo (Hydros 2014b) and the 2013 Draft Water Quality Effects Report (ERO and Tetra Tech 2015). In general, the creation of a reservoir where none currently exists was considered to be a beneficial increase in aquatic habitat. For the existing Horsetooth Reservoir and Carter Lake, the effects of the project and alternatives were evaluated using professional judgment considering the changes in reservoir characteristics. For both new and existing reservoirs, the potential for mercury accumulation in fish was also evaluated.

4.12.2 No Action Alternative (Alternative 1)

The Corps directed that the No Action Alternative be compared to Future Conditions so that the effect of the No Action Alternative could be discriminated from other likely future actions, as explained in Section 4.2.2. Therefore, the effects of the No Action Alternative on aquatic biological resources are compared to Future Conditions in Chapter 5.

4.12.3 District's Preferred Alternative (Alternative 2)

4.12.3.1 Reservoir Sites

Alternative 2 would include the construction of Glade and Galeton Reservoirs. At an elevation of 5,517 feet when full, Glade Reservoir would be suitable to support both coldwater and warmwater recreationally important fish species. The creation of Glade Reservoir would represent a major beneficial effect of Alternative 2 for aquatic organisms. The reservoir would provide new habitat to sustain populations of a variety of organisms. The reservoir would also be suitable for the establishment and management of a recreational fishery that could support populations of both stocked and self-sustaining fish species and the reservoir would support a low to medium fishery quality.

Fluctuations in water level, combined with newly inundated vegetation, can lead to elevated levels of methylmercury in fish tissue. This suggests that fish in Glade Reservoir would have high body burdens of methylmercury, and like many other Front Range reservoirs such as Horsetooth Reservoir, Glade Reservoir may eventually have a mercury-based fish consumption advisory.

Galeton Reservoir is not currently proposed to be used for fishing. According to Hydros (2014b), the reservoir would be very productive (eutrophic) with high nutrient levels, algal blooms, and low dissolved oxygen in the hypolimnion. The construction of Galeton Reservoir would create new habitat for aquatic resources where none now exists and in this sense would be

a benefit. However, the conditions for aquatic resources in the reservoir would likely be poor and the beneficial effect would be minor.

Alternative 2 with the No Reclamation Action Option would have no changes in the operation of Horsetooth Reservoir and Carter Lake and there would be no effect on aquatic organisms in these reservoirs. Alternative 2 with the Reclamation Action Option would generally result in less drawdown of Horsetooth Reservoir over the summer and less seasonal fluctuation of water levels (CDM Smith 2014b). This would have a minor beneficial impact for fish and other aquatic organisms. There are expected to be negligible to minor changes to water quality with Alternative 2 with the Reclamation Action Option, which would have little effect on aquatic resources in Horsetooth Reservoir. In Carter Lake, Alternative 2 with the Reclamation Action Option would have a negligible impact because changes in reservoir operation would be small.

4.12.3.2 Conveyance Systems

Alternative 2 is expected to have a temporary negligible impact on aquatic biological resources along the route of the conveyance systems. The conveyance systems are proposed to occur primarily in rural agricultural areas and within road rights-of-way. However, some of the proposed conveyance alignments would cross streams. The conveyance alignments will be refined for the FEIS and stream crossings for the conveyance alignments will be presented in the FEIS.

4.12.3.3 River Segments

4.12.3.3.1 Poudre River

With Alternative 2, water primarily would be diverted from the mainstem during the high flow months of May and June as discussed in more detail in Section 4.2.3. Alternative 2 includes a flow augmentation program to increase Poudre River streamflows during traditionally low-flow times of the year, especially winter (Section 4.2.1.1.3). The augmentation water would be added in the middle of Segment A, but the effects would be most noticeable downstream of the Larimer-Weld Canal headgate dry-up point, which is just upstream of Segment B. The augmentation water would be diverted at the Timnath Reservoir Inlet near the downstream end of Segment B.

With Alternative 2, the changes in flow and resulting changes in other aspects of habitat would have an overall minor adverse impact to aquatic organisms compared to Current Conditions in Segment A. Changes to many individual components of the aquatic environment in this segment would be negligible but changes to others mostly would have minor adverse impacts. There could be a minor to moderate increase in summer temperatures that, if unmitigated, could have an adverse impact on trout.

Fish

Changes in fish habitat availability with Alternative 2 would be similar both in flowing sections of Segment A and at the dry-up points at the Greeley Filters Pipeline Intake, the Little Cache/Terry Lake Inlet, and the Watson Lake Fish Hatchery. The changes in flow would result

in a mix of adverse and beneficial impacts to fish species. Longnose dace may benefit from the lower peak runoff flows and the resulting increase in minimum habitat availability and because high-quality habitat exists for this species at low flows. Alternative 2 would have a minor adverse impact on the two recreationally important species in Segment A, brown and rainbow trout, due to reductions in habitat availability for adults during the critical spring period and the decrease in habitat quality with a decrease in high flows,. There could be a minor to moderate increase in summer temperatures that could have an adverse impact on trout. Negligible impacts are expected for suckers, juvenile trout, and trout fry. The loss of some SSCV habitat during diversions of peak spring flows at 20th percentile (dry years) and 80th percentile (wet years) flows would be detrimental in some years. There would be limited effects associated with changes in flow metrics such as the coefficient of variation during peak flows, minimum flows, or sudden flow fluctuations. Changes in sedimentation conditions would be negligible and have negligible impacts to riffle-pool complexes, but localized channel narrowing and vegetative encroachment would continue. There are not expected to be changes in species composition of the fish community. Brown and rainbow trout would continue to be common although the relative abundance of trout may decrease slightly.

In Segment B, the effect of Alternative 2 would be an overall moderate beneficial impact. Changes to many individual components of the aquatic environment in this segment would have minor to moderate beneficial impacts but other components would have negligible to minor adverse impacts. The augmented winter flows would approximately double minimum flows upstream of the Timnath Reservoir Inlet. The occurrence of extreme low flows would be approximately 90% less and the frequency of extreme flow fluctuations would be reduced by half. At the Larimer-Weld Canal dry-up point, low flows would be increased substantially. There could be a minor to moderate increase in summer temperatures that could have an adverse impact on trout. Changes in sedimentation conditions would be negligible and the spatial variability of riffle-pool complexes would be maintained. Ongoing localized channel narrowing and vegetative encroachment would continue.

Habitat availability for almost all species of fish would benefit from the augmented flows during the winter, early spring, and other low flow times of the year in sections upstream of the Timnath Reservoir Inlet. Some species, such as longnose dace and rainbow trout juveniles and fry, would also benefit from the reduced spring flows. Species that use SSCV habitat would also benefit from increases in this habitat in median and low flow years. Abundance of fish likely would increase and some species that now maintain low population levels may account for a higher proportion of the community. These changes indicate there would be a moderate beneficial impact to the fish community. However, minor to moderate increases in summer temperatures could dampen the benefit to trout.

Changes in fish habitat availability would be very different in the lower portion of Segment B at the dry-up point downstream of the Timnath Reservoir Inlet. Without augmented low flows, there would be mostly minimal changes in habitat availability for most fish species and a negligible impact.

Alternative 2 would have an overall minor adverse impact to aquatic organisms in Segment C. Changes to many individual components of the aquatic environment in this segment would have negligible impacts but other components would have minor to moderate adverse impacts. Changes to the magnitude and duration of low flow periods with Alternative 2 would be negligible both in flowing sections of the segment and at the dry-up point. There could be a minor increase in summer temperatures in a portion of Segment C near the Boxelder Gage that could have an adverse impact on trout. Changes in sedimentation conditions would be negligible and have negligible impacts to riffle-pool complexes. Ongoing localized channel narrowing and vegetative encroachment would continue.

The reductions in spring flows in Segment C would have a negligible impact on the small-bodied fish species including darters, sand shiners, and fathead minnows as these species have higher habitat availability at relatively low flows and already tolerate the somewhat degraded water quality in this segment. These species would benefit slightly from the increases in SSCV habitat in median and dry years. Lower frequency of flow fluctuations would also benefit fish. Longnose dace would benefit to a small degree with greater habitat availability at the lower spring runoff flows. However, adult trout would experience lower habitat availability with lower spring flows. For brown and rainbow trout, these two species do not maintain resident, reproducing populations in Segment C (GEI 2013), but seasonally use the habitat in the segment when temperatures are suitable. The increased temperatures with Alternative 2 could further limit the time when temperatures are suitable for trout. The lowered spring flows would reduce habitat availability and the seasonal use by these recreationally important species. Alternative 2 would have a moderate adverse impact on trout. There likely would not be a change in the overall species composition of the fish community with Alternative 2, but the community relative abundance may shift to one more dominated by small-bodied warmwater species with fewer trout.

Alternative 2 would have an overall minor adverse impact to aquatic organisms in Segments D, E, and F. Changes to many individual components of the aquatic environment in this segment would have minor adverse impacts but other components would have negligible impacts. The reductions in spring flows in June would extend the period of low to intermediate flows in these segments from May through August. Decreases in fluctuations would also be beneficial. Sedimentation, channel narrowing, and vegetative encroachment would worsen with reduced spring flows with Alternative 2 and alter riffle-pool complexes with fewer deep pools and more uniform habitat.

The changes would have negligible to minor impacts on habitat availability for fish and the increased sedimentation would have a minor adverse impact. The species present in Segments D, E, and F already tolerate the somewhat degraded habitat and water quality in this segment and there would be no changes in the number of species in this segment.

Macroinvertebrates

In Segment A, macroinvertebrate community abundance may benefit slightly from lower spring flows and augmented low flows downstream of the augmentation point. In Segment B, macroinvertebrate abundance would benefit from lower spring flows and augmented low flows.

In Segment C, macroinvertebrate abundance may benefit slightly from lower spring flows. In all three segments, the community may sustain a higher proportion of species that prefer moderate to slow current velocity. Species composition may change to species more suited to the altered flow regime, which would be a minor impact.

Segments A and B support a high proportion of rheophilic (prefer fast current) species but also support many other sensitive species of mayflies, stoneflies, caddisflies, and beetles that prefer more moderate current and that result in high MMI scores. Almost all MMI scores for samples in Segment A of the river were well above the threshold score of 43 for attaining the aquatic life use. Since 2002, MMI scores at the various sites in this segment ranged from 35.0 to 87.8 with most of the scores relatively high, greater than 58. A few of the scores from 2002 and 2003 were less than 50 and near the threshold for attaining the aquatic life use. MMI scores for samples in Segment B of the river since 2003 ranged from 60.2 to 69.7 and were well above the threshold score of 43 for attaining the aquatic life use. In Segment C, the macroinvertebrate community supports sensitive species that would lead to high MMI scores. The single MMI score of 48.5 for a sample in this segment of the river from 1993 was higher than the threshold of 43. The changes in species composition and loss of a few rheophilic species that may occur with Alternative 2 would likely not be sufficient to change MMI scores in these three segments much. The macroinvertebrate communities would still contain many sensitive species including some rheophilic and other species that prefer moderate currents. This would result in high MMI scores, which indicates the macroinvertebrate communities would continue to have MMI scores above the threshold and indicate attainment of the aquatic life use in these three segments.

In Segments D, E, and F, the increased sedimentation and lowered minimum flows may result in a macroinvertebrate community with fewer sensitive species and a shift away from rheophilic species that prefer faster currents. Species composition may change to species more suited to the altered flow regime, which would be a minor adverse impact due to loss of some rheophilic species.

There is very little MMI information for these three segments. Segments D, E, and F support a macroinvertebrate community dominated by tolerant species as presented in the 2013 CTP Aquatic Resources Baseline Report (GEI 2013). These segments support at least some sensitive and rheophilic species that result in high MMI scores, but fewer than in upstream segments. The few MMI scores for samples in this section of the river sometimes scored above and sometimes below the threshold for the attainment of the aquatic life use. There are no scores for Segment D. Samples in Segment E from 2001 and 1993 had scores of 59.1 and 35.4, respectively, well above the threshold of 23 for Biotype 3 streams (plains). One sample from Segment F in 2002 scored only 18.2, well below the threshold. The changes in species composition with Alternative 2 would likely not be sufficient to change MMI scores in these three segments much and would not change the aquatic life use designations. The macroinvertebrate communities would still contain some sensitive species including some rheophilic and other species that prefer moderate currents, which would result in MMI scores above the threshold most of the time.

Periphyton

Throughout the six segments of the mainstem, the reduced runoff flows with Alternative 2 would not change water quality conditions to an extent that would affect periphyton or aquatic plants. However, the lower runoff flows may allow periphyton abundance to increase, especially for filamentous green algae. Increased sedimentation in Segments D, E, and F would reduce habitat quality for periphyton. There also may be changes in species composition to species more suited to the lower runoff flows and increased sedimentation. The continued encroachment of riparian vegetation and channel narrowing may allow for greater abundance of aquatic plants on channel margins. Similar to conditions for macroinvertebrates, these changes would have a minor impact that could be considered both adverse and beneficial. However, the increase in filamentous green algae would be considered an adverse impact.

Poudre River Summary

The negligible to moderate impacts to aquatic resources and their habitat with Alternative 2 would not cause the crossing of a tipping point in the mainstem. Segment A would continue to function as a coldwater stream segment supporting coldwater species of fish and macroinvertebrates. Brown trout, longnose dace, and suckers are expected to remain as the dominant fish species. Segment B would continue to function as a warmwater stream segment supporting a wide variety of both coldwater and warmwater species of fish and macroinvertebrates. There would be slight changes in species relative abundance, but brown trout, longnose dace, and suckers are expected to remain as some of the most common fish species along with numerous warmwater species. Segment C would continue to function as a warmwater stream segment supporting a wide variety of warmwater species of fish and macroinvertebrates and seasonally support some trout that move downstream from Segment B. Segment D would continue to function as a warmwater stream segment supporting a wide variety of warmwater species of fish including minnows, darters, and suckers and a somewhat degraded community of macroinvertebrates. There may be slight reductions in fish abundance but the numerous warmwater species would continue to be the dominant component of the fishery. Segments E and F would continue to function as warmwater stream segments supporting a wide variety of warmwater species of fish and a somewhat degraded community of macroinvertebrates. The fish community in these two segments has already crossed a tipping point and nonnative species such as carp, gizzard shad, largemouth bass, and mosquitofish are common and only a few native species such as white suckers, fathead minnows, and green sunfish continue to be common (GEI 2013). There may be slight reductions in fish abundance but the fishery would still contain numerous species of native and introduced warmwater species.

4.12.3.3.2 South Platte River

Alternative 2 would have an overall negligible impact on aquatic resources in the South Platte River. Changes to almost all individual components of the aquatic environment in this segment would have negligible impacts. Changes in water quality, water temperatures, riparian vegetation, and channel geomorphology in the South Platte River would be negligible and not have much effect on aquatic organisms. The small changes in flow would have little effect on habitat availability and a negligible impact for most fish species. There could be a minor adverse

impact on plains killifish due to reductions in habitat availability in fall and during spring runoff for this species of special concern in Colorado.

There is expected to be a negligible impact on the macroinvertebrate community in the South Platte River. Most MMI scores for samples in this section of the South Platte River were above the threshold for attaining the aquatic life use, although a few scores were below the threshold. The most recent samples from 2002 and 2003 at a site near Kersey had scores of 43.6 and 18.4, one above and one below the threshold of 23. Past scores from the 1990s at the same site ranged from 15.6 to 49.1, with three of the four scores above the threshold. This segment supports a community dominated by tolerant species and supports only a few sensitive and rheophilic species and this resulted in the low MMI scores. The negligible changes in the macroinvertebrate community and species composition with Alternative 2 would likely continue to result in low MMI scores that are sometimes below the threshold for attainment.

The negligible impacts to most components of aquatic resources and their habitat with Alternative 2 would not cause the crossing of a tipping point in Segment 1 of the South Platte River. This segment would continue to function as a warmwater stream segment supporting a wide variety of warmwater species of fish and a somewhat degraded community of macroinvertebrates. The fish community has a higher proportion of native species compared to the community in the mainstem of the Poudre River (GEI 2013). Native minnow species are most common with introduced species present, but usually in relatively low numbers. The negligible impacts to most components of the aquatic environment with Alternative 2 indicate the fishery would still contain numerous species of native and introduced warmwater species.

4.12.3.3.3 Effects Summary

Alternative 2 would have minor adverse impacts to most aquatic resource components in the mainstem (Table 4-86). The augmented low flows in Segment B would have a moderate beneficial impact. In the South Platte River, the changes in flow would be relatively small and there would be a negligible impact.

Table 4-86. Aquatic biological resources effects summary by river segment for Alternative 2.

Segment	Overall Impact	Fish	Macroinvertebrates	Periphyton and Plants
Mainstem Poudre River				
A	Minor Adverse	Minor adverse impact to adult trout due to reduced runoff flows, negligible impacts to other species/life stages	Minor adverse impact with changes in species composition due to reduced peak flows	Minor adverse impact with increases in filamentous green algae due to reduced peak flows
B	Moderate Beneficial	Minor to moderate beneficial impact to most species of fish with augmented low flows	Beneficial impact to abundance, minor adverse impact with changes in species composition due to reduced peak flows	Minor adverse impact with increases in filamentous green algae due to reduced peak flows
C	Minor Adverse	Negligible impact to most species, moderate adverse impact to trout with reduced runoff flows and higher temperatures	Minor adverse impact with changes in species composition due to reduced peak flows	Minor adverse impact with increases in filamentous green algae due to reduced peak flows
D	Minor Adverse	Minor adverse impact for some species with reductions in runoff flows, negligible impact for others	Minor adverse impact with changes in species composition due to reduced peak flows	Minor adverse impact with increases in filamentous green algae due to reduced peak flows
E	Minor Adverse	Minor adverse impact for most species with reduced runoff flows	Minor adverse impact with changes in species composition due to reduced peak flows	Minor adverse impact with increases in filamentous green algae due to reduced peak flows
F	Minor Adverse	Minor adverse impact for most species with reduced runoff flows	Minor adverse impact with changes in species composition due to reduced peak flows	Minor adverse impact with increases in filamentous green algae due to reduced peak flows
South Platte River				
1	Negligible	Negligible impacts for most species	Negligible impacts	Negligible impacts

4.12.3.4 Nuisance Species

The distribution and abundance of nuisance species would not be affected substantially by Alternative 2. Common carp and mosquitofish would continue to thrive in the altered habitats of the mainstem. Lower spring runoff flows would be beneficial to these two species, neither of which is adapted to high water velocities. Whirling disease presence and infectivity in the mainstem would likely not change, because water temperatures would not change substantially under this alternative. Didymo blooms could increase slightly near the upstream end of the study area in Segments A and B, in response to reduced spring runoff flows. Higher proportions of fine substrate and only relatively small reductions in the already low spring runoff flows that are typical in the lower segments of the mainstem would not improve conditions for Didymo and make it unlikely that blooms would increase in Segments C, D, E, or F of the mainstem. New Zealand mud snails are currently absent from the Poudre Drainage and all drainages connected to it through transbasin diversions. This would not change with Alternative 2. The

prevalence of West Nile virus would not change under Alternative 2. Alternative 2 would not create any new habitat along the mainstem of the Poudre River that would be suitable to support mosquitoes. Mosquitoes would not be expected to live in the two proposed reservoirs due to the presence of fish and other predators.

The creation of Glade Reservoir could increase habitat for aquatic nuisance species. Whirling disease would likely become established in Glade Reservoir as whirling disease positive fish enter the reservoir through the Poudre Valley Canal. Common carp may also become established in Glade Reservoir. Glade Reservoir could provide ample habitat for zebra mussels or quagga mussels, but these species could only be introduced via transfer from contaminated objects such as boats or boating equipment. Current state regulations require boat inspection and disinfection to prevent spread of these species. These practices have minimized the potential for introductions of the mussels into lakes and reservoirs so it is unlikely that they would become established in Glade Reservoir.

4.12.4 Alternative 3

4.12.4.1 Reservoir Sites

At an elevation of 5,239 feet when full, Cactus Hill Reservoir would be suitable to support both coldwater and warmwater recreationally important fish species. The creation of Cactus Hill Reservoir would represent a major beneficial effect of Alternative 3 for aquatic organisms. The reservoir would provide new habitat to sustain populations of a variety of organisms. The reservoir would also be suitable for the establishment and management of a recreational fishery that could support populations of both stocked and self-sustaining fish species and the reservoir would support a low to medium fishery quality.

Fluctuations in water level, combined with newly inundated vegetation, can lead to elevated levels of methylmercury in fish tissue. This suggests that fish in Cactus Hill Reservoir would have high body burdens of methylmercury, and like many other Front Range reservoirs such as Horsetooth Reservoir, Cactus Hill Reservoir may eventually have a mercury-based fish consumption advisory.

As previously described for Alternative 2 (Section 4.12.3.1), the creation of Galeton Reservoir would create new habitat for aquatic resources where none now exists and in this sense would be a benefit. However, the conditions for aquatic resources in the reservoir would likely be poor and the beneficial effect would be minor. With Alternative 3, there would be no changes in the operation of Horsetooth Reservoir. Alternative 3 would have no impact on Horsetooth Reservoir or Carter Lake.

4.12.4.2 Conveyance Systems

Alternative 3 is expected to have a temporary negligible impact on aquatic biological resources along the route of the conveyance systems. The conveyance systems are proposed to occur primarily in rural agricultural areas and within road rights-of-way. However, some of the

proposed conveyance alignments would cross streams. The conveyance alignments will be refined for the FEIS and stream crossings for the conveyance alignments will be presented in the FEIS.

4.12.4.3 River Segments

4.12.4.3.1 Poudre River

Alternative 3 is similar to Alternative 2 in that it includes diversions of water from the mainstem just downstream of the North Fork. Water primarily would be diverted from the mainstem during the high flow months of May and June. Alternative 3 would divert on average about 5,500 to 6,000 AFY more water from the Poudre River than Alternative 2 to compensate for increased reservoir evaporation from Cactus Hill Reservoir and conveyance loss. Additionally, Alternative 3 does not include the flow augmentation program that is proposed under Alternative 2 because there would be no infrastructure to make flow releases from Cactus Hill Reservoir to the Poudre River.

Alternative 3 would have similar impacts as previously presented for Alternative 2 (Section 4.12.3.3.1) compared to Current Conditions in all segments except for Segment B of the mainstem. This would include minor adverse impacts to aquatic resources in segments A, C, D, E, and F of the mainstem, as described for Alternative 2.

Fish

Changes in fish habitat availability with Alternative 3 would be similar both in flowing sections of Segment B and at the dry-up point. A reduction in sudden flow fluctuations would occur with implementation of the low flow augmentation program, which would benefit fish and invertebrates as discussed in the 2015 Aquatic Resources Effects Report (GEI 2015b). Longnose dace would benefit from the lower peak runoff flows and the resulting increase in minimum habitat availability. Alternative 3 would have a moderate adverse impact on the two recreationally important species in Segment B, brown and rainbow trout, due to reductions in habitat availability for adults during the critical spring period. There could be a minor to moderate increase in summer temperatures that could have an adverse impact on trout. Brown trout are one of the most common species in Segment B and the effects to this species would have a moderate adverse impact on the fishery. Negligible impacts are expected for suckers, darters, or juvenile trout of either species. In most years, SSCV habitat would increase slightly under Alternative 3; the small increases could be beneficial. Changes in sedimentation conditions would be negligible and have negligible impacts to riffle-pool complexes, but localized channel narrowing and vegetative encroachment would continue. There are expected to be no changes in the species composition of the fish community although the relative abundance may shift with reductions in brown trout.

Macroinvertebrates

Macroinvertebrate community abundance may benefit slightly from lower spring flows and the community may sustain a higher proportion of species that prefer moderate to slow current velocity. Species composition may change to species more suited to the altered flow regime,

which would be a minor adverse impact. Segment B supports a high proportion of rheophilic species and many other sensitive species of macroinvertebrates that result in the high MMI scores. The changes in species composition with Alternative 3 would likely not be sufficient to change MMI scores much. The macroinvertebrate communities would still contain many sensitive species including some rheophilic and other species that prefer moderate currents, which would result in high MMI scores. This indicates the community would continue to score above the threshold and indicate attainment.

Periphyton

Similar to macroinvertebrates, there may be a minor increase in abundance of periphyton and aquatic plants and minor adverse impact to species composition.

Poudre River Summary

The negligible to moderate adverse impacts to aquatic resources and their habitat with Alternative 3 would not cause the crossing of a tipping point in Segment B. Segment B would continue to function as a warmwater stream segment supporting a wide variety of both coldwater and warmwater species of fish and macroinvertebrates. There would be slight changes in species relative abundance, but brown trout, longnose dace, and suckers are expected to remain as some of the most common fish species along with numerous warmwater species.

4.12.4.3.2 South Platte River

Alternative 3 would have similar impacts as previously presented for Alternative 2 (Section 4.12.3.3.2) compared to Current Conditions in the South Platte River. This would include a negligible impact in the South Platte River, as described for Alternative 2.

4.12.4.3.3 Effects Summary

Alternative 3 would have minor adverse impacts to most aquatic resource components in the mainstem (Table 4-87). In Segment B there would be a minor to moderate adverse impact. In the South Platte River, the changes in flow would be relatively small and there would be a negligible impact.

Table 4-87. Aquatic biological resources effects summary by river segment for Alternative 3.

Segment	Overall Impact	Fish	Macroinvertebrates	Periphyton and Plants
Mainstem Poudre River				
A	Minor Adverse	Minor adverse impact to adult trout due to reduced runoff flows, negligible impacts to other species/life stages	Minor adverse impact with changes in species composition due to reduced peak flows	Minor adverse impact with increases in filamentous green algae due to reduced peak flows
B	Minor/ Moderate Adverse	Moderate adverse impact to adult trout due to reduced runoff flows, negligible impacts to other species/life stages	Minor adverse impact with changes in species composition due to reduced peak flows	Minor adverse impact with increases in filamentous green algae due to reduced peak flows
C	Minor Adverse	Negligible impact to most species, moderate adverse impact to trout with reduced runoff flows and higher temperatures	Minor adverse impact with changes in species composition due to reduced peak flows	Minor adverse impact with increases in filamentous green algae due to reduced peak flows
D	Minor Adverse	Minor adverse impact for some species with reductions in runoff flows, negligible impact for others	Minor adverse impact with changes in species composition due to reduced peak flows	Minor adverse impact with increases in filamentous green algae due to reduced peak flows
E	Minor Adverse	Minor adverse impact for most species with reduced runoff flows	Minor adverse impact with changes in species composition due to reduced peak flows	Minor adverse impact with increases in filamentous green algae due to reduced peak flows
F	Minor Adverse	Minor adverse impact for most species with reduced runoff flows	Minor adverse impact with changes in species composition due to reduced peak flows	Minor adverse impact with increases in filamentous green algae due to reduced peak flows
South Platte River				
1	Negligible	Negligible impacts for most species	Negligible impacts	Negligible impacts

4.12.4.4 Nuisance Species

Alternative 3 would have similar impacts to the distribution and abundance of nuisance species as that previously presented for Alternative 2 (Section 4.12.3.4). Cactus Hill Reservoir could support nuisance species similar to the conditions previously described for Glade Reservoir (Section 4.12.3.4).

4.12.5 Alternative 4

4.12.5.1 Reservoir Sites

Alternative 4 would have similar impacts to reservoirs as previously described for Alternative 3 (Section 4.12.4.1).

4.12.5.2 Conveyance Systems

Alternative 4 is expected to have a temporary negligible impact on aquatic biological resources along the route of the conveyance systems. The conveyance systems are proposed to occur primarily in rural agricultural areas and within road rights-of-way. However, some of the proposed conveyance alignments would cross streams. The conveyance alignments will be refined for the FEIS and stream crossings for the conveyance alignments will be presented in the FEIS.

4.12.5.3 River Segments

4.12.5.3.1 Poudre River

Alternative 4 would be similar to Alternative 3 in many respects, except that there would be two points of diversion. For Alternative 4, approximately 75% of the water would be diverted from the mainstem at the Poudre Valley Canal, the same location as other alternatives, but about 25% of the water would be diverted at the New Cache la Poudre Co. Ditch east of I-25 and east of Fort Collins. Relative to Alternatives 2 and 3, this would allow more water to flow through the Fort Collins area before being diverted. Water primarily would be diverted from the mainstem during the high flow months of May and June. Like Alternative 3, Alternative 4 would divert on average about 5,500 to 6,000 AFY more water from the Poudre River than Alternative 2 to compensate for increased reservoir evaporation from Cactus Hill Reservoir and conveyance loss. Alternative 4 also does not include the flow augmentation program that is proposed under Alternative 2 because there would be no infrastructure to make flow releases from Cactus Hill Reservoir to the Poudre River.

Fish, Macroinvertebrates, and Periphyton

In Segments A, B, and C, Alternative 4 would divert spring runoff flows to a smaller extent than Alternative 3 and consequently would have smaller but similar negligible to minor adverse impacts to benthic macroinvertebrates, periphyton, and aquatic plants (Section 4.12.4.3.1). Macroinvertebrate species composition may change to species more suited to the altered flow regime, which would be a minor impact but MMI scores are expected to continue to indicate attainment of the aquatic life use. The macroinvertebrate communities would still contain many sensitive species including some rheophilic species and other species that prefer moderate currents, which would result in high MMI scores. This indicates the macroinvertebrate communities would continue to have MMI scores above the threshold and indicate attainment of the aquatic life use in these three segments. The continued encroachment of riparian vegetation

and channel narrowing may allow for greater abundance of aquatic plants on channel margins. The increase in filamentous green algae would be considered an adverse impact. The changes in Segments A, B, and C would not cause the crossing of tipping points in these segments.

The differences in hydrology between Alternatives 2, 3, and 4 would be minimal on most days in Segments D, E, and F of the mainstem. The resulting differences in habitat availability for fish and macroinvertebrates between the three alternatives would also be minimal. Therefore, Alternative 4 would have the same impacts as previously presented for Alternatives 2 (Section 4.12.3.3.1) and Alternative 3 (Section 4.12.4.3.1) in Segments D, E, and F. This would include minor adverse effects to aquatic resources in these segments of the mainstem.

4.12.5.3.2 South Platte River

Alternative 4 would have the same impacts as previously presented for Alternatives 2 (Section 4.12.3.3.2) and Alternative 3 (Section 4.12.4.3.2) in the South Platte River. This would include a negligible impact in the South Platte River.

4.12.5.3.3 Effects Summary

Alternative 4 would have negligible to minor adverse impacts to most aquatic resource components in the mainstem (Table 4-88). In Segment B there would be a minor to moderate adverse impact. In the South Platte River, the changes in flow would be relatively small and there would be a negligible impact.

Table 4-88. Aquatic biological resource effects summary by river segment for Alternative 4.

Segment	Overall Impact	Fish	Macroinvertebrates	Periphyton and Plants
Mainstem Poudre River				
A	Minor Adverse	Minor adverse impact to adult trout due to reduced runoff flows, negligible impacts to other species/life stages	Minor adverse impact with changes in species composition due to reduced peak flows	Minor adverse impact with increases in filamentous green algae due to reduced peak flows
B	Negligible	Negligible impact to most species	Negligible to minor adverse impact with changes in species composition due to reduced peak flows	Negligible to minor adverse impact with increases in filamentous green algae due to reduced peak flows
C	Negligible	Negligible impact to most species	Minor adverse impact with changes in species composition due to reduced peak flows	Negligible to minor adverse impact with increases in filamentous green algae due to reduced peak flows
D	Minor Adverse	Minor adverse impact for some species with reductions in runoff flows, negligible impact for others	Minor adverse impact with changes in species composition due to reduced peak flows	Minor adverse impact with increases in filamentous green algae due to reduced peak flows
E	Minor Adverse	Minor adverse impact for most species with reduced runoff flows	Minor adverse impact with changes in species composition due to reduced peak flows	Minor adverse impact with increases in filamentous green algae due to reduced peak flows
F	Minor Adverse	Minor adverse impact for most species with reduced runoff flows	Minor adverse impact with changes in species composition due to reduced peak flows	Minor adverse impact with increases in filamentous green algae due to reduced peak flows
South Platte River				
1	Negligible	Negligible impacts for most species	Negligible impacts	Negligible impacts

4.12.5.4 Nuisance species

Impacts to nuisance species for Alternative 4 would be similar to those previously presented for Alternative 3 (Section 4.12.4.4).

4.12.6 Unavoidable Adverse Impacts

All three action alternatives would reduce runoff flows along the length of the mainstem of the Poudre in the study area. This would generally result in minor adverse impacts to fish, benthic macroinvertebrates, periphyton, and aquatic plants in most segments. In Segment B, Alternative 3 would result in a minor to moderate adverse impact with reduced habitat availability for trout.

4.12.7 Impact Summary

The No Action Alternative is not compared to Existing Conditions or the action alternatives in this section. The No Action Alternative is compared to Future Conditions and the action alternatives in Chapter 5 of this SDEIS.

All three action alternatives would reduce spring flows. However, the locations of the diversions would vary by alternative, with Alternatives 2 and 3 diverting at the Poudre Valley Canal and Alternative 4 comprising about 75% diversion at the Poudre Valley Canal and approximately 25% diversion at the New Cache la Poudre Company Ditch. Alternative 2 would augment winter flows in the lower portion of Segment A and through almost all of Segment B. These differences among alternatives would change the impact intensity in Segments A, B, and C of the mainstem (Table 4-89). In Segment B, Alternative 2 would have a moderate beneficial impact on aquatic biological resources mainly due to augmented flows in winter, early spring, and in September. In this segment Alternative 3 would have a minor to moderate adverse impact due to reductions in runoff flows and no winter flow augmentation. Alternative 4 would result in a minor adverse impact in Segment A with reduced runoff flows and result in negligible impacts to Segments B and C by allowing approximately 25% of the water that would have been diverted at the Poudre Valley Canal (with Alternatives 2 and 3) to flow through these segments before being diverted at the New Cache Canal. All action alternatives would have similar minor adverse impacts in Segments D, E, and F of the mainstem and negligible impacts in the South Platte River. All alternatives would also include the construction of Galeton Reservoir and either Glade Reservoir or Cactus Hill Reservoir which would be a major beneficial impact.

The relative impacts of the three alternatives would not be very different; there would be similar impacts in many segments, especially downstream of Segment C (Table 4-89). The augmented low flows with Alternative 2 through parts of Segments A and B would result in less impact through these segments than Alternatives 3 and 4. Alternative 3 would have no augmented low flows and a greater level of impact compared to the other two alternatives. Alternative 4 would also have no augmented flows but would have some of the water diverted after flowing through Segments A, B, and C and would have an intermediate level of impact compared to the other action alternatives.

The effects from proposed reservoirs and on existing reservoirs are summarized in Table 4-89. All action alternatives would have a major beneficial effect with the creation of either Glade Reservoir (Alternative 2) or Cactus Hill Reservoir (Alternatives 3 and 4). Galeton Reservoir would create a minor beneficial effect for all action alternatives. Alternative 2 Reclamation Action Option would generally result in less drawdown of Horsetooth Reservoir over the summer and less seasonal fluctuation of water levels, which would have a minor beneficial impact for fish and other aquatic organisms. Alternative 2 No Reclamation Action Option, Alternative 3, and Alternative 4 would have a negligible effect on Horsetooth Reservoir. All action alternatives would have a negligible effect on aquatic resources at Carter Lake.

Table 4-89. Summary of aquatic biological resources effects determinations by river segment and reservoir.

Segment	Alternative 2 Reclamation Action Option	Alternative 2 No Reclamation Action Option	Alternative 3	Alternative 4
Mainstem Poudre River				
Segment A	Minor Adverse	Minor Adverse	Minor Adverse	Minor Adverse
Segment B	Moderate Beneficial	Moderate Beneficial	Minor/Moderate Adverse	Negligible
Segment C	Minor Adverse	Minor Adverse	Minor Adverse	Negligible
Segment D	Minor Adverse	Minor Adverse	Minor Adverse	Minor Adverse
Segment E	Minor Adverse	Minor Adverse	Minor Adverse	Minor Adverse
Segment F	Minor Adverse	Minor Adverse	Minor Adverse	Minor Adverse
South Platte River				
Segment 1	Negligible	Negligible	Negligible	Negligible
Reservoirs				
Glade	Major Beneficial	Major Beneficial	N/A	N/A
Cactus Hill	N/A	N/A	Major Beneficial	Major Beneficial
Galeton	Minor Beneficial	Minor Beneficial	Minor Beneficial	Minor Beneficial
Horsetooth	Minor Beneficial	Negligible	Negligible	Negligible
Carter	Negligible	Negligible	Negligible	Negligible

4.13 TRAFFIC AND TRANSPORTATION

This section summarizes the predicted potential effects of the NISP alternatives on traffic and transportation. Constructing Cactus Hill Reservoir in Alternatives 1, 3, and 4 would require relocating a segment of three Weld County roads and constructing Glade Reservoir in Alternative 2 would require relocating a segment of U.S. 287. No new studies on traffic and transportation were performed for the SDEIS. Subsequent to the DEIS, CDOT selected the western alignment as its preferred alternative for the realignment of U.S. 287 under Alternative 2. Sections 4.19 and 4.29.14 of the DEIS addressed effects to traffic and transportation.

4.13.1 Methods

Effects to traffic and transportation were assessed based on information obtained from the Weld County Public Works Department and CDOT. The traffic and transportation assessment focused on the three proposed reservoir sites because these inundated areas would have the greatest potential for permanent impacts to traffic and transportation.

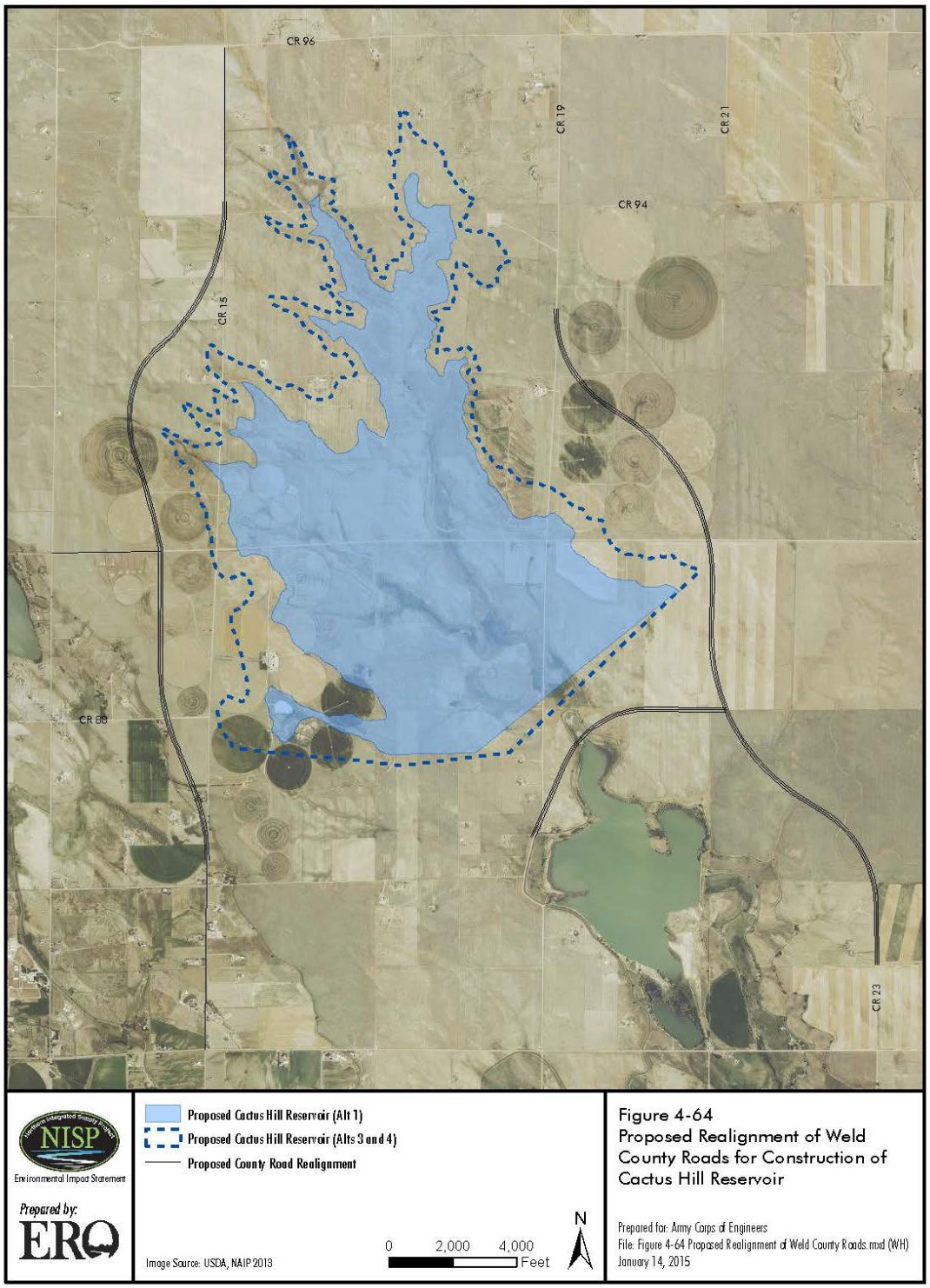
4.13.2 No Action Alternative (Alternative 1)

4.13.2.1 Cactus Hill Reservoir

Cactus Hill Reservoir would directly impact local WCR 15, 19, and 90. WCR 15 is proposed to be realigned one mile east of the existing alignment, generally following the eastern edge of the proposed reservoir. Based on the low traffic volume of WCR 15, impacts to existing traffic using this road would be minor.

To accommodate Cactus Hill Reservoir, a portion of WCR 19 would be abandoned between Black Hollow Reservoir and WCR 94. Similarly, a section of WCR 90, 4 to 5 miles in length, also would be inundated. In lieu of these existing routes, a new road would be built along the east side of the reservoir. This new road would extend WCR 23 north of WCR 86 and meander toward the reservoir and tie into the existing WCR 19 one mile south of WCR 96. A short segment would be built to connect the southern portion of WCR 19 (at Black Hollow Reservoir) to the new roadway (Figure 4-64). Travel times for vehicles using WCR 19 would increase a few minutes between State Highway (SH) 14 and WCR 96. Vehicles using WCR 90 would travel around the proposed Cactus Hill Reservoir via the new roadways and the existing WCR 96, which would add 8 miles to their current route, increasing travel times for these vehicles by 10 to 15 minutes. It is anticipated that the Cactus Hill Reservoir and dam would not have a substantial impact to daily traffic volumes on the existing roadway network, but it would increase travel times for some local traffic.

Figure 4-64. Proposed Realignment of Weld County Roads for Construction of Cactus Hill Reservoir.



Weld County would require a traffic impact study before approving the new alignments. In addition, access to the Cactus Hill Reservoir facility from the existing roadway network would require a permit from Weld County.

During construction of the Cactus Hill Reservoir and dam, a minimal increase in traffic associated with workers accessing the site would occur on the roads in the immediate vicinity. Trucks and heavy vehicles necessary for site development would likely remain on-site for the duration of construction and would not contribute to daily traffic.

4.13.2.2 Conveyance Systems

The Participants would employ trenchless technology for pipeline construction for many road crossings. Trenchless construction methods would cause little or no disruption to traffic and would have negligible, short-term effects. Any roadway with a pipeline aligned longitudinally beneath it would use open-cut construction. Open-cut construction of pipelines would require a trench to be dug along the length of the pipeline, affecting the portion of the road that requires the trench. The pipeline would then be laid in the trench, and the trench would be backfilled to pre-existing conditions. Roadways that would be open cut would either have temporary lane closures or would be closed to traffic and pedestrians, and a detour route would be required during construction.

The District estimates that about 200 vehicles per day (400 one-way trips) would be needed during construction of water pipelines, pump stations, and water treatment plants. Traffic effects would be short term because construction of each pipeline mile is expected to last between 2 and 10 weeks. Construction contractors would be required to develop traffic control plans for any construction within a roadway; traffic control plans would be subject to approval by the transportation agency responsible for the affected roadway. Consequently, short-term effects to traffic in local roadways during construction primarily would be minor to moderate.

4.13.3 District's Preferred Alternative (Alternative 2)

4.13.3.1 Reservoir Sites

4.13.3.1.1 Glade Reservoir

Changes in traffic volumes from reservoir construction would be similar to the effects of constructing the Cactus Hill Reservoir described in the No Action Alternative. Alternative 2 would not affect any county roads. Proposed public recreation at Glade Reservoir is predicted to be about 439,300 visitor days annually (BBC and HCR 2015b), which would increase traffic volumes of area roads seasonally. The Glade Reservoir site would see sizeable increases in traffic seasonally associated with recreation.

U.S. 287. Construction of the Glade Reservoir and dam would inundate a 7-mile portion of the existing U.S. 287 between Ted's Place and Larimer County Road (LCR) 68. As a result, a portion of the highway between LCR 68 on the north and Overland trail on the south would be

realigned to maintain this connectivity. The new alignment would be 2.5 miles shorter, reducing travel times by a few minutes (Figure 2-8). The current conceptual construction plan includes concurrent construction of the U.S. 287 realignment and dam foundation excavation west of existing U.S. 287. The existing U.S. 287 would remain open to both lanes of traffic and signage and other traffic control would be provided for any construction related traffic entering or exiting the site. Minor disruptions to travel may occur when the realigned portion of U.S. 287 is joined with the existing U.S. 287 and the abandoned section of U.S. 287 is closed.

The realignment of U.S. 287 would not change the highway designations or the access control for either U.S. 287 or SH 14. The final design of the realignment would meet all CDOT and Larimer County requirements. Other traffic-related impacts associated with the realignment would include:

- Existing traffic patterns are not expected to change; therefore, reduced traffic volumes are anticipated along the section of SH 14 where the two highways would no longer run concurrently (between Overland trail and Ted's Place).
- The existing U.S. 287/SH 14 intersection (at Ted's Place) is under stop control for the west leg (SH 14) of the intersection. It is expected that this traffic control would be maintained.
- The existing U.S. 287/Overland Trail Road intersection is under stop control for vehicles turning onto U.S. 287. It is expected that this traffic control would be maintained. It is estimated that the increase in northbound traffic turning left onto U.S. 287 from Overland Trail Road would increase by 25 vehicles in the peak hour and is not anticipated to substantially alter the operation of this intersection or any local roadway or street in Laporte (Section 4.29.14 of the DEIS).
- The Bonner Spring Ranch Road and Big Ridge Way would be affected by the realignment and the placement of Glade Reservoir. Alternative access would be provided.
- Access to a CSU/State Land Board parcel west of Glade Reservoir would be affected. Alternative access would be provided.

4.13.3.1.2 Galeton Reservoir

The SPWCP and Galeton Reservoir are common to all action alternatives. During construction of the dam and reservoir, a minimal increase in traffic, associated with workers accessing the site, can be expected on the roads in the immediate vicinity. Trucks and heavy vehicles necessary for site development would likely remain on-site for the duration of construction and would not contribute to daily trip generations. It is anticipated that any traffic associated with operation of the Galeton Reservoir and dam would be minor. In general, only vehicles associated with the daily operation and maintenance of the facility are expected to access the site. Public recreational activities are not planned for Galeton Reservoir. It is not expected that this site would generate enough traffic to warrant any improvement to the area roadway network. The proposed location for Galeton Reservoir is such that it would not infringe on or disturb any existing public roadways. Access to the reservoir would need to occur from one of the existing roads surrounding the site. This may include an extension of one of the existing roadways or

construction of a private drive or roadway for purposes of accessing and maintaining the facility. The District would obtain a permit to gain access from either a local road (Weld County) or from the state highway (CDOT). In Weld County, the requirements of any new development are determined on a case-by-case basis. A traffic impact study would be required prior to approval of the development to be constructed.

4.13.3.2 Conveyance Systems

Changes in traffic volumes from pipeline and pump station construction would be similar to the effects of constructing the pipeline and pump station described in the No Action Alternative.

4.13.4 Alternative 3

4.13.4.1 Reservoir Sites

4.13.4.1.1 Cactus Hill Reservoir

Changes in traffic volumes from Cactus Hill Reservoir construction would be the same as the No Action Alternative.

4.13.4.1.2 Galeton Reservoir

Changes in traffic volumes from Galeton Reservoir construction would be the same as Alternative 2.

4.13.4.2 Conveyance Systems

Changes in traffic volumes from pipeline and pump station construction would be similar to the effects of constructing the pipeline and pump station described in the No Action Alternative.

4.13.5 Alternative 4

4.13.5.1 Reservoir Sites

4.13.5.1.1 Cactus Hill Reservoir

Changes in traffic volumes from Cactus Hill Reservoir construction would be the same as Alternative 3.

4.13.5.1.2 Galeton Reservoir

Changes in traffic volumes from Galeton Reservoir construction would be the same as Alternative 2.

4.13.5.2 Conveyance Systems

Changes in traffic volumes from pipeline and pump station construction would be similar to the effects of constructing the pipeline and pump station described in the No Action Alternative.

4.13.6 Unavoidable Adverse Impacts

Construction of all alternatives would cause short-term impacts to traffic associated with increased construction traffic and potential temporary lane closures and/or detours associated with pipeline construction. These effects are expected to be short-lived and minor.

Construction of all alternatives would require the realignment of road segments displaced by the proposed dams and reservoirs. Realignment of roads would cause minor short-term impacts to traffic associated with increased construction traffic and potential temporary lane closures and/or detours associated with road construction. The road realignments would cause minor long-term changes to traffic circulation and travel times. For Alternatives 1, 3, and 4, travel times for vehicles using WCR 19 would increase a few minutes between SH 14 and WCR 96. Vehicles using WCR 90 would travel around the proposed Cactus Hill Reservoir via the new roadways and the existing WCR 96, which would add 8 miles to their current route, increasing travel times for these vehicles by 10 to 15 minutes. For Alternative 2, the western alignment of U.S. 287 would be about 2.5 miles shorter than existing U.S. 287, reducing travel times on U.S. 287 by a few minutes. The realignment of U.S. 287 would also affect access for some parties. Bonner Spring Ranch Road, Big Ridge Way, and access to the CSU/State Land Board parcel west of Glade Reservoir would be affected by the realignment and Glade Reservoir. These impacts to access would be minor because alternative access would be provided.

Glade Reservoir (Alternative 2) is proposed to be managed for public recreation, which would likely slightly increase traffic volumes of area roads seasonally. The Glade Reservoir site would see sizeable increases in traffic seasonally associated with public recreation.

All impacts to traffic and transportation associated with the alternatives are expected to be minor, except seasonal traffic impacts associated with visitation to Glade Reservoir. Annual visitor days for Glade Reservoir are estimated to be about 439,300 (BBC and HCR 2015b). Construction of the reservoirs and pipelines would require local approvals including traffic control plans that would include measures to minimize impacts to traffic. The final design of the proposed road realignments would be required to meet all requirements of the agency responsible for the road.

4.13.7 Impact Summary

All impacts to traffic and transportation associated with the alternatives are expected to be minor except seasonal traffic impacts associated with visitation to Glade Reservoir (Table 4-90). All alternatives would cause short-term impacts to traffic associated with increased construction traffic and potential temporary lane closures and/or detours associated with pipeline and road construction. These effects would be similar for Alternatives 1, 3, and 4 because Cactus Hill Reservoir is common to these alternatives and conveyance systems would be similar.

All alternatives would unavoidably impact sections of existing roads. The proposed road realignments would require abandonment of the affected sections of existing roads and their associated right-of-way (ROW) and acquiring new ROW associated with the road realignments. Alternative 2 is predicted to have greater short-term and long-term effects on traffic and

transportation. The realignment of U.S. 287 involves moving a segment of the main arterial road in the area, whereas Alternatives 1, 3, and 4 involve the realignment of county roads. Some local access would be affected by Glade Reservoir and U.S. 287 realignment, although alternative access would be provided. Additionally, Alternative 2 would have minor seasonal increases in traffic volumes of area roads associated with public recreation, which is not proposed for Cactus Hill Reservoir. Although these effects associated with Alternative 2 are greater than the other alternatives, the effects are estimated to be minor.

Table 4-90. Summary of traffic and transportation impacts.

Alternative	Predicted Impacts
Alternative 1	Short-term minor impacts to traffic would occur associated with increased construction traffic and potential temporary lane closures and/or detours associated with pipeline and road realignment construction. Realignment of WCRs would be a minor effect that would slightly increase travel times.
Alternative 2	Short-term minor impacts to traffic would occur associated with increased construction traffic and potential temporary lane closures and/or detours associated with pipeline and road realignment construction. The western alignment of U.S. 287 would be 2.5 miles shorter than existing U.S. 287, reducing travel times on U.S. 287 by a few minutes. Minor seasonal increases in traffic volumes of area roads would have a minor impact. Local access would be affected by the reservoir and U.S. 287 realignment. This is predicted to be a minor effect because alternative access would be provided.
Alternative 3	Short-term minor impacts to traffic would occur associated with increased construction traffic and potential temporary lane closures and/or detours associated with pipeline and road realignment construction. Realignment of WCRs would be a minor effect that would slightly increase travel times.
Alternative 4	Short-term minor impacts to traffic would occur associated with increased construction traffic and potential temporary lane closures and/or detours associated with pipeline and road realignment construction. Realignment of WCRs would be a minor effect that would slightly increase travel times.

4.14 AIR QUALITY

This section summarizes the predicted potential air quality effects of the NISP alternatives. New air quality studies were conducted for the SDEIS. Air quality effects associated with construction were estimated based on emissions from anticipated project construction equipment, workforce, and fugitive dust (GEI 2013) and carbon dioxide emissions associated with operation of the alternatives (BBC 2014). After release of the DEIS, Metropolitan Denver and the north Front Range were classified as a "marginal" ozone nonattainment area by the EPA effective July 20, 2012. The marginal nonattainment designation does not impose any new planning requirements on Colorado at this time; however, the nonattainment area must meet the standard before 2015 or new requirements may be imposed. Subsequent to the DEIS, CDOT determined that the western alignment for U.S. 287, associated only with Alternative 2, was their preferred alignment. The western alignment is within the Denver/North Front Range ozone nonattainment area but outside of the Fort Collins carbon monoxide (CO) attainment/maintenance area. The western alignment has been included in the regional air conformity analysis as part of the Statewide Transportation Improvement Program (STIP). This section supplements Section 4.25 of the DEIS that addressed air quality.

4.14.1 Methods

Air quality can potentially be affected by short-term direct effects associated with construction of the alternatives (e.g., emissions from construction equipment, workers' vehicles, delivery vehicles, and fugitive dust) or by long-term indirect effects such as changes to transportation (e.g., the realignment of U.S. 287) or from project operations (e.g., emissions associated with pumping). Air quality effects associated with construction were estimated based on emissions from anticipated project construction equipment, workforce, and fugitive dust. Equipment usage was estimated based on construction quantities and anticipated construction schedule. Emission load factors were developed based on Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling, EPA-420-P-04-005 and AP-42 (EPA 2004). The assessment of predicted effects on air quality is presented in detail in the 2013 Air Quality Analysis Memo (GEI 2013).

The assessment of construction-related emissions for the alternatives focuses on determining the need for a general air quality conformity analysis. The estimated emissions for CO, oxides of nitrogen (NO_x), particulate matter less than 10 microns (PM_{10}), sulfur dioxide (SO_2), and volatile organics carbons (VOCs) are compared to defined *de minimis* levels for pollutants for nonattainment and maintenance areas in the NISP study area (Table 3-41). As discussed in Section 3.14.3, the alternatives would occur within the nonattainment area for ozone. For comparison purposes the conformity *de minimis* thresholds for CO, NO_x, PM_{10}, SO_2, and VOC are presented; however, it is the exceedance of *de minimis* thresholds for annual emission of NO_x and SO_2 that would determine the need for a general conformity analysis to ensure that the ozone nonattainment area remains in compliance with the National Ambient Air Quality Standards (NAAQS). The emissions are expressed as tons averaged over the estimated duration of construction for each alternative. Construction of the alternative components would overlap and

there would likely be periods of higher and lower emissions than the estimated annual average. The general conformity analysis would determine the levels of emissions during the various construction phases. The realignment of U.S. 287 was included in the STIP for regional ozone conformity determinations by NFRMPO as discussed in Section 3.14.4.1.

The estimated long-term greenhouse gas (carbon dioxide) emissions that could result under each alternative were based on the projected energy requirements for pumping for the alternatives (BBC 2014). Energy requirements were based on volumes of water required to be moved through the various parts of the system under each alternative (Section 4.22), including for Alternative 2, Reclamation Action Option, the need for additional pumping of water to Carter Lake. Annual electric generation required for the alternatives was converted into projected carbon dioxide emissions using the EPA Greenhouse Gas Equivalencies Calculator (http://www.epa.gov/cleanenergy/energy-resources/calculator.html).

4.14.2 No Action Alternative (Alternative 1)

The No Action Alternative would involve the construction of a 120,000-AF Cactus Hill Reservoir (smaller than the Cactus Hill Reservoir proposed for Alternatives 3 and 4), regional treatment plants, and pipelines. Table 4-91 presents the estimated emissions for construction of the proposed alternatives. The average annual emission of NO_x is greater than the conformity *de minimis* level of 100 tons/year for the ozone nonattainment area. Therefore, the No Action Alternative would need to undergo a general conformity analysis to ensure that the region remains in compliance with the NAAQS.

Table 4-91. Estimated construction emissions in tons for the No Action Alternative.

	Constituent				
	CO	**NO_x**	**PM_{10}**	**SO_2**	**VOC**
Conformity *de minimis* threshold	**100**	**100**	**100**	**100**	**100**
Cactus Hill Reservoir	801.3	618.3	1,678.1	12.0	89.2
Pipelines	287.1	229.2	42.9	4.3	33.6
Total Emissions (tons)	1,088.4	847.5	1,721.0	16.3	122.8
Construction Duration (years)	4.8	4.8	4.8	4.8	4.8
Average Annual Emissions (tons)	226.8	176.6	358.5	3.4	25.6

Notes: CO = carbon monoxide; NO_x = oxides of nitrogen; PM_{10} = particulate matter less than 10 microns; SO_2 = sulfur dioxide; VOC = volatile organic carbons.

Alternative is in ozone nonattainment areas in which NO_x and SO_2 *de minimis* thresholds apply.

4.14.2.1 Cactus Hill Reservoir

Reservoir construction is predicted to contribute to most of the emissions for NO_x that exceed the annual *de minimis* level for the ozone nonattainment area. The construction of the smaller Cactus Hill Reservoir and dam are estimated to contribute about 618.3 tons of NO_x over the 40 months of estimated construction for the reservoir.

4.14.2.2 Conveyance Systems

Pipeline construction is predicted to contribute about 229.2 tons of NO_x over the 22 months of estimated pipeline construction. Some of the pipeline construction would overlap with reservoir construction.

4.14.2.3 No Action Irrigated Lands

There would be no construction related emissions associated with the transfer of water from irrigated agricultural lands. During the transition from irrigation to dry land crops or upland grasslands there could be a temporary increase in fugitive dust associated with dry exposed soils until the formerly irrigated lands are revegetated.

4.14.3 District's Preferred Alternative (Alternative 2)

Alternative 2 would involve construction of Glade Reservoir, a forebay, realignments of canals, the realignment of the portion of U.S. 287 within the Glade Reservoir site, and the construction of Galeton Reservoir and facilities associated with the SPWCP. Both the No Reclamation Action Option and the Reclamation Action Option would also include construction of pipelines. Table 4-92 and Table 4-93 present the estimated annual emissions for construction of the proposed options under Alternative 2. The average annual emission of NO_x for either Reclamation option is greater than the conformity *de minimis* level of 100 tons/year for the ozone nonattainment area. Therefore, Alternative 2 would need to undergo a general conformity analysis to ensure that the region remains in compliance with the NAAQS.

Table 4-92. Estimated construction emissions in tons for Alternative 2 (Reclamation Action Option).

	Constituent				
	CO	**NO_x**	**PM_{10}**	**SO_2**	**VOC**
Conformity *de minimis* threshold	**100**	**100**	**100**	**100**	**100**
Glade Reservoir	1,607.0	1,245.7	3,937.6	24.2	179.7
Galeton Reservoir	455.3	343.8	875.4	6.8	49.5
SPWCP	114.9	80.5	41.9	1.5	11.6
Pipelines	121.9	97.4	18.2	1.8	14.3
U.S. 287 Realignment	27.7	22.5	1.3	0.4	3.3
Total Emissions (tons)	2,326.8	1,789.9	4,874.4	34.7	258.4
Construction Duration (years)	9.1	9.1	9.1	9.1	9.1
Average Annual Emissions (tons)	255.7	196.7	535.6	3.8	28.4

Notes: CO = carbon monoxide; Nox = oxides of nitrogen; PM_{10} = particulate matter less than 10 microns; SO_2 = sulfur dioxide; VOC = volatile organic carbons.

Alternative is in ozone nonattainment areas in which NO_x and SO_2 *de minimis* thresholds apply.

Table 4-93. Estimated construction emissions in tons for Alternative 2 (No Reclamation Action Option).

	Constituent				
	CO	**Nox**	**PM_{10}**	**SO_2**	**VOC**
Conformity *de minimis* threshold	**100**	**100**	**100**	**100**	**100**
Glade Reservoir	1,607.0	1,245.7	3,937.6	24.2	179.7
Galeton Reservoir	455.3	343.8	875.4	6.8	49.5
SPWCP	114.9	80.5	41.9	1.5	11.6
Pipelines	195.2	155.8	29.1	2.9	22.8
U.S. 287 Realignment	27.7	22.5	1.3	0.4	3.3
Total Emissions (tons)	2,400.1	1,848.3	4,885.3	35.8	266.9
Construction Duration (years)	9.1	9.1	9.1	9.1	9.1
Average Annual Emissions (tons)	263.7	203.1	536.8	3.9	29.3

Notes: CO = carbon monoxide; NO_x = oxides of nitrogen; PM_{10} = particulate matter less than 10 microns; SO_2 = sulfur dioxide; VOC = volatile organic carbons.

Alternative is in ozone nonattainment areas in which NO_x and SO_2 *de minimis* thresholds apply.

4.14.3.1 Reservoir Sites

4.14.3.1.1 Glade Reservoir

Reservoir construction is predicted to contribute to most of the emissions for NO_x that exceed the annual *de minimis* level for Alternative 2 for the ozone nonattainment area. The construction of Glade Reservoir and dam are estimated to contribute about 1,246 tons of NO_x over the estimated 60 months of construction for the reservoir.

U.S. 287. Construction of the Glade Reservoir and dam would inundate a portion of the existing U.S. 287 between Ted's Place and Owl Canyon Road. Alternative 2 includes realignment of about 7 miles of U.S. 287. The new route for U.S. 287 would be about 2.3 miles shorter than the existing alignment, which could reduce emissions, to include GHGs, from vehicles compared to the current length of existing U.S. 287. The reduced vehicle emissions from a shorter U.S. 287 may be somewhat tempered by steeper grades associated with a portion of the proposed realignment. NFRMPO determined that a regional ozone conformity analysis was not needed because the new route would be shorter than the existing alignment. Construction of the U.S. 287 realignment is estimated to contribute about 22.5 tons of NO_x over the estimated 6.1 months of construction.

4.14.3.1.2 Galeton Reservoir

The construction of Galeton Reservoir and dam and the SPWCP facilities are estimated to contribute about 424.3 tons of NO_x over the estimated 45 months of construction.

4.14.3.2 Conveyance Systems

Pipeline construction is predicted to contribute about 97.4 tons of NO_x (Reclamation Action Option) and 155.8 tons of NO_x (No Reclamation Action Option) during pipeline construction. Some of the pipeline construction would overlap with reservoir construction.

4.14.4 Alternative 3

Alternative 3 would involve the construction of a 190,000-AF Cactus Hill Reservoir, pipelines, Galeton Reservoir, and facilities for the SPWCP. Table 4-94 presents the estimated emissions for construction of Alternative 3. The average annual emission of NO_x is greater than the conformity *de minimis* level of 100 tons/year for the ozone nonattainment area. Therefore, Alternative 3 would need to undergo a general conformity analysis to ensure that the region remains in compliance with the NAAQS.

Table 4-94. Estimated construction emissions in tons for Alternative 3.

	Constituent				
	CO	**NO_x**	**PM_{10}**	**SO_2**	**VOC**
Conformity *de minimis* threshold	**100**	**100**	**100**	**100**	**100**
Cactus Hill Reservoir	1,268.7	979.0	2,657.0	19.0	141.2
Galeton Reservoir	455.3	343.8	875.4	6.8	49.5
SPWCP	114.9	80.5	41.9	1.5	11.6
Pipelines	390.7	312.0	58.3	5.9	45.7
Total Emissions (tons)	2,229.6	1,715.2	3,632.6	33.2	248.0
Construction Duration (years)	8.0	8.0	8.0	8.0	8.0
Average Annual Emissions (tons)	278.7	214.4	454.1	4.2	31.0

Notes: CO = carbon monoxide; NO_x = oxides of nitrogen; PM_{10} = particulate matter less than 10 microns; SO_2 = sulfur dioxide; VOC = volatile organic carbons.
Alternative is in ozone nonattainment areas in which NO_x and SO_2 *de minimis* thresholds apply.

4.14.4.1 Reservoir Sites

4.14.4.1.1 Cactus Hill Reservoir

Reservoir construction is predicted to contribute to most of the emissions for NO_x that exceed the annual *de minimis* level for the ozone nonattainment area. The construction of the larger Cactus Hill Reservoir and dam are estimated to contribute about 979.0 tons of NO_x over the 52 months of estimated construction for the reservoir.

4.14.4.1.2 Galeton Reservoir

The construction of Galeton Reservoir and dam and the SPWCP are estimated to contribute about 424.3 tons of NO_x over the estimated 45 months of construction.

4.14.4.2 Conveyance Systems

Pipeline construction is predicted to contribute about 312.0 tons of NO_x over the 25.7 months of estimated pipeline construction. Some of the pipeline construction would overlap with reservoir construction.

4.14.5 Alternative 4

Alternative 4 would involve the construction of a 190,000-AF Cactus Hill Reservoir, pipelines, Galeton Reservoir, and facilities for the SPWCP. Table 4-95 presents the estimated emissions for construction of Alternative 4. The average annual emission of NO_x is greater than the

conformity *de minimis* level of 100 tons/year for the ozone nonattainment area. Therefore, Alternative 4 would need to undergo a general conformity analysis to ensure that the region remains in compliance with the NAAQS.

Table 4-95. Estimated construction emissions in tons for Alternative 4.

	Constituent				
	CO	**NO_x**	**PM_{10}**	**SO_2**	**VOC**
Conformity *de minimis* threshold	**100**	**100**	**100**	**100**	**100**
Cactus Hill Reservoir	1268.7	979.0	2657.0	19.0	141.2
Galeton Reservoir	455.3	343.8	875.4	6.8	49.5
SPWCP	114.9	80.5	41.9	1.5	11.6
Pipelines	430.5	343.7	64.3	6.5	50.3
Total Emissions (tons)	2,269.4	1,747.0	3,638.6	33.8	252.6
Construction Duration (years)	8.0	8.0	8.0	8.0	8.0
Average Annual Emissions (tons)	283.7	218.4	454.8	4.2	31.6

Notes: CO = carbon monoxide; NO_x = oxides of nitrogen; PM_{10} = particulate matter less than 10 microns; SO_2 = sulfur dioxide; VOC = volatile organic carbons.

Alternative is in ozone nonattainment areas in which NO_x and SO_2 *de minimis* thresholds apply.

4.14.5.1 Reservoir Sites

4.14.5.1.1 Cactus Hill Reservoir

Reservoir construction is predicted to contribute to most of the emissions for NO_x that exceed annual *de minimis* level for the ozone nonattainment area. The construction of Cactus Hill Reservoir and dam are estimated to contribute about 979.0 tons of NO_x over the 52 months of estimated construction for the reservoir.

4.14.5.1.2 Galeton Reservoir

The construction of Galeton Reservoir and dam and the SPWCP are estimated to contribute about 424.3 tons NO_x over the estimated 45 months of construction.

4.14.5.2 Conveyance Systems

Pipeline construction is predicted to contribute about 343.7 tons of NO_x over the 25.7 months of estimated pipeline construction. Some of the pipeline construction would overlap with reservoir construction.

4.14.6 Unavoidable Adverse Impacts

All alternatives would unavoidably increase the emission of CO, NO_x, PM_{10}, SO_2, and VOCs during construction. All alternatives would have estimated average annual emissions of NO_x greater than the conformity *de minimis* level of 100 tons/year for the ozone nonattainment area. These emissions would temporarily elevate pollutant concentrations in the immediate vicinity of the construction activities. Impacts to air quality during construction activities are expected to be minor throughout most of the construction period because the general conformity process would ensure that construction emissions would not cause exceedances of the NAAQS. Fugitive dust

on windy days may travel beyond the construction area and have a moderate effect on local air quality.

During the general conformity process, the CDPHE Air Pollution Control Division (APCD) would review NISP to determine if NISP conformed to the SIP for NO_x. During its conformity analysis, the APCD would determine if the Project's estimated emissions are included in the state's emission inventory. If NISP emissions (in conjunction with other known projects) did not exceed the SIP budget, NISP would conform to the SIP and the Project could go forward without change. If the APCD determines that NISP emissions exceeded the SIP budget, the agency can request mitigation to reduce construction emissions.

Unavoidable long-term non-construction related impacts on air quality may occur periodically associated with the exposed shorelines of reservoirs that may cause fugitive dust emissions. Project operations would contribute to long-term impacts to air quality associated with pumping.

4.14.7 Impact Summary

Table 4-96. Impacts to air quality.

Alternative	Predicted Temporary Air Quality Effects	Predicted Annual Carbon Dioxide Emissions for Project Operation at Full Utilization (English Tons)
Alternative 1	Construction over an estimated 4.8 years would have a short-term minor impact on air quality. Average annual emissions of NO_x are predicted to be greater than the conformity *de minimis* level of 100 tons/year for the ozone nonattainment area. The transfer of water from 64,200 acres of irrigated agricultural lands could cause a short-term increase in fugitive dust until lands are revegetated.	27,087
Alternative 2 Reclamation Action Option	Construction over an estimated 9.1 years would have a short-term minor impact on air quality. Exposed reservoir shorelines could periodically contribute to local fugitive dust.	37,259
U.S. 287	Construction over the estimated 6.1 months of would have a short-term minor impact on air quality.	NA
Alternative 2 No Reclamation Action Option	Construction over an estimated 9.1 years would have a short-term minor impact on air quality. Average annual emissions of NO_x are predicted to be greater than the conformity *de minimis* level of 100 tons/year for the ozone nonattainment area. Exposed reservoir shorelines could periodically contribute to local fugitive dust.	47,677
U.S. 287	Construction over the estimated 6.1 months of would have a short-term minor impact on air quality.	NA
Alternative 3	Construction over an estimated 8 years would have a short-term minor impact on air quality. Average annual emissions of NO_x are predicted to be greater than the conformity *de minimis* level of 100 tons/year for the ozone nonattainment area. Exposed reservoir shorelines could periodically contribute to local fugitive dust.	45,944

Alternative	Predicted Temporary Air Quality Effects	Predicted Annual Carbon Dioxide Emissions for Project Operation at Full Utilization (English Tons)
Alternative 4	Construction over an estimated 8 years would have a short-term minor impact on air quality. Average annual emissions of NO_x are predicted to be greater than the conformity *de minimis* level of 100 tons/year for the ozone nonattainment area. Exposed reservoir shorelines could periodically contribute to local fugitive dust.	50,122

During construction, all alternatives would have estimated average annual emissions of NO_x greater than the conformity *de minimis* level of 100 tons/year for the ozone nonattainment area. The No Action Alternative would have the least predicted annual carbon dioxide emissions and Alternative 4 would have the greatest predicted annual carbon dioxide emissions.

4.15 NOISE

This section describes the noise effects that could result from implementing the Project. Noise associated with the realignment of U.S. 287 was identified as a concern during comments on the DEIS. The noise assessment for the western alignment of U.S. 287 was revised to incorporate CDOT's 2013 revised Noise Analysis and Abatement guidelines and to use projected 2035 traffic levels (Hankard 2014). More detail on the noise assessment for U.S. 287 can be found in the 2014 Noise Impact Assessment for U.S. 287 Memo (Hankard 2014). No other new noise assessments were conducted for the SDEIS.

Noise from construction is subject to state and local regulations, with which construction activities would be required to comply. The U.S. 287 realignment is located within the State of Colorado and Larimer County with the southern portion of the project within Laporte, Colorado. There are no known noise ordinances for Laporte, Colorado. There are noise ordinances for Larimer County, Colorado (Code of Ordinances, Chapter 30, Article 5, Noise; Ordinance Number 97-03) and the State of Colorado (Colorado Revised Statutes 25-12). For construction projects, both Larimer County and the State of Colorado limit construction noise to a maximum level of 80 dBA during the daytime (7am to 7pm) and 75 dBA during the nighttime (7pm to 7am).

4.15.1 Methods

Estimates of short-term increases in noise levels associated with construction were based on the types of construction equipment predicted to be used and the location of facilities. An updated noise impact analysis for the U.S. 287 realignment was conducted for the western alignment. Noise levels associated with the realignment of U.S. 287 were modeled using projected 2035 traffic levels and 41 representative receptor locations within 500 feet of the centerline of the western alignment (Hankard 2014). Noise levels were predicted at the noise sensitive receptors (residences) located within 500 feet of the existing U.S. 287 alignment, within 1,000 feet of the proposed western alignment, and at least 500 feet beyond the planned construction extents. Receptors and their land uses were identified during a field survey in December 2012. All noise level predictions were conducted using the Federal Highway Administration's Traffic Noise Model (TNM) v2.5. Noise levels were measured at the site to validate the noise models and to define the existing background noise levels. Under CDOT's policy, receptors are considered impacted by noise when loudest-hour design-year noise levels are predicted to approach or exceed CDOT's Noise Abatement Criteria (66 dBA residences or campgrounds, 71 dBA commercial), or where design-year noise levels are predicted to be a substantial increase (10 dB or more) over existing noise levels.

CDOT's guidelines establish noise abatement criteria and design requirements for noise mitigation. The guidelines state that noise mitigation should be considered for any receptor or group of receptors where predicted traffic noise levels, using design-year traffic volumes and roadway conditions, equal or exceed CDOT's Noise Abatement Criteria, which are listed in Table 4-97. The guidelines also state that noise mitigation should be considered for any

receptors where predicted noise levels for design-year conditions create a substantial increase over existing levels, which is defined by CDOT as 10 dBA or more.

Table 4-97. CDOT noise abatement criteria.

Activity Category	L_{eq}[2] (dBA)	Description of Activity Category
A	56 (Exterior)	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B[1]	66 (Exterior)	Residential
C[1]	71 (Exterior)	Active sport areas, amphitheaters, auditoriums, campgrounds, cemeteries, day care centers, hospitals, libraries, medical facilities parks, picnic areas, places of worship, playgrounds, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, recreational areas, Section 4(f) sites, schools, television studios, trails, and trail crossings
D	51 (Interior)	Auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public meeting rooms, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.
E[1]	71 (Exterior)	Hotels, motels, offices, restaurants/bars, and other developed lands, properties or activities not included in A-D or F.
F	NA	Agriculture, airports, bus yards, emergency services, industrial, logging, maintenance facilities, manufacturing, mining, rail yards, retail facilities, ship yards, utilities (water resources, water treatment, electrical), and warehousing.
G	NA	Undeveloped lands that are not permitted for development.

[1]Includes undeveloped lands permitted for this activity.
[2]Hourly A-weighted sound level reflecting a 1 dBA approach value below (more stringent) than Federal Highways Administration values in 23 CFR 772.
NA=Not Applicable.

The intensity of effects for each alternative is based on the following determinations. Negligible effects would have new noise sources below existing levels. Minor effects would be from new noise sources above existing levels but below existing noise standards. Temporary noise increases are typically minor. Blasting needed for excavation for the construction of dams or the U.S. 287 realignment would occur only during daylight hours, would be regulated and controlled for noise and vibration, and would be a minor effect because the noise effects would be short-term and only occur periodic. Moderate effects would have new noise sources that would be substantially above existing levels and would exceed existing noise standards during construction. Major effects would have new noise sources substantially above existing levels and would exceed existing noise standards on a permanent basis.

4.15.2 No Action Alternative (Alternative 1)

4.15.2.1 Cactus Hill Reservoir

The noise effects from the construction of Cactus Hill Reservoir are described in Section 4.24.2 of the DEIS. The noise effects from construction of Cactus Hill Reservoir would be minor because the noise increase would be temporary and construction activities would be subject to county noise ordinances.

4.15.2.2 Conveyance Systems

The noise effects from the construction of the No Action Alternative conveyance systems would be similar to those described in Section 4.24.2 of the DEIS. The noise effects from construction of conveyance systems would be minor because the noise increase would only be temporary and construction activities would be subject to county noise ordinances. Permanent increases in noise from pump stations would also be minor because the building design would maintain noise levels below noise standards.

4.15.3 District's Preferred Alternative (Alternative 2)

4.15.3.1 Reservoir Sites

4.15.3.1.1 Glade Reservoir

The noise effects from the construction of Glade Reservoir are described in Sections 4.24.2 and 4.24.3 of the DEIS. The noise effects from construction of Glade Reservoir would be minor because the noise increase would be temporary and construction activities would be subject to county noise ordinances.

Glade Reservoir may be managed for public recreation. Recreational activities and associated traffic would increase the current noise level at the Glade Reservoir site. These increases are expected to be minor because they would only be slightly above existing levels and would not exceed existing standards.

U.S. 287. Based on the noise analysis for the western realignment, the predicted noise levels ranged from 44 dBA to the maximum predicted loudest-hour design-year noise level of 65 dBA with the maximum increase of 1 dB at any of the receptors. Because predicted Leq (hourly) is below 66 dBA at all residential and campground receptors, below 71 dBA at the one commercial receptor, and the maximum noise level increase is below 10 dB, minor permanent noise impacts are predicted for residential or commercial receptors adjacent to the western realignment for the design-year (2035). Construction of the highway would create temporary minor effects from noise increases and traffic on the realigned highway, which would introduce new noise but would be below the standards.

4.15.3.1.2 Galeton Reservoir

The noise effects from the construction of Galeton Reservoir are described in Section 4.24.2 of the DEIS. Galeton Reservoir construction noise effects would be minor because the noise increase would be temporary and construction activities would be subject to county noise ordinances.

4.15.3.2 Conveyance Systems

The noise effects from the construction of Alternative 2 conveyance systems would be similar to those described in Section 4.24.2 of the DEIS. The noise effects from construction of conveyance systems would be minor because the noise increase would only be temporary and

construction activities would be subject to county noise ordinances. Permanent increases in noise from pump stations would also be minor because the building design would maintain noise levels below noise standards.

4.15.4 Alternative 3

4.15.4.1 Reservoir Sites

4.15.4.1.1 Cactus Hill Reservoir

The noise effects for Cactus Hill Reservoir are the same as the No Action Alternative and are described in Section 4.15.2.1.

4.15.4.1.2 Galeton Reservoir

The noise effects for Galeton Reservoir are the same as Alternative 2 and are described under Section 4.15.3.1.2.

4.15.4.2 Conveyance Systems

The noise effects from the construction of Alternative 3 conveyance systems would be similar to those described in Section 4.24.2 of the DEIS. The noise effects from construction of conveyance systems would be minor because the noise increase would only be temporary and construction activities would be subject to county noise ordinances. Permanent increases in noise from pump stations would also be minor because the building design would maintain noise levels below noise standards.

4.15.5 Alternative 4

4.15.5.1 Reservoir Sites

4.15.5.1.1 Cactus Hill Reservoir

The noise effects for Cactus Hill Reservoir are the same as the No Action Alternative and are described in Section 4.15.2.1.

4.15.5.1.2 Galeton Reservoir

The noise effects for Galeton Reservoir are the same as Alternative 2 and are described under Section 4.15.3.1.2.

4.15.5.2 Conveyance Systems

The noise effects from the construction of Alternative 3 conveyance systems would be similar to those described in Section 4.24.2 of the DEIS. The noise effects from construction of conveyance systems would be minor because the noise increase would only be temporary and construction activities would be subject to county noise ordinances. Permanent increases in

noise from pump stations would also be minor because the building design would maintain noise levels below noise standards.

4.15.6 Unavoidable Adverse Impacts

All alternatives would have short-term unavoidable adverse impacts from construction noise. None of the alternatives would have long-term unavoidable adverse impacts from noise increases.

4.15.7 Impact Summary

Noise effects for all alternatives are predicted to be minor for all alternatives (Table 4-98). The No Action Alternative would have fewer components that would contribute to the noise effects compared to the action alternatives.

Table 4-98. Effects determination for noise.

Study Area	Alternative 1	Alternative 2 Reclamation Action Option	Alternative 2 No Reclamation Action Option	Alternative 3	Alternative 4
Glade Reservoir	NA	Minor	Minor	NA	NA
U.S. 287	NA	Minor	Minor	NA	NA
Galeton Reservoir	NA	Minor	Minor	Minor	Minor
Cactus Hill Reservoir	Minor	NA	NA	Minor	Minor
Conveyance Systems	Minor	Minor	Minor	Minor	Minor

NA = Not a component of the alternative.

4.16 RECREATION

This section summarizes the predicted potential effect of the NISP alternatives on recreation resources, including boating, fishing, hunting trail use, and developed recreation facilities and replaces Section 4.17 of the DEIS. No additional studies were conducted for recreation resources for the SDEIS although new analysis based on updated information was conducted. Revised information on recreation is presented in the 2015 Recreation Resources Supplement (ERO 2015e), which supplemented the 2008 Recreation Report (ERO 2008g).

4.16.1 Methods

Both water- and land-based recreation resources, including activities such as boating, fishing, hiking, cycling, camping, picnicking, wildlife watching, hunting, and other potential recreational opportunities, were inventoried in the NISP study areas. Much of the information on recreation resources, infrastructure, and uses in the study area was gathered from recreation resource plans and studies prepared by local, state, and federal agencies. Information related to the type, location, and amount of recreational use (both historical and projected) was documented to the extent possible to develop an understanding of recreation resources in the NISP study areas. This information provided a baseline from which to compare potential conditions resulting from implementation of the NISP alternatives. The effects assessment was based on potential changes to recreational use and opportunities.

Indirect effects on recreation resources along the Poudre River relate to predicted changes in river flow associated with operation of the alternatives. Changes in river flows are predicted using the CTP hydrologic modeling by comparing various model runs. This section evaluates potential indirect effects from flow changes between Current Conditions hydrology and implementation of the NISP action alternatives with Current Conditions. Information on the CTP model can be found in the 2013 CTP Hydrologic Modeling Report (CDM Smith and DiNatale 2013). The Poudre River was divided into six segments (Table 4-99; Figure 3-4) that represent different sections of the river in which flow, channel characteristics, and biological conditions are fairly uniform for that segment.

Table 4-99. Poudre River segments and representative gages.

Poudre River Segment	Extent of Poudre River Segment	Representative Stream Gage or Diversion
Segment A	From the mouth of the Poudre Canyon to the Larimer-Weld Canal.	Canyon Gage
Segment B	Larimer-Weld Canal to Spring Creek in Fort Collins.	Lincoln Street Gage
Segment C	Spring Creek to the New Cache Diversion. This segment continues through Fort Collins and crosses under Interstate 25 (I-25).	Boxelder Gage
Segment D	New Cache Canal to County Road 17, near Windsor. This segment runs through Timnath.	Downstream of New Cache Headgate
Segment E	County Road 17 to the 59th Avenue Railroad Bridge upstream of Greeley. This segment runs through Greeley.	Downstream of Greeley No. 3 Headgate Diversion
Segment F	The 59th Avenue Railroad Bridge upstream of Greeley to the South Platte River. This segment is adjacent to and downstream of Greeley.	Greeley Gage

For the effects analysis for boating in Segment B through Fort Collins, daily flows were used to assess the change in the number of days for which flows would be greater than 150 cfs for each alternative during the period of record (Appendix B in CDM Smith 2014a). The 150 cfs threshold was based on comments on the DEIS from a local boating group on the minimum flows that would be needed to allow reasonable passage by canoe through Fort Collins; a 100 cfs threshold was previously used in the DEIS.

Effects to recreational fishing opportunities were primarily based on the findings of the aquatic resources analysis (2015 Aquatic Resources Effects Report, GEI 2015b) along with the known value and importance of various water bodies for recreational fishing.

The analysis of effects to ponds within natural areas along the Poudre River was based on the maximum predicted stage change/ground water levels associated with potential flow changes on the Poudre resulting from implementation of NISP. The analysis of alluvial ground water effects along the Poudre River is described in the 2014 Wetland and Riparian Resources Effects Report (ERO 2014d).

Recreation effects, which could be either adverse or beneficial, are categorized as negligible, minor, moderate, or major. Negligible effects would be at the lowest levels of detection, barely measurable, with no perceptible consequences. Minor effects might result in a detectable change, but the change would be slight. Minor is used when the effects would be short-term, occur at low levels, and are not likely to have a long-term noticeable effect on recreational activities of residents and visitors in the study areas. Minor effects include temporary impacts during construction. Moderate effects would result in a clearly detectable change, with measureable effects. Moderate effects would likely change recreational activities of residents and visitors in the study areas in some way, but residents and visitors could easily adapt to moderate changes, such as the localized loss or alteration of a recreational resource. Moderate effects typically are long-term. Major effects would result in readily apparent effects with substantial consequences. Major is used for large reductions in usable recreational flows and large impacts to recreational fish species. Major effects typically are long-term. Major effects

may permanently interrupt Current Conditions or recreational activities and would likely change recreational activities of residents and visitors. Major recreational effects could be adapted to by residents and visitors but may require considerable effort and modifications in order to do so.

4.16.2 No Action Alternative (Alternative 1)

4.16.2.1 Cactus Hill Reservoir

The Cactus Hill Reservoir site is on private land and no public recreation currently occurs at the site. While the construction of the proposed 120,000 AF reservoir for the No Action Alternative could potentially provide new recreation opportunities in the future (i.e., fishing or hunting), no such public access is currently proposed. The No Action Alternative would not affect public recreation at the Cactus Hill Reservoir site.

4.16.2.2 Conveyance Systems

The No Action Alternative would include the construction of several new water conveyance pipelines throughout portions of northern Colorado, including the communities of Windsor, Greeley, Evans, Firestone, Frederick, Dacono, Erie, and Lafayette. The specific alignments of these pipelines have not been determined but are conceptually located along existing roads and highways. Depending on the final alignment, these conveyance pipelines may intersect existing recreation resources such as parks or trails. It is assumed that construction would result in short-term disturbance, any access to trails or recreation sites would be maintained with detours, and any impacts on parks or other recreation amenities would be fully repaired following construction. With these assumptions, the effects of conveyance pipelines on recreation sites would be negligible.

4.16.2.3 Poudre River

The No Action Alternative was evaluated under Future Conditions hydrology only, as explained in Section 4.2.2 and, therefore, the indirect effects analyses for the No Action Alternative for the Poudre River mainstem are presented in Chapter 5.

4.16.2.4 South Platte River

No recreational uses or facilities along the South Platte River would be measurably affected by the No Action Alternative because public access is limited along the South Platte River and unlike the action alternatives, the No Action Alternative would not affect the Mitani-Tokuyasu SWA that provides public access to the South Platte River.

4.16.3 District's Preferred Alternative (Alternative 2)

4.16.3.1 Reservoir Sites

4.16.3.1.1 Glade Reservoir

The land in and around the Glade Reservoir site would be owned by the District, with a potential agreement with CPW or Larimer County to manage public recreation. Construction of the proposed 170,000 AF Glade Reservoir could provide new recreational opportunities including lake fishing, boating, camping, hiking, horseback riding, and biking. Annual visitation to Glade Reservoir is estimated to be about 338,600 visits if it were to be managed for recreation (BBC and HCR 2015b). Fluctuations in surface water elevations would be comparable to those at Horsetooth Reservoir and would not diminish the overall recreation potential or use. Overall, the benefits from new recreation opportunities would be major, because Glade Reservoir would provide public recreation similar to the recreation at Horsetooth Reservoir, which has been demonstrated to be of regional importance. Construction and operation of the reservoir would diminish some existing opportunities for hunting and fishing on land owned by the Colorado State Land Board. These limited impacts, however, would be minor because these diminished opportunities would likely be offset by new fishing and waterfowl hunting opportunities.

Land used for educational purposes by Colorado State University and the Poudre School District would be partially affected due to reservoir inundation and access changes, resulting in a minor effect on those uses.

U.S. 287. Glade Reservoir would displace a segment of U.S. 287. The existing U.S. 287 corridor provides some opportunity for road biking. The realigned U.S. 287 would provide similar road biking opportunities. The U.S. 287 realignment may have an adverse effect on visitation to the KOA Campground by reducing the passing traffic or a beneficial effect associated with proposed public recreation at Glade Reservoir. The magnitude of these potential effects is uncertain.

4.16.3.1.2 Galeton Reservoir

The proposed Galeton Reservoir would be located mostly on private land with a small parcel of State Land Board land at the southwest edge of the site. The proposed Galeton Reservoir would be bordered by lands managed as the Pawnee National Grasslands at the north end. The Galeton forebay would be located south of the Galeton Reservoir, within the Mitani-Tokuyasu State Wildlife Area (SWA).

While Galeton Reservoir would potentially provide new hunting opportunities, it is not planned or intended to be managed for public access or recreational use. The proposed Galeton forebay would permanently impact about one-third of the land within the Mitani-Tokuyasu SWA, which is popular for hunting and trapping and provides access to the South Platte River for these activities. This loss would be a moderate impact to the Mitani-Tokuyasu SWA because users of the SWA could still use the SWA and because there are other nearby SWAs along the South Platte River within about 10 miles of the Mitani-Tokuyasu SWA. The loss of land at the Mitani-Tokuyasu SWA may be partially offset by the open water associated with the proposed forebay,

which may attract waterfowl and small game to the SWA. Recreational use of the Pawnee National Grasslands, which borders the proposed Galeton Reservoir to the north, would not be affected.

4.16.3.2 Conveyance Systems

4.16.3.2.1 No Reclamation Action Option—Glade to Southern Water Supply Pipeline Conveyance

The No Reclamation Action Option under Alternative 2 would involve the construction of the Carter Pipeline. The proposed Carter Pipeline would be a buried pipeline beginning at the Glade Reservoir Dam, traveling along the east side of Horsetooth Reservoir, and then south to Carter Lake where it would tie into the existing SWSP and the existing St. Vrain Supply Canal (Figure 2-3). While the specific alignment of the pipeline has not been determined, it would likely cross through portions of Horsetooth Reservoir County Park, Reservoir Ridge Natural Area, Maxwell Natural Area, and Rimrock Open Space, crossing over several existing recreation trails within these areas. Potentially affected trails include the Reservoir Ridge Trail, Foothills Trail, Ridge Trail, and Rimrock Trail. Construction of the pipeline would have short-term effects on these parks, open space, and natural areas, and trails during construction. These construction effects would have a negligible to minor effect on recreational access and experiences because they would be short-term and detours would likely be provided.

The pipeline would also cross Larimer County Roads 23 and 38E, which provide access to Horsetooth Reservoir and Lory State Park. These access routes may be unusable for a short time during construction dependent upon alignment, although it is assumed that alignment design, construction methods, and detours would allow for continued access, resulting in a negligible impact to recreation.

4.16.3.2.2 Reclamation Action Option—Glade to Horsetooth Pipeline

The Reclamation Action Option would include a pipeline connecting the proposed Glade Reservoir and Horsetooth Reservoir, if needed in the future (see Section 2.5.5.2.1). An excess capacity, exchange and/or storage contract under this option would involve an exchange of water between Glade Reservoir and C-BT facilities (including Horsetooth Reservoir and Carter Lake).

The proposed Glade to Horsetooth pipeline would travel 5.5 miles from the proposed Glade Reservoir Dam to the north end of Horsetooth Reservoir. While the exact alignment of this pipeline has not yet been determined, it is likely to cross the northern extent of the Horsetooth Reservoir County Park in an area that has no trails or recreation amenities. Potential recreation impacts associated with this pipeline would be limited to disruptions of road access associated with construction. In addition, there would be a negligible effect on recreation at Horsetooth Reservoir associated with water level changes. Overall, recreation effects from this option would be negligible.

4.16.3.2.3 SPWCP

Alternative 2 also includes the SPWCP pipelines in the portions of Weld County east of Highway 85 and south of Highway 14. While the specific locations of these pipeline alignments

have not been determined, no developed recreation sites or amenities are located in the area. Therefore, construction of the SPWCP pipelines would not affect recreation resources.

Overall, these conveyance systems would have negligible to minor, short-term impacts on several recreational facilities and opportunities during construction. The degree of the temporary effects would be determined by the exact alignment of the pipeline, whether construction detours are possible, or if the trails or recreation areas require full closure during construction.

4.16.3.3 Poudre River

The diversion point for Alternative 2 is located at the Poudre Valley Canal. Potential water-based recreation effects, by segment, are as follows:

- **Segment A.** There would be a negligible effect on boating in Segment A, because boating is not a popular activity in this segment and public access is limited. Alternative 2 would result in minor adverse effects to fishing opportunities, due to reductions in habitat for brown and rainbow trout.
- **Segment B.** Segment B is popular for boating (canoeing and kayaking) and is the location of a proposed whitewater park. Target flows for quality boating opportunities are at or above 150 cfs. Compared with Current Conditions, Alternative 2 would result in an average reduction of 3 to 7 boating days per month (a total of 19 fewer days over the May-August period), resulting in a moderate to major adverse effect on boating opportunities in Segment B. Augmented winter flows in Alternative 2 would result in minor beneficial effects on recreational fishing opportunities in Segment B, based on an increased abundance and overall health of recreational fish species (e.g., rainbow trout) that are sought by anglers.
- **Segment C.** Alternative 2 would not affect boating in Segment C and would result in negligible adverse effects on recreational fishing opportunities.
- **Segments D, E, and F.** Alternative 2 would not affect boating in Segments D, E, or F and would result in negligible adverse effects on recreational fishing opportunities.

Under Alternative 2, changes in streamflows are not expected to result in discernible visual impacts on recreational experiences along the Poudre River, or the availability of land-based recreational activities such as trail use, wildlife viewing, and photography. Likewise, wildlife-related recreation along the mainstem, such as hunting, environmental education, and photography, would also be unaffected. Numerous ponds along the mainstem are open to public recreation and the water surface elevations in some of these ponds can be altered by water surface elevations in the nearby Poudre River. Based on ground water-surface water relationships developed for the SDEIS, the 2014 Recreation Resources Report determined that the predicted reductions in streamflow would have negligible effects on recreation for most of the ponds along the mainstem. Unlined ponds within 100 feet of the river were predicted to be more sensitive to reductions in streamflow, and potential seasonal reductions in the water surface elevations at these ponds could have a minor seasonal effect on recreation at these ponds.

4.16.3.4 South Platte River

The Mitani-Tokuyasu SWA is located at the confluence of the Poudre and South Platte Rivers and provides hunting and trapping access to the South Platte River. As discussed in Section 4.16.3.1.2, the proposed Galeton Reservoir forebay would permanently impact about one-third of the land within the Mitani-Tokuyasu SWA. Effects to hunting and trapping opportunities for the South Platte River are expected to be minor because access to the South Platte River for hunting and trapping would be maintained and because there are other nearby SWAs along the South Platte River within about 10 miles of the Mitani-Tokuyasu SWA.

4.16.4 Alternative 3

4.16.4.1 Reservoir Sites

4.16.4.1.1 Cactus Hill Reservoir

As described for the No Action Alternative, the Cactus Hill Reservoir site is on private land and no public recreation currently occurs or is proposed at the site. The 190,000 AF Cactus Hill Reservoir proposed for Alternative 3 would not affect public recreation.

4.16.4.1.2 Galeton Reservoir

The effects on recreation at the Galeton Reservoir and forebay under Alternative 3 would be the same as those described for Alternative 2 (Section 4.16.3.1.2).

4.16.4.2 Conveyance Systems

4.16.4.2.1 Cactus Hill Reservoir to Participants

Alternative 3 includes the construction of pipelines to convey water from Cactus Hill Reservoir south to the NISP Participants (Figure 2-9). Depending on the final alignment, these conveyance pipelines may intersect existing recreation resources such as parks or trails. It is assumed that construction would result in short-term disturbance, any access to trails or recreation sites would be maintained with detours, and any impacts on parks or other recreation amenities would be fully repaired following construction. With these assumptions, the effects of conveyance pipelines on recreation sites would be negligible.

4.16.4.2.2 SPWCP

Similar to Alternative 2, Alternative 3 also includes the SPWCP pipelines in the portions of Weld County east of Highway 85 and south of Highway 14. While the specific locations of these pipeline alignments have not been determined, no developed recreation sites or amenities are located in the area. Therefore, construction of the SPWCP pipelines would not affect recreation resources.

4.16.4.3 Poudre River

The diversion point for Alternative 3 is located at the Poudre Valley Canal. Potential water-based recreation effects, by segment, are as follows:

- **Segment A.** There would be a negligible effect on boating in Segment A, because boating is not a popular activity in this segment and public access is limited. Alternative 3 would result in minor adverse effects to fishing opportunities, due to reductions in habitat for brown and rainbow trout.
- **Segment B.** Segment B is popular for boating (canoeing and kayaking), and is the location of a proposed whitewater park. Target flows for quality boating opportunities are above 150 cfs. Similar to Alternative 2, Alternative 3 would result in an average reduction of 3 to 6 boating days per month (a total of 18 fewer days over the May-August period), resulting in a moderate to major adverse effect on boating opportunities in Segment B. Alternative 3 would have moderate to major adverse effects on recreational fishing opportunities in Segment B, due to reductions in habitat availability for adult brown and rainbow trout during the critical spring period.
- **Segment C.** Alternative 3 would not affect boating in Segment C and would result in negligible adverse effects on recreational fishing opportunities.
- **Segments D, E, and F.** Alternative 3 would not affect boating in Segments D, E, or F and would result in negligible adverse effects on recreational fishing opportunities.

Under Alternative 3, changes in streamflows are not expected to result in discernible visual impacts on recreational experiences along the Poudre River, or the availability of land-based recreational activities such as trail use, wildlife viewing, and photography. Likewise, wildlife-related recreation in this segment, such as hunting, environmental education, and photography, at these locations would also be unaffected. Numerous ponds along the mainstem are open to public recreation and the water surface elevations in some of these ponds can be altered by water surface elevations in the nearby Poudre River. Based on ground water-surface water relationships developed for the SDEIS, the 2014 Recreation Resources Report determined that the predicted reductions in streamflow would have negligible effects on recreation for most of the ponds along the mainstem. Unlined ponds within 100 feet of the river were predicted to be more sensitive to reductions in streamflow, and potential seasonal reductions in water surface elevations at these ponds could have a minor seasonal effect on recreation at these ponds.

4.16.4.4 South Platte River

The effects on recreational use of the South Platte River under Alternative 3 would be the same as those described for Alternative 2.

4.16.5 Alternative 4

4.16.5.1 Reservoir Sites

4.16.5.1.1 Cactus Hill Reservoir

As described for the No Action Alternative, the Cactus Hill Reservoir site is on private land and no public recreation currently occurs or is proposed at the site. The 190,000 AF Cactus Hill Reservoir proposed for Alternative 4 would not affect public recreation.

4.16.5.1.2 Galeton Reservoir

The effects on recreation at the Galeton Reservoir and forebay under Alternative 4 would be the same as those described for Alternatives 2 and 3.

4.16.5.2 Conveyance Systems

The effects on recreation from conveyance pipelines under Alternative 4 would be the same as Alternative 3.

4.16.5.3 Poudre River

As described in Section 2.7, Alternative 4 would divert less water from the Poudre Valley Canal than Alternatives 2 and 3, with the New Cache direct flow exchange water remaining in the river and diverted at the New Cache Canal. Potential water-based recreation effects, by segment, are as follows:

- **Segment A.** There would be a negligible effect on boating in Segment A, because boating is not a popular activity in this segment and public access is limited. Alternative 4 would also have a negligible effect on fishing opportunities.
- **Segment B.** Segment B is popular for boating (canoeing and kayaking), and is the location of a proposed whitewater park. Target flows for quality boating opportunities are at or above 150 cfs. Compared with Current Conditions, Alternative 4 would have a negligible effect on boating opportunities, with a small reduction in boating days (a total of four fewer days over the May-August period). Alternative 4 would not affect recreational fishing opportunities in Segment B.
- **Segment C.** Similar to the other action alternatives, Alternative 4 would not affect boating in Segment C. Hydrology changes in Alternative 4 would result in negligible to minor adverse effects on the limited recreational fishing that occurs along this reach.
- **Segment D, E, and F.** Alternative 4 would not affect boating in Segments D, E, or F and would result in negligible adverse effects on recreational fishing opportunities.

In Alternative 4, changes in streamflows are not expected to result in discernible visual impacts on recreational experiences along the Poudre River, or the availability of land-based recreational activities such as trail use, wildlife viewing, and photography. Likewise, wildlife-related recreation along the mainstem, such as hunting, environmental education, and photography, would also be unaffected. Numerous ponds along the mainstem are open to public recreation

and the water surface elevations in some of these ponds can be altered by water surface elevations in the nearby Poudre River. Based on ground water-surface water relationships developed for the SDEIS, the 2014 Recreation Resources Report determined that the predicted reductions in streamflow would have negligible effects on recreation for most of the ponds along the mainstem. Unlined ponds within 100 feet of the river were predicted to be more sensitive to reductions in streamflow, and potential seasonal reductions in water surface elevations at these ponds could have a minor seasonal effect on recreation at these ponds.

4.16.5.4 South Platte River

The effects on recreational use of the South Platte River under Alternative 4 would be the same as those described for Alternative 2.

4.16.6 Unavoidable Adverse Impacts

All action alternatives would result in unavoidable adverse impacts to recreation resources. The construction and operation of Glade Reservoir (Alternative 2) would result in the permanent loss of some lands that are used for educational purposes and hunting and fishing opportunities. The Galeton forebay (Alternatives 2, 3, and 4) would result in the permanent loss of a substantial portion of a SWA that is popular for hunting. Flow changes in Alternatives 2 and 3 would adversely affect boating and fishing opportunities along the Poudre River through Fort Collins (Segment B). The District's proposed mitigation will be reviewed by the Corps to determine whether unavoidable adverse impacts would remain with the implementation of the District's proposed mitigation.

4.16.7 Impact Summary

All three action alternatives would result in moderate effects to the Mitani-Tokuyasu SWA, which would be permanently impacted by the construction of the Galeton forebay. The construction of Glade Reservoir in Alternative 2 would be unique in that the new recreation opportunities would be a major benefit; the other reservoirs would not provide any new recreation. Flow changes along the Poudre River in Alternatives 2 and 3 would result in negligible to minor effects to recreation (primarily fishing) in Segment A (west of downtown Fort Collins). These effects would be greater in Segment B through Fort Collins, where flow changes would result in minor to moderate effects to boating under Alternatives 2 and 3. Moderate to major effects to fishing would occur under Alternative 3. Winter flow augmentation in Alternative 2 would provide a minor benefit to fishing in Segment B. Alternatives 1 and 4 would not have any of these effects to Poudre River recreation in Segment B. None of the alternatives would affect upland recreation facilities or use, except for the construction of the Carter or Glade to Horsetooth pipeline in Alternative 2, which would result in negligible to minor, temporary impacts to trail access and use in multiple parks and natural areas during construction. A summary comparison of the alternative effects to recreation is presented in the following table (Table 4-100).

Table 4-100. Effects determinations for recreation resources.

Study Area	Alternative 1	Alternative 2 Reclamation Action Option	Alternative 2 No Reclamation Action Option	Alternative 3	Alternative 4
Glade Reservoir	NA	Major benefits from new regional recreation opportunities; minor effect to educational uses	Same as the Reclamation Action Option	NA	NA
U.S. 287 Realignment	NA	Negligible to minor effects		NA	NA
Cactus Hill Reservoir	No effect	NA	NA	No effect	No effect
Galeton Reservoir	NA	No effect	Same as the Reclamation Action Option	No effect	No effect
Galeton Forebay	NA	Moderate effect	Same as the Reclamation Action Option	Moderate effect	Moderate effect
Conveyance Systems	Negligible	Negligible	Negligible to minor	No effect	No effect
Poudre River Segment A	Negligible	Negligible to minor	Same as the Reclamation Action Option	Negligible to minor	Negligible
Poudre River Segment B	Negligible	Moderate to major effect to boating; minor benefit to fishing	Same as the Reclamation Action Option	Moderate to major effects to boating; moderate to major effects to fishing	Negligible
Poudre River Segment C	Negligible	Negligible	Same as the Reclamation Action Option	Negligible	Negligible
Poudre River Segments D-F	Negligible	Negligible	Same as the Reclamation Action Option	Negligible	Negligible
South Platte River	No effect	Moderate effect associated with impacts to SWA	Same as the Reclamation Action Option	Moderate effect associated with impacts to SWA	Moderate effect associated with impacts to SWA

NA = Not a component of the alternative.

4.17 LAND USE

This section describes potential changes in land use associated with the NISP alternatives. No new analyses for land use were performed for the SDEIS. Information in this section is provided for alternatives that have changed subsequent to the DEIS. Additional information on land uses and ownership are presented in the 2008 Land Use Report (ERO 2008b) prepared for the DEIS and summarized in Sections 4.21 and 4.29.15 of the DEIS. Information on land use, growth, regional plans, and ownership will be reviewed and updated, as necessary, for the FEIS.

4.17.2 Methods

Existing land use data were gathered from local, state, and federal sources to characterize land ownership and land use patterns in the NISP study areas. This characterization included a review of land ownership maps and land management plans, personal conversations with city and town planners, and a review of information provided in county and community master plans. Land management policies and programs associated with regional government councils and planning commissions also were included in this review. The impact assessment focused on the probable changes to land use and land ownership that would result from implementation of the alternatives. The impact assessment also identified possible conflicts between the alternatives and federal, state, and local land use plans, policies, and regulations for the NISP study areas. Additional information on methods and sources is provided in the 2008 Land Use Report (ERO 2008b).

4.17.3 No Action Alternative (Alternative 1)

The No Action Alternative for the SDEIS is different than the No Action Alternative presented in the DEIS. The No Action Alternative for the SDEIS would involve the construction of Cactus Hill Reservoir and the transfer of water from an estimated 64,200 acres of irrigated agricultural lands.

4.17.3.1 Cactus Hill Reservoir

Most of the Cactus Hill Reservoir site is owned by Anheuser-Busch and is not open for public use. It is used for disposal of wastewater associated with beer production. The construction of Cactus Hill Reservoir would require Anheuser-Busch to find another location to dispose of wastewater associated with beer production. Other land uses and associated impacts are discussed below.

4.17.3.1.1 Agriculture

Some areas of the Cactus Hill Reservoir study area are used for agricultural purposes such as crop production and livestock grazing. Portions of the Cactus Hill Reservoir site are enrolled in the Conservation Reserve Program (CRP) and are not in production. In addition, a small area of State Land Board land occurs in the northwest corner of the Cactus Hill Reservoir site. Overall, 289.1 acres of land would be temporarily affected and 2,615.3 acres of land would be

permanently affected by construction of Cactus Hill Reservoir. Permanent effects consist of the dam, proposed roads, a pump station, the reservoir, and associated facilities.

4.17.3.1.2 Urban and Residential

Two private residences would be inundated by Cactus Hill Reservoir and six additional residences are within 500 feet of the proposed Cactus Hill Reservoir. Those residences within visual range of the proposed dam structure may experience a decrease in property values, while lakefront homes may experience an increase in property values.

4.17.3.1.3 Roads

Cactus Hill Reservoir would inundate portions of WCR 15, 19, and 90; WCR 15 is proposed to be realigned approximately 1 mile east of the existing alignment (Figure 4-64).

4.17.3.2 Conveyance Systems

The conveyance systems are proposed to occur primarily in rural agricultural areas and within road rights-of-way. However, some of the proposed conveyance alignments may cross open space, trails, and natural areas. The conveyance alignments will be refined for the FEIS and land use information for the conveyance alignments will be presented in the FEIS.

4.17.3.3 Poudre River

The projected trajectory for the Poudre River downstream of I-25 is for continued channel contraction (with or without the NISP alternatives). Under the No Action Alternative is the trajectory would continue and likely result in increases in flood stage at some locations that would be difficult to discern. The increase in flooding would not change the floodplain rating (zone designation) within existing flood prone areas, but may increase the limits of this flood zone. Increases in floodplain stage can affect insurable structures and may adversely affect the cost of flood insurance.

4.17.3.4 South Platte River

Channel contraction and increased flooding are not predicted for the South Platte River downstream of the confluence with the Poudre River to the Kersey Gage.

4.17.3.5 No Action Irrigated Lands

The no action irrigated lands are agricultural lands managed to produce corn, hay, and vegetables and to pasture livestock. The No Action Alternative would not change the agricultural status of these lands; however, the proposed transfer of water from these lands would change the crops capable of being grown. Once irrigation of these lands was discontinued, the lands would likely be used for dry land crop production (e.g., winter wheat or barley) or revegetated to upland grasslands for livestock grazing.

4.17.4 District's Preferred Alternative (Alternative 2)

There is no new information on land use for Alternative 2 with the exception of CDOT selecting the western alignment as its preferred alternative for the realignment of U.S. 287. Sections 4.21 and 4.29.15 (U.S. 287) of the DEIS describe the estimated effects to land use for Alternative 2. The following is a summary of what is presented in the DEIS.

4.17.4.1 Reservoir Sites

4.17.4.1.1 Glade Reservoir

The District currently owns the majority of the land that would be permanently affected (1,442.4 acres) at the proposed Glade Reservoir and does not allow public access (Figure 7 of the 2014 Recreation Resources Technical Report). The State Land Board owns the State Trust Land (340.1 permanently impacted acres) on the west side of the proposed Glade Reservoir. The State Land Board land is leased to CPW for deer and small game hunting at specified times of the year and is open for fishing year-round. Access to the State Trust Land is by foot or horseback only. The majority of this land is held in trust for CSU and the Poudre School District for educational purposes. The BLM manages a 160-acre parcel that borders the east side of the proposed Glade Reservoir. Approximately 25.9 acres of this BLM parcel would be permanently impacted by the proposed Glade Reservoir. There is no public access to this parcel. Alternative 2 also would require realigning four H-frame structures and 0.6 miles of a 69-kV electric transmission line owned by the Poudre Valley REA at the Glade Reservoir site.

U.S. 287. A portion of U.S. 287 would be inundated by the proposed Glade Reservoir. Subsequent to the DEIS, CDOT selected the western alignment for the realignment of U.S. 287. As part of the proposed realignment, the District would provide a 250-foot ROW for the U.S. 287 realignment and CDOT would abandon the 7.3-mile inundated portion of U.S. 287. The western alignment would cross mostly private lands. Most of these lands are owned by Holcim, Inc. and were used for limestone mining and a cement plant. The Holcim Mine completed the process of reclamation after 80 years of mining. The Weaver Ranch is located at the north end of the proposed realignment and would be dissected by the western alignment. Two towers on the Platte River Power Authority 230-kV transmission line would have to be relocated to accommodate the proposed intersection and tie in to the existing U.S. 287. A section of this line would have to be raised over or buried beneath the roadway fill section approaching the hogback cut.

4.17.4.1.2 Galeton Reservoir

Effects to land use associated with Galeton Reservoir were not included in the DEIS and are described here. The proposed Galeton Reservoir and associated flood pool would be located mostly on private land, with a small parcel of State Land Board land at the southwestern edge (Table 4-101) and would border the Pawnee National Grasslands administrative boundary at the northern end. Most of the lands within the administrative boundary are private lands that the U.S. Forest Service does not actively manage and has no current plans to acquire (Youngman, pers. Comm. 2015). The proposed Galeton forebay would be located south of the proposed

Galeton Reservoir, within the 67.3-acre Mitani-Tokuyasu SWA (managed by CPW) and permanently impact about one-third of the land within the Mitani-Tokuyasu SWA, which is popular for hunting and trapping (Table 4-101). Permanent impacts associated with the SPWCP would be associated with two pump stations located on private lands, which are not anticipated to conflict with existing land uses (Table 4-102).

Table 4-101. Land ownership acreages within Galeton Reservoir and Galeton forebay boundaries.

Ownership/Location	Permanent Impacts (acres)	Temporary Impacts (acres)
State Land Board/Galeton Reservoir 45,624 AF	40.29	12.37
Private/Galeton Reservoir 45,624 AF	1,887.47	132.36
CPW/Galeton forebay	21.00	10.12
Private/Galeton forebay	0.47	2.02

Table 4-102. Land ownership acreages for SPWCP.

Ownership	Permanent Impacts (acres)	Temporary Impacts (acres)
CPW	0.00	0.98
State Land Board	0.00	7.13
Private	1.00	212.17

4.17.4.2 Conveyance Systems

The conveyance systems are proposed to occur primarily in rural agricultural areas and within road rights-of-way. However, some of the proposed conveyance alignments would cross open space and natural areas. The conveyance alignments will be refined for the FEIS and land use information for the conveyance alignments will be presented in the FEIS.

Conveyances for the Reclamation Action and No Reclamation Action Options differ. Conveyance for the Reclamation Action Option would include the future construction of the Glade to Horsetooth Pipeline, if needed. The proposed Glade to Horsetooth pipeline would be a buried pipeline and would travel 5.5 miles from the proposed Glade Reservoir Dam to the north end of Horsetooth Reservoir. While the exact alignment of this pipeline has not yet been determined, it is likely to cross the northern extent of the Horsetooth Reservoir County Park in an area that has no trails or recreation amenities.

The No Reclamation Action Option would involve the construction of the Carter Pipeline. The proposed Carter Pipeline would be a buried pipeline beginning at the Glade Reservoir Dam, traveling south along the east side of Horsetooth Reservoir, and then south to Carter Lake where it would tie into the existing SWSP and the existing St. Vrain Supply Canal (Figure 2-3). While the specific alignment of the pipeline has not been determined, it would likely cross through portions of Horsetooth Reservoir County Park, Reservoir Ridge Natural Area, Maxwell Natural Area, and Rimrock Open Space, crossing over several existing recreation trails within these

areas. Potentially affected trails include the Reservoir Ridge Trail, Foothills Trail, Ridge Trail, and Rimrock Trail.

4.17.4.3 Poudre River

Channel contraction downstream of I-25 would likely result in increases in flood stage at some locations that would be difficult to discern. The increase in flooding would not change the floodplain rating (zone designation) within existing flood prone areas, but may increase the limits of this flood zone. Increases in floodplain stage can affect insurable structures and may adversely affect the cost of flood insurance.

4.17.4.4 South Platte River

Channel contraction and increased flooding are not predicted for the South Platte River downstream of the confluence with the Poudre River to the Kersey Gage.

4.17.5 Alternative 3

4.17.5.1 Reservoir Sites

4.17.5.1.1 Cactus Hill Reservoir

The effects to land use associated with Cactus Hill Reservoir are the same as described under the No Action Alternative except for the number of residences affected by the reservoir. Under the No Action Alternative, Cactus Hill Reservoir would be 120,000 AF. Under Alternatives 3 and 4, Cactus Hill Reservoir would be 190,000 AF. The larger reservoir would inundate six residences and another 10 residences would be within 500 feet of the reservoir.

4.17.5.1.2 Galeton Reservoir

The effects to land use associated with Galeton Reservoir are described under Alternative 2.

4.17.5.2 Conveyance Systems

The conveyance systems are proposed to occur primarily in rural agricultural areas and within road rights-of-way. However, some of the proposed conveyance alignments would likely cross open space and natural areas. The conveyance alignments will be refined for the FEIS and land use information for the conveyance alignments will be presented in the FEIS.

4.17.5.3 Poudre River

Channel contraction downstream of I-25 would likely result in increases in flood stage at some locations that would be difficult to discern. The increase in flooding would not change the floodplain rating (zone designation) within existing flood prone areas, but may increase the limits of this flood zone. Increases in floodplain stage can affect insurable structures and may adversely affect the cost of flood insurance.

4.17.5.4 South Platte River

Channel contraction and increased flooding are not predicted for the South Platte River downstream of the confluence with the Poudre River to the Kersey Gage.

4.17.6 Alternative 4

4.17.6.1 Reservoir Sites

4.17.6.1.1 Cactus Hill Reservoir

The effects to land use associated with Cactus Hill Reservoir are described under Alternative 3.

4.17.6.1.2 Galeton Reservoir

The effects to land use associated with Galeton Reservoir are described under Alternative 2.

4.17.6.2 Conveyance Systems

The conveyance systems are proposed to occur primarily in rural agricultural areas and within road rights-of-way. However, some of the proposed conveyance alignments would likely cross open space and natural areas. The conveyance alignments will be refined for the FEIS and land use information for the conveyance alignments will be presented in the FEIS.

4.17.6.3 Poudre River

Channel contraction downstream of I-25 would likely result in increases in flood stage at some locations that would be difficult to discern. The increase in flooding would not change the floodplain rating (zone designation) within existing flood prone areas, but may increase the limits of this flood zone. Increases in floodplain stage can affect insurable structures and may adversely affect the cost of flood insurance.

4.17.6.4 South Platte River

Channel contraction and increased flooding are not predicted for the South Platte River downstream of the confluence with the Poudre River to the Kersey Gage.

4.17.7 Unavoidable Adverse Impacts

All alternatives would unavoidably affect current land uses. Relative to the other alternatives, the No Action Alternative has the potential to affect current land use over a broader area due to the transfer of water from about 64,200 acres of irrigated agricultural lands. The No Action Alternative would not change the agricultural status of these lands; however, the proposed transfer of water from these lands would change the crops capable of being grown. Reservoirs associated with all alternatives would unavoidably inundate residences; however, Alternatives 1, 3, and 4 would inundate the greatest number of residences due to the construction of Cactus Hill

Reservoir. Alternatives 1, 3, and 4 would also unavoidably displace the Anheuser-Busch wastewater disposal facility and Anheuser-Busch would need to find another location to dispose of wastewater associated with beer production. Alternative 2 would unavoidably affect State Trust Land and BLM land. All action alternatives would unavoidably permanently impact about one-third of the land within the Mitani-Tokuyasu SWA. All alternatives would unavoidably impact sections of existing roads. The proposed road realignments would require abandonment of the affected sections of existing roads and their associated ROW and acquiring new ROW associated with the road realignments.

There are no known conflicts between the alternatives and the objectives of federal, regional, state, and local land use plans, policies, and controls. All alternatives involve construction that would require authorizations from local governments (Section 1.6). Local authorizations would require compliance with local land use policies and controls. All action alternatives involve the SPWCP that would affect lands owned or managed by the State Land Board and CPW. The construction of any of the action alternatives would require meeting federal and state requirements for effects to these lands.

4.17.8 Impact Summary

Table 4-103. Effects determinations for land use.

Study Area	Alternative 1	Alternative 2 Reclamation Action	Alternative 2 No Reclamation Action	Alternative 3	Alternative 4
Glade Reservoir	NA	Major effect to Poudre School District Trust land; minor effect to CSU Trust land and BLM land. Minor effect to REA utility line and a minor effect due to moving the Munroe Canal.	Same as Reclamation Action.	NA	NA
U.S. 287 Realignment	NA	Moderate effect to private ranch.		NA	NA
Cactus Hill Reservoir	Major effect to Anheuser-Busch wastewater disposal operations. Minor effect to State Land Board land. Inundation of 2 residences and another 6 within 500 feet of the reservoir would be a major effect to local landowners.	NA	NA	Major effect to Anheuser-Busch wastewater disposal operations. Minor effect to State Land Board land. Inundation of 6 residences and another 10 within 500 feet of the reservoir would be a major effect to local landowners. Minor effect to Platte River Power Authority utility line.	Major effect to Anheuser-Busch wastewater disposal operations. Minor effect to State Land Board land. Inundation of 6 residences and another 10 within 500 feet of the reservoir would be a major effect to local landowners. Minor effect to Platte River Power Authority utility line.
Galeton Reservoir	NA	Minor	Same as Reclamation Action	Minor	Minor
Galeton Forebay	NA	Moderate effect associated with impact to about one-third of the land within the Mitani-Tokuyasu SWA.	Same as Reclamation Action	Moderate effect associated with impact to about one-third of the land within the Mitani-Tokuyasu SWA.	Moderate effect associated with impact to about one-third of the land within the Mitani-Tokuyasu SWA.
Conveyance Systems	Negligible	Minor short-term effects to open space, parks and trails.	Minor short-term effects possible on the Reservoir Ridge Trail, Foothills Trail, Ridge Trail, and Rimrock Trail	Negligible	Negligible

Study Area	Alternative 1	Alternative 2 Reclamation Action	Alternative 2 No Reclamation Action	Alternative 3	Alternative 4
No Action Irrigated Lands	Loss of irrigation from 64,200 acres would be a major effect in the change of crop type.	NA	NA	NA	NA
Poudre River	The ongoing trend of channel contraction downstream of I-25 is predicted to continue and would likely result in increases in flood stage at some locations that would be difficult to discern. The increase in flooding would not change the floodplain rating (zone designation) within existing flood prone areas, but may increase the limits of this flood zone.	Channel contraction downstream of I-25 would likely result in increases in flood stage at some locations that would be difficult to discern. The increase in flooding would not change the floodplain rating (zone designation) within existing flood prone areas, but may increase the limits of this flood zone.	Same as Reclamation Action	Channel contraction downstream of I-25 would have similar effects on flooding as described for Alternative 2.	Channel contraction downstream of I-25 would have similar effects on flooding as described for Alternative 2.
South Platte River	No channel contraction predicted and no effects on flooding predicted.	No channel contraction predicted and no effects on flooding predicted.	Same as Reclamation Action	No channel contraction predicted and no effects on flooding predicted.	No channel contraction predicted and no effects on flooding predicted.

NA = Not a component of the alternative.

4.18 VISUAL RESOURCES AND AESTHETICS

This section summarizes the predicted potential effects of the NISP alternatives on existing landscapes, considering both natural and manmade features. No new studies for visual resources were conducted for the SDEIS. Detailed information on visual resources are presented in the 2008 Visual Resources Report (ERO 2008h) and the 2008 Visual Resources Highway 287 Report (ERO and HLA 2008) produced for the DEIS.

The NISP alternatives would have various effects on streamflows, reducing flows at some locations and increasing flows at other locations and at different times of the year. In general, the NISP alternatives would have only a minor effect on flow levels during periods of low flows, when streams are most sensitive to visual change and the Project generally would not be diverting. Most of the flow changes would occur during periods of naturally higher flows (May, June, and July). The resulting flows (see Section 4.2) would still be within the range of natural variability, both seasonally and from year-to-year, that is currently experienced by viewers. The aesthetic experience along the Poudre River corridor is recognized as a contributing factor to the enjoyment of recreational activities in the area. Given the amount of visitation along the corridor, flow reductions in certain times of the year may have minor, indirect effects to the overall experience for visitors and residents along certain segments of the mainstem. Impacts associated with scenery-dependent recreational activities within the study area are described in Section 4.16.

4.18.1 Methods

The methods for analyzing visual resources effects are described in Section 4.19.1 of the DEIS. The level of impact to visual resources within the Study area was determined according to the following:

- Negligible – the proposed project components would result in imperceptible changes in the landscape due to distance, topography, vegetation, previous disturbance, or low scenic quality
- Minor – the proposed project components would result in slight but detectable changes to the landscape
- Moderate – the proposed project components would result in clearly detectable changes, with observable effects to the landscape
- Major – the proposed project components would result in changes that are readily apparent and would have substantial impacts on the visual character of the area

4.18.2 No Action Alternative (Alternative 1)

4.18.2.1 Cactus Hill Reservoir

The effects on visual resources from the construction of Cactus Hill Reservoir and dam are described in Section 4.19.4, 4.19.9, and 4.19.10 of the DEIS. Temporary construction activities

would create major adverse temporary direct effects to visual resources at the reservoir site, including staging areas, stockpiles, vegetation removal, heavy construction equipment, and haul roads. The long-term direct effects on visual resources from Cactus Hill Reservoir Dam would be moderate because of the visibility of the artificial form of the dam from multiple observation points and in the context of the Cactus Hill Reservoir site, the dam would appear relatively small. The presence of the reservoir would be a minor beneficial effect because water would add color and texture variety. Although Cactus Hill Reservoir would be smaller under the No Action Alternative than under Alternatives 3 and 4, the effects on visual resources would be similar. The Cactus Hill Reservoir site occurs within the High Plains character region with predominately low-lying landforms and low-growing grasslands with scattered residences, ponds, and small lakes (Section 3.19.2 of the DEIS). The construction of Cactus Hill Reservoir would change the visual character of the immediate area from rural agricultural and grasslands to open water. However, the region surrounding the reservoir would retain a similar visual character and the reservoir would not be out of character with the surrounding High Plains character region as Cobb Lake and Black Hollow Reservoir would be nearby.

4.18.2.2 Conveyance Systems

Effects on visual resources along the conveyance systems for the No Action Alternative would occur during construction and before disturbed areas have been revegetated. During construction, the generation of dust, the presence of construction equipment, potential construction nighttime lighting and vegetation clearing would affect the scenic quality. Dust would be emitted from earthmoving activities, construction vehicles, and equipment; and from areas within the construction zone that have been disturbed or where excavated material is stockpiled. This “fugitive” dust could temporarily distract from, or partially obscure, existing views. The pipeline alignments would be located within existing road rights-of-way or previously disturbed rural agricultural areas to the maximum extent practicable. Open trenching pipeline installation within riparian corridors would result in tree removal and subsequent breaks within continuous tree canopies. After construction is complete but before areas are revegetated, disturbed, unvegetated areas would be a temporary minor effect on visual quality because of the contrast with adjacent areas. Over time, the contrast would lessen and become a negligible effect. New aboveground facilities such as water treatment facilities and pump stations would be visible, resulting in minor to moderate long-term direct impacts on visual resources.

4.18.2.3 No Action Irrigated Lands

The 64,200 acres of irrigated agricultural lands from which water would be transferred as part of the No Action Alternative produce a mostly green landscape in straight long rows during the spring and summer and brown standing crops after harvest or bare tilled ground between crops. Irrigated hay fields and pastures remain green for most of the year without a defined pattern. The vegetation cover would change from irrigated agriculture to dryland crops or upland vegetation species with a mix of native and introduced species similar to other unirrigated areas in the region. Conversion of these areas to non-irrigated agriculture would result in a noticeable

visual change to individual fields, but would not be out of character with the broader region and would therefore be a minor effect.

4.18.2.4 Poudre River

The No Action Alternative was evaluated under Future Conditions hydrology only, as explained in Section 4.2.1 and, therefore, the indirect visual effects analysis for the No Action Alternative for the Poudre River mainstem is presented in Chapter 5.

4.18.2.5 South Platte River

The No Action Alternative was evaluated under Future Conditions hydrology only, as explained in Section 4.2.1 and, therefore, the indirect visual effects analysis for the No Action Alternative for the South Platte River is presented in Chapter 5.

4.18.3 District's Preferred Alternative (Alternative 2)

4.18.3.1 Reservoir Sites

4.18.3.1.1 Glade Reservoir

The effects on visual resources from Glade Reservoir and dam are described in Section 4.19.2 of the DEIS. The visual effects from Glade Reservoir Dam would be major because of the visual contrast with the surrounding landscape from various observation points, and in the context of the Glade Reservoir site the dam would appear relatively large. The presence of the reservoir would be a minor beneficial effect because water would add color and texture variety. The Glade Reservoir site occurs within the Foothills Character region that includes low mountains, geological hogback formations, and the valley of the existing U.S. 287 corridor. The region is predominately characterized by ponderosa pine and shrub covered hills and low mountains which include highly visible large rock out crops and boulders (Section 3.19.3 of the DEIS). The construction of Glade Reservoir would change the visual character of the immediate area from a valley with a highway bordered by hogbacks covered with shrubs and ponderosa pines to an expanse of open water bordered by hogbacks covered with shrubs and ponderosa pines. The resulting visual character would be similar to Horsetooth Reservoir, which is located in a similar visual and geologic setting about five miles south of the proposed Glade Reservoir site.

U.S. 287. The effects on visual resources associated with the western alignment of U.S. 287 are described in Sections 4.19.5 and 4.19.7 of the DEIS. The effects on visual resources from the realignment of U.S. 287 would be major for both travelers on the new highway and from observation points. The relocated highway would introduce night time lights from vehicles and a noticeable contrast to the surrounding landscape for residences in the area. For travelers on the highway, previous disturbance in the former Holcim Mine would be less scenic than vegetation along the existing highway, and the large cut through the hogback formation would create visible contrast in landform and rock form color and texture.

4.18.3.1.2 Galeton Reservoir

The effects on visual resources from construction of Galeton Reservoir and dam are described in Section 4.19.3 of the DEIS. The effects on visual resources from Galeton Reservoir would be moderate due to the presence of the artificial form of the dam from some observation points in an area with other dams and artificial forms. Additionally, in the context of the Galeton Reservoir site, the dam would appear relatively small. The presence of the reservoir would be a minor beneficial effect because water would add color and texture variety. The Galeton Reservoir site occurs within the High Plains character region with predominately low-lying landforms and low-growing grasslands with scattered residences, ponds and small lakes (Section 3.19.2 of the DEIS). The Galeton Reservoir site also has numerous oil and gas wells as does much of the region. The construction of Galeton Reservoir would change the visual character of the immediate area from rural agricultural and grasslands to open water. However, the region surrounding the reservoir would retain the similar visual character of open grasslands and rural agricultural areas with scattered oil and gas wells, ponds and small lakes.

4.18.3.2 Conveyance Systems

The predicted effects on visual resources from the Alternative 2 conveyance systems and the effects determination would be similar to those described for the No Action Alternative conveyance systems in Section 4.18.2.2.

4.18.3.3 Poudre River

Due to the proposed flow augmentation program, the segments of the river affected by it would experience increased flows during the winter months. This would result in a minor beneficial effect to visual resources. Flows in the Poudre River are highly variable and reduced flows associated with Alternative 2 may not be noticed by the majority of Poudre River trail users and other viewers of the river. The greatest flow changes would occur during high flow periods when visual cues to changes in flows (e.g., exposed shoreline, bars, islands, and river bed) are expected to be minimal. For viewers who value the visual quality of viewing the river at high flows, the experience would be incrementally diminished. Most visitors along the Poudre River relate their visual experience of flows in the river to river height or elevation (stage) relative to river features and not necessarily flow. The majority of seasonal fluctuations in flow and stage on the mainstem occur from May through September, which is also the time of increased visitation along the mainstem, and the time when most of the diversions under Alternative 2 would occur. Changes in river stage of 0.5 foot would be an imperceptible change for most viewers and therefore a negligible visual effect. Under Alternative 2, the predicted percentage of the period of record with a decline of 0.5 foot or greater in river stage was predicted to be 10% or less from May through September for all but the Martinez Park study site (representative of Segment B) (Section 4.9.5.3.1). Such infrequent declines of greater than 0.5 feet would also likely be an imperceptible change for most viewers and, therefore, a negligible visual effect. At Martinez Park, Alternative 2 is predicted to have weekly average river stage declines of 0.5 foot or greater during the May through September period for 19% of the period of record. The

increased frequency of predicted reductions in stage greater than 0.5 feet (almost twice as frequent as the other segments) in a segment of the river that is highly used, would likely be noticeable to many viewers familiar with the river in this segment and would likely have a minor seasonal effect on the visual quality of viewing the river Segment B.

4.18.3.4 South Platte River

Alternative 2 would result in flow changes to the South Platte River of less than 10% on an average annual basis. For visitors to the South Platte River, these minor flow changes would likely be indiscernible because of the existing daily and seasonal water level fluctuations and the volume of flow of the South Platte River within the Study area. Visual effects along the South Platte River would be negligible under Alternative 2.

4.18.4 Alternative 3

4.18.4.1 Reservoir Sites

4.18.4.1.1 Cactus Hill Reservoir

The effects on visual resources from construction of Cactus Hill Reservoir and dam are described in Section 4.19.4 of the DEIS. The effects determinations are the same as for the No Action Alternative (Section 4.18.2.1).

4.18.4.1.2 Galeton Reservoir

The effects on visual resources from construction of Galeton Reservoir and dam are described in Section 4.19.3 of the DEIS. The effects determinations are the same as for Alternative 2 (Section 4.18.3.1.2).

4.18.4.2 Conveyance Systems

The effects on visual resources from the Alternative 3 conveyance systems and the effects determinations are similar to those described for the No Action Alternative conveyance systems in Section 4.18.2.2.

4.18.4.3 Poudre River

The predicted effects of changes in flow and stage on visual resources along the Poudre River for Alternative 3 are similar to those previously described for Alternative 2. Alternative 3 is predicted to have weekly average river stage declines of 0.5 foot or greater from May through September of 21% of the period of record at the Martinez Park study site (representative of Segment B), a slight increase in the frequency of greater stage changes compared to Alternative 2. The increased frequency of predicted reductions in stage greater than 0.5 feet would likely be noticeable to many viewers familiar with Segment B, and would likely have a minor seasonal effect on the visual quality of Segment B. For the reasons discussed for Alternative 2, changes in river stage in the other Poudre River segments are predicted to have negligible visual effects.

4.18.4.4 South Platte River

Alternative 3 would result in flow changes to the South Platte River of less than 10% on an average annual basis. For visitors to the South Platte River, these minor flow changes would likely be indiscernible because of the existing daily and seasonal water level fluctuations and the volume of flow of the South Platte River within the Study area. Visual effects along the South Platte River would be negligible under Alternative 3.

4.18.5 Alternative 4

4.18.5.1 Reservoir Sites

4.18.5.1.1 Cactus Hill Reservoir

The effects on visual resources from construction of Cactus Hill Reservoir and dam are described in Section 4.19.4 of the DEIS. The effects determinations are the same as for the No Action Alternative (Section 4.18.2.1).

4.18.5.1.2 Galeton Reservoir

The effects on visual resources from construction of Galeton Reservoir and dam are described in Section 4.19.3 of the DEIS. The effects determinations are the same as for Alternative 2 (Section 4.18.3.1.2).

4.18.5.2 Conveyance Systems

The effects on visual resources from the Alternative 2 conveyance systems and effects determinations are similar to those described for the No Action Alternative conveyance systems in Section 4.18.2.2.

4.18.5.3 Poudre River

Under Alternative 4, all Poudre River segments, including the Martinez Park study site, are predicted to have a decline in river stage of 0.5 foot or greater of 10% or less from May through September for the period of record (Section 4.9.7.3.1). As described previously for Alternative 2, such infrequent declines in stage of greater than 0.5 feet would result in imperceptible changes and have a negligible effect on the visual quality of the river.

4.18.5.4 South Platte River

Alternative 4 would result in flow changes to the South Platte River of less than 10% on an average annual basis. For visitors to the South Platte River, these minor flow changes would likely be indiscernible because of the existing daily and seasonal water level fluctuations and the volume of flow of the South Platte River within the Study area. Visual effects along the South Platte River would be negligible under Alternative 4.

4.18.6 Unavoidable Adverse Impacts

All alternatives would result in unavoidable adverse impacts on visual resources from the construction of the reservoirs and dams. Reservoirs would result in an unavoidable change to the visual character by inundating vegetation and creating a water storage feature. Changes in flows on the Poudre River associated with Alternatives 2 and 3 are predicted to have an unavoidable minor effect of the visual quality of Segment B.

4.18.7 Impact Summary

The effects on visual resources would be slightly less for the No Action Alternative because only one reservoir would be constructed compared to two reservoirs under Alternatives 2, 3, and 4. Alternative 2 would have additional adverse effects on visual resources associated with the realignment of the portion of U.S. 287 that would be inundated by Glade Reservoir. The temporary visual resources effects for conveyance systems would be minor for all alternatives until disturbed areas have been completely revegetated, at which time effects would become negligible. Similarly, the transfer of water from 64,200 acres of irrigated lands under the No Action Alternative would be a short-term minor effect until the fields have been completely revegetated or dry land crops established at which time visual effects would become negligible. Long-term permanent minor to moderate visual effects would result from the presence of infrastructure associated with the conveyance systems such as pump stations and water treatment facilities (Table 4-104). The visual resources effects along the Poudre and South Platte Rivers would be negligible to minor under all alternatives.

Table 4-104. Visual resources effects determinations.

Study Area	Alternative 1	Alternative 2 Reclamation Action Option	Alternative 2 No Reclamation Action Option	Alternative 3	Alternative 4
Glade Dam	No effect	Major	Major	No effect	No effect
Glade Reservoir	No effect	Minor beneficial	Minor beneficial	No effect	No effect
U.S. 287 realignment	NA	Major	Major	NA	NA
Galeton Dam	NA	Moderate	Moderate	Moderate	Moderate
Galeton Reservoir	NA	Minor beneficial	Minor beneficial	Minor beneficial	Minor beneficial
Cactus Hill Dam	Moderate	NA	NA	Moderate	Moderate
Cactus Hill Reservoir	Minor beneficial	NA	NA	Minor beneficial	Minor beneficial
Conveyance Systems	Negligible	Negligible	Negligible	Negligible	Negligible
Poudre River	See Chapter 5	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible
South Platte River	See Chapter 5	Negligible	Negligible	Negligible	Negligible

NA = Not a component of the alternative.

4.19 CULTURAL, HISTORICAL, AND PALEONTOLOGICAL RESOURCES

This section summarizes the predicted potential effects of the NISP alternatives on cultural, historical, and paleontological resources. No additional studies were conducted for cultural or historical resources for the SDEIS. More detailed information on cultural and historical resources is in the 2008 Cultural Resources Report (WCRM 2008). The preliminary identification of cultural and historical resources relied on three forms of information retrieval and collection: 1) Class I file and literature searches at the Colorado Office of Archaeology and Historic Preservation; 2) Class I field checks of the proposed Glade, Galeton, and Cactus Hill Reservoir sites; and 3) review of the General Land Office land patenting records and plats. If an alternative is permitted by the Corps, a Class III level pedestrian survey would be conducted for the alternative including pipelines and other facilities associated with the permitted alternative. A Class III survey is an intensive inventory and comprehensive systematic effort to identify all resources within the area of concern that might qualify for the National Register of Historic Places (NRHP) and to record information sufficient to permit their evaluation or to indicate what further work is necessary to accomplish their evaluation. The Class III surveys would be done per the draft Programmatic Agreement (Appendix C of the DEIS) for cultural and historic resources prior to any ground-disturbing activities. The Programmatic Agreement will be updated if needed prior to issuance of the Corps' ROD.

Cultural, historical, and paleontological resources would not be affected by changes in streamflow; therefore, effects for the Poudre and South Platte Rivers study areas were not evaluated.

Paleontological resources were evaluated for the U.S. 287 western alignment as the proposed highway realignment would impact known fossil-bearing geologic formations; paleontological resources were not evaluated for other study areas, including the reservoir sites and conveyance systems. The 2014 Paleontological Report (RMP 2014) provides updated information on museum record searches and addresses comments from the DEIS on paleontological resources.

4.19.1 Methods

The methods for the assessment of cultural and historical resources was described in Section 4.18.1 of the DEIS. The methods for paleontological resources included a review of relevant scientific literature, geologic maps, and museum records. The museums included in the record search were the University of Colorado Museum, the Denver Museum of Nature and Science, the University of Wyoming Geology Museum, Colorado State University, and the Fort Collins Museum of Discovery. The museum record searches were updated in August 2014 (RMP 2014). The University of Wyoming Museum, Colorado State University, and the Fort Collins Museum of Discovery have no institutional paleontological records within the Area of Potential Effect (APE). The paleontological evaluation procedures for this study were conducted in accordance with Society of Vertebrate Paleontology (SVP) (1995) guidelines.

Paleontological surveys were conducted within a 200-foot wide corridor for the western realignment; the width of the corridor was designed to encompass the maximum area of surface disturbance associated with highway construction. The survey consisted of an inspection of the APE for 1) surface fossils, 2) exposures of potentially fossiliferous rocks, and 3) areas in which fossiliferous rocks or younger potentially fossiliferous surficial deposits could be exposed or otherwise impacted during construction-related ground disturbance. For paleontological surveys in general, areas where geologic units of moderate and high paleontological sensitivities are exposed are subject to a 100% pedestrian inspection, and areas with exposures of low sensitivity deposits are evaluated based on the professional judgment of the principal investigator. Areas with no paleontological sensitivity are not inspected.

4.19.2 No Action Alternative (Alternative 1)

4.19.2.1 Cactus Hill Reservoir

The effects on cultural and historical resources within and near Cactus Hill Reservoir are described in Section 4.18.2 and Section 4.18.5.2 of the DEIS. No substantial cultural, historical, or paleontological resources are known to exist within the APE for the construction of Cactus Hill Reservoir. Cultural and historical resources were determined to be present within a 1-mile buffer from the maximum pool elevation, but ground disturbing activities such as the realignment of county roads are not anticipated to affect these resources. Effects on paleontological resources are unknown at this time.

4.19.2.2 Conveyance Systems

No information has been gathered on cultural, historical, or paleontological resources for the conveyance systems associated with the No Action Alternative. However, if this alternative was constructed, a Class III level pedestrian survey would be conducted for the pipelines and other facilities associated with the permitted alternative prior to construction.

4.19.2.3 Poudre River

Changes in streamflow under the No Action Alternative would have no effect on cultural, historical, or paleontological resources associated with the Poudre River.

4.19.2.4 South Platte River

Changes in streamflow under the No Action Alternative would have no effect on cultural, historical, or paleontological resources associated with the South Platte River.

4.19.3 District's Preferred Alternative (Alternative 2)

4.19.3.1 Reservoir Sites

4.19.3.1.1 Glade Reservoir

The effects on cultural and historical resources at and near Glade Reservoir are described in Section 4.18.2 and Section 4.18.4.1 of the DEIS. Two known cultural resources and an estimated 35 NRHP eligible sites occur within areas that would be disturbed by the construction of Glade Dam and Reservoir and its associated facilities or would be inundated by the reservoir. This would be a major effect due to the substantial loss of cultural resources. Indirect effects were estimated for a 1-mile buffer around the maximum pool elevation. Because recreation facilities are proposed at Glade Reservoir, development could indirectly affect about 14 cultural resources determined or recommended eligible for listing in the NRHP. It is assumed that effects on cultural resources could be avoided; therefore, the indirect effects on these resources would be negligible. Effects on paleontological resources are unknown at this time.

U.S. 287. The effects on cultural and historical resources for the U.S. 287 realignment were discussed in Section 4.29.10 of the DEIS. Seven known cultural resources and seven unrecorded cultural resources would be affected by the western realignment of U.S. 287. Of the known cultural sites, one of these is an eligible site, three are not eligible, and three have not been assessed. Effect determinations and mitigation resolution would be determined following formal cultural resource documentation or reevaluation, agency review, and consultation with SHPO.

The effects on paleontological resources for the U.S. 287 realignment were discussed in Section 4.29.2 of the DEIS. Based on updated information in the 2014 Paleontological Report (RMP 2014), no previously recorded fossil localities have been documented within the APE for the western alignment. Although no paleontological resources were identified during the review, the U.S. 287 realignment study area includes known fossil-bearing formations, and opportunities for new discoveries would be present during construction.

4.19.3.1.2 Galeton Reservoir

The effects on cultural and historical resources within and near Galeton Reservoir are described in Section 4.18.2 and Section 4.18.4.2 of the DEIS. Fifteen known cultural resources occur within areas that would be disturbed by the construction of Galeton Dam and Reservoir and its associated facilities or would be inundated by the reservoir. Of these 15 sites, 13 have not had an official determination and may be eligible for listing in the NRHP. The other two are not eligible. From Class III surveys, it was estimated that another 17 cultural resources determined or recommended eligible for listing in the NRHP would occur within the maximum pool elevation. These direct effects would be a major effect due to the substantial loss of cultural resources. Cultural and historical resources were determined to be present within a 1-mile buffer from the maximum pool elevation. Some ground disturbing activities associated with reservoir construction may occur within the 1-mile buffer. Effects on paleontological resources are unknown at this time.

4.19.3.2 Conveyance Systems

No information has been gathered on cultural, historical, and paleontological resources for the conveyance systems associated with Alternative 2. If this alternative is permitted by the Corps, a Class III level pedestrian survey would be conducted for the pipelines and other facilities associated with the permitted alternative prior to construction.

4.19.3.3 Poudre River

Changes in streamflow under Alternative 2 would not have effects on cultural, historical, or paleontological resources associated with the Poudre River.

4.19.3.4 South Platte River

Changes in streamflow under Alternative 2 would not have effects on cultural, historical, or paleontological resources associated with the South Platte River.

4.19.4 Alternative 3

4.19.4.1 Reservoir Sites

4.19.4.1.1 Galeton Reservoir

The effects on cultural and historical resources within and near Galeton Reservoir are described in Section 4.18.2 and Section 4.18.4.2 of the DEIS. The effects determination is the same as Alternative 2 (Section 4.19.3.1.2). Effects on paleontological resources are unknown at this time.

4.19.4.1.2 Cactus Hill Reservoir

The effects on cultural and historical resources within and near Cactus Hill Reservoir are described in Section 4.18.2 and Section 4.18.5.2 of the DEIS. The effects determination is the same as the No Action Alternative (Section 4.19.2.1). Effects on paleontological resources are unknown at this time.

4.19.4.2 Conveyance Systems

No information has been gathered on cultural, historical, and paleontological resources for the conveyance systems associated with Alternative 3. If this alternative is permitted by the Corps, a Class III level pedestrian survey would be conducted for the pipelines and other facilities associated with the permitted alternative prior to construction.

4.19.4.3 Poudre River

Changes in streamflow under Alternative 3 would not have effects on cultural, historical, or paleontological resources associated with the Poudre River.

4.19.4.4 South Platte River

Changes in streamflow under Alternative 3 would not have effects on cultural, historical, or paleontological resources associated with the South Platte River.

4.19.5 Alternative 4

4.19.5.1 Reservoir Sites

4.19.5.1.1 Galeton Reservoir

The effects on cultural and historical resources within and near Galeton Reservoir are described in Section 4.18.2 and Section 4.18.4.2 of the DEIS. The effects determination is the same as Alternative 2 (Section 4.19.3.1.2). Effects on paleontological resources are unknown at this time.

4.19.5.1.2 Cactus Hill Reservoir

The effects on cultural and historical resources within and near Cactus Hill Reservoir are described in Section 4.18.2 and Section 4.18.5.2 of the DEIS. The effects determination is the same as the No Action Alternative (Section 4.19.2.1). Effects on paleontological resources are unknown at this time.

4.19.5.2 Conveyance Systems

No information has been gathered on cultural, historical, and paleontological resources for the conveyance systems associated with Alternative 4. If this alternative is permitted by the Corps, a Class III level pedestrian survey would be conducted for the pipelines and other facilities associated with the permitted alternative prior to construction.

4.19.5.3 Poudre River

Changes in streamflow under Alternative 4 would not have effects on cultural, historical, or paleontological resources associated with the Poudre River.

4.19.5.4 South Platte River

Changes in streamflow under Alternative 4 would not have effects on cultural, historical, or paleontological resources associated with the South Platte River.

4.19.6 Unavoidable Adverse Impacts

All alternatives would result in unavoidable adverse impacts on cultural resources inundated by the reservoirs. Data recovery would also be an unavoidable adverse impact. Unavoidable effects on cultural resources would be mitigated through the development of mitigation plans approved

by the Corps, in consultation with the SHPO as set forth in the draft Programmatic Agreement (Appendix C of the DEIS).

4.19.7 Impact Summary

The No Action Alternative would have no known direct effects on cultural, historical, and paleontological resources. Because Alternative 2 includes Glade Reservoir, Galeton Reservoir, and the realignment of U.S. 287, it would have the greatest adverse effect on cultural resources. The effects on cultural resources from Alternatives 3 and 4 would be the same under both alternatives but less than Alternative 2 because there are no known cultural or historical resources within the Cactus Hill Reservoir APE and the U.S. 287 realignment is not a component of Alternatives 3 and 4. Effects to cultural and historic resources resulting from Alternative 2 would potentially be greater under the No Reclamation Action Option than the Reclamation Action Option due to an increase in pipeline construction with the No Reclamation Action Option. Table 4-105 summarizes the effects determinations for each component by alternative.

Table 4-105. Cultural, historical, and paleontological resources effects determinations.

Study Area	Alternative 1	Alternative 2 Reclamation Action Option	Alternative 2 No Reclamation Action Option	Alternative 3	Alternative 4
Cultural and Historical Resources					
Glade Reservoir	NA	Major	Major	NA	NA
U.S. 287 Realignment	NA	Unknown	Unknown	NA	NA
Galeton Reservoir	NA	Major	Major	Major	Major
Cactus Hill Reservoir	No effect	NA	NA	No effect	No effect
Conveyance Systems	Unknown	Unknown	Unknown	Unknown	Unknown
Poudre River	No effect	No effect	No effect	No effect	No effect
South Platte River	No effect	No effect	No effect	No effect	No effect
Paleontological Resources					
Glade Reservoir	NA	Unknown	Unknown	NA	NA
U.S. 287 Realignment	NA	Unknown	Unknown	NA	NA
Galeton Reservoir	NA	Unknown	Unknown	Unknown	Unknown
Cactus Hill Reservoir	Unknown	NA	NA	Unknown	Unknown
Conveyance Systems	Unknown	Unknown	Unknown	Unknown	Unknown
Poudre River	No effect	No effect	No effect	No effect	No effect
South Platte River	No effect	No effect	No effect	No effect	No effect

NA = Not part of the alternative.

4.20 SOCIOECONOMIC RESOURCES

This section summarizes the projected potential effects of the NISP alternatives on socioeconomic resources. The socioeconomic effects analysis for the SDEIS was reorganized to more clearly and extensively evaluate and present potential socioeconomic effects in areas beyond the "Study area" consisting of the NISP Participants' service areas. This section replaces Sections 4.22 and 4.29.16 of the DEIS. In addition to the Study area, the SDEIS effects analysis describes projected potential effects within the "Poudre River Communities." This area includes the municipalities of Fort Collins, Greeley, Timnath, Windsor, and the Census Designated Place (CDP) of Laporte. Some socioeconomic effects could extend beyond the areas contained within the Study area and the Poudre River Communities. These effects are described under the category of "other regional effects" in the evaluation of each alternative.

4.20.1 Methods

The analysis of potential socioeconomic effects involved both quantitative and qualitative methods. Quantitative estimates of potential effects were developed for socioeconomic issues or concerns where the NISP alternatives (including the No Action Alternative) would result in quantifiable direct or indirect effects. In particular, the effects analysis provides quantitative estimates of financial effects on the Participants and their customers, effects on recreation values in the Poudre River Communities and elsewhere in the region, and effects on irrigated agriculture and the agriculture-related economy. Other socioeconomic issues or concerns were assessed qualitatively, primarily based on interpretation of the outcomes of the effects analyses for other resources (e.g., water quality, wetlands and riparian resources, aquatics, and stream morphology). Further detail on the methods used in this evaluation, and more detailed information on socioeconomic effects, are presented in the 2015 Socioeconomic Effects Report (BBC and HCR 2015b).

4.20.2 No Action Alternative (Alternative 1)

The No Action Alternative for the SDEIS is different than the No Action Alternative presented in the DEIS. The No Action Alternative for the SDEIS would involve the construction of a 120,000 AF Cactus Hill Reservoir and the transfer of water from an estimated 64,200 acres of irrigated agricultural lands.

4.20.2.1 Effects within the Study Area

Potential socioeconomic effects evaluated within the Study area include changes in water rates and the affordability of residential water service, and potential effects on population growth.

4.20.2.1.1 Water Rates and Affordability

Including the costs of acquiring water rights from agricultural users, the No Action Alternative would have the highest projected capital costs among the NISP alternatives (see Table 2-13). Although the projected annual costs for pumping and other operating and maintenance (O&M)

are lower for the No Action Alternative than the other alternatives, the greater capital costs would outweigh these lower annual operational costs in terms of the financial impacts on NISP Participants and their customers.

Excluding effects from general inflation, the average annual cost of water service for households served by the NISP Participants is projected to increase from about $541 per year in 2010 to $755 per year by 2020 and then decline gradually through year 2040. The average cost for a new tap (connection fee) is projected to follow a similar trajectory, increasing from $14,546 in 2010 to $18,592 by 2020 and then gradually declining.

Based on the EPA affordability metric which compares annual household costs for water service to median household income, water supplies would remain relatively affordable (less than 2.5% of annual household income) for most of the NISP Participants under the No Action Alternative. On average, NISP water rates (excluding inflation) would increase from about 0.9% of annual household income to a maximum of 1.2% of annual household income in 2020 then would decline back to about 0.9% by 2040. Affordability under the No Action Alternative could be a concern for some Participants, however. The highest household water rate burden is projected to increase from about 1.7% in 2010 (which is well below the EPA 2.5% threshold) to 3.9% in 2020, and to remain above the 2.5% threshold through 2030.

Overall, relative to existing conditions, the No Action Alternative is projected to have a moderate to major impact on the costs and affordability of water service in the Study area. The degree of impact would vary among the Participants and their customers.

4.20.2.1.2 Population Growth

The No Action Alternative, like the action alternatives, was formulated to meet a portion of the need for municipal water supply based on current population and anticipated future population growth in the NISP Participants' service areas. Population and economic growth within the Study area is likely to be the same under the No Action Alternative as under any of the action alternatives. The increased costs of water connection charges for new homes might have a minor effect on housing prices and, consequently, on the competitiveness of new residential developments within the broader regional housing market. Given the relative magnitudes of potential increases in connection charges compared to overall home prices, this impact on the distribution of future growth is expected to be minor.

4.20.2.2 Effects within the Poudre River Communities

Potential socioeconomic effects evaluated within the Poudre River Communities for each alternative include effects on recreation resources, effects on property values and risks in proximity to the Poudre River, effects on water and wastewater treatment costs, other community effects, and effects on population growth and local economic conditions.

The No Action Alternative was evaluated under future conditions hydrology, as explained in Section 4.2.1 and, therefore, the flow-related socioeconomic effects for the No Action Alternative for the Poudre River Communities are presented in Chapter 5.

4.20.2.3 Effects within the Broader Study Area

Among the elements considered in this category of potential socioeconomic effects, effects on agriculture and construction-related economic effects are the most relevant for the No Action Alternative.

4.20.2.3.1 Effects on Agricultural Economy

As described in Section 4.20.2.1.2, each of the NISP alternatives was formulated to meet projected future water demands, and population and economic growth within the study area are likely to be the same under the No Action Alternative as under any of the action alternatives. Based on extrapolations assuming future development served by the municipal NISP Participants would occur at the same density as existing development within each of their service areas, the future population projections would result in the conversion of about 59,000 acres of land from agricultural use to municipal uses (including residential and commercial development and open space for parks and other purposes). Based on the current proportion of irrigated agricultural lands within the future planning areas of the NISP Participants, an estimated 25,300 irrigated acres could be taken out of production due to redevelopment (Hydros 2012). Under the No Action Alternative (or any of the action alternatives), this reduction in irrigated agricultural production due to land use conversion would have an estimated annual impact on agricultural-related economic output in the study area of approximately $34 million and an estimated reduction in agriculture-related employment of about 291 jobs.

Under the No Action Alternative, the NISP Participants would also rely on transfers of irrigated agricultural water rights to provide a portion of their future water supply. Agricultural ditch transfers are projected to result in the "dry up" (i.e., revegetated or converted to dryland farming) of 64,200 irrigated acres. Because dryland farming or revegetation are less economically productive, less labor and input intensive, and produce less revenue than irrigated farming, such changes in land use would have an impact on the region's economy. The annual total effect on economic output in the study area from agricultural water rights transfers under the No Action Alternative is estimated at $87 million, with a projected loss of 738 agriculture-related jobs.

Transfer of water from agriculture to municipal use by NISP Participants under the No Action Alternative would be achieved through the purchase of shares in local ditch companies. In this context of transactions between willing buyers and willing sellers, farmers selling their water rights are presumably adequately compensated for those sales. The primary economic impact would instead fall on farm workers, agriculture-related businesses, and the tax base of local governments. Eventual redevelopment of some of these lands for residential or commercial purposes, or reuse of the lands for dryland agriculture, could reduce some of these estimated economic and fiscal effects. Overall, given the relatively large magnitude of the potential water transfers involved under the No Action Alternative, this alternative would likely result in a moderate to major impact on the irrigated agricultural economy in the study area.

4.20.2.3.2 Economic Effects from Construction Activity

Each of the NISP alternatives, including the No Action Alternative, involves the construction of dams, reservoirs, pipelines, and other physical facilities. Though more than half of the projected cost for the No Action Alternative is related to acquiring water rights from agricultural users, that

alternative also involves development of a 120,000 AF Cactus Hill Reservoir and extensive pipelines and conveyance facilities to move water to the reservoir and from the reservoir to the Participants. During the construction period, expenditures to develop facilities under any of the alternatives would provide a short-term stimulus to the construction industry along Colorado's Front Range but would provide no overall net economic benefit over time because the economic stimulus to the construction industry during project development would be gradually paid for by local residents and businesses over the course of the next few decades.

4.20.2.4 Environmental Justice

Several of the NISP Participants serve communities with relatively high proportions of minority and/or low income residents, including Evans, Dacono, Fort Lupton, Fort Morgan, and Lafayette. Dacono, Evans, and CWCWD have relatively large shares of elderly residents within their service areas. Because the No Action Alternative would have a moderate to major impact on the affordability of residential water service, it would adversely affect the cost of household water supplies for these minority and low income populations. Since the effects would occur through changes in water rates, which would affect customers in proportion to their water use, the adverse effects on these groups would likely not be disproportionate compared to the effects on other residents within the Participants' service areas.

The No Action Alternative is projected to have a moderate to major impact on irrigated agriculture in the region due to the dry up of irrigated lands to provide water supplies to the Participants. Farm workers may be disproportionately comprised of minority and low income individuals and would not be compensated for potential adverse impacts on their employment or income due to water transfers.

4.20.2.5 Summary of Socioeconomic Impacts of the No Action Alternative

The effects of the No Action Alternative, along with the other alternatives, are summarized in Table 4-106 at the end of this section.

4.20.3 District's Preferred Alternative (Alternative 2)

Alternative 2 would involve construction of the 170,000 AF Glade Reservoir and development of the SPWCP, which would include the new 45,624 AF Galeton Reservoir. It also includes proposed flow augmentation, which is described in Section 2.5.6.

4.20.3.1 Effects within the Study Area

4.20.3.1.1 Water Rates and Affordability

Due to their projected differences in cost, separate financial effects evaluations were conducted for the Alternative 2 – Reclamation Action Option and the No Reclamation Action Option.

With the Reclamation Action Option, Alternative 2 would have the lowest projected capital costs among the NISP alternatives (see Table 2-13). Although the projected annual costs for pumping

and other O&M would higher for Alternative 2 than for the No Action Alternative, they would be lower than under the other action alternatives. These cost estimates, however, did not include payments to Reclamation for the contract or additional costs for pumping additional water to Carter Lake that cannot be accurately projected prior to negotiation (Section 1.1.1 of the DEIS). Excluding the effects of inflation and measuring future rates and connection charges in constant 2010 dollars, the average cost of household water service would increase only slightly by 2020, to about $560 per year (4% higher than in 2010) before declining to levels below 2010 in 2030 and 2040. The affordability of household water service for the average NISP Participant would remain unchanged through 2020 (with the annual household water bill projected to remain at 0.9% of median household income). Affordability would then improve slightly in 2030 and 2040, with the average annual household water bill projected to decline to 0.8% of median household income). As noted in Section 4.20.2.1.1, the EPA affordability benchmark for identifying when the costs of water may be unaffordable is 2.5% of median household income. Overall, relative to existing conditions and in terms of inflation adjusted 2010 dollars, the Alternative 2 – Reclamation Action Option is projected to have a minor impact on the costs and affordability of water service in the Study area for most of the Participants.

The No Reclamation Action Option would have higher construction, O&M, and pumping costs than the Reclamation Action Option (see Table 2-13). Excluding the effects of inflation and measuring future rates and connection charges in 2010 dollars indicates that the average cost of household water service would increase to about $616 per year by 2020 (14% higher than in 2010) before declining to within 3% of 2010 levels by 2030 and below 2010 levels by 2040. The affordability of household water service for the average NISP Participant would diminish slightly through 2020 (with the annual household water bill projected to increase from 0.9% to 1.0% of median household income). Affordability would return to levels comparable to 2010 by 2030. Overall, relative to existing conditions, Alternative 2 – No Reclamation Action Option is projected to have a minor to moderate impact on the costs and affordability of water service in the Study area.

4.20.3.1.2 Population Growth

Alternative 2, like the No Action Alternative and the other action alternatives, was formulated to meet a portion of the need for municipal water supply based on current population and anticipated future population growth in the NISP Participants' service areas. Population and economic growth within the Study area are assumed to be the same under each of the alternatives. Alternative 2 – Reclamation Action Option would have little or no effect on housing prices or the competitiveness of new residential developments within the broader regional housing market.

Under the No Reclamation Action Option, Alternative 2 would likely result in more substantial increases in connection charges and water. However, given the relative magnitudes of potential increases in connection charges compared to overall home prices, this option would also be unlikely to affect the distribution of future population growth in Northern Colorado.

4.20.3.2 Effects within the Poudre River Communities

4.20.3.2.1 Effects on Recreation-related Economy

Local recreation activities primarily affected by Alternative 2 would include river-based recreation through the City of Fort Collins and downstream into Weld County, including land-based activities along the Poudre River Trail.

Changes in flows resulting from the upstream diversion associated with Alternative 2 would impact visitation levels, the length of the recreation season, and potentially the value of the recreational experience for activities on the Poudre River. The stretch of the Poudre River from the Canyon Gage through the City of Fort Collins would likely experience the largest impact to recreation values from Alternative 2. Reductions in flows as a result of Alternative 2 would result in average flows in May and July below 100 to 150 cfs, which is the approximate flow range necessary to sustain boating activity in this reach. Boating visitation is projected to be reduced by two-thirds, resulting in a projected annual decrease in recreation value of $241,000.

Reduced flows may not be noticed by the majority of Poudre River Trail users because they occur during high flow periods and visual impacts are expected to be minimal. Although the number of visitors using the Poudre River Trail system is unlikely to be noticeably affected by Alternative 2, the quality of the experience could be incrementally diminished because of public concern that the River's condition would be less "natural" as a result of the increased peak period diversions. This reduction in value translates to a projected 9% reduction in the recreational value from use of the Poudre River Trail, corresponding to an impact of $784,500 per year under Alternative 2 relative to existing conditions.

As concluded in the 2015 Aquatics Resources Effects Report (GEI 2015b), Alternative 2 is not anticipated to have a net adverse impact on fish habitat from the mouth of the Poudre River Canyon through the City of Fort Collins—the areas with the greatest amount of fishing. In part, the lack of adverse effects on recreational fishing is also due to the planned flow augmentation through the City of Fort Collins during the winter months under this alternative, which would help maintain fish populations.

Overall, Alternative 2 is projected to result in a major impact on boating recreation value in Fort Collins, a moderate impact on the recreational value of the Poudre River Trail in Fort Collins, and no effect on fishing recreational values.

4.20.3.2.2 Effects on Property Values and Risks

Flood flows under a 25-year flood event, and the frequency of bankfull flows, would be reduced under Alternative 2. However, neither Alternative 2 nor any of the other NISP alternatives is expected to have a discernible effect in reducing flood flows under major flood conditions, such as a 100-year flood event. Absent NISP, the general trend of increasing sedimentation of the Poudre River channel downstream of I-25 is projected to continue, with a corresponding gradual increase in the potential risk of damages from a 100-year flood. Alternative 2 would reinforce or accelerate that trend and consequently could result in a corresponding increase in overbank flooding/flood damages downstream of I-25 during a 100-year flood (ACE 2014). Relative to floodplain ratings or values, the increase in flooding would not change the floodplain rating

(zone designation) within existing flood prone areas, but may increase the limits of this flood zone. Increases in floodplain stage can affect insurable structures and may adversely affect the cost of flood insurance. The extent of these effects is too uncertain to provide quantitative projections of these changes.

In sum, Alternative 2 may have a minor adverse effect on future flood risk and flood damages under a 100-year flood event downstream of I-25 and a minor benefit on future flood risk and flood damages under a 25-year flood event.

Predicted declines in river stage associated with Alternative 2 may have an adverse impact on riparian and wetland plant communities that are shallowly rooted, associated with shallow alluvial ground water levels, and occur close to the riverbank. Since this effect would be limited to about 10 acres out of the 2,500 acres that make up the overall riparian area along the river (ERO 2014d) (less than 1%), it would likely produce a minor adverse impact on property values closest to the affected area.

4.20.3.2.3 Effects on Water and Wastewater Treatment Costs

Alternative 2 is anticipated to have no effects on either the required chemical dosages for removing total organic carbon or the treated water quality at Greeley's Bellvue Water Treatment Plant or the water treatment plants that rely on supplies from Horsetooth Reservoir. There would be no effect on downstream water treatment costs (ERO and Tetra Tech 2015).

Alternative 2 would also not affect the cost of construction or operations for the downstream waste water treatment plants. These plants will face major changes in the future in order to meet future and chronic ammonia removal requirements. These improvements will be necessary with or without implementation of Alternative 2 (ERO and Tetra Tech 2015).

4.20.3.2.4 Other Socioeconomic Effects on Poudre River Communities

While there are numerous examples of cities that have invested in riverfront redevelopment as part of their economic development strategy, there is no direct way to estimate the effect (if any) of changes in peak flows in the Poudre River on business attraction or retention in Fort Collins. Based on analysis of sales tax data for the City of Fort Collins during the spring and summer of 2012, a very dry year with unusually low flows in the Poudre River, there is no evidence of a systematic relationship between flow levels in the Poudre River and overall Fort Collins economic conditions. Economic development and the overall economy in Fort Collins are unlikely to be affected by reductions in peak flows associated with Alternative 2.

However, Fort Collins residents also appear to have substantial non-use values associated with the Poudre River, meaning that they place a high value on the existing flow regime in the river, even if they do not actively participate in recreation activities related to the river. A study by Colorado State University Professor John Loomis estimated that the average Fort Collins household was willing to pay at least $250 per year to avoid a 50% reduction in peak flows in the Poudre River (Loomis 2008). Under Alternative 2, peak flow reductions would approach the 50% level described in the Loomis study, indicating a potential major adverse impact to the non-use values of Fort Collins residents.

4.20.3.3 Effects within the Broader Study Area

4.20.3.3.1 Other Regional Recreation Resources

Alternative 2 would provide additional benefits from regional recreation resources due to the development of Glade Reservoir. It would be of similar size to Horsetooth Reservoir, but is currently expected to be either non-motorized or "wakeless". New terrestrial recreation activities indirectly provided by Glade Reservoir could include camping, hiking, sightseeing, wildlife viewing, and biking. It is assumed that Glade Reservoir would have full public access and would be managed similarly to Horsetooth Reservoir, with the exception that boating would be non-motorized. At present, it appears likely that recreation at Glade Reservoir would be managed by Larimer County.

Seasonal fluctuations in water levels may be comparable, or less, at Glade Reservoir than they have historically been at Horsetooth Reservoir, across all types of years (dry, average, and wet). Glade Reservoir levels should support a viable recreation facility with respect to seasonal water levels, but Glade's recreation value may diminish toward the end of prolonged dry periods. Annual visitation of 338,600 visitor days is estimated based on a projected average Glade Reservoir surface area during the recreation season of 1,240 acres. It would likely take a number of years to reach this estimated visitation due to the time needed to develop the facilities. The annual value of recreation at Glade Reservoir, at full development, would be an estimated $13.2 million.

4.20.3.3.2 Effects on Agricultural Economy

Like each of the other alternatives (including the No Action Alternative), conversion of irrigated agricultural lands to municipal uses under Alternative 2 would have an impact on the agriculture-related economy in the region. Effects would be the same as described in Section 4.20.2.3.1.

Unlike the No Action Alternative, Alternative 2 would not rely on transfers of agricultural water rights as a source of supply. Consequently, there would not be additional impacts on the irrigated agriculture-related economy due to water transfers. However, Alternative 2 would include the exchange of Poudre River water currently used by agriculture for water supplies from the South Platte River through the South Platte Water Conservation Project (SPWCP). SPWCP would result in increased levels of salinity in irrigation water (CDM Smith 2014b, Section 6.2). Water would be exchanged with irrigators currently served by the Larimer-Weld and New Cache Canals.

Under average conditions, SPWCP supplies are expected to average 14% of the water supply in the Larimer-Weld Canal and 24% of the water supply from the New Cache Canal system over the course of the irrigation season (CDM Smith 2014b). In years with average proportions of SPCWP supplies and average rainfall, SPWCP would not affect crop yields. Under maximum case conditions (a high proportion of SPWCP supplies relative to native water supplies and low rainfall), yield reductions for dry beans and vegetables could result in decreased annual production value of about $487,000 (in 2010 dollars). This represents 1% of total production value of the affected acreage. When compared to the total annual production value for crop farming in the study area of about $433 million (NASS 2009, updated to 2010 dollars), the maximum case loss in production value due to water quality changes resulting from SPWCP

would amount to about 0.1% of the total crop value in the region. These maximum case estimates of potential effects on crop production from SPWCP would correspond to an annual decrease in regional earnings of $207,000 to $573,000 and an annual direct and indirect decrease in farm-related employment of between 3.5 and 6 jobs. Compared to the scale of existing economic activity related to irrigated farming in the study area, the maximum case scenario represents a minor impact. The frequency under which this type of maximum case scenario could occur is unknown, since there does not appear to be any correlation between the proportion of SPCWC supplies and the amount of rainfall occurring during the irrigation season (Turner, pers. comm. 2014). The assessment of potential effects does not consider any mitigation that may be proposed by the District.

4.20.3.3.3 Socioeconomic Impacts of U.S. 287 Relocation

The District's Proposed Action would require the relocation of 7.0 miles of U.S. 287, a portion of which would be inundated by the proposed Glade Reservoir. Both the area that would be inundated and the area along the proposed realignment are rural and sparsely developed. Realignment of U.S. 287 would likely improve access to nearby properties, but would also affect their current, remote character. Very few businesses would be affected by the proposed relocation, with the exception of a gasoline station/convenience store and a campground located at Ted's Place at the current intersection of U.S. 287 and State Highway 14. The proposed relocation of U.S. 287 would move the U.S. 287/State Highway 14 interchange three miles to the east and U.S. 287 traffic would no longer directly pass these businesses. If the customer traffic for these businesses is proportionate to the relative traffic volumes on U.S. 287 and State Highway 14, and their business consequently declines by as much as 2/3 with the relocation of U.S. 287, these businesses may no longer be viable. Both businesses, however, might experience some offsetting positive benefits from recreational visitors to the proposed Glade Reservoir.

4.20.3.3.4 Economic Effects from Construction Activity

Like the other NISP alternatives, including the No Action Alternative, construction of NISP facilities under Alternative 2 would create a short-term economic stimulus in the region, but would provide no overall net economic benefit over time because the economic stimulus to the construction industry during project development would be gradually paid for by local residents and businesses over the course of the next few decades.

4.20.3.4 Environmental Justice

Alternative 2 with the Reclamation Action Option would have a minor impact on the affordability of residential water service, and a correspondingly minor impact on the cost of household water supplies for minority and low income populations served by the NISP Participants. With the No Reclamation Action Option, there would be a minor to moderate impact on the costs of household water supplies for these customers. Since the effects would occur through changes in water rates, which would affect customers in proportion to their water use, the adverse effects on these groups would likely not be disproportionate compared to the effects on other residents within the Participants' service areas.

Within the Poudre River Communities, only the City of Greeley has a substantially larger share of minority and/or low income residents than average across the State of Colorado as a whole. Based on the current trajectory regarding geomorphology in the Poudre River, properties in, or immediately adjacent to, the 100-year floodplain in Greeley would likely experience gradual increases in flood risk due to increased sedimentation of the Poudre River channel even in the absence of any of the NISP alternatives. Alternative 2, like the other NISP action alternatives, is predicted to reinforce or accelerate this trend and associated risks of increased damage from a 100-year flood in this area.

4.20.3.5 Summary of Socioeconomic Impacts of District's Preferred Alternative (Alternative 2)

The effects of Alternative 2, along with the other alternatives, are summarized in Table 4-106 at the end of this section.

4.20.4 Alternative 3

Alternative 3 is similar to Alternative 2, except that water diverted from the Poudre River would be stored in the proposed Cactus Hill Reservoir instead of the proposed Glade Reservoir. Alternative 3 would divert on average 5,500 to 6,000 AFY more water from the Poudre River than Alternative 2 to compensate for increased reservoir evaporation from Cactus Hill Reservoir and conveyance loss. Additionally, Alternative 3 does not include the Poudre River flow augmentation program that is proposed under Alternative 2.

4.20.4.1 Effects within the Study Area

4.20.4.1.1 Water Rates and Affordability

Alternative 3 would have an estimated capital cost of $660 million, similar to Alternative 2 – No Reclamation Action Option (see Table 2-12). Since projected O&M and pumping costs are also similar, the projected financial effects under Alternative 3 would be very similar to those under Alternative 2 – No Reclamation Action Option. Alternative 3 would have a minor to moderate impact on the costs and affordability of water service in the Study area.

4.20.4.1.2 Population Growth

Alternative 3, like the No Action Alternative and the other action alternatives, was formulated to meet a portion of the need for municipal water supply based on current population and anticipated future population growth in the NISP Participants' service areas. Population and economic growth within the Study area are assumed to be the same under each of the alternatives. While Alternative 3 could lead to minor to moderate increases in the connection charges for new homes within the NISP Participants' service areas, the relative magnitudes of these increases are small compared to overall home prices, so this alternative would be unlikely to have more than a negligible effect on the distribution of future population growth in northern Colorado.

4.20.4.2 Effects within the Poudre River Communities

4.20.4.2.1 Effects on Recreation-related Economy

Alternative 3's impact to flow through the Poudre River communities and the economic value of recreation would be somewhat larger than the impacts of Alternative 2 because upstream diversions to the proposed Cactus Hill facility would be marginally greater than diversions to the proposed Glade facility to compensate for greater transit and evaporative losses, and because Alternative 3 does not provide for flow augmentation through the City of Fort Collins during the winter months.

Local recreation activities primarily affected by Alternative 3 would include river-based recreation through the City of Fort Collins and downstream into Weld County, including land-based activities along the Poudre River Trail. Similar to Alternative 2, reductions in flows as a result of Alternative 3 would result in average flows in May and July below 100 to 150 cfs, which is the approximate flow range necessary to sustain boating activity in this reach. Boating visitation is projected to be reduced by two-thirds, resulting in a projected annual decrease in recreation value of $241,000.

Without winter flow augmentation, impacts to cold water fish habitat would be moderately adverse compared to Current Conditions, with a corresponding adverse impact to anglers fishing for these species within the City of Fort Collins.

Overall, Alternative 3 is projected to result in a major impact on boating recreation value in Fort Collins and a moderate impact on the recreational value of the Poudre River Trail in Fort Collins.

4.20.4.2.2 Effects on Property Values and Risks

Alternative 3 may have a minor adverse effect on future flood risk and flood damages under a 100-year flood event downstream of I-25 and a minor benefit on future flood risk and flood damages under a 25-year flood event. Relative to floodplain ratings or values, the increase in flooding would not change the floodplain rating (zone designation) within existing flood prone areas, but may increase the limits of this flood zone. Increases in floodplain stage can affect insurable structures and may adversely affect the cost of flood insurance. The extent of these effects is too uncertain to provide quantitative projections of these changes.

Predicted declines in river stage associated with Alternative 3 may also have an adverse impact on riparian and wetland plant communities that are shallowly rooted, associated with shallow alluvial ground water levels, and occur close to the riverbank. Since this effect would be limited to about 10 acres out of the 2,500 acres that make up the overall riparian area along the river (less than 1%), it would likely produce a minor adverse impact on property values closest to the affected area.

4.20.4.2.3 Effects on Water and Wastewater Treatment Costs

Alternative 3 would have no effect on downstream water treatment costs or the cost of construction or operations for the downstream waste water treatment plants because it is anticipated to have no effects on either the required chemical dosages for removing total organic carbon or the treated water quality at Greeley's Bellvue Water Treatment Plant or the water treatment plants that rely on supplies from Horsetooth Reservoir (ERO and Tetra Tech 2015).

Alternative 3 would also not affect the cost of construction or operations for the downstream waste water treatment plants. These plants will face major changes in the future in order to meet future and chronic ammonia removal requirements. These improvements will be necessary with or without implementation of Alternative 3 (ERO and Tetra Tech 2015).

4.20.4.2.4 Other Socioeconomic Effects on Poudre River Communities

As discussed previously in Section 4.20.3.2.4, there is no evidence of a systematic relationship between flow levels in the Poudre River and overall Fort Collins economic conditions. Economic development and the overall economy in Fort Collins are unlikely to be affected by reductions in peak flows associated with Alternative 3. However, there could be a major adverse impact on the non-use values Fort Collins residents have in relation to peak flows in the Poudre River under Alternative 3.

4.20.4.3 Effects within the Broader Study Area

4.20.4.3.1 Other Regional Recreation Resources

Alternative 3 would use a 190,000-AF Cactus Hill Reservoir rather than Glade Reservoir for storage of diverted Poudre River flow. Since no interest has been expressed by an entity willing to manage recreation at the proposed site, there is not anticipated to be a recreation component to Cactus Hill Reservoir. As a result, there would be no regional recreation benefit associated with this facility.

4.20.4.3.2 Effects on Agricultural Economy

Like each of the other alternatives (including the No Action Alternative), conversion of irrigated agricultural lands to municipal uses under Alternative 3 would have an impact on the agriculture-related economy in the region. Effects would be the same as described in Section 4.20.2.3.1. Alternative 3 also includes the exchange of South Platte River water supplies for irrigators' supplies from the Poudre River through the SPWCP. It would have very similar effects to Alternatives 2 and 4 in terms of increasing the salinity of water supplied to participating irrigators within the Larimer-Weld and New Cache irrigation systems (CDM Smith 2014b, Section 6.2). Under average conditions, additional salinity from the SPWCP would not affect crop yields under Alternative 3. Under maximum case conditions (a high proportion of SPWCP supplies relative to native water supplies and low rainfall), Alternative 3 could result in a minor adverse impact to irrigated crop production and the regional agricultural economy. The assessment of potential effects does not consider any mitigation that may be proposed by the District.

4.20.4.3.3 Socioeconomic Impacts of Road Relocation

U.S. 287 would not be relocated under Alternative 3, since Glade Reservoir would not be developed. Three segments of two 2-lane roads in Weld County, totaling 10.3 road miles, would be relocated due to the development of Cactus Hill Reservoir. No substantial socioeconomic effects are anticipated from these road relocations.

4.20.4.3.4 Economic Effects from Construction Activity

Like the other NISP alternatives, including the No Action Alternative, construction of NISP facilities under Alternative 3 would create a short-term economic stimulus in the region, but would provide no overall net economic benefit over time because the economic stimulus to the construction industry during project development would be gradually paid for by local residents and businesses over the course of the next few decades.

4.20.4.4 Environmental Justice

Alternative 3 would have a minor to moderate impact on the affordability of residential water service, and a correspondingly minor to moderate impact on the cost of household water supplies for minority and low income populations served by the NISP Participants. Since the effects would occur through changes in water rates, which would affect customers in proportion to their water use, the adverse effects on these groups would likely not be disproportionate compared to the effects on other residents within the Participants' service areas.

Alternative 3, like the other NISP action alternatives, is predicted to reinforce or accelerate the trend of gradual increases in flood risk due to increased sedimentation of the Poudre River channel downstream of I-25 and correspondingly increase the risks of damage from a major flood within the 100-year floodplain in Greeley. The extent of this gradual increase in flood risk, and the degree to which Alternative 3 would accelerate this trend, are too uncertain to provide quantitative projections of these changes.

4.20.4.5 Summary of Socioeconomic Impacts of Alternative 3

The effects of Alternative 3, along with the other alternatives, are summarized in Table 4-106 at the end of this section.

4.20.5 Alternative 4

Alternative 4 would include the proposed Cactus Hill Reservoir, rather than the proposed Glade Reservoir, like Alternative 3. However, Alternative 4 would allow more water to remain in the Poudre River between the Poudre Valley Canal and the New Cache Canal before being diverted for exchanges. In Alternative 4, 100% of the New Cache direct flow exchange water would continue to flow downstream in the Poudre River channel to its current diversion location at the New Cache headgate east of Fort Collins and I-25. Like Alternative 3, Alternative 4 would divert on average 5,500 to 6,000 AFY more water from the Poudre River than Alternative 2 to compensate for increased reservoir evaporation from Cactus Hill Reservoir and conveyance loss. Additionally, Alternative 4 does not include the Poudre River flow augmentation program that is proposed under Alternative 2.

4.20.5.1 Effects within the Study Area

4.20.5.1.1 Water Rates and Affordability

Alternative 4 would have the largest estimated capital costs ($701 million) among the action alternatives. This alternative also has the highest annual O&M and pumping costs among all alternatives (see Table 2-12). Excluding the effects of inflation and measuring future rates and connection charges in 2010 dollars indicates that the average cost of household water service would increase to about $637 per year by 2020 (18% higher than in 2010) before declining to levels below 2010 by 2040. The affordability of household water service for the average NISP Participant would diminish slightly through 2020 (with the annual household water bill projected to increase from 0.9% to 1.0% of median household income). Affordability would return to levels comparable to 2010 by 2030. As noted in Section 4.20.2.1.1, the EPA affordability benchmark for identifying when the costs of water may be unaffordable is 2.5% of median household income. Overall, relative to existing conditions, Alternative 4 is projected to have a moderate impact on the costs and affordability of water service in the Study area.

4.20.5.1.2 Population Growth

Alternative 4, like the No Action Alternative and the other action alternatives, was formulated to meet a portion of the need for municipal water supply based on current population and anticipated future population growth in the NISP Participants' service areas. Population and economic growth within the Study area are assumed to be the same under each of the alternatives. While Alternative 4 could lead to moderate increases in the connection charges for new homes within the NISP Participants' service areas, the relative magnitudes of these increases are small compared to overall home prices, so this alternative would be unlikely to have more than a negligible effect on the distribution of future population growth in Northern Colorado.

4.20.5.2 Effects within the Poudre River Communities

4.20.5.2.1 Effects on Recreation-related Economy

Alternative 4 is designed to allow some flow to pass through the Fort Collins area and be diverted lower on the river at the New Cache Canal headgate. Relative to the other action alternatives, under Alternative 4, more water would remain in the mainstem between the Poudre Valley Canal and New Cache Canal before it is diverted for exchanges. This would maintain river flows through the City of Fort Collins at slightly lower volumes than the No Action Alternative but at higher volumes than Alternatives 2 and 3. May through July flow levels would be maintained above 150 cfs under average year hydrologic conditions, maintaining acceptable river-based recreation through Fort Collins throughout the peak summer period. Overall, Alternative 4 would have a negligible effect on recreation values for boating, fishing, and Poudre Trail activities due to reduced flow levels compared to current conditions.

4.20.5.2.2 Effects on Property Values and Risks

Like the other action alternatives, Alternative 4 may have a minor adverse effect on future flood risk and flood damages under a 100-year flood event downstream of I-25 and provide a minor

benefit on future flood risk and flood damages under a 25-year flood event. Relative to floodplain ratings or values, the increase in flooding would not change the floodplain rating (zone designation) within existing flood prone areas, but may increase the limits of this flood zone. Increases in floodplain stage can affect insurable structures and may adversely affect the cost of flood insurance. The extent of these effects is too uncertain to provide quantitative projections of these changes.

Estimated declines in river stage associated with Alternative 4 are not predicted to have an adverse impact on riparian and wetland plant communities that are shallowly rooted, associated with shallow alluvial ground water levels, and occur close to the riverbank. Consequently, Alternative 4 would not affect property values for properties closest to where riparian and wetland plant communities are shallowly rooted, associated with shallow alluvial ground water levels, and occur close to the riverbank.

4.20.5.2.3 Effects on Water and Wastewater Treatment Costs

Alternative 4 would have no effect on downstream water treatment costs or the cost of construction or operations for the downstream waste water treatment plants because it is anticipated to have no effects on either the required chemical dosages for removing total organic carbon or the treated water quality at Greeley's Bellvue Water Treatment Plant or the water treatment plants that rely on supplies from Horsetooth Reservoir (ERO and Tetra Tech 2015).

Alternative 4 would also not affect the cost of construction or operations for the downstream waste water treatment plants. These plants will face major changes in the future in order to meet future and chronic ammonia removal requirements. These improvements will be necessary with or without implementation of Alternative 3 (ERO and Tetra Tech 2015).

4.20.5.2.4 Other Socioeconomic Effects on Poudre River Communities

As discussed previously in Section 4.20.3.4, there is no evidence of a systematic relationship between flow levels in the Poudre River and overall Fort Collins economic conditions. Economic development and the overall economy in Fort Collins are unlikely to be affected by reductions in peak flows associated with Alternative 4. Since Alternative 4 would have smaller impacts on peak flows for the Poudre River through Fort Collins, Alternative 4 would also be less likely to affect the non-use values of Fort Collins residents associated with the Poudre River.

4.20.5.3 Effects within the Broader Study Area

4.20.5.3.1 Other Regional Recreation Resources

Like Alternative 3, Alternative 4 would use a 190,000-AF Cactus Hill Reservoir rather than Glade Reservoir for storage of diverted flow from the Poudre River. There would be no regional recreation benefit associated with this facility, as explained in Section 4.20.4.3.1.

4.20.5.3.2 Effects on Agricultural Economy

Like each of the other alternatives (including the No Action Alternative), conversion of irrigated agricultural lands to municipal uses under Alternative 4 would have an impact on the agriculture-related economy in the region. Effects would be the same as described in Section 4.20.2.3.1. Alternative 4 also includes the exchange of South Platte River water supplies for irrigators'

supplies from the Poudre River through the SPWCP. It would have very similar effects to Alternatives 2 and 3 in terms of increasing the salinity of water supplied to participating irrigators within the Larimer-Weld and New Cache irrigation systems (CDM Smith 2014b, Section 6.2). Under average conditions, additional salinity from the SPWCP would not affect crop yields under Alternative 4. Under maximum case conditions (a high proportion of SPWCP supplies relative to native water supplies and low rainfall), Alternative 4 could result in a minor adverse impact to irrigated crop production and the regional agricultural economy. The assessment of potential effects does not consider any mitigation that may be proposed by the District.

4.20.5.3.3 Socioeconomic Impacts of Road Relocation

U.S. 287 would not be relocated under Alternative 4 and no substantial socioeconomic effects are anticipated from the relocations of three segments of two 2-lane roads in Weld County for the development of Cactus Hill Reservoir.

4.20.5.3.4 Economic Effects from Construction Activity

Like the other NISP alternatives, including the No Action Alternative, construction of NISP facilities under Alternative 4 would create a short-term economic stimulus in the region, but would provide no overall net economic benefit over time because the economic stimulus to the construction industry during project development would be gradually paid for by local residents and businesses over the course of the next few decades.

4.20.5.4 Environmental Justice

Alternative 4 would have a moderate impact on the affordability of residential water service, and a correspondingly moderate impact on the cost of household water supplies for minority and low income populations served by the NISP Participants. Since the effects would occur through changes in water rates, which would affect customers in proportion to their water use, the adverse effects on these groups would likely not be disproportionate compared to the effects on other residents within the Participants' service areas.

While Alternative 4, like the other NISP action alternatives, is predicted to reinforce or accelerate the trend of gradual increases in flood risk due to increased sedimentation of the Poudre River channel downstream of I-25 (and correspondingly increase the risks of damage from a major flood within the 100-year floodplain in Greeley), these effects are expected to be smaller under Alternative 4 than the other action alternatives because Alternative 4 would result in the smallest increase in stream sedimentation in this area as described in Section 4.4.

4.20.5.5 Summary of Socioeconomic Impacts of Alternative 4

The effects of Alternative 4, along with the other alternatives, are summarized in Table 4-106 at the end of this section.

4.20.6 Unavoidable Adverse Impacts

All alternatives would result in unavoidable adverse impacts on either the affordability of water service or the cost of connection charges for new customers (and corresponding cost of new homes), or both, because the cost of developing additional water supplies under any of the alternatives would be greater than the historical cost of the supplies already controlled by the Participants.

Increases in the risks of damage or destruction from major flood events (e.g., the 100-year flood) to properties downstream of I-25 in the 100-year floodplain are an unavoidable adverse impact under any of the alternatives due to the predicted reinforcement or acceleration of the trend of gradual increases in sedimentation of the Poudre River channel downstream of I-25.

There would be unavoidable adverse impacts to agricultural production, and the agricultural economy, under any of the alternatives. These impacts would be moderate to major under the No Action Alternative due to the dry-up of 64,200 acres of irrigated agricultural lands, and negligible to minor under the action alternatives due to increased salinity for irrigators participating in the SPWCP project.

4.20.7 Impact Summary

Table 4-106 summarizes the potential socioeconomic impacts associated with each of the NISP alternatives. Effects are presented for each of the subareas within the overall study area.

Table 4-106. Summary of socioeconomic effects for each NISP alternative.

Study Area/Socioeconomic Resources	Alternative 1	Alternative 2 Glade Reservoir with Reclamation Action Option	Alternative 2 Glade Reservoir No Reclamation Action Option	Alternative 3 Cactus Hill Reservoir Poudre Valley Canal Diversion	Alternative 4 Cactus Hill Reservoir Multiple Diversions
Study Area					
Water Rates/Affordability	Moderate to major impact on rates and affordability for most Participants	Minor impact on rates and affordability for some Participants	Minor to moderate impact on rates and affordability for most Participants	Minor to moderate impact on rates and affordability for most Participants	Moderate impact on rates and affordability for most Participants
Population Growth	Potential minor redistribution of future regional growth	No effect	No effect	No effect	No effect
Poudre River Communities					
Recreation Resources	For flow-related effects, see Chapter 5.	Major impact on boating recreation value in Fort Collins. Moderate impact on recreational value of Poudre River Trail in Fort Collins. No effect on value of recreational fishing.	Major impact on boating recreation value in Fort Collins. Moderate impact on recreational value of Poudre River Trail in Fort Collins. No effect on value of recreational fishing.	Major impact on boating recreation value in Fort Collins. Moderate impact on recreational value of Poudre River Trail in Fort Collins. Moderate impact on value of recreational fishing.	Negligible effect on boating recreation value in Fort Collins. Negligible effect on recreational value of Poudre River Trail in Fort Collins. Negligible impact of value of recreational fishing.
Property Values	No effect	No effect in Fort Collins. Potential minor effects downstream of I-25 due to changes in flood risks.	No effect in Fort Collins. Potential minor effects downstream of I-25 due to changes in flood risks.	No effect in Fort Collins. Potential minor effects downstream of I-25 due to changes in flood risks.	No effect in Fort Collins. Potential minor effects downstream of I-25 due to changes in flood risks.
Water/Wastewater Treatment Costs	No effect	No effect	No effect	No effect	No effect

Study Area/Socioeconomic Resources	Alternative 1	Alternative 2 Glade Reservoir with Reclamation Action Option	Alternative 2 Glade Reservoir No Reclamation Action Option	Alternative 3 Cactus Hill Reservoir Poudre Valley Canal Diversion	Alternative 4 Cactus Hill Reservoir Multiple Diversions
Other Socioeconomic Effects	No effect	Likely no additional effect on Fort Collins economy/economic development. Potential moderate impact on non-use values associated with Poudre River for Fort Collins residents.	Likely no additional effect on Fort Collins economy/economic development. Potential moderate impact on non-use values associated with Poudre River for Fort Collins residents.	Likely no additional effect on Fort Collins economy/economic development. Potential moderate impact on non-use values associated with Poudre River for Fort Collins residents.	No effect
Broader Study Area					
Regional Recreation Resources	No effect	Major benefit from recreation at Glade Reservoir.	Major benefit from recreation at Glade Reservoir.	No effect	No effect
Irrigated Agriculture-related Economy	Moderate to major impact due to dry-up of irrigated lands	No effect under average conditions. Minor effect under potential maximum case conditions due to increased salinity.	No effect under average conditions. Minor effect under potential maximum case conditions due to increased salinity.	No effect under average conditions. Minor effect under potential maximum case conditions due to increased salinity.	No effect under average conditions. Minor effect under potential maximum case conditions due to increased salinity.
Road Relocation Effects	No anticipated effects from county road relocations at Cactus Hill.	Moderate to major impact on gasoline station and campground at Ted's Place. No net effect on value of residential properties.	Moderate to major impact on gasoline station and campground at Ted's Place. No net effect on value of residential properties.	No anticipated effects from county road relocations at Cactus Hill.	No anticipated effects from county road relocations at Cactus Hill.

Study Area/Socioeconomic Resources	Alternative 1	Alternative 2 Glade Reservoir with Reclamation Action Option	Alternative 2 Glade Reservoir No Reclamation Action Option	Alternative 3 Cactus Hill Reservoir Poudre Valley Canal Diversion	Alternative 4 Cactus Hill Reservoir Multiple Diversions
Agricultural-Related Economic Output	Estimated annual impact on agricultural-related economic output in the study area of approximately $34 million and an estimated reduction in agriculture-related employment of about 291 jobs associated with growth onto agricultural lands and their conversion to municipal uses. Estimated annual impact on economic output from agricultural water rights transfers under the No Action Alternative is estimated at $87 million, with a projected loss of 738 agriculture-related jobs.	Estimated annual impact on agricultural-related economic output in the study area of approximately $34 million and an estimated reduction in agriculture-related employment of about 291 jobs associated with growth onto agricultural lands and their conversion to municipal uses.	Estimated annual impact on agricultural-related economic output in the study area of approximately $34 million and an estimated reduction in agriculture-related employment of about 291 jobs associated with growth onto agricultural lands and their conversion to municipal uses.	Estimated annual impact on agricultural-related economic output in the study area of approximately $34 million and an estimated reduction in agriculture-related employment of about 291 jobs associated with growth onto agricultural lands and their conversion to municipal uses.	Estimated annual impact on agricultural-related economic output in the study area of approximately $34 million and an estimated reduction in agriculture-related employment of about 291 jobs associated with growth onto agricultural lands and their conversion to municipal uses.
Construction Effects	----------Construction stimulus paid for by regional residents over future years. No net effect----------				

4.21 HAZARDOUS MATERIALS

This section summarizes the direct and indirect impacts from hazardous materials expected to occur as a result of implementing a NISP alternative. Hazardous materials were addressed in Sections 4.23 and 4.29.17 of the DEIS. Additional studies for the SDEIS were performed on the TCE plume associated with the Atlas "E" Missile Site 13 near the proposed Glade Reservoir forebay. The results of these studies can be found in the 2010 TCE Plume Memorandum (ERO 2010a).

4.21.1 Methods

Known hazardous materials sites within the study areas were reviewed using existing data based on known sites and potential sites identified as part of DEIS comments (Section 3.21).

4.21.2 No Action Alternative (Alternative 1)

4.21.2.1 Cactus Hill Reservoir

None of the oil and gas well sites within the reservoir study area have reported spill incidents. However, if this alternative was constructed, a detailed analysis of oil and gas facilities would be conducted by the Participants prior to construction. No other known hazardous materials sites were identified within or adjacent to the proposed Cactus Hill Reservoir study area.

4.21.2.2 Conveyance Systems

No information has been gathered on hazardous materials for the conveyance systems associated with the No Action Alternative. Site-specific investigations for potential hazardous materials sites along conveyance system alignments would be conducted during final design to avoid and minimize impacts from any sites discovered.

4.21.2.3 Poudre River

The No Action Alternative was evaluated under Future Conditions hydrology, as explained in Section 4.2.2 and, therefore, effects analyses for the No Action Alternative are only presented in Chapter 5.

4.21.2.4 South Platte River

The No Action Alternative was evaluated under Future Conditions hydrology, as explained in Section 4.2.2 and, therefore, effects analyses for the No Action Alternative are only presented in Chapter 5.

4.21.2.5 No Action Irrigated Lands

The removal of irrigation from the No Action Irrigated Lands is predicted to have no effect on hazardous materials because the removal of irrigation from these lands would not affect the status of any unknown hazardous material sites.

4.21.3 District's Preferred Alternative (Alternative 2)

4.21.3.1 Reservoir Sites

4.21.3.1.1 Glade Reservoir

The proposed Glade Reservoir forebay is located near the Atlas "E" Missile Site 13 and a known TCE plume associated with the missile site. The TCE plume is discussed in Section 3.21.2. TCE-contaminated soil is not expected within the proposed footprint of the forebay. The forebay is not located within the source area of the TCE plume where the potential for TCE contaminated soils may still exist, and TCE concentrations in ground water above the Colorado Basic Ground Water Standards of 5 µg/L were not detected beneath or downgradient of the proposed forebay indicating that the potential for saturated soils to contain TCE above applicable soil standards is not anticipated. Ground water may be encountered during excavation activities within the southern half of the forebay, but inflow to the forebay during construction would likely be very low, given the low hydraulic conductivity of the fractured rock. It is unlikely that ground water encountered during construction of the Glade Reservoir would contain detectable TCE and potential changes in the ground water hydraulics around the proposed forebay would not result in future contamination of the forebay by the TCE plume. Additional information on studies performed for the SDEIS on the TCE plume can be found in the 2010 TCE Plume Memorandum (ERO 2010a).

If Glade Reservoir is constructed, U.S. 287 between Highway 14 and the Owl Canyon Road site and the Forks Lumber Company site would require site-specific investigations and remediation, if necessary, to be conducted during final design to avoid and minimize any potential impacts to the proposed Glade Reservoir. Should the Larimer County Sheriff's pistol range continue to be used, implementation of best management practices described in CDPHE's guidance (CDPHE 2005) and construction of berms to limit direct stormwater runoff from the range into the proposed Glade Reservoir would be required.

U.S. 287. As discussed in the DEIS, the proposed realignment of U.S. 287 has been designed to avoid the Holcim Mine cement kiln dust landfill. Therefore, no impact from hazardous materials is expected from the U.S. 287 realignment as there are no other known hazardous sites within the realignment corridor.

4.21.3.1.2 Galeton Reservoir

Oil and gas well sites within the reservoir site have had reported spill incidents. The incidents are closed and no additional remedial activities are required. However, if this alternative is permitted by the Corps, a detailed analysis of oil and gas facilities would be conducted prior to construction. No other known hazardous sites were identified within or adjacent to the proposed

Galeton Reservoir study area. Additional information on oil and gas development at the proposed Galeton Reservoir site can be found in the 2012 Oil and Gas Development Memo (ERO 2012c).

4.21.3.2 Conveyance Systems

No information has been gathered on hazardous materials for the conveyance systems associated with Alternative 2. Site-specific investigations for potential hazardous materials sites along conveyance system alignments would be conducted during final design to avoid and minimize impacts from any sites discovered.

4.21.3.3 Poudre River

Excluding the Coal Tar site, no information has been gathered on hazardous materials along the Poudre River. Site-specific investigations for potential hazardous materials sites along the Poudre River would be conducted during final design to avoid and minimize impacts from any sites discovered and to determine the presence of potentially hazardous sites.

The NISP modeling location closest to the Coal Tar Site is the Lincoln Street Gage. The modeling results indicate that a net reduction in monthly average flow would predominately occur during the months of April through August. The reduced flow rate and water surface elevation during the months of April through August would still be greater than the flow rate and water surface elevation along the river during the winter months. Since the remedial system was designed to operate under the low flow conditions typically observed during the winter months, NISP induced flow rate reductions observed during the months of April through August would not impact the Coal Tar site remedial system.

4.21.3.4 South Platte River

No information has been gathered on hazardous materials along the South Platte River. Site-specific investigations for potential hazardous materials sites along the South Platte River would be conducted during final design to avoid and minimize impacts from any sites discovered. An oil and gas well site along the South Platte River downstream of the Poudre River confluence has had a reported spill incident. The incident is closed and no additional remedial activities are required. A detailed analysis of oil and gas facilities along the South Platte River would be conducted during final design to avoid and minimize impacts to the facilities and to determine the presence of potentially hazardous sites.

4.21.4 Alternative 3

4.21.4.1 Reservoir Sites

4.21.4.1.1 Galeton Reservoir

The effects from hazardous materials at the Galeton Reservoir site would be the same as described for Alternative 2 in Section 4.1.3.1.2.

4.21.4.1.2 Cactus Hill Reservoir

None of the oil and gas well sites within the reservoir study area have reported spill incidents. However, if this alternative is constructed, a detailed analysis of oil and gas facilities would be conducted prior to construction. No other known hazardous materials sites were identified within or adjacent to the proposed Cactus Hill Reservoir study area.

4.21.4.1.3 Conveyance Systems

No information has been gathered on hazardous materials for the conveyance systems associated with Alternative 3. Site-specific investigations for potential hazardous materials sites along conveyance system alignments would be conducted during final design to avoid and minimize impacts from any sites discovered and to determine the presence of potentially hazardous sites.

4.21.4.2 Poudre River

Excluding the Coal Tar site, no information has been gathered on hazardous materials along the Poudre River. Site-specific investigations for potential hazardous materials sites along the Poudre River would be conducted during final design to avoid and minimize impacts from any sites discovered and to determine the presence of potentially hazardous sites.

For the Coal Tar site, reduced flows in the Poudre River would not affect the performance of the remedial barrier wall because of the vertical hydraulic control system design.

4.21.4.3 South Platte River

No information has been gathered on hazardous materials along the South Platte River. Site-specific investigations for potential hazardous materials sites along the South Platte River would be conducted during final design to avoid and minimize impacts from any sites discovered.

4.21.5 Alternative 4

4.21.5.1 Reservoir Sites

4.21.5.1.1 Galeton Reservoir

The effects from hazardous materials at the Galeton Reservoir site would be the same as described for Alternative 2 in Section 4.21.3.1.2.

4.21.5.1.2 Cactus Hill Reservoir

The effects from hazardous materials at the Cactus Hill Reservoir site would be the same as described for Alternative 3 in Section 4.21.4.1.2.

4.21.5.2 Conveyance Systems

No information has been gathered on hazardous materials for the conveyance systems associated with Alternative 4. Site-specific investigations for potential hazardous materials sites along conveyance system alignments would be conducted during final design to avoid and minimize impacts from any sites discovered.

4.21.5.3 Poudre River

Excluding the Coal Tar site, no information has been gathered on hazardous materials along the Poudre River. Site-specific investigations for potential hazardous materials sites along the Poudre River would be conducted during final design to avoid and minimize impacts from any sites discovered and to determine the presence of potentially hazardous sites.

For the Coal Tar site, reduced flows in the Poudre River would not affect the performance of the remedial barrier wall because of the vertical hydraulic control system design.

No information has been gathered on hazardous materials along the South Platte River. Site-specific investigations for potential hazardous materials sites along the South Platte River would be conducted during final design to avoid and minimize impacts from any sites discovered and to determine the presence of potentially hazardous sites.

4.21.6 Unavoidable Adverse Impacts

There are no known unavoidable adverse impacts associated with hazardous materials that cannot be mitigated.

4.21.7 Impact Summary

There are no predicted impacts associated with known hazardous materials sites for any of the alternatives, including those alternatives that include Galeton Reservoir (Alternatives 2, 3, and 4). However, the potential for effects from hazardous materials exists. The potential effects from hazardous materials would be greater for alternatives with more pipeline conveyances and facilities, such as pump stations and water treatment plants, because of the increased potential that soil and/or ground water contamination would be encountered during construction, especially in urban locations. In addition, the alternatives that include Galeton Reservoir have more potential for effects from hazardous materials because of ongoing oil and gas development in the proposed reservoir area. Table 4-107 shows the number of acres of conveyance systems and facilities for each Alternative. Site-specific investigations for potential hazardous materials sites at the reservoir sites and along conveyance system alignments would be conducted during

final design to avoid and minimize impacts from any sites discovered and to determine the presence of potentially hazardous sites.

Table 4-107. Area of potential disturbance due to conveyances and facilities in acres.

Study Area	Alternative 1	Alternative 2 Reclamation Action Option	Alternative 2 No Reclamation Action Option	Alternative 3	Alternative 4
Conveyances and Facilities	837	345	457	854	915

4.22 ENERGY USE

All alternatives would rely on electrical energy to pump water up to reservoirs or to deliver water to the NISP Participants. No new substations or major high voltage transmission lines are anticipated with any of the alternatives. Estimated annual electrical energy use for operation of the alternatives was updated for the SDEIS and replaces Section 4.26 of the DEIS. Electrical energy requirements were estimated based on the volumes of water required to be moved through various parts of the system under each alternative (BBC 2014). Table 4-108 presents the estimated electrical energy requirements to operate each alternative at full utilization. In Colorado for 2012, the retail sale of electricity was 53,685,297 mega-watt hours (MWhrs). For Alternative 4, estimated to have the highest annual electric energy requirements of the NISP alternatives, this would be about 0.12% of the 2012 retail sales of electricity in Colorado. An average Colorado household consumes about 7.5 MWhrs per year (http://www.eia.gov/electricity/state/). The estimated annual electrical energy requirements of Alternative 4 would be equivalent to the electrical energy use of about 8,593 Colorado households (http://www.eia.gov/consumption/residential/reports/2009/state_briefs/pdf/co.pdf).

Table 4-108. Projected annual electrical energy requirements for NISP alternatives at full project utilization.

Alternative	Annual Kilowatt Hours
Alternative 1 – No Action Alternative (Reduced Size Cactus Hill)	34,828,300
Alternative 2 – Glade + SPWCP, Reclamation Action Option	48,135,987
Alternative 2 – Glade + SPWCP, No Reclamation Action Option	61,302,050
Alternative 3 – Cactus Hill + SPWCP, Poudre Valley Canal Diversion	59,074,504
Alternative 4 – Cactus Hill + SPWCP, Multiple Diversion Locations	64,445,426

4.23 SUMMARY

Table 4-109 summarizes the predicted effects on the various resources for each alternative. More specific information on effects determinations can be found in the methods section of each respective resource. All effects are considered to be adverse unless otherwise stated as beneficial. Some of the information included in Table 4-109 is from the DEIS.

Table 4-109. Summary of estimated effects for the alternatives.

Resource/Issue	Alternative 1	Alternative 2 Proposed Action Glade and SPWCP – Reclamation Action Option	Alternative 2 Proposed Action Glade and SPWCP – No Reclamation Action Option	Alternative 3 Cactus Hill, Poudre Valley Canal Diversion, and SPWCP	Alternative 4 Cactus Hill, Multiple Diversion Locations, and Modified SPWCP
Surface Water	See Chapter 5.	**Poudre River** - Average diversion of **35,100** AFY at Poudre Valley Canal (Poudre Valley Canal) to Glade Reservoir. - Flows in 1.48 mile river reach between Poudre Valley Canal and Hansen Supply Canal would be greater (average 8,200 AFY) than No Reclamation Action Option. - Due to exchanges with CB-T, average reduction of 7,700 AFY in releases to Poudre River at Hansen Supply Canal. - Flows in Poudre River downstream of Hansen Supply Canal essentially same for Reclamation Action and No Reclamation Action Options due to releases from Glade Reservoir for Reclamation Action Option. - Diversions would primarily reduce peak flows during May and June in years with average to above average flows. - Reduced flows between Poudre Valley Canal and Larimer-Weld and New Cache headgates due to direct flow and storage exchanges during April-October (irrigation season). - Flow augmentation program would release water from Glade Reservoir to maintain flow of 10 cfs at downstream side of Larimer-Weld Canal headgate from November 1 through April 30 and September 1 through September 30. **South Platte River** - Average diversion of **28,400** AFY just downstream of confluence of Poudre and South Platte Rivers. - Diversions would be limited to a maximum of 200 cfs and could occur in all months when water rights are in priority. - Change in flow would be less than 10% of average monthly flows at Kersey Gage. **Horsetooth Reservoir** Variations in water levels would be similar to existing conditions. **Carter Lake** Variations in water levels would be similar to existing conditions.	**Poudre River** - Average diversion of **43,300** AFY at Poudre Valley Canal to Glade Reservoir. - Less flow (average 8,200 AFY) than Reclamation Action Option between Poudre Valley Canal and Hansen Supply Canal (distance of 1.48 miles) - Flows in Poudre River downstream of Hansen Supply Canal would be essentially same for Reclamation Action and No Reclamation Action Options due to continuation of historical releases from Hansen Supply Canal for No Reclamation Action Option. - Diversions would primarily reduce peak flows during May and June in years with average to above average flows. - Reduced flows between Poudre Valley Canal and Larimer-Weld and New Cache headgates due to direct flow and storage exchanges during April-October (irrigation season). - Flow augmentation program would release water from Glade Reservoir to maintain flow of 10 cfs at downstream side of Larimer-Weld Canal headgate from November 1 through April 30 and September 1 through September 30. **South Platte River** Same as Reclamation Action Option **Horsetooth Reservoir** No effect on water levels. **Carter Lake Reservoir** No effect on water levels.	**Poudre River** - Average diversion of **49,200** AFY at Poudre Valley Canal to Cactus Hill Reservoir. - Diversions would primarily reduce peak flows during May and June in years with average to above average flows. - Reduced flows between Poudre Valley Canal and Larimer-Weld and New Cache headgates due to direct flow and storage exchanges during April-October (irrigation season). - No proposed flow augmentation program. **South Platte River** - Average diversion of **30,000** AFY just downstream of confluence of Poudre and South Platte Rivers. - Diversions would be limited to a maximum of 200 cfs and would occur in all months. - Change in flow would be less than 10% of average monthly flows at Kersey Gage. **Horsetooth Reservoir** No effect on water levels. **Carter Lake Reservoir** No effect on water levels.	**Poudre River** - Average diversion of **48,800** AFY from Poudre River, with 37,800 AFY diverted at Poudre Valley Canal and 11,000 AFY diverted at New Cache Canal, 23-river miles downstream of Poudre Valley Canal. - Averaged over 5 months (May-September) when diversions at New Cache headgate would occur, about 36 cfs more water would be left in this reach compared to other action alternatives. - Diversions that reduce peak flows at Poudre Valley Canal during May and June would be less than other action alternatives. - Reduced flows between Poudre Valley Canal and Larimer-Weld headgate due to direct flow and storage exchanges during April-October (irrigation season). - No proposed flow augmentation program. **South Platte River** - Average diversion of **32,000** AFY just downstream of confluence of Poudre and South Platte Rivers. - Diversions would be limited to maximum of 200 cfs and would occur in all months. - Change in flow would be less than 10% of average monthly flows at Kersey Gage. **Horsetooth Reservoir** No effect on water levels. **Carter Lake Reservoir** No effect on water levels.

Resource/Issue	Alternative 1	Alternative 2 Proposed Action Glade and SPWCP – Reclamation Action Option	Alternative 2 Proposed Action Glade and SPWCP – No Reclamation Action Option	Alternative 3 Cactus Hill, Poudre Valley Canal Diversion, and SPWCP	Alternative 4 Cactus Hill, Multiple Diversion Locations, and Modified SPWCP
Surface Water Quality					
Poudre and South Platte River Constituents					
Nutrients	See Chapter 5 for flow related effects on nutrients.	Ammonia and total phosphorus increases may be measurable below WWTPs due to reduced river flows, may exceed standard at some locations in Segment 12 of Poudre River and 1b on South Platte River (standards are exceeded under Current Conditions for these nutrients).	Same as Reclamation Action Option.	Alternative 3 is not expected to substantively affect ammonia or nitrate concentrations in Segment 10. Chloride and sulfate concentrations may increase during the operational months; however, a change in the low end concentrations is not expected to exceed their respective water quality standard in Segment 11. Ammonia and total phosphorus increases may be measurable below WWTPs due to reduced river flows, may exceed standard at some locations in Segment 12 of Poudre River and 1b on South Platte River (standards are exceeded under Current Conditions for ammonia and total phosphorous in Segment 12 and for total phosphorous in Segment 1b).	Alternative 4 is not expected to substantively affect ammonia or nitrate concentrations in Segment 10. Chloride and sulfate concentrations may increase during the operational months; however, a change in the low end concentrations is not expected to exceed their respective water quality standard in Segment 11. Ammonia and total phosphorus increases may be measurable below WWTPs due to reduced river flows, may exceed standard at some locations in Segment 12 of Poudre River and 1b on South Platte River (standards are exceeded under Current Conditions for ammonia and total phosphorous in Segment 12 and for total phosphorous in Segment 1b).
Metals	See Chapter 5 for flow related effects on metals.	Increases and decreases in metal concentrations due to flow changes may not be measurable. Medium chance of copper and dissolved manganese standard exceedance in Segment 10 of Poudre River. Medium chance of exceeding total phosphorus standard and a high potential for continued exceedance of selenium standard in Segment 11 of Poudre River. Iron, ammonia, total phosphorus, and selenium concentrations currently exceed standards in Segment 12 of Poudre River and likely to remain above standards. Iron, total phosphorus, and sulfate concentrations remain above standard in Segment 1b of South Platte River. Ammonia and dissolved manganese have a medium chance of exceeding standard in Segment 1b of South Platte River.	Same as Reclamation Action Option.	Increases and decreases in metal concentrations due to flow changes may not be measurable. Medium chance of copper and dissolved manganese standard in Segment 10 of Poudre River. Medium chance of exceeding total phosphorus standard and a high potential for continued exceedance of selenium standard in Segment 11 of Poudre River. Manganese concentrations may increase, but concentrations are not expected to exceed the agricultural water quality standard. Iron, ammonia, total phosphorus, and selenium concentrations currently exceed standards in Segment 12 of Poudre River and likely to remain above standards. Iron, total phosphorus, and sulfate concentrations remain above standard in Segment 1b of South Platte River. Ammonia and dissolved manganese have a medium chance of exceeding standard in Segment 1b of South Platte River.	Increases and decreases in metal concentrations due to flow changes may not be measurable. Medium chance of copper and dissolved manganese standard in Segment 10 of Poudre River. Medium chance of exceeding total phosphorus standard and a high potential for continued exceedance of selenium standard in Segment 11 of Poudre River. Manganese concentrations may increase, but concentrations are not expected to exceed the agricultural water quality standard. Iron, ammonia, total phosphorus, and selenium concentrations currently exceed standards in Segment 12 of Poudre River and likely to remain above standards. Iron, total phosphorus, and sulfate concentrations remain above standard in Segment 1b of South Platte River. Ammonia and dissolved manganese have a medium chance of exceeding standard in Segment 1b of South Platte River
Temperature	See Chapter 5 for flow related effects on temperature.	Adverse effects on stream temperature possible in sensitive reaches of Segment 10 and Segment 11 including key months of July and August. Flow augmentation program would provide net benefit in parts of Segments 10 and 11 (from 0.37 miles upstream of Larimer County Canal to Timnath Inlet headgate) in key months of March and September.	Same as Reclamation Action Option.	Effects slightly greater than Alternative 2.	Effects slightly less than Alternative 2.
Dissolved Oxygen	See Chapter 5 for flow related effects on dissolved oxygen.	Diversions at Poudre Valley Canal could exacerbate occasionally observed DO issues in July and August in Segment 11. Flow augmentation would likely provide DO benefit November through April and in September. Aeration of releases from Glade Reservoir should also help maintain DO concentrations within standards	Same as Reclamation Action Option.	Effects slightly greater than Alternative 2 in Segment 11.	Effects slightly less than Alternative 2 in Segment 11.

Resource/Issue	Alternative 1	Alternative 2 Proposed Action Glade and SPWCP – Reclamation Action Option	Alternative 2 Proposed Action Glade and SPWCP – No Reclamation Action Option	Alternative 3 Cactus Hill, Poudre Valley Canal Diversion, and SPWCP	Alternative 4 Cactus Hill, Multiple Diversion Locations, and Modified SPWCP
Larimer-Weld and New Cache Canal/Crop Yield	No effect. Alternative 1 does not include proposed Galeton Reservoir or canal exchanges.	Elevated salinity and selenium concentrations in Galeton Reservoir releases to canals would result in decrease in crop yields where water used for irrigation.	Same as Reclamation Action Option.	Same as Alternative 2.	Same as Alternatives 2 and 3.
Channel Morphology and Sediment Transport					
Change in flow regime	See Chapter 5.	Mean flow reduced **20-30%** mid-April to mid-July. Duration of flows at or above 1,000 cfs reduced **30-35%**. 2% flow reduced **10-30%**. 10-year flood peak reduced up to **21%**. *Laporte Reach:* 1, 2, and 5% exceedance flows reduced **11-26%**. Lower flows (10 and 25% flows) reduced **16-28%**. *Fort Collins Reach:* Winter low flows increased up to 35% from flow augmentation. 1, 2, and 5% flows reduced **13-47%**. Lower flows (10 and 25% flows) reduced **12-41%**. 2-year flood reduced **19-36%** in Fort Collins and upper Timnath reaches. 25-year flood reduced up to **10%** in Fort Collins. *Timnath, Windsor, Greeley Upstream, Greeley Channelized, and Greeley Reaches:* Impact greatest on 5% exceedance flows, reduced **25-42%**. Impact on floods up to 25-year flood reasonably uniform, with 2, 10, and 25-year flood peaks all reduced **16-21%**.	Same as Reclamation Action Option.	Mean flow reduced **20-35%** mid-April to mid-July. Duration of flows at or above 1,000 cfs reduced **30-40%**. 2% flow reduced **15-37%**. 10-year flood peak reduced up to **26%**. *Laporte Reach:* 1, 2, and 5% exceedance flows reduced **15-29%**. Lower flows (10 and 25% flows) reduced **18-32%**. *Fort Collins Reach:* 1, 2, and 5% flows reduced **17-55%**. Lower flows (10 and 25% flows) reduced **12-43%**. 2-year flood reduced **30-40%** in Fort Collins and upper Timnath reaches. 25-year flood reduced up to **15%** in Fort Collins. *Timnath, Windsor, Greeley Upstream, Greeley Channelized, and Greeley Reaches:* Impact greatest on 5% exceedance flows, reduced **30-45%**. Impact on floods up to 25-year flood reasonably uniform, with 2, 10, and 25-year flood peaks all reduced **19-25%**.	Mean flow reduced **20-25%** mid-April to mid-July. Duration of flows at or above 1,000 cfs reduced **20-30%**. 2% flow reduced 12-30%. 10-year flood peak reduced up to **23%**. *Laporte Reach:* 1, 2, and 5% exceedance flows reduced **12-24%**. Lower flows (10 and 25% flows) reduced **12-20%**. *Fort Collins Reach:* Moderate flows less impacted because some exchange water diverted downstream of Fort Collins. 1, 2, and 5% flows reduced **13-39%**. Lower flows (10 and 25% flows) reduced **5-20%**. 2-year flood reduced **11-15%** in Fort Collins and upper Timnath reaches. 25-year flood reduced up to **19%** in Fort Collins. *Timnath, Windsor, Greeley Upstream, Greeley Channelized, and Greeley Reaches:* Impact greatest on 5% exceedance flows, reduced **14-43%**. Impact on floods up to 25-year flood is predicted to be reasonably uniform, with the 2-year, 10-year and 25-year flood peaks all reduced **17-23%**.
Fining of surficial material	See Chapter 5.	At 55% of cross sections duration of flows that flush river bed fines reduced **5-50%**. For remaining 45% of cross sections no flushing or no change in duration of flushing flows. *Laporte Reach:* 15 flushing events under Current Conditions lasting 132 days total reduced to **10** flushing events lasting **94** days total (26-year period of record) *Fort Collins Reach:* 23 flushing events under Current Conditions lasting 325 days total reduced to **16** flushing events lasting **222** days total (26-year period of record) *Timnath, Windsor, Greeley Upstream, Greeley Channelized, and Greeley Reaches:* 18 flushing events under Current Conditions lasting 292 days total for Windsor reach reduced to **19** flushing events lasting **218** days total (26-year period of record)	Same as Reclamation Action Option.	At 55% of cross sections duration of flows that flush river bed fines reduced **8% to 50%**. For remaining 45% of cross sections no flushing or no change in duration of flushing flows. *Laporte Reach:* 15 flushing events under Current Conditions lasting 132 days total reduced to **11** flushing events lasting **82** days total (26-year period of record) *Fort Collins Reach:* 23 flushing events under Current Conditions lasting 325 days total reduced to **18** flushing events lasting **205** days total (26-year period of record) *Timnath, Windsor, Greeley Upstream, Greeley Channelized, and Greeley Reaches:* 18 flushing events under Current Conditions lasting 292 days total for Windsor reach reduced to **16** flushing events lasting **197** days total (26-year period of record)	At 55% of cross sections duration of flows that flush river bed fines reduced **5% to 50%**. For remaining 45% of cross sections no %. For remaining 45% of cross sections no flushing or no change in duration of flushing flows. *Laporte Reach:* 15 flushing events under Current Conditions lasting 132 days total reduced to **11** flushing events lasting **88** days total (26-year period of record) *Fort Collins Reach:* 23 flushing events under Current Conditions lasting 325 days total reduced to **20** flushing events lasting **231** days total (26-year period of record) *Timnath, Windsor, Greeley Upstream, Greeley Channelized, and Greeley Reaches:* 18 flushing events under Current Conditions lasting 292 days total for Windsor reach reduced to **17** flushing events lasting **217** days total (26-year period of record)

Resource/Issue	Alternative 1	Alternative 2 Proposed Action Glade and SPWCP – Reclamation Action Option	Alternative 2 Proposed Action Glade and SPWCP – No Reclamation Action Option	Alternative 3 Cactus Hill, Poudre Valley Canal Diversion, and SPWCP	Alternative 4 Cactus Hill, Multiple Diversion Locations, and Modified SPWCP
Loss of morphologic complexity	See Chapter 5.	Duration of bed material movement reduced on average **21%** and up to **40%** in some locations. Temporal variability of habitats reduced throughout. Spatial variability reduced downstream of I-25. *Laporte Reach:* Channel has barely responded to historical changes in flow regime over last two centuries. Any change predicted to be similarly constrained by lack of sediment supply. *Fort Collins Reach:* Effective discharge of 2,000 cfs remains unchanged from Current Conditions hydrology. Channel capacity similar unless quantity or size distribution of available sediment changes. Current channel still undergoing slow adjustment in response to historical changes in flow regime. Any change would be incremental to that existing response. *Timnath, Windsor, Greeley Upstream, Greeley Channelized, and Greeley Reaches:* Complexity of in-channel morphologic features already low in reaches downstream of I-25 from sand deposition smothering bed and reducing magnitude and frequency of pool and riffle sequences. Further channel contraction would exacerbate this condition.	Same as Reclamation Action Option.	Duration of bed material movement reduced on average **26%** and up to **40%** in some locations. Temporal variability of habitats reduced throughout. Spatial variability reduced downstream of I-25. *Laporte Reach:* Similar to Alternative 2. *Fort Collins Reach:* Similar to Alternative 2. *Timnath, Windsor, Greeley Upstream, Greeley Channelized, and Greeley Reaches:* Similar to Alternative 2.	Duration of bed material movement reduced on average **24%** and up to **40%** in some locations. Temporal variability of habitats reduced throughout. Spatial variability reduced downstream of I-25. *Laporte Reach:* Similar to Alternative 2. *Fort Collins Reach:* Similar to Alternative 2. *Timnath, Windsor, Greeley Upstream, Greeley Channelized, and Greeley Reaches:* Similar to Alternative 2.
Channel contraction	See Chapter 5.	Sediment transport potential reduced throughout river. Capability of river to move bed material reduced **12-31%** (upstream of I-25) and **8-18%** (downstream of I-25). Propensity toward channel contraction throughout system but mainly downstream of I-25 where material of relevant size fraction available for deposition and bio-geomorphic feedback loops would prevail. Likely acceleration of channel contraction would lead to increased frequency of flooding downstream of 1-25. *Laporte Reach:* Channel capacity similar to Current Conditions unless quantity or size distribution of available sediment changes. *Fort Collins Reach:* Channel capacity similar under Current Conditions unless quantity or size distribution of available sediment changes. *Timnath Reach:* Channel contraction would occur as extension of processes already underway by deposition on bars, islands, riffles, and channel margins.	Same as Reclamation Action Option.	Sediment transport potential reduced throughout river. Capability of river to move bed material reduced **16-37%** (upstream of I-25) and **12-33%** (downstream of I-25). Propensity toward channel contraction throughout system but mainly downstream of I-25 where material of relevant size fraction available for deposition and bio-geomorphic feedback loops would prevail. Likely acceleration of channel contraction would lead to increased frequency of flooding downstream of 1-25. *Laporte Reach:* Similar to Alternative 2. *Fort Collins Reach:* Similar to Alternative 2. *Timnath, Windsor, Greeley Upstream, Greeley Channelized, and Greeley Reaches:* Similar to Alternative 2.	Sediment transport potential reduced throughout river. Capability of river to move bed material reduced **12-26%** (upstream of I-25) and **11-20%** (downstream of I-25). Propensity toward channel contraction throughout system but mainly downstream of I-25 where material of relevant size fraction available for deposition and bio-geomorphic feedback loops would prevail. Likely acceleration of channel contraction would lead to increased frequency of flooding downstream of 1-25. *Laporte Reach:* Similar to Alternative 2 *Fort Collins Reach:* Similar to Alternative 2. *Timnath, Windsor, Greeley Upstream, Greeley Channelized, and Greeley Reaches:* Similar to Alternative 2.
South Platte River	See Chapter 5.	Minor effects to river morphology and sediment transport. Channel-forming flows (1.5-year peak flows of 3,858 cfs) would be reduced from ~ 3% to less than 1% of the time. Scouring flows equivalent to 25-year peak flows would continue to occur.	Same as Reclamation Action Option.	Similar to Alternative 2.	Similar to Alternative 2.

Resource/Issue	Alternative 1	Alternative 2 Proposed Action Glade and SPWCP – Reclamation Action Option	Alternative 2 Proposed Action Glade and SPWCP – No Reclamation Action Option	Alternative 3 Cactus Hill, Poudre Valley Canal Diversion, and SPWCP	Alternative 4 Cactus Hill, Multiple Diversion Locations, and Modified SPWCP
Ground Water	See Chapter 5 for flow related effects on ground water. Minimal seepage from Cactus Hill Reservoir to alluvium could increase water availability to vegetation. No impacts on ground water quality.	Minimal effects to ground water from reduced river flows and associated changes in river stage. Greatest changes would be within 50 feet of Poudre River. Minimal seepage from reservoir to alluvium could increase water availability to vegetation. No impacts on ground water quality.	Same as Reclamation Action Option.	Same as Alternative 2.	Same as Alternatives 2 and 3.
Geology	Disturbance from construction activities and excavation of sand, gravel, and bedrock for Cactus Hill Reservoir Dam construction.	Disturbance from construction activities and excavation of sand, gravel, and bedrock for Glade Dam and Galeton Dam embankments, foundation, and rip rap. Excavation and removal of Paleozoic and Mesozoic sedimentary rocks associated with the U.S. 287 realignment.	Same as Reclamation Action Option.	Same as Alternative 2, except realignment of U.S. 287 not part of this alternative.	Same as Alternative 3.
Prime Farmland if Irrigated (acres lost)	377	686	686	794	794
Vegetation					
Permanent impacts on all vegetation (acres)	2,609	3,895	3,895	5,906	5,906
Permanent impacts on native plant communities (acres)	648	2,857	2,857	2,276	2,276
Irrigated agricultural lands dry up (acres)	64,200	0	0	0	0
Noxious Weeds	Increased distribution and cover by noxious weeds due to construction disturbance and dry-up of irrigated lands. Periods of prolonged low water levels at Cactus Hill Reservoir would allow for noxious weeds to colonize the drawdown area.	Increased distribution and cover by noxious weeds due to construction disturbance. Periods of prolonged low water levels at Glade and Galeton Reservoirs would allow for noxious weeds to colonize the drawdown area	Same as Reclamation Action Option.	Same as Alternative 2	Same as Alternative 2.
Wetlands and Other Waters					
Wetlands (permanent direct effects) (acres)	32	44	44	34	34
Wetlands (temporary direct effects) (acres)	16	8	10	19	19
Wetlands from Irrigation Dry-up (permanent indirect effects) (acres)	219	0	0	0	
Wetlands from Poudre Valley Canal lining (permanent indirect effects) (acres)	0	0	0	47	47
Wetlands from Poudre River flow changes (indirect effects) (acres)	0	9	9	9	0
Waters (permanent direct effects) (acres)	6	12	12	92	92
Waters (temporary direct effects) (acres)	17	3	4	12	12
Riparian Resources					
Riparian shrubland and woodland (permanent direct effects) (acres)	4 (inundation and construction)	112 (inundation and construction)	112 (inundation and construction)	16 (inundation and construction)	16 (inundation and construction)
Riparian shrubland and woodland(temporary direct effects) (acres)	15	8	9	16	16
Wildlife					
Mule Deer					
Overall Range (acres)	Permanent – 2,615 Temporary – 1,122	Permanent – 3,995 Temporary – 782	Permanent – 3,996 Temporary – 897	Permanent – 5,999 Temporary – 1,271	Permanent – 6,000 Temporary – 1,332

Resource/Issue	Alternative 1	Alternative 2 Proposed Action Glade and SPWCP – Reclamation Action Option	Alternative 2 Proposed Action Glade and SPWCP – No Reclamation Action Option	Alternative 3 Cactus Hill, Poudre Valley Canal Diversion, and SPWCP	Alternative 4 Cactus Hill, Multiple Diversion Locations, and Modified SPWCP
Winter Range (acres)	Permanent – 2,602 Temporary – 466	Permanent – 3,789 Temporary – 647	Permanent – 3,789 Temporary – 746	Permanent – 5,687 Temporary – 534	Permanent – 5,688 Temporary – 567
Winter Range Permanent Local Effect (%)	**18**	**16**	**16**	**23**	**22**
Severe Winter Range (acres)	Permanent – 0 Temporary – 16	Permanent – 228 Temporary – 173	Permanent – 128 Temporary – 239	Permanent – 45 Temporary – 41	Permanent – 45 Temporary – 41
Winter Concentration Area (acres)	Permanent – 1,635 Temporary – 186	Permanent – 70 Temporary – 152	Permanent – 70 Temporary – 231	Permanent – 2,332 Temporary – 146	Permanent – 2,332 Temporary – 146
White-Tailed Deer					
Overall Range (acres)	Permanent – 2,615 Temporary – 1,122	Permanent – 2,057 Temporary – 582	Permanent – 2,056 Temporary – 693	Permanent – 4,071 Temporary – 416	Permanent – 4,071 Temporary – 1,176
Winter Range (acres)	Permanent – 2,602 Temporary – 405	Permanent – 416 Temporary – 192	Permanent – 416 Temporary – 181	Permanent – 3,929 Temporary – 284	Permanent – 3,929 Temporary – 284
Winter Range Permanent Local Effect (%)	**20**	**8**	**8**	**25**	**24**
Concentration Area (acres)	Permanent – 2,601 Temporary – 454	Permanent – 421 Temporary – 203	Permanent – 421 Temporary – 182	Permanent – 3,928 Temporary – 327	Permanent – 3,928 Temporary – 355
Pronghorn					
Overall Range (acres)	Permanent – 2,596 Temporary – 330	Permanent – 2,256 Temporary – 335	Permanent – 2,256 Temporary – 335	Permanent – 5,796 Temporary – 440	Permanent – 5,796 Temporary – 446
Winter Range (acres)	Permanent – 220 Temporary – 41	Permanent – 2,256 Temporary – 295	Permanent – 2,256 Temporary – 295	Permanent – 2,317 Temporary – 234	Permanent – 2,317 Temporary – 234
Winter Range Permanent Local Effect (%)	**13**	**25**	**25**	**27**	**27**
Severe Winter Range (acres)	0	Permanent – 2,254 Temporary – 256	Permanent – 2,254 Temporary – 256	Permanent – 1,927 Temporary – 171	Same as Alternative 3
Winter Concentration Area (acres)	0	Permanent – 1,928 Temporary – 204	Permanent – 1,928 Temporary – 204	Permanent – 1,928 Temporary – 204	Permanent – 1,928 Temporary – 204
Winter Concentration Area Permanent Local Effect (%)	**0**	**31**	**31**	**31**	**31**
Elk					
Overall Range (acres)	Permanent – 0 Temporary – 25	Permanent – 2,043 Temporary – 386	Permanent – 2,043 Temporary – 456	Permanent – 46 Temporary – 35	Permanent – 46 Temporary – 35
Overall Range Permanent Local Effect (%)	0	18	18	1	1
Winter Range (acres)	0	Permanent – 186 Temporary – 101	Permanent – 196 Temporary – 167	Permanent – 10 Temporary – 15	Permanent – 10 Temporary – 15
Severe Winter Range (acres)	0	Permanent – 2 Temporary – 8	Permanent – 2 Temporary – 8	0	0
Winter Concentration Area (acres)	0	Permanent – 124 Temporary – 75	Permanent – 124 Temporary – 74	0	0
Winter Concentration Area Permanent Local Effect (%)	**0**	**13**	**13**	**0**	**0**

Resource/Issue		Alternative 1	Alternative 2 Proposed Action Glade and SPWCP – Reclamation Action Option	Alternative 2 Proposed Action Glade and SPWCP – No Reclamation Action Option	Alternative 3 Cactus Hill, Poudre Valley Canal Diversion, and SPWCP	Alternative 4 Cactus Hill, Multiple Diversion Locations, and Modified SPWCP
Migratory birds and raptors, amphibians and reptiles, and other wildlife (acres)		Loss of **32** acres of wetland, **6** acres of aquatic habitat, **4** acres of riparian woodlands, and **2,290** acres of grasslands. Dry up of **64,200** acres of irrigated agricultural land, including **218** acres of low to moderate quality irrigated wetlands. Many dried-up lands probably replaced by upland grassland habitat.	Loss of **44** acres of wetlands, **12** acres of aquatic habitat, **537** acres of shrublands, **29** acres of riparian woodlands, and **2,929** acres of grassland habitat. Mortality and nest destruction could occur during construction. Temporary impacts include disturbance of vegetation and increased noise and human presence. Reductions in streamflows on Poudre and South Platte Rivers not anticipated to cause loss of riparian and/or wetland habitat. **9** acres of wetland habitat along banks could experience change in species composition.	Similar to Reclamation Action Option.	Loss of **81** acres of wetlands (**34** acres from construction impacts and **47** acres from loss of supportive hydrology downgradient of Poudre Valley Canal), loss of **92** acres of aquatic habitat (of which **85** acres would change from unlined canal to concrete-lined canal), **16** acres of riparian woodlands, and **4,525** acres of grassland habitat. Mortality and nest destruction could occur during construction. Temporary impacts include disturbance of vegetation and increased noise and human presence. Reductions in streamflows on Poudre and South Platte Rivers not anticipated to cause loss of riparian and/or wetland habitat. **9** acres of wetland habitat along banks could experience change in species composition.	Effects on wildlife similar to Alternative 3. Reductions in streamflows on Poudre and South Platte not anticipated to cause a loss of riparian and/or wetland habitat or change in species composition.
Aquatic Biological Resources						
Poudre River Fish	Segment A	See Chapter 5	Minor adverse impact to adult trout due to reduced runoff flows, negligible impacts to other species/life stages	Same as Reclamation Action Option.	Minor adverse impact to adult trout due to reduced runoff flows, negligible impacts to other species/life stages	Minor adverse impact to adult trout due to reduced runoff flows, negligible impacts to other species/life stages
	Segment B	See Chapter 5	Minor to moderate beneficial impact to most species of fish with augmented low flows	Same as Reclamation Action Option.	Moderate adverse impact to adult trout due to reduced runoff flows, negligible impacts to other species/life stages	Negligible impact to most species
	Segment C	See Chapter 5	Negligible impact to most species, moderate adverse impact to trout with reduced runoff flows and higher temperatures	Same as Reclamation Action Option.	Negligible impact to most species, moderate adverse impact to trout with reduced runoff flows and higher temperatures	Negligible impact to most species
	Segment D	See Chapter 5	Minor adverse impact for some species with reductions in runoff flows, negligible impact for others	Same as Reclamation Action Option.	Minor adverse impact for some species with reductions in runoff flows, negligible impact for others	Minor adverse impact for some species with reductions in runoff flows, negligible impact for others
	Segment E	See Chapter 5	Minor adverse impact for most species with reduced runoff flows	Same as Reclamation Action Option.	Minor adverse impact for most species with reduced runoff flows	Minor adverse impact for most species with reduced runoff flows
	Segment F	See Chapter 5	Minor adverse impact for most species with reduced runoff flows	Same as Reclamation Action Option.	Minor adverse impact for most species with reduced runoff flows	Minor adverse impact for most species with reduced runoff flows
Poudre River Macroinvertebrates	Segment A	See Chapter 5	Minor adverse impact with changes in species composition due to reduced peak flows	Same as Reclamation Action Option.	Minor adverse impact with changes in species composition due to reduced peak flows	Minor adverse impact with changes in species composition due to reduced peak flows
	Segment B	See Chapter 5	Beneficial impact to abundance, minor adverse impact with changes in species composition due to reduced peak flows	Same as Reclamation Action Option.	Minor adverse impact with changes in species composition due to reduced peak flows	Negligible to minor adverse impact with changes in species composition due to reduced peak flows
	Segment C	See Chapter 5	Minor adverse impact with changes in species composition due to reduced peak flows	Same as Reclamation Action Option.	Minor adverse impact with changes in species composition due to reduced peak flows	Minor adverse impact with changes in species composition due to reduced peak flows
	Segment D	See Chapter 5	Minor adverse impact with changes in species composition due to reduced peak flows	Same as Reclamation Action Option.	Minor adverse impact with changes in species composition due to reduced peak flows	Minor adverse impact with changes in species composition due to reduced peak flows
	Segment E	See Chapter 5	Minor adverse impact with changes in species composition due to reduced peak flows	Same as Reclamation Action Option.	Minor adverse impact with changes in species composition due to reduced peak flows	Minor adverse impact with changes in species composition due to reduced peak flows
	Segment F	See Chapter 5	Minor adverse impact with changes in species composition due to reduced peak flows	Same as Reclamation Action Option.	Minor adverse impact with changes in species composition due to reduced peak flows	Minor adverse impact with changes in species composition due to reduced peak flows
Poudre River Periphyton and Plants	Segment A	See Chapter 5	Minor adverse impact with increases in filamentous green algae due to reduced peak flows	Same as Reclamation Action Option.	Minor adverse impact with increases in filamentous green algae due to reduced peak flows	Minor adverse impact with increases in filamentous green algae due to reduced peak flows
	Segment B	See Chapter 5	Minor adverse impact with increases in filamentous green algae due to reduced peak flows	Same as Reclamation Action Option.	Minor adverse impact with increases in filamentous green algae due to reduced peak flows	Negligible to minor adverse impact with increases in filamentous green algae due to reduced peak flows
	Segment C	See Chapter 5	Minor adverse impact with increases in filamentous green algae due to reduced peak flows	Same as Reclamation Action Option.	Minor adverse impact with increases in filamentous green algae due to reduced peak flows	Negligible to minor adverse impact with increases in filamentous green algae due to reduced peak flows

Resource/Issue		Alternative 1	Alternative 2 Proposed Action Glade and SPWCP – Reclamation Action Option	Alternative 2 Proposed Action Glade and SPWCP – No Reclamation Action Option	Alternative 3 Cactus Hill, Poudre Valley Canal Diversion, and SPWCP	Alternative 4 Cactus Hill, Multiple Diversion Locations, and Modified SPWCP
	Segment D	See Chapter 5	Minor adverse impact with increases in filamentous green algae due to reduced peak flows	Same as Reclamation Action Option.	Minor adverse impact with increases in filamentous green algae due to reduced peak flows	Minor adverse impact with increases in filamentous green algae due to reduced peak flows
	Segment E	See Chapter 5	Minor adverse impact with increases in filamentous green algae due to reduced peak flows	Same as Reclamation Action Option.	Minor adverse impact with increases in filamentous green algae due to reduced peak flows	Minor adverse impact with increases in filamentous green algae due to reduced peak flows
	Segment F	See Chapter 5	Minor adverse impact with increases in filamentous green algae due to reduced peak flows	Same as Reclamation Action Option.	Minor adverse impact with increases in filamentous green algae due to reduced peak flows	Minor adverse impact with increases in filamentous green algae due to reduced peak flows
South Platte River Fish, Macroinvertebrates, Periphyton, and Plants		See Chapter 5.	Negligible	Negligible	Negligible	Negligible
Special Status Species						
Preble's meadow jumping mouse		No permanent impacts on known occupied Preble's habitat. Temporary impacts on 5 acres of occupied habitat from pipelines could occur.	Permanent loss of **53** acres of known Preble's habitat. Temporary disturbance to **24** acres of Preble's habitat. Potential disturbance of Preble's behavior due to increased noise and human presence and physical harm to individual Preble's from construction machinery and future recreational activities at Glade. Changes in flows in Poudre River unlikely to affect Preble's habitat.	Permanent loss of **53** acres of known Preble's habitat. Temporary disturbance to **28** acres of Preble's habitat. Potential disturbance of Preble's behavior due to increased noise and human presence and physical harm to individual Preble's from construction machinery and future recreational activities at Glade. Changes in flows in Poudre River unlikely to affect Preble's.	**No** permanent impacts on known occupied Preble's habitat. Temporary impacts on **less than 1** acre of Preble's habitat. Unlikely but potential Preble's habitat could occur in other wetland or riparian areas crossed by conveyance facilities, roads, or other project components. Habitat assessments or trapping surveys would be conducted prior to construction in suitable habitat that would be impacted.	Similar to Alternative 3.
Bald eagle		**9** acres of nest buffer permanently lost. Temporary impacts to **67** acres of winter concentration area and **41** acres of nest buffer. Cactus Hill Reservoir could provide additional summer foraging habitat, especially if stocked with fish.	Permanent impacts of **21** acres and temporary impacts of **13** acres of winter concentration area. **Less than 1** acre of nest buffer permanently affected and **8** acres temporarily affected. Pipeline construction impacts could result in nest abandonment or decreased nesting success if conducted during sensitive breeding and nesting periods. Glade Reservoir could provide additional summer foraging habitat, especially if stocked with fish. Galeton Reservoir could provide additional summer foraging habitat.	Similar to Reclamation Action Option.	Permanent impacts of **62** acres and temporary impacts of **79** acres of winter concentration area. **10** acres of permanently impacted nest buffer and **45** acres temporarily impacted. Cactus Hill Reservoir could provide additional summer foraging habitat, especially if stocked with fish.	Impacts similar to Alternative 3, but with **82** acres of temporary impacts to winter concentration area.
Colorado butterfly plant (CBP)		**No effect**. No known populations occur in study area and is unlikely to occur in study area.	**No effect**. No known populations occur in study area and is unlikely to occur in study area. Changes in flows in Poudre River unlikely to affect CBP.	Same as Alternative 2.	Same as Alternative 2.	Same as Alternative 2.
Ute ladies'-tresses orchid (ULTO)		**No effect**. None found during surveys of study area. No known populations occur in study area and is unlikely to occur in study area. Prior to construction, ULTO habitat assessments and/or final surveys would be conducted for potentially impacted suitable habitat not previously evaluated. Changes in flows in Poudre River unlikely to affect ULTO.	**No effect**. None found during surveys of study area. No known populations occur in study areas and is unlikely to occur in SPWCP pipeline study area. Glade to Horsetooth pipeline route less than 1 mile from currently known populations of ULTO. Prior to construction, ULTO habitat assessments and/or final surveys would be conducted for potentially impacted suitable habitat not previously evaluated. Changes in flows in Poudre River unlikely to affect ULTO.	Similar to Reclamation Action Option.	Same as Alternative 1.	Same as Alternative 1.
Black-tailed prairie dog and burrowing owl		**65** acres of prairie dog colony permanently impacted and **9** acres temporarily impacted.	Permanent impacts on **367** acres of prairie dog habitat, mostly from construction of Galeton Reservoir.	Similar to Reclamation Action Option.	Permanent impacts on **414** acres of prairie dog habitat, mostly from construction of Galeton Reservoir.	Similar to Alternative 3.
Swift fox		Permanent impacts on **2,306** acres of overall swift fox range (**0.4 to 1.2** home ranges/pair).	Permanent impacts on **1,928** acres of overall swift fox range (**0.3 to 1.0** home ranges/pair).	Similar to Reclamation Action Option.	Permanent impacts on **5,247** acres of overall swift fox range. (**0.5 to 1.8** home ranges/pair).	Same as Alternative 3.

Resource/Issue	Alternative 1	Alternative 2 Proposed Action Glade and SPWCP – Reclamation Action Option	Alternative 2 Proposed Action Glade and SPWCP – No Reclamation Action Option	Alternative 3 Cactus Hill, Poudre Valley Canal Diversion, and SPWCP	Alternative 4 Cactus Hill, Multiple Diversion Locations, and Modified SPWCP
Common gartersnake and northern leopard frog	Permanent loss of **32** acres of wetland, **6** acres of aquatic habitat, and **4** acres of riparian woodland habitat (gartersnake only). Permanent loss of **218** acres of wetland habitat from the removal of irrigation. Temporary loss of **16** acres of wetland habitat, **17** acres of aquatic habitat, and **14** acres of riparian woodland habitat (gartersnake only).	Permanent loss of **44** acres of wetland habitat, **11** acres of aquatic habitat, and **28** acres of riparian woodland habitat (gartersnake only). Temporary impacts on **8** acres of wetland habitat, **3** acres of aquatic habitat, and **8** acres of riparian woodland (gartersnake only).	Permanent loss of **44** acres of wetland habitat, **12** acres of aquatic habitat, and **28** acres of riparian woodland habitat (gartersnake only). Temporary impacts on **10** acres of wetland habitat, **4** acres of aquatic habitat, and **9** acres of riparian woodland (gartersnake only).	Permanent loss of **81** acres of wetlands (**34** acres from construction impacts and **47** acres from loss of supportive hydrology downgradient of the Poudre Valley Canal), **92** acres of aquatic habitat (of which **85** acres is marginal habitat and would be converted from an unlined canal to a concrete-lined canal), and 16 acres of riparian woodland habitat. **47** acres of wetland habitat would be indirectly affected by lining of the Poudre Valley Canal. Temporary impacts on **19** acres of wetland habitat, 12 acres of aquatic habitat, and 15 acres of riparian woodland (gartersnake only).	Similar to Alternative 3.
Smokey-eyed brown butterfly, two-spotted skipper, and American currant	No effect.	No effect.	No effect.	No effect.	No effect.
Bell's twinpod	No effect.	Permanent loss of **29** acres and temporary impacts on **45** acres from western realignment of U.S. 287.	Similar to Reclamation Action Option.	**1** acre of permanent impact from lining Poudre Valley Canal.	Same as Alternative 3.
Brassy minnow and common shiner	No effect	No effect	No effect	No effect	No effect
Iowa darter	Negligible	Negligible except Segment B, which would be moderate beneficial	Negligible except Segment B, which would be moderate beneficial	Negligible	Negligible
Recreation Resources					
Boating (kayaking and canoeing)	No public access planned at Cactus Hill Reservoir. See Chapter 5 for Poudre River effects.	If Glade is managed for recreation, new flat water boating opportunities would exist, a major beneficial effect. No public access planned at Galeton Reservoir. Poudre River Segment A: Negligible effects. Poudre River Segment B: Moderate to major effects with 3 to 7 fewer boating days per month (total of 19 fewer days over May-August period) based on target flows of 150 cfs or greater. Poudre River Segments C, D, E, and F: No effects.	Similar to Reclamation Action Option.	No public access planned at Cactus Hill or Galeton Reservoirs. Poudre River Segment A: Negligible effects. Poudre River Segment B: Moderate to major effects with 3 to 6 fewer boating days per month (total of 18 fewer days over May-August period) based on target flows of 150 cfs or greater. Poudre River Segments C, D, E, and F: No effects.	No public access planned at Cactus Hill or Galeton Reservoirs. Poudre River Segment A: Negligible effects. Poudre River Segment B: Negligible effect on boating opportunities, with a small reduction in boating days (a total of four fewer days over the May-August period). Poudre River Segments C, D, E, and F: No effects.
Fishing	No public access planned at Cactus Hill Reservoir. See Chapter 5 for Poudre River effects.	If Glade is managed for recreation, would provide a new fishery, a major beneficial effect. No public access planned at Galeton Reservoir. Poudre River Segment A: Reductions in habitat for brown and rainbow trout would be a minor adverse effect on fishing. Poudre River Segment B: Augmented winter flows would result in minor beneficial effects on recreational fishing. Poudre River Segments C, D, E, and F: Negligible effects.	Similar to Reclamation Action Option.	No public access planned at Cactus Hill or Galeton Reservoirs. Similar to Alternative 2 except no flow augmentation and in Segment B, impact to cold water fish habitat would be moderately to majorly adverse, with corresponding adverse impact to anglers fishing for these species within City of Fort Collins.	No public access planned at Cactus Hill or Galeton Reservoirs. Similar to Alternative 3 but flows through Fort Collins (Segment B) higher than Alternative 3, which would result in no effect on recreational fishery. Segments A, D, E, and F would have negligible effects and Segment C would have a negligible to minor effect on recreational fishery.

Resource/Issue	Alternative 1	Alternative 2 Proposed Action Glade and SPWCP – Reclamation Action Option	Alternative 2 Proposed Action Glade and SPWCP – No Reclamation Action Option	Alternative 3 Cactus Hill, Poudre Valley Canal Diversion, and SPWCP	Alternative 4 Cactus Hill, Multiple Diversion Locations, and Modified SPWCP
Hunting	No public access planned for Cactus Hill Reservoir. Construction of reservoir may improve habitat, therefore improving hunting opportunities at nearby lands.	Loss of **340** acres of Poudre River State Trust Land, which is managed for hunting and fishing by CPW. Construction of Glade Reservoir may improve habitat, therefore improving hunting opportunities. Loss of **21** acres of Mitani-Tokuyasu SWA. Mule deer and white-tailed deer winter range may be affected at SPWCP forebay, thus affecting nearby big game hunting. Pronghorn winter and severe winter range and mule deer winter range affected at Galeton Reservoir and may have an effect on nearby big game hunting. Construction of Galeton Reservoir may improve waterfowl habitat in area, which may improve nearby hunting opportunities.	Same as Reclamation Action Option.	Loss of **21** acres of Mitani-Tokuyasu SWA. Mule deer and white-tailed deer winter range may be affected at SPWCP forebay, thus affecting nearby big game hunting. Mule deer and white-tailed deer winter range may be affected at SPWCP forebay, thus affecting nearby big game hunting. Pronghorn winter and severe winter range and mule deer winter range affected at Galeton Reservoir site and may have an effect on nearby big game hunting. Construction of Galeton Reservoir may improve waterfowl habitat in area, which may improve nearby hunting opportunities.	Similar to Alternative 3.
Other Recreational Activities	No public access planned at Cactus Hill Reservoir so no impacts on other recreational activities. Construction of reservoir may improve waterfowl habitat thereby improving wildlife viewing and photography opportunities at nearby lands.	Construction of Glade to Horsetooth pipeline would temporarily disrupt dispersed recreational uses along its alignment. Reductions in flows on Poudre River not expected to affect aesthetic qualities of riparian habitat of Poudre River, Poudre River Trail, or natural areas. Construction of Galeton Reservoir may improve habitat in area, which may improve nearby wildlife viewing or photography opportunities. Construction of SPWCP pipelines is not expected to affect recreation resources.	Construction of the Carter pipeline would temporarily disrupt use of Foothills Trail in several places and would temporarily impact aesthetic qualities of Horsetooth Reservoir Park, and Reservoir Ridge, Maxwell, Pineridge, and Coyote Ridge natural areas.	No public access planned for Cactus Hill so no impacts on other recreational activities. Construction of reservoir may improve waterfowl habitat thereby improving wildlife viewing and photography opportunities at nearby lands. Reductions in flows on Poudre River not expected to affect aesthetic qualities of riparian habitat of Poudre River, Poudre River Trail, or natural areas. Construction of Galeton Reservoir may improve habitat in area, which may improve nearby wildlife viewing or photography opportunities. Construction of SPWCP pipelines is not expected to affect recreation resources.	Impacts same as Alternative 3
Cultural Resources	**No** cultural resources identified to date within area of direct effect for Cactus Hill Reservoir.	**2** known cultural resources and an estimated **35** NRHP eligible sites affected by construction of Glade Dam and Reservoir and associated facilities or would be inundated by reservoir. **7** known cultural resources and **7** unrecorded cultural resources would be affected by western realignment of U.S. 287. Of the known cultural sites, 3 of these are eligible sites, 1 is not eligible, and 3 have not been assessed. **15** known cultural resources occur within areas that would be disturbed by construction of Galeton Dam and Reservoir and associated facilities or would be inundated by reservoir. Of these 15 sites, 13 have not had an official determination and may be eligible for listing in NRHP and two are not eligible.	Similar to Reclamation Action Option.	No cultural resources identified to date within area of direct effect for Cactus Hill Reservoir. Effects at Galeton Reservoir same as Alternative 2.	Similar to Alternative 3.
Paleontological Resources - U.S. 287	U.S. 287 realignment not part of this alternative.	Adverse impacts on subsurface fossils in areas underlain by Class 5 geologic units (Morrison Formation). Adverse impacts on potentially substantial vertebrate, invertebrate, plant, and trace fossils possible in Class 3 geologic units (Niobrara Formation, Benton Group, Dakota Group, Undivided Jelm, and Sundance Formations). Adverse impacts on potentially substantial vertebrate, invertebrate, plant, and trace fossils unlikely but possible in Class 2 geologic units (Lykins Formation). Adverse impacts consist of destruction of fossils by breakage and crushing during construction-related ground disturbance.	Same as Reclamation Action Option.	U.S. 287 realignment not part of this alternative.	U.S. 287 realignment not part of this alternative.

Resource/Issue	Alternative 1	Alternative 2 Proposed Action Glade and SPWCP – Reclamation Action Option	Alternative 2 Proposed Action Glade and SPWCP – No Reclamation Action Option	Alternative 3 Cactus Hill, Poudre Valley Canal Diversion, and SPWCP	Alternative 4 Cactus Hill, Multiple Diversion Locations, and Modified SPWCP
Aesthetics and Visual Resources	Change in landscape from terrestrial to open water for Cactus Hill Reservoir. Reservoir dam would change current visual character of site.	Change in landscape from terrestrial to open water for Glade and Galeton Reservoirs. Reservoir dams would change current visual character of sites. One-third of Mitani-Tokuyasu SWA would be replaced by Galeton forebay resulting in substantial reduction in scenic quality. Realignment of U.S. 287 would create contrast in scenic quality elements where it cuts through hogback formation.	Same as Reclamation Action Option.	Change in landscape from terrestrial to open water for Cactus Hill and Galeton Reservoirs. Reservoir dams would change current visual character of sites. One-third of Mitani-Tokuyasu SWA replaced by Galeton forebay resulting in substantial reduction in scenic quality.	Same as Alternative 3.
Traffic and Transportation					
Traffic Volumes	No anticipated impact to traffic volumes.	Existing traffic patterns not expected to change so reduced traffic volumes along SH 14 between Overland Trail and Ted's Place. If recreation provided at Glade Reservoir minor seasonal fluctuations in vehicle volumes can be anticipated.	Same as Reclamation Action Option.	No anticipated impact to traffic volumes.	Same as Alternative 3.
Existing Roadways	Local roads WCR 15, WCR 19, and WCR 90 directly impacted by construction of Cactus Reservoir. WCR 15 proposed to be realigned ~ 1 mile east of existing alignment, generally following eastern edge of reservoir. Part of WCR 19 vacated between Black Hollow Reservoir and WCR 94. 4 to 5 miles of WCR 90 inundated to accommodate reservoir.	7-mile portion of U.S. 287 relocated. New alignment 2.3 miles shorter. Location of Galeton Reservoir would not infringe on or disturb any existing roadways.	Same as Reclamation Action Option.	Same as Alternative 1 for WCRs. Location of Galeton Reservoir would not infringe on or disturb any existing roadways.	Same as Alternative 3.
Current Travel Patterns	New road built along west side of reservoir. Increased travel times (2 to 3 minutes) on WCR 19 between SH 14 and WCR 96. Vehicles using WCR 90 would have to travel around Cactus Hill Reservoir via new roadways and existing WCR 96, adding ~ 8 miles to current route and increasing travel times up to 10 minutes. Pipeline construction would potentially temporarily disrupt some transportation, depending upon alignment.	New U.S. 287 alignment would be about 2.3 miles shorter. Access to Bonner Spring Ranch Road may be affected by realignment and new access would be provided. Pipeline construction would potentially temporarily disrupt some transportation, depending upon alignment.	Same as Reclamation Action Option.	Same as Alternative 1.	Same as Alternative 1.
Site Access	No known impact.	Construction of Galeton Reservoir would require extension an existing roadway or construction of a private drive for purposes of accessing and maintaining facility.	Same as Reclamation Action Option	Same as Alternative 2.	Same as Alternative 2.
Land Use					
Agriculture	64,200 acres irrigated lands dried up. About 240 acres of permanent crop production loss at Cactus Hill Reservoir from inundation.	Portion of Munroe Canal inundated by Glade Reservoir. Canal would be realigned with Poudre Valley Canal or routed under Glade Reservoir.	Same as Reclamation Action Option.	About 555 acres of permanent crop production loss at Cactus Hill Reservoir from inundation.	Same as Alternative 3.
Grazing	64,200 acres of irrigated lands dried up. Some of this land previously used for crop production may be used for livestock grazing. About 2,315 acre currently used for grazing at Cactus Hill Reservoir would be lost.	Grazing permittee would lose use of District lands at Glade Reservoir. 26 acres of BLM land used for grazing inundated by Glade Reservoir About 36 acres of a grazing lease affected on State Land Board lands at Galeton Reservoir site.	Same as Reclamation Action Option.	About 3,235 acres of grazing land lost at Cactus Hill Reservoir. About 36 acres of a grazing lease affected on State Land Board lands at Galeton Reservoir site.	Same as Alternative 3.

Resource/Issue	Alternative 1	Alternative 2 Proposed Action Glade and SPWCP – Reclamation Action Option	Alternative 2 Proposed Action Glade and SPWCP – No Reclamation Action Option	Alternative 3 Cactus Hill, Poudre Valley Canal Diversion, and SPWCP	Alternative 4 Cactus Hill, Multiple Diversion Locations, and Modified SPWCP
Access	Anheuser-Busch would relocate its disposal of wastewater associated with beer production from Cactus Hill Reservoir site. Portions of WCR 15, 19, 88, 90, and 94 would be inundated by Cactus Hill Reservoir; 10.3 miles of WCR 15 and 19 would be realigned.	CSU and Poudre School District access road into State Trust Land inundated. Existing access to Bonner Springs Ranch residential area from south altered by U.S. 287 realignment. Construction of SPWCP forebay would inundate a portion of access road and parking area of Mitani-Tokuyasu SWA.	Same as Reclamation Action Option and access to Horsetooth Reservoir via Larimer County Roads 23 and 38E temporarily disrupted by construction of Carter pipeline. Construction of SPWCP forebay would inundate a portion of access road and parking area of Mitani-Tokuyasu SWA.	Portions of WCR 15, 19, 88, 90, and 94 would be inundated by Cactus Hill Reservoir; 10.3 miles of WCR 15 and 19 would be realigned. Construction of SPWCP forebay would inundate a portion of access road and parking area of Mitani-Tokuyasu SWA. Anheuser-Busch would relocate its disposal of wastewater associated with beer production from Cactus Hill Reservoir site.	Same as Alternative 3.
Utilities	Realignment of 6.8 miles of a 230-kV electric transmission line owned by Platte River Power Authority.	Two towers on Platte River Power Authority 230-kV transmission line relocated. Realignment of four H-frame structures and 0.6 miles of a 69-kV electric transmission line owned by Poudre Valley REA. Proposed Cheyenne-Totem gas pipeline is shown to partially parallel SPWCP pipelines and cross proposed Galeton Reservoir forebay. Thirty-one producing oil and gas wells are within Galeton Reservoir footprint. District would relocate any well that would interfere with reservoir operations. District anticipates all wells would be abandoned by operator before Galeton Reservoir was built.	Same as Reclamation Action Option.	Realignment of 6.8 miles of a 230-kV electric transmission line owned by Platte River Power Authority. Proposed Cheyenne-Totem gas pipeline is shown to partially parallel SPWCP pipelines and cross proposed Galeton Reservoir forebay. Thirty-one producing oil and gas wells are within Galeton Reservoir footprint. District would relocate any well that would interfere with reservoir operations. District anticipates all wells would be abandoned by operator before Galeton Reservoir was built.	Same as Alternative 3.
Natural Areas	No known permanent impact to natural areas would occur; depending on final pipeline alignments, temporary effects to natural areas could occur.	Reservoir Ridge Natural Area temporarily affected during construction of Glade to Horsetooth pipeline.	Reservoir Ridge, Maxwell, Pineridge, and Coyote Ridge natural areas temporarily affected by proposed alignment of Carter pipeline.	No known permanent impact to natural areas would occur; depending on final pipeline alignments, temporary effects to natural areas could occur.	Same as Alternative 3.
Urban/Residential	2 residences inundated during construction of Cactus Hill Reservoir and 6 residences located within 500 feet of the reservoir.	2 residences inundated during construction of Glade Reservoir and 1 residence located within 500 feet of the reservoir. Construction of Glade to Horsetooth pipeline and other pipelines could potentially temporarily affect some urban and residential uses, depending upon final alignments.	Same as Reclamation Action Option.	6 residences inundated during construction of Cactus Hill Reservoir and 10 residences located within 500 feet of reservoir. Pipeline construction would potentially temporarily affect some urban and residential uses, depending upon final alignments.	Same as Alternative 3.
Industry	Anheuser-Busch would lose private land used for wastewater disposal.	No impact to industry.	No impact to industry.	Anheuser-Busch would lose private land used for wastewater disposal.	Same as Alternative 3.
Socioeconomic Resources					
Study area					
Water Rates/Affordability	Moderate to major impact on rates and affordability for most Participants.	Minor impact on rates and affordability for some Participants.	Minor to moderate impact on rates and affordability for most Participants.	Minor to moderate impact on rates and affordability for most Participants.	Minor to moderate impact on rates and affordability for most Participants.
Population growth	Potential minor redistribution of future regional growth.	No effect.	No effect.	No effect.	No effect.
Poudre River Communities					
Recreation Resources	See Chapter 5.	Major impact on boating recreational value in Fort Collins. Moderate impact on recreational value of Poudre River Trail in Fort Collins. No effect on fishing recreation values.	Major impact on boating recreational value in Fort Collins. Moderate impact on recreational value of Poudre River Trail in Fort Collins. No effect on fishing recreation values.	Major impact on boating recreational value in Fort Collins. Moderate impact on recreational value of Poudre River Trail in Fort Collins. Moderate impact on fishing recreation values	Minor effect on boating recreation value in fort Collins. Minor effect on recreation value of Poudre River Trail in Fort Collins. Minor effect on fishing recreation values.
Property Values	See Chapter 5.	No effect in Fort Collins. Potential minor effects downstream of I-25 due to changes in flood risks.	No effect in Fort Collins. Potential minor effects downstream of I-25 due to changes in flood risks.	No effect in Fort Collins. Potential minor effects downstream of I-25 due to changes in flood risks.	No effect in Fort Collins. Potential minor effects downstream of I-25 due to changes in flood risks
Water/Wastewater Treatment Costs	See Chapter 5.	No effect.	No effect.	No effect.	No effect.

Resource/Issue	Alternative 1	Alternative 2 Proposed Action Glade and SPWCP – Reclamation Action Option	Alternative 2 Proposed Action Glade and SPWCP – No Reclamation Action Option	Alternative 3 Cactus Hill, Poudre Valley Canal Diversion, and SPWCP	Alternative 4 Cactus Hill, Multiple Diversion Locations, and Modified SPWCP
Other Socioeconomic Effects	See Chapter 5.	Likely no additional effect on Fort Collins economy/economic development. Potential major impact on nonuse values associated with Poudre River for Fort Collins residents.	Likely no additional effect on Fort Collins economy/economic development. Potential major impact on nonuse values associated with Poudre River for Fort Collins residents.	Likely no additional effect on Fort Collins economy/economic development. Potential major impact on nonuse values associated with Poudre River for Fort Collins residents.	No effect.
Broader Study Area					
Regional Recreation Resources	No effect.	Major benefit from recreation at Glade Reservoir.	Major benefit from recreation at Glade Reservoir.	No effect.	No effect.
Irrigated Agriculture-Related Economy	Moderate to major impact due to dry-up of 64,200 acres of irrigated lands.	No effect under average conditions. Minor effect under potential worst-case conditions due to increased salinity associated with the SPWCP ditch exchange.	No effect under average conditions. Minor effect under potential worst-case conditions due to increased salinity associated with the SPWCP ditch exchange.	No effect under average conditions. Minor effect under potential worst-case conditions due to increased salinity associated with the SPWCP ditch exchange.	No effect under average conditions. Minor effect under potential worst-case conditions due to increased salinity associated with the SPWCP ditch exchange.
Road Relocation Effects	No anticipated effects from WCR relocations at Cactus Hill.	Moderate to major impact on gasoline station and campground at Ted's Place. No net effect on value of residential properties.	Moderate to major impact on gasoline station and campground at Ted's Place. No net effect on value of residential properties.	Same as Alternative 1.	Same as Alternatives 1 and 3.
Construction Effects	Construction stimulus paid for by regional residents over future years. No net effect.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.
Agricultural-related economy	Estimated annual impact on agricultural-related economic output in the study area of approximately $34 million and an estimated reduction in agriculture-related employment of about 291 jobs associated with growth onto agricultural lands and their conversion to municipal uses. Estimated annual impact on economic output from agricultural water rights transfers under the No Action Alternative is estimated at $87 million, with a projected loss of 738 agriculture-related jobs.	Estimated annual impact on agricultural-related economic output in the study area of approximately $34 million and an estimated reduction in agriculture-related employment of about 291 jobs associated with growth onto agricultural lands and their conversion to municipal uses.	Estimated annual impact on agricultural-related economic output in the study area of approximately $34 million and an estimated reduction in agriculture-related employment of about 291 jobs associated with growth onto agricultural lands and their conversion to municipal uses.	Same as Alternative 2	Same as Alternative 2
Hazardous Sites	No anticipated effects to known sites.	Proposed Glade Reservoir forebay located near Atlas "E" Missile Site 13 and known TCE plume associated with missile site. Currently no detectable TCE within footprint of proposed forebay. Soil containing TCE not expected within proposed footprint of forebay. As contaminant mass continues to naturally attenuate TCE plume will continue to decrease in size.	Same as Reclamation Action Option.	No anticipated effects to known sites.	No anticipated effects to known sites.
Noise	Increased noise associated with reservoir and pipeline construction and realignment of WCR 15 and 19 would occur in localized areas temporarily.	Increased noise associated with reservoir and pipeline construction and realignment of U.S. 287 would occur in localized areas temporarily.	Same as Reclamation Action Option.	Same as Alternative 1.	Same as Alternatives 1 and 3.
Air Quality	Construction-related emissions.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.	Same as Alternative 1.
Energy Use/Greenhouse Gases	Electrical energy used to pump water up to reservoir and for conveyance of water. Projected annual electricity requirements at full utilization = 34,828,300 KwH Projected annual carbon dioxide emissions at full utilization (English tons) = 27,087	Electrical energy used to pump water up to reservoirs and for conveyance of water and for SPWCP exchange; includes additional pumping of water to Carter Lake. Projected annual electricity requirements at full utilization = 48,135,987 KwH Projected annual carbon dioxide emissions at full utilization (English tons) = 37,259	Electrical energy used to pump water up to reservoirs and for conveyance of water and for SPWCP exchange. Projected annual electricity requirements at full utilization = 61,302,050 KwH Projected annual carbon dioxide emissions at full utilization (English tons) = 47,677	Electrical energy used to pump water up to reservoirs and for conveyance of water and for SPWCP exchange. Projected annual electricity requirements at full utilization = 59,074,504 KwH Projected annual carbon dioxide emissions at full utilization (English tons) = 45,944	Electrical energy used to pump water up to reservoirs and for conveyance of water and for SPWCP exchange. Projected annual electricity requirements at full utilization = 64,445,426 KwH Projected annual carbon dioxide emissions at full utilization (English tons) = 50,122

Resource/Issue	Alternative 1	Alternative 2 Proposed Action Glade and SPWCP – Reclamation Action Option	Alternative 2 Proposed Action Glade and SPWCP – No Reclamation Action Option	Alternative 3 Cactus Hill, Poudre Valley Canal Diversion, and SPWCP	Alternative 4 Cactus Hill, Multiple Diversion Locations, and Modified SPWCP
Construction Duration	6 years (up to an additional 10 years to acquire necessary water rights).	6 years.	6 years.	6 years (up to an additional 3 years to acquire necessary water rights and an unknown time period to permit the relocation of Anheuser-Busch effluent disposal).	6 years (up to an additional 3 years to acquire necessary water rights and an unknown time period to permit the relocation of Anheuser-Busch effluent disposal).

CHAPTER 5

CUMULATIVE EFFECTS

CHAPTER 5

CUMULATIVE EFFECTS

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Chapter 5. Cumulative Effects

5.1 INTRODUCTION

Chapter 5 addresses the estimated cumulative effects of the NISP alternatives. A cumulative effect is defined as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and RFFAs regardless of what agency (federal or nonfederal) or person undertakes such other actions" (40 CFR Part 1508.7). Past actions have resulted in cumulative effects, which continue to influence the present environmental conditions, which in turn are predicted to be affected by the NISP alternatives and RFFAs.

During the final stages of developing the NISP SDEIS, the Cities of Fort Collins and Greeley requested that separate EISs be prepared for their proposed water supply projects, the enlargement of Halligan Reservoir and the enlargement of Seaman Reservoir, respectively. The Corps concurred with this request and published a Notice of Intent to separate the EISs on February 4, 2015. The two projects have independent utility and require separate authorizations by the Corps. The NISP SDEIS refers to these projects as the HSWSPs; however, they are two separate projects that are now being analyzed in two EISs. The CTP Run 5 hydrology, which includes the proposed Halligan and Seaman Reservoir enlargements, is still valid since the proposed actions for these projects have not changed. The Corps will continue to use the CTP for analysis of flow related effects for the two projects since the purpose of the CTP is to ensure a consistent approach is used between these projects and NISP.

The 404(b)(1) Guidelines state that "cumulative impacts are the changes in an aquatic ecosystem that are attributable to the collective effect of a number of individual discharges of dredged or fill material. Although the impact of a particular discharge may constitute a minor change in itself, the cumulative effect of numerous such piecemeal changes can result in a major impairment of the water resources and interfere with the productivity and water quality of existing aquatic ecosystems" (40 CFR 230.11[g][1]).

5.1.1 Past/Ongoing Present Actions

Past or ongoing actions were considered in the cumulative effects analysis if they met the following two criteria:

- Similar water- or land-related actions have occurred within the cumulative effects study area (Figure 5-1), or
- A past or current action, the incremental impact of which, when evaluated in addition to a NISP alternative, might have cumulative effects.

5.1.1.1 Past Water-related Actions

As described in the 2014 Water Resources Report (CDM Smith 2014a) and the 2014 Stream Morphology Effects Report (ACE 2014), the Poudre River has a long history of diversions, transbasin imports and channel modifications that have affected resources along the Poudre

River. These past actions have altered the historical hydrology of the mainstem and have established a trajectory for channel morphology, sediment transport, and wetland and riparian resources along the mainstem. This historical perspective and trajectory is discussed in Section 3.4.2, Section 3.12.1.3, and Section 4.9.1.1. These past actions have also affected the species composition of fish currently found in the mainstem. A total of 7 native species of fish historically found in the mainstem are believed to no longer inhabit the mainstem (Section 3.12.1.3).

Additionally, the following past actions have affected the channel and aquatic habitats of the mainstem:

- Channel confinement
- Channel realignment
- Levee construction
- Bank armoring
- Floodplain development
- Bridge construction
- Snag clearing
- Clearing of riparian areas for agriculture
- Aggregate mining within the floodplain
- Invasion of wetlands and riparian areas by nonnative species
- Encroachment of the active channel by wetland and riparian vegetation resulting in narrowing of the active channel

Similar past actions have occurred on the South Platte River as well.

5.1.1.2 Past and Ongoing Land-related Actions

The population of the region has grown steadily during the past decade. From 2000 to 2010, the overall average annual growth rate for the study area was 5.2% (Section 3.20.1.1.1). Past and continuing population growth and accompanying commercial and residential development has altered, and continues to alter, the landscape of the region as historically rural agricultural land is developed. Ongoing oil and gas development in the region is anticipated to continue over the near-term. Oil and gas development has fueled population growth in the region and oil and gas pads, roads, and collection and conveyance systems have disturbed lands in the region.

5.1.2 Reasonably Foreseeable Actions

Actions that are likely to occur by 2050 and meet all of the following criteria were considered reasonably foreseeable and were included in the cumulative effects analysis:

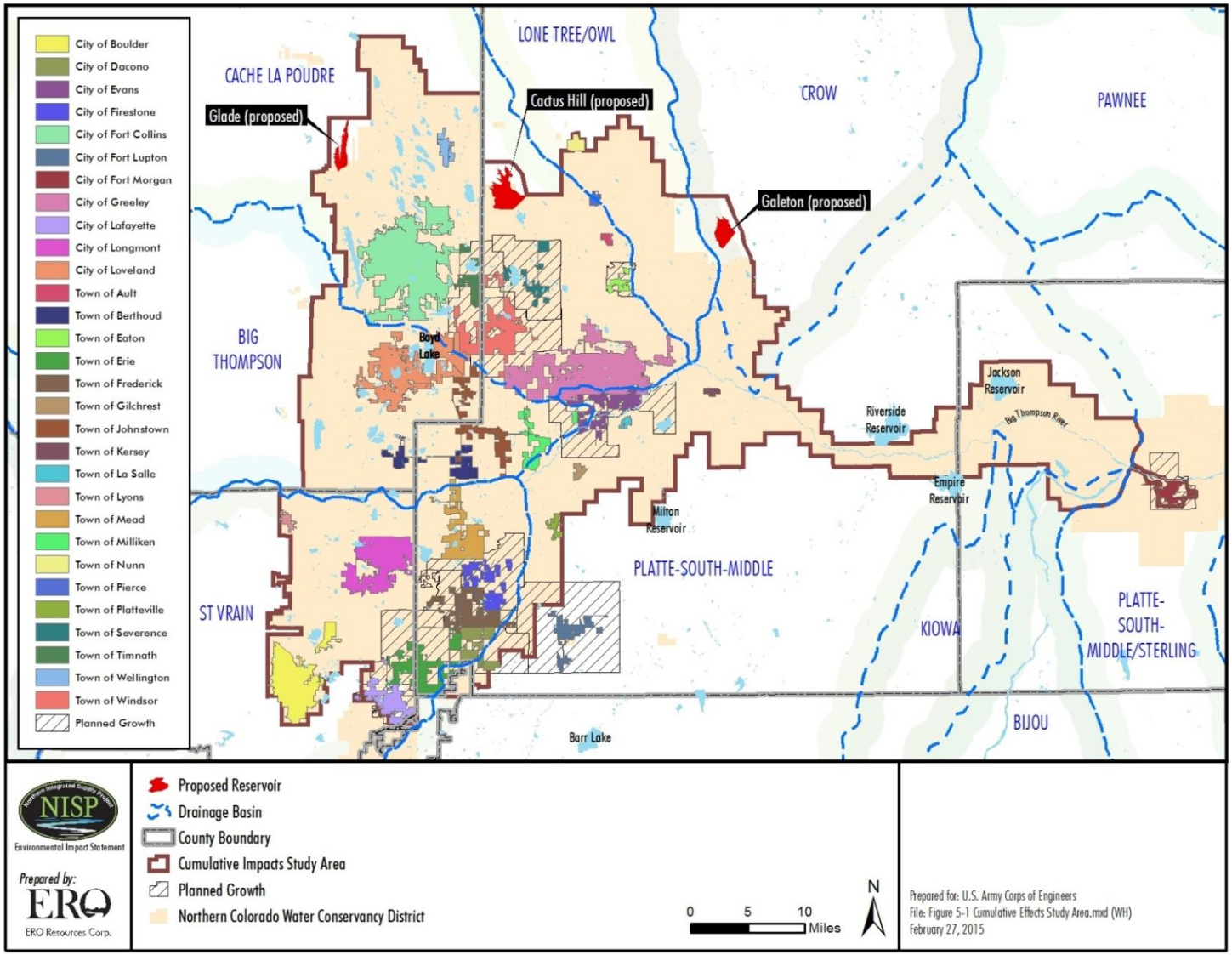
- The action would occur within the same geographic area where effects from the NISP alternatives are expected to occur (the cumulative effects study area is shown in Figure

5-1, and includes the District boundaries, outside of which, impacts from NISP are not expected to occur).

- The action would affect the same environmental resources as the NISP alternatives, and measurably contribute to the total resource impact.
- There is reasonable certainty as to the likelihood of the future action occurring; the future action is not speculative.
- There is sufficient information available to define the future action and conduct a meaningful analysis.

The RFFAs are divided into flow-related and land-based actions. Flow-related RFFAs are actions predicted to affect flows in the Poudre and/or South Platte Rivers. The flow based RFFAs were considered in developing the CTP hydrologic modeling for Future Conditions Effects and Cumulative Effects. The CTP hydrologic runs used in the cumulative effects analysis for flow-related resources are described in detail in Section 5.2.1.

Figure 5-1. Cumulative Effects Study Area.



5.1.2.1 Flow-related Reasonably Foreseeable Future Actions Included in the CTP Hydrologic Modeling

As defined for the CTP modeling analyses, the RFFAs include those water supply infrastructure projects and operational actions that are likely to be undertaken (i.e., are "reasonably foreseeable") by water providers during the planning period to 2050 for NISP and the HSWSPs, but are independent of the Applicants' Proposed Actions and alternatives for NISP and the HSWSPs. RFFAs may include independent water supply system improvements by the District, the individual NISP Participants, Fort Collins, Greeley, NPIC, or other agricultural, municipal, domestic, or industrial water providers. The RFFAs, along with 2050 municipal and agricultural water demands, define the Future Conditions hydrology (Table 5-1). The following assumptions regarding RFFAs were used in all Future Conditions hydrology modeling:

- The amount of Colorado-Big Thompson (C-BT) Project water delivered to agricultural users in 2050 was reduced in accordance with analyses performed by the District to simulate the ongoing transfer of C-BT Project units to, and the increased use of C-BT water by, municipal water providers. Additional information on the trend of the transfer of C-BT units from agricultural ownership to M&I can be found in Section 2.2.5.2 and Appendix 2 of the 2013 CTP Hydrologic Modeling Report (CDM Smith and DiNatale 2013).
- The District's C-BT carryover policy allows C-BT allottees to retain a percentage of their annual water allocation in storage in C-BT reservoirs for use in future years. The C-BT carryover policy was incorporated into the environmental effects analyses since the District stated during CTP model development that the policy will not likely change. However, for HSWSPs firm yield and project sizing model runs, it is assumed that the C-BT carryover policy is not permanent and is therefore not available. This was a conservative assumption for water supply planning requested by the HSWSPs participants (Section 2.5.1.2, CDM Smith and DiNatale 2013).
- The Tri-Districts specified reasonable assumptions for their future (2050) water supply sources and infrastructure (CDM Smith 2010, see Technical Appendix 5). This information is incorporated into the PBN and the Tri-Districts System Model as appropriate for Future Conditions modeling.
- There will be increased demand for augmentation of wells that are withdrawing lower South Platte River tributary ground water. This demand is accounted for in the PBN.
- The Moffat Collection System Project, Chatfield Reservoir Reallocation Project, Denver Water Board Reuse Project, and the Aurora Prairie Waters Project will have effects accruing to the South Platte River above the confluence with the Poudre River. The effects of these projects are included in adjustments made to South Platte River flows to capture the effects of future Front Range urbanization and reuse by water providers.
- Greeley's Bellvue Pipeline will increase the City's delivery capability and may reduce exchange potential in certain reaches of the Poudre River. This reduction in exchange potential is included in the calculations of monthly final river flows.

- Fort Collins, Greeley, and the Tri-Districts will use the Overland Trail Gravel Pits for municipal water supply storage. Fort Collins will also use the South Gravel Pit, and Greeley will have additional gravel pit storage in the lower Poudre Basin.
- The CTP modeling of Future Conditions hydrology assumes that the Windy Gap Firming Project (WGFP) is successfully completed, and the projected WGFP yield is factored into the inputs developed for the Greeley System Model for Future Conditions model runs.
- Development of junior conditional rights will be subject to meeting fish hatchery and recreational minimum flow targets for the Poudre River at Watson Lake, the Fort Collins Boat Chute, and the Fort Collins Nature Center. Decrees and stipulations governing the administration of these water rights are discussed in Section 7.5.1 of the 2013 Hydrologic Modeling Report (CDM Smith and DiNatale 2013).
- Future agricultural water demands will be reduced due to agricultural-to-municipal water transfers. Municipal water demands will be increased to reflect the addition of these supplies to the water providers' portfolios.

The above RFFAs are represented in the Future Conditions model runs through modifications to the PBN and, where appropriate, the individual water providers' system models.

Table 5-1. RFFAs considered for the CTP model runs.

Key Modeling Component		Model Sequence			Inclusion in Model Run or Qualitative Analysis?	
Component #	**Modeling Component**	**Run 2 – Future Conditions**	**Run Series 4 – Future Conditions Effects**	**Run Series 5 – Cumulative Effects**	**Included in Model Runs**	**Qualitative**
1	Reduction in M&I leased CBT water delivered to Poudre agricultural users and decreased agricultural CBT ownership. Used NCWCD CBT Projection Tool.	**X**	**X**	**X**	**X**	
2	CBT Carryover Policy	**X**	**X**	Ran model series both with and without the CBT Carryover Policy for a HSWSPs sensitivity analysis	**X**	

Key Modeling Component		Model Sequence			Inclusion in Model Run or Qualitative Analysis?	
Component #	**Modeling Component**	**Run 2 – Future Conditions**	**Run Series 4 – Future Conditions Effects**	**Run Series 5 – Cumulative Effects**	**Included in Model Runs**	**Qualitative**
3	Tri-Districts RFFAs (plains reservoirs, agricultural acquisitions and conversions, Overland pits, pipeline from Overland to Pleasant Valley Pipeline, North Weld-Elko Water Transmission (NEWT pipeline), non-potable ditch for M&I delivery, ownership of Worster Reservoir, etc.)	**X**	**X**	**X**	Tri-District exchanges from Overland Trail Pits and direct flow rights to Munroe/ Pleasant Valley Pipeline will be included	Tri-Districts and others use of ditch water for nonpotable impacts demands and not flows
4	City of Thornton RFFAs (junior water right, WSSC exchanges/diversions)					The Corps met with Thornton in 2011 and Thornton indicated that its projections show that Thornton will not use/need their conditional and/or exchange rights by 2050
5	Non-NISP/HSWSPs contemplated future M&I agricultural conversions (Windsor, Wellington, Ault, etc.)					**X**
6	Nonpotable reuse	**X**	**X**	**X**		**X**
7	Box Elder flood control					**X**
8	Red Feather Lakes reservoir					**X**
9	Cache la Poudre Flood Reduction and Ecosystem Restoration Project					**X**
10	Augmentation of Lower South Platte River wells	**X**	**X**	**X**	Any impacts will be on South Platte and Poudre River flows. Modeled South Platte River flows incorporate augmentation assumptions.	

Key Modeling Component		Model Sequence			Inclusion in Model Run or Qualitative Analysis?	
Component #	**Modeling Component**	**Run 2 – Future Conditions**	**Run Series 4 – Future Conditions Effects**	**Run Series 5 – Cumulative Effects**	**Included in Model Runs**	**Qualitative**
11	Dry Creek Reservoir Project;	X	X	X	Any impacts of these projects will be on South Platte River flows upstream of the Poudre and South Platte River confluence; flows have been modified in the model for these projects.	
12	Moffat Collection System Project	X	X	X		
13	Chatfield Reservoir Reallocation Project					Not modeled explicitly but due to the relatively low firm yield and location of Participants it is effectively covered by the reuse/urbanization adjustments
14	Denver Water Board Reuse Project	X	X	X		
15	City of Aurora Prairie Waters Project	X	X	X		
16	Bellvue Pipeline (Greeley)	X	X	X	X	
17	Overland Trail Pits (Greeley)	X	X	X	X	
18	Greeley lower Poudre gravel pits	X	X	X	X	
19	Nonpotable ditch systems for M&I irrigation (Greeley)	X	X	X	Greeley's use of ditches for nonpotable is reflected in demands	
20	Windy Gap Firming Project	X	X	X	Yield from Greeley's Windy Gap Firming Project participation	
21	Overland Trail Pits (Fort Collins)	X	X	X	X	
22	South Gravel Pit (Fort Collins)	X	X	X	X	
23	Fort Collins Nature Center, Boat Chute and Watson in streamflow rights	X	X	X	X	
24	NISP and HSWSPs Conditional rights for Projects/Alternatives: Halligan Enlargement Seaman Enlargement Grey Mountain Rockwell		X	X	X	

Key Modeling Component		Model Sequence			Inclusion in Model Run or Qualitative Analysis?	
Component #	**Modeling Component**	**Run 2 – Future Conditions**	**Run Series 4 – Future Conditions Effects**	**Run Series 5 – Cumulative Effects**	**Included in Model Runs**	**Qualitative**
25	Increased municipal agricultural ownership to projected 2050 portfolios	**X**	**X**	**X**	**X**	
26	NISP Operations		**X**	**X**	**X**	
27	Enlarged Halligan		**X**	**X**	**X**	
28	Enlarged Seaman		**X**	**X**	**X**	

5.1.2.2 Flow-related Reasonably Foreseeable Future Actions Not Included in the CTP Hydrologic Modeling

The following flow-related RFFAs were not included in the CTP hydrologic modeling.

Minimum Instream Flows within Fort Collins. Identification of management options that reduce or eliminate low flows as well as moderate low-flow volatility, and is working toward establishment of a dedicated minimum instream flow within Fort Collins. The establishment of these instream flows could improve water quality and aquatic habitat within Fort Collins.

Soldier Canyon Filter Plant/Tri-Districts Storage in Horsetooth Reservoir. The Tri-Districts have requested a 40-year excess capacity contract in Horsetooth Reservoir from Reclamation. The initial request is for an excess capacity account for 3,000 AF with the ability to increase the volume up to 7,000 AF within the 40-year term of the contract. The Tri-Districts have also requested an exchange of up to 3,000 AFY into storage with the ability to increase the exchange volume. Reclamation approved 1-year temporary contracts for 3,400 AF in 2012 and for 1,250 AF in 2013. The Tri-Districts will continue to request temporary contracts until the 40-year contract approval process has been completed. An exchange is required along the Hansen Supply Canal to move Tri-Districts' Poudre River water supplies into Horsetooth Reservoir. The Tri-Districts will need to also obtain an agreement with the District to utilize the Hansen Supply Canal to facilitate the required exchange. The majority of the releases from Horsetooth Reservoir to the Soldier Canyon Treatment plant are expected to occur during the winter based on operations with the temporary contracts in 2012 and 2013. The additional requested storage in Horsetooth Reservoir could affect future reservoir levels; however, any changes in reservoir levels due to the requested storage would be minor because the maximum requested storage volume of 7,000 AF is about 5% of Horsetooth Reservoir's capacity. Exchanges with C-BT facilities associated with Alternative 2 Reclamation Action Option that could involve changes in operations of the Hansen Supply Canal could potentially affect the Tri-Districts ability to use the Hansen Supply Canal to facilitate the required exchange.

Future Changes in Water Quality Standards. Recent water quality regulatory initiatives by CDPHE will affect future effluent limits for total phosphorus (TP) and total inorganic nitrogen

(TIN) which could improve water in the Poudre and South Platte Rivers in the future. There are two pending regulatory initiatives that are likely to affect the operation of WWTPs and water quality in Colorado streams and rivers:

1. When the numeric nutrient criteria in Regulation 31 becomes effective in 2022, the interim TP concentration of 0.17 mg/L, and 2.01 mg/L for TN will become the in-stream standards. All WWTPs discharging to the Poudre River will likely have to install supplemental phosphorous and nitrogen removal facilities beyond those needed for compliance with Regulation 85. This could include biological and/or chemical removal facilities, as well as second stage denitrification and soluble carbon addition.
2. In August 2013, EPA promulgated new and more stringent instream ammonia standards. The new standards now include the protection of fresh water mussels and gill-bearing snails. CDPHE has not yet determined how and when the new criteria will be implemented in Colorado. It is assumed that the new standards will be applied throughout Colorado except where dischargers demonstrate that its receiving stream does not contain fresh water mussels and gill-bearing snails or the habitat for them (which have not yet been evaluated for the Poudre River). The new criteria substantially reduce allowable instream ammonia concentrations under chronic (30E3) conditions.

These projected changes in water quality regulations and waste water treatment would likely affect future water quality in a similar manner under all of the alternatives.

5.1.2.3 Land-based Reasonably Foreseeable Actions

Land-based RFFAs are actions that would involve construction of residential, commercial, and industrial structures, construction and expansion of city, county, state, and federal roads and highways, construction of reservoirs and pipelines (these may be considered in the context of flow-related and land-based actions, and they likely involve both types of impacts), placement of utility lines and pipelines, oil and gas development, mining, and other infrastructure such as railroads and airports, and other continuing or future actions that could have overlapping impacts with NISP reservoir construction. The construction of Chimney Hollow Reservoir, the expansion of Halligan and Seaman Reservoirs, and several proposed actions associated with the Poudre River described below are considered land-based actions as well as flow related actions, because they would affect the lands on which they are constructed.

Population Growth in the Northern Front Range. Continued population growth and accompanying commercial and residential development is expected to occur in the northern Front Range Colorado communities served by the Participants regardless of the NISP alternatives.

Land Development. A variety of new land developments are expected to occur in the vicinity of the potential NISP reservoir sites in Larimer and Weld Counties. In September 2005, Holcim (U.S.), Inc. auctioned approximately 3,080 acres of property located mostly east of the proposed realignment alternative for U.S. 287. Most of the auctioned property includes 35-acre or greater

parcels for residential development. The plat approved by Larimer County includes about 60 residential parcels, some of which occur near the proposed realignment for U.S. 287.

North I-25 Transportation Improvements. CDOT evaluated multi-modal transportation improvements such as inter-regional bus service, combination general purpose/high occupancy vehicle lanes, and passenger rail service along about 60 miles of the I-25 corridor between the Fort Collins-Wellington area and Denver. The North I-25 EIS was finalized and a ROD was signed in 2011. To accommodate funding limitations, CDOT anticipates constructing the improvements in phases over time. CDOT is currently in the design process for the segments to be improved.

Commercial and Residential Development along the Poudre River in Fort Collins. Woodward Technologies is building a legacy headquarters and manufacturing campus on the former Link-N-Greens golf course on the north side of the Poudre River between Lincoln and Mulberry avenues west of Lemay Avenue. Woodward has donated 31 acres for Natural Areas and habitat restoration. The campus is expected to employ 1,400 people. Additionally, a variety of residential and commercial developments are proposed to occur near the Poudre River.

Poudre Trail Connections. The City of Fort Collins is planning to extend the Poudre River Trail to the southeast from its current terminus at the Environmental Learning Center, to a new underpass at I-25 to reach the town of Timnath. These connections are planned for construction in phases, beginning with the I-25 underpass (City of Fort Collins 2013, 2014). A future connection between Timnath and Windsor has been envisioned, but is not currently planned or funded. On the east side of Greeley, an extension of the Poudre River Trail is also envisioned to extend from Island Grove Park to the east towards the South Platte River (City of Greeley 2011).

Oil and Gas Development. Ongoing oil and gas development in the region is anticipated to continue over the near-term. Oil and gas pads, roads, and collection and conveyance systems will continue to disturb lands in the region. Oil and gas development in the region typically involves hydraulic fracturing to increase the extraction of oil and gas from deep shale formations. Hydraulic fracturing uses primarily water, as well as chemical additives and propping agents such as sands to keep fractures in the shale open once they are produced under pressure. The hydraulic fracturing process can also result in produced water that needs to be disposed. Water for hydraulic fracturing currently comes from a variety of regional sources, including short-term leases from some of the NISP Participants. As the oil and gas development matures in the region, the oil and gas companies are developing their own long-term sources of water for hydraulic fracturing. The firm yield of NISP is not intended to support future oil and gas development and hydraulic fracturing in the region, which has developed independently of NISP and will continue in the region with or without NISP.

Mountain Pine Beetle Infestation. Infestation of pines, particularly lodgepole pine, by the mountain pine beetle (MPB) in the Poudre River watershed is expected to continue. Based on studies of clear-cuts in watersheds some researchers have predicted increased run-off associated with the beetle kill. However, recent studies caution against assuming that total yield will change in a consistent direction and magnitude across all beetle-affected watersheds. A change in runoff timing to earlier runoff peaks is more likely to occur (Lukas and Gordon 2010). This

predicted change in timing of peak runoff could be amplified by climate change. Initial results from recent field studies, in general, do not indicate nutrient loading or other water chemistry changes of the magnitude that would present problems for either human water use or aquatic ecosystems. However, total organic carbon (TOC) in streams was observed to increase from needle cast (Lukas and Gordon 2010). Future MPB infestations in the Poudre River watershed may change runoff timing to earlier runoff peaks and increase TOC levels in the Poudre River until a new forest canopy is established.

Poudre River Restoration Projects. The City of Fort Collins Natural Areas Department is sponsoring or collaborating on the following restoration projects along the Poudre River that are intended to increase the health of aquatic and riparian resources:

- Restoration work in the vicinity of the North Shields Ponds Natural Area to create in-river habitat, reconnect the Poudre River with its adjacent floodplain through riverbank lowering, and expanding the river's native cottonwood woodlands
- Restoration in the vicinity of the McMurry Natural Area that will lower a quarter mile of the north riverbank and reconnect the Poudre River to its historical floodplain
- Restoration work adjacent to the Poudre River near the Woodward Governor development (referenced above)
- Restoration of a gravel pit north of Strauss Cabin (POE Pit) for habitat enhancement and channel stability

Poudre River Corridor Conservation Plans. The Poudre River corridor has been identified as a land conservation focus area in the City of Fort Collins Natural Area Master Plan, while the areas near Timnath and Windsor have also been identified as desired community separators. This designation directs the City to continue to collaborate with neighboring communities and governments on conservation efforts in these areas. No specific conservation actions are identified in the plan (City of Fort Collins 2014); however, in 2015, more than 200 acres adjacent to or near the Poudre River were acquired by the City.

Modification of Diversion Structures. The City of Fort Collins is planning to modify the Fossil Creek Reservoir Diversion and other diversion structures on the Poudre River in the Fort Collins area to allow fish passage.

Improvements to Lee Martinez Park. The City of Fort Collins will be implementing improvements to Lee Martinez Park, including riverfront improvements.

Post-fire Restoration Activities. Numerous organizations are involved in implementing post-fire restoration activities in the Hewlett Gulch and High Park burn areas. These restoration activities could improve water quality and reduce sediment contributions for the Poudre River in the future.

Greeley Poudre River Flood Control and Environmental Restoration Project. The Corps and the City of Greeley are investigating opportunities for flood control through the implementation of wetland and riparian restoration projects on a 17-mile reach of the Poudre River beginning at Weld County Road 27, running through Greeley and ending at the confluence

with the South Platte River. This reach of the Poudre River has been the subject of planning efforts to reduce the potential for flood damage and to enhance habitat value. This reach of the river passes through the northeast corner of downtown Greeley and has been termed the high damage reach by City planners due to flooding of neighboring properties.

Fort Collins Poudre River Master Plan. The City of Fort Collins has developed a draft master plan for the Poudre River in the downtown corridor (Shields Street to Mulberry Street) to improve in-river and bankside recreation, habitat connectivity, restoration and rehabilitation, bank protection, flood mitigation and floodplain management, water quality, public safety and access, and transportation. These improvements are anticipated to take decades to implement. The focus for work in 2015 and 2016 is expected to occur in the reach between College Avenue and the Burlington Northern Railroad bridge. The Master Plan for this reach of the Poudre River also includes construction of the whitewater park and removal of the Coy Ditch diversion.

5.1.3 Actions Not Considered Reasonably Foreseeable

A summary of potential actions considered and the reasons why they are not reasonably foreseeable is discussed below. Although these actions are not currently considered reasonably foreseeable, they could occur at some point in the future; however, based on the best available information, these actions did not meet the criteria for reasonably foreseeable actions (Section 5.1.2).

Decrease in Acres of Agricultural Farmland. In Boulder, Larimer, Morgan, and Weld Counties (the counties in which the NISP Participants are located), the area of agricultural farmland has decreased in the past 20 years, and likely will continue to decrease due to commercial and residential development and the transfer of irrigation water to M&I uses. The specific timing, amount, and location of the decreases in farmland cannot be accurately determined and would be speculative to consider for the cumulative effects analysis. However, the general trend of decreased agricultural lands is considered when determining the cumulative effects of the transfer of irrigation water from agricultural lands associated with the No Action Alternative and to the degree that the No Action Alternative would add to or accelerate this regional trend.

Ongoing Gravel Mining. It is likely that gravel mining will continue in northeastern Colorado, and that many gravel mines will be converted to water storage lakes following mining. It is not possible to accurately predict the specific location and timing of the mining because they are subject to market forces. However, the general trend of continued gravel mining and conversion of many of the gravel mines to water storage lakes following mining is recognized.

Wildfire in the Poudre River Watershed. Periodic wildfires have occurred in the Poudre River watershed and will continue to occur. When and where the fires will occur and the severity of the fires cannot be predicted. When wildfires occur, they will temporarily reduce vegetation cover within the watershed and likely introduce sediment and ash into the river that can affect water quality, sediment supply, aquatic habitat, and the operations of water supply

projects either directly affected by the fires or indirectly by associated water quality, ash, and sediment.

For example, the 2012 Hewlett Gulch and High Park fires burned a contiguous area of about 95,000 acres in the Poudre River watershed. These were the two largest fires in recorded history for the Poudre River watershed (Oropeza and Heath 2013). Ash and sediment associated with the fires were introduced into the Poudre River and in early July 2012 the cities of Fort Collins and Greeley temporarily curtailed diversions from the Poudre River due to poor water quality. Changes in water quality due to the fires were of short duration and typically followed localized rain events. Long-term changes in water quality associated with the fires have not been observed (http://www.fcgov.com/common/pdfs/spotlight-pdf.php?id=611). Background (non-event) TOC concentrations did not appear to be affected by post-fire conditions. Storm events did mobilize organic carbon and resulted in elevated concentrations; however, the response was small and did not pose concerns to water treatment (Oropeza and Heath 2013). As long as the burned hill slopes are exposed, the potential for sediment introductions to the river remain.

Large rainfall events in September 2013 created flows in the Poudre River estimated to be about 8,000 cfs, which flushed most of the observable ash from the river. This cycle of periodic wildfire and large flows that flush ash and sediment are expected to occur in the future in the Poudre River watershed. NISP diversions during such high flows would have little effect on the high flows due to limited diversion capacity. The NISP alternatives involve proposed off-channel reservoirs that are unlikely to be significantly affected by wildfires and associated filling with ash and sediment, although NISP diversions may need to be curtailed during periods of poor water quality associated with wildfires.

The timing, location, and severity of wildfires in the Poudre River watershed cannot be accurately determined and would be speculative to consider for the cumulative effects analysis.

Emerald Ash Borer Infestation. Emerald ash borer (EAB) was found in Boulder, Colorado, in September 2013. As a non-native insect, EAB lacks predators to keep it in check. EAB only attacks ash trees, and is responsible for the death of millions of ash trees in the Midwest (http://www.colorado.gov/cs/Satellite/ag_Plants/CBON/1251646251641).

If not contained, the EAB is likely to spread along the Front Range. If and when the EAB invades the Poudre River area cannot be accurately predicted. Riparian areas along the Poudre River, as well as urban forests in the region, support green ash that will be susceptible to EAB infestation. Infestation by the EAB would adversely affect riparian woodlands with a green ash component as well as the urban forest in the region. Studies for the EIS project that green ash will become a larger component of the mainstem Poudre River riparian woodlands and plains cottonwood will decrease in the future (with or without the NISP alternatives). If green ash becomes a substantial component of the mainstem Poudre River woodlands and is then infested by EAB, the loss of green ash would be an adverse effect to the riparian woodlands.

The occurrence and timing of an EAB infestation in the Poudre River region cannot be accurately determined and would be speculative to consider for the cumulative effects analysis.

5.1.4 Climate Change

On December 24, 2014, CEQ issued draft NEPA guidance on climate change and greenhouse gas emissions. Section IV of the draft guidance states: "An agency should identify the affected environment so as to provide a basis for comparing the current and the future state of the environment should the proposed action or any of its reasonable alternatives proceed." 40 CFR 1502.16 and 1508.9. Additionally, "The analysis of impacts on the affected environment should focus on those aspects of the human environment that are impacted by both the proposed action and climate change." Section IV goes on to say that agencies should identify the "reasonably foreseeable future condition of the affected environment," which would take climate change into account. Each of the following resource sections includes a discussion of how climate change may affect the respective resource. In addition to the analysis of predicted changes to the hydrology of the Poudre River with climate change, other future factors associated with climate change (e.g., increases in temperature, increases in the number and duration of droughts and increases in evaporation and transpiration) are identified that could affect each resource.

5.2 SURFACE WATER RESOURCES

The assessment of how river flows would change with RFFAs and the alternatives (i.e., with Future Conditions hydrology) forms the basis for the cumulative effects assessment for the flow-related resources. This section describes how the modeling for Future Conditions Effects and Cumulative Effects was developed, what hydrologic modeling runs apply to the assessment of Cumulative Effects and how Poudre and South Platte River flows are predicted to change under Future Conditions Effects and Cumulative Effects for the alternatives. The time series data output from the hydrologic modeling were provided for use as inputs to the models and other analytical tools for assessing potential NISP impacts to other flow-related or flow-dependent resources. The resource analysts using these datasets contributed to QA/QC reviews of the modeled streamflows, which were deemed acceptable to use for all intended analytical purposes for their respective resources. The flow-related resource analyses, including water quality, river morphology, sediment transport, aquatic habitat, ground water, riparian areas, and wetlands, are documented in other technical reports and subsequent sections herein.

5.2.1 NISP Alternatives and Hydrologic Model Runs

The CTP hydrologic modeling (CTP Runs 1 and 2 and Run Series 3, 4, and 9) was used to predict the effects of flow changes associated with the NISP alternatives on the flow-related resources. The Run 5 series of the CTP hydrologic modeling was used to predict the cumulative effects of NISP and the proposed actions for the Halligan-Seaman Water Supply Projects (HSWSPs) on flows when combined with RFFAs. The RFFAs are listed in Section 5.1.2 and are discussed in Section 1.2.6 of the CTP Hydrologic Modeling Report (CDM Smith and DiNatale 2013). The following terms are used to describe the hydrologic model runs when discussing predicted effects for the flow-related resources:

- Current Conditions (2010 flows - Run 1)
- Future Conditions (2050 flows with RFFAs - Run 2)
- Current Conditions Effects (2010 flows with NISP alternatives - Run Series 3)
- Future Conditions Effects (2050 flows with RFFAs + NISP alternatives - Run Series 4)
- Cumulative Effects (2050 flows with RFFAs + HSWSPs + NISP alternatives - Run Series 5)
- Alternative 1 effects (2050 flows with RFFAs + No action Alternative - Run 9a)

The RFFAs, along with 2050 municipal and agricultural water demands, define the Future Conditions hydrology (CTP Run 2; see Section 4.2.1.1.3). The Future Conditions hydrology with each of the action alternatives (NISP Run 4 series) is used for comparison to determine cumulative effects for the alternatives (NISP Run 5 series) (Table 5-2). The modeled changes in streamflow associated with the RFFAs, action alternatives and cumulative effects and associated trends can be traced by comparing CTP Run 2 with the Run 4 series and then the Run 5 series.

Table 5-2. Summary of NISP alternatives and associated Cumulative Effects hydrology model runs.

Alternative Number	Alternative Name	Cumulative Effects Comparison
1	No Action	No Comparison
2	District's Proposed Action – Glade Reservoir and South Platte Water Conservation Project (SPWCP)	Runs 4a vs. 5a
3	Cactus Hill Reservoir, Poudre Valley Canal Diversion, SPWCP	Runs 4b1 vs. 5b1
4	Cactus Hill Reservoir, Multiple Diversion Locations, SPWCP	Runs 4b2 vs. 5b2

Key to Runs:
Run 4a – NISP with RFFAs – Glade (Alternative 2).
Run 4b1 – NISP with RFFAs – Cactus Hill (Alternative 3).
Run 4b2 – NISP with RFFAs – Cactus Hill (Alternative 4).
Run 5a – NISP cumulative effects (Glade – Alternative 2, Halligan Seaman, and RFFAs).
Run 5b1 – NISP cumulative effects (Cactus Hill – Alternative 3, Halligan Seaman, and RFFAs).
Run 5b2 – NISP cumulative effects (Cactus Hill – Alternative 4, Halligan Seaman, and RFFAs).

For cumulative effects assessments, the proposed actions for the HSWSPs include the proposed enlargements of the existing Halligan Reservoir and Seaman Reservoir, both located on-channel on the North Fork of the Poudre River. Descriptions of the proposed NISP alternatives are provided in Chapter 2. The No Action Alternative was evaluated under Future Conditions hydrology only, as explained in Section 4.2.2. NISP Run 9a was compared to Future Conditions hydrology (CTP Run 2) to predict how changes in Poudre River flows due to the No Action Alternative would affect flow-related resources along the mainstem.

CTP Run 2 shows the predicted effects of the RFFAs without NISP or HSWSPs. The Run 4 series shows the predicted effects of adding the NISP action alternatives to CTP Run 2. The Run 5 series shows the predicted effects of the NISP action alternatives in combination with the HSWSPs and CTP Run 2. Therefore, the comparisons of the Run 5 series vs. Run 4 series are effectively an estimate of the impacts of the HSWSPs proposed actions, i.e., the incremental effects of the HSWSPs added to the RFFAs, as configured for the NISP SDEIS hydrologic modeling (see Section 7.5.2 of the CTP Hydrologic Modeling Report [CDM Smith and DiNatale 2013]). Run 5 series represents the Cumulative Effects hydrology after incorporating the effects of the NISP action alternatives combined with RFFA and HSWSPs.

NISP diversions are very similar in the Run 4 series and Run 5 series. For example, total NISP diversions at the Poudre Valley Canal with Run 4a (Table 5-2 for model run numbers descriptions) were modeled at 43,300 AFY and total NISP diversions at the Poudre Valley Canal with Run 5a were modeled at 43,600 AFY. Therefore, most of the differences in flow and flow related effects between the Run 4 series (Future Conditions with NISP) and Run 5 series (cumulative effects) are considered attributable to the proposed HSWSPs.

For Alternative 2 there are two options proposed. Under the Reclamation Action Option, 10 of the 15 NISP Participants would take an average annual NISP delivery of 29,500 AFY by exchange through C-BT Project facilities, with the remaining 10,500 AFY delivered by means not involving C-BT facilities. Under the Reclamation No Action Option, all NISP Participants

would take full deliveries totaling 40,000 AFY directly from Glade Reservoir through existing or new pipeline facilities, or through releases to the Poudre River. Further details regarding the Reclamation Action Option and Reclamation No Action Option are provided in Section 1.3.2.3 of the Water Resources Technical Report (CDM Smith 2014a).

As described in Section 4.2.3.4.1 (see Figure 4-21 and text immediately preceding and following), streamflow differences between the Reclamation Action Option and the No Reclamation Action Option for Alternative 2 are anticipated to be minimal and would affect only a limited reach of the Poudre River between the Poudre Valley Canal diversion and the Hansen Supply Canal outlet. In addition, the proposed flow augmentation program (see Section 4.2.1.1.3) would be included under both options. As a result, there is a single unique set of with-project streamflows to analyze for Alternative 2 with each modeled hydrologic scenario (Current Conditions hydrology, NISP Run 3a; Future Conditions Effects hydrology, NISP Run 4a; and Cumulative Effects, CTP Run 5a).

The modeled cumulative effects hydrology does not include any potential mitigation requirements for the RFFAs, NISP or HSWSPs that would lessen flow reductions currently modeled for the Run 4 and Run 5 series.

5.2.2 Modeled Demands – Future Conditions Effects and Cumulative Effects

The proposed NISP demand is simulated as 42,000 AFY (40,000 AFY firm yield request by the Participants plus 5% [2,000 AFY] to account for seepage, transit losses, shrink charges, and other factors) in all alternatives model runs. Municipal and industrial demands for HSWSPs Applicants City of Fort Collins and City of Greeley are modeled as shown in Table 5-3 under Future Conditions Effects (Run Series 4) and Cumulative Effects (Run Series 5) scenarios.

Table 5-3. Average modeled municipal demands under Future Conditions hydrology, IY 1950-2005, in AFY.

Entity	2050 Future Conditions Hydrology (CTP Run 2)	NISP Alternatives with Future Conditions Hydrology (NISP Runs 4a/4b1/4b2)	NISP Alternatives with Cumulative Effects of HSWSPs Proposed Actions (CTP Run 5a and NISP Runs 5b1/5b2)
Fort Collins	36,090	36,090	38,570
Greeley	48,130	48,130	55,150

As shown in Table 5-3, although CTP Run 2, Run Series 4, and Run Series 5 are all 2050 Future Conditions scenarios, modeled demands for Fort Collins and Greeley differ. Modeled Fort Collins demands are about 2,500 AFY greater under cumulative effects scenarios than Future Conditions without the proposed HSWSPs, and Greeley demands are about 7,000 AFY greater under cumulative effects. However, this is a simplifying modeling decision, not a direct reflection of anticipated demands; actual 2050 system demands for Fort Collins and Greeley in all scenarios are estimated to be those used for the cumulative effects runs. Without the

proposed HSWSPs, the full 2050 demands would not be met, and the system reliability criteria would not be satisfied.

If Run 2 and Run Series 4 were simulated with full 2050 demands for Fort Collins and Greeley, both municipalities would be expected to show a shortage due to the future demand levels not being met. As a precautionary modeling measure to preclude the Fort Collins and Greeley systems from inappropriately drawing on water supply sources that they cannot use, and to prevent the resulting appearance of associated impacts, the demands simulated in CTP Run 2 and Run Series 4 were reduced to levels appropriate given the cities' water supply portfolios and system reliability criteria without the proposed HSWSPs.

Further information regarding the modeling of Fort Collins and Greeley system demands in the various CTP and NISP model runs can be found in the following resources:

- Memorandum: Modeled Demands and Water Rights for Fort Collins and Greeley (CDM Smith, DiNatale, and Hydros 2012)
- CTP Hydrologic Modeling Report (CDM Smith and DiNatale 2013)
  - Section 4.3.2 Modeled Fort Collins Demands
  - Section 6.3.3 [Greeley] Municipal Demands
  - Section 7.5.2 Modeling of HSWSPs proposed actions for Cumulative Effects Runs

The effect of higher modeled demands in the cumulative effects runs is that effluent returns and return flow obligations from Fort Collins and Greeley may increase at certain times and in certain locations. As a result, there are instances in which the simulated streamflows in Run Series 5 are higher than in Run Series 4, despite the added infrastructure and operations of the HSWSPs proposed actions under the cumulative effects scenarios.

5.2.3 Methods

The methods used to model streamflow are presented in Section 4.2.1 and in detail in the CTP Hydrologic Modeling Report (CDM Smith and DiNatale 2013). The model run comparisons used to predict the changes in streamflow under Future Conditions Effects and Cumulative Effects are presented in Table 5-2. The comparisons of Run Series 5 vs. Run Series 4 are intended to illustrate the combined effects of the action alternatives in combination with RFFA and the proposed actions for the HSWSPs under Future Conditions hydrology. The following sections summarize the data analysis performed to assess cumulative effects.

Overall, modeled NISP diversions and other operations under Alternative 2 with Future Conditions Effects or the Cumulative Effects are similar to those with Current Conditions hydrology presented in Section 4.2.3. The same is true for Alternatives 3 and 4; the modeled parameters for each of the NISP alternatives (e.g., demands, water supply sources, and proposed infrastructure) are fixed and do not change with the underlying hydrology of a particular model run. To transition from Current Conditions hydrology (CTP Run 1) to Future Conditions hydrology (CTP Run 2), the RFFAs are incorporated into the model, but the modeled configuration of each particular NISP alternative is unchanged. Model runs of the NISP

alternatives with Future Conditions Effects (Run Series 4) only differ from Cumulative Effects (Run Series 5) in that the proposed actions for the HSWSPs were added to the simulation.

For a given hydrologic scenario (Current Conditions, Future Conditions, or Cumulative), the relative proportions in the mix of NISP water supply sources (Grey Mountain right, SPWCP exchanges) or the timing of diversions may vary somewhat, but the total modeled demand is always the same and the modeled project operations are similar. More so than any change attributable to NISP itself, these relatively minor variations in modeled diversions and other project operations are the result of NISP responding to external changes in the underlying hydrologic effects scenario (i.e., the inclusion of RFFAs or the HSWSPs). These built-in modifications to the hydrologic condition might alter the flow in a particular month in such a way that slightly alters the timing or volume of NISP's in-priority diversions or exchange volume. The volume of water divertible under the Grey Mountain right might decrease slightly, but would be offset by increased diversions under the proposed SPWCP exchanges. However, the modeled changes in NISP operations between hydrologic effects scenarios is rarely, if ever, drastic. Consequently, the modeled changes in streamflow attributable to NISP are similar; the trends in streamflow changes reported for Current Conditions in Chapter 4 are consistent for Future Conditions Effects and Cumulative Effects as well.

5.2.4 No Action Alternative (Alternative 1)

The primary water supply source for the No Action Alternative would consist of 45,200 AFY of permanently transferred historical consumptive use associated with agricultural water rights within the Poudre River and Big Thompson River Basins (estimated to equal 64,200 acres of fallowed agricultural land). Historical return flows associated with these agricultural water rights would remain at the headgates for maintenance of ditch losses and return flows. In addition, a filing would be made for a conditional junior water right in the Poudre River Basin (estimated to yield 750 AF on average), to be diverted at the existing Poudre Valley Canal headgate. It is assumed that historical diversion locations and amounts would be maintained for water right transfers within the Big Thompson Basin and thus no streamflow impacts are predicted as a direct result of these transfers. For water right transfers within the Poudre River Basin, associated points of diversion include the Poudre Valley Canal headgate, the Larimer-Weld Canal headgate, and the New Cache Canal headgate. All diversions at the Poudre Valley Canal headgate and a portion of the Larimer-Weld Canal headgate diversions would be achieved through exchanges with Larimer-Weld and New Cache or an alternate point of diversion water right in order to divert further upstream and preserve water quality. Additionally, the conditional junior water right is assumed to be diverted at the Poudre Valley Canal headgate.

Nearly all effects to Poudre River flows associated with the No Action Alternative would occur in the nearly 23-mile reach of the Poudre River mainstem between the Poudre Valley Canal headgate and the New Cache Canal headgate. Predicted changes in the modeled streamflows associated with the No Action Alternative are attributable to (a) diverting as much of the transferred Larimer-Weld water upstream at the Poudre Valley Canal headgate as is possible given existing canal capacity constraints (no improvements would be made to the Poudre Valley

Canal under the No Action Alternative), and (b) diverting as much as possible of the transferred New Cache water upstream at the Poudre Valley Canal or Larimer-Weld Canal headgates. These exchanges or alternate points of diversion would improve the source quality of raw water stored in Cactus Hill Reservoir or delivered directly to the Participants.

Table 5-4 summarizes the Poudre River Basin transferred agricultural consumptive use for the No Action Alternative by source and diversion location.

Table 5-4. Summary of average annual Poudre River Basin APOD/exchanges and diversions for the No Action Alternative, in AFY.

	Larimer-Weld	New Cache
Exchanged to Poudre Valley Canal	12,200	5,000
Exchanged to Larimer-Weld	0	1,100
Diverted at Original Headgate	4,000	13,000
Met from in-ditch storage	3,700	2,200
Total	**19,900**	**21,300**

Including transferable CU from Larimer-Weld and New Cache and the proposed new junior water right, the total estimated diversions from the Poudre River at the Poudre Valley Canal, Larimer-Weld, and New Cache headgates under the No Action Alternative would be about 36,000 AFY. An additional 5,900 AFY would be supplied from off-channel storage under the Larimer-Weld and New Cache irrigation systems. The remaining 4,000 AFY of the No Action Alternative yield would come from the Home Supply system in the Big Thompson River Basin. Figure 5-2 (Canyon Gage), Figure 5-3 (Lincoln Street Gage), Figure 5-4 (Greeley Gage), and Figure 5-5 (Kersey Gage) show how flows are predicted to change with the No Action Alternative.

Figure 5-2. Alternative 1 Future Conditions Median Monthly Flow at DDM 5.63 (Canyon Gage), IY 1980-2005.

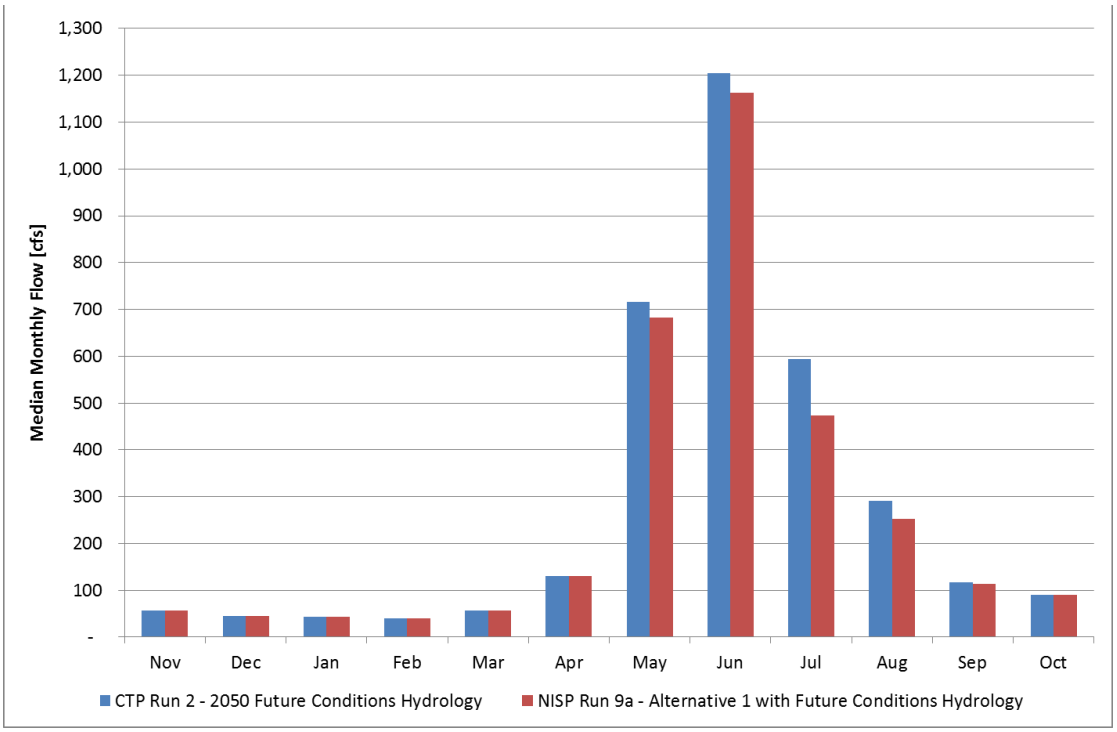


Figure 5-3. Alternative 1 Future Conditions Median Monthly Flow at DDM 16.84 (Lincoln Street Gage), IY 1980-2005.

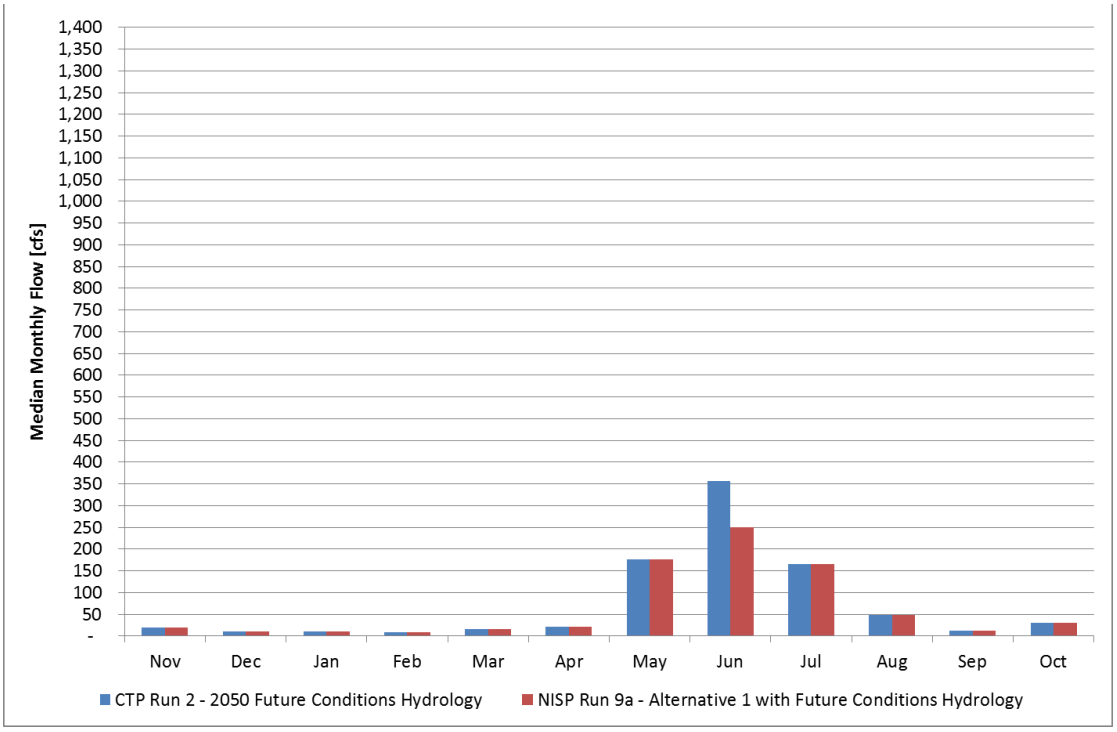


Figure 5-4. Alternative 1 Future Conditions Median Monthly Flow at DDM 57.43 (Greeley Gage), IY 1980-2005.

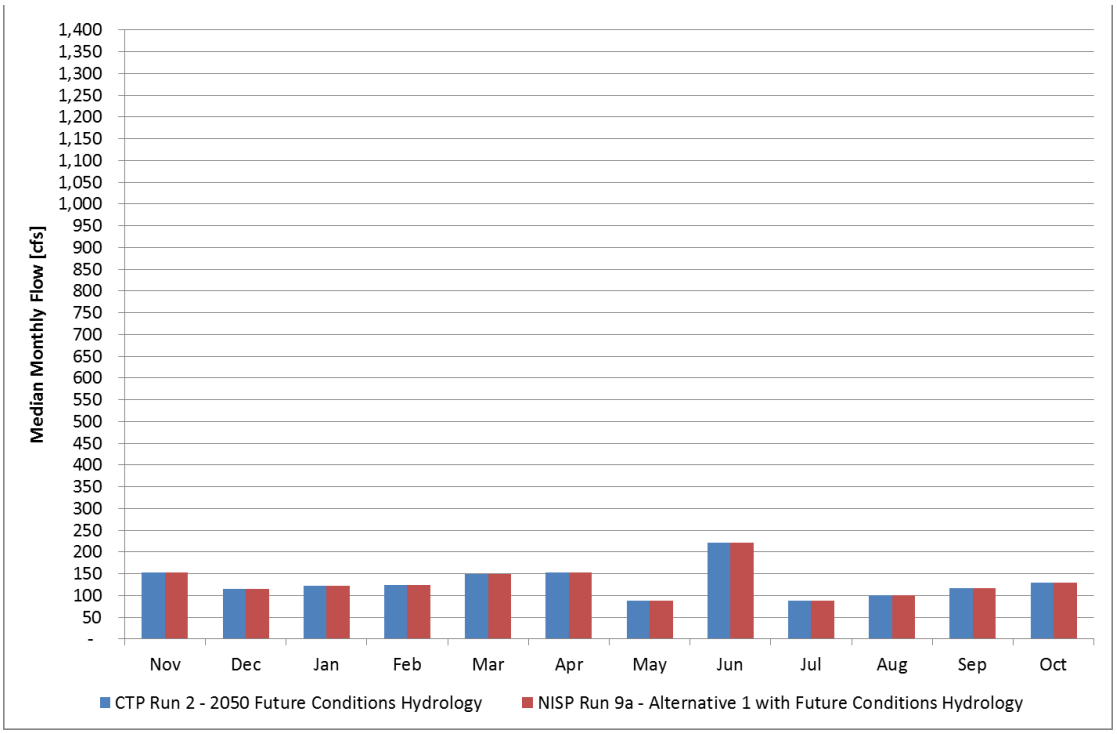
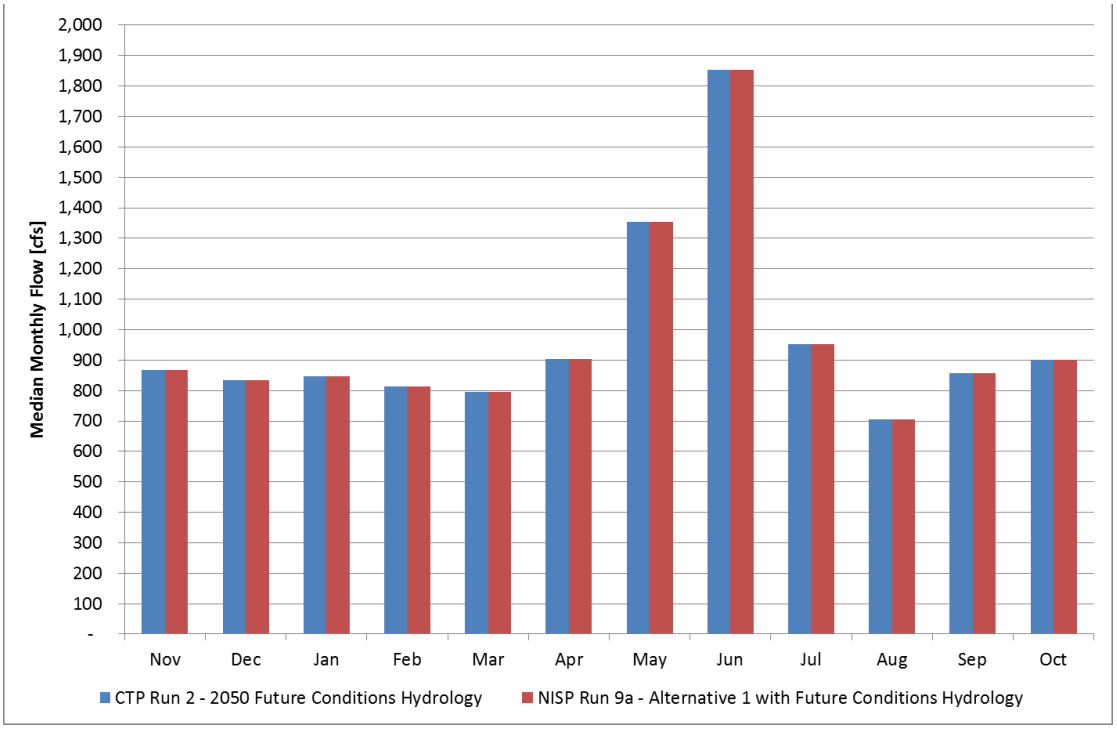


Figure 5-5. Alternative 1 Future Conditions Median Monthly Flow at Kersey Gage (South Platte River), IY 1980-2005.



5.2.5 Alternative 2

Alternative 2 includes a No Reclamation Action Option and Reclamation Action Option as described in Section 2.5.5. Cumulative effects associated with changes in streamflows are predicted to be the same for the Reclamation Action and No Reclamation Action Options for reasons discussed previously in Section 4.2.1.1.3, Section 4.2.3.4.1, and Section 5.2.1.

5.2.5.1 Alternative 2 Diversions with Future Conditions Effects (NISP Run 4a) and Cumulative Effects (CTP Run 5a)

This section characterizes the modeled diversions and resultant streamflow changes associated with Alternative 2, the District's Preferred Alternative, with Future Conditions Effects and with Cumulative Effects of the RFFAs and the HSWSPs. All NISP Poudre River supply sources would be diverted at the Poudre Valley Canal headgate for delivery to Glade Reservoir under Alternative 2. As shown below in Table 5-5, modeled NISP Alternative 2 diversions under Future Conditions Effects and Cumulative Effects are estimated to be similar. Additional information regarding modeled NISP diversions for Alternative 2 with Future Conditions Effects (NISP Run 4a) is presented in Section 3.1 of the 2014 Operations Plan Report (CDM Smith 2014b).

Table 5-5. Estimated average annual NISP Alternative 2 diversions at the Poudre Valley Canal with Future Conditions Effects (NISP Run 4a) and Cumulative Effects (CTP Run 5a), IY 1950-2005, in AFY.

	Grey Mountain Right	SPWCP Direct Flow Exchange from Larimer-Weld and New Cache	SPWCP Reservoir Exchange from Terry Lake, Big Windsor, and Timnath Reservoir	Total NISP Diversion at Poudre Valley Canal
NISP Run 4a	18,000	20,500	4,900	43,300
CTP Run 5a	17,600	21,400	4,600	43,600

The Canyon Gage (DDM 5.63) is located just downstream of the Poudre Valley Canal and it is here that the streamflow changes resulting from Alternative 2 are first observed. CTP modeling results show a reduction in streamflow at the Canyon Gage when compared to Future Conditions hydrology (CTP Run 2). This decrease in streamflow would be greatest during the months of May and June when the Grey Mountain right is in priority (in years with average to above-average hydrology) and is also pronounced during other summer months when the SPWCP exchanges are in priority (most years). Figure 5-7 illustrates the estimated changes in monthly streamflows (NISP Run 4a vs. CTP Run 2) at the Canyon Gage in conjunction with estimated NISP diversions (Grey Mountain right; SPWCP direct flow exchange from Larimer-Weld and New Cache; and SPWCP reservoir exchanges from Terry Lake, Big Windsor Reservoir, and Timnath Reservoir) during the 1990s. Similar future conditions figures for other decades and locations are provided in Appendix C of the 2014 Water Resources Technical Report (CDM Smith 2014a; also see Section 4.2.1.3.6). Figure 5-7 provides the same comparison of modeled

streamflow changes and NISP diversions for the Cumulative Effects scenario (CTP Run 5a vs. CTP Run 2).

Figure 5-6. Canyon Gage 1990s Streamflow Diversion Plot for Run 4a vs. Run 2.

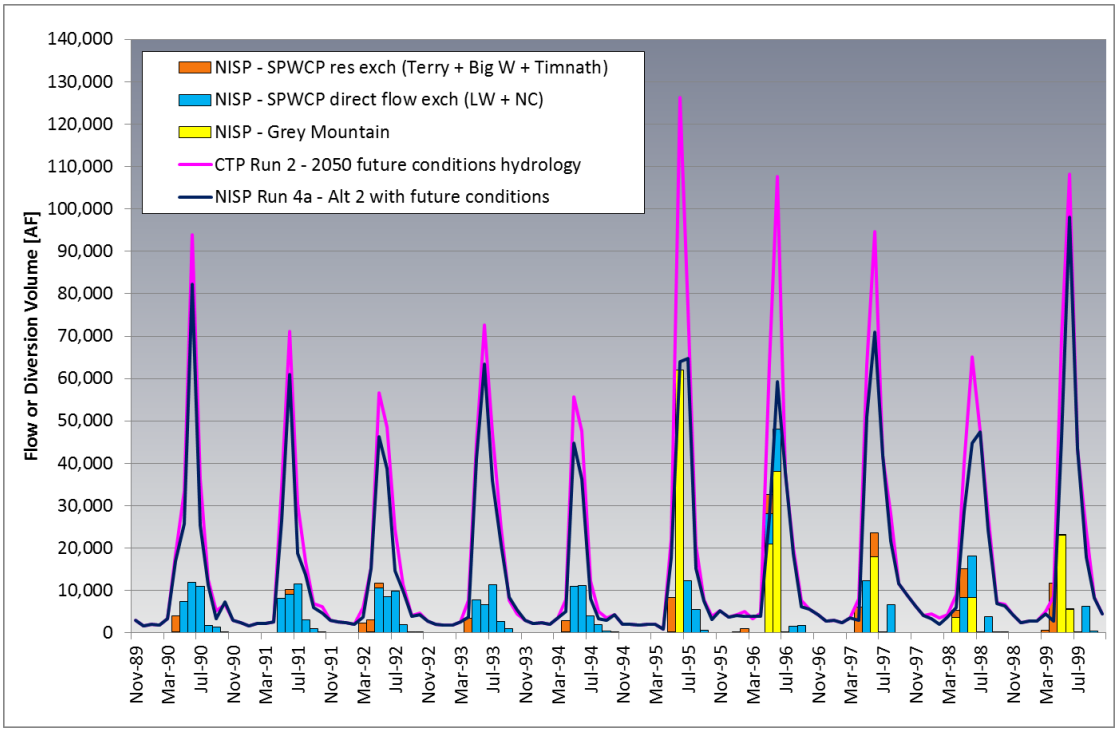
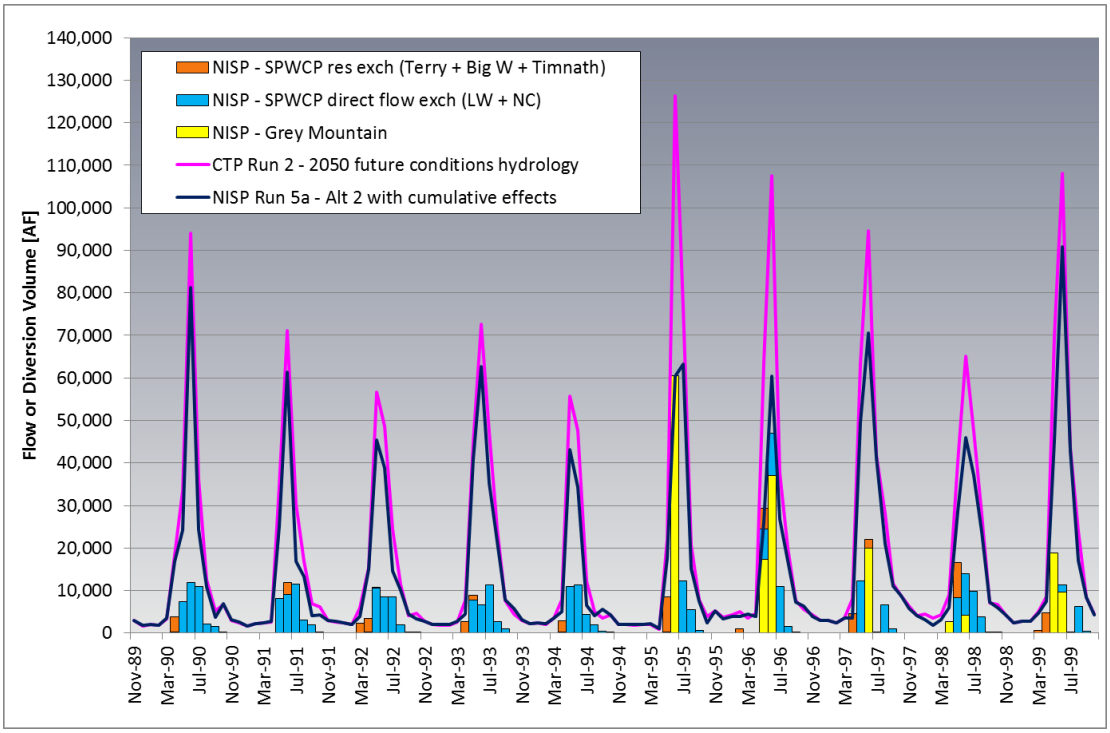


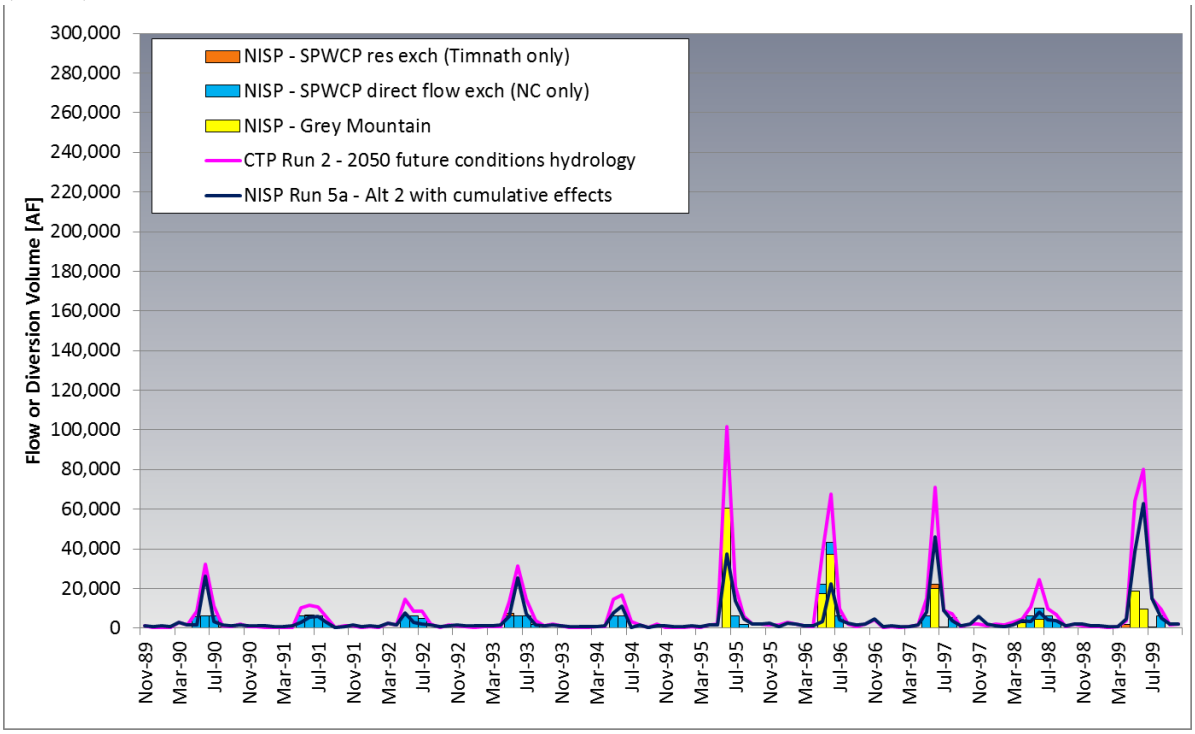
Figure 5-7. Canyon Gage Pre- and Post-NISP Monthly Flows with NISP Alternative 2 Diversions (1990s).



The differences between NISP diversions with Future Conditions Effects (NISP Run 4a) and Cumulative Effects (CTP Run 5a) are subtle, consistent with the small differences in average annual diversions shown in Table 1-3. This also serves to emphasize the relatively small contributions of the HSWSPs—as modeled in CTP Run 5a—to the changes in streamflow associated with Cumulative Effects. The same is true at downstream locations, and thus only the Cumulative Effects figures will be shown subsequently.

As expected, downstream of the Canyon Gage CTP modeling results continue to show a reduction in streamflow during months with NISP diversions; however, the magnitude of this reduction tapers downstream of the Larimer-Weld Canal. The originating headgates for the SPWCP direct flow exchange with Larimer-Weld and the SPWCP reservoir exchanges with Terry Lake (Little Cache Canal) and Big Windsor Reservoir (Larimer-Weld Canal) are all upstream of the Lincoln Street Gage in Fort Collins. Thus, as shown in Figure 5-8, the modeled changes in streamflows would result from NISP diversions under the Grey Mountain right, the SPWCP direct flow exchange from the New Cache Canal, and the SPWCP reservoir exchange from Timnath Reservoir, as well as diversions or other operations associated with the HSWSPs.

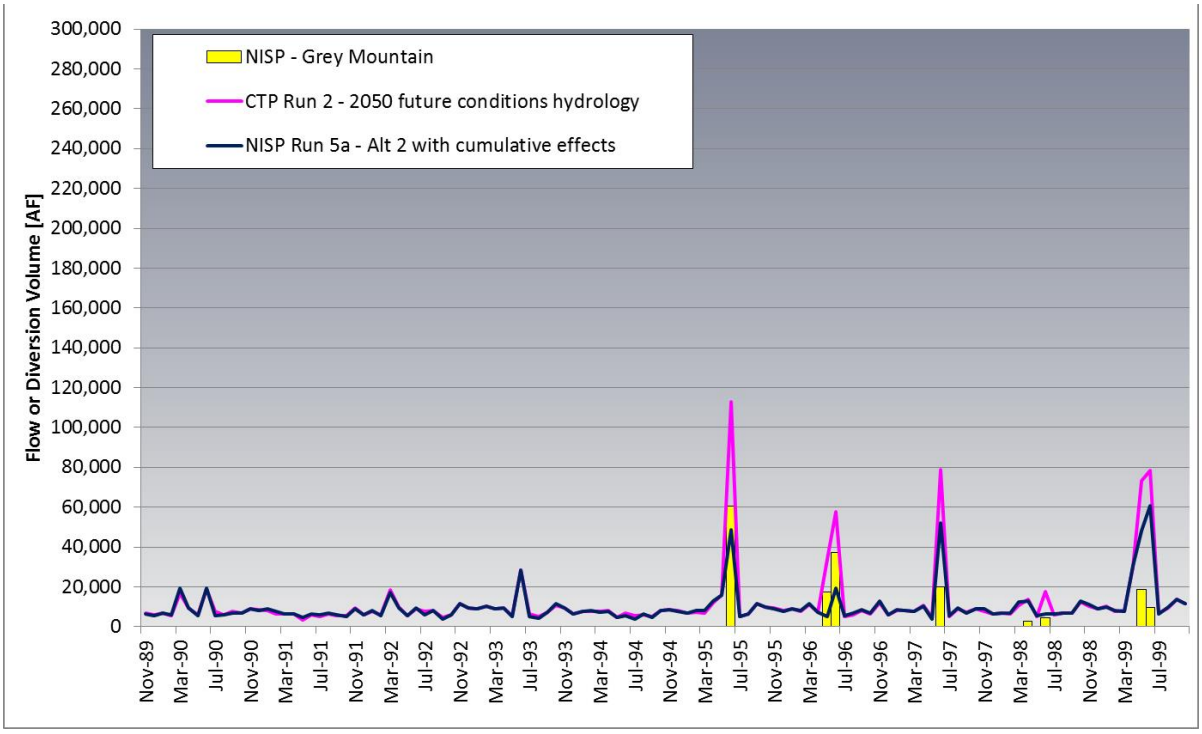
Figure 5-8. Lincoln Street Gage Pre- and Post-NISP Flows with NISP Alternative 2 Diversions (1990s).



The proposed streamflow augmentation for Alternative 2 would include the reach in which the Lincoln Street Gage is located. CTP modeling results show a substantial reduction in the number of days with an average streamflow less than 10 cfs as a direct result of implementation of the flow augmentation program. This improvement to streamflow is discussed in Section 8 of the 2014 Operations Plan Report (CDM Smith 2014b).

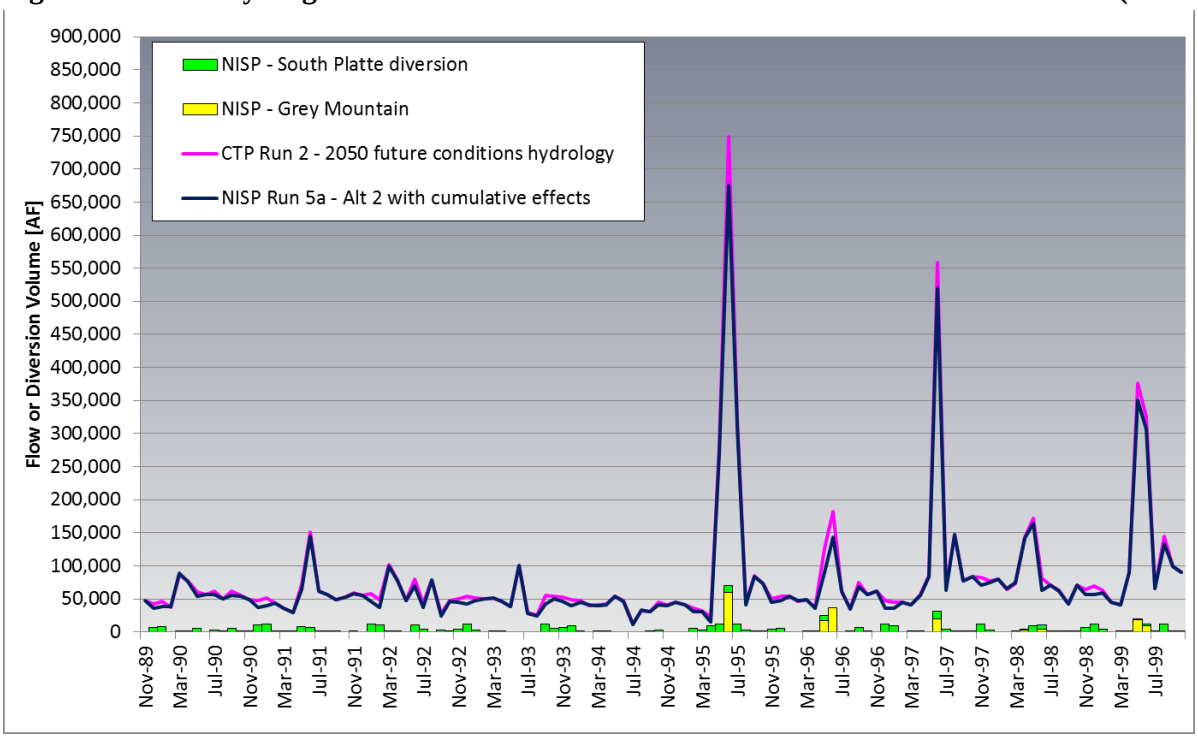
Below the New Cache Canal, the SPWCP direct flow and reservoir exchanges would no longer affect streamflow, and the Grey Mountain right would be the sole source of the modeled changes in streamflow. This is illustrated in Figure 5-9 for the Greeley Gage.

Figure 5-9. Greeley Gage Pre- and Post-NISP Flows with NISP Alternative 2 Diversions (1990s).



The effects of diversions under the Grey Mountain right would propagate downstream into the lower South Platte River. All of the NISP action alternatives include a South Platte River diversion a short distance downstream of the Poudre River confluence. At the Kersey Gage (Figure 5-10), the CTP modeling results show additional reductions to streamflow as water would be diverted for storage in the proposed Galeton Reservoir or direct pipeline delivery to the Larimer-Weld and New Cache Canals to meet the SPWCP direct flow and reservoir exchange obligations. This reduction in streamflow, on average, is similar in magnitude to those modeled just downstream of the Poudre Valley Canal; however, due to the South Platte River's larger size the reduction would make up a much smaller percentage of total streamflow.

Figure 5-10. Kersey Gage Pre- and Post-NISP Flows with NISP Alternative 2 Diversions (1990s).



5.2.5.2 Alternative 2 with Cumulative Effects Compared to Alternative 2 with Future Conditions Effects (CTP Run 5a vs. NISP Run 4a)

As described above (see Table 5-4, Figure 5-2, and Figure 5-3, modeled NISP diversions are quite similar, within a few hundred AFY on average for Future Conditions Effects and Cumulative Effects. Given a common modeling foundation—both Run Series 4 and Run Series 5 are built upon Future Conditions hydrology (CTP Run 2)—it is reasonable to conclude that most of the differences seen in model data comparisons of CTP Run 5a vs. NISP Run 4a are attributable to the HSWSPs. Note that the Cumulative Effects do not necessarily translate to additional decreases in flow, but may actually result in flow increases at some locations on some dates (Section 5.2.2).

Figure 5-11 shows the modeled median daily streamflows at Canyon Gage for CTP Run 1, CTP Run 2, NISP Run 4a, and CTP Run 5a. Figure 5-12, Figure 5-13, and Figure 5-14 show the same at the Lincoln Street, Greeley, and Kersey Gages, respectively.

Figure 5-11. Median Daily Flows at Canyon Gage (DDM 5.63), Alternative 2 Cumulative Effects Comparisons, IY 1980-2005.

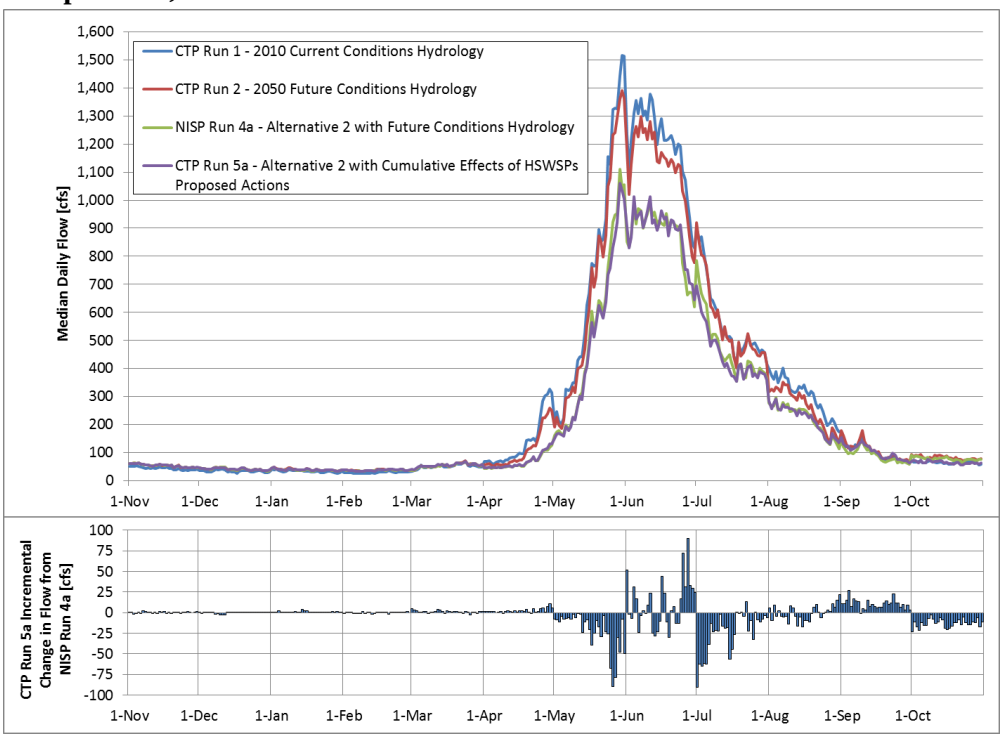


Figure 5-12. Median Daily Flows at Lincoln Street Gage (DDM 16.84), Alternative 2 Cumulative Effects Comparisons, IY 1980-2005.

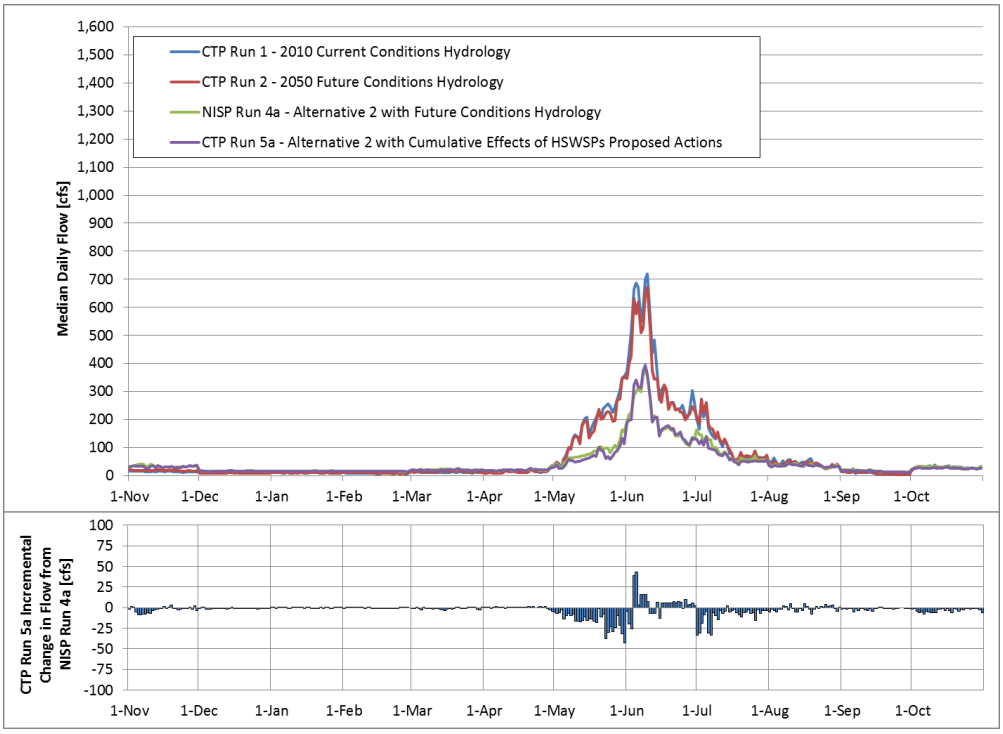


Figure 5-13. Median Daily Flows at Greeley Gage (DDM 57.43), Alternative 2 Cumulative Effects Comparisons, IY 1980-2005.

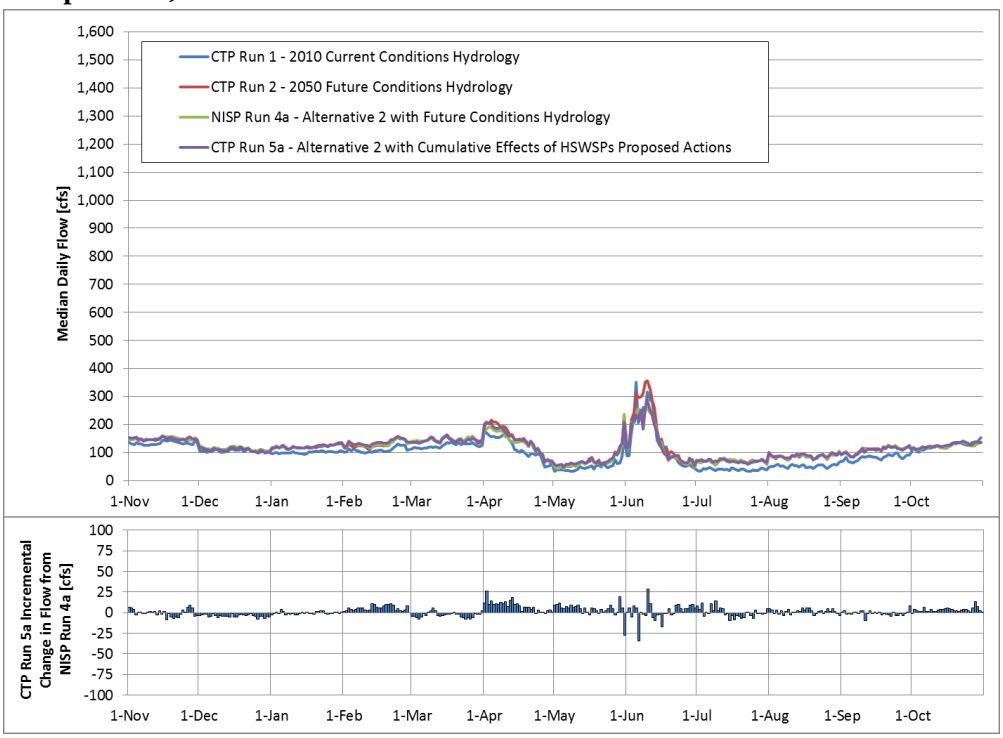
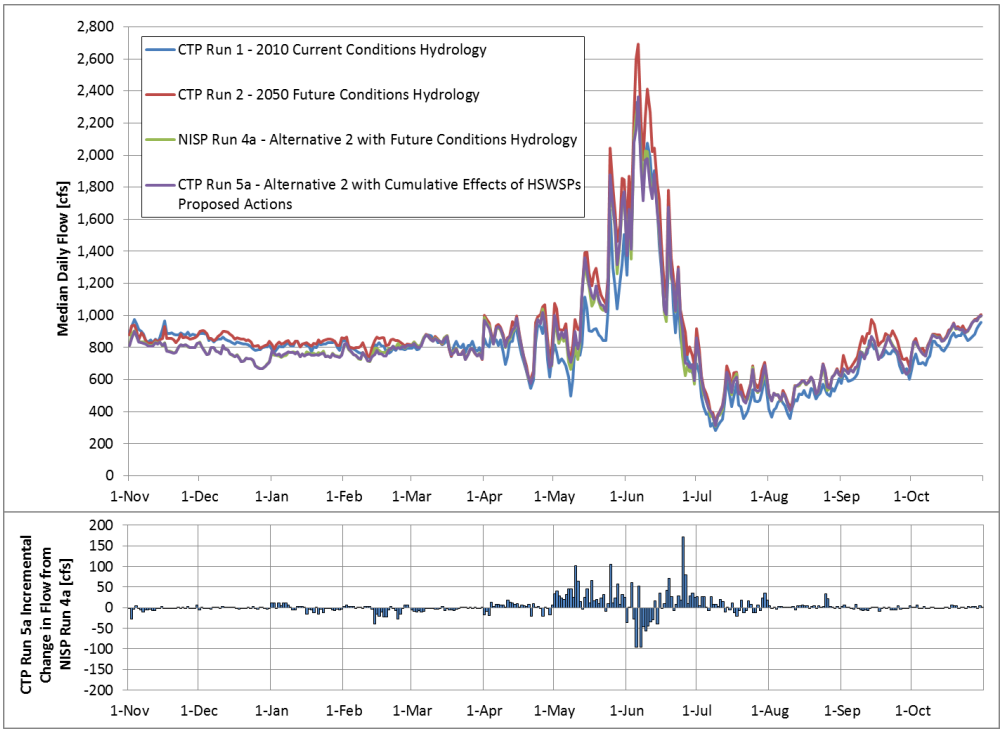


Figure 5-14. Median Daily Flows at Kersey Gage (South Platte River), Alternative 2 Cumulative Effects Comparisons, IY 1980-2005.



5.2.6 Alternative 3

Alternative 3 would divert on average about 5,500 to 6,000 AFY more water from the Poudre River than Alternative 2 to compensate for increased reservoir evaporation from Cactus Hill Reservoir and conveyance loss. Additionally, Alternative 3 does not include the Poudre River flow augmentation program that is proposed under Alternative 2.

5.2.6.1 Alternative 3 Diversions with Future Conditions Effects (NISP Run 4b1) and Cumulative Effects (NISP Run 5b1)

As shown below in Table 5-6, modeled Alternative 3 diversions under Future Conditions Effects and Cumulative Effects are estimated to be similar.

Table 5-6. Estimated average annual NISP Alternative 3 diversions at the Poudre Valley Canal with Future Conditions Effects (NISP Run 4b1) and Cumulative Effects (CTP Run 5b1), IY 1950-2005, in AFY.

	Total NISP Diversion at Poudre Valley Canal	Grey Mountain Right	SPWCP Direct Flow Exchange from Larimer-Weld and New Cache	SPWCP Reservoir Exchange from Terry Lake, Big Windsor, and Timnath Reservoir
NISP Run 4b1	48,900	21,400	23,000	4,600
NISP Run 5b1	48,900	20,400	24,000	4,600

The overall headgate diversions for Alternative 3 with Future Conditions Effects and with Cumulative Effects are approximately equal, but similar to Alternative 2, there is some movement between sources, e.g., the modeled decrease in Grey Mountain is offset by the modeled increase in SPWCP direct flow exchange diversions. For further information regarding future conditions diversions under Alternative 3, see Section 4.1 of the 2014 Operations Plan Report (CDM Smith 2014b). The full model results for NISP Run 4b1 are presented there, and as shown in Table 5-6 above, model results for cumulative effects (NISP Run 5b1) are very similar. It is reasonable to conclude that most of the differences seen in model data comparisons of CTP Run 5b1 vs. NISP Run 4b2 are attributable to the proposed actions for the HSWSPs. Note that the cumulative effects do not necessarily translate to additional decreases in flow, but may actually result in flow increases at some locations on some dates (Section 5.2.2).

5.2.6.2 Alternative 3 with Cumulative Effects Compared to Alternative 3 with Future Conditions Effects (NISP Run 5b1 vs. NISP Run 4b1)

Figure 5-15 shows the modeled median daily streamflows at Canyon Gage for CTP Run 1, CTP Run 2, NISP Run 4b1, and NISP Run 5b1. Figure 5-16, Figure 5-17, and Figure 5-18 show the same at the Lincoln Street, Greeley, and Kersey Gages, respectively.

Figure 5-15. Median Daily Flows at Canyon Gage (DDM 5.63), Alternative 3 Cumulative Effects Comparisons, IY 1980-2005.

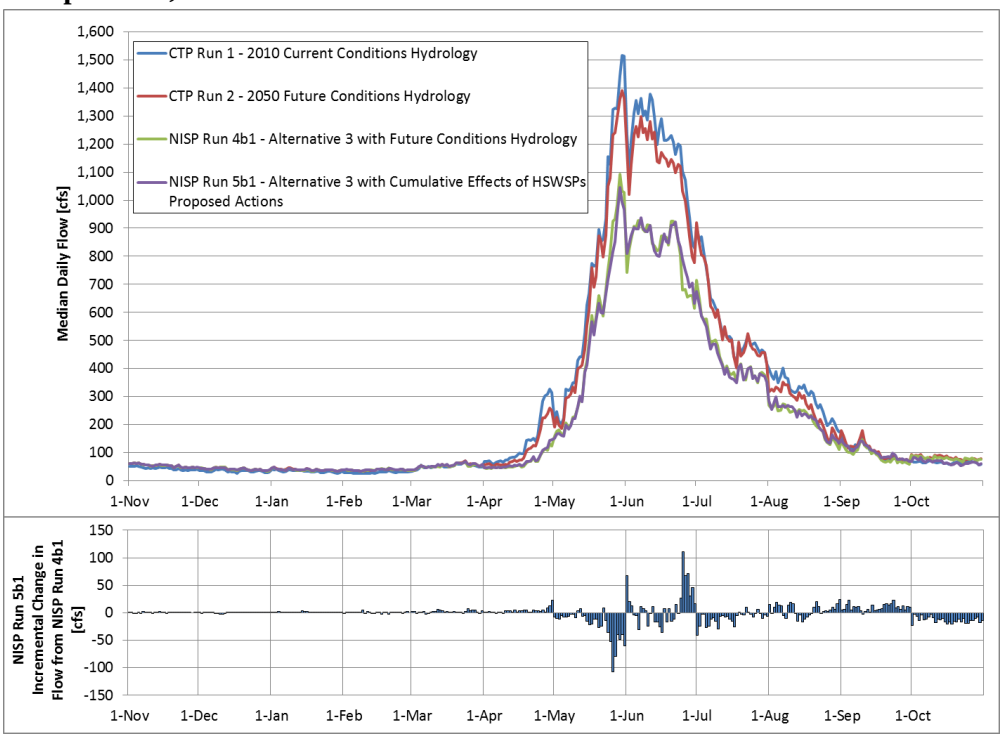


Figure 5-16. Median Daily Flows at Lincoln Street Gage (DDM 16.84), Alternative 3 Cumulative Effects Comparisons, IY 1980-2005.

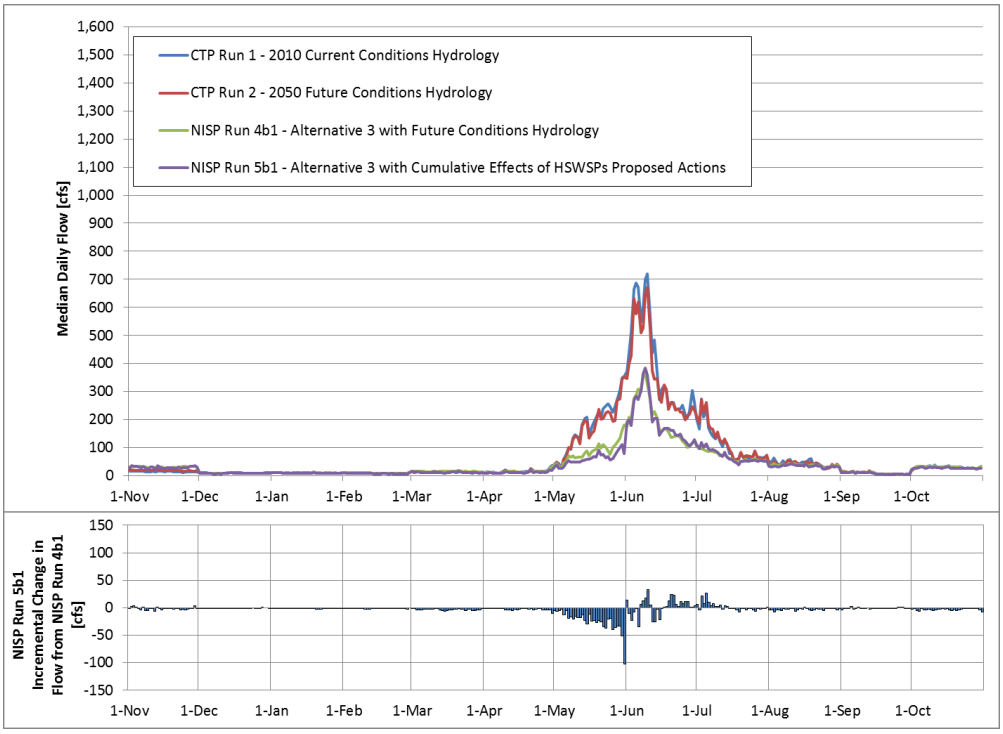


Figure 5-17. Median Daily Flows at Greeley Gage (DDM 57.43), Alternative 3 Cumulative Effects Comparisons, IY 1980-2005.

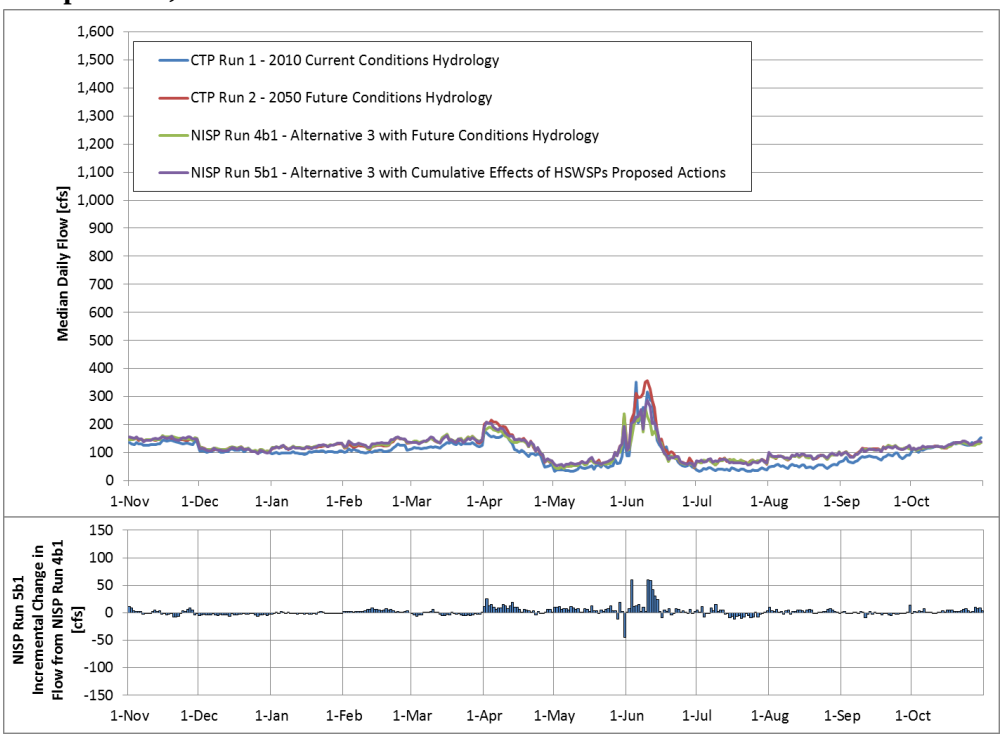
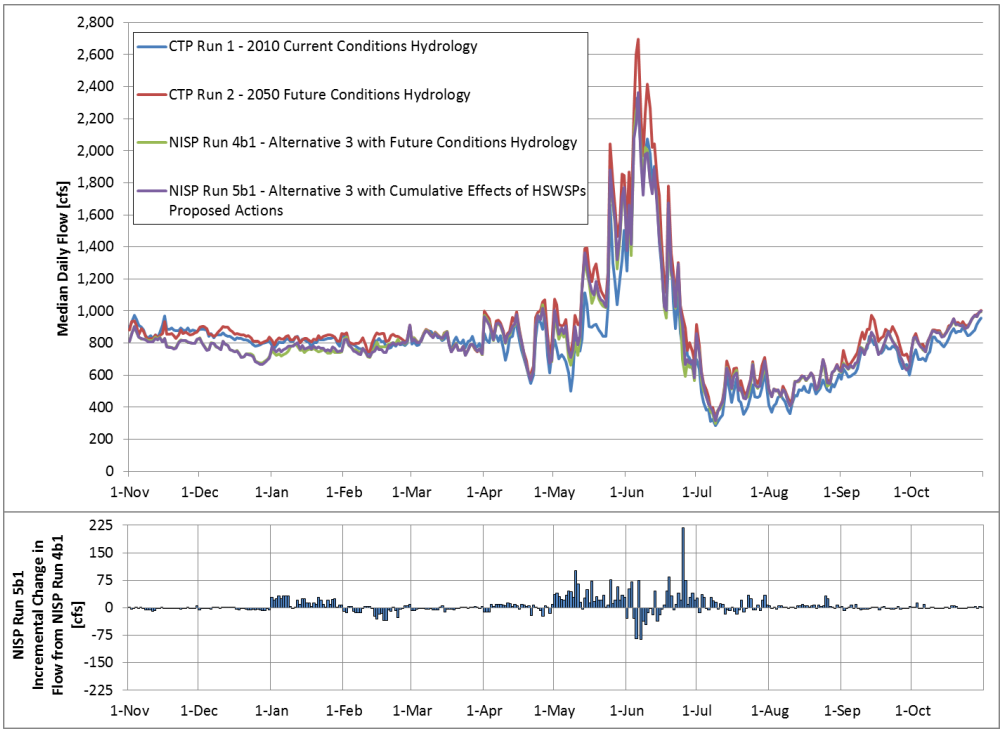


Figure 5-18. Median Daily Flows at Kersey Gage (South Platte River), Alternative 3 Cumulative Effects Comparisons, IY 1980-2005.



5.2.7 Alternative 4

Similar to Alternative 3, Alternative 4 would divert on average about 5,500 to 6,000 AFY more water from the Poudre River at the Poudre Valley Canal than Alternative 2 to compensate for increased reservoir evaporation from Cactus Hill Reservoir and conveyance loss. Alternative 4 is designed to allow some flow to pass through the Fort Collins area and be diverted lower on the river at the New Cache Canal headgate. Relative to the other action alternatives, under Alternative 4, more water would remain in the mainstem between the Poudre Valley Canal and New Cache Canal before it is diverted for exchanges. Additionally, Alternative 4 does not include the Poudre River flow augmentation program that is proposed under Alternative 2.

5.2.7.1 Alternative 4 Diversions with Future Conditions Effects (NISP Run 4b2) and Cumulative Effects (NISP Run 5b2)

This section characterizes the diversions under Alternative 4 with Future Conditions Effects and Cumulative Effects. As shown in Table 5-7, modeled Alternative 4 diversions under Future Conditions Effects and Cumulative Effects are similar.

Table 5-7. Estimated average annual NISP Alternative 4 diversions[1] with Future Conditions Effects (NISP Run 4b2) and Cumulative Effects (CTP Run 5b2), IY 1950-2005, in AFY.

	Grey Mountain Right	SPWCP Direct Flow Exchange		SPWCP Reservoir Exchange from Terry Lake, Big Windsor, and Timnath Reservoir	Total NISP Diversion at Poudre Valley Canal
		From Larimer-Weld	From New Cache		
NISP Run 4b2	20,400	9,700	12,300	5,900	35,700
NISP Run 5b2	20,000	9,800	12,600	5,700	35,200

[1] Link HG_GLADE represents total diversions at the Poudre Valley Canal. Links GreyMtnDecree, OWNGALE1, and APOD1 represent source component diversions at the Poudre Valley Canal. Link OWNGALE1_NC diverted at the New Cache Canal headgate.

The diversions are not identical, and there is some movement between sources, e.g., the modeled decrease in Grey Mountain diversions is consistent with the modeled increase in SPWCP direct flow exchange diversions. However, overall diversions are quite similar, within about 500 AFY, on average. A more detailed presentation of diversions associated with Alternative 4 under Future Conditions Effects (NISP Run 4b2) can be found in Section 4.1 of the 2014 Operations Plan Report (CDM Smith 2014b). Given the similar average diversions presented in Table 5-7 above, it is reasonable to conclude that most of the differences seen in model data comparisons of NISP Run 5b1 vs. NISP Run 4b1 are attributable to the HSWSPs. As with previous comparisons, note that the Cumulative Effects do not necessarily translate to additional decreases in flow but may actually result in flow increases at some locations on some dates (Section 5.2.2).

5.2.7.2 Alternative 4 with Cumulative Effects Compared to Alternative 4 with Future Conditions Effects (NISP Run 5b2 vs. NISP Run 4b2)

Although the model results for Alternative 3 and Alternative 4 show total diversions of similar magnitudes under both Future Conditions Effects and Cumulative Effects (between 48,000 AFY and 49,000 AFY), the diversion of more than 12,000 AFY at the New Cache headgate under Alternative 4 would result in different streamflow changes between the Poudre Valley Canal and New Cache headgates. Below the New Cache Canal, the streamflow reductions seen in the model results at downstream locations are similar between Alternative 4 and Alternative 3 due to Grey Mountain average annual diversions with similar magnitudes (Table 5-7). Timing and magnitude of the Grey Mountain diversions resulting in these downstream effects may vary slightly between runs on a monthly basis, resulting in some variability in the estimated streamflow changes.

Figure 5-19 shows the median daily streamflows at Canyon Gage for CTP Run 1, CTP Run 2, NISP Run 4b2, and CTP Run 5b2. Figure 5-20, Figure 5-21, and Figure 5-22 show the same at the Lincoln Street, Greeley, and Kersey Gages, respectively.

Figure 5-19. Median Daily Flows at Canyon Gage (DDM 5.63), Alternative 4 Cumulative Effects Comparisons, IY 1980-2005.

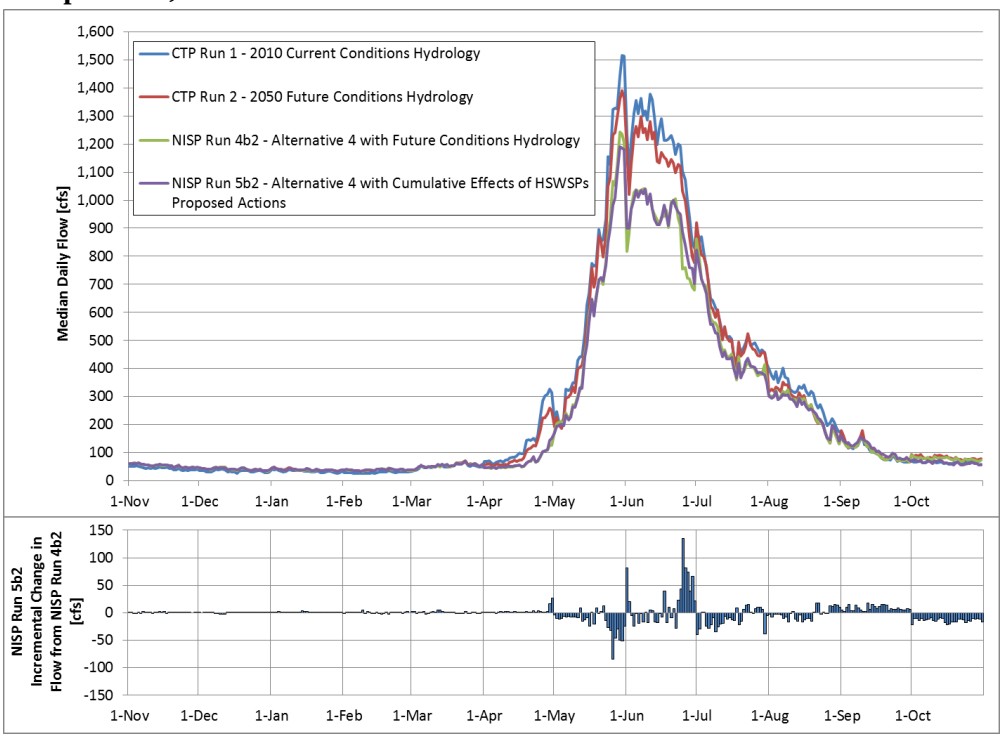


Figure 5-20. Median Daily Flows at Lincoln Street Gage (DDM 16.84), Alternative 4 Cumulative Effects Comparisons, IY 1980-2005.

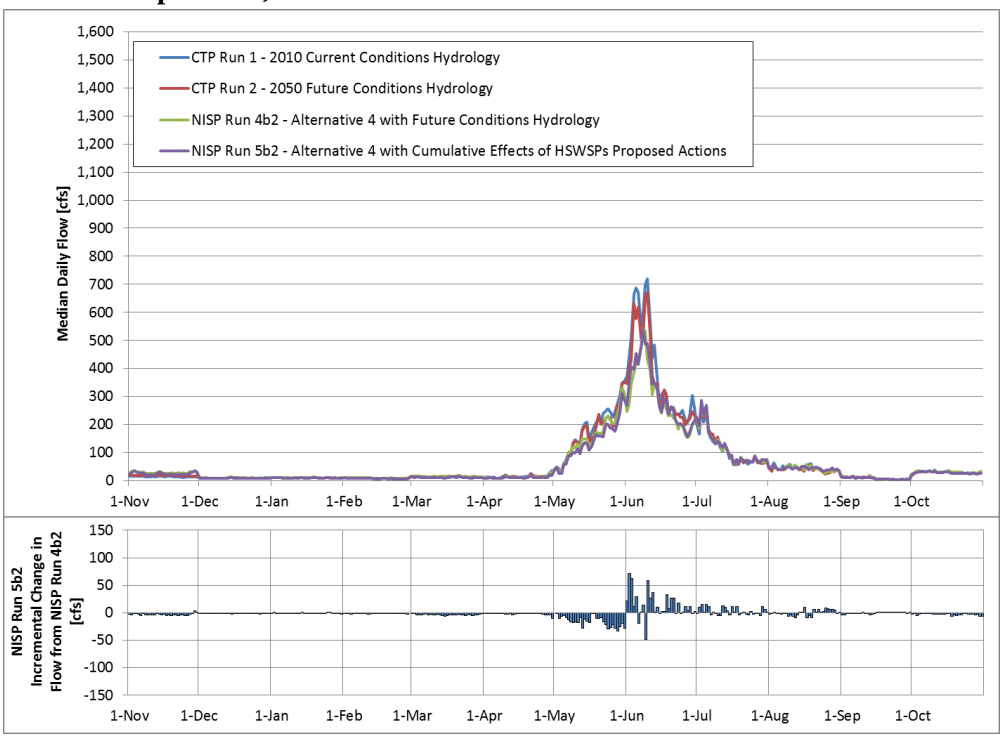


Figure 5-21. Median Daily Flows at Greeley Gage (DDM 57.43), Alternative 4 Cumulative Effects Comparisons, IY 1980-2005.

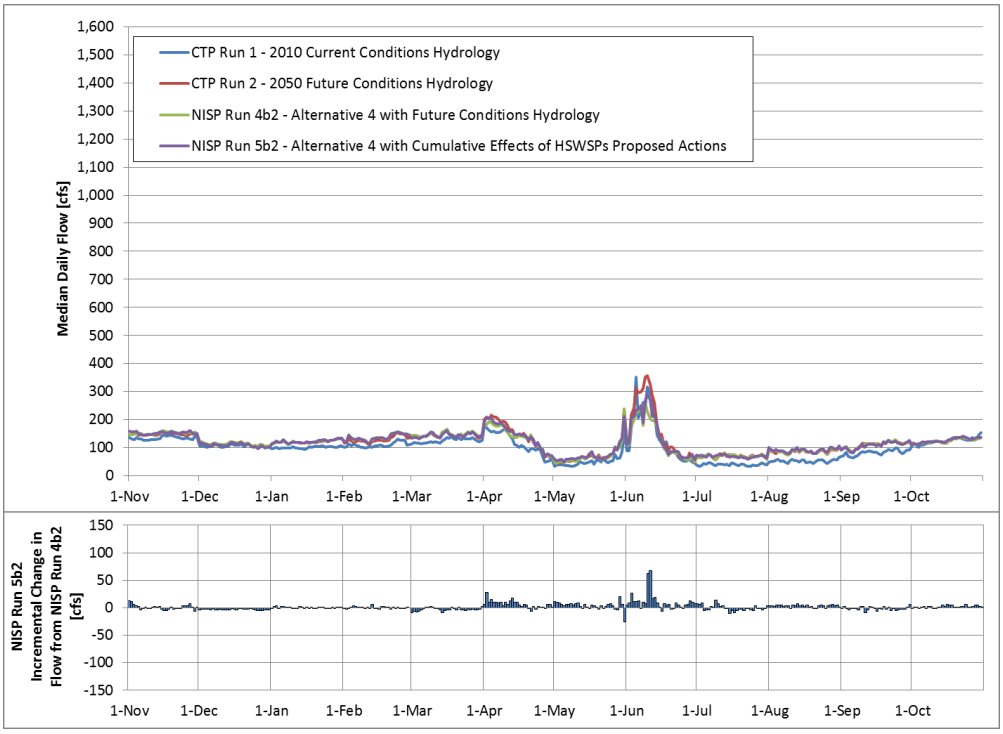
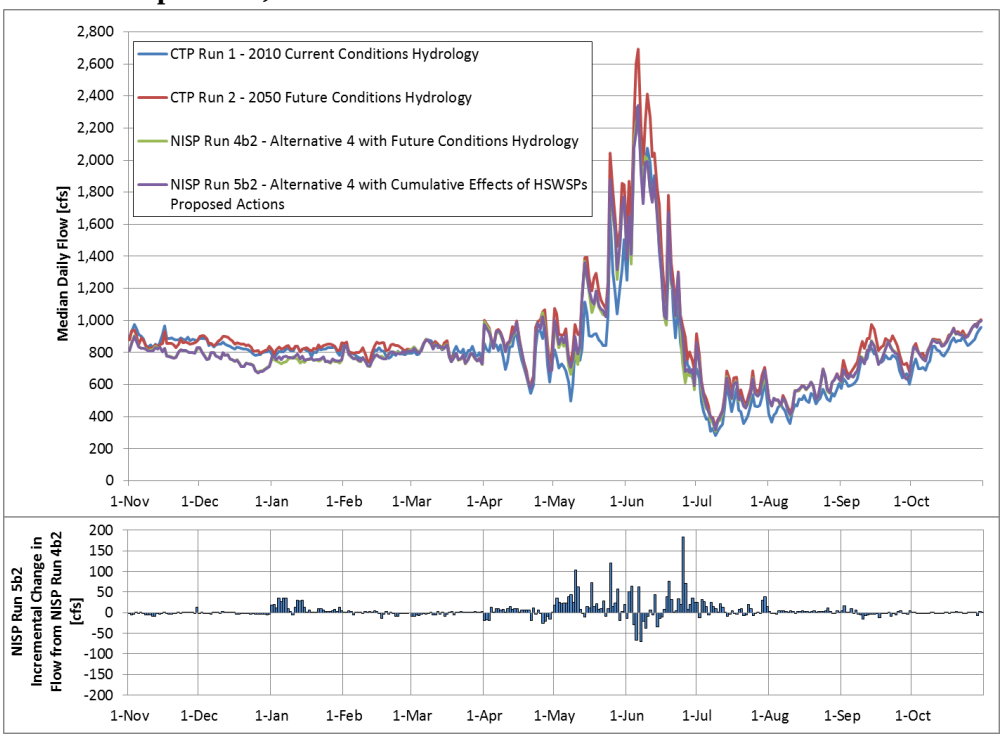


Figure 5-22. Median Daily Flows at Kersey Gage (South Platte River), Alternative 4 Cumulative Effects Comparisons, IY 1980-2005.



5.2.8 Climate Change

The NISP SDEIS considers climate change to be a trend that is predicted to affect the future environment and potential resource condition. The potential for climate change to affect the hydrology of the Poudre Basin relative to the historical climate and hydrologic patterns was assessed (DiNatale and CDM Smith 2014). A generally accepted scientific method by which current climate change information is translated into predictable streamflow changes and assimilated into water supply decision-making is currently not available. Therefore, the potential impact of climate change on the cumulative effects model run (Run 5 series) results were described qualitatively (DiNatale and CDM Smith 2014). A reasonable range of potential climate change impacts based on findings from historical trends in temperature and runoff, published studies, reports, and other scientific literature was used to guide the description of the potential impacts on hydrology and was translated into predicted effects for the flow-related resources.

A large volume of scientific information supports the conclusion that global temperatures are increasing and that precipitation trends would change in the future. The warming trend is expected to accelerate in coming decades. In the western United States, longer periods of drought are expected. There is also general agreement by climate scientists that climate change information specific to Colorado indicates that snowpack melting and spring runoff would occur earlier in the year and temperatures would increase by approximately 4°F by 2050, with summers warming more than winters. However, there is little agreement on the potential

changes to precipitation in Colorado, although modeling of the Colorado River Basin indicates overall lower runoff on the West Slope (DiNatale and CDM Smith 2014).

Climate change is expected to change the naturalized flow and runoff patterns in the Poudre Basin. However, changes in naturalized flow do not necessarily correspond to similar changes in observed flow (e.g., increase in naturalized flow during the peak naturalized flow does not necessarily mean gaged flows will be higher at all locations during that time). Naturalized flows provide insight to the 'supply' side of the equation that relates supply, demand, and distribution.

The hydrology of the Poudre River is anticipated to change under climate change conditions and in turn is predicted to change current operations of diversion, storage and delivery of water. The predicted changes to flows at any given point are a result of a combination of changes in runoff volume and timing (water supply), increased demands due to temperature increases (both agricultural and municipal and industrial (M&I)), the complex interaction of water rights administration with the changing water supply and demand scenarios, and changes in evaporation at reservoirs. The following are key points associated with each of these components.

5.2.8.1 Changes to Streamflow Runoff Volume and Timing

- The most substantial predicted changes to the naturalized flows from a volumetric perspective are in April (substantial increase in runoff) and June (substantial reduction in runoff). See Figure 5-23.
- An earlier onset of runoff is predicted as shown by the earlier rising limb of the hydrograph in Figure 5-23 and Figure 5-24.
- Naturalized flow is predicted to be less in the summer months of July, August, and September under climate change. See Figure 5-23.
- Winter flows may increase moderately due to a shift in winter snowfall to rainfall, but much of the Poudre Basin headwaters area is above 8,200 feet in elevation, above which winter precipitation is anticipated to remain primarily snowfall.

5.2.8.2 Changes to Demand

- Irrigation water requirements per acre of crops normally grown in the Poudre Basin are predicted to increase 15% to 25% due to increasing temperatures under climate change scenarios.
- Alfalfa is predicted to have a longer growing season, beginning in March, and extending into November compared to the historical growing season of April through October.

5.2.8.3 Changes to Diversion Patterns and Streamflows

- Projections of changes to diversion patterns and streamflows at specific locations are difficult due to changing water supply, demand, water rights administration, future transfers of water to M&I use, and other operational constraints.

- A basin-wide analysis of water supply compared to demand shows:
  - Under non-climate change conditions, water supply exceeds demand in May and June, and is lower than demand in July through April (Figure 5-24, top portion).
  - Under climate change conditions, water supply is predicted to exceed demand in April and May, and is lower than demand in June through February. Supply and demand are approximately equal in March (Figure 5-24, bottom portion).

Figure 5-23. Potential Changes to Naturalized Flow at the Canyon Gage Under Climate Change Conditions.

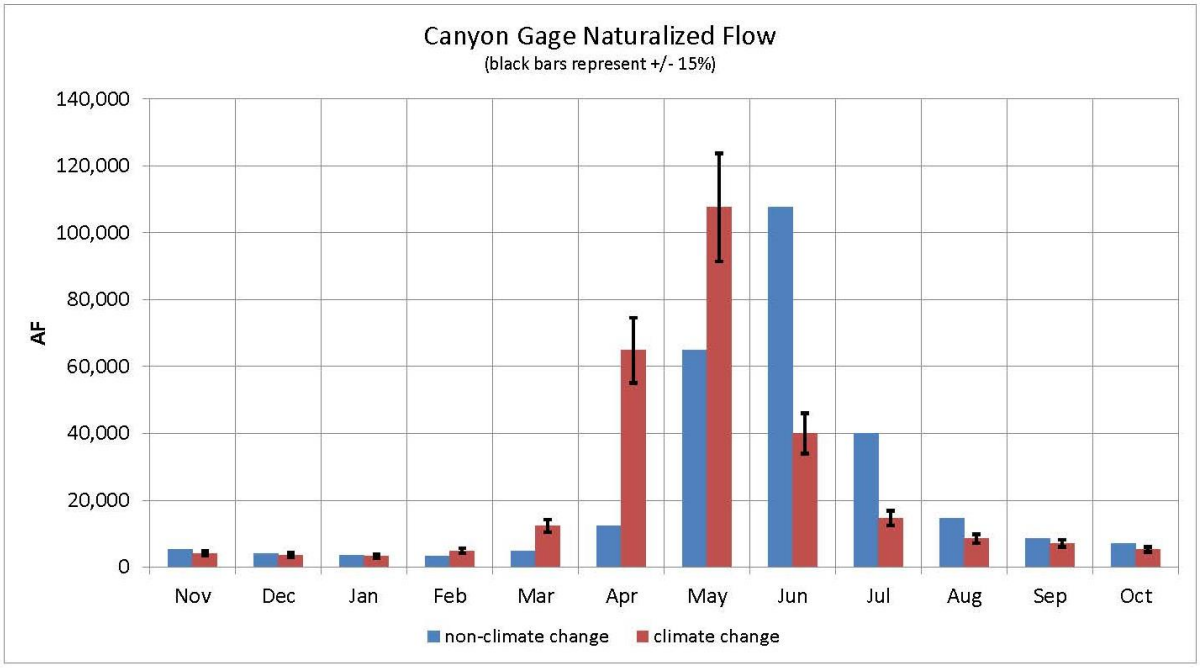
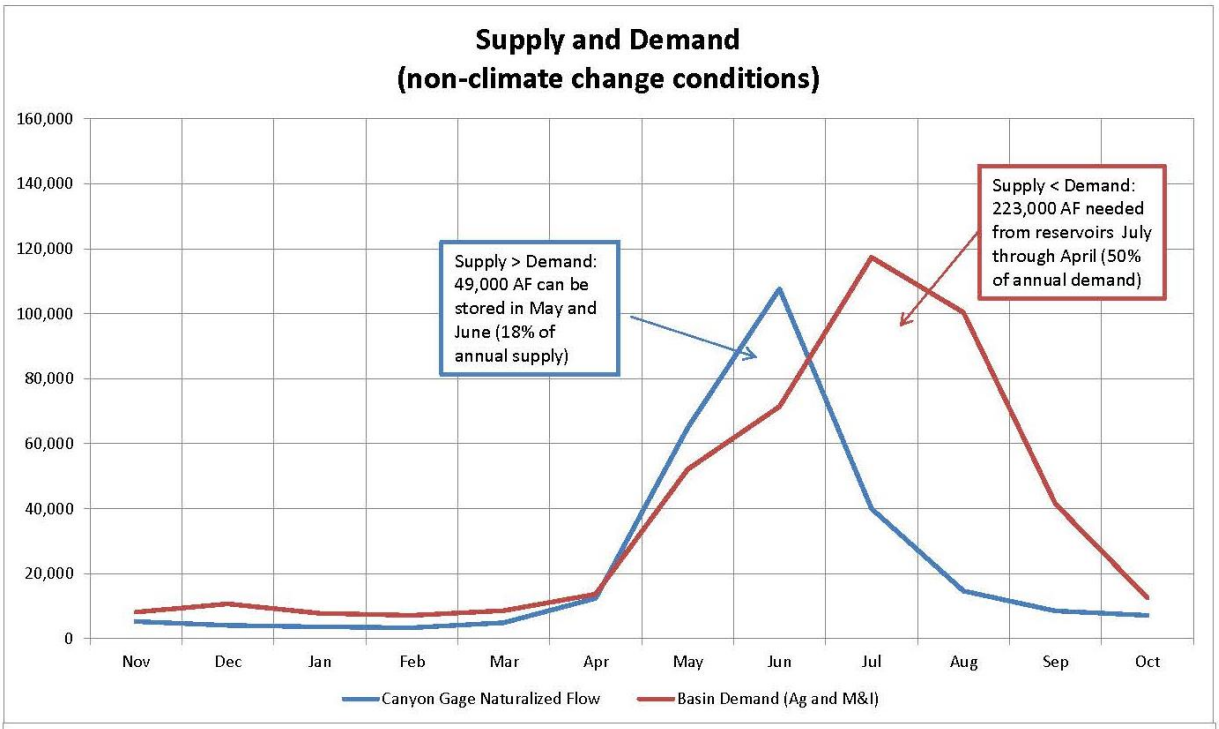
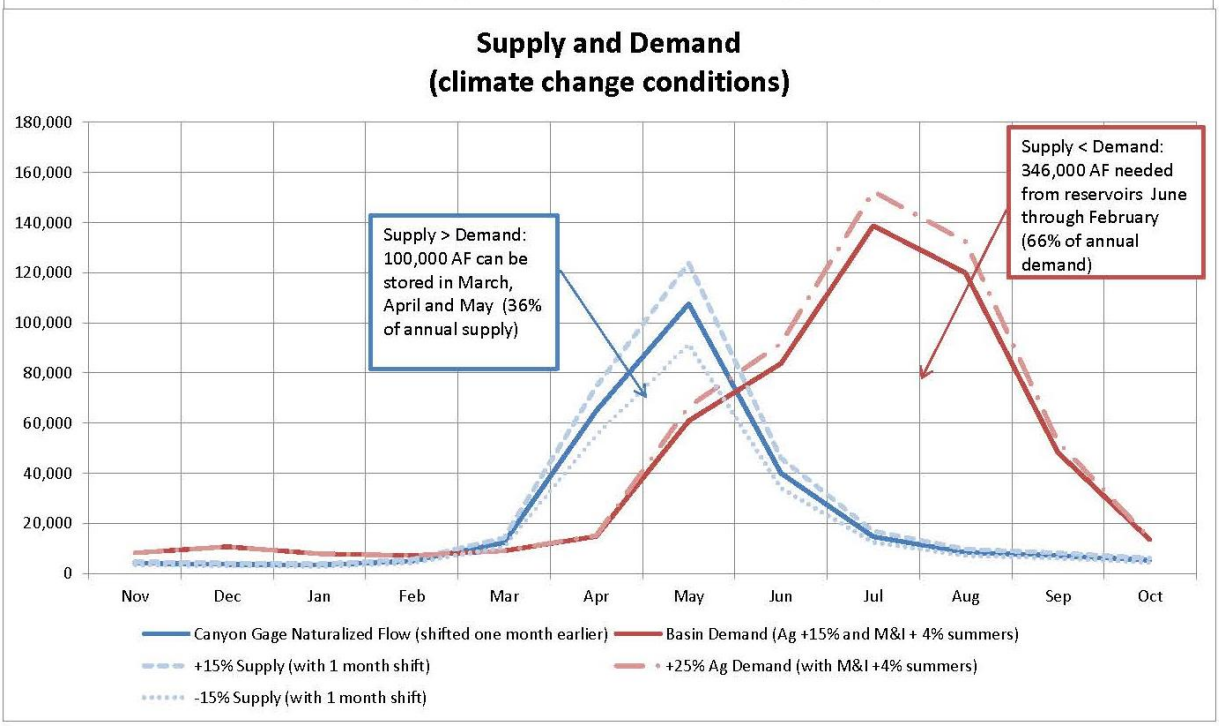


Figure 5-24. Monthly Supply and Demand Under Non-climate Change Conditions and Potential Supply and Demand Under Climate Change Conditions.





- Under climate change scenarios (projections of water supply and demands without climate change), the amount of storable water is predicted to be larger than under non-climate change conditions. Existing storage facilities may not have the capacity to store this amount of water (Figure 5-24, bottom portion).
- The average annual water deficit (demands greater than native supply) is predicted to increase from 43,000 AFY under non-climate change conditions to between 53,000 AFY and 168,000 AFY with climate change.

- Analysis of specific reaches based on season and water rights administration suggests:
  - Little change in winter flow due to project operations is predicted due to minimum flow constraints on NISP diversions and seniority of Timnath, Terry and Big Windsor Reservoirs during the winter months and the Fort Collins and Greeley senior direct flow water rights diverted at their respective pipelines.
  - Changes to the timing of the runoff and demands are expected to result in the following operational changes:
    - increased diversions to storage (increased available water for storage rights);
    - decreased diversions to direct-flow water rights (demand limited);
    - decreased diversions to direct-flow water rights during peak demand (supply limited); and
    - increased deliveries from reservoirs during peak demand (due to reduction in direct-flow supply).
  - Changes in water supply due to climate change will likely increase diversions at mountain reservoirs in dry years due to the increased availability of water on the rising limb of the hydrograph and the relative seniority of the water rights at these reservoirs.
  - Flows downstream of mountain reservoirs are predicted to be reduced on the rising limb of the hydrograph, and increased later in the year due to increased deliveries to primarily M&I reservoir owners.
  - Yields of conditional and junior water rights will likely increase in average and wet years via diversions during the earlier runoff before direct flow demands commence. This will have the effect of reducing flows at most points in the basin below the Canyon Mouth during the peak flow, which is predicted to occur earlier.
  - Streamflows in the late irrigation season will likely not change substantially under climate change conditions:
    - the low-flow period is predicted to be longer, beginning in June instead of July or August;
    - the seniority of water rights at dry-up locations will not change and will likely result in administration similar to current late-season irrigation;
    - reservoir releases are predicted to occur earlier, but many of the agricultural reservoirs are off-channel, release directly to ditches, and would have no impact to streamflows; and
    - use of ground water may shift to better accommodate crop demands and could shift return flow patterns slightly.
  - An additional month of lower flows during the later irrigation season may result in M&I providers exchanging transferred water rights to upstream storage facilities earlier in the year when exchange potential exists. These exchanges may be further limited by available storage capacity.

  - Municipalities without sufficient storage may see decreases in usable yields of transferred water rights due to a combination of lack of demand or storage capacity when water rights are in priority and exchange potential during the rising limb and peak of the hydrograph.
  - There are additional uncertainties associated with transfers of water rights that specify specific start and end dates for diversions, or monthly limits to the transfer to M&I use if the hydrology shifts and the decreed amount of water is no longer available under climate change conditions.
- Under climate change conditions, evaporation rates are projected to increase by approximately 25%:
  - Average annual evaporation volume from basin reservoirs is predicted to increase from 23,000 AFY to 29,000 AFY assuming similar precipitation and end-of-month contents as under non-climate change scenarios.
  - Changes in diversion patterns may draw reservoirs down earlier in the year to meet earlier irrigation deficits. This may result in less reservoir surface area during high evaporation months, thereby partially offsetting the increase in evaporation rate.

5.3 SURFACE WATER QUALITY

5.3.1 Introduction

This section summarizes the potential cumulative effects to surface water quality from NISP alternatives and other identified RFFAs. Water quality is primarily affected by flow-related RFFAs as described previously in Section 5.1.2.1. The HSWSPs when combined with other flow-related RFFAs and NISP alternatives have the potential to result in cumulative effects to surface water quality in the Poudre and South Platte Rivers. The hydrologic model runs used in the evaluation of cumulative effects are described in Section 5.2 (Surface Water Resources).

Several changes in water quality standards by CDPHE are anticipated in the future that would result in new effluent limits for total phosphorus and total inorganic nitrogen. More stringent instream ammonia standards are also likely in some locations, which would decrease effluent limits. These new standards would likely require additional biological/chemical treatment facilities that would improve water quality in the Poudre and South Platte Rivers. These improvements may diminish some of the impacts to these parameters associated with alternative NISP actions. However, a recent study indicates that total phosphorus concentration in the Poudre River may exceed new water quality standards even with reduced loading from WWTP effluent because of the large total phosphorus load from other sources (Sons et al. 2015).

In addition to the flow-related RFFAs incorporated in the CTP hydrologic modeling (CDM Smith and DiNatale 2013) and potential changes to water quality standards, other RFFAs have been identified that may affect surface water quality such as:

- Minimum instream flows within Fort Collins
- Reservoir construction and expansion
- Population growth in the northern Front Range
- Land development
- Commercial and residential development along the Poudre River
- Oil and gas development
- Mountain pine beetle infestation
- Poudre River restoration projects
- Post-fire restoration activities

5.3.2 Methods

The methods used to evaluate surface water quality cumulative effects were the same as those used for evaluating effects with Current Conditions hydrology (Run 1) as described in Section 4.3.1. Output from the CTP hydrologic model provided a basis for evaluating changes in Poudre River and South Platte River flows as the result of alternative NISP actions and with implementation of RFFAs and the HSWSPs (Cumulative Effects). As described in Section 5.2 (Surface Water Resources section) the Cumulative Effects of NISP action alternatives were

evaluated using Future Conditions hydrology (Run 2). Flow changes for the action alternatives plus the RFFAs, but not with the HSWSPs, were predicted using the CTP hydrology Run 4 series (Future Conditions Effects). The Run 5 series was used to predict flow changes for the NISP action alternatives plus the RFFAs and HSWSPs (Cumulative Effects). Water quality impacts under Future Conditions Effects and Cumulative Effects are similar because the hydrology under these two model runs is similar. The effect of the No Action Alternative was evaluated under Future Conditions hydrology only, as explained in Section 4.2.2, with CTP hydrology Run 9 used to predict flow changes. Impacts to existing and new reservoirs would be the same as described in Surface Water Quality Section 4.3 because reservoir operations would essentially be the same with Cumulative Effects.

Water quality cumulative effect evaluations were based on predicted changes in flows for each of the alternatives. Because the analysis of water quality effects is primarily qualitative, it was assumed that lower streamflows would generally result in reduced water quality. However, not all water quality parameters have a direct concentration/flow relationship and other stream processes, inflows, and outflow contribute to cumulative water quality impacts. Potential effects to canal water quality, and WTP and WWTP operations were qualitatively evaluated as described in the Methods Section 4.3.1.

Primary technical memorandum relied upon for the assessment of cumulative surface water quality impacts are listed below and provide additional detailed information.

- Stream Temperature and Dissolved Oxygen Analysis for NISP Supplemental Draft EIS – Summary of Current Conditions and Qualitative Anticipated Effects of NISP Alternatives (Hydros 2014a)
- Northern Integrated Supply Project Supplemental Draft Environmental Impact Statement. Water Quality Assessment Report, Phase I (GEI 2015a)

5.3.3 No Action Alternative (Alternative 1)

Under the No Action Alternative, the delivery of water to NISP Participants would occur from the transfer of about 45,200 AFY of agricultural water supplies from the Poudre and Big Thompson Basins. On the Poudre River, direct flow diversions would be exchanged from the Larimer-Weld Canal and the New Cache Canal upstream to the Poudre Valley Canal. Existing reservoirs would be used and a new 120,000 AF Cactus Hill reservoir would be constructed.

5.3.3.1 Projected Reservoir Water Quality

Under the No Action Alternative, water would be stored in the existing Big Windsor and Lone Tree Reservoirs and a new Cactus Hill Reservoir.

5.3.3.1.1 Existing Reservoirs

Converting operation of existing reservoirs, such as Big Windsor and Lone Tree, from irrigation to municipal use would likely result in water being stored in the reservoirs for longer periods of time to meet year-round municipal demands. The longer retention time could lead to evapoconcentration of salts in the reservoirs and reduced water quality. There would be no effect on Carter Lake or Horsetooth Reservoir.

5.3.3.1.2 Cactus Hill Reservoir

Cactus Hill Reservoir would receive water from Big Windsor Reservoir and the Poudre Valley Canal. Specific operation of Cactus Hill Reservoir is unknown, but water quality is likely to be similar to that described for the larger Cactus Hill Reservoir included in Alternative 3 (Section 4.3.5.1.2). In general, Cactus Hill Reservoir is likely to experience elevated selenium concentrations, hypoxic (low oxygen) concentrations near the bottom in the summer, summer algal blooms, elevated selenium concentrations.

5.3.3.2 Poudre River

5.3.3.2.1 Flows

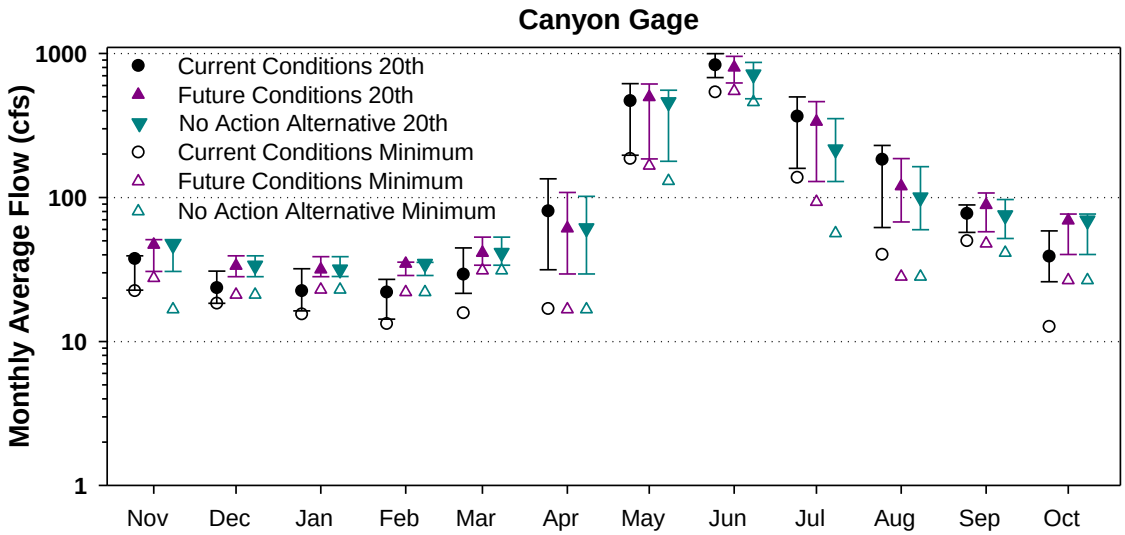
The delivery of water to Participants would occur by transferring agricultural water supplies from the Poudre and Big Thompson Basins. Cactus Hill Reservoir would be constructed and there would be additional water stored in several other existing reservoirs. Diversions of water from the Poudre River would occur primarily in May through August. Because the water would be transferred from agricultural uses, most of the water is already being diverted and substantial changes in flow in the Poudre River are not anticipated. However, the transfer of agricultural water rights to domestic water supply may change water quality characteristics even though substantial changes in flow conditions are not expected. Return flows from WWTPs would increase and agricultural irrigation return flows via ground water would decrease. Agricultural return flows that enter the Poudre River channel via percolation into the ground water or surface flows provide a stronger geochemical (i.e., metals anion/cation) signature along with more nutrients depending upon the pathway, whereas the quality of municipal return flow is strongly influenced by nutrients and less influenced by geochemical inputs. The differences in these water quality characteristics are tied to the return time and sources of the elements within each pathway.

Segment 10

Under Future Conditions hydrology, the 20th percentile and minimum monthly flow during the November to March (winter) low-flow period at the Canyon Gage shows a modest increase in flow by approximately 10 cfs over Current Conditions hydrology (Figure 5-25). The month of April shows that Future Conditions 20th percentile flows may be less than Current Conditions by approximately 20 cfs or 24% less. The 20th percentile flow conditions are expected to be very similar during the summer months of May, June and July, while Future Conditions 20th percentile flows are predicted to be less in August. Under the No Action Alternative, the 20th percentile flows are expected to be very similar to Future Conditions for most months except the period from May to September, when the 20th percentile flow conditions decrease by approximately

17%. In general, the 20th percentile flow conditions appear to be slightly improved under Future Conditions; however, it is important to note that total flow (i.e., peak flows) is predicted to be less in the Poudre River given the increased demand (CDM Smith 2014a).

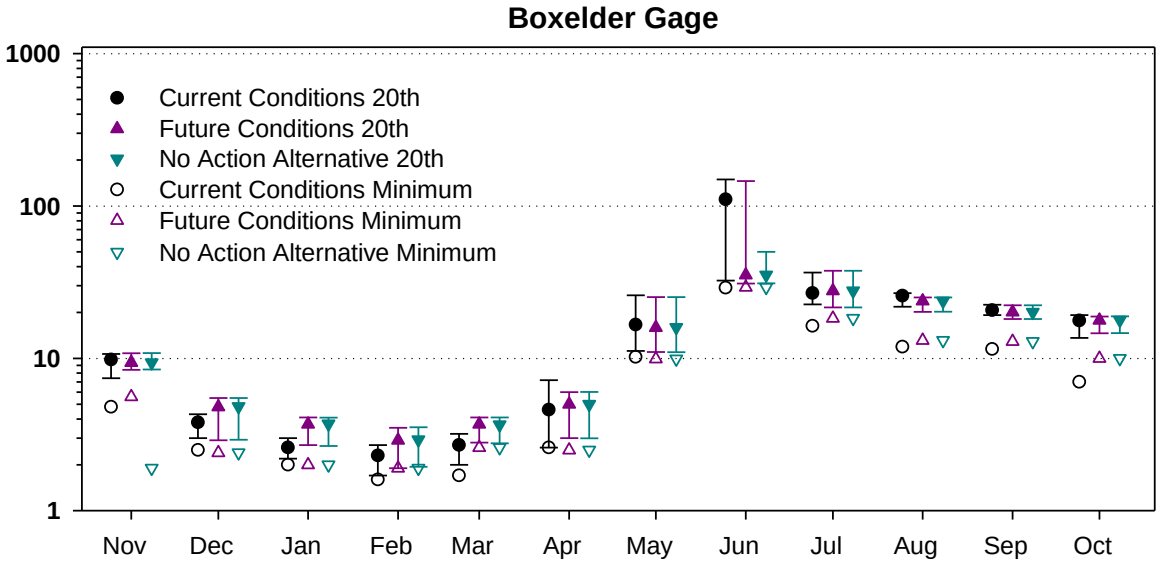
Figure 5-25. Comparison of the 20th Percentile and Minimum Monthly Average Flow for Current Conditions, Future Conditions and the No Action Alternative at Canyon Gage. Error Bars Represent the 95% Confidence Interval Around the 20th Percentile.



Segment 11

The Boxelder Gage characterizes flow conditions influenced by hydrological inputs from a WWTP and ground water as well as major diversions. In general, the Future Conditions hydrology 20th percentile flow is expected to be similar to Current Conditions during most months of the year (Figure 5-26). During the winter months, the Future Conditions hydrology 20th percentile monthly and minimum flows would result in <1 cfs increase from Current Conditions (Figure 5-26). One difference between Future and Current conditions hydrology appears during June, when Future Conditions 20th percentile flows are expected to be approximately 75 cfs less than Current Conditions. Low base flow conditions (i.e., <10 cfs) are expected to continue through the winter months and differences between the minimum monthly flows are expected to be negligible. Under the No Action Alternative, the 20th percentile flows are expected to be nearly identical to Future Conditions at the Boxelder Gage.

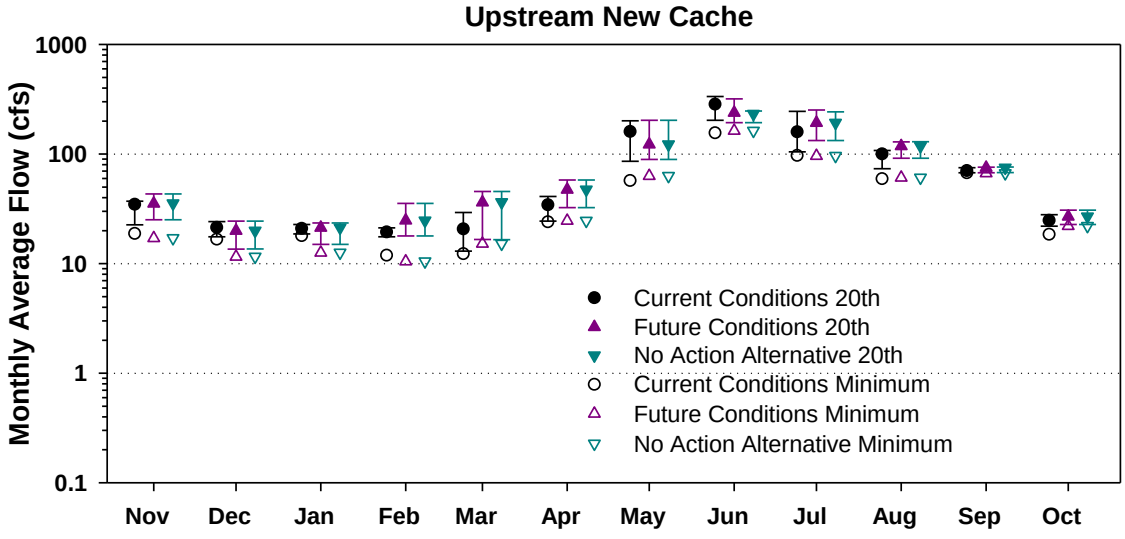
Figure 5-26. Comparison of the 20th Percentile and Minimum Monthly Average Flow for Current Conditions, Future Conditions and the No Action Alternative at Boxelder Gage. Error Bars Represent the 95% Confidence Interval Around the 20th Percentile.



Segment 12 – Upper Reach

The CTP node immediately upstream of the New Cache Canal headgate represents flow conditions in the upper reach of Segment 12, as it encompasses tributary inputs from Boxelder Creek, inclusive of the Boxelder WWTP discharge and flows from Fossil Creek as well as ground water inflows. Under Future Conditions hydrology, the 20th percentile and minimum monthly flow from November through April would result in negligible changes when compared with the Current Conditions hydrology immediately upstream of the New Cache Canal (Figure 5-27). In May and June, Future Conditions hydrology may reduce the 20th percentile monthly flows by 24% and 16%, respectively, which correspond to reductions in flow of 38 cfs and 46 cfs. From July through October, the Future Conditions hydrology 20th percentile and minimum monthly flow are very similar to Current Conditions hydrology. Under the No Action Alternative, the low flow conditions are expected to be very similar to modeled Future Conditions hydrology at the New Cache Canal.

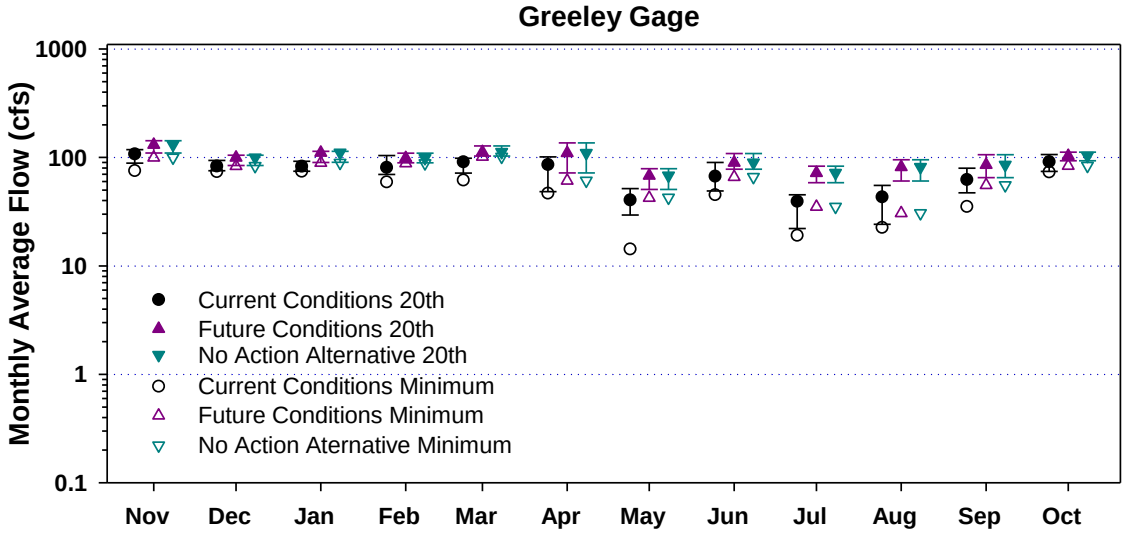
Figure 5-27. Comparison of the 20th Percentile and Minimum Monthly Average Flow for Current Conditions, Future Conditions and the No Action Alternative at Upstream New Cache. Error Bars Represent the 95% Confidence Interval Around the 20th Percentile.



Segment 12 – Lower Reach

The Greeley Gage represents the most downstream location on the Poudre River and receives multiple sources of inflow that include WWTPs, agricultural return flows, and ground water inflows. While the relative percentages of these sources which comprise the surface water flows are not well documented, it is expected that the contributions, or at least their percentages, would likely change in the future. Under Future Conditions hydrology and the No Action Alternative, the 20th percentile and minimum monthly flows are projected to be greater than Current Conditions during all months (Figure 5-28). From November through April, the Future Conditions hydrology 20th percentile flows are projected to increase by approximately 22 cfs or 25%. During the spring and summer months, Future Conditions hydrology indicates the largest increase in 20th percentile flows, representing approximately 30 cfs or 68% increase on average. The potential increase in low flow conditions during the future and under the No Action Alternative is likely tied to the transfer of agricultural water use to domestic water use and the fact that WWTP discharge volume is more uniform throughout the year.

Figure 5-28. Comparison of the 20th Percentile and Minimum Monthly Average Flow for Current Conditions, Future Conditions and the No Action Alternative at Greeley Gage. Error Bars Represent the 95% Confidence Interval Around the 20th Percentile.



5.3.3.2.2 Constituent Effects

Segment 10

Under the No Action Alternative, the 20th percentile streamflow conditions show a modest reduction in flow (-17%) as compared to the Future Conditions hydrology from May through September. These changes in flow are likely due to the shift in water rights from agricultural use to domestic water supply. Based on the available metals data for Segment 10 –, manganese, copper, and selenium – there are no apparent relationships between flow and concentration or seasonal patterns in the data that would indicate a change in concentration under the No Action Alternative. Furthermore, the concentrations for these parameters are well below their respective water quality standard. Total recoverable iron concentrations show a slight increase during spring snowmelt conditions; however, concentrations are not expected to substantially change under the No Action Alternative because this parameter is driven by larger watershed inputs upstream of the segment rather than nearby source or non-point source inputs to Segment 10. Sulfate is the only parameter of interest that shows relatively higher concentrations during low flows conditions in Segment 10. Any change under the No Action Alternative should not adversely affect water quality, because the sulfate concentrations are currently well below the current water supply standard of 250 µg/L. Based on available data for Segment 10, the reduced flows under the No Action Alternative would have a negligible effect on nutrient and metal concentrations.

Segment 11

Under the No Action Alternative, the 20th percentile flow conditions are expected to be nearly identical to Future Conditions hydrology. June is the only month that indicates a substantial reduction in flow when both the Future Conditions hydrology and the No Action Alternative are

compared to Current Conditions hydrology at the Boxelder Gage. Under the No Action Alternative, water quality conditions are expected to be very similar to Current Conditions. Parameters that currently show greater concentrations during low flow conditions – such as manganese, selenium, nitrate, sulfate, and chloride – are expected to show similar patterns under the No Action Alternative. Of these parameters, selenium would likely continue to show relatively high concentrations under the No Action Alternative when compared to the current water quality standard.

Upper Reach of Segment 12

Under the No Action Alternative, the 20th percentile flow conditions would be reduced during the peak snowmelt runoff (May and June), and would remain very similar to both Future Conditions and Current Conditions hydrology during the other calendar months. Hydrological changes in the future are expected to shift due to water right changes, with more water being designated for water supply, and less for agricultural use. In the upper reaches of Segment 12, the water quality conditions should shift from those associated with ground water (e.g., metals) to those associated with wastewater treatment facilities (e.g., nutrients). As more water is diverted for water supply use, it would be returned to the river through wastewater treatment plants. With less water being used for agriculture, the ground water and agricultural surface flows would likely be reduced which may reduce the metals concentrations in this reach. Both ammonia and phosphorus currently exceed their water quality standards in the upper reach of Segment 12, and these concentrations would likely continue to exceed the standard under the No Action Alternative given the influence of WWTPs in the upper reach. However, future water quality standards and permit limits for WWTPs will eventually be implemented for total nitrogen, total phosphorus, and possibly ammonia, which would decrease their effluent concentrations and likely decrease concentrations in the Poudre River. Selenium concentrations also currently exceed the water quality standard, and may continue to exceed the standard under the No Action Alternative; however, if the relative proportion of ground water return flows decrease in the future, then selenium concentrations may decrease in the upper reach of Segment 12.

Lower Reach of Segment 12

Under the No Action Alternative, the 20th percentile flow conditions are expected to increase during all months of the year. This increase in low flow conditions is tied to the wastewater return flows rather than agricultural return flows, which have a more uniform discharge rate throughout the year. Similar to the upstream reach of Segment 12, ammonia and total phosphorus concentrations currently exceed their regulatory standard, and under the No Action Alternative, these conditions would likely continue to exceed their relative standard until WWTP upgrade their nutrient reduction capabilities to meet the impending future water quality standards. Selenium concentrations also currently exceed the water quality standard, and may continue to exceed the standard under the No Action Alternative; however, if the relative proportion of ground water return flows decrease in the future, then selenium concentrations may decrease in the lower reach of Segment 12.

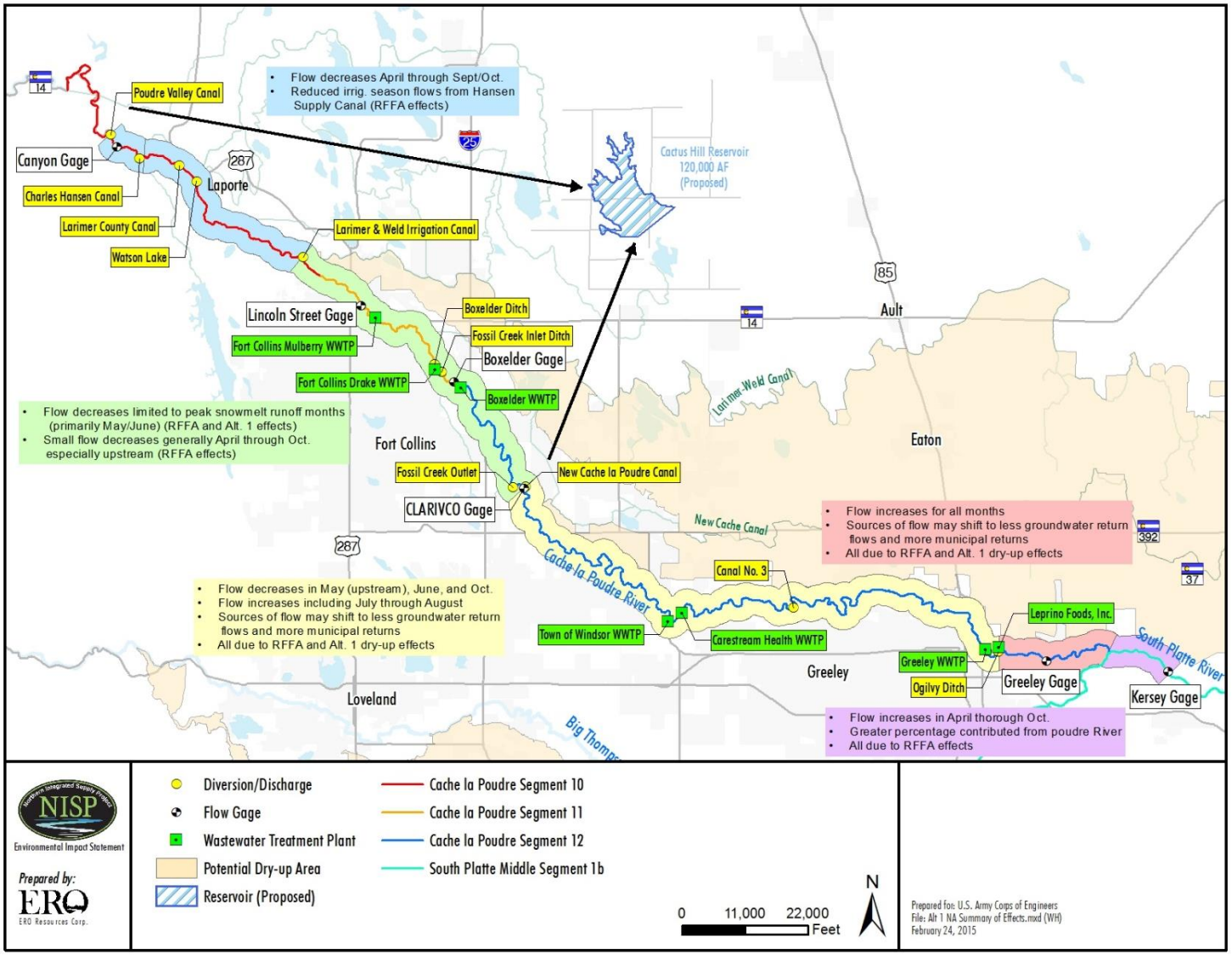
5.3.3.2.3 Temperature Effects

The No Action Alternative is expected to decrease median flow rates from the Canyon Gage to the Larimer-Weld Canal from April through September/October, which would likely result in an increase to Poudre River water temperatures over this reach; potentially increasing the magnitude and frequency of standard excursions in March, July, and August. The reduction of cooling inflow for the Hansen Supply Canal would also lead to warmer water downstream of the Hansen Supply Canal.

From the Larimer-Weld Canal to the New Cache Canal diversion, flow reductions associated with the No Action Alternative are primarily focused on peak snowmelt runoff periods (primarily May/June), with some additional minor flow reductions from April through October, due to upstream reductions in Hansen Supply Canal inflows. May and June is not a temperature sensitive period in this reach. Through the summer, there could be some warming in this reach due to the inflow of warmer water from upstream and small reductions in irrigation-season flow rates. This could exacerbate conditions somewhat at locations with current temperature issues just upstream of Boxelder Creek and the New Cache Canal diversion. Additionally, the cooling effects of ground water inflows would likely be reduced somewhat by anticipated extensive dry-up of irrigated areas, though this effect would likely be smaller upstream of New Canal Cache as compared to the rest of Segment 12. This could result in warmer water from Boxelder Creek to the New Cache Canal diversion.

From the New Cache Canal diversion to the confluence with the Greeley WWTP, median flow rates are anticipated to increase in July and August and decrease in May, June, and October. The timing of the decreases in flow rates is outside the sensitive period for temperature in this reach. Downstream from the Greeley WWTP to the confluence with the South Platte, median flow rates are anticipated to increase for all months. There is however, a potential adverse impact due to changes in the sources of water to this reach from the New Cache diversion to the South Platte River. Extensive anticipated dry-up of irrigated lands would reduce the relative contribution of cooling ground water return flows to the river. The effect of increased WWTP effluent volumes could be mixed, with warming in most months and possible cooling effects in peak temperature months (typically July and August). Figure 5-29 summarizes changes in flow and the potential effect to stream water temperature along the Poudre and South Platte Rivers.

Figure 5-29. Potential Impacts to Poudre River and South Platte River Stream Temperature from Hydrologic Changes under Alternative 1.



5.3.3.2.4 Dissolved Oxygen Effects

Lower flows from the Canyon Gage to the Larimer-Weld Canal in the months of April through October could result in lower DO concentrations at times of already low flows, particularly around diversions and diversion dams. Because this reach is not considered highly sensitive for DO, and because the effects on low flow rates are less than those at the median flow rates, the effects are expected to be minimal.

From the Larimer-Weld Canal to the New Cache Canal diversion, flow reductions, primarily in May and June, are unlikely to substantially affect DO. Additionally, the inflow of low-DO ground water may decrease somewhat in this area due to anticipated extensive dry-up of irrigated land. From the New Cache Canal diversion to the confluence with the South Platte River, median flow rates would decrease in May, June, and October and increase in July and August upstream of the Greeley WWTP. Downstream of the Greeley WWTP median flow rates would increase in all months. Over this entire reach, the relative contribution of low-DO ground water return flows to the river may decrease due to dry-up of agricultural lands, which could be beneficial for DO conditions. Increased fractions of WWTP effluent in the river may increase nutrient and organic matter concentrations, which would lower DO concentrations. However, reductions in WWTP effluent nutrient concentrations, including ammonia and organic nitrogen, are likely to occur in the future due to Regulation 85, and possible adoption of numeric standards for nutrients in streams (WQCC 2014). In short, the net effect to DO concentrations over this reach is difficult to definitively estimate because of the multiple variables influencing DO.

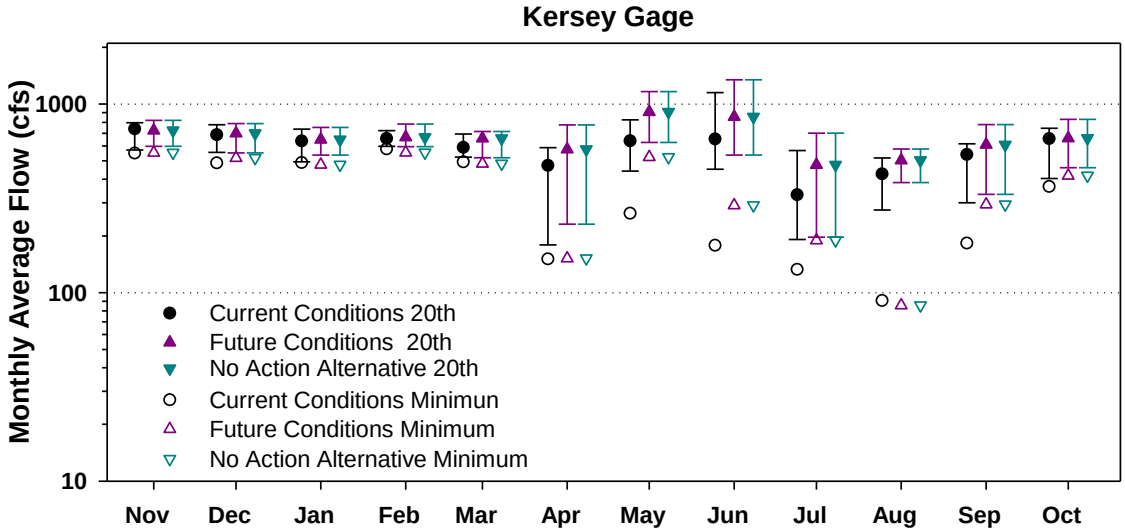
5.3.3.3 South Platte River

5.3.3.3.1 Flow

Segment 1b

The Kersey Gage on the South Platte River represents the downstream boundary for evaluation of NISP effects. Under Future Conditions hydrology, the 20th percentile flows are very similar to Current Conditions hydrology, with the spring and summer months projected to show a slight increase in low flows (Figure 5-30). During these months, the 20th percentile flows may increase by approximately 160 cfs or 32% under Future Conditions hydrology near the Greeley Gage on the Poudre River, the projected increase in low flow conditions may be a result of the transfer of agricultural water use to domestic water use. The No Action Alternative would result in low-flow conditions very similar to Future Conditions hydrology on the South Platte River.

Figure 5-30. Comparison of the 20th Percentile and Minimum Monthly Average Flow for Current Conditions, Future Conditions and the No Action Alternative at Kersey Gage, South Platte River. Error Bars Represent the 95% Confidence Interval Around the 20th Percentile.



5.3.3.3.2 Segment 1b Constituent Effects

Water quality conditions at Kersey Gage, South Platte River, currently exceed the sulfate and total recoverable iron water quality standards, as well as the interim total phosphorus value. While the Poudre River contributes to the elevated sulfate and total phosphorus concentrations observed in the South Platte River, these concentrations likely exceed the standard upstream of the confluence with the South Platte River due to the dominant wastewater input from the Denver Metropolitan area. Furthermore, the relative contribution in flow from the Poudre River is small compared to the amount of flow in the South Platte River. Elevated total recoverable iron concentrations are likely due to the South Platte River sources, because concentrations in the Poudre River are relatively low and less than the standard. Given the relatively low volume of water contributed by the Poudre River to the South Platte River, these water quality parameters would likely continue to exceed standards under the No Action Alternative.

5.3.3.3.3 Temperature Effects

Currently the South Platte River experiences exceedance of DM standards, primarily from June through August. Temperature in the South Platte is not highly sensitive to inflow from the Poudre River because of the low volume contributed by the Poudre. There would be no change in flow rates on the South Platte River at Kersey, so any temperature effects would be limited to a fraction of the increase in Poudre River temperatures, proportional to the mixing balance at the confluence with the Poudre River.

5.3.3.3.4 Dissolved Oxygen Effects

Currently the South Platte River at Kersey does not exhibit DO standard excursions. There would be increased median flow rates from April through October on the South Platte River at Kersey, in part reflecting increased contributions from the Poudre River. While DO from the Poudre River may increase or decrease slightly at times during the irrigation season, effects on

South Platte DO are not anticipated due to limited sensitivity and the low relative volume contributed by the Poudre River.

5.3.3.4 Effects on Irrigation Water Quality

Water would be conveyed by the Larimer-Weld Canal, New Cache Canal, and Poudre Valley Canal from different diversion points on the Poudre River, and by the Home Supply Canal diverted from the Big Thompson River. It is unknown when, how often, and the quantities to which the alternative point of diversion or exchange operations would take place in the future. New diversions on existing canals also would be needed, including the Poudre Valley Canal, New Cache Canal, and the Lone Tree Reservoir Outlet Canal. It is not possible at this time to predict ditch water quality for irrigation use because of the many variables associated with operation of the ditch system under the No Action Alternative.

5.3.3.5 Effects on Water Treatment Plant Operations

No change in water quality constituents, including TOC concentrations, is expected in the Poudre River at Greeley's Bellvue WTP diversion point that would affect WTP operations. Horsetooth Reservoir operations would not change, so there would be no change in water quality deliveries to the Fort Collins FCWTF and the Tri-District SCFP. Overall, no change to existing WTP operations from Poudre River diversions or Horsetooth Reservoir intake is anticipated under the No Action Alternative because there would be no adverse impact to raw water inputs. However, direct delivery from Cactus Hill Reservoir to a Participant WTP could require treatment for TOC depending on the quality of the source water to Cactus Hill, lake processes that affect TOC, and the time of the year.

5.3.3.6 Effect Waste Water Treatment Operations

Hydrological changes in the future are expected to shift due to water right changes, with more water being designated for water supply, and less designated for agricultural use. This change in water usage would likely affect the quantity and timing of the return flows to the river. As more water is diverted for water supply use, it would be returned to the river through wastewater treatment plants. With less water being used for agriculture, the ground water and agricultural surface return flows would likely be reduced. This change in usage should result in a shift of the constituents from those associated with ground water (e.g., metals) to those associated with wastewater treatment facilities (e.g., nutrients).

Changes in hydrology under both the Future Conditions and the No Action Alternative would mainly affect Segment 12 of the Poudre River and Segment 1b of the South Platte River. The increase in wastewater treatment plant inputs may result in increased nutrients in these segments, some of which are already exceeding standards. However, the implementation of Regulation 85 may result in an overall decrease in nutrient concentrations as more facilities improve their treatment processes to comply with new regulations in the future.

Wastewater effluent limits are based on regulatory low flows and water quality standards for the receiving stream. Regulatory low flows include the chronic 30-day average low flow with an average 1-in-3-year recurrence (30E3) and the acute 1-day low flow with an average 1-in-3-year recurrence (1E3) spanning the most recent 10 years of measured data. There are some notable differences in the regulatory low flows and the minimum 30-day average modeled (CTP Model) low flow for both the Windsor and Carestream Health facilities and these differences are likely due to different modeling assumptions used to calculate the low flow conditions rather than observed conditions.

5.3.4 District's Preferred Alternative (Alternative 2)

As described in the Methods section (5.1.2) the cumulative effects assessment of Alternative 2 uses Future Conditions hydrology compared to Future Conditions Effects (Run 4a) and Cumulative Effects (Run 5a). As explained in Section 4.2.3.4.1, a single set of modeled streamflows was evaluated for the Reclamation Action Option and the No Reclamation Action Option for Alternative 2 because the net effects on streamflow below the Hansen Supply Canal outfall would, on average, effectively be the same under either option. In general, Poudre River flows would be lower than Current Conditions hydrology in the spring and summer months with RFFAs and HSWSPs added to Alternative 2 operations with fewer changes in the fall in winter. South Platte River flows would typically be greater than Current Conditions hydrology from spring through fall and slightly lower in the winter and early spring.

5.3.4.1 Reservoirs

Modeled NISP operation under Alternative 2 indicated very minor changes in diversions for Future Conditions Effects and Cumulative Effects. Thus, potential impacts to Horsetooth Reservoir with and without the Reclamation Action Option would be similar to what was described in Section 4.3.4.1.3. Piping high quality water from Glade Reservoir to Horsetooth Reservoir under the Reclamation Action Option is anticipated to have a minor effect on water quality because maximum annual deliveries of 9,274 AF would be a small fraction of storage at any given time in the 156,000 AF reservoir. Additionally, the multi-level outlet at Glade Reservoir would allow options for delivery of quality water to Horsetooth Reservoir. Because no new sources of water would be introduced into Carter Lake and the net operational changes would be very small, water quality impacts are expected to be negligible and thus, no detailed analysis was conducted.

Water quality in Glade and Galeton Reservoirs would also be similar to the evaluation conducted for Current Conditions in Sections 4.3.4.1.1 and 4.3.4.1.2, respectively because reservoir storage and operation would not change substantially with RFFAs and HSWSPs. The lands surrounding Glade Reservoir are anticipated to be managed as Park and open space and would have negligible effects on reservoir water quality. Fluctuations in water level, combined with newly inundated vegetation, can lead to elevated levels of methylmercury in fish tissue. This suggests that fish in Glade Reservoir would have high body burdens of methylmercury, and like many other Front Range reservoirs such as Horsetooth Reservoir, Glade Reservoir may eventually

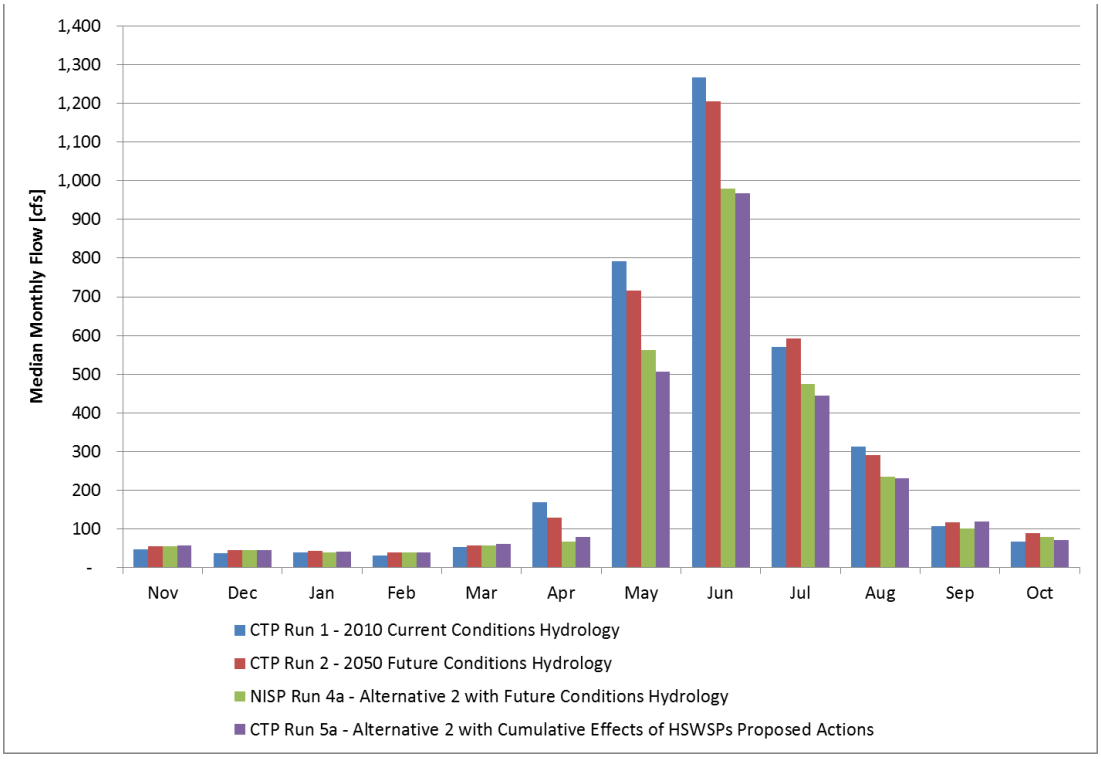
have a mercury-based fish consumption advisory. Residential development around Galeton Reservoir is not anticipated. Oil and gas development will likely continue in the area surrounding Galeton Reservoir. Although spills have occurred in the past, they were remediated and the incidents were closed. If oil and gas drilling occurs with the same safety record and remediation as what has previously occurred in the Galeton Reservoir study area, the cumulative effect would be negligible from future spills.

5.3.4.2 Poudre River

5.3.4.2.1 Segment 10

The difference between Alternative 2 diversions with Future Conditions Effects and Cumulative Effects is small. The reduction in spring and summer flows from May to August under Alternative 2 at the Canyon Gage would increase with the addition of RFFAs and the HSWSPs (Figure 5-31). However, during September and the winter months flows in the lower Segment 10 reach would increase slightly from augmentation releases from Glade Reservoir. These releases would have a beneficial effect on water quality parameters compared to Current Conditions.

Figure 5-31. Alternative 2 Median Monthly Flows at Canyon Gage, 1980-2005.



Metal and nutrient concentrations are predicted to remain below water quality standards, with a medium potential for copper or dissolved manganese to exceed standards. A medium potential indicates that current water quality is approaching the standard and changes in flow associated with the alternative could result in standard exceedances. Copper exceeded water quality standards in 2006, but that appeared to be related to copper based herbicide use to manage

vegetation. This practice has been discontinued, so future exceedance of the copper water quality standard is unlikely. Median dissolved manganese concentrations show elevated levels in January and February, thus there is a medium potential for standards exceedance in the future; however, this is outside of the period when most NISP diversions would occur.

The frequency and magnitude of temperature DM and MWAT excursions upstream of the Hansen Supply Canal in July and August is likely to increase with further decreases in flow. This reach of the Poudre River currently exhibits temperature and standard exceedances in March, July, and August. Downstream from the Hansen Supply Canal to the Larimer-Weld Canal, further reductions of median flow rates from March to October, attributable largely to the reduction of cool inflows from the Hansen Supply Canal in the future would result in warmer water in this reach. While this reach does not currently exceed the temperature standard because of the cool inflows from the Hansen Supply Canal, this reach would be more sensitive to Poudre River flow changes and the potential for exceedance of the temperature standard would increase, particularly near the downstream end of the reach. Flow augmentation planned as part of Alternative 2 could provide a temperature benefit to the reach from ~1 mile below Hansen Supply Canal to the Timnath Inlet Headgate, which includes the sensitive reach at the downstream end of Segment 10. Under the proposed augmentation plan, the overlap of timing of additional releases with temperature months of concern is primarily limited to September.

Localized effects on DO concentrations are possible in Segment 10; however, this is not considered a sensitive reach for DO. Therefore, additional standard excursions are not anticipated. Glade Reservoir releases as part of the augmentation plan would be beneficial to DO levels in the Poudre River in September.

5.3.4.2.2 Segment 11

Poudre River flows at the Lincoln Street Gage in the upper reach of Segment 11 would decrease primarily from May to July with implementation of Alternative 2 and RFFAs and HSWSPs (Figure 5-32). From the Larimer-Weld Canal to the New Cache Canal in Segment 12, anticipated flow rate reductions are less than those upstream. Augmentation flows would supplement flows above Current Conditions in September and November through April. In the lower reach of Segment 11 at the Boxelder Gage, flows are reduced primarily in June with smaller changes in other months (Figure 5-33).

Figure 5-32. Alternative 2 Median Monthly Flow at Lincoln Street Gage, 1980-2005.

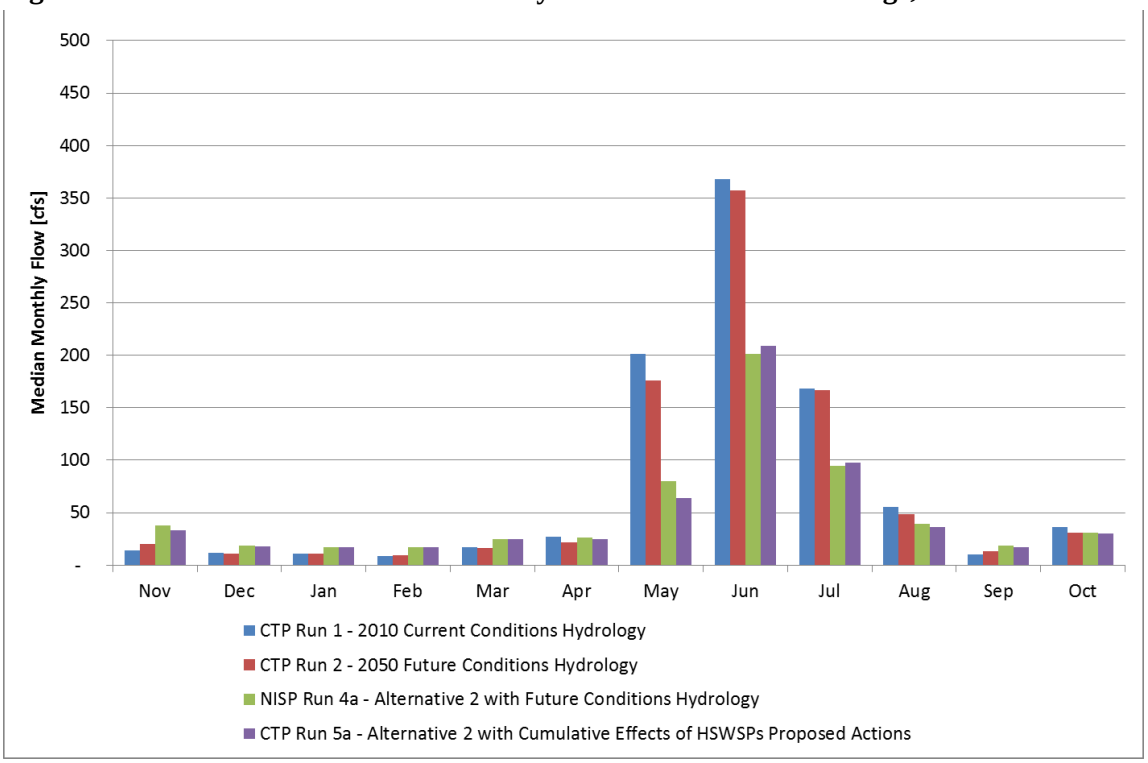
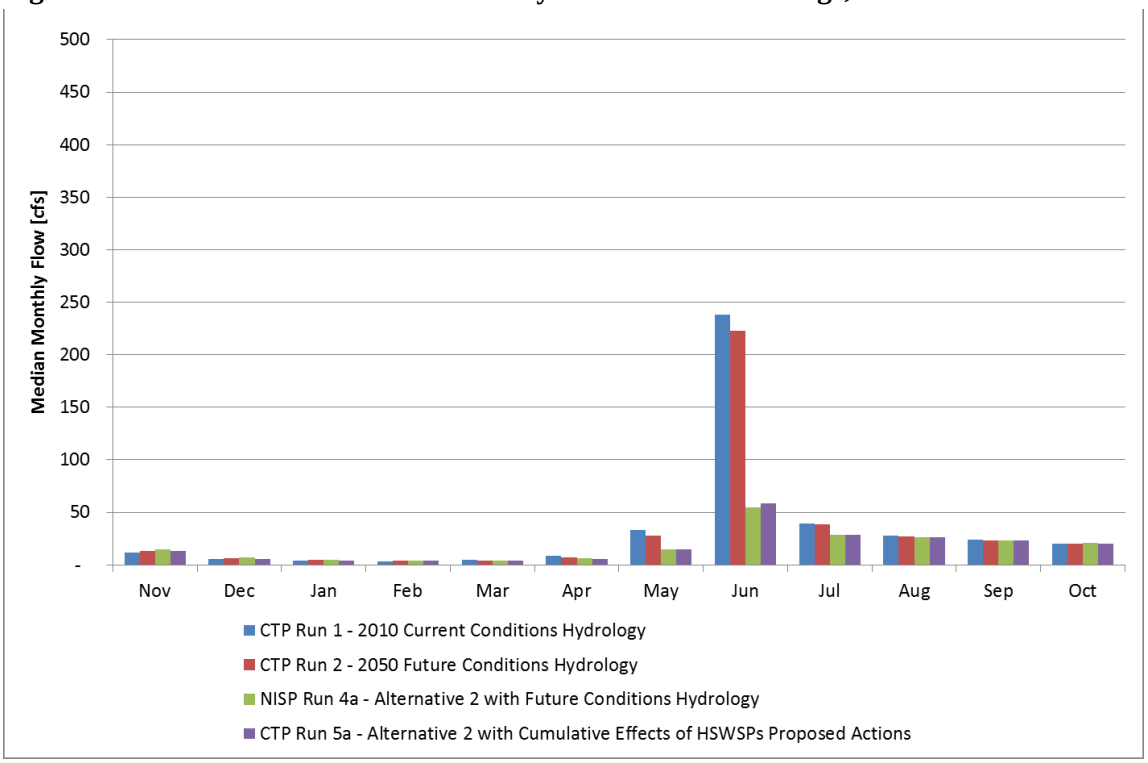


Figure 5-33. Alternative 2 Median Monthly Flow at Boxelder Gage, 1980-2005.



The potential for exceedance of water quality standards would be medium for total phosphorus and high for selenium, which currently exceeds water quality standards. Other nutrient and metal concentrations are unlikely to exceed water quality standards because values are currently low and reduced flows are not anticipated to substantially change concentrations. Reductions in flow rates in July and possibly August could elevate Poudre River temperatures in sensitive reaches upstream of Boxelder Creek increasing the potential for exceedance of the DM or MWAT. Although the flow changes are smaller in this reach, potentially warmer flows upstream from Segment 10 may increase the sensitivity of this reach to exceedance of temperature standards. Reduced summertime flow rates in localized areas that have historically exhibited DO standard excursions in Segment 11 could increase the frequency and magnitude of exceedances if reductions occur during or create low flow conditions. Augmentation of Poudre River flows with Glade Reservoir releases would improve DO concentrations downstream to the Timnath Reservoir inlet in September and from November to April.

5.3.4.2.3 Segment 12

From the New Cache Canal diversion to the confluence with the South Platte River, flow rates would generally increase slightly from Current Conditions except for decreases in June, September, and October at some locations above the Greeley Gage (Figure 5-34 and Figure 5-35) with Alternative 2. The decreases are due to diversions, while the increases are related to increased municipal return flows in the future.

Figure 5-34. Alternative 2 Median Flow Downstream of the New Cache Canal, 1980-2005.

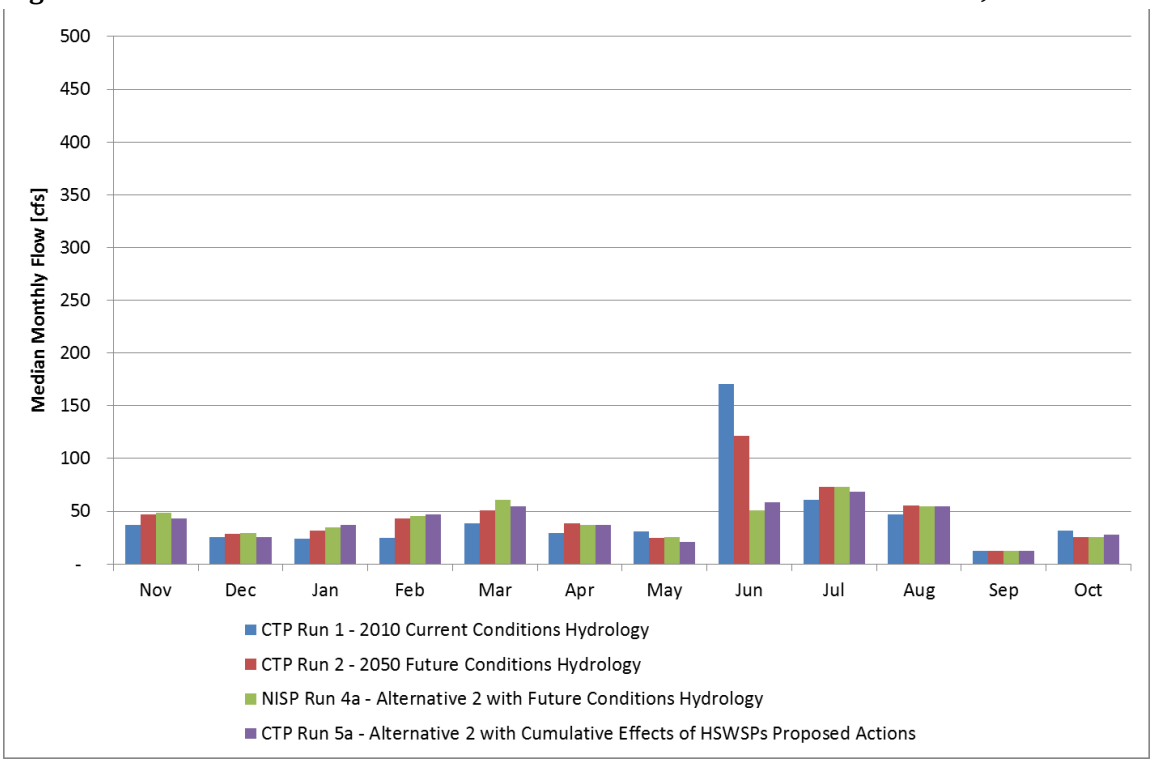
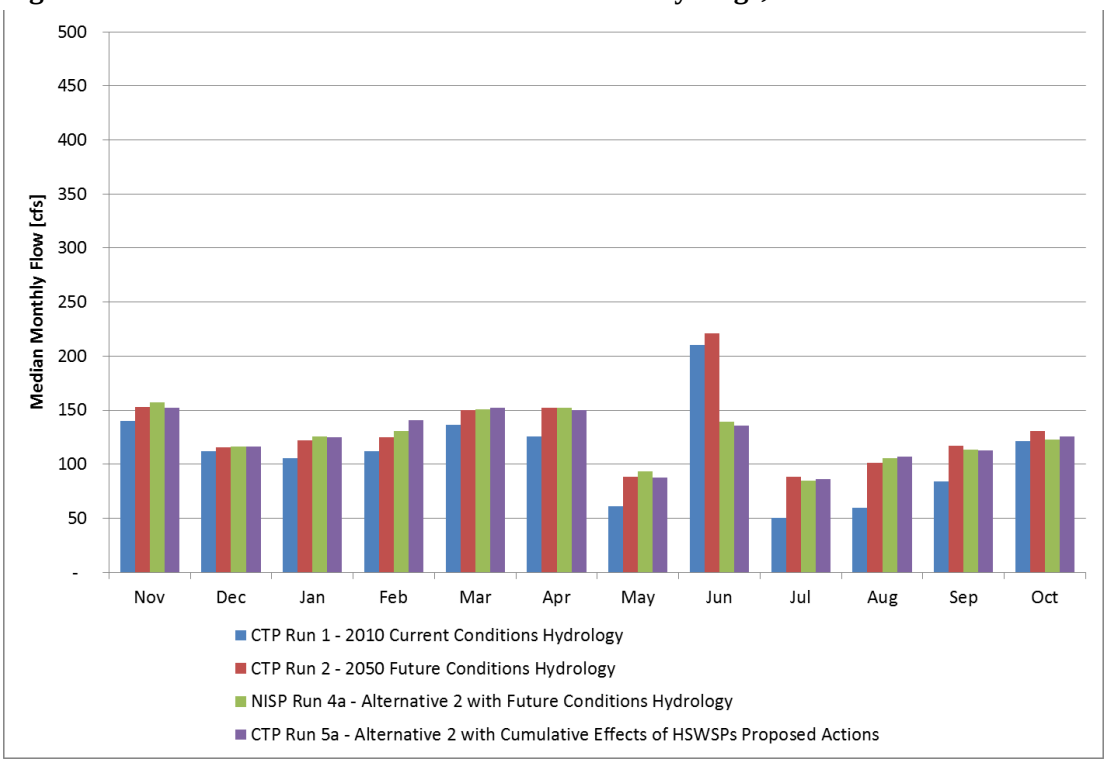


Figure 5-35. Alternative 2 Median Flow at the Greeley Gage, 1980-2005.

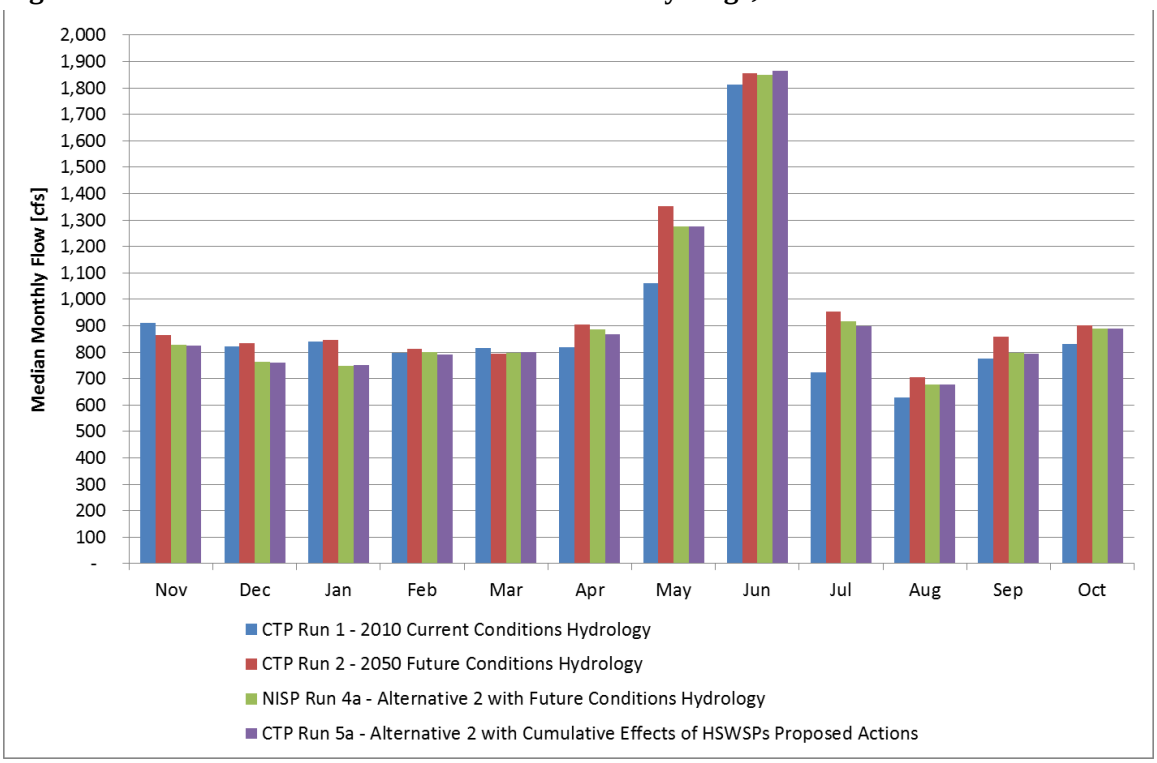


The potential for exceedance of water quality standards in Segment 12 would remain high for total recoverable iron, ammonia, total phosphorus, and selenium, which all currently exceed water quality standards. E. coli concentrations would also likely remain above standards from May to October. Nutrients and metals have a low potential for exceeding water quality standards. For temperature, median flows are anticipated to decrease in June in Segment 12; however, this is not a sensitive month for temperature in this reach. In most other months median flow rates are anticipated to increase, with increased WWTP volumes and possible decreased ground water inflows if irrigation return flows decline in the future. The net effect of this shift in sources of inflow would likely be warming, including summer months. Increased flow would generally benefit DO; however, increased WWTP effluent volumes may have negative effects depending on the resulting in-river ammonia and/or dissolved organic matter concentrations. Future Regulation 85 standards for nutrients could also result in lower nutrient discharges from WWTP. Changes in the volume of ground water return flows, which currently have low DO concentrations, could increase Poudre River DO concentrations in Segment 12.

5.3.4.2.4 South Platte River – Segment 1b

Streamflow in the South Platte River at the Kersey Gage with Alternative 2 and RFFAs and HSWSPs would typically be greater than Current Conditions hydrology from April to October and lower or about the same from November to March (Figure 5-36). The SPWCP would divert water from the South Platte River for delivery to Galeton Reservoir, which would reduce flows in the winter months.

Figure 5-36. Alternative 2 Median Flow at the Kersey Gage, 1980-2005.



Impacts to nutrient and metal concentrations would be similar to those described for Current Conditions in Section 4.3.4.3. Total recoverable iron, total phosphorus, and selenium, which currently exceed water quality standards would continue to exceed standards. Dissolved manganese and ammonia would have a medium potential for standard exceedance, while other constituents are unlikely to exceed water quality standards under Alternative 2 with RFFAs and HSWSPs. Under cumulative effects hydrology, there may be a slight increase in the temperature of water from the Poudre River and a slight increase in the percent contribution of the Poudre River flows to the South Platte River. These projected changes are unlikely to substantially effect temperature in the South Platte River, which has limited sensitivity in this reach. Increased flows in the South Platte River would generally be beneficial to DO concentrations. As mentioned for Segment 12, WWTP discharges and future nutrient regulations could also affect DO concentrations.

5.3.5 Alternative 3

5.3.5.1 Reservoirs

Modeled NISP operations under Alternative 3 indicate minor changes in diversions for Future Conditions Effects and Cumulative Effects. There would be no water quality impacts to Carter Lake or Horsetooth Reservoir, and the water quality of Cactus Hill Reservoir would be similar to the evaluation conducted for Current Conditions in Section 4.3.5.1.2., because the RFFAs and HSWSPs would not substantially change reservoir storage or operations. The lands surrounding

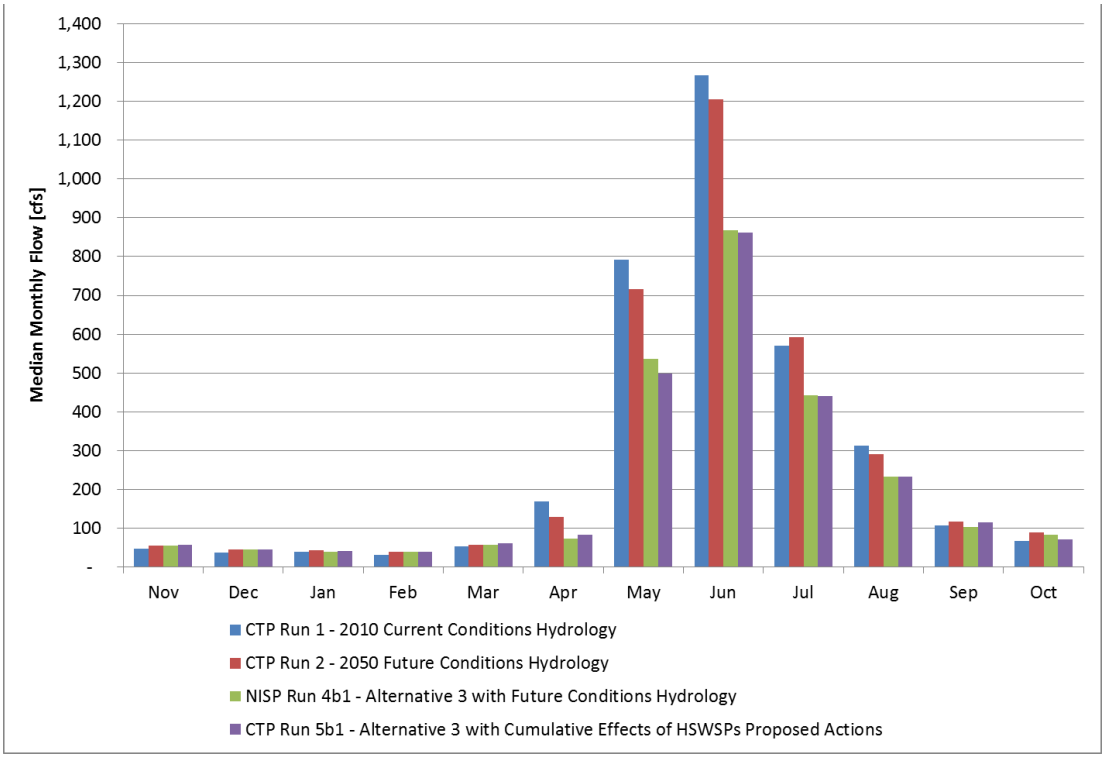
Cactus Hill Reservoir may experience increased residential development, but the development is expected to be similar to the low density residential development currently in the area and effects on reservoir water quality would be negligible. Residential development around Galeton Reservoir is not anticipated. Oil and gas development will likely continue in the area surrounding Galeton Reservoir. Although spills have occurred in the past, they were remediated and the incidents were closed. If oil and gas drilling occurs with the same safety record and remediation as what has previously occurred in the Galeton Reservoir study area, the cumulative effect would be negligible from future spills.

5.3.5.2 Poudre River

5.3.5.2.1 Segment 10

Median streamflow at the Canyon Gage would decrease from April through August under Alternative 3 with RFFAs and HSWSPs compared to Current Conditions hydrology (Figure 5-37). The majority of Alternative 3 diversions at the Poudre Valley Canal would occur during May and June. Hydrology effects would be similar to Alternative 2, although Alternative 3 diversions would be greater to account for the greater evaporative loss that would occur at Cactus Hill Reservoir. In the lower part of Segment 10 and upper portion of Segment 11, flows would be less in the winter and September with Alternative 3 compared to Alternative 2 because there would be no augmentation releases from Glade Reservoir.

Figure 5-37. Alternative 3 Median Monthly Flow at Canyon Gage, 1980-2005.



Exceedance of water quality standards for nutrients and metals is expected to be low for most parameters. Copper and dissolved manganese would have a medium potential for exceedance of water quality standards. Potential exceedance of the DM and MWAT standards in July and August would increase with reduced flows. Stream temperature effects would be greater, particularly in Segment 10 and the upper half of Segment 11 of the Poudre River, if the cool inflows from the Hansen Supply Canal are reduced in the future. The potential for exceeding temperature standards at the downstream end of Segment 10 would be slightly greater than for Alternative 2, as a result of greater upstream diversions and without augmentation flows from Glade Reservoir (augmentation effect likely limited to September). Localized effects on DO concentrations are possible in Segment 10; however, this is not considered a sensitive reach for DO. Therefore, additional standard excursions are not anticipated.

5.3.5.2.2 Segment 11

Under Alternative 3, with RFFAs and HSWSPs, flows would be lower at the Lincoln Street Gage from April through August (Figure 5-38). At the downstream end of Segment 11 at the Boxelder Gage, the majority of flow decreases occur in June, with minor changes during other months of the year (Figure 5-39).

Figure 5-38. Alternative 3 Median Monthly Flow at Lincoln Street Gage, 1980-2005.

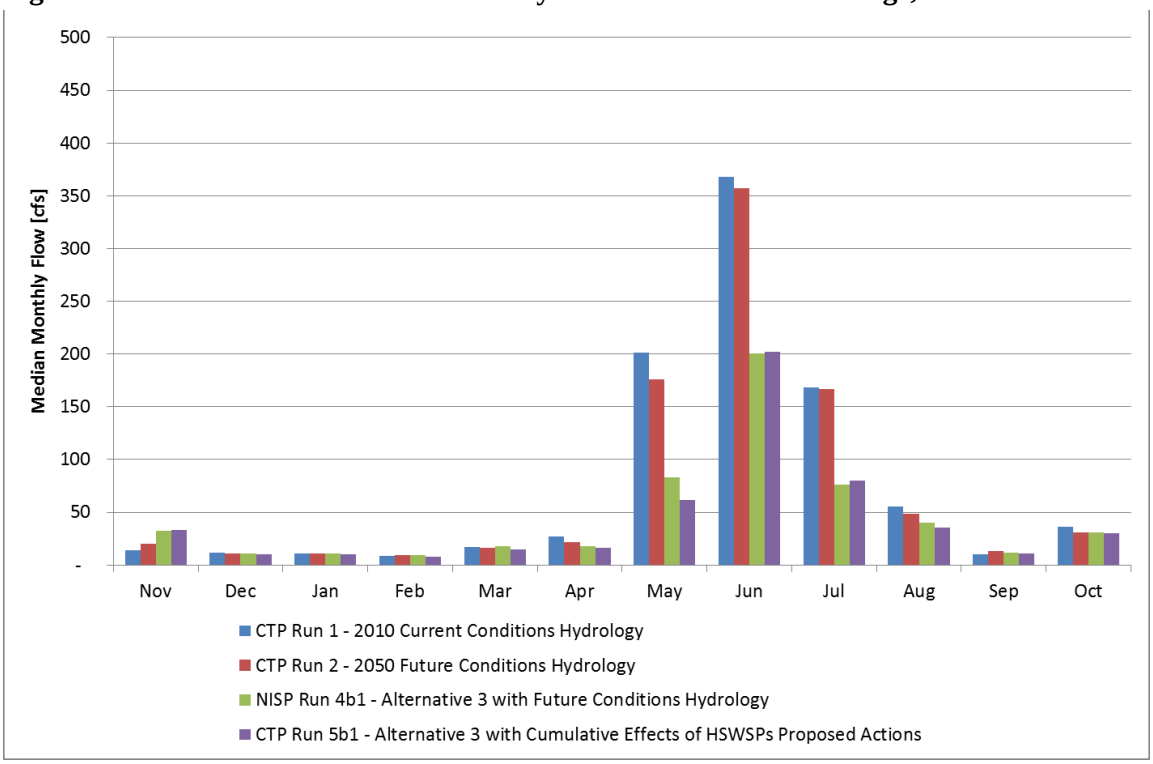
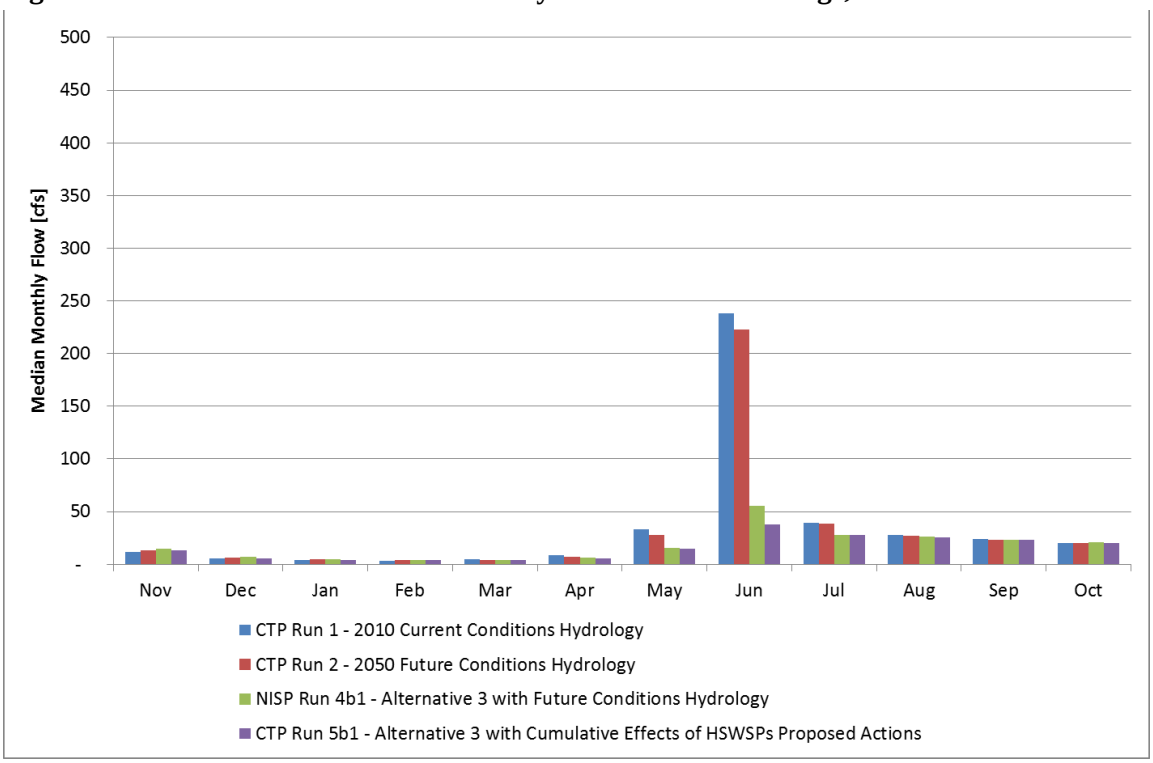


Figure 5-39. Alternative 3 Median Monthly Flow at Boxelder Gage, 1980-2005.



Under Alternative 3 with RFFAs and HSWSPs, the potential exceedance of the water quality standard for total phosphorus would be medium and exceedance of the selenium standard would continue. No exceedance of other nutrient or metal standards is anticipated. Lower streamflows in July and August would increase the potential exceedance of temperature standards in the Segment 11, particularly just upstream of Boxelder Creek. Reduced summertime flow rates in localized areas that have historically exhibited DO standard excursions in Segment 11 could increase the frequency and higher magnitude of exceedances if reductions occur during or create low flow conditions.

5.3.5.2.3 Segment 12

Hydrologic conditions in Segment 12, under Alternative 3 with RFFAs and HSWSPs, indicate flows slightly greater than Current Conditions except for decreases in June, September, and October at some locations above the Greeley Gage. Therefore, effects on water quality constituents, temperature, and DO are expected to be similar to those described for Alternative 2 in Section 5.3.4.2.3.

5.3.5.3 South Platte River – Segment 1b

Hydrologic conditions in the South Platte River under Alternative 3 with RFFAs and HSWSP would also be similar to those described for Alternative 2. Thus, effects on water quality constituents, temperature, and DO are expected to be similar to those for Alternative 2 in Section 5.3.4.2.3.

5.3.6 Alternative 4

5.3.6.1 Reservoirs

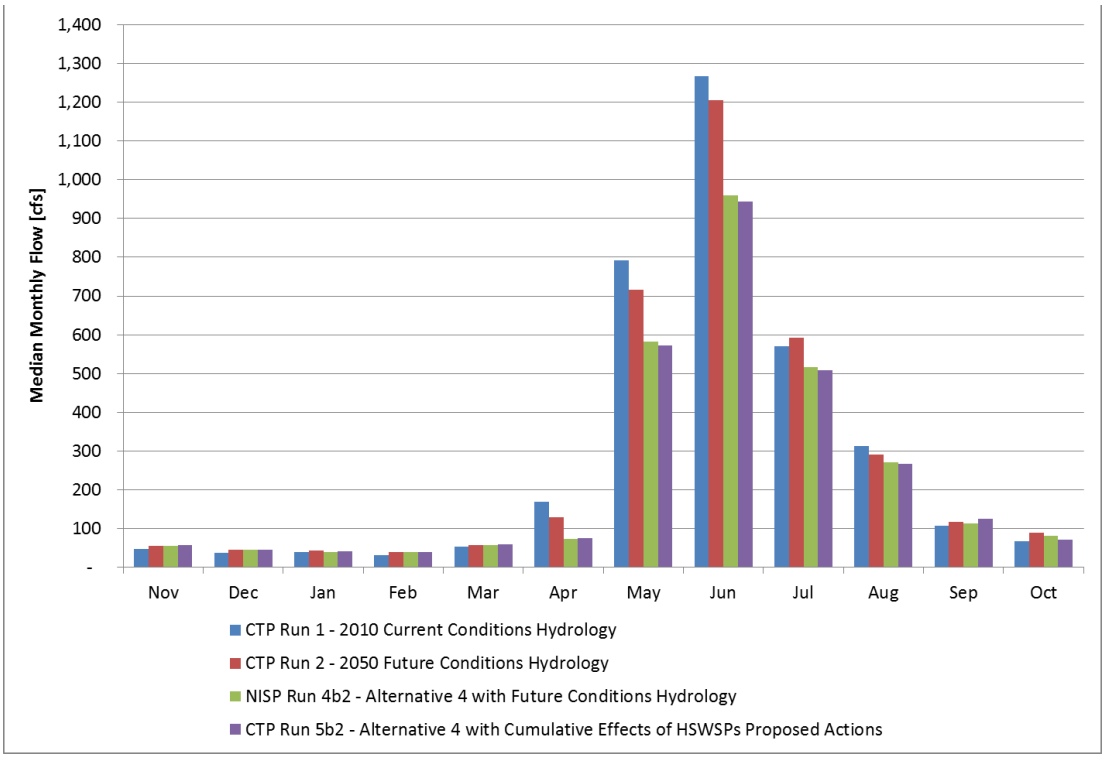
Modeled NISP operations under Alternative 4 indicate minor changes in diversions for Future Conditions Effects and Cumulative Effects. There would be no water quality impacts to Carter Lake or Horsetooth Reservoir, and the cumulative effects to water quality at Cactus Hill Reservoir would be similar to those described for Alternative 3.

5.3.6.2 Poudre River

5.3.6.2.1 Segment 10

Under Alternative 4, about 75% of the diversions would occur at the Canyon Gage with the remainder downstream at the New Cache Canal. With RFFAs and HSWSPs, flows would be slightly lower, but the pattern of monthly decreases would be similar. Flows would be lower than current conditions from April through August, with the largest changes in May and June (Figure 5-40).

Figure 5-40. Alternative 4 Median Monthly Flow at Canyon Gage, 1980-2005.



Future Condition Effects and Cumulative Effects under Alternative 4 would have a medium potential for exceedance of the copper and dissolved manganese water quality standard. Potential adverse impacts on stream temperature would be slightly less in the upper reaches of Segment 10, since diversions at the Poudre Valley Canal are lower under Alternative 4. Expansion of existing DM and MWAT standard exceedance is possible in March, July, and

August upstream from the Hansen Supply Canal and the downstream reach of Segment 10. Localized effects on DO concentrations are possible in Segment 10 for Alternative 4; however, this is not considered a sensitive reach for DO and additional standard excursions are not anticipated.

5.3.6.2.2 Segment 11

Poudre River streamflow would be lower in May and June under Alternative 4 with RFFAs and HSWSPs compared to Current Conditions hydrology at the Lincoln Street Gage (Figure 5-41). At Boxelder Gage near the bottom of Segment 11 reduced flows occur in June with only minor changes in other months (Figure 5-42).

Figure 5-41. Alternative 4 Median Monthly Flow at Lincoln Street Gage, 1980-2005.

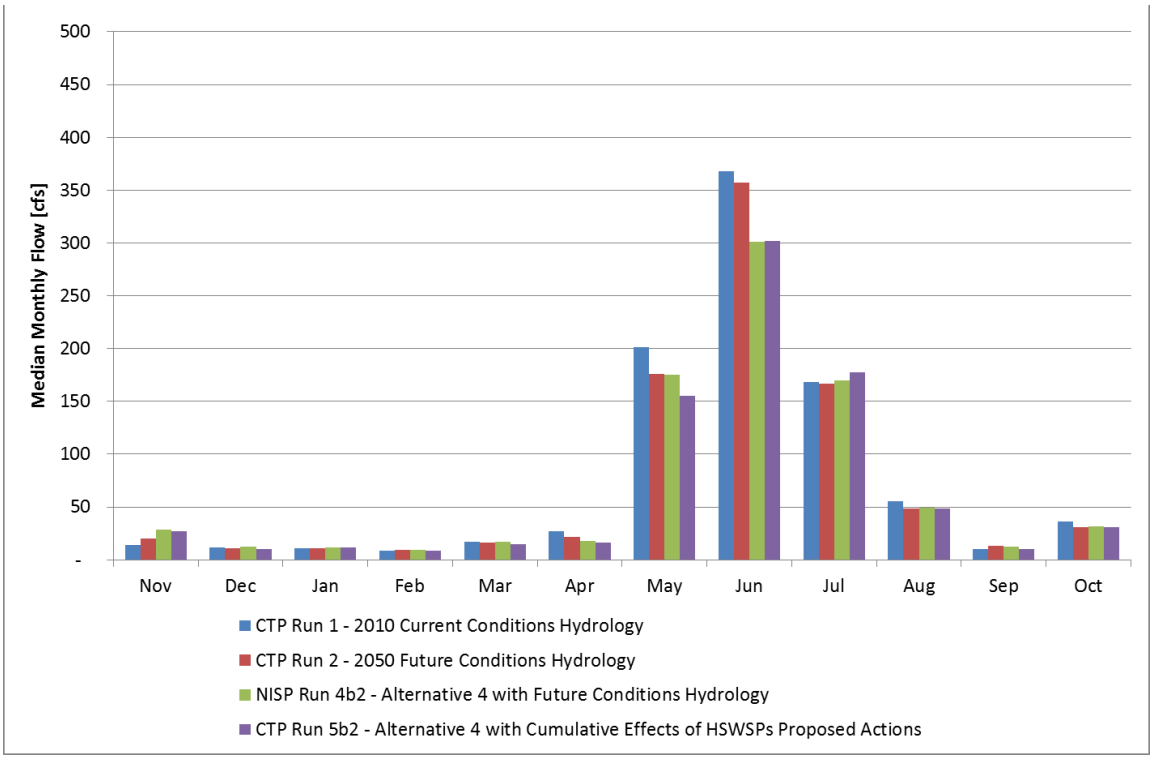
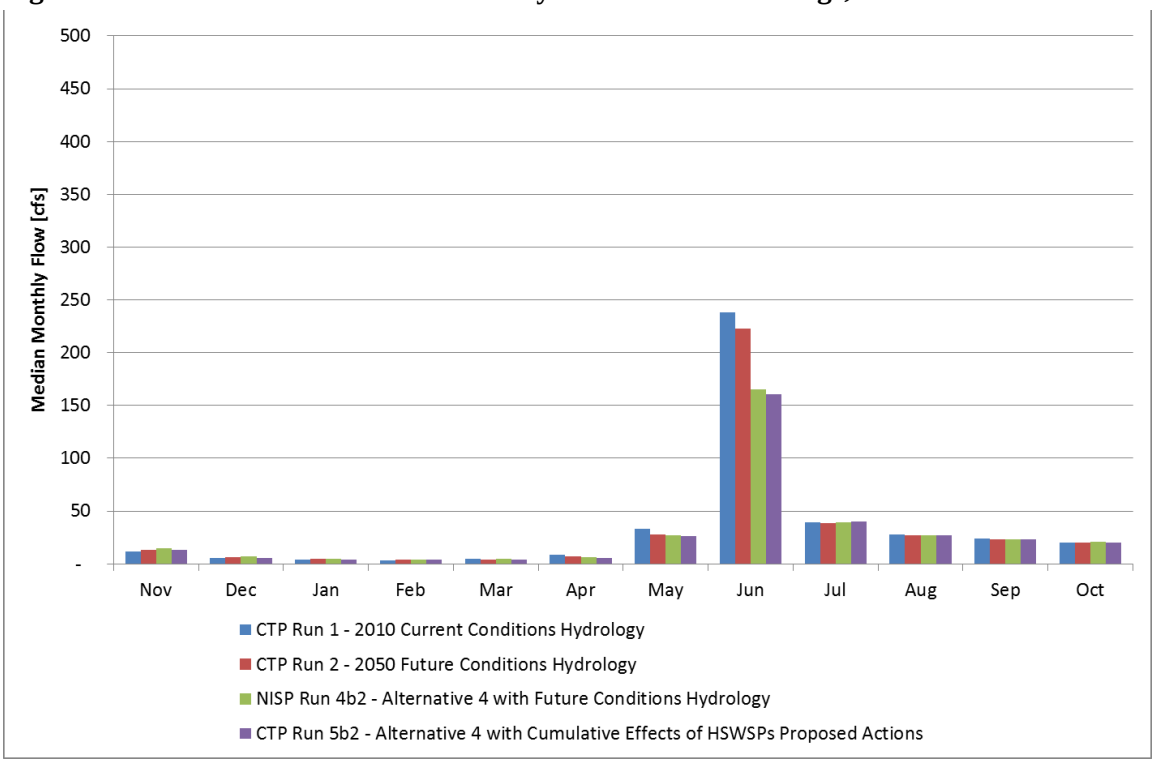


Figure 5-42. Alternative 4 Median Monthly Flow at Boxelder Gage, 1980-2005.



Impacts to water quality constituents would be slightly less than Alternative 3, because the flow reductions would be less in May and June at the Lincoln Street Gage and slightly higher in July. Impacts to metals and nutrients would be the same as Alternative 3 at the New Cache Canal Gage. Overall, the potential for exceedance of water quality standards in Segment 11 would be medium for total phosphorus, and selenium would continue to exceed water quality standards in a section of this reach above Boxelder Creek. Potential effects to stream temperature are unlikely because stream temperature is typically not a concern in May and June when lower median flow rates are anticipated. Localized effects on DO concentrations are possible; however, this is not considered a sensitive reach for DO, and anticipated decreased median flow rates are focused at times of higher flow rates (May and June). Therefore, additional standard excursions are not anticipated.

5.3.6.2.3 Segment 12

Streamflow in Segment 12 with Alternative 4 and RFFAs and HSWSPs would result in a decrease in June flows compared to Current Conditions hydrology with minimal changes and slight increases in other months similar to Alternative 2 (Figure 5-34 and Figure 5-35). Potential exceedance of water quality standards for those parameters currently exceeding standards (total recoverable iron, ammonia, total phosphorus, and iron) would remain the same. With flow rates and water sources similar to those for Alternative 3, impacts of Alternative 4 on temperature and DO are expected to be similar in Segment 12 to those described for Alternative 3 (Section 5.1.5.2.3).

5.3.6.3 South Platte River – Segment 1b

Median monthly streamflows at the Kersey Gage under Alternative 4 with RFFAs and HSWSPs would be greater than Current Conditions hydrology from April to October and slightly less from November to March, similar to Alternative 2 (Figure 5-36) similar to those described for Alternative 2. Thus, effects on water quality constituents, temperature, and DO are expected to be similar to those described for Alternative 2 in Section 5.3.4.2.3.

5.3.7 Crop Yield and Ditch Water Quality

All of the action alternatives include the SPWCP with diversions from the South Platte River to Galeton Reservoir. Water would then be delivered from Galeton Reservoir to the Larimer-Weld and New Cache Canal systems from April through October in exchange for water diverted from the Poudre River. Operation of the SPWCP is anticipated to result in increased salinity and selenium concentrations for water delivered to the canals that may affect crop production on irrigated lands. Anticipated impacts under the Cumulative Effects analysis are anticipated to be similar to those discussed for Current Conditions in Section 4.3.4.4 because changes in hydrology and water quality in the South Platte River would be similar. However, RFFAs such as commercial and residential development and spills associated with oil and gas development in the region, can contribute nonpoint source runoff and pollution that have the potential to adversely affect canal water quality. The potential socioeconomic impacts associated with impacts to crop yield are discussed in Section 5.20.2.3.2.

5.3.8 Water Treatment Plants

Potential impacts to water quality at water treatment plant intakes are possible where the City of Greeley diverts water from the Poudre River at the canyon mouth for its Bellvue WTP and at Horsetooth Reservoir, where Fort Collins and the Tri-District take water for their WTPs. Potential effects to water quality at Horsetooth Reservoir only occur under Alternative 2 under the Reclamation Action Option. Cumulative Effects for Alternative 2 would have the same potential effects to water quality at Horsetooth Reservoir as described for Current Conditions hydrology in Section 4.3.4.5 and is not anticipated to substantially change TOC concentrations or drinking water treatment requirements. TOC concentrations in the Poudre River at Greeley's WTP diversion point are not expected to change under Cumulative Effects hydrology under any of the action alternatives, and no impact on Greeley's WTP operations are predicted due to the NISP alternatives combined with water-based RFFAs and the HSWSPs Cumulative Effects hydrology. However, TOC in streams has been observed to increase from needle cast associated with mountain pine beetle infestations (Lukas and Gordon 2010). Future mountain pine beetle infestations in the Poudre River watershed may periodically increase TOC levels in the Poudre River and could periodically affect water treatment of Poudre River water until a new forest canopy is established.

5.3.9 Wastewater Treatment Plants

Changes in flow under all of the action alternatives combined with RFFAs and HSWSP has the potential to affect effluent discharges limitations for the seven wastewater treatment plants located on the Poudre River. Impacts on regulatory low flows would be similar to that described under Current Conditions in Section 4.3.7. In general, all of the action alternatives could have a small incremental impact on meeting minimum monthly flows (30E3 chronic low flow) in some locations in some months. Further reductions in flow with RFFAs and HSWSPs could exacerbate conditions where current chronic low flow requirements are not being met. Overall, the action alternative are expected to have a negligible to minor effect on chronic low flows and potential effects on Colorado's Pollutant Discharge System permittees. In addition, future changes in water quality standards, as discussed below in Section 5.1.10.2, may require more stringent effluent limits for total phosphorus, total inorganic nitrogen, and ammonia that would improve water quality in the Poudre and South Platte Rivers.

5.3.10 Climate Change

Climate change is a trend in the affected environment that has the potential to contribute to water quality cumulative effects. Earlier snowpack melting and spring runoff could change the timing of flows in the Poudre River and South Platte River. If peak runoff occurs earlier in the spring, base flows in the river could be lower during the summer months when air temperatures are higher. Warmer air temperatures combined with lower flows are likely to result in greater frequency and magnitude of exceedances of DM and MWAT in the Poudre and Platte Rivers. Temperature exceedances that currently occur in July and August could be expanded to June and may result in additional shoulder season temperature standard exceedances. Although predicted changes in precipitation due to climate change are mixed, any reduction in precipitation and runoff would exacerbate temperature concerns. Warmer river temperatures could also increase the potential for reducing DO concentrations in rivers. Changes in the volume and timing of flows as a result of climate change also have the potential to affect the concentration of nutrients and metals in the rivers. Specific water quality impacts are difficult to predict because the numerous variables that influence water quality in the river including administration of water rights, WWTP effluent discharges, nonpoint discharge, ground water return flows, and agricultural practices, all of which could be affected by climate change, which in itself is difficult to predict.

5.3.11 Impact Summary

A number of flow-related and land-based RFFAs and the HSWSPs combined with alternative NISP actions have the potential to result in cumulative impacts to water quality in the Poudre and South Platte Rivers. Cumulative water quality impacts are primarily the result of changes in the amount or timing of flows, although other RFFAs such as changes in WWTP discharges, habitat restoration, and changes to water quality regulations all would contribute to cumulative effects. Several RFFAs have the potential to improve water quality including changes in water quality

standards that would likely require additional biological/chemical treatment facilities, minimum instream flows for the Poudre River within Fort Collins and Poudre River restoration projects that could benefit river temperature through the maintenance of flows at critical low flow periods and increased shading by restoration of riparian areas. Post-fire restoration activities in the upper Poudre River watershed can benefit water quality by reducing the introduction of sediment into the Poudre River.

Other RFFAs have the potential to degrade water quality. Population growth and land development in the northern Front Range have the potential to increase point and non-point discharges to both the Poudre and South Platte Rivers. The mountain pine beetle infestation in the upper Poudre River watershed has the potential to increase TOC in the Poudre River due to an increase in needle cast (Lukas and Gordon 2010). Oil and gas development in the region has the potential to locally and periodically adversely affect surface water quality due to spills or floods.

While the interaction of all these variables is difficult to predict, qualitative inferences on potential water quality effects for all of the alternatives are summarized in Table 5-8. A medium rating for exceedances in Table 5-8 indicates that current water quality is approaching the standard and changes in flow associated with the alternative could result in standard exceedances. Parameters with a high rating are likely to continue exceeding the standard and the alternative could contribute to a greater magnitude and/or frequency of standard exceedance. The 404(b)(1) Guidelines at 40 CFR 230.10(b) specify that no discharge of dredged or fill material may be permitted if it will cause or contribute to violations of any applicable State water quality standard. Therefore, in order for the proposed Project to be permitted, the District must propose measures to avoid causes or contributions specifically attributable to the Project to standard violations. The disclosure of potential effects to water quality is based on the evaluation of effects without consideration of the avoidance measures proposed by the District (Appendix F).

Table 5-8. Surface water quality Future Conditions Effects and Cumulative Effects comparison for the no action and action alternatives.

Study Area	Alternative 1[1]	Alternative 2	Alternative 3	Alternative 4
Horsetooth Reservoir	No effect	Negligible effects under the Reclamation Action Option/No Pipeline; minor effect with Pipeline. No effect with the No Reclamation Action Option.	No effect.	No effect.
Carter Lake	No effect	Negligible effects under the Reclamation Action Option and no effect with the No Reclamation Action Option.	No effect.	No effect.
Glade Reservoir	Not a component of this alternative.	This new reservoir would have water quality similar to Horsetooth Reservoir.	Not a component of this alternative.	Not a component of this alternative.

Study Area	Alternative 1[1]	Alternative 2	Alternative 3	Alternative 4
Galeton Reservoir	Not a component of this alternative.	Nutrient and chlorophyll *a* concentrations are likely to exceed interim value standards. Specific conductance, pH, and selenium concentrations are likely to be high. Low DO concentrations near the bottom are expected in the summer.	Nutrient and chlorophyll a concentrations are likely to exceed interim value standards. Specific conductance, pH, and selenium concentrations are likely to be high. Low DO concentrations near the bottom are expected in the summer.	Nutrient and chlorophyll a concentrations are likely to exceed interim value standards. Specific conductance, pH, and selenium concentrations are likely to be high. Low DO concentrations near the bottom are expected in the summer.
Cactus Hill Reservoir	Cactus Hill Reservoir is likely to experience elevated selenium concentrations, hypoxic (low oxygen) concentrations near the bottom in the summer, summer algal blooms, elevated selenium concentrations.	Not a component of this alternative.	Water quality in Cactus Hill would be lower than Glade Reservoir, but better than Galeton Reservoir.	Water quality would be slightly lower under Alternative 4 because a portion of the water would come from the New Cache Canal, which has lower water quality than diversions at the upstream Poudre Valley Canal.

Study Area	Alternative 1[1]	Alternative 2	Alternative 3	Alternative 4
Poudre River – Segment 10: Potential for exceedance of water quality standards.	Potential for increased frequency of exceedance of temperature standards in July and August upstream of the Hansen Supply Canal (due to increased diversions at Poudre Valley Canal) and at the downstream end of Segment 10 (with reduced inflows from Hansen Supply Canal). Reduced flows in this reach have a low potential for exceedance of water quality standards for metals, nutrients, and DO.	Potential for increased frequency of exceedance of temperature standards in July and August upstream of the Hansen Supply Canal (due to increased diversions at Poudre Valley Canal) and at the downstream end of Segment 10 (with reduced inflows from Hansen Supply Canal). Glade Reservoir releases in the flow augmentation program would have a beneficial effect on temperature in September at the downstream end of Segment 10, and on all constituents in September and November to March. Medium potential for exceedance of copper and manganese standard. Low potential for exceedance of standards for other metals, nutrients, and DO.	Diversions at the Poudre Valley Canal would be greater than Alternative 2 and there would be no flow augmentation program. Potential exceedance of the DM and MWAT standards in July and August would increase with reduced flows. Stream temperature effects would be greater, particularly in Segment 10 and the upper half of Segment 11 of the Poudre River, if the cool inflows from the Hansen Supply Canal are reduced in the future. Medium potential for exceedance of copper and manganese standard. Low potential for exceedance of standards for other metals, nutrients, and DO.	Diversions at the Poudre Valley Canal would be lower than Alternatives 2 and 3 and there would be no flow augmentation program. Potential for increased frequency of exceedance of temperature standards in July and August upstream of the Hansen Supply Canal and at the downstream end of Segment 10 (with reduced inflows from Hansen Supply Canal) would be slightly less than Alternatives 2 and 3. Medium potential for exceedance of copper and manganese standard. Low potential for exceedance of standards for other metals, nutrients, and DO.

Study Area	Alternative 1[1]	Alternative 2	Alternative 3	Alternative 4
Poudre River – Segment 11: Potential for exceedance of water quality standards.	Small reductions in flow rates during the irrigation season could increase temperature exceedances in the sensitive reach upstream of Boxelder Creek, particularly during July and August. Constituent water quality would be similar to Current Conditions. Selenium would continue to have a high potential for exceedance of standards, while other parameters would have a low potential for standard exceedance.	Reductions in flow rates could increase temperature exceedances in the sensitive reach upstream of Boxelder Creek, particularly in July and August. Small, localized decreases in DO could occur due to potential reductions in summertime flow rates if they occur during or create low flow conditions. Augmentation flows would provide beneficial water quality effects, including cooling to the Timnath Headgate. Total phosphorus would have a medium potential for exceedance of standards. Selenium, which currently exceeds standards in one reach, would continue to have a high potential for standard exceedance. Other constituents would have a low potential for standard exceedance.	Flow reductions greater than Alternative 2 could increase temperature exceedances in the sensitive reach upstream of Boxelder Creek, particularly in July and August. Small, localized decreases in DO could occur due to potential reductions in summertime flow rates if they occur during or create low flow conditions. Total phosphorus would have a medium potential for exceedance of standards. Selenium, which currently exceeds standards in one reach, would continue to have a high potential for standard exceedance. Other constituents would have a low potential for standard exceedance.	Flow reductions less than Alternatives 2 and 3 would have slightly less potential for increased temperature exceedances in the sensitive reach upstream of Boxelder Creek, particularly in July and August. Small, localized decreases in DO could occur due to potential reductions in summertime flow rates if they occur during or create low flow conditions. Total phosphorus would have a medium potential for exceedance of standards. Selenium, which currently exceeds standards in one reach, would continue to have a high potential for standard exceedance. Other constituents would have a low potential for standard exceedance.

Study Area	Alternative 1[1]	Alternative 2	Alternative 3	Alternative 4
Poudre River – Segment 12: Potential for exceedance of water quality standards.	Extensive dry-up of agricultural lands is likely to reduce ground water return flows to the lower Poudre River, resulting in a net warming effect. The anticipated net increase in flow rates in summer months would reduce the rate of warming along this reach. There is a possibility of increased standard exceedances of DO; however, the net effect is difficult to anticipate with competing effects of decreased low-DO ground water inflows, increased WWTP effluent, and more stringent future standards for ammonia and nutrient in WWTP effluent. Continued exceedance of total recoverable iron, ammonia, total phosphorus, and selenium standards would have a high potential. Although, lower ground water return flows could reduce selenium concentrations.	In spite of increased flow rates in summer months, stream temperatures may increase somewhat due to reduced cooling ground water inflows and increased WWTP effluent volumes. Increased flow would generally benefit DO; however, increased WWTP effluent volumes may have negative or positive effects depending on the resulting in-river ammonia and/or dissolved organic matter concentrations resulting from future Regulation 85 standards. Reduced contribution of low-DO ground water would have a beneficial effect on DO. The net effect on DO is uncertain. Total recoverable iron, ammonia, total phosphorus, and selenium, which currently exceed standards would have high potential for continued exceedance. Other parameters would have a low probability for standard exceedance.	In spite of increased flow rates in summer months, stream temperatures may increase somewhat due to reduced cooling ground water inflows and increased WWTP effluent volumes. Increased flow would generally benefit DO; however, increased WWTP effluent volumes may have negative or positive effects depending on the resulting in-river ammonia and/or dissolved organic matter concentrations resulting from future Regulation 85 standards. Reduced contribution of low-DO ground water would have a beneficial effect on DO. The net effect on DO is uncertain. Total recoverable iron, ammonia, total phosphorus, and selenium, which currently exceed standards would have high potential for continued exceedance. Other parameters would have a low probability for standard exceedance.	In spite of increased flow rates in summer months, stream temperatures may increase somewhat due to reduced cooling ground water inflows and increased WWTP effluent volumes. Increased flow would generally benefit DO; however, increased WWTP effluent volumes may have negative or positive effects depending on the resulting in-river ammonia and/or dissolved organic matter concentrations resulting from future Regulation 85 standards. Reduced contribution of low-DO ground water would have a beneficial effect on DO. The net effect on DO is uncertain. Total recoverable iron, ammonia, total phosphorus, and selenium, which currently exceed standards would have high potential for continued exceedance. Other parameters would have a low probability for standard exceedance.

Study Area	Alternative 1[1]	Alternative 2	Alternative 3	Alternative 4
South Platte River – Segment 1b: Potential for exceedance of water quality standards.	Any effects on temperature are not expected to be substantial due to the relative flow contribution of the Poudre River and low temperature sensitivity of this reach. The potential for continued exceedance of the total recoverable iron, total phosphorus, and total sulfate standards would be high. Potential exceedance of other nutrients, metals, and DO would be low.	Slightly warmer inflows from the Poudre River may result in some warming, but the potential for exceedance of temperature standards would be low. The potential for continued exceedance of the total recoverable iron, total phosphorus, and total sulfate standards would be high. Exceedance of the dissolved manganese and ammonia standard would be medium, while exceedance of DO and other water quality parameters would be low.	Slightly warmer inflows from the Poudre River may result in some warming, but the potential for exceedance of temperature standards would be low. The potential for continued exceedance of the total recoverable iron, total phosphorus, and total sulfate standards would be high. Exceedance of the dissolved manganese and ammonia standard would be medium, while exceedance of DO and other water quality parameters would be low.	Slightly warmer inflows from the Poudre River may result in some warming, but the potential for exceedance of temperature standards would be low. The potential for continued exceedance of the total recoverable iron, total phosphorus, and total sulfate standards would be high. Exceedance of the dissolved manganese and ammonia standard would be medium, while exceedance of DO and other water quality parameters would be low.
Larimer-Weld and New Cache Canal water quality and Crop Yield	Changes in canal operations, diversions, exchanges, and reservoir use may affect irrigation water quality, but because specific operational details are unknown, impacts on canal water quality or crop yields is unknown.	Operation of the SPWCP is anticipated to result in increased salinity and selenium concentrations for water delivered to the irrigation canals. Some reduction in crop yield is likely depending on the crop and mixing with other sources of water.	Operation of the SPWCP is anticipated to result in increased salinity and selenium concentrations for water delivered to the irrigation canals. Some reduction in crop yield is likely depending on the crop and mixing with other sources of water.	Operation of the SPWCP is anticipated to result in increased salinity and selenium concentrations for water delivered to the irrigation canals. Some reduction in crop yield is likely depending on the crop and mixing with other sources of water.
WTP	No change in water quality constituents, including TOC concentrations, are expected for WTP intakes on the Poudre River. Direct delivery from Cactus Hill Reservoir to a WTP could require treatment for TOC depending on the quality of the source water to Cactus Hill, in reservoir processes, and the time of the year.	No substantial change TOC concentrations or drinking water treatment requirements are predicted for intakes at Horsetooth Reservoir or the Poudre River.	No substantially change TOC concentrations or drinking water treatment requirements are predicted for intakes on the Poudre River.	No substantially change TOC concentrations or drinking water treatment requirements are predicted for intakes on the Poudre River.

Study Area	Alternative 1[1]	Alternative 2	Alternative 3	Alternative 4
WWTP	The shift from agricultural use to municipal use would increase WWTP discharges. Thus, nutrient concentrations could increase and metal concentrations could decrease. New nutrient standards could reduce nutrient loading from WWTPs.	A potential small incremental impact on meeting minimum monthly flows (30E3 chronic low flow) is possible at some locations in some months. Future changes in water quality standards may require more stringent effluent limits for total phosphorus, total inorganic nitrogen, and ammonia that would improve water quality and which could change the chronic low flow requirements.	A potential small incremental impact on meeting minimum monthly flows (30E3 chronic low flow) is possible at some locations in some months. Future changes in water quality standards may require more stringent effluent limits for total phosphorus, total inorganic nitrogen, and ammonia that would improve water quality and which could change the chronic low flow requirements.	A potential small incremental impact on meeting minimum monthly flows (30E3 chronic low flow) is possible at some locations in some months. Future changes in water quality standards may require more stringent effluent limits for total phosphorus, total inorganic nitrogen, and ammonia that would improve water quality and which could change the chronic low flow requirements.
Determination of Effects	Alternative 1 with Future Conditions Effects would have negligible to moderate adverse impacts on temperature in the Poudre River, with minor effects in the South Platte River. Negligible to minor adverse impact on metals, nutrient, and DO are likely, although continued exceedance of several water quality standards is likely in the Poudre and South Platte Rivers.	Alternative 2 with Future Conditions Effects and Cumulative Effects would have negligible to moderate adverse impacts on stream temperature in the Poudre River and negligible to minor adverse effects on South Platte River temperatures. Impacts on nutrient and metal concentrations would range from negligible to moderate with continued or increased exceedance of several water quality standards.	Alternative 3 with Future Conditions Effects and Cumulative Effects would have negligible to moderate adverse impacts on stream temperature in the Poudre River and negligible to minor adverse effects on South Platte River temperatures. Impacts on nutrient and metal concentrations would range from negligible to moderate with continued or increased exceedance of several water quality standards.	Alternative 4 with Future Conditions Effects and Cumulative Effects would have negligible to moderate adverse impacts on stream temperature in the Poudre River and negligible to minor adverse effects on South Platte River temperatures. Impacts on nutrient and metal concentrations would range from negligible to moderate with continued or increased exceedance of several water quality standards.

[1]The No Action Alternative is compared to Future Conditions.

5.4 STREAM MORPHOLOGY AND SEDIMENT TRANSPORT

This section summarizes the predicted potential cumulative effects of the NISP alternatives on river morphology and sediment transport. Additional studies and impact assessments for river morphology and sediment transport for the Poudre River mainstem were undertaken for this SDEIS based on comments on the NISP DEIS. These new studies are described in Section 3.4 and the 2013 Stream Morphology Baseline Report (ACE 2013). New baseline and effects technical reports were prepared using new and revised information and the CTP hydrology. Detailed information on effects can be found in the 2014 Stream Morphology Effects Report (ACE 2014). This section presents results and interpretations for river morphology and sediment transport using the same analyses that were described in the 2013 Stream Morphology Baseline Report (ACE 2013). The analyses that form the basis of effects assessment are listed in Table 4-50. As discussed in the 2013 Stream Morphology Baseline Report (ACE 2013), there is no deterministic analysis that can provide an unequivocal description of future river morphology and sediment transport under each of the alternatives. Instead, based on the range of analyses listed in Table 4-50, the predicted river response is presented and discussed in light of the current trajectory of river condition presented in Section 3.4.2.

In overview, the trajectory of the river is expected to continue under Future Conditions Effects and Cumulative Effects as the result of ongoing channel contraction, fining of surficial material, and loss of channel complexity. These predicted changes in river condition are a fluvial response to historical and contemporary physical and hydrologic changes to the river, floodplain, and watershed. Based largely on an observational model of response to Current Conditions hydrology, the trends that were identified in the 2013 Stream Morphology Baseline Report (ACE 2013) are expected to be more severe downstream of I-25 than upstream of I-25 (Section 4.4).

The complexity of in-channel morphologic features is low in the reaches downstream of I-25 as the result of sand deposition smothering the bed and reducing the magnitude and frequency of pool and riffle sequences. Further channel contraction under Future Conditions Effects and Cumulative Effects is predicted to exacerbate this condition. Although channel contraction is predicted to lead to floodplain engagement at lower flows, and this could have ecological benefits, the frequency of flood flows would also be reduced.

The rate of change in channel morphology cannot be directly predicted by these analyses. However, predictions can be made based on the history of channel change through the reach. Investigations for the 2013 Stream Morphology Baseline Report (ACE 2013) concluded that the river downstream of I-25 had crossed a bio-geomorphic threshold and is on a trajectory leading to a shallower and narrower channel. While the net response over several years is expected to reveal a trend toward a shallower and narrower channel, the response at any time depends on the relative location and the recent hydrologic history. For example, observations following the 2013 flood suggest that some previously deposited sand in the Timnath and Windsor reaches was mobilized only to deposit further downstream in the Windsor and Greeley Reaches.

In addition to the RFFAs for the CTP hydrologic modeling (CDM Smith and DiNatale 2013), other factors have been identified that may affect channel morphology and sediment transport:

- Reservoir construction and expansion
- Greeley Poudre River Flood Control and Environmental Restoration Project
- Commercial and residential development along the Poudre River
- Continued gravel mining
- Effects from future forest fires in the Poudre River watershed
- Fort Collins Poudre River Master Plan
- Poudre River restoration projects

The RFFAs with any of the alternatives would likely exaggerate and extend these contemporary changes in channel morphology. Nevertheless the rate of change is dominated by the rate of sediment supply. The rate of sediment supply from upstream of I-25 and from local catchments is not sensitive to the hydrologic changes predicted for Future Conditions Effects and Cumulative Effects with the alternatives, so it is likely that the rate of change below I-25 would not be sensitive to the changes either. The best prediction of the rate of change under Future Conditions Effects and Cumulative Effects with any of the alternatives is that the rate of change will continue at current rates.

Section 4.3.3.1.2 describes the effects of reduced flows on sediment transport, channel contraction and loss of channel complexity on the mainstem of the Poudre River upstream and downstream of I-25 for which Future Conditions Effects and Cumulative Effects with the alternatives would have similar effects.

The analyses presented in this section focuses on potential Cumulative Effects to river morphology and sediment transport associated with streamflow changes and presents comparisons between the Current Conditions, Future Conditions Effects, and Cumulative Effects hydrology for each alternative for key sediment transport variables. The discussion in this section is informed and focused by the effects analyses presented in Section 4.9. Instead of repeating all of the analyses presented in Section 4.9, the Cumulative Effects analyses focus on how the 2% exceedance probability discharge, flows that flush fines and flows that move bed material would be affected by Future Conditions Effects and Cumulative Effects. Changes in these variables provide examples of how reductions in flows under Future Conditions Effects and Cumulative Effects are predicted to affect flood flows, sediment transport and channel morphology.

As discussed in Section 4.4, the predicted reductions in the frequency of occurrence of high flows have the potential to cause morphologic change through reduced sediment mobility. These implications are discussed below under *Sediment Transport*.

The 2013 Stream Morphology Baseline Report (ACE 2013) concluded that the ongoing trend associated with channel contraction downstream of I-25 would likely lead to an increase in overbank flooding. The 2014 Stream Morphology Effects Report suggests that the predicted effect of the trend of channel contraction on flooding is balanced to some extent by the decreased frequency of flooding at each recurrence interval associated with project diversions. However, larger flood events (such as the 100-year flood), would be less affected by this decrease in flood

frequency. Additionally, while project alternatives could provide positive benefits in the reduction of flooding, there is no certainty that the diversions would occur during a flood event.

It is likely that the acceleration of channel contraction with Future Conditions Effects would lead to an increased frequency of flooding. The magnitude of the predicted increase in flooding frequency would be dependent on location and would be site specific. Relative to floodplain ratings or values, the increase in flooding would not change the floodplain rating (zone designation) within existing flood prone areas, but may increase the limits of this flood zone. Increases in floodplain stage can affect insurable structures and may adversely affect the cost of flood insurance. Implementation of the Greeley Poudre River Flood Control and Environmental Restoration Project could reduce flooding in the Greeley reaches in the future. Implementation of the Greeley Poudre River Flood Control and Environmental Restoration Project could reduce flooding in the Greeley reaches in the future.

The discussion of effects focuses on sediment transport because it was the focus of comments on the DEIS. No comments were received on the DEIS regarding stream morphology or sediment transport on the South Platte River; therefore, no new studies or analysis were done on these subjects for the SDEIS for the South Platte River. Section 4.4.1 of the DEIS and the 2008 South Platte River Stream Morphology Report (ERO 2008a) describe effects to the South Platte River. Most of the predicted effects attributable to the NISP action alternatives under Cumulative Effects occur with the comparison of Future Conditions hydrology (CTP Run 2) and the Run 4 series. This is because the NISP diversions are very similar in the Run 4 series and Run 5 series (i.e., the major difference between the Run 4 series and CTP Run 5 series is the operations of the HSWSPs). Future Conditions hydrology compared to Current Conditions hydrology provides an estimate of the effects that would occur in the future with the modeled RFFAs, but without the NISP alternatives.

River morphology and sediment transport would not be impacted by construction activities at Glade, Galeton, or Cactus Hill Reservoirs or within the conveyance systems study areas, therefore Cumulative Effects to river morphology and sediment transport associated with these alternative components were not evaluated.

5.4.1 Methods

The methods used to provide the results for each alternative are described in detail in the 2013 Stream Morphology Baseline Report (ACE 2013) and summarized in Section 4.4.1. The Cumulative Effects analyses repeat the analyses described in the 2013 Stream Morphology Baseline Report (ACE 2013) for each of the modeled daily flow data sets. The concept of space for time substitution was used to aid interpretation by recognizing that change occurs through both time and through space. Contemporaneous observations at different locations on the mainstem can represent changes to be expected at a single location through time. Examples of channel contraction already occurring were examined to provide insight into the likelihood and nature of similar impacts elsewhere along the mainstem.

5.4.2 No Action Alternative (Alternative 1)

5.4.2.1 Poudre River

The No Action Alternative was evaluated under Future Conditions hydrology only, as explained in Section 4.1.2.

5.4.2.1.1 Flows and Flooding

Table 5-9 shows how the 2% exceedance probability discharge (the flow that is predicted to be exceeded 2% of the time) is predicted to change from Current Conditions to Future Conditions hydrology, and to Future Conditions Effects with the No Action Alternative for selected cross sections along the mainstem. Flows are predicted to consistently decrease with Future Conditions hydrology (i.e., without the NISP alternatives) and in all instances flows from the Canyon Gage to the confluence would decline further with the No Action Alternative. Generally, the decline in flows would be greater from Current Conditions to Future Conditions hydrology than from Future Conditions Effects with the No Action Alternative. The percent change in the 2% exceedance probability discharge for the No Action Alternative compared to Future Conditions Effects would be relatively minor ranging from no change to a 5.4% reduction. Flood flows would be reduced, but the reductions in flood flows would be minor.

Table 5-9. Comparison of 2% exceedance probability discharge - Alternative 1.

Study Reach	Location	Current Conditions (Run 1) (cfs)	Future Conditions (Run 2) (cfs)	Alternative 1 Effects (cfs)	% Change Alternative 1 vs. Future Conditions
Laporte	Between North Fork Confluence and Poudre Valley Canal	2,315	2,240	2,240	0.0
	Canyon Gage	2,238	2,132	2,016	-5.4
	Between Hansen and LCC	2,170	2,000	1,912	-4.4
	Between LCC and Little Cache	1,988	1,832	1,733	-5.4
	Between Little Cache and LW	1,865	1,712	1,621	-3.0
Fort Collins	Shields Street	1,704	1,523	1,477	-3.4
	Lincoln Street Gage	1,694	1,516	1,464	-5.4
	Between Timnath inlet and Fossil Creek inlet	1,772	1,597	1,510	-5.4
Timnath	US/DS Boxelder Creek	1,603	1,444	1,338	-0.4
	US/DS New Cache headgate	1,674	1,550	1,535	-0.1
Windsor	Between Whitney and Greeley No. 3	1,711	1,570	1,563	-0.4
Greeley US	US/DS Greeley No. 3 headgate	1,760	1,583	1,580	-0.2
Greeley CH	US/DS Greeley WWTP discharge	1,802	1,633	1,614	-1.6
Greeley DS	Greeley Gage	1,812	1,676	1,655	-1.3

Note: US=upstream; DS=downstream; CH=channelized.

5.4.2.1.2 Sediment Transport

Table 5-10 provides a comparison of how flows that flush fines at selected cross sections along the mainstem are predicted to change with Future Conditions hydrology (Run 2) and the No Action Alternative. Generally, Future Conditions hydrology and the No Action Alternative are predicted to have a negligible effect on the number of events that fines would be flushed from the selected cross sections. The greatest effect is predicted to occur in the Fort Collins 5 cross section (near Cache la Poudre Reservoir inlet Canal) that would decline from 15 events under Current Conditions hydrology to 10 events under the No Action Alternative.

Table 5-10. Comparison of flows that flush fines from bed at selected sections - Alternative 1.

Study Reach	Representative Section[1]	Flow Threshold to Flush Fines (cfs)	Number of Events in 26 Years		
			Current Conditions (Run 1)	Future Conditions (Run 2)	Alternative 1 Future Conditions Effects
Laporte	300786	3,511	6	3	2
Laporte	269124	4,885	2	2	2
Laporte	257663	2,203	12	12	10
Ft. Collins 1	244249	9,206	0	0	0
Ft. Collins 2	238538	3,971	1	1	1
Ft. Collins 3	231351	1,115	23	22	20
Ft. Collins 4	228361	7,387	0	0	0
Ft. Collins 5	219576	2,239	15	9	10
Ft. Collins 6	215717	5,084	2	2	2
Timnath A	200420	5,301	2	2	1
Timnath B	161905	3,892	2	1	1
Windsor	141023	1,111	18	19	18
Greeley US	91769	118	97	98	98
Greeley CH	32333	10	88	92	92
Greeley DS	5230	158	176	242	242

[1]The locations of representative sections are noted in 2013 Stream Morphology Baseline Report (ACE 2013).
Note: US=upstream; DS=downstream; CH=channelized.

Table 5-11 provides a comparison of how flows that move bed material at selected cross sections along the mainstem are predicted to change with Future Conditions hydrology and the No Action Alternative. Generally, Future Conditions hydrology and the No Action Alternative are predicted to have a negligible effect on the number of events that bed material is moved at most of the selected cross sections. The greatest declines are predicted to occur in the Fort Collins 3 (near Lake Canal), and Windsor (near Whitney Irrigation Ditch) cross sections that would decline by 2 to 3 events under the No Action Alternative and the Greeley upstream cross section that would decline from 38 events under Current Conditions hydrology to 28 events under the No Action Alternative.

Table 5-11. Comparison of flows that move bed material at selected sections - Alternative 1.

Study Reach	Representative Section[1]	Flow Threshold to Move Bed Material (cfs)	Number of Events in 26 Years		
			Current Conditions	Future Conditions	Alternative 1 Effects
Laporte	300786	6,351	0	0	0
Laporte	269124	>10,000	0	0	0
Laporte	257663	5,216	2	2	3
Ft. Collins 1	244249	>10,000	0	0	0
Ft. Collins 2	238538	5,815	1	1	1
Ft. Collins 3	231351	2208	12	9	9
Ft. Collins 4	228361	>10,000	0	0	0
Ft. Collins 5	219576	>10,000	0	0	0
Ft. Collins 6	215717	9,701	0	0	0
Timnath A	200420	6,816	0	0	0
Timnath B	161905	5,344	2	2	2
Windsor	141023	2,338	14	10	10
Greeley US	91769	461	38	28	28
Greeley CH	32333	1,227	17	19	18
Greeley DS	5230	260	98	127	127

[1] The locations of representative sections are noted in 2013 Stream Morphology Baseline Report (ACE 2013).
Note: US=upstream; DS=downstream; CH=channelized.

5.4.2.2 South Platte River

No new studies or analysis were done for the SDEIS for the South Platte River. Section 4.4.1 of the DEIS and the 2008 South Platte River Stream Morphology Report (ERO 2008a) describe effects to the South Platte River. The No Action Alternative was revised for the SDEIS. The No Action Alternative for the SDEIS would on average reduce flows on the South Platte River by less than 10% and is not predicted to affect channel morphology or sediment transport on the South Platte River.

5.4.3 District's Preferred Alternative (Alternative 2)

5.4.3.1 Poudre River

The Cumulative Effects assessment of Alternative 2 uses Future Conditions hydrology (Run 2) compared to hydrology Runs 4a and 5a. Assessments of the Cumulative Effects of Alternative 2 with Future Conditions Effects and Cumulative Effects would amplify the trajectory of the river conditions reflected in continuing channel contraction, fining of surficial material, and loss of channel complexity. As explained in Section 4.2.3.4.1, a single set of modeled streamflows was evaluated for the Reclamation Action Option and the No Reclamation Action Option for Alternative 2 because the net effects on streamflow below the Hansen Supply Canal outfall would, on average, effectively be the same under either option.

5.4.3.1.1 Flows and Flooding

Table 5-12 shows how the 2% exceedance probability discharge (the flow that is predicted to be exceeded 2% of the time) is predicted to change from Current Conditions to Future Conditions hydrology, to Future Conditions Effects with Alternative 2, and to Cumulative Effects for selected cross sections along the mainstem. This provides an example comparison of how relatively large flows (flooding) are predicted to change. Reductions in flow would be variable reflecting the complex interactions of diversions, transfers, and returns at different locations (Section 4.4.3.1). The 2% exceedance probability discharge is predicted to consistently decrease with Future Conditions hydrology (i.e., with the RFFAs, but without the NISP and HSWSPs alternatives) and in all instances these flows would decline further with Alternative 2 with Future Conditions Effects and Cumulative Effects. The greatest predicted percent reduction in the 2% exceedance flow under Cumulative Effects would occur in the Fort Collins Reach near the Lincoln Street Gage and the Greeley Reach near the Greeley No. 3 headgate.

Table 5-12. Comparison of 2% exceedance probability discharge - Alternative 2.

Study Reach	Location	Current Conditions (Run 1) (cfs)	Future Conditions (Run 2) (cfs)	Alt 2 Future Conditions Effects (cfs)	Alt 2 Cumulative Effects (cfs)	% Change Alt 2 vs. Cumu-lative Effects
Laporte	Between North Fork Confluence and Poudre Valley Canal	2,315	2,240	2,236	2,190	-2.1%
	Canyon Gage	2,238	2,132	1,775	1,657	-6.6%
	Between Hansen and LCC	2,170	2,000	1,701	1,594	-6.3%
	Between LCC and Little Cache	1,988	1,832	1,476	1,371	-7.1%
	Between Little Cache and LW	1,865	1,712	1,342	1,245	-7.2%
Fort Collins	Shields Street	1,704	1,523	1,103	995	-9.8%
	Lincoln Street Gage	1,694	1,516	1,072	957	-10.7%
	Between Timnath inlet and Fossil Creek inlet	1,772	1,597	1,068	988	-7.5%
Timnath	US/DS Boxelder Creek	1,603	1,444	889	805	-9.4%
	US/DS New Cache headgate	1,674	1,550	993	916	-7.8%
Windsor	Between Whitney and Greeley No. 3	1,711	1,570	1,005	918	-8.7%
Greeley US	US/DS Greeley No. 3 headgate	1,760	1,583	1,066	953	-10.6%
Greeley CH	US/DS Greeley WWTP discharge	1,802	1,633	1,101	1,009	-8.4%
Greeley DS	Greeley Gage	1,812	1,676	1,165	1,064	-8.7%

Note: US=upstream; DS=downstream; CH=channelized.

5.4.3.1.2 Sediment Transport

Table 5-13 provides a comparison of how flows that flush fines at selected cross sections along the mainstem are predicted to change with Future Conditions hydrology, Alternative 2 with Future Conditions Effects, and Cumulative Effects. Generally, Future Conditions hydrology would have no to minor effects on the number of events that would flush fines from the selected

cross sections. At about half of the cross sections, the number of events that would flush fines would decrease with Alternative 2 with Future Conditions Effects and with Cumulative Effects. The greatest percent change in in the number of flushing events under Cumulative Effects would be for the Laporte, Fort Collins 5, and Timnath A cross sections where the number of flushing events is predicted to be reduced by 50%. Overall the predicted reduction in the number of flushing events would be a minor effect. For those representative sections where the number of flushing events over the period of record would decline by more than 10% the effect would be moderate.

Table 5-13. Comparison of flows that flush fines from bed at selected sections - Alternative 2.

Study Reach	Representative Section[1]	Flow Threshold to Flush Fines (cfs)	Number of Events in 26 Years				
			Current Conditions (Run 1)	Future Conditions (Run 2)	Alt 2 Future Conditions Effects (cfs)	Alt 2 Cumulative Effects (cfs)	% Change Alt 2 vs. Cumulative Effects
Laporte	300786	3,511	6	3	2	1	-50.0%
Laporte	269124	4,885	2	2	2	2	0.0%
Laporte	257663	2,203	15	12	8	5	-37.5%
Ft. Collins 1	244249	9,206	0	0	0	0	0.0%
Ft. Collins 2	238538	3,971	1	1	1	1	0.0%
Ft. Collins 3	231351	1,115	23	22	19	15	-21.1%
Ft. Collins 4	228361	7,387	0	0	0	0	0.0%
Ft. Collins 5	219576	2,239	15	9	8	4	-50.0%
Ft. Collins 6	215717	5,084	2	2	2	2	0.0%
Timnath A	200420	5,301	2	2	2	1	-50.0%
Timnath B	161905	3,892	2	1	1	1	0.0%
Windsor	141023	1,111	18	19	20	15	-25.0%
Greeley US	91769	118	97	98	102	101	-1.0%
Greeley CH	32333	10	88	92	87	83	-4.6%
Greeley DS	5230	158	176	242	234	236	0.9%

[1] The locations of representative sections are noted in 2013 Stream Morphology Baseline Report (ACE 2013).
Note: US=upstream; DS=downstream; CH=channelized.

Table 5-14 provides a comparison of how flows that move bed material at selected cross sections along the mainstem are predicted to change with Future Conditions hydrology, Alternative 2 with Future Conditions Effects and Cumulative Effects. Generally, Future Conditions hydrology and Alternative 2 with Future Conditions Effects are predicted to have a negligible effect on the number of events at most of the selected cross sections. The greatest percent declines in the number of events that bed material is predicted to be moved with Cumulative Effects would be at the Fort Collins 3 (-33.3%) and Greeley channelized (-35.3%) cross sections.

Table 5-14. Comparison of flows that move bed material at selected sections - Alternative 2.

Study Reach	Representative Section[1]	Flow Threshold to Move Bed Material (cfs)	Number of Events in 26 Years				
			Current Conditions (Run 1)	Future Conditions (Run 2)	Alt 2 Future Conditions Effects (cfs)	Alt 2 Cumulative Effects (cfs)	% Change Alt 2 vs. Cumulative Effects
Laporte	300786	6,351	0	0	0	0	0.0%
Laporte	269124	>10,000	0	0	0	0	0.0%
Laporte	257663	5,216	2	2	2	2	0.0%
Ft. Collins 1	244249	>10,000	0	0	0	0	0.0%
Ft. Collins 2	238538	5,815	1	1	1	1	0.0%
Ft. Collins 3	231351	2208	12	9	9	6	-33.3%
Ft. Collins 4	228361	>10,000	0	0	0	0	0.0%
Ft. Collins 5	219576	>10,000	0	0	0	0	0.0%
Ft. Collins 6	215717	9,701	0	0	0	0	0.0%
Timnath A	200420	6,816	0	0	0	0	0.0%
Timnath B	161905	5,344	2	2	2	2	0.0%
Windsor	141023	2,338	14	10	5	4	-20.0%
Greeley US	91769	461	38	28	25	21	-16.0%
Greeley CH	32333	1,227	17	19	17	11	-35.3%
Greeley DS	5230	260	98	127	124	128	-3.2%

[1] The locations of representative sections are noted in 2013 Stream Morphology Baseline Report (ACE 2013).
Note: US=upstream; DS=downstream; CH=channelized.

The complexity of in-channel morphologic features is already low in the reaches downstream of I-25 as the result of sand deposition smothering the bed and reducing the magnitude and frequency of pool and riffle sequences. Further channel contraction under Alternative 2 is predicted to exacerbate this condition. Although channel contraction is predicted to lead to floodplain engagement at lower flows, and this could have ecological benefits, the frequency of floods would also be reduced.

Alternative 2 with Future Conditions Effects and Cumulative Effects would likely exaggerate and extend these contemporary changes in channel morphology. Section 4.3.3.1.2 describes the effects of reduced flows on sediment transport, channel contraction and loss of channel complexity on the mainstem of the Poudre River upstream and downstream of I-25 for which Alternative 2 with Future Conditions Effects and Cumulative Effects would have similar effects.

5.4.3.2 South Platte River

No new studies or analysis were done for the SDEIS for the South Platte River. Section 4.4.1 of the DEIS and the 2008 South Platte River Stream Morphology Report (ERO 2008a) describe effects to the South Platte River. Channel-forming flows (1.5-year peak flows of 3,858 cfs) would occur or be exceeded about 3% of the time. Under the action alternatives, flows of this magnitude would occur less than 1% of the time. High flows of up to about 24,200 cfs were modeled to occur under baseline conditions; flows exceeding about 22,600 cfs would not occur under the action alternatives. Scouring flows equivalent to the 25-year peak flows would continue to occur in the South Platte River under the alternatives. It is unlikely that implementation of Alternative 2 with Future Conditions Effects and Cumulative Effects would

affect the morphology of the South Platte River downstream of the confluence with the Poudre River.

5.4.4 Alternative 3

5.4.4.1 Poudre River

Alternative 3 would divert on average about 5,500 to 6,000 AFY more water from the Poudre River than Alternative 2 to compensate for increased reservoir evaporation from Cactus Hill Reservoir and conveyance loss. Additionally, Alternatives 3 does not include the Poudre River flow augmentation program that is proposed under Alternative 2.

The Cumulative Effects assessment of Alternative 3 uses Future Conditions hydrology (Run 2) compared to hydrology Runs 4b1 and 5b1. Assessments of the Cumulative Effects of Alternative 3 with Future Conditions Effects and Cumulative Effects would amplify the trajectory of the river conditions reflected in continuing channel contraction, fining of surficial material, and loss of channel complexity.

5.4.4.1.1 Flows and Flooding

Table 5-15 shows how the 2% exceedance probability discharge (the flow that is predicted to be exceeded 2% of the time) is predicted to change from Current Conditions to Future Conditions hydrology, to Future Conditions Effects with Alternative 3, and to Cumulative Effects for selected cross sections along the mainstem. This provides an example comparison of how relatively large flows (flooding) are predicted to change. Reductions in flow would be variable reflecting the complex interactions of diversions, transfers, and returns at different locations (Section 4.4.3.1). The 2% exceedance probability discharge is predicted to consistently decrease with Future Conditions hydrology (i.e., without the NISP alternatives) and in all instances these flows would decline further with Alternative 3 with Future Conditions Effects and Cumulative Effects. The greatest predicted percent reduction in the 2% exceedance flow under Cumulative Effects would occur in the Fort Collins Reach at Shields Street and the Lincoln Street Gage.

Table 5-15. Comparison of 2% exceedance probability discharge - Alternative 3.

Study Reach	Location	Current Conditions (Run 1) (cfs)	Future Conditions (Run 2) (cfs)	Alt 3 Future Conditions Effects (cfs)	Alt 3 Cumulative Effects (cfs)	% Change Alt 3 vs. Cumulative Effects
Laporte	Between North Fork Confluence and Poudre Valley Canal	2,315	2,240	2,232	2,183	-2.2%
	Canyon Gage	2,238	2,132	1,700	1,599	-5.9%
	Between Hansen and LCC	2,170	2,000	1,647	1,522	-7.6%
	Between LCC and Little Cache	1,988	1,832	1,405	1,298	-7.6%
	Between Little Cache and LW	1,865	1,712	1,290	1,169	-9.4%
Fort Collins	Shields Street	1,704	1,523	989	876	-11.4%
	Lincoln Street Gage	1,694	1,516	941	835	-11.3%
	Between Timnath inlet and Fossil Creek inlet	1,772	1,597	950	858	-9.7%
Timnath	US/DS Boxelder Creek	1,603	1,444	748	670	-10.4%
	US/DS New Cache headgate	1,674	1,550	755	713	-5.6%
Windsor	Between Whitney and Greeley No. 3	1,711	1,570	758	728	-4.0%
Greeley US	US/DS Greeley No. 3 headgate	1,760	1,583	819	761	-7.1%
Greeley CH	US/DS Greeley WWTP discharge	1,802	1,633	884	840	-5.0%
Greeley DS	Greeley Gage	1,812	1,676	950	898	-5.5%

Note: US=upstream; DS=downstream; CH=channelized.

5.4.4.1.2 Sediment Transport

Table 5-16 provides a comparison of how flows that flush fines at selected cross sections along the mainstem are predicted to change with Future Conditions hydrology, Alternative 3 with Future Conditions Effects, and Cumulative Effects. Generally, Future Conditions hydrology would have no to minor effects on the number of events that would flush fines from the selected cross sections. At about a third of the cross sections, the number of events that would flush fines would decrease with Alternative 3 with Future Conditions Effects and with Cumulative Effects. The greatest percent change in in the number of flushing events under Cumulative Effects would be for the Fort Collins 5 cross section where the number of flushing events is predicted to be reduced by 50%. For those representative sections where the number of flushing events over the period of record would decline by more than 10% the effect would be moderate.

Table 5-16. Comparison of flows that flush fines from bed at selected sections - Alternative 3.

Study Reach	Representative Section[1]	Flow Threshold to Flush Fines (cfs)	Number of Events in 26 Years				
			Current Conditions (Run 1)	Future Conditions (Run 2)	Alt 3 Future Conditions Effects (cfs)	Alt 3 Cumulative Effects (cfs)	% Change Alt 3 vs. Cumu-lative Effects
Laporte	300786	3,511	6	3	1	1	0.0%
Laporte	269124	4,885	2	2	2	2	0.0%
Laporte	257663	2,203	15	12	7	6	-14.3%
Ft. Collins 1	244249	9,206	0	0	0	0	0.0%
Ft. Collins 2	238538	3,971	1	1	1	1	0.0%
Ft. Collins 3	231351	1,115	23	22	15	13	-13.3%
Ft. Collins 4	228361	7,387	0	0	0	0	0.0%
Ft. Collins 5	219576	2,239	15	9	4	2	-50.0%
Ft. Collins 6	215717	5,084	2	2	2	2	0.0%
Timnath A	200420	5,301	2	2	1	1	0.0%
Timnath B	161905	3,892	2	1	1	1	0.0%
Windsor	141023	1,111	18	19	15	12	-20.0%
Greeley US	91769	118	97	98	101	100	-1.0%
Greeley CH	32333	10	88	92	83	84	1.2%
Greeley DS	5230	158	176	242	236	236	0.0%

[1] The locations of representative sections are noted in 2013 Stream Morphology Baseline Report (ACE 2013).
Note: US=upstream; DS=downstream; CH=channelized.

Table 5-17 provides a comparison of how flows that move bed material at selected cross sections along the mainstem are predicted to change with Future Conditions hydrology, Alternative 3 with Future Conditions Effects, and Cumulative Effects. Generally, Future Conditions hydrology and Alternative 3 are predicted to have a negligible effect on the number of events. Percent declines in the number of events that bed material is predicted to be moved with Cumulative Effects are at the Fort Collins 3 (-71.4%), Windsor (-25.0%), Greeley upstream (-14.8%) and Greeley channelized (-15.4%) cross sections.

The complexity of in-channel morphologic features is already low in the reaches downstream of I-25 as the result of sand deposition smothering the bed and reducing the magnitude and frequency of pool and riffle sequences. Further channel contraction under Alternative 3 with Future Conditions Effects and Cumulative Effects is predicted to exacerbate this condition. Although channel contraction is predicted to lead to floodplain engagement at lower flows, and this could have ecological benefits, the frequency of floods would also be reduced.

Alternative 3 with Future Conditions Effects and Cumulative Effects would likely exaggerate and extend these contemporary changes in channel morphology. Section 4.3.3.1.2 describes the effects of reduced flows on sediment transport, channel contraction and loss of channel complexity on the mainstem of the Poudre River upstream and downstream of I-25 for which Alternative 3 with Future Conditions Effects and Cumulative Effects would have similar effects.

Table 5-17. Comparison of flows that move bed material at selected sections - Alternative 3.

Study Reach	Representative Section[1]	Flow Threshold to Move Bed Material (cfs)	Number of Events in 26 Years				
			Current Conditions (Run 1)	Future Conditions (Run 2)	Alt 3 Future Conditions Effects (cfs)	Alt 3 Cumulative Effects (cfs)	% Change Alt 3 vs. Cumulative Effects
Laporte	300786	6,351	0	0	0	0	0.0%
Laporte	269124	>10,000	0	0	0	0	0.0%
Laporte	257663	5,216	2	2	2	2	0.0%
Ft. Collins 1	244249	>10,000	0	0	0	0	0.0%
Ft. Collins 2	238538	5,815	1	1	1	0	-100%
Ft. Collins 3	231351	2208	12	9	7	2	-71.4%
Ft. Collins 4	228361	>10,000	0	0	0	0	0.0%
Ft. Collins 5	219576	>10,000	0	0	0	0	0.0%
Ft. Collins 6	215717	9,701	0	0	0	0	0.0%
Timnath A	200420	6,816	0	0	0	0	0.0%
Timnath B	161905	5,344	2	2	2	2	0.0%
Windsor	141023	2,338	14	10	4	3	-25.0%
Greeley US	91769	461	38	28	27	23	-14.8%
Greeley CH	32333	1,227	17	19	13	11	-15.4%
Greeley DS	5230	260	98	127	122	122	0.0%

[1] The locations of representative sections are noted in 2013 Stream Morphology Baseline Report (ACE 2013).
Note: US=upstream; DS=downstream; CH=channelized.

5.4.4.2 South Platte River

No new studies or analysis were done for the SDEIS for the South Platte River. Section 4.4.1 of the DEIS and the 2008 South Platte River Stream Morphology Report (ERO 2008a) describe effects to the South Platte River. Channel-forming flows (1.5-year peak flows of 3,858 cfs) would occur or be exceeded about 3% of the time. Under the action alternatives, flows of this magnitude would occur less than 1% of the time. High flows of up to about 24,200 cfs were modeled to occur under baseline conditions; flows exceeding about 22,600 cfs would not occur under the action alternatives. Scouring flows equivalent to the 25-year peak flows would continue to occur in the South Platte River under the alternatives. It is unlikely that implementation of Alternative 3 with Future Conditions Effects and Cumulative Effects would affect the morphology of the South Platte River downstream of the confluence with the Poudre River.

5.4.5 Alternative 4

5.4.5.1 Poudre River

Alternative 4 is designed to allow some flow to pass through the Fort Collins area and be diverted lower on the river at the New Cache Canal headgate. Relative to the other action alternatives, Alternative 4 would allow more water to remain in the mainstem between the Poudre Valley Canal and the New Cache Canal before it is diverted for exchanges. Like

Alternative 3, Alternative 4 would divert on average about 5,500 to 6,000 AFY more water from the Poudre River than Alternative 2 to compensate for increased reservoir evaporation from Cactus Hill Reservoir and conveyance loss. Additionally, Alternative 4 does not include the Poudre River flow augmentation program that is proposed under Alternative 2.

The Cumulative Effects assessment of Alternative 4 uses Future Conditions hydrology (Run 2) compared to hydrology Runs 4b2 and 5b2. Assessments of the Cumulative Effects of Alternative 4 with Future Conditions Effects and Cumulative Effects would amplify the trajectory of the river conditions reflected in continuing channel contraction, fining of surficial material, and loss of channel complexity.

5.4.5.1.1 Flows and Flooding

Table 5-18 shows how the 2% exceedance probability discharge (the flow that is predicted to be exceeded 2% of the time) is predicted to change from Current Conditions to Future Conditions hydrology, to Future Conditions Effects with Alternative 4, and to Cumulative Effects for selected cross sections along the mainstem. This provides an example comparison of how relatively large flows (flooding) are predicted to change. Reductions in flow would be variable reflecting the complex interactions of diversions, transfers, and returns at different locations (Section 4.4.3.1). The 2% exceedance probability discharge is predicted to consistently decrease with Future Conditions hydrology (i.e., without the NISP alternatives) and in all instances these flows would decline further with Alternative 4 with Future Conditions Effects and Cumulative Effects. The greatest predicted percent reduction in the 2% exceedance flow under Cumulative Effects would occur in the Fort Collins Reach at Shields Street and between the Timnath Inlet and Fossil Creek Inlet in the Timnath Reach in the vicinity of Boxelder Creek.

Table 5-18. Comparison of 2% exceedance probability discharge - Alternative 4.

Study Reach	Location	Current Conditions (Run 1)	Future Conditions (Run 2)	Alt 4 Future Conditions Effects (cfs)	Alt 4 Cumulative Effects (cfs)	% Change Alt 4 vs. Cumulative Effects
Laporte	Between North Fork Confluence and Poudre Valley Canal	2,315	2,240	2,237	2,197	-1.8%
	Canyon Gage	2,238	2,132	1,765	1,655	-6.2%
	Between Hansen and LCC	2,170	2,000	1,643	1,547	-5.8%
	Between LCC and Little Cache	1,988	1,832	1,435	1,335	-7.0%
	Between Little Cache and LW	1,865	1,712	1,303	1,194	-8.4%
Fort Collins	Shields Street	1,704	1,523	1,105	984	-11.0%
	Lincoln Street Gage	1,694	1,516	1,062	959	-9.7%
	Between Timnath inlet and Fossil Creek inlet	1,772	1,597	1,114	987	-11.4%
Timnath	US/DS Boxelder Creek	1,603	1,444	869	766	-11.9%
	US/DS New Cache headgate	1,674	1,550	834	780	-6.5%
Windsor	Between Whitney and Greeley No. 3	1,711	1,570	860	803	-6.6%
Greeley US	US/DS Greeley No. 3 headgate	1,760	1,583	873	850	-2.6%
Greeley CH	US/DS Greeley WWTP discharge	1,802	1,633	959	911	-5.0%
Greeley DS	Greeley Gage	1,812	1,676	1,006	965	-4.1%

Note: US=upstream; DS=downstream; CH=channelized.

5.4.5.1.2 Sediment Transport

Table 5-19 provides a comparison of how flows that flush fines at selected cross sections along the mainstem are predicted to change with Future Conditions hydrology, Alternative 4 with Future Conditions Effects, and Cumulative Effects. Generally, Future Conditions hydrology would have no to minor effects on the number of events that would flush fines from the selected cross sections. At about half of the cross sections, the number of events that would flush fines would decrease with Alternative 4 with Future Conditions Effects and with Cumulative Effects. The greatest percent change in in the number of flushing events under Cumulative Effects would be for the Laporte, Fort Collins 5, and Timnath A cross sections where the number of flushing events is predicted to be reduced by about 43% to 50%. For those representative sections where the number of flushing events over the period of record would decline by more than 10% the effect would be moderate.

Table 5-19. Comparison of flows that flush fines from bed at selected sections - Alternative 4.

Study Reach	Representative Section[1]	Flow Threshold to Flush Fines (cfs)	Number of Events in 26 Years				
			Current Conditions (Run 1)	Future Conditions (Run 2)	Alt 4 Future Conditions Effects (cfs)	Alt 4 Cumulative Effects (cfs)	% Change Alt 4 vs. Cumu-lative Effects
Laporte	300786	3,511	6	3	2	1	-50.0%
Laporte	269124	4,885	2	2	2	2	0.0%
Laporte	257663	2,203	15	12	9	6	-33.3%
Ft. Collins 1	244249	9,206	0	0	0	0	0.0%
Ft. Collins 2	238538	3,971	1	1	1	1	0.0%
Ft. Collins 3	231351	1,115	23	22	18	16	-11.1%
Ft. Collins 4	228361	7,387	0	0	0	0	0.0%
Ft. Collins 5	219576	2,239	15	9	7	4	-42.9%
Ft. Collins 6	215717	5,084	2	2	2	2	0.0%
Timnath A	200420	5,301	2	2	2	1	-50.0%
Timnath B	161905	3,892	2	1	1	1	0.0%
Windsor	141023	1,111	18	19	16	14	-12.5%
Greeley US	91769	118	97	98	102	100	-2.0%
Greeley CH	32333	10	88	92	86	82	-4.7%
Greeley DS	5230	158	176	242	236	238	0.8%

[1] The locations of representative sections are noted in 2013 Stream Morphology Baseline Report (ACE 2013).
Note: US=upstream; DS=downstream; CH=channelized.

Table 5-20 provides a comparison of how flows that move bed material at selected cross sections along the mainstem are predicted to change with Future Conditions hydrology, Alternative 4 with Future Conditions Effects, and Cumulative Effects. Generally, Future Conditions hydrology and Alternative 4 are predicted to have a negligible effect on the number of events with Future Conditions Effects at most of the selected cross sections. Percent declines in the number of events that bed material is predicted to be moved with Cumulative Effects are at the Fort Collins 2 (-100.0%), Fort Collins 3 (-70.0), Windsor (-20.0%), Greeley upstream (-12.0%), Greeley channelized (-13.3%) and Greeley downstream (-3.2%) cross sections.

Table 5-20. Comparison of flows that move bed material at selected sections - Alternative 4.

Study Reach	Representative Section[1]	Flow Threshold to Move Bed Material (cfs)	Number of Events in 26 Years				
			Current Conditions (Run 1)	Future Conditions (Run 2)	Alt 4 Future Conditions Effects (cfs)	Alt 4 Cumulative Effects (cfs)	% Change Alt 4 vs. Cumulative Effects
Laporte	300786	6,351	0	0	0	0	0.0%
Laporte	269124	>10,000	0	0	0	0	0.0%
Laporte	257663	5,216	2	2	2	2	0.0%
Ft. Collins 1	244249	>10,000	0	0	0	0	0.0%
Ft. Collins 2	238538	5,815	1	1	1	0	-100%
Ft. Collins 3	231351	2208	12	9	10	3	-70.0%
Ft. Collins 4	228361	>10,000	0	0	0	0	0.0%
Ft. Collins 5	219576	>10,000	0	0	0	0	0.0%
Ft. Collins 6	215717	9,701	0	0	0	0	0.0%
Timnath A	200420	6,816	0	0	0	0	0.0%
Timnath B	161905	5,344	2	2	2	2	0.0%
Windsor	141023	2,338	14	10	5	4	-20.0%
Greeley US	91769	461	38	28	25	22	-12.0%
Greeley CH	32333	1,227	17	19	15	13	-13.3%
Greeley DS	5230	260	98	127	124	128	3.2%

[1] The locations of representative sections are noted in 2013 Stream Morphology Baseline Report (ACE 2013).
Note: US=upstream; DS=downstream; CH=channelized.

The complexity of in-channel morphologic features is already low in the reaches downstream of I-25 as the result of sand deposition smothering the bed and reducing the magnitude and frequency of pool and riffle sequences. Further channel contraction under Alternative 4 with Future Conditions Effects and Cumulative Effects is predicted to exacerbate this condition. Although channel contraction is predicted to lead to floodplain engagement at lower flows, and this could have ecological benefits, the frequency of floods would also be reduced.

Alternative 4 with Future Conditions Effects and Cumulative Effects would likely exaggerate and extend these contemporary changes in channel morphology. Section 4.3.3.1.2 describes the effects of reduced flows on sediment transport, channel contraction and loss of channel complexity on the mainstem of the Poudre River upstream and downstream of I-25 for which Alternative 4 with Future Conditions Effects and Cumulative Effects would have similar effects.

5.4.5.2 South Platte River

No new studies or analysis were done for the SDEIS for the South Platte River. Section 4.4.1 of the DEIS and the 2008 South Platte River Stream Morphology Report (ERO 2008a) describe effects to the South Platte River. Channel-forming flows (1.5-year peak flows of 3,858 cfs) would occur or be exceeded about 3% of the time. Under the action alternatives, flows of this magnitude would occur less than 1% of the time. High flows of up to about 24,200 cfs were modeled to occur under baseline conditions; flows exceeding about 22,600 cfs would not occur under the action alternatives. Scouring flows equivalent to the 25-year peak flows would continue to occur in the South Platte River under the alternatives. It is unlikely that

implementation of Alternative 4 with Future Conditions Effects and Cumulative Effects would affect the morphology of the South Platte River downstream of the confluence with the Poudre River.

5.4.6 Climate Change

Climate change is a trend that has the potential to accelerate the cumulative effects described above. A large volume of scientific information supports the conclusion that global temperatures are increasing and that precipitation trends would change in the future. The warming trend is expected to accelerate in coming decades. In the western United States, longer periods of drought are expected. There is also general agreement by climate scientists that climate change information specific to Colorado indicates that snowpack melting and spring runoff would occur earlier in the year and temperatures would increase by approximately 4°F by 2050, with summers warming more than winters. This could interact with RFFAs such as mountain pine beetle infestations that are also predicted to result in an earlier runoff (Lukas and Gordon 2010). However, there is little agreement on the potential changes to precipitation in Colorado, although modeling of the Colorado River Basin indicates overall lower runoff on the West Slope (DiNatale and CDM Smith 2014). Predicted increases in summer temperatures and longer periods of drought would likely accelerate the trends in channel contraction, loss of channel complexity, and fining of bed material reported above.

5.4.7 Impact Summary

5.4.7.1 Poudre River

The predicted effects for channel morphology and sediment transport for the mainstem under Future Conditions Effects and Cumulative Effects ratifies and amplifies the trends that were presented in Sections 3.9 and 4.9. The assessment of Cumulative Effects for the alternatives further confirm and amplify that this trajectory is expressed in continuing channel contraction, fining of surficial material and a loss of channel complexity. The progression of effects can be seen by comparing the effects predicted to occur with project alternatives compared to Current Conditions hydrology and the effects predicted to occur with Cumulative Effects. For example, flood flows would be reduced by the action alternatives by about 10% to 29% when compared to Current Conditions hydrology. Flood flows would be further reduced by about an additional 10% under Cumulative Effects. Similar progressions in effects are also predicted to occur for the reduction in flushing events that would be reduced by the action alternatives by about 6% to 33% when compared to Current Conditions hydrology and would be further reduced by about an additional 10% under Cumulative Effects. Table 5-21 summarizes the predicted Cumulative Effects for the alternatives for the mainstem of the Poudre River.

The Greeley Poudre River Flood Control and Environmental Restoration Project could reduce flooding in the 17-mile reach of the Poudre River in the Greeley area and help to reduce predicted increases in flooding associated with channel constriction.

Table 5-21. River morphology and sediment transport cumulative effects comparison for NISP alternatives for the Poudre River mainstem.

Potential Effect	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Change in Flood Flows	Flood flows would be reduced slightly with a predicted decrease in the 2% exceedance probability discharge of about 0-5%.	Flood flows would be reduced with a predicted decrease in the 2% exceedance probability discharge of about 6-11%.	Flood flows would be reduced slightly with a predicted decrease in the 2% exceedance probability discharge of about 4-11%.	Flood flows would be reduced slightly with a predicted decrease in the 2% exceedance probability discharge of about 3-12%.
Fining of Surficial Material	Slight decreases in the number of flushing events at a few representative sections.	No decreases in the number of flushing events at about half of the representative sections. At about half of the representative sections, the number of flushing events would decrease by about 1-50% for the period of record.	No decreases in the number of flushing events at about two-thirds of the representative sections. At about one-third of the representative sections, the number of flushing events would decrease by about 1-50% for the period of record.	No decreases in the number of flushing events at about half of the representative sections. At about half of the representative sections, the number of flushing events would decrease by about 2-50% for the period of record.
Loss of Morphologic Complexity	Slight to no decreases in the number of events that move bed material at the representative sections for the period of record.	No decreases in the number of events that move bed material at about two-thirds of the representative sections. At about one-third of the representative sections, the number of events that move bed material would decrease by about 3-35% for the period of record. The complexity of in-channel morphologic features is already low in the reaches downstream of I-25 as the result of sand deposition smothering the bed and reducing the magnitude and frequency of pool and riffle sequences. Further channel contraction under Cumulative Effects is predicted to exacerbate this condition.	No decreases in the number of events that move bed material at about half of the representative sections. At about one-third of the representative sections, the number of events that move bed material would decrease by about 1-50% for the period of record. The complexity of in-channel morphologic features is already low in the reaches downstream of I-25 as the result of sand deposition smothering the bed and reducing the magnitude and frequency of pool and riffle sequences. Further channel contraction under Cumulative Effects is predicted to exacerbate this condition.	No decreases in the number of events that move bed material at about two-thirds of the representative sections. At about one-third of the representative sections, the number of events that move bed material would decrease by about 12-100% for the period of record. The complexity of in-channel morphologic features is already low in the reaches downstream of I-25 as the result of sand deposition smothering the bed and reducing the magnitude and frequency of pool and riffle sequences. Further channel contraction under Cumulative Effects is predicted to exacerbate this condition.

Potential Effect	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Channel Contraction	Based on the current trajectory, there is predicted to be a propensity toward channel contraction throughout the system, but this is predicted to be mainly realized downstream of I-25 where there would be material of the relevant size fraction available for deposition and bio-geomorphic feedback loops are predicted to prevail. It is likely that the acceleration of channel contraction would lead to an increased frequency of flooding downstream of I-25.	Based on the current trajectory, there is predicted to be a propensity toward channel contraction throughout the system, but this is predicted to be mainly realized downstream of I-25 where there would be material of the relevant size fraction available for deposition and bio-geomorphic feedback loops are predicted to prevail. It is likely that the acceleration of channel contraction would lead to an increased frequency of flooding downstream of I-25.	Based on the current trajectory, there is predicted to be a propensity toward channel contraction throughout the system but this is predicted to be mainly realized downstream of I-25 where there would be material of the relevant size fraction available for deposition and bio-geomorphic feedback loops are predicted to prevail. It is likely that the acceleration of channel contraction would lead to an increased frequency of flooding downstream of I-25.	Based on the current trajectory, there is predicted to be a propensity toward channel contraction throughout the system but this would be mainly realized downstream of I-25 where there would be material of the relevant size fraction available for deposition and bio-geomorphic feedback loops are predicted to prevail. It is likely that the acceleration of channel contraction would lead to an increased frequency of flooding downstream of I-25.
Determination of Effects	Alternative 1 with Future Conditions Effects would have minor effects on flood flows, flushing flows and flows that move bed material, but would contribute to the current trajectory that may result in a detectable change that is considered to be ***minor*** in the reaches upstream of I-25. Downstream of I-25 Cumulative Effects may result in a clear detectable change that is considered to be ***moderate***.	Cumulative Effects with Alternative 2 on geomorphology and sediment transport may result in a detectable change that is considered to be ***minor*** in the reaches upstream of I-25. Downstream of I-25 Cumulative Effects may result in a clear detectable change that is considered to be ***moderate***.	Cumulative Effects with Alternative 3 on geomorphology and sediment transport are considered to be ***minor*** in the reaches upstream of I-25. Downstream of I-25 Cumulative Effects are considered to be ***moderate***.	Cumulative Effects with Alternative 4 on geomorphology and sediment transport are considered to be ***minor*** in the reaches upstream of I-25. Downstream of I-25 Cumulative Effects are considered to be ***moderate***.

5.4.7.2 South Platte River

It is unlikely that implementation of any of the alternatives with Future Conditions Effects and/or Cumulative Effects would affect the morphology of the South Platte River downstream of the confluence with the Poudre River. No new studies or analysis were done for the SDEIS for the South Platte River. Section 4.4.1 of the DEIS concluded that channel-forming flows (1.5-year peak flows of 3,858 cfs) would occur or be exceeded about 3% of the time. Under the action alternatives, flows of this magnitude would occur less than 1% of the time. High flows of up to about 24,200 cfs were modeled to occur under baseline conditions; flows exceeding about 22,600 cfs would not occur under the action alternatives. Scouring flows equivalent to the 25-year peak flows would continue to occur in the South Platte River under the alternatives.

5.4.7.3 Comparison of Alternatives

All of the alternatives would reduce flows in the mainstem of the Poudre River. Alternatives 3 and 4 would divert on average about 5,500 to 6,000 AFY more water from the Poudre River than Alternative 2 to compensate for increased reservoir evaporation from Cactus Hill Reservoir and conveyance loss. Alternative 4 would allow some flow to pass through the Fort Collins area and be diverted lower on the river at the New Cache Canal headgate. Relative to the other action alternatives, Alternative 4 would allow more water to remain in the mainstem between the Poudre Valley Canal and the New Cache Canal before it is diverted for exchanges. Alternatives 3 and 4 do not include the Poudre River flow augmentation program that is proposed under Alternative 2. These differences in the alternatives would result in some differences in predicted effects on channel morphology and sediment transport. All of the alternatives with Cumulative Effects are predicted to contribute to the existing trend of channel contraction, loss of channel complexity, and increased flooding downstream of I-25.

The Cumulative Effects for the action alternatives would all reduce the 2% exceedance flow by varying percentages reflecting the complex interactions of diversions, transfers, and returns at different locations (Figure 4-56). The Cumulative Effects for the action alternatives would all reduce the number of days of flushing events for the period of record at a variety of locations on the mainstem (Figure 5-44). At locations where the number of days of flushing of fines is predicted to be reduced, Alternative 2 is predicted to generally have the greatest percent reduction in the number of days of flushing flows. The Cumulative Effects for the action alternatives would all reduce the number of days of movement of bed material at a variety of locations on the mainstem (Figure 5-45). At the few locations where the number of days of the movement of bed material is predicted to be reduced, Alternatives 3 and 4 typically have the greatest percent reduction in the number of days bed material would be moved, except for the lowest reaches on the mainstem.

Figure 5-43. Percent Change in 2% Exceedance Discharge: Alternative vs. Cumulative Effects.

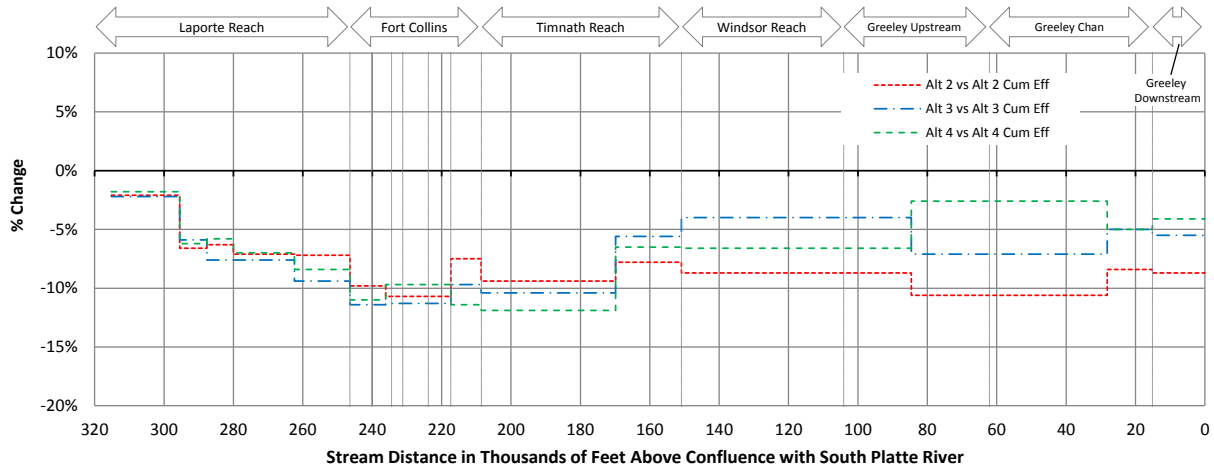


Figure 5-44. Percent Change in Number of Days Flushing of Fines Occurs – Alternatives 2, 3, and 4 vs. Cumulative Effects.

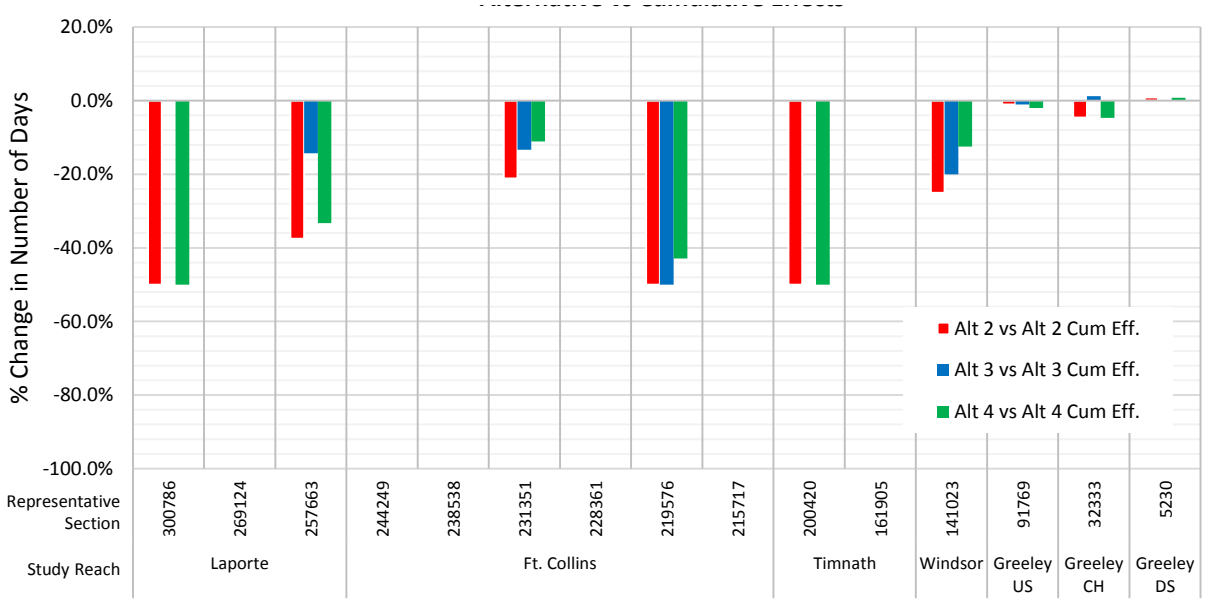
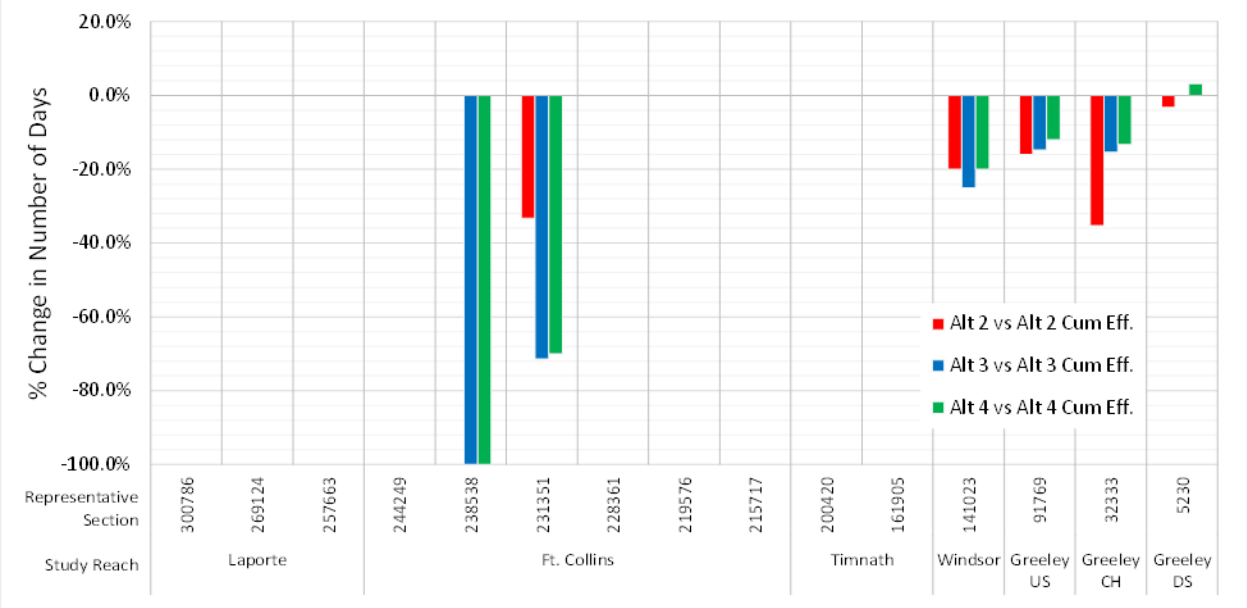


Figure 5-45. Percent Change in Number of Days Movement of Bed Material Occurs – Alternatives 2, 3, and 4 vs. Cumulative Effects.



5.5 GROUND WATER

Similar to surface water, information on the predicted changes in ground water levels associated with cumulative effects were used by resource scientists to predict effects on various resources. The role of ground water as it relates to other resources is addressed in Section 5.3 Surface Water Quality and Section 5.9 Wetlands, Riparian Resources, and Other Waters. This section summarizes how the modeled Cumulative Effects hydrology (includes flow-related RFFAs) is predicted to change ground water levels, and how land-based RFFAs could further affect ground water within the cumulative effects study area. Growth and development are land-based RFFAs, that when combined with the NISP alternatives, would have the potential to have cumulative effects on ground water. The trend in the region has been toward increased urbanization and reduced agricultural lands. This trend could affect the quantity and distribution of irrigation in the region that could in turn affect ground water and ground water contributions to streams.

5.5.1 Methods

The methods to predict changes to alluvial ground water levels associated with changes in river flow and stage are presented in Section 4.5. This analysis uses existing data presented in the 2012 Ground Water Report (ERO 2012b) and predicted stage changes from the CTP hydrologic model to predict how ground water levels would be reduced as a function of reduction in river stage and distance from the river for each of the alternatives. The assessment of how predicted reductions in Poudre River flows associated with the alternatives are estimated to reduce ground water levels along the Poudre River focused on the brief and infrequent predicted maximum reductions in river stage representing a maximum effect scenario. This approach was taken because most of the reductions in river stage are predicted to be 0.5 feet or less (Section 4.8.4.3.1) and therefore would have only minor reductions on associated alluvial ground water levels. A maximum effect scenario was of interest because changes in alluvial ground water levels can influence cottonwood woodlands and reductions in ground water levels below the annual water table low (Section 4.8.2.1.2) can stress cottonwoods. Changes in river flows were predicted using the CTP hydrology modeling by comparing various model runs (Table 5-2). As described in Section 5.2.1, the Cumulative Effects of NISP action alternatives were evaluated using Future Conditions hydrology (Run 2). Flow changes for the action alternatives plus the RFFAs, but not with the HSWSPs, were predicted using the CTP hydrology Run 4 series. The Run 5 series was used to predict flow changes for the NISP action alternatives plus the RFFAs and HSWSPs. The No Action Alternative was evaluated under Future Conditions hydrology only, as explained in Section 4.1.2 of the SDEIS, with CTP hydrology Run 9 used to predict flow changes. Predicted changes in Poudre River stages from the various model runs were used to predict change in ground water levels along the mainstem.

5.5.2 No Action Alternative (Alternative 1)

5.5.2.1 Cactus Hill Reservoir Site

Ground water resources for Cactus Hill Reservoir were discussed in Section 4.7.4 of the DEIS. No cumulative effects to ground water resources at the Cactus Hill Reservoir site are predicted.

5.5.2.2 Poudre River

For the four river segments that were analyzed (A, B, C, and F), the predicted reductions in maximum river stage would range from about 0.4 foot to 1.0 foot. Water levels in alluvial ground water monitoring wells located within tens of feet of the river would be at about the same elevation as river stage. At a distance of about 50 feet from the river, the effect of reductions in maximum river stage on ground water levels would decrease with greater distance from the river. Figure 4-59 compares estimated ground water level reductions with distance from the river for each of the alternatives at four of the study sites based on predicted maximum reduction in river stage. Figure 4-59 indicates there would be observable differences between the predicted maximum ground water level reductions associated with the No Action Alternative and the action alternatives, particularly in the near-bank areas.

5.5.2.2.1 Poudre River Segments

Segment A. The maximum predicted river stage reduction for Segment A would be less of a reduction than is predicted for the other study sites (Figure 4-59). At the Watson Lake study site (representative of Segment A), a maximum reduction in river stage of about 0.4 foot is estimated to result in a 0.2 foot decline in ground water levels at about 50 feet from the river and a 0 foot decline in ground water levels 600 feet from the river. The Watson Lake study site differs from the other study sites in that buried river channels coincide with 2 of the monitoring wells about 280 feet and 900 feet from the river. The effect of these buried channels can be seen on Figure 4-59 where predicted ground water level reductions are out of character with distance from the river and neighboring monitoring wells.

Segment B. The greatest reduction in flows and maximum reduction in river stage are predicted to occur in Segment B; however, the reductions in ground water levels are attenuated in a relatively short distance from the river (Figure 4-59). At the Martinez Park study site (representative of Segment B), a maximum reduction in river stage of about 1.0 foot is estimated to result in a 0.6 foot decline in ground water levels at about 50 feet from the river, a 0.2 foot decline in ground water levels at about 200 feet, and a 0 foot decline in ground water levels at about 400 feet from the river.

Segment C. A maximum reduction in river stage of about 1.0 foot is estimated to result in a 2.4 feet decline in ground water levels at about 50 feet from the river, a 0.6 foot decline in ground water levels at about 100 feet, and a 0 foot decline in ground water levels at about 375 feet from the river. Similar to Segment B, the reductions in ground water levels would be attenuated in a relatively short distance from the river (Figure 4-59).

Segment D. The Eastman Park study site represents conditions where ground water levels correspond to river stage, particularly in the wells closest to the river. The five monitoring wells are completely within the alluvial system. Ground water levels are controlled by the river and nearby ponds and there is not a good correlation between ground water levels and distance from the river. For these reasons, the Eastman Park study site wells are not discussed for the other alternatives.

Segment E. The 59th Avenue study site represents conditions where the relationship between river stage and ground water levels can seasonally reverse, where ground water levels are controlled by a river meander, and there is not a good correlation between ground water levels and distance from the river. For much of the year, ground water flows across the interior of the river meander from the upstream side to the downstream side. However, at times (such as during the spring), ground water appears to flow into the meander from outside of the river area, recharging both the alluvium within the meander and eventually the river. For these reasons, the 59th Avenue study site wells are not discussed for the other alternatives.

Segment F. At the Bird Farm study site (representative of Segment F) a maximum reduction in river stage of about 0.6 foot is estimated to result in a 0.5 foot decline in ground water levels at about 50 feet to 100 feet from the river and about a 0.2 foot decline in ground water levels at about 400 feet from the river. Unlike segments B and C, the reductions in ground water levels would not be attenuated in a relatively short distance from the river, but would level off for the first 100 feet then decline to about 0.2 foot within about 400 feet of the river (Figure 4-59).

5.5.2.3 South Platte River

The No Action Alternative would on an average monthly basis reduce flows on the South Platte River by less than 10% and the stage reductions are predicted to be small (up to 0.33 feet). Given the minor reductions in flow and stage, it is unlikely that there would be measurable changes to alluvial ground water along the South Platte River associated with the No Action Alternative and RFFAs.

5.5.2.4 No Action Irrigated Lands

Under the No Action Alternative, the NISP Participants would rely on transfers of irrigated agricultural water rights to provide their future water supply. Agricultural ditch transfers are projected to result in the "dry up" (i.e., revegetated or converted to dryland farming) of 64,200 irrigated acres. The No Action Alternative would result in a large percentage reduction in irrigated land in the Poudre River Basin which would likely result in a large percentage reduction in the current ground water return flows to the Poudre River, particularly during the mid to late summer, and possibly into the fall. This potential reduction in return flows was not part of the modeling of Run 9a. The dry up of irrigated land may result in the flattening of the hydraulic gradient between the river and adjacent lands, due to the reduction in ground water flow or flux towards the Poudre River (Section 4.5.2.4). Future transfers of irrigation water and/or increased use of alluvial ground water for irrigation or water supply could contribute to

Cumulative Effects on ground water when combined with the No Action Alternative and RFFAs. Depending on the degree of future transfers of irrigation water and/or increased use of alluvial ground water for irrigation or water supply the cumulative effect on ground water could range from minor to moderate.

5.5.3 District's Preferred Alternative (Alternative 2)

5.5.3.1 Glade Reservoir Site

A TCE plume occurs near the Glade Reservoir site. Additional information on the TCE plume near the proposed Glade Reservoir forebay is provided in Section 4.21.3.1.1 of the Hazardous Materials section. Effects to ground water resources at Glade Reservoir are discussed in Section 4.7.2 of the DEIS and in Section 4.5 of the SDEIS. Studies performed for the SDEIS indicate that the TCE plume has retracted so that there is currently no detectable TCE within the footprint of the proposed Glade Reservoir forebay. As the contaminant mass continues to naturally attenuate, the plume will continue to decrease in size. No Cumulative Effects to ground water resources at the Glade Reservoir site are predicted because no identified RFFAs would affect ground water resources.

5.5.3.2 Galeton Reservoir Site

Information on effects to ground water at Galeton Reservoir is presented in Section 4.7.3 of the DEIS. Subsequent to the DEIS, there has been drilling for oil and gas production at the Galeton Reservoir site. The oil and gas development and any potential effects to ground water quality are addressed in the 2012 Oil and Gas Development Memo (ERO 2012c) and in Section 4.21. Continued oil and gas development in the vicinity of Galeton Reservoir is an RFFA. All previous spills have been fully remediated and closed, which is likely to continue in the future.

As part of the SDEIS, additional ground water studies at the Galeton Reservoir site determined that no selenium or salinity impacts are predicted to occur to the ground water underlying Galeton Reservoir and no impacts are predicted to occur to the South Platte River from ground water at the Galeton Reservoir migrating to the South Platte River (Section 4.5.3.1). Therefore, no Cumulative Effects to ground water resources at the Galeton Reservoir site are predicted to occur, including oil and gas development.

5.5.3.3 Poudre River

For the four river segments that were analyzed (A, B, C, and F), the predicted reductions in maximum river stage would range from about 1.4 feet to 3.4 feet for the action alternatives with Future Conditions Effects and 2.0 feet to 3.2 feet for the action alternatives with Cumulative Effects. Water levels in alluvial ground water monitoring wells located within tens of feet of the river would be at about the same elevation as river stage. At a distance of about 50 feet from the river, the effect of reductions in maximum river stage on ground water levels would decrease with greater distance from the river. Figure 4-59 compares estimated ground water level

reductions with distance from the river for each of the alternatives at four of the study sites based on predicted maximum reduction in river stage (Section 5.5.1).

As Figure 4-59 demonstrates, there would be little difference between the action alternatives in ground water level reductions associated with predicted maximum river stage reductions. This lack of difference between the action alternatives is discussed in Section 4.5.3.2.

5.5.3.3.1 Poudre River Segments

Segment A. The maximum predicted river stage reduction with Future Conditions Effects for Segment A would be less of a reduction than is predicted for the other study sites (Figure 4-59). At the Watson Lake study site (representative of Segment A), a maximum reduction in river stage of about 1.4 feet with Future Conditions Effects and 2.1 feet with Cumulative Effects is estimated to result in about a 0.5 foot maximum decline in ground water levels at about 50 feet from the river and a 0 foot decline in ground water levels 600 feet from the river. The Watson Lake study site differs from the other study sites in that buried river channels coincide with 2 of the monitoring wells about 280 feet and 900 feet from the river. The effect of these buried channels can be seen on Figure 4-59 where predicted ground water level reductions are out of character with distance from the river and neighboring monitoring wells.

Segment B. The greatest reduction in flows and maximum reduction in river stage are predicted to occur in Segment B; however the reductions in ground water levels are attenuated in a relatively short distance from the river (Figure 4-59). At the Martinez Park study site (representative of Segment B), a maximum reduction in river stage of about 3.5 feet is estimated to result in a 2.0 feet decline in ground water levels at about 50 feet from the river, a 0.5 foot decline in ground water levels at about 200 feet, and a 0 foot decline in ground water levels at about 400 feet from the river.

Segment C. A maximum reduction in river stage of about 2.5 feet with Future Conditions Effects and with Cumulative Effects is estimated to result in about a 2.0 feet decline in ground water levels at about 50 feet from the river, a 1.4 feet decline in ground water levels at about 100 feet, and a 0 foot decline in ground water levels at about 375 feet from the river. Similar to Segment B, the reductions in ground water levels would be attenuated in a relatively short distance from the river (Figure 4-59).

Segment F. At the Bird Farm study site (representative of Segment F) a maximum reduction in river stage of about 2.5 feet with Future Conditions Effects and with Cumulative Effects are estimated to result in about a 2.0 feet decline in ground water levels at about 50 feet to 100 feet from the river and about a 1.0 foot decline in ground water levels about 400 feet from the river. Unlike Segments B and C, the reductions in ground water levels would not be attenuated in a relatively short distance from the river, but would level off for the first 100 feet then decline to about 1.0 to 1.3 feet within about 400 feet of the river (Figure 4-59).

5.5.3.4 South Platte River

Alternative 2 would on an average monthly basis reduce flows on the South Platte River by less than 10% and the stage reductions are predicted to be small (up to 0.33 feet). Given the minor

reductions in flow and stage, it is unlikely that there would be measurable changes to alluvial ground water along the South Platte River associated with Alternative 2 and RFFAs.

5.5.4 Alternative 3

5.5.4.1 Cactus Hill Reservoir Site

No Cumulative Effects to ground water resources at the Cactus Hill Reservoir site are predicted.

5.5.4.2 Galeton Reservoir Site

The effects on ground water associated with Galeton Reservoir are similar to those for Alternative 2 and are discussed in Section 5.5.3.2. No Cumulative Effects to ground water resources at the Galeton Reservoir site are predicted.

5.5.4.3 Poudre River

As discussed in Section 4.5.3.2 and shown in Figure 5-1, there would be little predicted difference between the action alternatives in ground water level reductions associated with maximum river stage reductions, with the exception of Segment F Cumulative Effects as discussed below.

5.5.4.3.1 Poudre River Segments

Segment A. The ground water level reductions for Alternative 3 with Future Conditions Effects and with Cumulative Effects associated with the predicted maximum river stage reduction would be the same as described for Alternative 2.

Segment B. The ground water level reductions for Alternative 3 with Future Conditions Effects and with Cumulative Effects associated with the predicted maximum river stage reduction would be similar to those described for Alternative 2.

Segment C. The ground water level reductions for Alternative 3 with Future Conditions Effects and with Cumulative Effects associated with the predicted maximum river stage reduction would be similar to those described for Alternative 2.

Segment F. Cumulatively, a maximum reduction in river stage of about 3.2 feet under Alternative 3 Cumulative Effects is estimated to result in about a 2.5 feet decline in ground water levels at about 50 feet to 100 feet from the river and about a 1.0-foot decline in ground water levels at about 400 feet from the river. Unlike Segments B and C, the reductions in ground water levels would not be attenuated in a relatively short distance from the river, but would level off for the first 100 feet then decline to about 1.0 to 1.3 feet within about 400 feet of the river (Figure 4-59).

5.5.4.4 South Platte River

Alternative 3 would on an average monthly basis reduce flows on the South Platte River by less than 10% and the stage reductions are predicted to be small (up to 0.33 feet). Given the minor reductions in flow and stage, it is unlikely that there would be measurable changes to alluvial ground water along the South Platte River associated with Alternative 3 and RFFAs.

5.5.5 Alternative 4

5.5.5.1 Cactus Hill Reservoir Site

No Cumulative Effects to ground water resources at the Cactus Hill Reservoir site are predicted.

5.5.5.2 Galeton Reservoir Site

The effects on ground water associated with Galeton Reservoir are similar to those for Alternatives 2 and 3 and are discussed in Section 5.5.3.2. No Cumulative Effects to ground water resources at the Galeton Reservoir site are predicted.

5.5.5.3 Poudre River

As discussed in Section 4.5.3.2 and shown in Figure 5-1, there would be little predicted difference between the action alternatives in ground water level reductions associated with maximum river stage reductions, with the exception of Segment F Cumulative Effects as discussed below.

5.5.5.3.1 Poudre River Segments

Segment A. The ground water level reductions for Alternative 4 with Future Conditions Effects and with Cumulative Effects associated with the predicted maximum river stage reduction would be similar to those described for Alternatives 2 and 3.

Segment B. The ground water level reductions for Alternative 4 with Future Conditions Effects and with Cumulative Effects associated with the predicted maximum river stage reduction would be similar to those described for Alternatives 2 and 3.

Segment C. The ground water level reductions for Alternative 4 with Future Conditions Effects and with Cumulative Effects associated with the predicted maximum river stage reduction would be similar to those described for Alternatives 2 and 3.

Segment F. Similar to Alternative 3, a maximum reduction in river stage of about 3.2 feet under Alternative 4 with Cumulative Effects is estimated to result in about a 2.5 feet decline in ground water levels at about 50 feet to 100 feet from the river and about a 1.0-foot decline in ground water levels at about 400 feet from the river. Unlike segments B and C, the reductions in ground water levels would not be attenuated in a relatively short distance from the river, but would level off for the first 100 feet then decline to about 1.0 to 1.3 feet within about 400 feet of the river (Figure 4-59).

5.5.5.4 South Platte River

Alternative 4 would on an average monthly basis reduce flows on the South Platte River by less than 10% and the stage reductions are predicted to be small (up to 0.33 feet). Given the minor reductions in flow and stage, it is unlikely that there would be measurable changes to alluvial ground water along the South Platte River associated with Alternative 4 and RFFAs.

5.5.6 Climate Change

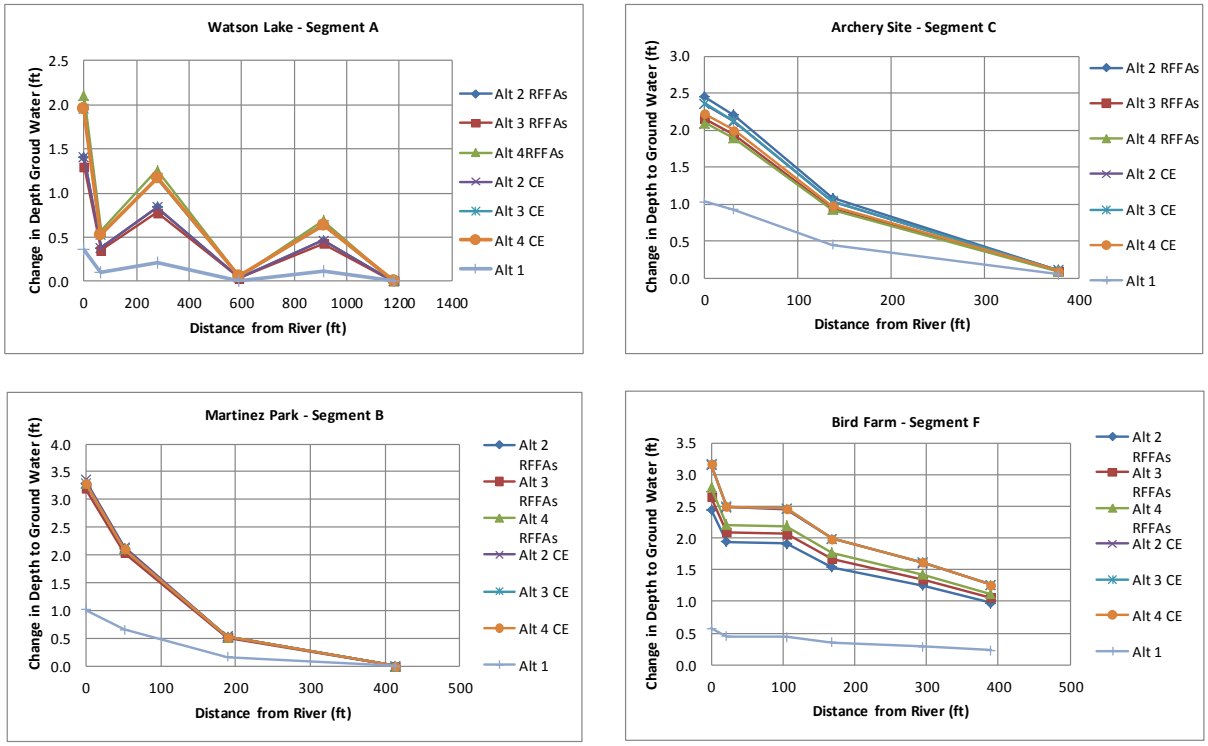
Climate change has the potential to contribute to the cumulative effects described above. A large volume of scientific information supports the conclusion that global temperatures are increasing and that precipitation trends would change in the future. The warming trend is expected to accelerate in coming decades. In the western United States, longer periods of drought are expected. There is also general agreement by climate scientists that climate change information specific to Colorado indicates that snowpack melting and spring runoff would occur earlier in the year and temperatures would increase by approximately 4°F by 2050, with summers warming more than winters (DiNatale and CDM Smith 2014). Under climate change, peak flows at most points in the Poudre River Basin below the canyon mouth are predicted to occur earlier and be reduced on the rising limb of the hydrograph compared to Current Conditions. These changes would likely affect the storage of water for irrigation and administration of the river.

These predicted changes in the river, operations and administration combined with increases in temperatures, a longer growing season and increases in the frequency and duration of droughts could influence how ground water is used in the basin. Use of ground water may shift to accommodate crop demands and could shift current ground water return flow patterns. Increased drought and increased irrigation requirements could reduce the amount of irrigable lands within the region. Reductions in irrigable lands would likely reduce current ground water return flows to the Poudre River, particularly during the mid to late summer, and possibly into the fall. When combined with the potential effects of climate change, the transfer of irrigation water from 64,200 acres of irrigated agricultural lands could have a major effect on ground water contributions to the Poudre River.

5.5.7 Impact Summary

As discussed above, reductions in alluvial ground water levels were used by other resource specialists to predict cumulative effects to resources and are addressed in those sections of the SDEIS. The predicted reductions to ground water levels in the alluvium would be similar for all action alternatives and the differences in predicted reductions in ground water levels between alternatives would decrease as a function of distance from the river (Figure 4-59). The No Action Alternative would have substantially less effect on reductions in ground water levels than the action alternatives (Figure 4-59).

Figure 5-46. Predicted Ground Water Level Reductions vs. Distance from the Poudre River Based on Maximum River Stage Reductions.



RFFAs = Reasonably foreseeable future actions (hydrology model Run Series 4)
CE = Cumulative effects (hydrology model Run Series 5)

5.6 GEOLOGY

This section summarizes the potential land-based cumulative effects predicted to occur to geologic resources within the NISP cumulative effects study area. RFFAs that would result in cumulative effects on geologic resources, when combined with the effects of the proposed project, include the construction of Chimney Hollow Reservoir, the expansion of the Halligan and Seaman Reservoirs, population growth and urban development, the North 1-25 improvement project, other construction projects, oil and gas development, and proposed projects along the Poudre River.

5.6.1 No Action Alternative (Alternative 1)

Information on geologic resources directly affected by the No Action Alternative is provided in Section 4.6.2. Most direct effects on geologic resources would occur from the construction of Cactus Hill Reservoir. The construction of Cactus Hill Reservoir and its associated facilities combined with the RFFAs would result in the loss of geologic resources such as sand, gravel, and bedrock. The cumulative effects on geologic resources under the No Action Alternative would be moderate because there would be a clearly detectable change to these resources with measurable effects.

5.6.2 District's Preferred Alternative (Alternative 2)

Information on geologic resources directly affected by Alternative 2 is provided in Section 4.6.3. Most direct effects would occur from the construction of Glade and Galeton Reservoirs and their associated facilities and the realignment of U.S. 287. Alternative 2 combined with the RFFAs would result in the loss of geologic resources such as sand, gravel, and bedrock. The cumulative effects on geologic resources under the Alternative 2 would be the same as the No Action Alternative.

5.6.3 Alternative 3

Information on geologic resources directly affected by Alternative 3 is provided in Section 4.6.4. Most direct effects on geologic resources would occur from the construction of Cactus Hill and Galeton Reservoirs and their associated facilities. Alternative 3 combined with the RFFAs would result in the loss of geologic resources such as sand, gravel, and bedrock. The cumulative effects on geologic resources under the Alternative 3 would be the same as the No Action Alternative.

5.6.4 Alternative 4

Information on geologic resources directly affected by Alternative 4 is provided in Section 4.6.5. Most direct effects would occur from the construction of Cactus Hill and Galeton Reservoirs and their associated facilities. Alternative 4 combined with the RFFAs would result in the loss of

geologic resources such as sand, gravel, and bedrock. The cumulative effects on geologic resources under the Alternative 4 would be the same as the No Action Alternative.

5.6.5 Climate Change

Climate change is not expected to have an effect on geologic resources.

5.6.6 Impact Summary

The cumulative effects on geologic resources for all alternatives would be moderate.

5.7 SOILS

This section summarizes the potential land-based cumulative effects predicted to occur on Prime Farmland and soil erodibility. RFFAs that would result in cumulative effects on Prime Farmland and soil erodibility, when combined with the effects of the proposed project, include population growth and urban development, the North 1-25 improvement project, other construction projects that affect soils, oil and gas development, and proposed projects along the Poudre River. The construction of Chimney Hollow Reservoir and the expansion of the Halligan and Seaman Reservoirs would not result in losses of Prime Farmland because the reservoir sites are in upland locations with no land currently farmed or irrigated.

5.7.1 No Action Alternative (Alternative 1)

Information on Prime Farmland permanently lost under the No Action Alternative is provided in Section 4.7.2. Most direct effects to Prime Farmland would occur from the construction of Cactus Hill Reservoir. Future development in response to population growth is likely to occur in the northern Colorado Front Range. The construction of Cactus Hill Reservoir and its associated facilities combined with the RFFAs would contribute to the ongoing regional trend of reduced agricultural lands, including Prime Farmland.

The No Action Alternative is also expected to indirectly cause the dry up of 64,200 acres of agricultural lands, which would likely be converted to areas of dry land crops or uplands with mixed species. With future urban development, agricultural land and rangeland would be converted to residential, commercial, and industrial uses. While the total acreage of Prime Farmland lost cannot be determined because the exact location of the agricultural dry up and urban development is unknown, it is likely that more than 1% of the total acres of Prime Farmland in Larimer and Weld Counties would be lost (Section 4.7.2) under the No Action Alternative alone. The removal of irrigation from 64,200 acres of agricultural land would likely increase soil erodibility due to a decrease in soil moisture levels. Soil erodibility would temporarily increase during construction phases of new development projects. The cumulative effects on soils under the No Action Alternative would be moderate to major depending on the amount of future urban development.

5.7.2 District's Preferred Alternative (Alternative 2)

Information on Prime Farmland permanently lost under Alternative 2 is provided in Section 4.7.3. Most direct effects would occur from the construction of Glade and Galeton Reservoirs and their associated facilities and the realignment of U.S. 287. Alternative 2 combined with the RFFAs would result in a loss of Prime Farmland and a temporary increase of soil erodibility. The cumulative effects on soils under the Alternative 2 would be minor to moderate depending on the amount of future urban development.

5.7.3 Alternative 3

Information on Prime Farmland permanently lost under Alternative 3 is provided in Section 4.7.4. Most direct effects would occur from the construction of Cactus Hill and Galeton Reservoirs and their associated facilities. Alternative 3 combined with the RFFAs would result in a loss of Prime Farmland and a temporary increase of soil erodibility. The cumulative effects on soils under the Alternative 3 would be minor to moderate depending on the amount of future urban development.

5.7.4 Alternative 4

Information on Prime Farmland permanently lost under Alternative 4 is provided in Section 4.7.5. Most direct effects would occur from the construction of Cactus Hill and Galeton Reservoirs and their associated facilities. Alternative 4 combined with the RFFAs would result in a loss of Prime Farmland and a temporary increase of soil erodibility. The cumulative effects on soils under the Alternative 4 would be minor to moderate depending on the amount of future urban development.

5.7.5 Climate Change

Climate change has the potential to accelerate the cumulative effects described above. A large volume of scientific information supports the conclusion that global temperatures are increasing and that precipitation trends would change in the future. The warming trend is expected to accelerate in coming decades. In the western United States, longer periods of drought are expected. There is also general agreement by climate scientists that climate change information specific to Colorado indicates that snowpack melting and spring runoff would occur earlier in the year and temperatures would increase by approximately 4°F by 2050, with summers warming more than winters (DiNatale and CDM Smith 2014). Under climate change, warmer temperatures and prolonged drought would reduce soil moisture levels and fertility, which would have an adverse effect on farmland and soil erodibility.

5.7.6 Impact Summary

The cumulative effects on soils for the No Action Alternative would be moderate to major depending on the amount of future urban development. For Alternatives 2, 3, and 4 it would be minor to moderate depending on the amount of future urban development.

5.8 VEGETATION

This section summarizes the potential land-based cumulative effects predicted to occur to vegetation resources, including upland vegetation communities, sensitive plant communities tracked by the CNHP, and noxious weed distribution. Cumulative effects to individual sensitive plant species are discussed in Section 5.11. Flow-related and land-based cumulative effects on wetland and riparian resources are discussed in Section 5.9. RFFAs that would result in cumulative effects on vegetation resources, when combined with the effects of the proposed project, include construction of Chimney Hollow Reservoir, the expansion of Halligan and Seaman Reservoirs, population growth and urban development, the North I-25 improvement project, other construction projects that disturb vegetation resources, oil and gas development, and proposed projects along the Poudre River.

5.8.1 No Action Alternative (Alternative 1)

Information on vegetation communities permanently lost under the No Action Alternative from direct effects is provided in Section 4.8.2. Direct effects would occur from the construction of Cactus Hill Reservoir, inundation of vegetation by the reservoir, and construction of conveyance systems. The construction of Chimney Hollow Reservoir would permanently affect up to 788 acres of vegetation communities (Reclamation 2011), which would be an incremental loss of vegetation communities within the cumulative effects study area. The expansion of the Halligan and Seaman Reservoirs would result in impacts to mesic grasslands, woodlands, upland grasslands and shrublands. The preferred alternative of the North I-25 improvement project would affect up to 818 acres of vegetation communities (CDOT 2011), including agricultural land, native and disturbed grasslands, wetlands, woodlands, and landscaped areas. Of the 818 acres, about 15 acres are wetlands that are addressed in Section 5.9. The North I-25 improvement project would affect 803 of vegetation communities excluding wetlands.

Participants in the NISP cumulative effects study area have planning boundaries that have projected growth. Vegetation communities would be permanently lost from future urban development and construction projects. Areas in planning boundaries that would be disturbed contain a wide variety of vegetation types, such as croplands, grasslands, woodlands, and shrublands. In future developed areas, it is likely that these vegetation types would change to landscaped areas, disturbed areas, or developed areas.

The No Action Alternative is also expected to indirectly cause the dry up of 64,200 acres of agricultural lands, which would likely be converted to areas of dry land crops or uplands with mixed species. With future urban development throughout the cumulative effects study area, agricultural land and rangeland would be converted to residential, commercial, and industrial uses. The trend of transferring irrigation water from agricultural lands to M&I uses is likely to continue in the region. With the major direct effects on vegetation from the No Action Alternative combined with the predicted effects from the land-based RFFAs, the cumulative effects on vegetation communities would be major.

The removal of irrigation from 64,200 acres of agricultural land would likely increase the distribution of noxious weeds. An increase in the distribution of noxious weeds is expected to continue throughout the region with the cumulative effect of ground-disturbing activities for urban development and the continued transfer of irrigation water from agricultural lands. The cumulative effect on the increased distribution of noxious weeds is expected to be major.

5.8.2 District's Preferred Alternative (Alternative 2)

Information on vegetation communities permanently lost under Alternative 2 is provided in Section 4.8.3. Direct effects would occur from the construction of Glade and Galeton Reservoirs, inundation of vegetation by the reservoirs, the realignment of U.S. 287 and construction of conveyance systems. Land uses in and around Glade Reservoir study area has been affected by historical and current livestock operations and farming, mining, mine reclamation, and nearby land development including rural residential development, ditches and canals, and roads. Increasingly, lands throughout the northern Colorado Front Range and near Glade Reservoir have been developed to support increased demand for residential land uses. Vegetation communities would be lost from future residential development and may be converted to landscaped areas, disturbed areas, and developed areas. Glade Reservoir would impact 188 acres of the CNHP-tracked Foothills Shrublands (S2S3) community, and other development and construction projects near Glade Reservoir may impact additional stands. RFFAs that contribute to cumulative effects would be similar to those described for the No Action Alternative. With the major direct effects on vegetation from Alternative 2 combined with the predicted effects from the land-based RFFAs, the cumulative effects on vegetation communities would be major. The cumulative effect on the increased distribution of noxious weeds is expected to be major.

5.8.3 Alternative 3

Information on vegetation communities permanently lost under Alternative 3 is provided in Section 4.8.4. Direct effects would occur from the construction of Cactus Hill and Galeton Reservoirs, inundation of vegetation by the reservoirs, and construction of conveyance systems. RFFAs that contribute to cumulative effects would be similar to those described for the No Action Alternative. With the major direct effects on vegetation from Alternative 3 combined with the predicted effects from the land-based RFFAs, the cumulative effects on vegetation communities would be major. The cumulative effect on the increased distribution of noxious weeds is expected to be major.

5.8.4 Alternative 4

Information on vegetation communities permanently lost under Alternative 4 is provided in Section 4.8.5. Direct effects would occur from the construction of Cactus Hill and Galeton Reservoirs, inundation of vegetation by the reservoirs, and construction of conveyance systems. RFFAs that contribute to cumulative effects would be similar to those described for the No

Action Alternative. With the major direct effects on vegetation from Alternative 4 combined with the predicted effects from the land-based RFFAs, the cumulative effects on vegetation communities would be major. The cumulative effect on the increased distribution of noxious weeds is expected to be major.

5.8.5 Climate Change

Climate change has the potential to accelerate the cumulative effects described above. A large volume of scientific information supports the conclusion that global temperatures are increasing and that precipitation trends would change in the future. The warming trend is expected to accelerate in coming decades. In the western United States, longer periods of drought are expected. There is also general agreement by climate scientists that climate change information specific to Colorado indicates that snowpack melting and spring runoff would occur earlier in the year and temperatures would increase by approximately 4°F by 2050, with summers warming more than winters (DiNatale and CDM Smith 2014). Under climate change, warmer temperatures and prolonged drought would affect survival of many plants. Species composition would likely change while diversity may decrease. Drought-tolerant species would become more abundant and would move into areas that were once inhabited by more mesic species. Plant communities may change as some species becomes less able to adapt. Weeds, including noxious weeds, tend to have a greater ecological range for different habitats, can out-compete other species, and would likely become more abundant with climate change.

5.8.6 Impact Summary

With the predicted major direct effects on vegetation from all of the alternatives, combined with the predicted effects from the land-based RFFAs, the cumulative effects on vegetation communities would be major for all alternatives. The cumulative effect on the increased distribution of noxious weeds is also expected to be major.

5.9 WETLANDS, RIPARIAN RESOURCES, AND OTHER WATERS

5.9.1 Overview

Wetland and riparian resources along the mainstem have the potential to be affected by the following, which could be affected by the alternatives, RFFAs, and cumulative effects hydrology:

- Decline in alluvial ground water levels associated with reductions in river flows and stage
- Reduction in the distribution, frequency, and duration of inundation from flood flows
- Acceleration in the existing trends leading to shifts in woody species composition (i.e., from cottonwoods to green ash, Siberian elm, and Russian olive)

In addition to the flow-related RFFAs incorporated in the CTP hydrologic modeling (CDM Smith and DiNatale 2013), other land-based RFFAs have been identified that may affect wetlands and riparian resources such as:

- Reservoir construction and expansion
- Population growth in the northern Front Range
- Commercial and residential development along the Poudre River
- Continued gravel mining
- Poudre River regional trail connections and increased recreation along the Poudre River corridor
- Poudre River restoration projects
- Poudre River conservation plans

The NISP alternatives are predicted to affect river stage, ground water levels, and inundation (Section 4.9). The current trend leading to shifts in woody riparian species composition along the mainstem is expected to continue and to be affected by the NISP alternatives (Section 4.9.1.1). The combined effects of the RFFAs, NISP alternatives, and the HSWSPs (cumulative effects) are predicted to further reinforce and/or accelerate the previously described trajectory of wetland and riparian resources along the mainstem.

5.9.2 Methods

The assessment of effects to wetland and riparian resources along the mainstem associated with changes to Poudre River flow focuses on predicted changes to alluvial ground water levels and the frequency of inundation along the mainstem, as described in Section 4.9. Changes in river flows were predicted using the CTP hydrology modeling by comparing various model runs. The same methods described in Section 4.9.2 were used to assess cumulative effects. Predicted declines to river stage associated with river flow were used to estimate alluvial ground water levels within the mainstem riparian areas. Changes in maximum ground water levels for cottonwood woodlands were estimated using predicted changes in river stage comparing Future

Conditions hydrology to Cumulative Effects hydrology. The predicted changes in the maximum depth to ground water during the growing season were then compared to the observed maximum depth to ground water levels at monitoring wells associated with cottonwood woodlands. Impact thresholds are presented in Section 4.9.2.1. Wetland vegetation potentially sensitive to reductions in river stage was estimated for each river segment (ERO 2014d, Table 14).

Wetland functional assessments using the FACWet assessment procedure were performed for each of the representative Poudre River study sites for depressional and riverine wetlands. Table 5-11 summarizes how the alternatives are predicted to change the functional capacity index score for depressional wetlands and Table 5-12 summarizes how the alternatives are predicted to change the functional capacity index score for riverine wetlands.

Vegetation studies for the SDEIS included collecting and analyzing data on vegetation communities, nonnative species, and the recruitment and size distribution of woody vegetation at the Poudre River study sites. This information was used to develop trends and a trajectory for wetland and riparian resources along the mainstem as well as estimate how predicted changes in the frequency and duration of inundation and ground water levels during the growing season could affect the composition and distribution of plant communities along the mainstem (Section 3.9).

Information on the CTP hydrologic model can be found in the CTP 2013 Hydrologic Modeling Report (CDM Smith and DiNatale 2013). Section 3.9 describes the studies undertaken for riparian and wetland resources along the Poudre River. Additional detail on the studies and direct effects assessment can be found in the 2012 Wetlands and Riparian Resources Baseline Report (ERO 2012d) and the 2014 Wetlands and Riparian Resources Effects Report (ERO 2014d). Potential effects of the land-based RFFAs were determined by estimating how the RFFAs would increase or decrease the effects on wetland and riparian vegetation estimated in Chapter 4.

5.9.3 No Action Alternative (Alternative 1)

The No Action Alternative would reinforce the trajectory for wetland and riparian resources along the mainstem of the Poudre River. A total of 250.4 acres of wetlands is predicted to be lost, and 16.2 acres of wetlands would be temporarily affected by the No Action Alternative associated with the transfer of irrigation from agricultural lands and construction of Cactus Hill Reservoir, associated facilities, and conveyance system. A total of 4.2 acres of riparian woodland vegetation would be permanently impacted and a total of 15.3 acres of riparian woodland and shrubland vegetation would be temporarily impacted by the construction of the No Action Alternative (Section 2.4).

Section 4.9.3.1 and Section 4.9.3.2 describe the direct effects associated with the No Action Alternative on wetlands, riparian resources, and other waters not related to changes in flows. These impacts would contribute to other losses of wetland and riparian resources in the region associated with continued projected growth, development, and construction likely to impact wetlands and other waters in the future.

5.9.3.1 No Action Irrigated Lands

The proposed transfer of irrigation water from 64,200 acres of agricultural lands would cause an estimated loss of 218.6 acres of wetlands (included in the 250.4 total wetland acreage loss for the No Action Alternative). This predicted loss of wetlands would contribute to the cumulative loss of wetlands in the region associated with projected growth and development and additional transfers of irrigation water in the future.

5.9.3.2 Poudre River

The No Action Alternative was evaluated under Future Conditions hydrology only, as explained in Section 4.1.2. Alternative 1 Effects (Run 9a) was compared to Future Conditions hydrology (Run 2) to predict how changes in Poudre River flows would affect wetland and riparian resources along the mainstem. The trajectory previously described for the mainstem riparian resources (Section 4.9.1.1) is predicted to continue with or without the NISP alternatives. Changes in flows associated with the No Action Alternative would likely reinforce the trajectory.

5.9.3.2.1 River Stage

Changes in river stage during the growing season were used to predict indirect effects on shallowly rooted herbaceous wetland vegetation bordering the mainstem that is supported, at least in part, by water levels (river stage) in the river. For all the study sites, the predicted percentage of the period of record with a decline of 0.5 foot or greater is 10% or less (Table 5-22). A decline of 10% or less was identified as having negligible effects on wetland and riparian vegetation (Section 4.9.2.1). Compared to Future Conditions, the No Action Alternative is predicted to have a negligible effect on river stage and associated ground water levels as discussed below for the Poudre River segments.

Table 5-22. Alternative 1 – Cumulative effects summary of weekly average Poudre River stage declines by river segment (representative study site) of 0.5 foot or greater during the growing season.

Alternative 1 Model Runs 2 and 9a Compared	Years of Consecutive Decline[1] (Number of Years)	Number of Weeks[2]	Percentage of Period of Record
Segment A - Watson Lake	0	0	0
Segment B - Martinez Park	1983 (1 year)	16	3
Segment C - Archery Site	1983 (1 year)	20	4
Segment D - Eastman Park	0	2	<1
Segment E - 59th Avenue	0	1	<1
Segment F - Bird Farm	0	2	<1

[1] Years of consecutive declines are years in the period of record (1980-2005) with at least 4 consecutive weeks during the growing season (May 1 through September 30) of weekly average river stage declines of 0.5 foot or greater or a total of 6 weeks of declines of 0.5 foot or greater.

[2] Number of weeks with a decline of 0.5 foot or greater for the period of record (1980-2005) during the growing season. There are 546 weeks during the growing season for the period of record.

Segment A. Relative to the other segments, the predicted frequency of declines in river stage for Segment A are estimated to have the least potential effect on near-bank herbaceous wetland vegetation. The Watson Lake study site, representative of Segment A, is predicted to have 0% of

the period of record of weekly average stage declines of 0.5 foot or greater during the growing season (Table 5-22).

Segment B. The Martinez Park study site, representative of Segment B, would experience a decline of 0.5 foot or greater during the growing season for 3% of the period of record (Table 5-22).

Segment C. The Archery Site, representative of Segment C, would experience a decline of 0.5 foot or greater during the growing season for 4% of the period of record (Table 5-22).

Segment D. The Eastman Park study site, representative of Segment D, would have <1% of the period of record with a decline of 0.5 foot or greater during the growing season.

Segment E. The 59th Avenue study site, representative of Segment E, would have <1% of the period of record with a decline of 0.5 foot or greater during the growing season.

Segment F. The Bird Farm study site, representative of Segment F, would have <1% of the period of record with a decline of 0.5 foot or greater during the growing season.

5.9.3.2.2 Riparian Vegetation and Alluvial Ground Water

In general, the deepest observed and predicted annual water table depths during the growing season tends to increase in a downstream direction (the exception being Segment C at the Archery Site). Segment A has the shallowest and Segment F has the deepest observed annual water table depth during the growing season (Table 4-70). Under Cumulative Effects hydrology, the greatest predicted declines in alluvial ground water levels below the deepest observed annual water table depth during the growing season associated with cottonwood woodlands for the No Action Alternative are predicted to infrequently occur at the Eastman Park study site (Segment D) at monitoring wells Y4 (<0.1 foot) and Y5 (-0.3 foot), and at the Bird Farm study site (Segment F) at monitoring well D5 (-0.3 foot). These infrequent declines are estimated to have negligible effects on cottonwood woodlands as described below.

Segment A. Relative to the other segments, predicted maximum depth to ground water within the monitored cottonwood woodland locations at the Watson Lake study site are estimated to be the shallowest. The maximum ground water depths in monitoring wells within the cottonwood woodlands are predicted to be about 2.82 feet to 3.03 feet in September below the surface (Table 4-70). These estimated changes in the maximum depth to ground water are not predicted to adversely impact the cottonwood woodlands along Segment A because the changes would be well within the observed range of maximum ground water depths of 2.79 feet to 6.85 feet for cottonwoods during the growing season along the mainstem (Table 4-70).

Segment B. The maximum ground water depths in monitoring wells within the cottonwood woodlands at the Martinez Park study site are predicted to be about 5.29 feet to 6.04 feet in September below the surface (Table 4-70). These estimated changes in the maximum depth to ground water are not predicted to adversely impact the cottonwood woodlands along Segment B because the changes would be within the observed range of maximum ground water depths of 2.79 feet to 6.85 feet for cottonwoods during the growing season along the mainstem.

Segment C. The maximum ground water depths in monitoring wells within the cottonwood woodlands at the Archery Site are predicted to be about 6.61 feet (May) to 6.66 feet (July) below the surface (Table 4-70). These estimated changes in the maximum depth to ground water are not predicted to adversely impact the cottonwood woodlands along Segment C because the changes would be within the observed range of maximum ground water depths of 2.79 feet to 6.85 feet for cottonwoods during the growing season along the mainstem.

Segment D. The maximum ground water depths in monitoring wells within the cottonwood woodlands at the Eastman Park study site are predicted to infrequently reach depths of about 5.52 feet (September) to 7.19 feet below the surface in July (Table 4-70). This would be about 0.0 feet to 0.3 foot below the maximum ground water depths observed during the growing season at these monitoring wells and about 0.3 foot below the maximum ground water depth observed for cottonwoods during the growing season along the mainstem. Effects on cottonwood woodlands are predicted to be negligible because most of these predicted maximum ground water depths would be within the observed range of maximum ground water depths of 2.79 feet to 6.85 feet for cottonwoods during the growing season along the mainstem, and the two locations that are greater than these depths exceed the observed maximum ground water depth by about 0.3 foot which would occur infrequently.

Segment E. The maximum ground water depths in monitoring wells within the cottonwood woodlands at the 59th Avenue study site are predicted to infrequently reach depths of about 5.7 feet to about 6.3 feet below the surface (Table 4-70). This would be about 0 to 0.1 foot below the maximum ground water depths observed during the growing season at these monitoring wells. These estimated changes in the maximum depth to ground water are not predicted to adversely impact the cottonwood woodlands along Segment B because the changes would be within the observed range of maximum ground water depths of 2.79 feet to 6.85 feet for cottonwoods during the growing season along the mainstem.

Segment F. Relative to the other segments, Segment F is predicted to have the deepest maximum ground water depth within the monitored cottonwood woodland locations. Monitoring well D5 is predicted to infrequently have a maximum ground water depth of 7.1 feet in July. This would be about 0.3 foot below the maximum ground water depth observed during the growing season at this monitoring well and a maximum of about 0.3 foot feet below the maximum ground water depth observed for cottonwoods during the growing season along the mainstem. Effects on cottonwood woodlands are predicted to be negligible because most of these predicted maximum ground water depths would be within the observed range of maximum ground water depths of 2.79 feet to 6.85 feet for cottonwoods during the growing season along the mainstem, and the one location that is greater than these depths exceed the observed maximum ground water depth by about 0.3 foot, which would occur infrequently.

5.9.3.2.3 Inundation

The number of years that riparian and wetland resources along the mainstem would be inundated under Current Conditions hydrology declines slightly under Future Conditions hydrology, and Future Conditions Effects with the No Action Alternative (Table 5-23). The greatest estimated reduction in years of inundation (4 years) compared to Current Conditions hydrology is predicted

to occur at the Watson Lake study site (transect point WLT2.3), the Martinez Park study site (transect points LMT2.1, 2.2, and 2.3), the Archery study site (transect point AT1.2) and the 59th Avenue study site (transect point 59T3a.5). However, inundation at these locations under Current Conditions hydrology is not predicted to occur with enough frequency (at least 50% of the years in the period of record) to provide a reliable source of hydrologic support. Under the No Action Alternative, inundation of these 6 locations is predicted to decrease from 10 to 11 years under Current Conditions hydrology to 6 to 7 years with cumulative effects.

Eight vegetated points (points mapped as open water excluded) for the Spells Analysis were estimated to have at least one inundation event in 13 or more years during the period of record (Table 5-23). These riparian and wetland vegetation locations were identified as being inundated with enough frequency under Current Conditions hydrology to potentially be dependent to some degree on inundation for hydrologic support. These locations (WLT1.2 and 1.3, AT2.2, EPT2.1, 59T1.3, 3a.1, and 3b.1, and BFT3.3) are inundated by the more frequently occurring lower flows ranging from about 160 to 580 cfs. The No Action Alternative with Future Conditions Effects is predicted to have negligible effects on these wetland and riparian resources because these elevations are predicted to continue to be inundated in at least half of the years of the period of record.

The following discussion on predicted changes to inundation under the No Action Alternative with Future Conditions Effects for the Poudre River segments focuses on potential effects on cottonwood woodlands. Herbaceous near-bank riparian resources and wetlands are addressed under *River Stage*.

Table 5-23. Spells analysis of selected points along riparian transects for Poudre River study sites - Alternative 1.

Study Site/Transect/Point	Elevation-National Geodetic Vertical Datum (ft)	Approx. Distance from Riverbank (ft)	Vegetation Cover Type[1]	Minimum Inundation Flow (cfs)	No. of Years Inundated Current Conditions (Run 1)	No. of Years Inundated Future Conditions (Run 2)	No. of Years Inundated Alt. 1 Effects (Run 9a)
Watson Lake							
Transect 1							
WLT1.1	5,143.18	210	N/A	3,000	7	5	5
WLT1.2	5,140.93	75	NC/MG W	1,500	17	15	14
WLT1.3	5,139.10	10	RC H	800	26	26	26
WLT1.4	5,141.70	205	BE-NC/ROD W	3,000	7	5	5
WLT1.5	5,141.32	500	AM[RC] H	3,000	7	5	5
Transect 2							
WLT2.1	5,137.65	50	BE-NC/ROD W	2,500	9	7	7
WLT2.2	5,135.85	350	BE-NC/ROD W	3,000	7	5	5
WLT2.3	5,133.65	450	AM[RC] H	2,300	11	8	7
Martinez Park							
Transect 2							
LMT2.1	4,971.81	375	RO W	2,000	11	7	7
LMT2.2	4,969.95	30	RC H	2,000	11	7	7
LMT2.3	4,971.52	5	PC/SB W	2,000	11	7	7
LMT2.4	4,965.25	140	OW	40	26	26	26

Study Site/Transect/Point	Elevation-National Geodetic Vertical Datum (ft)	Approx. Distance from Riverbank (ft)	Vegetation Cover Type[1]	Minimum Inundation Flow (cfs)	No. of Years Inundated Current Conditions (Run 1)	No. of Years Inundated Future Conditions (Run 2)	No. of Years Inundated Alt. 1 Effects (Run 9a)
LMT2.5	4,972.45	180	PC/SW W	3,000	5	4	4
LMT2.6	4,970.47	250	PC/SB W	3,000	5	4	4
Transect 3							
LMT3.1	4,969.11	90	UG	2,500	7	5	5
LMT3.2	4,969.03	40	PC/SW W	3,200	4	4	4
LMT3.3	4,967.66	140	PC/SB W	3,200	4	4	4
LMT3.4	4,969.22	190	PC/SB W	3,200	4	4	4
Archery Site							
Transect 1							
AT1.1	4,859.15	65	PC/PC-S W	4,000	2	1	1
AT1.2	4,857.28	100	PC-(PW)/SW[RC] W	1,900	10	7	6
Transect 2							
AT2.1	4,857.06	25	PC/SB W	2,500	7	4	4
AT2.2	4,853.46	40	SW/MG-[RC] S	100	26	26	26
AT2.3	4,851.38	50	OW	10	26	26	26
AT2.4	4,858.67	15	UG	4,600	1	1	1
Eastman Park							
Transect 2							
EPT2.1	4,760.65	40	SW/MG-[RC] S	330	16	14	13
EPT2.2	4,767.01	70	PC/SB W	2,200	10	7	7
EPT2.3	4,765.91	225	PC/SB W	2,200	10	7	7
EPT2.4	4,766.83	275	PC/SB W	2,100	10	8	8
EPT2.5	4,764.55	675	PC/SB W	2,100	10	8	8
Transect 3							
EPT3.1	4,760.54	305	PC/SB W	2,100	10	8	8
EPT3.2	4,762.18	40	PC/SB W	1,900	11	9	9
59th Avenue							
Transect 1							
59T1.1	4,694.35	145	PC/SB W	4,000	3	2	1
59T1.2	4,692.97	5	PC/SB W	980	11	11	11
59T1.3	4,686.93	10	RC H	160	25	24	22
59T1.4	4,694.00	5	PC/SB W	2,300	9	7	7
Transect 3a							
59T3a.1	4,687.76	280	PC/SB W	580	15	15	15
59T3a.2	4,691.19	230	PC/SB W	1,900	11	9	9
59T3a.3	4,691.62	5	PC/SB W	1,900	11	9	9
59T3a.4	4,688.31	35	RC H	1,820	11	10	10
59T3a.5	4,691.89	5	PC/SB W	2,100	11	7	7
Transect 3b							
59T3b.1	4,689.84	70	UG	580	15	15	15
59T3b.2	4,692.68	10	PC/SB W	2,000	11	9	9
59T3b.3	4,689.97	125	PC/SB W	850	11	11	11
59T3b.4	4,689.27	150	PC/SB W	850	11	11	11
Bird Farm							
Transect 2							
BF2.1	4,612.98	155	PC/SB W	1,500	11	11	11
Transect 3							
BFT3.1	4,608.70	160	PC-(PW)/SW-[RC] W	2,200	11	8	8

Study Site/Transect/Point	Elevation-National Geodetic Vertical Datum (ft)	Approx. Distance from Riverbank (ft)	Vegetation Cover Type[1]	Minimum Inundation Flow (cfs)	No. of Years Inundated Current Conditions (Run 1)	No. of Years Inundated Future Conditions (Run 2)	No. of Years Inundated Alt. 1 Effects (Run 9a)
BFT3.2	4,608.95	5	UG	2,300	10	8	8
BFT3.3	4,606.12	30	SW/MG-[RC] S	520	18	19	19
BFT3.4	4,607.80	360	PC/SB W	1,500	11	11	11

[1]AM[RC] H - American Mannagrass[Reed Canarygrass] Herbaceous; BE-NC/ROD W - Boxelder-Narrowleaf Cottonwood/Red-Osier Dogwood Woodlands; N/A - Not Applicable; NC/MG W -Narrowleaf Cottonwood/Mesic Graminoid Woodlands; OW - Open Water; PC-(PW)/SW[RC] W - Plains Cottonwood-(Peachleaf Willow)/Sandbar Willow/[Reed Canarygrass] Woodland; PC/PC-S W - Plains Cottonwood/Prairie Cordgrass-Sedge Woodland; PC/SB W - Plains Cottonwood/Smooth Brome Woodland; PC/SW W - Plains Cottonwood/Slender Wheatgrass Woodland; RC H -Reed Canarygrass Herbaceous; RO W - Russian Olive Woodland; SW/MG-[RC] S - Sandbar Willow/Mesic Graminoid-[Reed Canarygrass] Shrubland; UG - Upland Grassland.

Segment A. The narrowleaf cottonwood woodland locations within the Watson Lake study site have minimum inundation flows of about 1,500 to 3,000 cfs (Table 5-23). Under Current Conditions hydrology, these locations would be inundated in about 7 to 17 years of the period of record. As discussed above, locations inundated in at least half of the years of the period of record under Current Conditions hydrology were assumed to receive some amount of hydrological support from inundation. Only one cottonwood woodland location at the Watson Lake study site is predicted to be inundated in at least half of the years of the period of record (WLLT1.2). The inundation under the No Action Alternative with Future Conditions Effects at this location is predicted to continue in slightly more than half of the years of the period of record (Table 5-23). Under the No Action Alternative, the predicted effects of reduced inundation are estimated to have a negligible effect on the cottonwood woodlands in Segment A because those few cottonwood stands that are inundated in half or more of the years of the period of record would continue to be inundated.

Segment B. The plains cottonwood woodland locations within the Martinez Park study site have minimum inundation flows of about 2,000 to 3,200 cfs (Table 5-23). Under Current Conditions hydrology, these locations would be inundated in about 5 to 11 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 0 to 4 years at these locations. None of these locations would be inundated in more than half of the years of the period of record under Current Conditions hydrology. Under the No Action Alternative with Future Conditions Effects, the estimated reduction in inundation is predicted to have a negligible effect on cottonwood woodlands in Segment B because under Current Conditions hydrology, the cottonwood woodlands are not inundated with enough frequency to provide consistent hydrologic support.

Segment C. The plains cottonwood woodland locations within the Archery Site have minimum inundation flows of about 1,900 to 4,000 cfs (Table 5-23). Under Current Conditions hydrology, these locations would be inundated in about 2 to 10 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 1 to 4 years at these locations. None of these locations would be inundated in more than half of the years of the period of record under Current Conditions hydrology. Under the No Action Alternative with Future Conditions Effects, the estimated reduction in inundation is predicted to have a negligible

effect on cottonwood woodlands in Segment C because under Current Conditions hydrology, the cottonwood woodlands are not inundated with enough frequency to provide consistent hydrologic support.

Segment D. The plains cottonwood woodland locations within the Eastman Park study site have minimum inundation flows of about 1,900 to 2,200 cfs (Table 5-23). Under Current Conditions hydrology, these locations would be inundated in about 10 to 11 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 0 to 2 years at these locations. Under the No Action Alternative, the predicted effects of reduced inundation are estimated to have a negligible effect the cottonwood woodlands in Segment D because those few cottonwood stands that are inundated in half or more of the years of the period of record would continue to be inundated in half or more of the years of the period of record.

Segment E. The plains cottonwood woodland locations within the 59th Avenue study site have minimum inundation flows of about 580 to 4,000 cfs (Table 5-23). Under Current Conditions hydrology, these locations would be inundated in about 3 to 15 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 0 to 4 years at these locations. Only one cottonwood woodland location at the 59th Avenue study site is predicted to be inundated in more than half of the years of the period of record (59T3a.1) and the number of years of inundation under the No Action Alternative with Future Conditions Effects at this location is not predicted to change. Under the No Action Alternative, the predicted effects of reduced inundation are estimated to have a negligible effect on the cottonwood woodlands in Segment E because under Current Conditions hydrology, the cottonwood woodlands are not inundated with enough frequency to provide consistent hydrologic support.

Segment F. The plains cottonwood woodland locations within the Bird Farm study site have minimum inundation flows of about 1,500 to 2,200 cfs (Table 5-23). Under Current Conditions hydrology, these locations would be inundated in about 11 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 0 to 3 years at these locations. None of these locations would be inundated in more than half of the years of the period of record under Current Conditions hydrology. Under the No Action Alternative with Future Conditions Effects, the estimated reduction in inundation is predicted to have a negligible effect on cottonwood woodlands in Segment F because under Current Conditions hydrology, the cottonwood woodlands are not inundated with enough frequency to provide consistent hydrologic support.

5.9.3.2.4 Vegetation Communities and Nonnative Species

The current trajectory for the plant communities bordering the mainstem involves less inundation. Cumulatively, Future Conditions hydrology combined with the effects of the No Action Alternative would further reduce inundation. Less inundation combined with potential changes in tree canopy cover and potentially greater recreational use of the mainstem riparian plant communities (e.g., social trails and access for fishing, wading, and tubing) would likely lead to the increased presence and distribution of nonnative vegetation in the plant communities along the mainstem. This predicted increase in nonnative species does not attempt to account for programs that may be implemented by land managers to reduce the presence and distribution of

nonnative vegetation along the mainstem or new nonnative species that may be introduced to the area. Reed canarygrass is expected to increase its distribution downstream of I-25.

5.9.3.2.5 Wetland Functions

The No Action Alternative with Future Conditions Effects is not predicted to lower the composite functional score in any of the segments for depressional wetlands (Table 4-72) and is predicted to slightly lower all of the composite functional scores for riverine wetlands (Table 4-73). The No Action Alternative with Future Conditions Effects is predicted to lower the composite functional score of the riverine wetlands in Segments D and E from functioning to functioning impaired, which would be a minor effect because the change in composite functional scores are typically based on a small change in one or more variables that contribute to the composite functional score, and the functions would not change substantially even though the functional classification would change for Segments D and E. For riverine wetlands in all segments, slight decreases in the score for functions of support of characteristic fish/aquatic habitat, flood attenuation, short- and long-term water storage, nutrient/toxicant removal, sediment retention/shoreline stabilization, and production export/food chain support would cause a slight decrease in overall function of riverine wetlands, a minor effect.

5.9.3.3 South Platte River

No new studies or analyses were performed for the SDEIS for the South Platte River. The No Action Alternative with Future Conditions Effects would on an average monthly basis reduce flows on the South Platte River by less than 10% and the stage reductions are predicted to be small (up to 0.33 feet). Given the minor reductions in flow and stage, the No Action Alternative is not predicted to affect wetland and riparian resources along the South Platte River.

5.9.4 District's Preferred Alternative (Alternative 2)

Alternative 2 includes a No Reclamation Action Option and Reclamation Action Option as described in Section 2.5.5. Direct and indirect impacts to wetlands, riparian resources and waters associated with the construction and operation of Alternative 2, to include Glade and Galeton Reservoirs, associated facilities, and conveyance systems are presented in Section 4.9.5. These impacts would contribute to other impacts to wetlands, riparian resources, and other waters in the region associated with the RFFAs.

5.9.4.1 Poudre River

The cumulative effects assessment of Alternative 2 uses Future Conditions hydrology compared to hydrology Run 4a and 5a. Cumulative effects associated with changes in streamflows are predicted to be the same for the Reclamation Action and No Reclamation Action Options. As explained in Section 4.2.3.4.1, a single set of modeled streamflows was evaluated for Alternative 2 because the net effects on streamflow below the Hansen Supply Canal outfall would, on average, effectively be the same under the Reclamation Action Option and the No Reclamation Action Option.

The trajectory previously described for the mainstem riparian resources (Section 4.9.1.1) is predicted to continue with or without the NISP alternatives. Changes in flows associated with Alternative 2 would accelerate and/or reinforce the trajectory. It is challenging to predict the degree to which acceleration of the current trajectory might occur because of the prolonged time over which the trajectory is predicted to occur and the many variables that could affect timing of the trajectory. However, further reductions in flow in the mainstem would likely reinforce the current trajectory.

5.9.4.1.1 River Stage

Changes in river stage during the growing season were used to predict indirect effects on shallowly rooted herbaceous wetland vegetation bordering the mainstem that is supported, at least in part, by water levels (river stage) in the river. Table 5-24 shows that for all study sites the predicted percentage of the period of record with a decline of 0.5 foot or greater in 10% or more increases with cumulative effects compared to Alternative 2 with Future Conditions Effects. Under Future Conditions Effects, only Segment B (represented by the Martinez Park study site) would have a weekly average stage decline of greater than 10% of the record. Under Cumulative Effects, Segment B, Segment C (represented by the Archery study site) and Segment D (represented by the 59th Avenue study site) would have a weekly average stage decline of greater than 10% of the record.

An estimated 9 acres of vegetation classes are potentially sensitive to declines in the ground water table within Segment B (Future Conditions Effects with Alternative 2). Under Alternative 2 with Cumulative Effects, an estimated 60 acres of vegetation classes are potentially sensitive to declines in the ground water table within Segments B, C, and D within 100 feet of the riverbanks (ERO 2014d, Table 14). This level of decline in river stage is predicted to result in a shift in species at wetlands dominated by obligate wetland species (e.g., cattail and threesquare bulrush) to those that tolerate greater fluctuations in river stage such as reed canarygrass. Since most wetlands along the banks of the mainstem are dominated by reed canarygrass and sandbar willow, two species that can tolerate a range of ground water levels, effects are predicted to be minor and likely not perceptible.

Table 5-24. Alternative 2 – Cumulative effects summary of weekly average Poudre River stage declines by river segment (representative study site) of 0.5 foot or greater during the growing season.

Alternative 2 Model Runs Compared	Years of Consecutive Decline[1] (Number of Years)	Number of Weeks[2]	Percentage of Period of Record
Segment A - Watson Lake			
Runs 2 and 4a	1980, 1995, 1996 (3 years)	18	3
Runs 2 and 5a	1980, 1983, 1995, 1996 (4 years)	34	6
Segment B - Martinez Park			
Runs 2 and 4a	1980, 1982, 1986, 1995, 1996, 1997, 1999 (7 years)	93	17
Runs 2 and 5a	1980, 1982, 1983, 1984, 1985, 1986, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1999, 2005 (16 years)	133	24
Segment C - Archery Site			
Runs 2 and 4a	1980, 1985, 1995, 1996, 1997, 1998 (6 years)	54	10
Runs 2 and 5a	1980, 1983, 1995, 1996, 1997, 1998 (6 years)	62	11
Segment D - Eastman Park			
Runs 2 and 4a	1986, 1995, 1996, 1997, 1998, 1999 (6 years)	43	8
Runs 2 and 5a	1984, 1985, 1986, 1990, 1991, 1992, 1994, 1995, 1996, 1997, 1998, 1999, 2001, 2002, 2003, 2005 (16 years)	108	20
Segment E - 59th Avenue			
Runs 2 and 4a	1996 (1 year)	28	5
Runs 2 and 5a	1986, 1995, 1996 (3 years)	45	8
Segment F - Bird Farm			
Runs 2 and 4a	1995, 1996 (2 years)	28	5
Runs 2 and 5a	1995, 1996, 1997, 1999 (4 years)	38	7

[1] Years of consecutive declines are years in the period of record (1980-2005) with at least 4 consecutive weeks during the growing season (May 1 through September 30) of weekly average river stage declines of 0.5 foot or greater or a total of 6 weeks of declines of 0.5 foot or greater.

[2] Number of weeks with a decline of 0.5 foot or greater for the period of record (1980-2005) during the growing season. There are 546 weeks during the growing season for the period of record.

Segment A. Relative to the other segments, the predicted frequency of declines in river stage for Segment A are estimated to have the least potential effect on near-bank herbaceous wetland vegetation. The Watson Lake study site is predicted to have the lowest percentage of period of record (3% under Future Conditions Effects; 6% under Cumulative Effects) of weekly average stage declines of 0.5 foot or greater during the growing season (Table 5-24).

Segment B. Relative to the other segments, predicted frequency of declines for Alternative 2 in river stage for Segment B are estimated to have the greatest potential effect on near-bank herbaceous wetland vegetation. The Martinez Park study site, representative of Segment B, would have the greatest number of weeks (93 under Future Conditions Effects; 133 under Cumulative Effects) and 17% of the period of record (under Future Conditions Effects) and 24% of the record (under Cumulative Effects) with a decline of 0.5 foot or greater during the growing

season (Table 5-24), which is greater than the impact threshold of 10% during the period of record during the growing season. An estimated 9 acres of vegetation classes are potentially sensitive to declines in the ground water table within Segment B; a minor effect because most wetlands along the banks of the mainstem are dominated by reed canarygrass and sandbar willow, two species that can tolerate a range of ground water levels, effects are predicted to be minor and likely not perceptible.

Segment C. Relative to the other segments, predicted declines in river stage for Segment C are estimated to occur more frequently than in Segment A, but less frequently than Segment B. Under Future Conditions Effects, the Archery Site would have 54 weeks and 10% of the period of record with a decline of 0.5 foot or greater during the growing season. Under Cumulative Effects, Segment C would have 11% of the period of record with a decline of 0.5 foot or greater during the growing season, which is slightly greater than the impact threshold. An estimated 30 acres of vegetation classes are potentially sensitive to declines in the ground water table within Segment C; a minor effect because most wetlands along the banks of the mainstem are dominated by reed canarygrass and sandbar willow, two species that can tolerate a range of ground water levels, effects are predicted to be minor and likely not perceptible.

Segment D. Under Future Conditions Effects, the Eastman Park study site would have 43 weeks and 8% of the period of record with a decline of 0.5 foot or greater during the growing season. Under Cumulative Effects, this would more than double to 108 weeks and 20% of the period of record with a decline of 0.5 foot or greater during the growing season, which exceeds the impact threshold. An estimated 21 acres of vegetation classes are potentially sensitive to declines in the ground water table within Segment D; a minor effect because most wetlands along the banks of the mainstem are dominated by reed canarygrass and sandbar willow, two species that can tolerate a range of ground water levels, effects are predicted to be minor and likely not perceptible.

Segment E. Relative to the other segments, the effects of reduced river stage for Alternative 2 in Segment E and Segment F are similar. The 59th Avenue study site is predicted to have the fewest number of years (1 year under Future Conditions Effects; 3 years under Cumulative Effects) of at least 4 consecutive weeks during the growing season of weekly average river stage declines of 0.5 foot or greater or a total of 6 weeks of declines of 0.5 foot or greater. Under Future Conditions Effects, the 59th Avenue study site would have 28 weeks and 5% of the period of record with a decline of 0.5 foot or greater during the growing season (Table 5-24). Under Cumulative Effects, this would increase to 45 weeks and 8% of the period of record with a decline of 0.5 foot or greater during the growing season.

Segment F. The predicted effects of reduced river stage in Segment F are similar to Segment E (Table 5-24).

5.9.4.1.2 Riparian Vegetation and Alluvial Ground Water

In general, the deepest observed and predicted annual water table depths during the growing season tends to increase in a downstream direction (the exception being Segment C at the Archery Site). Segment A has the shallowest and Segment F has the deepest observed annual water table depths during the growing season (Table 4-70). Under Cumulative Effects, the

greatest predicted declines in alluvial ground water levels during the growing season associated with cottonwood woodlands for Alternative 2 are predicted to infrequently occur at the Archery study site (Segment C) at monitoring well A3 (-2.0 feet), the Eastman Park study site (Segment D) at monitoring well Y5 (-1.9 feet), and at the Bird Farm study site (Segment F) at monitoring well D5 (-2.4 feet). These infrequent declines are estimated to have negligible to minor effects on cottonwood woodlands as described below.

Segment A. Relative to the other segments, predicted maximum depth to ground water within the monitored cottonwood woodland locations at the Watson Lake study site are estimated to be the shallowest. The maximum ground water depths in monitoring wells within the cottonwood woodlands are predicted to be about 3.02 feet to 3.72 feet in September below the surface (Table 4-70). These estimated changes in the maximum depth to ground water are not predicted to adversely impact the cottonwood woodlands along Segment A because the changes would be well within the observed range of maximum ground water depths of 2.79 feet to 6.85 feet for cottonwoods during the growing season along the mainstem (Table 4-70).

Segment B. The maximum ground water depths in monitoring wells within the cottonwood woodlands at the Martinez Park study site are predicted to be about 4.55 feet (September) to 6.76 feet (May) below the surface (Table 4-70). These estimated changes in the maximum depth to ground water are not predicted to adversely impact the cottonwood woodlands along Segment B because the changes would be within the observed range of maximum ground water depths of 2.79 feet to 6.85 feet for cottonwoods during the growing season along the mainstem.

Segment C. The maximum ground water depths in monitoring wells within the cottonwood woodlands at the Archery Site are predicted to be about 7.72 feet to 8.06 feet below the surface in May (Table 4-70). This would be about 1.5 feet to 2.0 feet below the maximum ground water depths observed during the growing season at these monitoring wells and about 1.2 feet below the maximum ground water depth observed for cottonwoods during the growing season along the mainstem. Effects on cottonwood woodlands are predicted to be minor in Segment C due to short-term increases in maximum ground water depths. As discussed above, minor effects on the cottonwoods associated with declines in river stage of 2 feet or greater are predicted to be limited to periodic short-lived stresses because these estimated declines in alluvial ground water levels are predicted to occur infrequently. Additionally, the infrequently occurring maximum predicted ground water depth of 8.06 feet in May would occur at the beginning of the growing season when soil moisture conditions are typically favorable for supporting cottonwoods without dependence on shallow ground water levels.

Segment D. The maximum ground water depths in monitoring wells within the cottonwood woodlands at the Eastman Park study site are predicted to infrequently reach depths of about 5.52 feet in September to 8.77 feet below the surface in May (Table 4-70). This would be about 0.0 feet to 1.9 feet below the maximum ground water depths observed during the growing season at these monitoring wells and about 1.9 feet below the maximum ground water depth observed for cottonwoods during the growing season along the mainstem. Effects on cottonwood woodlands are predicted to be minor in Segment D due to short-term increases in maximum ground water depths. Under Cumulative Effects, the maximum ground water depths are

predicted to exceed the maximum water table depth observed for cottonwood woodlands (6.85 feet) during the growing season in any of the months for wells Y4 and Y5. Most of these predicted maximum ground water depths are within a foot or less than the observed maximum water table depth for cottonwoods and would occur infrequently. Minor effects on the cottonwoods associated with declines in river stage of 2 feet or greater are predicted to be limited to periodic short-lived stresses because these estimated declines in alluvial ground water levels are predicted to occur infrequently.

Segment E. The maximum ground water depths in monitoring wells within the cottonwood woodlands at the 59th Avenue study site are predicted to infrequently reach depths of about 6.49 feet to about 7.67 feet below the surface (Table 4-70). This would be about 0.3 feet to 2.0 feet below the maximum ground water depths observed during the growing season at these monitoring wells and about 0.8 feet below the maximum ground water depth observed for cottonwoods during the growing season along the mainstem. Effects are predicted to be minor in Segment E on cottonwood woodlands due to short-term increases in maximum ground water depths. Minor effects on the cottonwoods associated with declines in river stage of 2 feet or greater are predicted to be limited to periodic short-lived stresses because these estimated declines in alluvial ground water levels are predicted to occur infrequently.

Segment F. Relative to the other segments, Segment F is predicted to have the deepest maximum ground water depth in a monitoring well within the monitored cottonwood woodland locations. Monitoring well D5 is predicted to infrequently have a maximum ground water depth of 9.24 feet in May. Additionally, monitoring well D4 is predicted to infrequently have a maximum ground water depth of 7.29 feet in May. This would be about 1.8 feet to 2.4 feet below the maximum ground water depths observed during the growing season at these monitoring wells and a maximum of about 2.4 feet below the maximum ground water depth observed for cottonwoods during the growing season along the mainstem. Effects are predicted to be minor in Segment F on cottonwood woodlands due to short-term increases in maximum ground water depths. Under Cumulative Effects, the maximum ground water depths are predicted to exceed the maximum water table depth observed for cottonwood woodlands (6.85 feet) during the growing season in any of the months for well D5. Most of these predicted maximum ground water depths are within a foot or less than the observed maximum water table depth for cottonwoods and would occur infrequently. Minor effects on the cottonwoods associated with declines in river stage of 2 feet or greater are predicted to be limited to periodic short-lived stresses because these estimated declines in alluvial ground water levels are predicted to occur infrequently.

5.9.4.1.3 Inundation

The number of years that riparian and wetland resources along the mainstem would be inundated under Current Conditions hydrology declines with Future Conditions hydrology, Future Conditions Effects with Alternative 2 and Cumulative Effects (Table 5-25). A comparison of Alternative 2 and Future Conditions Effects and Cumulative Effects provides an estimate of the effect of the HSWSPs. The greatest estimated reduction in years of inundation compared to Current Conditions hydrology is predicted to occur at the Watson Lake study site (transect points

WLT1.1 and WLT2.3) and the Martinez Park study site (transect points LMT2.1, 2.2, and 2.3). However, inundation at these locations under Current Conditions hydrology is not predicted to occur with enough frequency (at least 50% of the years in the period of record) to provide a reliable source of hydrologic support. Under Alternative 2, inundation of these 5 locations is predicted to decrease from 7 to 11 years under Current Conditions hydrology to 1 to 4 years with Cumulative Effects.

Eight vegetated points (points mapped as open water excluded) for the Spells Analysis were estimated to have at least one inundation event in 13 or more years (i.e., half the years) during the period of record (Table 5-23). These riparian and wetland vegetation locations were identified as being inundated with enough frequency under Current Conditions hydrology to potentially be dependent to some degree on inundation for hydrologic support. These locations (WLT1.2 and 1.3, AT2.2, EPT2.1, 59T1.3, 3a.1, and 3b.1, and BFT3.3) are inundated by the more frequently occurring lower flows ranging from about 160 to 580 cfs. With the exception of WLT1.2 and EPT2.1, Cumulative Effects are not predicted to adversely affect these wetland and riparian resources because these elevations are predicted to continue to be inundated in at least half of the years of the period of record.

However, locations WLT1.2 and EPT2.1 would be inundated less than half of the years under either Alternative 2 with Future Conditions Effects or Cumulative Effects. This would reduce the frequency of inundation at these locations to a degree that it is no longer potentially supportive and would likely reduce the vigor of the stand. Under Alternative 2, the predicted effects of reduced inundation are estimated to have a negligible effect on most of the cottonwood woodlands in Segment A. However, stands that are inundated at the more frequently occurring low flows are likely to be moderately impacted by a reduced number of years of inundation.

Future Conditions hydrology (without the NISP alternatives), Alternative 2 with Future Conditions Effects, and Cumulative Effects are all predicted to reduce inundation of wetland and riparian resources along the mainstem and would accelerate and/or reinforce the trajectory previously described for the riparian plains cottonwood woodlands. The following discussion on predicted changes to inundation under Alternative 2 for the Poudre River segments focuses on potential effects on cottonwood woodlands. Herbaceous near-bank riparian resources and wetlands are addressed under *River Stage*.

Table 5-25. Spells analysis of selected points along riparian transects for Poudre River study sites - Alternative 2.

Study Site/Transect/Point	Elevation-National Geodetic Vertical Datum (ft)	Approx. Distance from Riverbank (ft)	Vegetation Cover Type[1]	Minimum Inundation Flow (cfs)	No. of Years Inundated Current Conditions (Run 1)	No. of Years Inundated Future Conditions (Run 2)	No. of Years Inundated Future Conditions Effects (Run 4a)	No. of Years Inundated Cumulative Effects (Run 5a)
Watson Lake								
Transect 1								
WLT1.1	5,143.18	210	N/A	3,000	7	5	3	1
WLT1.2	5,140.93	75	NC/MG W	1,500	17	15	11	8
WLT1.3	5,139.10	10	RC H	800	26	26	22	21
WLT1.4	5,141.70	205	BE-NC/ROD W	3,000	7	5	3	1
WLT1.5	5,141.32	500	AM[RC] H	3,000	7	5	3	1

Study Site/Transect/Point	Elevation-National Geodetic Vertical Datum (ft)	Approx. Distance from Riverbank (ft)	Vegetation Cover Type[1]	Minimum Inundation Flow (cfs)	No. of Years Inundated Current Conditions (Run 1)	No. of Years Inundated Future Conditions (Run 2)	No. of Years Inundated Future Conditions Effects (Run 4a)	No. of Years Inundated Cumulative Effects (Run 5a)
Transect 2								
WLT2.1	5,137.65	50	BE-NC/ROD W	2,500	9	7	4	3
WLT2.2	5,135.85	350	BE-NC/ROD W	3,000	7	5	3	1
WLT2.3	5,133.65	450	AM[RC] H	2,300	11	8	5	3
Martinez Park								
Transect 2								
LMT2.1	4,971.81	375	RO W	2,000	11	7	4	4
LMT2.2	4,969.95	30	RC H	2,000	11	7	4	4
LMT2.3	4,971.52	5	PC/SB W	2,000	11	7	4	4
LMT2.4	4,965.25	140	OW	40	26	26	26	26
LMT2.5	4,972.45	180	PC/SW W	3,000	5	4	3	1
LMT2.6	4,970.47	250	PC/SB W	3,000	5	4	3	1
Transect 3								
LMT3.1	4,969.11	90	UG	2,500	7	5	4	2
LMT3.2	4,969.03	40	PC/SW W	3,200	4	4	2	1
LMT3.3	4,967.66	140	PC/SB W	3,200	4	4	2	1
LMT3.4	4,969.22	190	PC/SB W	3,200	4	4	2	1
Archery Site								
Transect 1								
AT1.1	4,859.15	65	PC/PC-S W	4,000	2	1	1	1
AT1.2	4,857.28	100	PC-(PW)/SW[RC] W	1,900	10	7	4	3
Transect 2								
AT2.1	4,857.06	25	PC/SB W	2,500	7	4	3	2
AT2.2	4,853.46	40	SW/MG-[RC] S	100	26	26	26	26
AT2.3	4,851.38	50	OW	10	26	26	26	26
AT2.4	4,858.67	15	UG	4,600	1	1	1	1
Eastman Park								
Transect 2								
EPT2.1	4,760.65	40	SW/MG-[RC] S	330	16	14	12	12
EPT2.2	4,767.01	70	PC/SB W	2,200	10	7	4	4
EPT2.3	4,765.91	225	PC/SB W	2,200	10	7	4	4
EPT2.4	4,766.83	275	PC/SB W	2,100	10	8	5	4
EPT2.5	4,764.55	675	PC/SB W	2,100	10	8	5	4
Transect 3								
EPT3.1	4,760.54	305	PC/SB W	2,100	10	8	5	4
EPT3.2	4,762.18	40	PC/SB W	1,900	11	9	5	4
59th Avenue								
Transect 1								
59T1.1	4,694.35	145	PC/SB W	4,000	3	2	1	1
59T1.2	4,692.97	5	PC/SB W	980	11	11	11	10
59T1.3	4,686.93	10	RC H	160	25	24	21	20
59T1.4	4,694.00	5	PC/SB W	2,300	9	7	5	3
Transect 3a								
59T3a,1	4,687.76	280	PC/SB W	580	15	15	14	13
59T3a.2	4,691.19	230	PC/SB W	1,900	11	9	5	5
59T3a.3	4,691.62	5	PC/SB W	1,900	11	9	5	5
59T3a.4	4,688.31	35	RC H	1,820	11	10	5	5
59T3a.5	4,691.89	5	PC/SB W	2,100	11	7	5	4
Transect 3b								
59T3b.1	4,689.84	70	UG	580	15	15	14	13
59T3b.2	4,692.68	10	PC/SB W	2,000	11	9	5	5
59T3b.3	4,689.97	125	PC/SB W	850	11	11	11	10
59T3b.4	4,689.27	150	PC/SB W	850	11	11	11	10

Study Site/Transect/Point	Elevation-National Geodetic Vertical Datum (ft)	Approx. Distance from Riverbank (ft)	Vegetation Cover Type[1]	Minimum Inundation Flow (cfs)	No. of Years Inundated Current Conditions (Run 1)	No. of Years Inundated Future Conditions (Run 2)	No. of Years Inundated Future Conditions Effects (Run 4a)	No. of Years Inundated Cumulative Effects (Run 5a)
Bird Farm								
Transect 2								
BF2.1	4,612.98	155	PC/SB W	1,500	11	11	10	8
Transect 3								
BFT3.1	4,608.70	160	PC-(PW)/SW-[RC] W	2,200	11	8	5	4
BFT3.2	4,608.95	5	UG	2,300	10	8	5	4
BFT3.3	4,606.12	30	SW/MG-[RC] S	520	18	19	18	18
BFT3.4	4,607.80	360	PC/SB W	1,500	11	11	10	8

[1]AM[RC] H - American Mannagrass[Reed Canarygrass] Herbaceous; BE-NC/ROD W - Boxelder-Narrowleaf Cottonwood/Red-Osier Dogwood Woodlands; N/A - Not Applicable; NC/MG W -Narrowleaf Cottonwood/Mesic Graminoid Woodlands; OW - Open Water; PC-(PW)/SW[RC] W - Plains Cottonwood-(Peachleaf Willow)/Sandbar Willow/[Reed Canarygrass] Woodland; PC/PC-S W - Plains Cottonwood/Prairie Cordgrass-Sedge Woodland; PC/SB W - Plains Cottonwood/Smooth Brome Woodland; PC/SW W - Plains Cottonwood/Slender Wheatgrass Woodland; RC H -Reed Canarygrass Herbaceous; RO W - Russian Olive Woodland; SW/MG-[RC] S - Sandbar Willow/Mesic Graminoid-[Reed Canarygrass] Shrubland; UG - Upland Grassland.

Segment A. The narrowleaf cottonwood woodland locations within the Watson Lake study site have minimum inundation flows of about 1,500 to 3,000 cfs (Table 5-25). Under Current Conditions hydrology, these locations would be inundated in about 7 to 17 years of the period of record. As discussed above, locations inundated in at least half of the years of the period of record under Current Conditions hydrology were assumed to receive some amount of hydrological support from inundation. Only one cottonwood woodland location at the Watson Lake study site is predicted to be inundated in at least half of the years of the period of record (WLLT1.2). The inundation under Alternative 2 and Future Conditions Effects and Cumulative Effects at this location is predicted to be reduced to less than half of the years of the period of record (Table 5-23). This would reduce the frequency of inundation of cottonwood woodland at this location to a degree that it is no longer supportive and would likely reduce the vigor of the stand. The predicted effects of reduced inundation are estimated to have a negligible effect on most of the cottonwood woodlands in Segment A. However, stands that are inundated at the more frequently occurring low flows are likely to be moderately impacted by a reduced number of years of inundation.

Segment B. The plains cottonwood woodland locations within the Martinez Park study site have minimum inundation flows of about 2,000 to 3,200 cfs (Table 5-25). Under Current Conditions hydrology, these locations would be inundated in about 5 to 11 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 4 to 7 years at these locations. None of these locations would be inundated in more than half of the years of the period of record under Current Conditions hydrology. The estimated reduction in inundation with either Future Conditions Effects or Cumulative Effects is predicted to have a negligible effect on cottonwood woodlands in Segment B because under Current Conditions hydrology, the cottonwood woodlands are not inundated with enough frequency to provide consistent hydrologic support.

Segment C. The plains cottonwood woodland locations within the Archery Site have minimum inundation flows of about 1,900 to 4,000 cfs (Table 5-25). Under Current Conditions hydrology, these locations would be inundated in about 2 to 10 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 1 to 7 years at these locations. None of these locations would be inundated in more than half of the years of the period of record under Current Conditions hydrology. The estimated reduction in inundation with either Future Conditions Effects or Cumulative Effects is predicted to have a negligible effect on cottonwood woodlands in Segment C because under Current Conditions hydrology, the cottonwood woodlands are not inundated with enough frequency to provide consistent hydrologic support.

Segment D. The plains cottonwood woodland locations within the Eastman Park study site have minimum inundation flows of about 1,900 to 2,200 cfs (Table 5-25). Under Current Conditions hydrology, these locations would be inundated in about 10 to 11 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 5 to 7 years at these locations. The estimated reduction in inundation with either Future Conditions Effects or Cumulative Effects is predicted to have a negligible effect on cottonwood woodlands in Segment C because under Current Conditions, hydrology the cottonwood woodlands are not inundated with enough frequency to provide consistent hydrologic support.

Segment E. The plains cottonwood woodland locations within the 59th Avenue study site have minimum inundation flows of about 580 to 4,000 cfs (Table 5-25). Under Current Conditions hydrology, these locations would be inundated in about 3 to 15 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 3 to 6 years at these locations. Only one cottonwood woodland location at the 59th Avenue study site is predicted to be inundated in more than half of the years of the period of record. The inundation under Cumulative Effects at this location is predicted to be reduced by 2 years, resulting in inundation that would still occur in about half of the years of the period of record. The estimated reduction in inundation with either Future Conditions Effects or Cumulative Effects is predicted to have a negligible effect on cottonwood woodlands in Segment E because under Current Conditions hydrology, most of the cottonwood woodlands are not inundated with enough frequency to provide consistent hydrologic support, and at the one location that is predicted to be inundated in more than half of the years of the period of record, inundation in at least half of the years of the period of record is predicted to continue.

Segment F. The plains cottonwood woodland locations within the Bird Farm study site have minimum inundation flows of about 1,500 to 2,200 cfs (Table 5-25). Under Current Conditions hydrology, these locations would be inundated in about 11 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 3 to 7 years at these locations. None of these locations would be inundated in more than half of the years of the period of record under Current Conditions hydrology. The estimated reduction in inundation with either Future Conditions Effects or Cumulative Effects is predicted to have a negligible effect on cottonwood woodlands in Segment F because under Current Conditions hydrology, the cottonwood woodlands are not inundated with enough frequency to provide consistent hydrologic support.

5.9.4.1.4 Vegetation Communities and Nonnative Species

The current trajectory for the plant communities bordering the mainstem involves less inundation. Future Conditions Effects and Cumulative Effects would further reduce inundation. Less inundation combined with potential changes in tree canopy cover and potentially greater recreational use of the mainstem riparian plant communities (e.g., social trails and access for fishing, wading, and tubing) would likely lead to the increased presence and distribution of nonnative vegetation in the plant communities along the mainstem. This predicted increase in nonnative species does not attempt to account for programs that may be implemented by land managers to reduce the presence and distribution of nonnative vegetation along the mainstem or new nonnative species that may be introduced to the area. As discussed above, reed canarygrass is expected to increase its distribution downstream of I-25.

5.9.4.1.5 Wetland Functions

Alternative 2 with Cumulative Effects hydrology is predicted to slightly lower the composite functional score in Segment E for depressional wetlands (Table 4-72) and is predicted to lower all of the composite functional scores for riverine wetlands (Table 4-73). For depressional wetlands in Segment E, the slight decrease in function of the support of characteristic fish/aquatic habitat, flood attenuation, and short- and long-term water storage would be imperceptible and would be a negligible cumulative effect on the overall function of the wetlands.

Alternative 2 with Cumulative Effects is predicted to lower the composite functional score of the riverine wetlands in Segments A, B, D, and E from functioning to functioning impaired, which would be a minor effect because the change in composite functional scores are typically based on a small change in one or more variables that contribute to the composite functional score, and the functions would not change substantially even though the functional classification would change for Segments A, B, D, and E. For riverine wetlands in all segments, slight decreases in the score for functions of the support of characteristic fish/aquatic habitat, flood attenuation, short- and long-term water storage, nutrient/toxicant removal, sediment retention/shoreline stabilization, and production export/food chain support would cause a slight decrease in overall function of riverine wetlands, a minor cumulative effect.

5.9.4.2 South Platte River

No new studies or analyses were performed for the SDEIS for the South Platte River. Alternative 2 with Cumulative Effects would on an average monthly basis reduce flows on the South Platte River by less than 10% and the stage reductions are predicted to be small (up to 0.33 feet). Given the minor reductions in flow and stage, Alternative 2 with Cumulative Effects is not predicted to affect wetland and riparian resources along the South Platte River.

5.9.5 Alternative 3

Direct and indirect impacts to wetlands, riparian resources and waters associated with the construction and operation of Alternative 3, to include Cactus and Galeton Reservoirs, lining of

the Poudre Valley Canal, associated facilities, and conveyance systems are presented in Section 4.9.6. These impacts would contribute to other impacts to wetlands, riparian resources, and other waters in the region associated with the RFFAs.

5.9.5.1 Poudre River

The cumulative effects assessment of Alternative 3 uses Future Conditions hydrology compared to hydrology Run 4b1 and 5b1. Changes in flows have the potential to affect wetland and riparian resources through changes in shallow alluvial ground water levels and or periodic inundation that support these resources and provide other ecological services (Section 4.9.6.3). Alternative 3 would divert on average about 5,500 to 6,000 AFY more water from the Poudre River than Alternative 2 to compensate for increased reservoir evaporation from Cactus Hill Reservoir and conveyance loss. Additionally, Alternative 3 does not include the Poudre River flow augmentation program that is proposed under Alternative 2.

5.9.5.1.1 River Stage

Changes in river stage during the growing season were used to predict indirect effects on shallowly rooted herbaceous wetland vegetation bordering the mainstem that is supported, at least in part, by water levels (river stage) in the river. Table 5-24 shows that for all study sites the predicted percentage of the period of record with a decline of 0.5 foot or greater in 10% or more of the period of record increases with Cumulative Effects compared to Alternative 3 under Future Conditions Effects. Under Future Conditions Effects, Segment B (represented by the Martinez Park study site), Segment C (represented by the Archery study site), and Segment D (represented by the Eastman Park study site) would have a weekly average stage decline of greater than 10% of the record. Under Cumulative Effects, Segments B, C, D, and E (represented by the 59th Avenue study site) would have a weekly average stage decline that exceeds the impact threshold.

This level of decline in river stage is predicted to result in a shift in species at wetlands dominated by obligate wetland species (e.g., cattail and threesquare bulrush) to those that tolerate greater fluctuations in river stage such as reed canarygrass. Since most wetlands along the banks of the mainstem are dominated by reed canarygrass and sandbar willow, two species that can tolerate a range of ground water levels, effects are predicted to be minor and likely not perceptible. An estimated 60 acres of vegetation classes are potentially sensitive to declines in the ground water table within Segments B, C, and D (Future Conditions Effects with Alternative 3). Under Alternative 3 with Cumulative Effects, an estimated 148 acres of vegetation classes are potentially sensitive to declines in the ground water table within Segments B, C, D, and E within 100 feet of the riverbanks (ERO 2014d, Table 14).

Table 5-26. Alternative 3 – Cumulative effects summary of weekly average Poudre River stage declines by river segment (representative study site) of 0.5 foot or greater during the growing season.

Alternative 3 Model Runs Compared	Years of Consecutive Decline[1] (Number of Years)	Number of Weeks[2]	Percentage of Period of Record
Segment A - Watson Lake			
Runs 2 and 4b1	1980, 1995, 1996, 1997, (4 years)	33	6
Runs 2 and 5b1	1980, 1983, 1995, 1996, 1997 (5 years)	45	8
Segment B - Martinez Park			
Runs 2 and 4b1	1980, 1982, 1983, 1984, 1985, 1986, 1995, 1996, 1997, 1998, 1999 (11 years)	106	19
Runs 2 and 5b1	1980, 1982, 1983, 1984, 1985, 1986, 1990, 1991, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2005 (16 years)	150	27
Segment C - Archery Site			
Runs 2 and 4b1	1980, 1983, 1986, 1995, 1996, 1997, 1998, 1999 (8 years)	66	12
Runs 2 and 5b1	1980, 1983, 1984, 1985, 1995, 1996, 1997, 1998, 1999 (9 years)	71	13
Segment D - Eastman Park			
Runs 2 and 4b1	1986, 1995, 1996, 1997, 1998, 1999, 2002, 2003 (8 years)	59	11
Runs 2 and 5b1	1980, 1984, 1985. 1986, 1990, 1991, 1992, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2005 (18 years)	114	21
Segment E – 59th Avenue			
Runs 2 and 4b1	1986, 1995, 1996, 1997, 1999 (5 years)	46	8
Runs 2 and 5b1	1980, 1983, 1985, 1986, 1995, 1996, 1997, 1999 (8 years)	61	11
Segment F - Bird Farm			
Runs 2 and 4b1	1986, 1995, 1996, 1997, 1999 (5 years)	41	8
Runs 2 and 5b1	1984, 1985, 1995, 1996, 1997, 1999 (6 years)	50	9

[1] Years of consecutive declines are years in the period of record (1980-2005) with at least 4 consecutive weeks during the growing season (May 1 through September 30) of weekly average river stage declines of 0.5 foot or greater or a total of 6 weeks of declines of 0.5 foot or greater.

[2] Number of weeks with a decline of 0.5 foot or greater for the period of record (1980-2005) during the growing season. There are 546 weeks during the growing season for the period of record.

Segment A. Relative to the other segments, the predicted frequency of declines in river stage for Segment A are estimated to have the least potential effect on near-bank herbaceous wetland vegetation. The Watson Lake study site is predicted to have the fewest number of years (4 years under Future Conditions Effects; 5 years under Cumulative Effects) of at least 4 consecutive weeks during the growing season of weekly average river stage declines of 0.5 foot or greater or a total of 6 weeks of declines of 0.5 foot or greater. It is also predicted to have the lowest

percentage of record (6% under Future Conditions Effects; 8% under Cumulative Effects) of weekly average stage declines of 0.5 foot or greater during the growing season (Table 5-26). The predicted percentage of the period of record with a decline of 0.5 foot in river stage would not exceed the impact threshold of 10% of the record during the growing season.

Segment B. Relative to the other segments, predicted frequency of declines in river stage for Segment B are estimated to have the greatest potential effect on near-bank herbaceous wetland vegetation. The Martinez Park study site, representative of Segment B, would have the greatest number of weeks (106 under Future Conditions Effects; 150 under Cumulative Effects) and 19% of the period of record (under Future Conditions Effects) and 27% of the record (under Cumulative Effects) with a decline of 0.5 foot or greater during the growing season (Table 5-26). An estimated 9 acres of vegetation classes are potentially sensitive to declines in the ground water table within Segment B; a minor effect as discussed above.

Segment C. Relative to the other segments, predicted declines in river stage for Segment C are estimated to occur more frequently than in Segment A, but less frequently than Segment B. The Archery Site, representative of Segment C, would have 12% (Future Conditions Effects) and 13% (Cumulative Effects) of the period of record with a decline of 0.5 foot or greater during the growing season, which is slightly greater than the impact threshold of a decline of 0.5 foot in river stage of 10% or less during the growing season. An estimated 30 acres of vegetation classes are potentially sensitive to declines in the ground water table within Segment C; a minor effect as discussed above.

Segment D. Under Future Conditions Effects, the Eastman Park study site, representative of Segment D, would have 59 weeks and 11% of the period of record with a decline of 0.5 foot or greater during the growing season. Under Cumulative Effects, this would almost double to 114 weeks and 21% of the period of record with a decline of 0.5 foot or greater during the growing season. Under both Future Conditions Effects and Cumulative Effects, the impact threshold of a weekly average stage decline of 10% of the record or less would be exceeded. An estimated 21 acres of vegetation classes are potentially sensitive to declines in the ground water table within Segment D; a minor effect as discussed above.

Segment E. Relative to the other segments, the effects of reduced river stage in Segment E and Segment F are similar. Under Future Conditions Effects, the 59th Avenue study site would have 46 weeks and 8% of the period of record with a decline of 0.5 foot or greater during the growing season (Table 5-26). Under Cumulative Effects, this would increase to 61 weeks and 11% of the period of record with a decline of 0.5 foot or greater during the growing season. Under Future Conditions Effects, the predicted percentage of the period of record with a decline of 0.5 foot in river stage would not exceed the impact threshold of 10% of the record during the growing season. Under Cumulative Effects, the percent of the period of record with a decline of 0.5 foot or greater during the growing season is slightly greater than the impact threshold. An estimated 88 acres of vegetation classes are potentially sensitive to declines in the ground water table within Segment E; a minor effect as discussed above.

Segment F. The predicted effects of reduced river stage in Segment F are similar to Segment E, but slightly less than Segment E for Cumulative Effects (Table 5-24). The predicted percentage

of the period of record with a decline of 0.5 foot in river stage would not exceed the impact threshold of 10% of the record during the growing season.

5.9.5.1.2 Riparian Vegetation and Alluvial Ground Water

Table 4-70 summarizes the predicted maximum depth to ground water during the growing season for the alternatives. In general, the deepest observed and predicted annual water table depths during the growing season tend to increase in a downstream direction (the exception being Segment C at the Archery Site). Segment A has the shallowest and Segment F has the deepest observed annual water table depth during the growing season (Table 4-70). Under Cumulative Effects, the greatest predicted declines in alluvial ground water levels below the deepest observed annual water table depth during the growing season associated with cottonwood woodlands are predicted to occur at the Archery study site (Segment C) at monitoring well A3 (-2.0 feet), the Eastman Park study site (Segment D) at monitoring well Y5 (-1.9 feet), and at the Bird Farm study site (Segment F) at monitoring well D5 (-2.4 feet). These infrequent declines are estimated to have negligible to minor effects on the cottonwood woodlands as described below.

Poudre River Segments. The descriptions of the maximum predicted ground water depths in monitoring wells within the cottonwood woodlands under Alternative 3 with Cumulative Effects are predicted to be about the same as Alternative 2 with Cumulative Effects (Table 4-70).

Segment A. Relative to the other segments, predicted maximum depth to ground water within the monitored cottonwood woodland locations at the Watson Lake study site, representative of Segment A, are estimated to be the shallowest. The maximum ground water depths in monitoring wells within the cottonwood woodlands are predicted to be about 2.84 feet to 3.12 feet in September below the surface (Table 4-70). These estimated changes in the maximum depth to ground water are not predicted to adversely impact the cottonwood woodlands along Segment A because the changes would be well within the observed range of maximum ground water depths of 2.79 feet to 6.85 feet for cottonwoods during the growing season along the mainstem (Table 4-70).

Segment B. The maximum ground water depths in monitoring wells within the cottonwood woodlands at the Martinez Park study site, representative of Segment B are predicted to be about 4.84 feet (September) to 6.87 feet (May) below the surface (Table 4-70). These estimated changes in the maximum depth to ground water are not predicted to adversely impact the cottonwood woodlands along Segment B because the changes Would be within or very close to the observed range of maximum ground water depths of 2.79 feet to 6.85 feet for cottonwoods during the growing season along the mainstem.

Segment C. The maximum ground water depths in monitoring wells within the cottonwood woodlands at the Archery Site, representative of Segment C, are predicted to be about 7.73 feet to 8.07 feet below the surface in May (Table 4-70). This would be about 1.5 feet to 2.0 feet below the maximum ground water depths observed during the growing season at these monitoring wells and about 1.2 feet below the maximum ground water depth observed for cottonwoods during the growing season along the mainstem. Effects on cottonwood woodlands are predicted to be minor in Segment C due to short-term increases in maximum ground water

depths. Minor effects on the cottonwoods associated with declines in river stage of 2 feet or greater are predicted to be limited to periodic short-lived stresses because these estimated declines in alluvial ground water levels are predicted to occur infrequently. Additionally, the infrequently occurring maximum predicted ground water depth of 8.07 feet in May would occur at the beginning of the growing season when soil moisture conditions are typically favorable for supporting cottonwoods without dependence on shallow ground water levels.

Segment D. The maximum ground water depths in monitoring wells within the cottonwood woodlands at the Eastman Park study site, representative of Segment D, are predicted to infrequently reach depths of about 5.52 feet in September to 8.72 feet below the surface in May (Table 4-70). This would be about 0.0 feet to 1.9 feet below the maximum ground water depths observed during the growing season at these monitoring wells and about 1.9 feet below the maximum ground water depth observed for cottonwoods during the growing season along the mainstem. Effects on cottonwood woodlands are predicted to be minor in Segment D due to short-term increases in maximum ground water depths. Under Cumulative Effects, the maximum ground water depths are predicted to exceed the maximum water table depth observed for cottonwood woodlands (6.85 feet) during the growing season in any of the months for wells Y4 and Y5. Most of these predicted maximum ground water depths are within a foot or less than the observed maximum water table depth for cottonwoods and would occur infrequently. Minor effects on the cottonwoods associated with declines in river stage of 2 feet or greater are predicted to be limited to periodic short-lived stresses because these estimated declines in alluvial ground water levels are predicted to occur infrequently.

Segment E. The maximum ground water depths in monitoring wells within the cottonwood woodlands at the 59th Avenue study site, representative of Segment E, are predicted to infrequently reach depths of about 6.49 feet in August to about 7.67 feet below the surface in May (Table 4-70). This would be about 0.3 feet to 2.0 feet below the maximum ground water depths observed during the growing season at these monitoring wells and about 0.8 feet below the maximum ground water depth observed for cottonwoods during the growing season along the mainstem. Effects are predicted to be minor in Segment E on cottonwood woodlands due to short-term increases in maximum ground water depths. Minor effects on the cottonwoods associated with declines in river stage of 2 feet or greater are predicted to be limited to periodic short-lived stresses because these estimated declines in alluvial ground water levels are predicted to occur infrequently.

Segment F. Relative to the other segments, Segment F is predicted to have the deepest maximum ground water depth in a monitoring well within the monitored cottonwood woodland locations. Monitoring well D5 is predicted to infrequently have a maximum ground water depth of 9.24 feet in May. Additionally, monitoring well D4 is predicted to infrequently have a maximum ground water depth of 7.29 feet in May. This would be about 1.8 feet to 2.4 feet below the maximum ground water depths observed during the growing season at these monitoring wells and a maximum of about 2.4 feet below the maximum ground water depth observed for cottonwoods during the growing season along the mainstem. Effects are predicted to be minor in Segment F on cottonwood woodlands due to short-term increases in maximum ground water depths. Under Cumulative Effects, the maximum ground water depths are

predicted to exceed the maximum water table depth observed for cottonwood woodlands (6.85 feet) during the growing season in any of the months for well D5. Most of these predicted maximum ground water depths are within a foot or less than the observed maximum water table depth for cottonwoods and would occur infrequently. Minor effects on the cottonwoods associated with declines in river stage of 2 feet or greater are predicted to be limited to periodic short-lived stresses because these estimated declines in alluvial ground water levels are predicted to occur infrequently.

5.9.5.1.3 Inundation

The number of years that riparian and wetland resources along the mainstem would be inundated under Current Conditions hydrology declines with Future Conditions hydrology, Future Conditions Effects with Alternative 3, and Cumulative Effects (Table 5-27). Future Conditions hydrology is an estimate of the reduction in inundation that would occur in the future with the modeled RFFAs, but without Alternative 3 (i.e., what is projected to occur in the future compared to Current Conditions hydrology without any of the NISP alternatives). A comparison of Alternative 3 with Future Conditions Effects and Cumulative Effects provides an estimate of the effect of the HSWSPs.

The greatest estimated reduction in years of inundation compared to Current Conditions hydrology is predicted to occur at the Watson Lake study site (transect point WLT2.3 with a decline of 10 years) and the 59th Avenue study site (transect point 59T3a.5 with a decline of 9 years). However, there are numerous locations with predicted declines in inundation of 8 years with Cumulative Effects. With the exception of the Watson Lake study site location (WLT2.3), inundation at these locations under Current Conditions hydrology is not predicted to occur with enough frequency (at least 50% of the years in the period of record) to provide a reliable source of hydrologic support. Inundation of these 2 locations is predicted to decrease from 11 to 17 years under Current Conditions hydrology to 2 to 7 years with Cumulative Effects.

Eight vegetated points (points mapped as open water excluded) for the Spells Analysis were estimated to have at least one inundation event in 13 or more years during the period of record (Table 5-25). These riparian and wetland vegetation locations were identified as being inundated with enough frequency under Current Conditions hydrology to potentially be dependent to some degree on inundation for hydrologic support. These locations (WLT1.2 and 1.3, AT2.2, EPT2.1, 59T1.3, 3a.1, and 3b.1, and BFT3.3) are inundated by the more frequently occurring lower flows ranging from about 160 to 580 cfs. With the exception of WLT1.2 and EPT2.1, Cumulative Effects is not predicted to adversely affect these wetland and riparian resources because these elevations are predicted to continue to be inundated in at least half of the years of the period of record.

However, locations WLT1.2 and EPT2.1 would be inundated less than half of the years under Alternative 3 with either Future Conditions Effects or Cumulative Effects. This would reduce the frequency of inundation at these locations to a degree that it is no longer supportive. To the degree that the riparian resources at these locations are dependent on relatively frequent inundation, the reduced inundation would be a moderate impact (i.e., likely reduce the vigor of the stands). The predicted effects of reduced inundation are estimated to have a negligible effect

on most of the riparian resources in Segments A and E. However, stands that are inundated at the more frequently occurring low flows of about 330 cfs to 580 cfs are likely to be moderately impacted by a reduced number of years of inundation.

The following discussion on predicted changes to inundation under for the Poudre River segments focuses on potential effects on cottonwood woodlands. Herbaceous near-bank riparian resources and wetlands are addressed under *River Stage*. Predicted reductions in inundation are estimated to have negligible effects on most stands of established cottonwood woodlands as discussed below.

Future Conditions hydrology (without the NISP alternatives), Alternative 3 with Future Conditions Effects, and Cumulative Effects are all predicted to reduce inundation of wetland and riparian resources along the mainstem and would accelerate and/or reinforce the trajectory previously described for the riparian plains cottonwood woodlands.

Table 5-27. Spells analysis of selected points along riparian transects for Poudre River study sites - Alternative 3.

Study Site/Transect/Point	Elevation-National Geodetic Vertical Datum (ft)	Approx. Distance from Riverbank (ft)	Vegetation Cover Type[1]	Minimum Inundation Flow (cfs)	No. of Years Inundated Current Conditions (Run 1)	No. of Years Inundated Future Conditions (Run 2)	No. of Years Inundated Future Conditions Effects (Run 4b1)	No. of Years Inundated Cumulative Effects (Run 5b1)
Watson Lake								
Transect 1								
WLT1.1	5,143.18	210	N/A	3,000	7	5	2	1
WLT1.2	5,140.93	75	NC/MG W	1,500	17	15	10	7
WLT1.3	5,139.10	10	RC H	800	26	26	21	21
WLT1.4	5,141.70	205	BE-NC/ROD W	3,000	7	5	2	1
WLT1.5	5,141.32	500	AM[RC] H	3,000	7	5	2	1
Transect 2								
WLT2.1	5,137.65	50	BE-NC/ROD W	2,500	9	7	4	1
WLT2.2	5,135.85	350	BE-NC/ROD W	3,000	7	5	2	1
WLT2.3	5,133.65	450	AM[RC] H	2,300	11	8	5	3
Martinez Park								
Transect 2								
LMT2.1	4,971.81	375	RO W	2,000	11	7	4	3
LMT2.2	4,969.95	30	RC H	2,000	11	7	4	3
LMT2.3	4,971.52	5	PC/SB W	2,000	11	7	4	3
LMT2.4	4,965.25	140	OW	40	26	26	26	26
LMT2.5	4,972.45	180	PC/SW W	3,000	5	4	1	1
LMT2.6	4,970.47	250	PC/SB W	3,000	5	4	1	1
Transect 3								
LMT3.1	4,969.11	90	UG	2,500	7	5	4	1
LMT3.2	4,969.03	40	PC/SW W	3,200	4	4	1	1
LMT3.3	4,967.66	140	PC/SB W	3,200	4	4	1	1
LMT3.4	4,969.22	190	PC/SB W	3,200	4	4	1	1
Archery Site								
Transect 1								
AT1.1	4,859.15	65	PC/PC-S W	4,000	2	1	1	1
AT1.2	4,857.28	100	PC-(PW)/SW[RC] W	1,900	10	7	4	3

Study Site/Transect/Point	Elevation-National Geodetic Vertical Datum (ft)	Approx. Distance from Riverbank (ft)	Vegetation Cover Type[1]	Minimum Inundation Flow (cfs)	No. of Years Inundated Current Conditions (Run 1)	No. of Years Inundated Future Conditions (Run 2)	No. of Years Inundated Future Conditions Effects (Run 4b1)	No. of Years Inundated Cumulative Effects (Run 5b1)
Transect 2								
AT2.1	4,857.06	25	PC/SB W	2,500	7	4	2	1
AT2.2	4,853.46	40	SW/MG-[RC] S	100	26	26	26	26
AT2.3	4,851.38	50	OW	10	26	26	26	26
AT2.4	4,858.67	15	UG	4,600	1	1	1	1
Eastman Park								
Transect 2								
EPT2.1	4,760.65	40	SW/MG-[RC] S	330	16	14	12	12
EPT2.2	4,767.01	70	PC/SB W	2,200	10	7	5	2
EPT2.3	4,765.91	225	PC/SB W	2,200	10	7	5	2
EPT2.4	4,766.83	275	PC/SB W	2,100	10	8	5	2
EPT2.5	4,764.55	675	PC/SB W	2,100	10	8	5	2
Transect 3								
EPT3.1	4,760.54	305	PC/SB W	2,100	10	8	5	3
EPT3.2	4,762.18	40	PC/SB W	1,900	11	9	5	3
59th Avenue								
Transect 1								
59T1.1	4,694.35	145	PC/SB W	4,000	3	2	1	1
59T1.2	4,692.97	5	PC/SB W	980	11	11	10	8
59T1.3	4,686.93	10	RC H	160	25	24	22	21
59T1.4	4,694.00	5	PC/SB W	2,300	9	7	4	2
Transect 3a								
59T3a.1	4,687.76	280	PC/SB W	580	15	15	14	13
59T3a.2	4,691.19	230	PC/SB W	1,900	11	9	5	4
59T3a.3	4,691.62	5	PC/SB W	1,900	11	9	5	4
59T3a.4	4,688.31	35	RC H	1,820	11	10	5	4
59T3a.5	4,691.89	5	PC/SB W	2,100	11	7	5	2
Transect 3b								
59T3b.1	4,689.84	70	UG	580	15	15	14	13
59T3b.2	4,692.68	10	PC/SB W	2,000	11	9	5	3
59T3b.3	4,689.97	125	PC/SB W	850	11	11	10	9
59T3b.4	4,689.27	150	PC/SB W	850	11	11	10	9
Bird Farm								
Transect 2								
BF2.1	4,612.98	155	PC/SB W	1,500	11	11	9	8
Transect 3								
BFT3.1	4,608.70	160	PC-(PW)/SW-[RC] W	2,200	11	8	5	3
BFT3.2	4,608.95	5	UG	2,300	10	8	5	2
BFT3.3	4,606.12	30	SW/MG-[RC] S	520	18	19	18	18
BFT3.4	4,607.80	360	PC/SB W	1,500	11	11	9	8

[1]AM[RC] H - American Mannagrass[Reed Canarygrass] Herbaceous; BE-NC/ROD W - Boxelder-Narrowleaf Cottonwood/Red-Osier Dogwood Woodlands; N/A - Not Applicable; NC/MG W -Narrowleaf Cottonwood/Mesic Graminoid Woodlands; OW - Open Water; PC-(PW)/SW[RC] W - Plains Cottonwood-(Peachleaf Willow)/Sandbar Willow/[Reed Canarygrass] Woodland; PC/PC-S W - Plains Cottonwood/Prairie Cordgrass-Sedge Woodland; PC/SB W - Plains Cottonwood/Smooth Brome Woodland; PC/SW W - Plains Cottonwood/Slender Wheatgrass Woodland; RC H -Reed Canarygrass Herbaceous; RO W - Russian Olive Woodland; SW/MG-[RC] S - Sandbar Willow/Mesic Graminoid-[Reed Canarygrass] Shrubland; UG - Upland Grassland.

Segment A. The narrowleaf cottonwood woodland locations within the Watson Lake study site, representative of Segment A, have minimum inundation flows of about 1,500 to 3,000 cfs (Table 5-25). Under Current Conditions hydrology, these locations would be inundated in about 6 to 17 years of the period of record. Locations inundated in at least half of the years of the period of record under Current Conditions hydrology were assumed to receive some amount of

hydrological support from inundation. Only one cottonwood woodland location at the Watson Lake study site is predicted to be inundated in at least half of the years of the period of record under Current Conditions hydrology (WLLT1.2). The inundation under Alternative 3 with Future Conditions Effects and Cumulative Effects at this location is predicted to be reduced to less than half of the years of the period of record (Table 5-27). This would reduce the frequency of inundation of cottonwood woodland at this location to a degree that it is no longer supportive and would likely reduce the vigor of the stand. The predicted effects of reduced inundation are estimated to have a negligible effect on most of the cottonwood woodlands in Segment A. However, stands that are inundated at the more frequently occurring low flows are likely to be moderately impacted by a reduced number of years of inundation.

Segment B. The plains cottonwood woodland locations within the Martinez Park study site, representative of Segment B, have minimum inundation flows of about 2,000 to 3,200 cfs (Table 5-27). Under Current Conditions hydrology, these locations would be inundated in about 5 to 11 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 4 to 8 years at these locations. None of these locations would be inundated in more than half of the years of the period of record under Current Conditions hydrology. The estimated reduction in inundation with either Future Conditions Effects or Cumulative Effects is predicted to have a negligible effect on cottonwood woodlands in Segment B because under Current Conditions hydrology, the cottonwood woodlands are not inundated with enough frequency to provide consistent hydrologic support.

Segment C. The plains cottonwood woodland locations within the Archery Site, representative of Segment C, have minimum inundation flows of about 1,900 to 4,000 cfs (Table 5-27). Under Current Conditions hydrology, these locations would be inundated in about 1 to 10 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 1 to 7 years at these locations. None of these locations would be inundated in more than half of the years of the period of record under Current Conditions hydrology. Under Alternative 3, the estimated reduction in inundation with either Future Conditions Effects or Cumulative Effects is predicted to have a negligible effect on cottonwood woodlands in Segment C because under Current Conditions hydrology, the cottonwood woodlands are not inundated with enough frequency to provide consistent hydrologic support.

Segment D. The plains cottonwood woodland locations within the Eastman Park study site, representative of Segment D, have minimum inundation flows of about 1,900 to 2,200 cfs (Table 5-27). Under Current Conditions hydrology, these locations would be inundated in about 10 to 11 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 7 to 8 years at these locations. The predicted effects of reduced inundation are estimated to have a negligible effect on most of the cottonwood woodlands in Segment D, because under Current Conditions hydrology, the cottonwood woodlands are not inundated with enough frequency to provide consistent hydrologic support.

Segment E. The plains cottonwood woodland locations within the 59th Avenue study site, representative of Segment E, have minimum inundation flows of about 580 to 4,000 cfs (Table 5-27). Under Current Conditions hydrology, these locations would be inundated in about 3 to

15 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 2 to 9 years at these locations. Only one cottonwood woodland location at the 59th Avenue study site (59T3a.1) is predicted to be inundated in more than half of the years of the period of record under Current Conditions hydrology. The inundation under Cumulative Effects at this location is predicted to be reduced by 3 years, resulting in inundation that would still occur in about half of the years of the period of record. The estimated reduction in inundation with either Future Conditions Effects or Cumulative Effects is predicted to have a negligible effect on cottonwood woodlands in Segment E because under Current Conditions hydrology, the cottonwood woodlands are not inundated with enough frequency to provide consistent hydrologic support.

Segment F. The plains cottonwood woodland locations within the Bird Farm study site, representative of Segment F, have minimum inundation flows of about 1,500 to 2,200 cfs (Table 5-27). Under Current Conditions hydrology, these locations would be inundated in about 11 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 3 to 8 years at these locations. None of these locations would be inundated in more than half of the years of the period of record under Current Conditions hydrology. The estimated reduction in inundation with either Future Conditions Effects or Cumulative Effects is predicted to have a negligible effect on cottonwood woodlands in Segment F because under Current Conditions hydrology, the cottonwood woodlands are not inundated with enough frequency to provide consistent hydrologic support.

5.9.5.1.4 Vegetation Communities and Nonnative Species

The trajectory previously described for the mainstem riparian resources (Section 4.9.1.1) is predicted to continue with or without the NISP alternatives. Future Conditions Effects and Cumulative Effects would further reduce inundation and would accelerate and /or reinforce the trajectory. This trajectory would likely lead to the increased presence and distribution of nonnative vegetation in the plant communities along the mainstem, including an expected increase in the distribution of reed canarygrass downstream of I-25. Section 4.9.9 provides a summary of the anticipated effects on the vegetation communities along the mainstem associated with this trajectory.

5.9.5.1.5 Wetland Functions

Alternative 3 with Cumulative Effects is predicted to slightly lower the composite functional score in Segment E for depressional wetlands (Table 4-72) and is predicted to slightly lower all of the composite functional scores for riverine wetlands (Table 4-73). For depressional wetlands in Segments A and E, the slight decrease in function of the support of characteristic fish/aquatic habitat, flood attenuation, and short- and long-term water storage would be imperceptible and would be a negligible effect on the overall function of the wetlands. Alternative 3 with Cumulative Effects is predicted to lower the composite functional score of the riverine wetlands in Segments A, B, D, and E from functioning to functioning impaired, which would be a minor effect because the change in composite functional scores are typically based on a small change in one or more variables that contribute to the composite functional score, and the functions would not change substantially even though the functional classification would change for Segments A,

B, D, and E. For riverine wetlands in all segments, slight decreases in the score for functions of support of characteristic fish/aquatic habitat, flood attenuation, short- and long-term water storage, nutrient/toxicant removal, sediment retention/shoreline stabilization, and production export/food chain support would cause a slight decrease in overall function of riverine wetlands, a minor cumulative effect.

5.9.5.2 South Platte River

No new studies or analyses were performed for the SDEIS for the South Platte River. Alternative 3 with Cumulative Effects would on an average monthly basis reduce flows on the South Platte River by less than 10% and the stage reductions are predicted to be small (up to 0.33 feet). Given the minor reductions in flow and stage, Alternative 3 with Cumulative Effects is not predicted to affect wetland and riparian.

5.9.6 Alternative 4

Direct and indirect impacts to wetlands, riparian resources and waters associated with the construction and operation of Alternative 4, to include Cactus and Galeton Reservoirs, lining of the Poudre Valley Canal, associated facilities, and conveyance systems are presented in Section 4.9.7. These impacts would contribute to other impacts to wetlands, riparian resources, and other waters in the region associated with the RFFAs.

5.9.6.1 Poudre River

The cumulative effects assessment of Alternative 4 uses Future Conditions hydrology compared to hydrology Runs 4b2 and 5b2. Changes in flows have the potential to affect wetland and riparian resources through changes in shallow alluvial ground water levels and or periodic inundation that support these resources and provide other ecological services. Alternative 4 would divert on average about 5,500 to 6,000 AFY more water from the Poudre River than Alternative 2 to compensate for increased reservoir evaporation from Cactus Hill Reservoir and conveyance loss. Alternative 4 is designed to allow some flow to pass through the Fort Collins area and be diverted lower on the river at the New Cache Canal headgate. Relative to the other action alternatives, under Alternative 4, more water would remain in the mainstem between the Poudre Valley Canal and New Cache Canal before it is diverted for exchanges. Additionally, Alternative 4 does not include the Poudre River flow augmentation program that is proposed under Alternative 2.

5.9.6.1.1 River Stage

Changes in river stage during the growing season were used to predict indirect effects on shallowly rooted herbaceous wetland vegetation bordering the mainstem that is supported, at least in part, by water levels (river stage) in the river. Table 5-28 shows that for all study sites the predicted percentage of the period of record with a decline of 0.5 foot or greater of 10% or more of the period of record increases with Cumulative Effects compared to Alternative 4 with Future Conditions Effects. Under Cumulative Effects, Segment B (represented by the Martinez

Park study site), and Segment D (represented by the Eastman Park study site) would have a weekly average stage decline of greater than 10% of the record. Under Alternative 4 with Future Conditions Effects, Segment D would have a weekly average stage decline of greater than 10% of the record.

This level of decline in river stage is predicted to result in a shift in species at wetlands dominated by obligate wetland species (e.g., cattail and threesquare bulrush) to those that tolerate greater fluctuations in river stage such as reed canarygrass. Since most wetlands along the banks of the mainstem are dominated by reed canarygrass and sandbar willow, two species that can tolerate a range of ground water levels, effects are predicted to be minor and likely not perceptible. An estimated 21 acres of vegetation classes are potentially sensitive to declines in alluvial ground water levels within Segment D (Future Conditions Effects with Alternative 4) and 30 acres in Segments B and D (Cumulative Effects) within 100 feet of the riverbanks (ERO 2014d, Table 14).

Table 5-28. Alternative 4 – Cumulative effects summary of weekly average Poudre River stage declines by river segment (representative study site) of 0.5 foot or greater during the growing season.

Alternative 4 Model Runs Compared	Years of Consecutive Decline[1] (Number of Years)	Number of Weeks[2]	Percentage of Period of Record
Segment A - Watson Lake			
Runs 2 and 4b2	1980, 1995, 1996, 1997 (4 years)	30	5
Runs 2 and 5b2	1980, 1983, 1995, 1996, 1997 (5 years)	36	7
Segment B - Martinez Park			
Runs 2 and 4b2	1980, 1983, 1985, 1986, 1995, 1996, 1997, 1999 (8 years)	52	10
Runs 2 and 5b2	1980, 1983, 1985, 1994, 1995, 1996, 1997, 1999 (8 years)	78	14
Segment C - Archery Site			
Runs 2 and 4b2	1980, 1983, 1995, 1996, 1997, 1999 (6 years)	41	8
Runs 2 and 5b2	1980, 1983, 1995, 1996, 1997, 1999 (6 years)	47	9
Segment D - Eastman Park			
Runs 2 and 4b2	1986, 1995, 1996, 1997, 1998, 1999, 2002 (7 years)	59	11
Runs 2 and 5b2	1984, 1985, 1986, 1990, 1991, 1992, 1994, 1995, 1996, 1997. 1998, 1999, 2001, 2002, 2003, 2005 (16 years)	110	20
Segment E - 59th Avenue			
Runs 2 and 4b2	1996, 1997, 1999 (3 years)	40	7
Runs 2 and 5b2	1983, 1986, 1985, 1995, 1996, 1997, 1999 (7 years)	54	10
Segment F - Bird Farm			
Runs 2 and 4b2	1995, 1996, 1997, 1999 (4 years)	39	7
Runs 2 and 5b2	1995, 1996, 1997, 1999 (4 years)	45	8

[1]Years of consecutive declines are years in the period of record (1980-2005) with at least 4 consecutive weeks during the growing season (May 1 through September 30) of weekly average river stage declines of 0.5 foot or greater or a total of 6 weeks of declines of 0.5 foot or greater.

[2]Number of weeks with a decline of 0.5 foot or greater for the period of record (1980-2005) during the growing season. There are 546 weeks during the growing season for the period of record.

Segment A. Relative to the other segments, the predicted frequency of declines in river stage for Segment A are estimated to have the least potential effect on near-bank herbaceous wetland vegetation. The Watson Lake study site, representative of Segment A, is predicted to have lowest percentage of the period of record (5% under Future Conditions Effects; 7% under Cumulative Effects) of weekly average stage declines of 0.5 foot or greater during the growing season (Table 5-28). The predicted percentage of the period of record with a decline of 0.5 foot in river stage would not exceed the impact threshold of 10% of the record during the growing season.

Segment B. The Martinez Park study site, representative of Segment B, would exceed the impact threshold under Cumulative Effects with a decline of 14% of the period of record of 0.5 foot or greater during the growing season (Table 5-28). An estimated 9 acres of vegetation

classes are potentially sensitive to declines in the ground water table within Segment B; a minor effects as described above.

Segment C. Relative to the other segments, predicted declines in river stage for Segment C are estimated to occur slightly more frequently than in Segment A, but less frequently than Segments B and D. The Archery Site, representative of Segment C, would not exceed the impact threshold of 10% of the record during the growing season.

Segment D. Under Future Conditions Effects, the Eastman Park study site, representative of Segment D, would have 59 weeks and 11% of the period of record with a decline of 0.5 foot or greater during the growing season. Under Cumulative Effects, this would almost double to 110 weeks and 20% of the period of record with a decline of 0.5 foot or greater during the growing season. Under both Future Conditions Effects and Cumulative Effects, the impact threshold of a weekly average stage decline of 10% of the record or less would be exceeded. An estimated 21 acres of vegetation classes are potentially sensitive to declines in the ground water table within Segment D; a minor effect as described above.

Segment E. Relative to the other segments, the effects of reduced river stage in Segment E and Segment F are similar. Under Future Conditions Effects, the 59th Avenue study site would have 40 weeks and 7% of the period of record with a decline of 0.5 foot or greater during the growing season (Table 5-28). Under Cumulative Effects, this would increase to 54 weeks and 10% of the period of record with a decline of 0.5 foot or greater during the growing season. Under both Future Conditions Effects and Cumulative Effects, the impact threshold of a weekly average stage decline of 10% of the record or less would not be exceeded.

Segment F. The predicted effects of reduced river stage in Segment F are similar to Segments A and E, but slightly less than Segment E. The Bird Farm study site, representative of Segment F, is predicted to have the fewest number of years (4 under Future Conditions Effects and Cumulative Effects) of at least 4 consecutive weeks during the growing season of weekly average river stage declines of 0.5 foot or greater or a total of 6 weeks of declines of 0.5 foot or greater. The predicted percentage of the period of record with a decline of 0.5 foot in river stage would not exceed the impact threshold of 10% of the record during the growing season.

5.9.6.1.2 Riparian Vegetation and Alluvial Ground Water

Table 4-70 summarizes the predicted maximum depth to ground water during the growing season for the alternatives. In general, the deepest observed and predicted annual water table depths during the growing season tend to increase in a downstream direction (the exception being Segment C at the Archery Site). Segment A has the shallowest and Segment F has the deepest observed annual water table depth during the growing season (Table 4-70). Under Cumulative Effects, the greatest predicted declines in alluvial ground water levels below the deepest observed annual water table depth during the growing season associated with cottonwood woodlands are predicted to infrequently occur at the Archery study site (Segment C) at monitoring well A3 (-2.0 feet), the Eastman Park study site (Segment D) at monitoring well Y5 (-1.9 feet), and at the Bird Farm study site (Segment F) at monitoring well D5 (-2.4 feet). These infrequent declines are estimated to have negligible to minor effects on the cottonwood woodlands as described below.

Poudre River Segments. Under Alternative 4 with Cumulative Effects, predicted maximum depths to ground water for monitoring wells within the cottonwood woodlands are similar to the predicted maximum depths for Alternatives 2 and 3 with Cumulative Effects.

Segment A. Relative to the other segments, predicted maximum depth to ground water within the monitored cottonwood woodland locations at the Watson Lake study site, representative of Segment A, are estimated to be the shallowest. The maximum ground water depths in monitoring wells within the cottonwood woodlands are predicted to be about 2.85 feet to 3.14 feet in September below the surface (Table 4-70). These estimated changes in the maximum depth to ground water are not predicted to adversely impact the cottonwood woodlands along Segment A because the changes would be within the observed range of maximum ground water depths of 2.79 feet to 6.85 feet for cottonwoods during the growing season along the mainstem (Table 4-70).

Segment B. The maximum ground water depths in monitoring wells within the cottonwood woodlands at the Martinez Park study site, representative of Segment B, are predicted to be about 4.88 feet (September) to 6.61 feet (May) below the surface (Table 4-70). These estimated changes in the maximum depth to ground water are not predicted to adversely impact the cottonwood woodlands along Segment B because the changes would be within the observed range of maximum ground water depths of 2.79 feet to 6.85 feet for cottonwoods during the growing season along the mainstem.

Segment C. The maximum ground water depths in monitoring wells within the cottonwood woodlands at the Archery Site, representative of Segment C, are predicted to be about 7.63 feet to 7.95 feet below the surface in May (Table 4-70). This would be about 1.1 feet to 1.4 feet below the maximum ground water depths observed during the growing season at these monitoring wells and about 1.1 feet below the maximum ground water depth observed for cottonwoods during the growing season along the mainstem. Effects on cottonwood woodlands are predicted to be minor in Segment C due to short-term increases in maximum ground water depths. Minor effects on the cottonwoods associated with declines in river stage of 2 feet or greater are predicted to be limited to periodic short-lived stresses because these estimated declines in alluvial ground water levels are predicted to occur infrequently. Additionally, the infrequently occurring maximum predicted ground water depth of 7.95 feet in May would occur at the beginning of the growing season when soil moisture conditions are typically favorable for supporting cottonwoods without dependence on shallow ground water levels.

Segment D. The maximum ground water depths in monitoring wells within the cottonwood woodlands at the Eastman Park study site, representative of Segment D, are predicted to infrequently reach depths of about 5.92 feet in September to 8.69 feet below the surface in May (Table 4-70). This would be about 0.0 feet to 1.8 feet below the maximum ground water depths observed during the growing season at these monitoring wells and about 1.8 feet below the maximum ground water depth observed for cottonwoods during the growing season along the mainstem. Effects on cottonwood woodlands are predicted to be minor in Segment D due to short-term increases in maximum ground water depths. Under Cumulative Effects, the maximum ground water depths are predicted to exceed the maximum water table depth observed

for cottonwood woodlands (6.85 feet) during the growing season in most months for wells Y4 and Y5. Most of these predicted maximum ground water depths are within a foot or less than the observed maximum water table depth for cottonwoods and would occur infrequently. Minor effects on the cottonwoods associated with declines in river stage of 2 feet or greater are predicted to be limited to periodic short-lived stresses because these estimated declines in alluvial ground water levels are predicted to occur infrequently.

Segment E. The maximum ground water depths in monitoring wells within the cottonwood woodlands at the 59th Avenue study site, representative of Segment E, are predicted to infrequently reach depths of about 6.49 feet in August to about 7.67 feet below the surface in May (Table 4-70). This would be about 0.3 feet to 2.0 feet below the maximum ground water depths observed during the growing season at these monitoring wells and about 0.8 feet below the maximum ground water depth observed for cottonwoods during the growing season along the mainstem. Effects are predicted to be minor in Segment E on cottonwood woodlands due to short-term increases in maximum ground water depths. Minor effects on the cottonwoods associated with declines in river stage of 2 feet or greater are predicted to be limited to periodic short-lived stresses because these estimated declines in alluvial ground water levels are predicted to occur infrequently.

Segment F. Relative to the other segments, Segment F is predicted to have the deepest maximum ground water depth in a monitoring well within the monitored cottonwood woodland locations. Monitoring well D5 is predicted to infrequently have a maximum ground water depth of 9.24 feet in May. Additionally, monitoring well D4 is predicted to infrequently have a maximum ground water depth of 7.29 feet in May. This would be about 1.8 feet to 2.4 feet below the maximum ground water depths observed during the growing season at these monitoring wells and a maximum of about 2.4 feet below the maximum ground water depth observed for cottonwoods during the growing season along the mainstem. Effects are predicted to be minor in Segment F on cottonwood woodlands due to short-term increases in maximum ground water depths. Under Cumulative Effects, the maximum ground water depths are predicted to exceed the maximum water table depth observed for cottonwood woodlands (6.85 feet) during the growing season in any of months for well D5. Most of these predicted maximum ground water depths are within a foot or less than the observed maximum water table depth for cottonwoods and would occur infrequently. Minor effects on the cottonwoods associated with declines in river stage of 2 feet or greater are predicted to be limited to periodic short-lived stresses because these estimated declines in alluvial ground water levels are predicted to occur infrequently.

5.9.6.1.3 Inundation

The number of years that riparian and wetland resources along the mainstem would be inundated under Current Conditions hydrology declines with Future Conditions hydrology, Future Conditions Effects with Alternative 4, and Cumulative Effects (Table 5-29). Future Conditions Effects is an estimate of the reduction in inundation that would occur in the future with the modeled RFFAs, but without Alternative 4 (i.e., what is projected to occur in the future compared to Current Conditions hydrology without any of the NISP alternatives). A comparison

of Alternative 4 with Future Conditions Effects and Cumulative Effects provides an estimate of the effect of the HSWSPs.

The greatest estimated reduction in years of inundation compared to Current Conditions hydrology is predicted to occur at the Watson Lake study site (transect point WLT2.3), the Eastman Park study site (transect point EPT3.2), and the 59th Avenue study site (transect point 59T3b.2) all with a predicted decline of 8 years. With the exception of the Watson Lake study site location (WLT2.3), inundation at these locations under Current Conditions hydrology is not predicted to occur with enough frequency (at least 50% of the years in the period of record) to provide a reliable source of hydrologic support. Inundation of these 3 locations is predicted to decrease from 11 to 17 years under Current Conditions hydrology to 3 to 9 years with Cumulative Effects.

Eight vegetated points (points mapped as open water excluded) for the Spells Analysis were estimated to have at least one inundation event in 13 or more years during the period of record (Table 5-25). These riparian and wetland vegetation locations were identified as being inundated with enough frequency under Current Conditions hydrology to potentially be dependent to some degree on inundation for hydrologic support. These locations (WLT1.2 and 1.3, AT2.2, EPT2.1, 59T1.3, 3a.1, and 3b.1, and BFT3.3) are inundated by the more frequently occurring lower flows ranging from about 160 to 580 cfs. With the exception of WLT1.2, Cumulative Effects is not predicted to adversely affect these wetland and riparian resources because these elevations are predicted to continue to be inundated in about half of the years of the period of record.

However, location WLT1.2 would be inundated in less than half of the years under Cumulative Effects. This would reduce the frequency of inundation of cottonwood woodlands at this location to a degree that it is no longer potentially supportive. To the degree that the cottonwood woodland at this and similar locations are dependent on relatively frequent inundation, the reduced inundation would be a moderate impact (i.e., likely reduce the vigor of the stands). Under Alternative 4, the predicted effects of reduced inundation with Future Conditions Effects or Cumulative Effects are estimated to have a negligible effect on most of the cottonwood woodlands in Segment A. However, stands that are inundated at the more frequently occurring low flows are likely to be moderately impacted by a reduced number of years of inundation.

Future Conditions hydrology (without the NISP alternatives), Alternative 4 with Future Conditions Effects, and Cumulative Effects are all predicted to reduce inundation of wetland and riparian resources along the mainstem and would accelerate and/or reinforce the trajectory previously described for the riparian plains cottonwood woodlands. The following discussion on predicted changes to inundation for the Poudre River segments focuses on potential effects on cottonwood woodlands. Herbaceous near-bank riparian resources and wetlands are addressed under *River Stage*. Predicted reductions in inundation are estimated to have negligible effects on most stands of established cottonwood woodlands as discussed below.

Table 5-29. Spells analysis of selected points along riparian transects for Poudre River study sites - Alternative 4.

Study Site/Transect/Point	Elevation-National Geodetic Vertical Datum (ft)	Approx. Distance from Riverbank (ft)	Vegetation Cover Type[1]	Minimum Inundation Flow (cfs)	No. of Years Inundated Current Conditions (Run 1)	No. of Years Inundated Future Conditions (Run 2)	No. of Years Inundated Future Conditions Effects (Run 4b2)	No. of Years Inundated Cumulative Effects (Run 5b2)
Watson Lake								
Transect 1								
WLT1.1	5,143.18	210	N/A	3,000	7	5	2	1
WLT1.2	5,140.93	75	NC/MG W	1,500	17	15	13	9
WLT1.3	5,139.10	10	RC H	800	26	26	26	26
WLT1.4	5,141.70	205	BE-NC/ROD W	3,000	7	5	2	1
WLT1.5	5,141.32	500	AM[RC] H	3,000	7	5	2	1
Transect 2								
WLT2.1	5,137.65	50	BE-NC/ROD W	2,500	9	7	5	1
WLT2.2	5,135.85	350	BE-NC/ROD W	3,000	7	5	2	1
WLT2.3	5,133.65	450	AM[RC] H	2,300	11	8	5	4
Martinez Park								
Transect 2								
LMT2.1	4,971.81	375	RO W	2,000	11	7	4	3
LMT2.2	4,969.95	30	RC H	2,000	11	7	4	3
LMT2.3	4,971.52	5	PC/SB W	2,000	11	7	4	3
LMT2.4	4,965.25	140	OW	40	26	26	26	26
LMT2.5	4,972.45	180	PC/SW W	3,000	5	4	1	1
LMT2.6	4,970.47	250	PC/SB W	3,000	5	4	1	1
Transect 3								
LMT3.1	4,969.11	90	UG	2,500	7	5	4	2
LMT3.2	4,969.03	40	PC/SW W	3,200	4	4	1	1
LMT3.3	4,967.66	140	PC/SB W	3,200	4	4	1	1
LMT3.4	4,969.22	190	PC/SB W	3,200	4	4	1	1
Archery Site								
Transect 1								
AT1.1	4,859.15	65	PC/PC-S W	4,000	2	1	1	1
AT1.2	4,857.28	100	PC-(PW)/SW[RC] W	1,900	10	7	4	3
Transect 2								
AT2.1	4,857.06	25	PC/SB W	2,500	7	4	2	1
AT2.2	4,853.46	40	SW/MG-[RC] S	100	26	26	26	26
AT2.3	4,851.38	50	OW	10	26	26	26	26
AT2.4	4,858.67	15	UG	4,600	1	1	1	1
Eastman Park								
Transect 2								
EPT2.1	4,760.65	40	SW/MG-[RC] S	330	16	14	12	12
EPT2.2	4,767.01	70	PC/SB W	2,200	10	7	4	3
EPT2.3	4,765.91	225	PC/SB W	2,200	10	7	4	3
EPT2.4	4,766.83	275	PC/SB W	2,100	10	8	5	3
EPT2.5	4,764.55	675	PC/SB W	2,100	10	8	5	3
Transect 3								
EPT3.1	4,760.54	305	PC/SB W	2,100	10	8	5	3
EPT3.2	4,762.18	40	PC/SB W	1,900	11	9	5	3
59th Avenue								
Transect 1								
59T1.1	4,694.35	145	PC/SB W	4,000	3	2	1	1
59T1.2	4,692.97	5	PC/SB W	980	11	11	9	9
59T1.3	4,686.93	10	RC H	160	25	24	22	21
59T1.4	4,694.00	5	PC/SB W	2,300	9	7	4	2

Study Site/Transect/Point	Elevation-National Geodetic Vertical Datum (ft)	Approx. Distance from Riverbank (ft)	Vegetation Cover Type[1]	Minimum Inundation Flow (cfs)	No. of Years Inundated Current Conditions (Run 1)	No. of Years Inundated Future Conditions (Run 2)	No. of Years Inundated Future Conditions Effects (Run 4b2)	No. of Years Inundated Cumulative Effects (Run 5b2)
Transect 3a								
59T3a.1	4,687.76	280	PC/SB W	580	15	15	14	13
59T3a.2	4,691.19	230	PC/SB W	1,900	11	9	5	4
59T3a.3	4,691.62	5	PC/SB W	1,900	11	9	5	4
59T3a.4	4,688.31	35	RC H	1,820	11	10	5	4
59T3a.5	4,691.89	5	PC/SB W	2,100	11	7	5	3
Transect 3b								
59T3b.1	4,689.84	70	UG	580	15	15	14	13
59T3b.2	4,692.68	10	PC/SB W	2,000	11	9	5	3
59T3b.3	4,689.97	125	PC/SB W	850	11	11	10	9
59T3b.4	4,689.27	150	PC/SB W	850	11	11	10	9
Bird Farm								
Transect 2								
BF2.1	4,612.98	155	PC/SB W	1,500	11	11	9	7
Transect 3								
BFT3.1	4,608.70	160	PC-(PW)/SW-[RC] W	2,200	11	8	5	4
BFT3.2	4,608.95	5	UG	2,300	10	8	5	3
BFT3.3	4,606.12	30	SW/MG-[RC] S	520	18	19	18	18
BFT3.4	4,607.80	360	PC/SB W	1,500	11	11	9	8

[1]AM[RC] H - American Mannagrass[Reed Canarygrass] Herbaceous; BE-NC/ROD W - Boxelder-Narrowleaf Cottonwood/Red-Osier Dogwood Woodlands; N/A - Not Applicable; NC/MG W -Narrowleaf Cottonwood/Mesic Graminoid Woodlands; OW - Open Water; PC-(PW)/SW[RC] W - Plains Cottonwood-(Peachleaf Willow)/Sandbar Willow/[Reed Canarygrass] Woodland; PC/PC-S W - Plains Cottonwood/Prairie Cordgrass-Sedge Woodland; PC/SB W - Plains Cottonwood/Smooth Brome Woodland; PC/SW W - Plains Cottonwood/Slender Wheatgrass Woodland; RC H -Reed Canarygrass Herbaceous; RO W - Russian Olive Woodland; SW/MG-[RC] S - Sandbar Willow/Mesic Graminoid-[Reed Canarygrass] Shrubland; UG - Upland Grassland.

Segment A. The narrowleaf cottonwood woodland locations within the Watson Lake study site, have minimum inundation flows of about 1,500 to 3,000 cfs (Table 5-29). Under Current Conditions hydrology, these locations would be inundated in about 6 to 17 years of the period of record. Locations inundated in at least half of the years of the period of record under Current Conditions hydrology were assumed to receive some amount of hydrological support from inundation. Only one cottonwood woodland location at the Watson Lake study site is predicted to be inundated in at least half of the years of the period of record under Current Conditions hydrology (WLLT1.2). The inundation under Alternative 4 with Future Conditions Effects and Cumulative Effects at this location is predicted to be reduced to less than half of the years of the period of record (Table 5-29). This would reduce the frequency of inundation of cottonwood woodland at this location to a degree that it is no longer supportive and would likely reduce the vigor of the stand. The predicted effects of reduced inundation are estimated to have a negligible effect on most of the cottonwood woodlands in Segment A. However, stands that are inundated at the more frequently occurring low flows are likely to be moderately impacted by a reduced number of years of inundation.

Segment B. The plains cottonwood woodland locations within the Martinez Park study site, have minimum inundation flows of about 2,000 to 3,200 cfs (Table 5-29). Under Current Conditions hydrology, these locations would be inundated in about 5 to 11 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 4 to 8 years at these locations. None of these locations would be inundated in more than half of the

years of the period of record under Current Conditions hydrology. The estimated reduction in inundation with either Future Conditions Effects or Cumulative Effects is predicted to have a negligible effect on cottonwood woodlands in Segment B because under Current Conditions hydrology, the cottonwood woodlands are not inundated with enough frequency to provide consistent hydrology hydrologic support.

Segment C. The plains cottonwood woodland locations within the Archery Site, have minimum inundation flows of about 1,900 to 4,000 cfs (Table 5-29). Under Current Conditions hydrology, these locations would be inundated in about 1 to 10 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 0 to 7 years at these locations. None of these locations would be inundated in more than half of the years of the period of record under Current Conditions hydrology. Under Alternative 4, the estimated reduction in inundation with either Future Conditions Effects or Cumulative Effects is predicted to have a negligible effect on cottonwood woodlands in Segment C because under Current Conditions hydrology, the cottonwood woodlands are not inundated with enough frequency to provide consistent hydrologic support.

Segment D. The plains cottonwood woodland locations within the Eastman Park study site, have minimum inundation flows of about 1,900 to 2,200 cfs (Table 5-29). Under Current Conditions hydrology, these locations would be inundated in about 9 to 11 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 6 to 8 years at these locations. The predicted effects of reduced inundation are estimated to have a negligible effect on most of the cottonwood woodlands in Segment D, because under Current Condition hydrology s, the cottonwood woodlands are not inundated with enough frequency to provide consistent hydrologic support.

Segment E. The plains cottonwood woodland locations within the 59th Avenue study site, have minimum inundation flows of about 580 to 4,000 cfs (Table 5-29). Under Current Conditions hydrology, these locations would be inundated in about 3 to 15 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 1 to 7 years at these locations. Only one cottonwood woodland location at the 59th Avenue study site (59T3a.1) is predicted to be inundated in more than half of the years of the period of record under Current Conditions hydrology. The inundation under Cumulative Effects at this location is predicted to be reduced by 2 years, resulting in inundation that would still occur in about half of the years of the period of record. The estimated reduction in inundation with either Future Conditions Effects or Cumulative Effects is predicted to have a negligible effect on cottonwood woodlands in Segment E because under Current Conditions hydrology, the cottonwood woodlands are not inundated with enough frequency to provide consistent hydrologic support.

Segment F. The plains cottonwood woodland locations within the Bird Farm study site, have minimum inundation flows of about 1,500 to 2,200 cfs (Table 5-29). Under Current Conditions hydrology, these locations would be inundated in about 11 years of the period of record. The number of years in which inundation would occur is predicted to be reduced by 4 to 6 years at these locations. None of these locations would be inundated in more than half of the years of the period of record under Current Conditions hydrology. The estimated reduction in inundation

with either Future Conditions Effects or Cumulative Effects is predicted to have a negligible effect on cottonwood woodlands in Segment F because under Current Conditions hydrology, the cottonwood woodlands are not inundated with enough frequency to provide consistent hydrologic support.

5.9.6.1.4 Vegetation Communities and Nonnative Species

The trajectory previously described for the mainstem riparian resources is predicted to continue with or without the NISP alternatives. Future Conditions Effects and Cumulative Effects would further reduce inundation and would reinforce the well-established trajectory. This trajectory would likely lead to the increased presence and distribution of nonnative vegetation in the plant communities along the mainstem, including an expected increase in the distribution of reed canarygrass downstream of I-25. Section 4.9.5.3.1 provides a summary of the anticipated effects on the vegetation communities along the mainstem associated with this trajectory.

5.9.6.1.5 Wetland Functions

Alternative 4 with Cumulative Effects is predicted to slightly lower the composite functional score in Segment E for depressional wetlands (Table 4-72) and is predicted to slightly lower all of the composite functional scores for riverine wetlands (Table 4-73). For depressional wetlands in Segment E, the slight decrease in function of the support of characteristic fish/aquatic habitat, flood attenuation, and short- and long-term water storage would be imperceptible and would be a negligible effect on the overall function of the wetlands. Alternative 4 with Cumulative Effects is predicted to lower the composite functional score of the riverine wetlands in Segments A, B, D, and E from functioning to functioning impaired, which would be a minor effect because the change in composite functional scores are typically based on a small change in one or more variables that contribute to the composite functional score, and the functions would not change substantially even though the functional classification would change for Segments A, B, D, and E. For riverine wetlands in all segments, slight decreases in the score for functions of the support of characteristic fish/aquatic habitat, flood attenuation, short- and long-term water storage, nutrient/toxicant removal, sediment retention/shoreline stabilization, and production export/food chain support would cause a slight decrease in overall function of riverine wetlands, a minor cumulative effect.

5.9.6.2 South Platte River

No new studies or analyses were performed for the SDEIS for the South Platte River. Alternative 4 with Cumulative Effects would on an average monthly basis reduce flows on the South Platte River by less than 10% and the stage reductions are predicted to be small (up to 0.33 feet). Given the minor reductions in flow and stage, Alternative 4 with Cumulative Effects is not predicted to affect wetland and riparian resources along the South Platte River.

5.9.7 Climate Change

Climate change has the potential to accelerate the Cumulative Effects described above. A large volume of scientific information supports the conclusion that global temperatures are increasing

and that precipitation trends would change in the future. The warming trend is expected to accelerate in coming decades. In the western United States, longer periods of drought are expected. There is also general agreement by climate scientists that climate change information specific to Colorado indicates that snowpack melting and spring runoff would occur earlier in the year and temperatures would increase by approximately 4°F by 2050, with summers warming more than winters (DiNatale and CDM Smith 2014). Under climate change, peak flows at most points in the basin below the canyon mouth are predicted to occur earlier and be reduced compared to Current Conditions hydrology. This could interact with RFFAs such as mountain pine beetle infestations that are also predicted to result in an earlier runoff (Lukas and Gordon 2010). These predicted changes in flow amounts and timing, increases in summer temperatures, and longer periods of drought would accelerate the trajectory previously described for wetland and riparian resources along the mainstem. Additionally, higher temperatures would lead to increased transpiration for wetland and riparian vegetation which when combined with less inundation and lower ground water levels would likely stress wetland and riparian vegetation and would likely lead to "drying" of the wetland and riparian areas under cumulative effects and changes to the plant communities that were better adapted to the more frequent warmer and dryer conditions. Additionally, these conditions could provide opportunities for colonization and spread of non-native plants.

5.9.8 Impact Summary

The direct and indirect impacts to wetlands, riparian resources, and other waters estimated to occur with the alternatives (Section 4.9) would contribute to the Cumulative Effects along with the RFFAs to wetlands, riparian resources, and other waters in the region. The construction and operation of all of the alternatives would cause a loss of wetlands, riparian resources and other waters that would contribute to the Cumulative Effects to wetlands, riparian resources and other waters in the region and the respective contributions of the alternatives to Cumulative Effects would be proportional to the effects described for each alternative in Section 4.9. All of the action alternatives would cause reductions in flows and river stage of the mainstem, which are predicted to accelerate and/or reinforce the well-established trajectory for riparian and wetland resources along the mainstem.

The degree to which impacts on wetland and riparian resources along the mainstem of Poudre River increase with Cumulative Effects can be seen in how predicted effects increase from Current Conditions hydrology to Cumulative Effects. This is particularly evident when comparing the predicted effects of stage changes on shallowly rooted near-bank herbaceous wetland vegetation (within 100 feet of the riverbanks). Alternative 3 is predicted to have the greatest effect on river stage. When compared to Current Conditions hydrology, the greatest predicted effect would be to an estimated 9 acres of vegetation classes that are potentially sensitive to declines in the ground water table within Segment B. Under Future Conditions Effects, the greatest predicted effect would be to an estimated 60 acres of vegetation classes that are potentially sensitive to declines in the ground water table within Segments B, C, and D. Under Cumulative Effects, the greatest predicted effect would be to an estimated 148 acres of

vegetation classes that are potentially sensitive to declines in the ground water table within Segments B, C, D, and E. This progression of predicted effects shows how effects are predicted to become more widespread along the mainstem with Future Conditions Effects and Cumulative Effects.

Generally, the No Action Alternative with Future Conditions Effects would have the least predicted flow-related indirect effect on wetland and riparian resources, and in most instances Alternative 3 would have the greatest predicted indirect effect on wetland and riparian resources along the mainstem. Alternative 3 with Cumulative Effects consistently would have the greatest number of weeks and percentage of the period of record with a decline in ground water levels of 0.5 foot or greater. For river Segments A, B, and C, Alternative 4 consistently would have the fewest number of weeks and percentage of the period of record with a decline in ground water levels of 0.5 foot or greater among the action alternatives.

The action alternatives vary slightly in terms of the number of years in which inundation of wetland and riparian areas are estimated to occur. Alternative 3 generally would decrease the number of years of inundation by about 1 more year for many of the Poudre River study site transects compared with Alternative 2. This slight decrease in the estimated number of years of inundation with Alternative 3 is to be expected because Alternative 3 would divert on average about 5,000 AFY to 6,000 AFY more from the Poudre River than Alternative 2. Alternative 4 would be similar to both Alternatives 2 and 3.

The No Action Alternative is predicted to cause a loss of 218.6 acres of wetlands associated with the transfer of irrigation from 64,200 acres of irrigated lands. This loss would add to the cumulative loss of wetlands in the region.

5.9.8.1 Poudre River

The predicted reductions in flows, inundation, river stage and associated alluvial ground water levels would reinforce the trajectory for wetland and riparian resources along the mainstem of the Poudre River (Table 5-30). However, several RFFAs could help reduce the effects of the projected trajectory and could help to reduce predicted Cumulative Effects. The proposed Poudre River restoration projects and the Fort Collins Poudre River Master Plan have an objective of reconnecting the Poudre River floodplain with high flows in the river through some reaches of Fort Collins. This could help to partially offset the effects of reduced inundation. Additionally, some of the restoration work (e.g., POE pit) has the opportunity to establish large new stands of plains cottonwood, a declining resource along the Poudre River mainstem. The Greeley Poudre River Flood Control and Environmental Restoration Project has the potential to restore wetlands and riparian areas along 17 miles of the Poudre River in the Greeley area that could improve and add to these resources in this reach of the river.

Table 5-30. Summary of flow-related indirect cumulative effects on mainstem wetland and riparian resources.

Predicted Changes to Hydrology and Effects on Resource	Alternative 1	Alternative 2 (Both Reclamation Options)	Alternative 3	Alternative 4
River Stage River stage is affected by flow and channel morphology. Changes in river flows would alter river stage. The assessment of effects associated with changes in river stage focused on near-bank herbaceous wetlands. A decline in river stage below the impact threshold is predicted to result in a shift in species at wetlands dominated by obligate wetland species to those that tolerate greater fluctuations in river stage such as reed canarygrass; a minor effect.	Minor predicted changes in river stage with negligible effect for all segments.	Future Conditions Effects and Cumulative Effects would frequently decrease river stage by 0.5 to 1.0 foot during the growing season. Future Conditions Effects: Negligible effect for all segments except Segment B (moderate effect); an estimated 9 acres of vegetation classes are potentially sensitive to declines in the ground water table. Cumulative Effects: Minor effects for Segments B, C, and D that would have a weekly average stage decline exceeding the impact threshold. An estimated 60 acres of vegetation classes are potentially sensitive to declines in the ground water table within Segments B, C, and D. Predicted to result in a shift in species at wetlands dominated by obligate wetland species to those that tolerate greater fluctuations in river stage.	Declines in river stage would be greater and more frequent than the other alternatives. Effects are predicted to be minor associated with a shift in species at wetlands dominated by obligate wetland species to those that tolerate greater fluctuations in river stage. Future Conditions Effects: Segments B, C, and D would have a weekly average stage declines that exceed the impact threshold. An estimated 60 acres of vegetation classes are potentially sensitive to declines in the ground water table. Cumulative Effects: Segments B, C, D, and E would have a weekly average stage decline that exceed the impact threshold. An estimated 148 acres of vegetation classes are potentially sensitive to declines in the ground water table. Predicted to result in a shift in species at wetlands dominated by obligate wetland species to those that tolerate greater fluctuations in river stage.	Effects are predicted to be minor associated with a shift in species at wetlands dominated by obligate wetland species to those that tolerate greater fluctuations in river stage. Future Conditions Effects: Segment D would have a weekly average stage decline that slightly exceeds the period of record. An estimated 21 acres of vegetation classes are potentially sensitive to declines in alluvial ground water levels within Segment D. Cumulative Effects: Segments B and D would have a weekly average stage decline that exceeds the impact threshold. An estimated 30 acres of vegetation classes are potentially sensitive to declines in the ground water in Segments B and D. Predicted to result in a shift in species at wetlands dominated by obligate wetland species to those that tolerate greater fluctuations in river stage.

Predicted Changes to Hydrology and Effects on Resource	Alternative 1	Alternative 2 (Both Reclamation Options)	Alternative 3	Alternative 4
Alluvial Ground Water Levels Alluvial ground water levels closely match river stage in locations close to the river. The relationship between river stage and ground water levels decreases with distance from the river. Declines in ground water levels focused on predicted declines below the observed maximum ground water depths during the growing season for cottonwood woodlands.	Negligible effect because the predicted changes in ground water levels would be within or very close to the observed range of maximum ground water depths of 2.79 feet to 6.85 feet for cottonwoods during the growing season along the mainstem.	Negligible effects on Segments A and B. Minor effects on cottonwood woodlands in Segments C, D, E, and F associated with infrequent short-lived declines below the observed maximum ground water depths during the growing season.	Declines in ground water levels are predicted to be slightly more frequent than under Alternative 2 due to increased diversions required for Cactus Hill Reservoir. Negligible effects on Segments A and B. Minor effects on cottonwood woodlands in Segments C, D, E, and F associated with infrequent short-lived declines below the observed maximum ground water depths during the growing season.	Similar to Alternatives 2 and 3, except fewer declines in ground water levels are predicted in Segments A and B due to shifting some diversions to downstream of Fort Collins. Negligible effects on Segments A, and B. Minor effects on cottonwood woodlands in Segments C, D, E, and F associated with infrequent short-lived declines below the observed maximum ground water depths during the growing season.
Inundation Frequent moderate flooding would no longer occur along the mainstem. All alternatives are predicted to further reduce inundation. The assessment of reduced flooding focused on the maintenance of cottonwood woodlands.	Reductions in inundation of cottonwood woodlands are predicted to be negligible because under Current Conditions hydrology most of the cottonwood woodlands are not inundated with enough frequency to provide consistent hydrologic support and those few cottonwood stands that are inundated in half or more of the years of the period of record would continue to be inundated.	The predicted effects of reduced inundation are estimated to have a negligible effect on most of the cottonwood woodlands. In Segment A, stands that are inundated at the more frequently occurring low flows would likely be moderately impacted by a reduced number of years of inundation.	Similar to Alternative 2. Declines in inundation are predicted to be slightly more frequent due to increased diversions required for Cactus Hill Reservoir. Reduced inundation is predicted to have a moderate effect on some cottonwood stands in Segment A that are predicted to be inundated in at least half of the years during the period of record because the frequency of inundation would be reduced to less than half of the years. Segments B, C, D, E, and F negligible effects to cottonwood woodlands.	Similar to Alternatives 2 and 3 except fewer declines in inundation frequency are predicted in Segments A and B due to shifting some diversions to downstream of Fort Collins. Reduced inundation is predicted to have a moderate effect on some cottonwood stands in Segment A that are predicted to be inundated in at least half of the years during the period of record because the frequency of inundation would be reduced to less than half of the years. Segments B, C, D, E, and F negligible effects to cottonwood woodlands.

Predicted Changes to Hydrology and Effects on Resource	Alternative 1	Alternative 2 (Both Reclamation Options)	Alternative 3	Alternative 4
Vegetation Communities The plains cottonwood woodlands appear to be on a trajectory that would eventually lead to their decline. Nonnative woody vegetation (e.g., green ash, Russian olive, and Siberian elm) are predicted to increase. In the future, plains cottonwoods would likely not dominate the riparian woodlands along the mainstem. Reed canarygrass is predicted to continue to colonize areas of the formerly active channel downstream of I-25. All alternatives are predicted to further reduce inundation.	Changes in flows associated with the No Action Alternative operations are predicted to reinforce the trajectory, but to a lesser degree than the action alternatives Minor effect; trajectory would continue with or without alternative but may be accelerated.	Changes in flows associated with NISP operations are predicted to reinforce the trajectory. Minor effect; trajectory would continue with or without alternative but may be accelerated.	Similar to Alternative 2. Minor effect; trajectory would continue with or without alternative but may be accelerated.	Similar to Alternative 2. Minor effect; trajectory would continue with or without alternative but may be accelerated.
Nonnative Species Reed canarygrass has colonized areas of the formerly active channel downstream of I-25 as the channel in this portion of the river continues to aggrade and narrow with accumulated sediment. The current trajectory of less inundation, combined with potential changes in tree canopy cover and potentially greater recreational use of the mainstem riparian plant communities, would likely lead to the increased presence and distribution of nonnative vegetation.	Changes in flows associated with the No Action Alternative operations are predicted to reinforce the trajectory, but to a lesser degree than the action alternatives Minor effect; trajectory would continue with or without alternative but may be accelerated.	Changes in flows associated with Alternative 2 are predicted to accelerate and/or reinforce the well-established trajectory. Minor effect; trajectory would continue with or without alternative.	Same as Alternative 2. Minor effect; trajectory would continue with or without alternative.	Same as Alternative 2. Minor effect; trajectory would continue with or without alternative.

Predicted Changes to Hydrology and Effects on Resource	Alternative 1	Alternative 2 (Both Reclamation Options)	Alternative 3	Alternative 4
Recruitment of Woody Riparian Vegetation Green ash, narrowleaf cottonwood, plains cottonwood, box elder, and possibly Russian olive are currently an important component of the regenerating riparian forest. The current woodland overstory, typically dominated by plains cottonwood, would likely become characterized by a greater mix of these tree species in the future.	Changes in flows associated with the No Action Alternative operations are predicted to reinforce the trajectory, but to a lesser degree than the action alternatives. Minor effect; trajectory would continue with or without alternative but may be accelerated.	Changes in flows associated with Alternative 2 are predicted to accelerate and/or reinforce the well-established trajectory. Minor effect; trajectory would continue with or without alternative.	Same as Alternative 2. Minor effect; trajectory would continue with or without alternative.	Same as Alternative 2. Minor effect; trajectory would continue with or without alternative.
Wetland Functions – Depressional Wetlands All Poudre River study site depressional wetlands are functioning under all alternatives with Segment F ranking the highest and Segment B ranking the lowest. Negligible effects would occur to the functions and services of depressional wetlands for any of the alternatives.	Little predicted change in function; negligible effect	Little predicted change in function; negligible effect.	Little predicted change in function; negligible effect.	Little predicted change in function; negligible effect.

Predicted Changes to Hydrology and Effects on Resource	Alternative 1	Alternative 2 (Both Reclamation Options)	Alternative 3	Alternative 4
Wetland Functions – Riverine Wetlands	Predicted to slightly lower all of the composite functional scores for riverine wetlands Predicted to lower the composite functional score of the riverine wetlands in Segments D and E from functioning to functioning impaired, which would be a minor effect because the functions would not change substantially even though the functional classification would change for Segments D and E.	Predicted to slightly lower all of the composite functional scores for riverine wetlands. Predicted to lower the composite functional score of the riverine wetlands in Segments A, B, D, and E from functioning to functioning impaired, which would be a minor effect because the functions would not change substantially even though the functional classification would change for Segments A, B, and D.	Predicted to slightly lower all of the composite functional scores for riverine wetlands. Predicted to lower the composite functional score of the riverine wetlands in Segments A, B, D, and E from functioning to functioning impaired, which would be a minor effect because the functions would not change substantially even though the functional classification would change for Segments A, B, and D.	Predicted to slightly lower all of the composite functional scores for riverine wetlands. Predicted to lower the composite functional score of the riverine wetlands in Segments A, B, D, and E from functioning to functioning impaired, which would be a minor effect because the functions would not change substantially even though the functional classification would change for Segments A, B, and D.
Other Flood-Related Functions Inundation is also associated with a variety of ecological processes including flushing salts, creating bare substrate for the establishment of riparian vegetation, recharging soil moisture, and exporting nutrients.	Minor effect; inundation would occur less often under the No Action Alternative, but substantially less than the action alternatives. The No Action Alternative would still likely reinforce the well-established trajectory for the mainstem riparian corridor and floodplain, which includes a reduction of functions associated with inundation.	Moderate effect; inundation would occur less often under Alternative 2 and this would reinforce the well-established trajectory for the mainstem riparian corridor and floodplain, which includes a reduction of functions associated with inundation.	Moderate effect; similar to Alternative 2.	Moderate effect; similar to Alternative 2.

5.9.8.2 South Platte River

No new studies or analyses were performed for the SDEIS for the South Platte River. Alternative 4 with Cumulative Effects would on an average annual basis reduce flows on the South Platte River by less than 10% and the stage reductions are predicted to be small (up to 0.33 feet). Given the minor reductions in flow and stage, Alternative 4 with Cumulative Effects is not predicted to affect wetland and riparian resources along the South Platte River.

Table 5-31. Predicted maximum ground water levels at ground water monitoring wells based on predicted maximum stage changes per month.

Monitoring Well	Watson Lake		Martinez Park			Archery Site		Eastman Park				59th Avenue			Bird Farm	
	G3	G5	L1	L4	L5	A3	A4	Y2	Y3	Y4	Y5	59-1	59-2	59-3	D4	D5
Distance (ft)[1]	475	50	400	50	200	25	75	600	500	375	100	50	200	100	100	<50
Percent Change[2]	20	65	0	65	15	90	70	0	0	20	47	80	35	47	78	90
Max depth to ground water during the growing season[3]																
May	2.11	2.44	4.44	5.04	3.47	5.95	6.08	4.83	5.19	6.01	6.29	4.30	3.97	4.41	4.83	6.40
June	2.11	1.98	3.83	3.94	1.92	4.47	4.55	4.22	4.32	4.77	5.41	NA	NA	5.32	5.59	NA
July	2.46	2.55	4.70	5.13	3.70	5.66	5.94	5.31	5.76	6.70	6.75	5.24	6.11	5.86	5.15	6.63
August	2.37	2.49	4.91	5.71	4.26	6.04	6.22	5.44	5.86	6.79	6.82	5.63	6.20	6.32	5.38	6.84
September	2.79	2.95	5.29	6.04	4.78	6.05	6.22	5.52	5.92	6.79	6.85	5.54	6.02	6.25	5.26	6.83
Alternative 1 - Run 9a maximum predicted ground water depth[4]																
May	2.17	2.64	4.44	5.42	3.56	6.61	6.59	4.83	5.19	6.08	6.46	4.40	4.01	4.47	4.95	6.54
June	2.18	2.20	3.83	4.38	2.02	5.25	5.16	4.22	4.32	4.80	5.49	NA	NA	NA	5.64	NA
July	2.53	2.78	4.70	5.79	3.85	6.59	6.66	5.31	5.76	**6.89**	7.18	5.70	6.31	6.13	5.59	**7.14**
August	2.41	2.61	4.91	5.79	4.28	6.26	6.39	5.44	5.86	6.79	6.82	5.63	6.20	6.32	5.38	6.84
September	2.82	3.03	5.29	6.04	4.78	6.05	6.22	5.52	5.92	6.79	6.85	5.54	6.02	6.25	5.26	6.83
Alternative 2 - Run 5a maximum predicted ground water depth[4]																
May	2.29	3.04	4.44	6.76	3.87	**8.06**	**7.72**	4.83	5.19	**7.04**	**8.72**	**7.67**	5.44	6.39	**7.29**	**9.24**
June	2.38	2.88	3.83	4.64	2.08	6.36	6.02	4.22	4.32	5.45	**7.00**	NA	NA	6.43	**7.10**	NA
July	2.55	2.86	4.70	5.86	3.87	6.69	6.74	5.31	5.76	**6.95**	**7.35**	5.87	6.39	6.23	5.40	**6.92**
August	2.43	2.70	4.91	6.14	4.36	6.36	6.47	5.44	5.86	**7.06**	**7.45**	6.29	6.49	6.71	5.48	**6.96**
September	3.02	3.72	5.29	6.47	4.88	6.08	6.24	5.52	5.92	**7.09**	**7.55**	5.78	6.13	6.39	5.42	**7.02**
Alternative 3 - Run 5b1 maximum predicted ground water depth[4]																
May	2.31	3.09	4.44	6.87	3.89	**8.07**	**7.73**	4.83	5.19	**7.04**	**8.72**	**7.67**	5.44	6.39	**7.29**	**9.24**
June	2.42	2.98	3.83	5.86	2.36	6.55	6.17	4.22	4.32	5.45	**7.01**	NA	NA	6.37	**7.10**	NA
July	2.55	2.86	4.70	5.81	3.86	6.69	6.74	5.31	5.76	**7.20**	**7.93**	5.86	6.38	6.22	5.55	**7.09**
August	2.48	2.86	4.91	6.44	4.43	6.34	6.45	5.44	5.86	**7.06**	**7.45**	6.29	6.49	6.71	5.50	**6.98**
September	2.84	3.12	5.29	6.31	4.84	6.10	6.26	5.52	5.92	**7.09**	**7.55**	5.78	6.13	6.39	5.45	**7.05**

Monitoring Well	Watson Lake		Martinez Park			Archery Site		Eastman Park				59th Avenue			Bird Farm	
	G3	G5	L1	L4	L5	A3	A4	Y2	Y3	Y4	Y5	59-1	59-2	59-3	D4	D5
Alternative 4 - Run 5b2 maximum predicted ground water depth[4]																
May	2.30	3.08	4.44	6.61	3.83	**7.95**	**7.63**	4.83	5.19	**7.03**	**8.69**	**7.67**	5.44	6.39	**7.29**	**9.24**
June	2.37	2.84	3.83	5.52	2.28	6.22	5.91	4.22	4.32	5.44	**6.99**	NA	NA	6.24	**7.20**	NA
July	2.51	2.73	4.70	5.89	3.88	5.82	6.07	5.31	5.76	**7.03**	**7.53**	5.93	6.41	6.26	5.40	**6.92**
August	2.40	2.59	4.91	6.33	4.40	6.07	6.24	5.44	5.86	**7.06**	**7.45**	6.30	6.49	6.71	5.44	**6.91**
September	2.85	3.14	5.29	6.47	4.88	6.08	6.24	5.52	5.92	**7.09**	**7.55**	5.79	6.13	6.40	5.36	**6.95**

[1]Distance from the riverbank to the ground water monitoring well.

[2]Percent of ground water level change vs. river stage change for the distance from the river.

Estimated to be May 1 through September 30.

The 59th Avenue and Bird Farm sites were not monitored for the full growing season in 2009.

[3]Ground water levels were collected in 2009 data were collected weekly through the growing season, except for 59th Avenue and Bird Farm sites; 2010 and 2011 data were collected twice during the growing season for each year: 5/11/10, 7/27/10, 5/20/11, and 8/24/11.

[4]Determined with the following formula: (Percent change x maximum stage change) + maximum ground water change.

NA= Not applicable because ground water levels were not collected at those wells for June for any of the years collected.

Bolded maximum water level depths are greater that the observed maximum ground water depth during the growing season of 6.85 feet.

Table 5-32. Composite FACWet functional capacity index score for depressional wetlands with cumulative effects.

Poudre River Study Site-Segment	Existing Conditions	Cumulative Effects			
		Alternative 1	Alternative 2	Alternative 3	Alternative 4
Watson Lake-A	0.72	0.72	0.72	0.71	0.72
Martinez Park-B	0.70	0.70	0.70	0.70	0.70
Archery Site-C	0.72	0.72	0.72	0.71	0.72
Eastman Park-D	0.73	0.73	0.73	0.72	0.72
59th Avenue-E	0.76	0.76	0.75	0.75	0.75
Bird Farm-F	0.77	0.77	0.77	0.77	0.77

1.0 to 0.9 – Reference Standard; <0.9 to 0.8 – Highly Functioning; <0.8 to 0.7 – Functioning; <0.7 to 0.6 – Functioning Impaired; <0.6 – Nonfunctioning.

Table 5-33. Composite FACWet functional capacity index score for riverine wetlands cumulative effects.

Poudre River Study Site-Segment	Existing Conditions	Cumulative Effects			
		Alternative 1	Alternative 2	Alternative 3	Alternative 4
Watson Lake-A	0.71	0.70	0.68	0.68	0.69
Martinez Park-B	0.71	0.70	0.68	0.68	0.69
Archery Site-C	0.69	0.68	0.67	0.67	0.66
Eastman Park-D	0.70	0.69	0.68	0.67	0.67
59th Avenue-E	0.70	0.69	0.68	0.67	0.68
Bird Farm-F	0.73	0.72	0.71	0.71	0.71

1.0 to 0.9 – Reference Standard; <0.9 to 0.8 – Highly Functioning; <0.8 to 0.7 – Functioning; <0.7 to 0.6 – Functioning Impaired; <0.6 – Nonfunctioning.

5.10 WILDLIFE

This section provides information on the potential cumulative effects of the alternatives on wildlife resources. Cumulative effects on individual special status wildlife species are discussed in Section 5.11. Cumulative effects on wildlife resources are described for both flow-related resources and land-based resources. Most wildlife are land-based resources; however, specific species or groups of species associated with aquatic habitats (e.g., beaver, waterfowl, shorebirds, fish-eating birds) or species that occur in riparian and wetlands habitats influenced by flows may be affected by cumulative changes to flows in the Poudre and South Platte Rivers.

The flow-related cumulative effects on wetland and riparian habitats are described in Section 5.9. The current trend leading to shifts in woody riparian species composition along the mainstem is expected to continue and to be affected by the NISP alternatives (Section 4.9.1.1). The combined effects of the RFFAs and NISP alternatives (cumulative effects) are predicted to further reinforce and/or accelerate the previously described trajectory of wetland and riparian resources along the mainstem.

RFFAs that would result in cumulative effects on wildlife resources, when combined with the effects of the proposed project, include construction of Chimney Hollow Reservoir associated with the Windy Gap Firming Project and the expansion of Halligan and Seaman Reservoirs, population growth and urban development, the North 1-25 improvement project, other construction projects that disturb vegetation resources and wildlife habitat, oil and gas development, Poudre River regional trail connections, and proposed projects along the Poudre River.

5.10.1 No Action Alternative (Alternative 1)

Information on wildlife and wildlife habitat permanently impacted under the No Action Alternative from direct and indirect effects is provided in Section 4.10.2. Wildlife habitat would be impacted under the No Action Alternative by construction and inundation of Cactus Hill Reservoir, construction of the conveyance system, dry-up of irrigated lands, and decreased water flows in the Poudre River.

5.10.1.1 Big Game

The combined effects of human population growth, commercial and residential development, transportation improvements and water storage and delivery, including the loss or degradation of 2,280 acres of grassland habitat due to the construction of a 120,000 AF Cactus Hill Reservoir under the No Action Alternative, would result in the loss or degradation of habitat, mortality from ground-disturbing activities and increased traffic, and creation or expansion of movement barriers. Cumulative effects were assessed for mule deer, pronghorn, and white-tailed deer. The No Action Alternative would not affect elk habitat and no cumulative effect would occur on elk.

The construction of Chimney Hollow Reservoir would permanently affect about 810 acres of mule deer winter range, mule deer concentration areas, and mule deer summer range. Chimney

Hollow also occurs within the overall range of white-tailed deer, but there would be no effect to winter or summer ranges (Reclamation 2011). The expansion of the Halligan and Seaman Reservoirs would also permanently affect mule deer winter concentration areas, winter and severe winter range. The expansion of Seaman Reservoir would restrict or substantially alter local movements of mule deer. Because different populations of big game occur in the plains grasslands (Cactus Hill and Galeton Reservoirs) compared to the Foothills grasslands (Chimney Hollow and Seaman Reservoirs), the No Action Alternative and RFFAs would not affect the same populations and there would be no cumulative effect on elk at a local scale and the cumulative effect on mule deer would occur from the other RFFAs and the No Action Alternative.

The North I-25 improvement project would also affect wildlife and big game corridors, although highway design would expand the openness of bridges and remove culverts to improve and maintain the existing corridors in the already severely fragmented landscape along I-25 (CDOT 2011). NISP Participants in the cumulative effects study area have planning boundaries that have projected human population growth. Big game habitat would be permanently lost from future commercial and residential development, particularly as development expands west into the foothills and along river corridors. In addition, the cumulative losses of grassland habitat from Cactus Hill Reservoir, oil and gas development and commercial and residential development would affect pronghorn and other grassland-associated wildlife.

On a regional scale, cumulative effects would be negligible for big game species because <1% of habitat available within each Game Management Unit established by CPW would be affected and the No Action Alternative and RFFAs would not likely have a noticeable effect on big game populations or sex ratios at a regional scale. On a local scale, cumulative effects would be major for mule deer because effects on winter concentration areas would be greater than 20% and moderate for pronghorn and white-tailed deer because the moderate direct effect at Cactus Hill and the loss of habitat associated with the RFFAs would not result in the loss of more than 20% of the local habitat.

5.10.1.2 Migratory Birds and Raptors

Migratory birds would be affected by the No Action Alternative through the loss of nesting, migratory, winter, and year-round habitat and the potential destruction of nests. Most direct effects would occur from the construction of Cactus Hill Reservoir. About 2,315 acres of grassland, wetland, and woodland habitat and 239 acres of agricultural land would be impacted at Cactus Hill Reservoir. The construction of Chimney Hollow Reservoir would affect 788 acres of vegetation communities, the effects from the expansion of the Halligan and Seaman Reservoirs have not been determined, and the North I-25 improvement project would affect 818 acres of vegetation communities, which would permanently affect habitat that provides foraging and nesting habitat for migratory birds (Reclamation 2011; CDOT 2011). Because of the permanent direct and indirect loss of 250 acres of wetlands (mostly from agricultural dry-up) and 2,541 acres of grassland habitat and agricultural land, the No Action Alternative would result in major effects on migratory birds. These impacts, in combination with impacts from other

RFFAs, would result in additional cumulative losses of migratory bird habitat. Some of these cumulative effects would be offset by the construction of new reservoirs that would provide new open water habitat for waterfowl as well as foraging habitat for fish-eating birds such as osprey. Newly created shorelines would provide new habitat for shore birds. Projects along the Poudre River that improve riparian habitat would increase habitat for migratory birds, which would offset some of the cumulative effects.

Direct impacts to raptors could occur under the No Action Alternative and RFFAs during construction and human activity around an active raptor nest. Depending on several factors such as species, the type of activity, topography, and individual sensitivity, disturbance could result in loss of eggs or young from nest abandonment. The Chimney Hollow Reservoir and the North I-25 improvement project have received RODs that require implementation of timing restrictions and nest avoidance measures similar to measures proposed for NISP to comply with the Migratory Bird Treaty Act. Implementation of these measures would reduce and minimize adverse cumulative effects to migratory birds and raptors. Cumulative effects to migratory birds and raptors would be minor.

5.10.1.3 Reptiles and Amphibians

Reptiles and amphibians occurring in the affected vegetation types described in the Vegetation section (4.8) would be directly affected by the No Action Alternative through the loss of habitat. Mortality of adults, eggs, or tadpoles could also occur during construction of Cactus Hill Reservoir, pipelines, and other project components. The cumulative effects on vegetation resources that provide habitat for reptiles and amphibians would be similar to those described for migratory birds because they occur in the same habitats.

The open water habitat created by the construction of Chimney Hollow Reservoir would provide some new habitat for amphibians but the habitat would likely be low quality because persistent wetland vegetation is typically prevented by large fluctuations of reservoir levels. Projects along the Poudre River that improve riparian habitat would increase habitat for reptiles and amphibians, which would offset some of the cumulative effects. Cumulative effects to reptiles and amphibians would be minor.

5.10.1.4 Other Wildlife Species

Small and large mammals associated with affected vegetation types described in the Vegetation section (4.9) would be directly affected by the No Action Alternative through the loss of habitat. Mortality of individuals of smaller, less mobile species could also occur during construction of reservoirs, pipelines, and other project components. Cumulative effects on general wildlife habitat from the No Action Alternative would be similar to those described above for migratory birds. New reservoirs such as Chimney Hollow could provide habitat and additional sources of water for various wildlife such as muskrat and beaver, depending on the composition of shorelines and reservoir fluctuations.

Pipelines, roads, and other linear facilities can create barriers to wildlife movements and fragment habitat. As described under the big game section, the North I-25 improvement project would use highway designs that expand the openness of bridges and remove culverts to improve and maintain the existing corridors in the already severely fragmented landscape along I-25 (CDOT 2011). No wildlife migration corridors would be crossed by conveyance systems under the No Action Alternative, with pipelines buried underground and alignments revegetated. Cumulative effects to general wildlife would be minor.

5.10.1.5 No Action Irrigated Lands

In addition to the cumulative effects described above, the dry up of irrigated agricultural land from future growth and development along with the dry-up of 62,400 acres of irrigated lands under the No Action would contribute to the to the ongoing regional trend of reduced agricultural lands, which is expect to decrease wetland (described above), irrigated meadow, and grassland habitats. Dry up of agricultural lands could include reestablishing native vegetation in some areas that would provide habitat for grassland-associated wildlife, which would be a beneficial effect for these species.

5.10.1.6 Flow-related cumulative effects on wildlife

Cumulative effects of Poudre River flow changes on wetland and riparian vegetation that provide habitat for migratory birds, amphibians, reptiles, and other wildlife are described in Section 5.8. The analysis found that under all alternatives, plains cottonwoods would likely continue to decline along the mainstem of the Poudre River, while nonnative species such as green ash, box elder, Siberian elm, Russian olive, and reed canarygrass would persist or increase. Under the No Action Alternative, herbaceous and shrub wetlands and riparian habitat are not expected to have measurable changes, mainly because the changes in hydrology occur in average and wetter than average years and the supportive hydrology would remain for most of the growing season. These negligible effects on herbaceous and shrub wetlands and riparian shrub communities are not expected to affect the many mammals, migratory birds, amphibians, and reptiles that currently use the riparian corridor. The cumulative effects on river stage and ground water levels for the No Action Alternative are expected to be negligible but would still contribute to the trajectory of changing vegetation communities. Corresponding changes in wildlife communities from the established trajectory on vegetation communities described in detail in the 2015 Wildlife Supplement (ERO 2015c) would include:

- A decrease in the abundance of roosting/nesting/breeding opportunities for riparian wildlife
- A shift in wildlife species composition
- A decreased abundance of suitable nesting and roosting habitat for colonial birds (herons and egrets) and raptors
- A shift of the relative abundance of the fish community to more small-bodied species

Section 5.12 predicted that reduced flows under the No Action Alternative with Future Conditions hydrology would not likely affect the overall species composition of the fish community, but the relative abundance may shift to a community more dominated by small-bodied warm-water species with fewer trout. Any change in the relative size of the fish within the fish community would have a corresponding change in the fish-eating bird community. Although the relative abundance of fish-eating birds may shift in response to changes in fish size within the Poudre River, the presence of alternative prey resources in lakes and ponds along the river corridor would likely moderate some of these effects. Minor effects on macroinvertebrates described in Section 5.12 would not likely adversely affect bird species that feed on macroinvertebrates. Projects along the Poudre River that improve riparian habitat would increase habitat for many species of wildlife, which would offset some of the adverse cumulative effects. Overall, flow-related cumulative effects on wildlife species along the Poudre are predicted to be negligible.

5.10.2 District's Preferred Alternative (Alternative 2)

Information on wildlife and wildlife habitat permanently impacted under Alternative 2 from direct and indirect effects is provided in Section 4.10.3. Wildlife habitat would be impacted under Alternative 2 by construction and inundation of Glade and Galeton Reservoirs, construction of the conveyance systems, decreased water flows in the Poudre River, and winter flow augmentation on the Poudre River. The minimal reduced flows on the South Platte would not result in cumulative effects on wildlife.

5.10.2.1 Big Game

The combined effects of human population growth, commercial and residential development, transportation improvements and water storage and delivery, including the permanent loss or degradation of about 3,500 acres of grassland, shrubland, and woodland habitat due to the construction of Glade, U.S. 287, and Galeton Reservoirs under Alternative 2, would result in the loss or degradation of habitat, mortality from ground-disturbing activities and increased traffic, and creation or expansion of movement barriers. Cumulative effects on mule deer, white-tailed deer, elk, and pronghorn were assessed. The construction of Chimney Hollow Reservoir would permanently affect about 810 acres of mule deer winter range, mule deer concentration areas, and mule deer summer range. Chimney Hollow also occurs within the overall range of white-tailed deer, but there would be no effect to winter or summer ranges (Reclamation 2011). The expansion of the Halligan and Seaman Reservoirs would also permanently affect mule deer winter concentration areas, winter and severe winter range. The expansion of Seaman Reservoir would restrict or substantially alter local movements of mule deer and a resident elk herd in the area north of highway 14 and west of U.S. 287. The North I-25 improvement project would also affect wildlife and big game corridors, although highway design would expand the openness of bridges and remove culverts to improve and maintain the existing corridors in the already severely fragmented landscape along I-25 (CDOT 2011).

The construction and inundation of Glade Reservoir, Galeton Reservoir, and the realignment of U.S. 287, as well as development of the former Holcim property and other RFFAs, would result in cumulative effects on deer, elk and pronghorn movement patterns. Existing barriers to movement of deer, and in particular the resident elk herd west of the proposed Glade Reservoir, include SH 14, Seaman Reservoir, and the steep canyons of the North Fork of the Poudre River. The proposed Glade Reservoir occurs along the eastern portion of elk range. Although eastward movement of deer and elk in this area is restricted by U.S. 287 and the Holcim Mine, Glade Reservoir would inundate areas identified as mule deer and elk highway crossing areas. Construction of Glade Reservoir would likely result in further disruption of east-west movement of deer and elk, displacing movement to the north and/or south of the proposed reservoir. The proposed expansion of the Seaman Reservoir would create a larger barrier to movement in the North Fork of the Poudre River. The cumulative effects of the Glade Reservoir and the proposed expansion of the Seaman Reservoir would further restrict deer and elk movements and could contribute to the geographic isolation of these herds. The U.S. 287 realignment would also bisect an area of pronghorn severe winter range. Combined with future development of the former Holcim mine, the realigned highway would likely impede movement or displace pronghorn from the southern end of this range. The North I-25 improvement Project would also expand existing movement barriers for mule and white-tailed deer. Final highway design would implement measures to avoid, minimize and maintain wildlife movement corridors (CDOT 2011). The loss of mule deer and pronghorn winter range and overall range at Galeton Reservoir would have less effect on movement because fewer barriers exist. On a regional scale, cumulative effects would be negligible for big game species because these projects would not likely have a noticeable effect on big game populations or sex ratios at a regional scale. On a local scale, cumulative effects would be minor for white-tailed deer and major for mule deer, pronghorn, and elk, particularly to local and resident herds in the Seaman to Glade/realigned U.S. 287 area because greater than 20% of the local habitat would be lost and more fragmented.

5.10.2.2 Migratory Birds and Raptors

Migratory birds would be directly affected by Alternative 2 through the loss of nesting, migratory, winter, and year-round habitat and the potential destruction of nests. Most of the effects would occur as a result of construction of Glade and Galeton Reservoirs.

The construction of Chimney Hollow Reservoir would affect 788 acres of habitat, the effects from the expansion of the Halligan and Seaman Reservoirs have not been determined, and the North I-25 improvement project would affect 818 acres of vegetation communities that provide foraging and nesting habitat for migratory birds (Reclamation 2011; CDOT 2011). These impacts, in combination with impacts from other RFFAs, would result in additional cumulative losses of migratory bird habitat. Some of these cumulative effects would be offset by the construction and expansion of reservoirs that would provide new open water habitat for waterfowl as well as foraging habitat for fish-eating birds such as osprey. Newly created shorelines would provide new habitat for shore birds. Projects along the Poudre River that improve riparian habitat would increase habitat for riparian birds, a beneficial effect.

Similar to the No Action Alternative, impacts to raptors could occur under Alternative 2 and the RFFAs during construction and human activity around an active raptor nest. Chimney Hollow Reservoir and the North I-25 Expansion Project have received RODs that require implantation of timing restrictions and nest avoidance measures similar to measures proposed for NISP to comply with the Migratory Bird Treaty Act. Implementation of these measures would reduce and minimize adverse cumulative effects to migratory birds and raptors. Cumulative effects to migratory birds and raptors would be minor.

5.10.2.3 Reptiles and Amphibians

Reptiles and amphibians occurring in the affected vegetation types described in the Vegetation section (4.9) would be directly affected by Alternative 2 through the loss of habitat. Mortality of adults, eggs, or tadpoles could also occur during construction of Glade and Galeton Reservoirs, U.S. 287, pipelines, and other project components. The cumulative effects on wetlands, grasslands and agricultural areas that provide habitat for reptiles and amphibians would be the same as described for migratory birds because similar habitats are used.

The open water habitat created with the construction and expansion of reservoirs would provide some new habitat for amphibians, but it would likely be low quality because of the lack of persistent wetland vegetation. Projects along the Poudre River that improve riparian habitat would increase habitat for riparian associated reptiles and amphibians, which would offset some of the cumulative effects. Cumulative effects to reptiles and amphibians would be minor.

5.10.2.4 Other Wildlife Species

Small and large mammals associated with affected vegetation types described in the Vegetation section (4.9) would be directly affected by Alternative 2 through the loss of habitat. Mortality of individuals of smaller, less mobile species could also occur during construction of reservoirs, pipelines, and other project components.

Cumulative effects on wildlife habitat from Alternative 2 would be similar to those described above for migratory birds. New reservoirs could provide habitat and additional sources of water for various wildlife, such as muskrat and beaver, depending on the composition of shorelines and reservoir fluctuations. Projects along the Poudre River that improve riparian habitat would increase habitat for riparian wildlife, which would offset some of the cumulative effects. Cumulative effects to general wildlife would be minor.

5.10.2.5 Flow-related cumulative effects on wildlife

Section 5.12 predicted that reduced spring flows under Alternative 2 with Future Conditions Effects and Cumulative Effects would not likely affect the overall species composition of the fish community. Except for Segment B, lower spring flows and warmer temperatures would likely decrease habitat availability for adult trout, but increase habitat for juvenile trout, longnose dace and other small-bodied fish. Alternative 2 in Segment B would have a minor to moderate beneficial impact to most species of fish through the flow augmentation program. Thus, the

overall relative abundance may shift to a fish community more dominated by small-bodied individuals with fewer large trout. Any change in the relative size of the fish within the fish community would have a corresponding change in the fish-eating bird community. Although the relative abundance of fish-eating birds may shift in response to changes in fish size within the Poudre River, the presence of alternative prey resources in lakes and ponds along the river corridor would likely moderate some of these effects. Minor effects on macroinvertebrates described in Section 5.12 would not likely adversely affect bird species that feed on macroinvertebrates. Reduced spring river flows would likely have a minor adverse effect on the overall abundance of wildlife and could alter species composition and distribution. The combined effects of the RFFAs and Alternative 2 are predicted to further reinforce and/or accelerate the trajectory of wetland and riparian resources along the mainstem described under the No Action Alternative. While declines in river stage may affect wetlands along the banks of the Poudre River, especially in Segments B and D, the changes in vegetation would be minor because most wetlands along the banks of the mainstem are dominated by reed canarygrass and sandbar willow, two species that can tolerate a range of ground water levels. Proposed projects along the Poudre River that improve riparian habitat would increase habitat for many species of wildlife, which would offset some of the adverse cumulative effects. Overall, flow-related cumulative effects on wildlife species along the Poudre are predicted to be negligible.

5.10.3 Alternative 3

Information on wildlife and wildlife habitat permanently impacted under Alternative 3 from direct and indirect effects is provided in Section 4.10.4. Wildlife habitat would be impacted under Alternative 3 by construction of a 190,000 AF Cactus Hill Reservoir, Galeton Reservoir, inundation by both reservoirs, construction of conveyance systems, lining of the Poudre Valley Canal, and decreased water flows in the Poudre River. Alternative 3 would not include a flow augmentation program that would benefit the Poudre River during winter. Because flow changes on the South Platte River are predicted to be minimal, no cumulative effects on wildlife are expected on the South Platte River. Generally, the effects, and subsequently the cumulative effects, on wildlife at Cactus Hill Reservoir are greater under Alternative 3 than under the No Action Alternative because of the larger reservoir size.

5.10.3.1 Big Game Species

As described in Section 5.10.1.1 and Section 5.10.2.1, construction and/or expansion of Chimney Hollow, Halligan and Seaman Reservoirs would all occur within elk and mule deer winter range and winter concentration areas. Under Alternative 3, most of the permanent effects on big game habitat would occur as a result of construction of Cactus Hill Reservoir and Galeton Reservoir. Because different populations of big game occur in the plains grasslands (Cactus Hill and Galeton Reservoirs) compared to the foothills grasslands (Chimney Hollow and Seaman Reservoirs), Alternative 3 and RFFAs would not affect the same populations and there would be no cumulative effect on elk at a local scale and the cumulative effect on mule deer would occur from the other RFFAs and Alternative 3. Pronghorn and deer would be affected by growth and

development and oil and gas development that removes habitat. The cumulative effect of Alternative 3 and the RFFAs would be similar to the No Action Alternative, although the extent and magnitude of effects on mule deer and pronghorn would be noticeably greater because the addition of Galeton Reservoir would cause the loss of mule deer and pronghorn overall and winter range (see Section 4.10.4.1). On a regional scale, cumulative effects would be negligible for big game species because Alternative 3 and RFFAs would not likely have a noticeable effect on big game populations or sex ratios at a regional scale. On a local scale, cumulative effects would be major for mule deer, white-tailed deer, and pronghorn because the Alternative 3 and future residential development would result in the loss of greater than 20% winter range, winter concentration area, and severe winter range.

5.10.3.2 Migratory Birds and Raptors

Migratory birds would be directly affected by Alternative 3 through the loss of nesting, migratory, winter, and year-round habitat and the potential destruction of nests. Under Alternative 3, most of the effects on migratory bird and raptor habitat would occur as a result of construction of Cactus Hill Reservoir and Galeton Reservoir. The construction of Chimney Hollow Reservoir (788 acres), the expansion of the Halligan and Seaman Reservoirs (acreage currently unknown), and the North I-25 improvement project (818 acres) would result in impacts that would permanently affect vegetation communities that provide foraging and nesting habitat for migratory birds (Reclamation 2011; CDOT 2011). These impacts, in combination with impacts from other RFFAs, would result in additional cumulative losses of migratory bird habitat. Some of these cumulative effects would be offset by the construction and expansion of reservoirs that would provide new open water habitat for waterfowl as well as foraging habitat for fish-eating birds such as osprey. Newly created shorelines would provide new habitat for shore birds. Projects along the Poudre River that improve riparian habitat would increase habitat for migratory birds, a beneficial effect.

Similar to the No Action Alternative, impacts to raptors could occur under Alternative 3 combined with the RFFAs during construction and human activity around an active raptor nest. Chimney Hollow Reservoir and the North I-25 Expansion Project have received RODs that require implementation of timing restrictions and nest avoidance measures similar to measures proposed for NISP to comply with the Migratory Bird Treaty Act. Implementation of these measures would reduce and minimize adverse cumulative effects to migratory birds and raptors. Cumulative effects to migratory birds and raptors would be minor.

5.10.3.3 Reptiles and Amphibians

Reptiles and amphibians occurring in the affected vegetation types described in the Vegetation section (4.9) would be directly affected by Alternative 3 through the loss of habitat. Mortality of adults, eggs, or tadpoles could also occur during construction of Cactus Hill and Galeton Reservoirs, pipelines, and other project components. The cumulative effects on wetlands, grasslands and agricultural areas that provide habitat for reptiles and amphibians would be the same as described for migratory birds. The open water habitat created with the construction of

Cactus Hill and Galeton Reservoirs would provide some new habitat for amphibians but the habitat would likely be low quality because persistent wetland vegetation is typically prevented by fluctuations of reservoir levels. Projects along the Poudre River that improve riparian habitat would increase habitat for reptiles and amphibians, a beneficial effect, which would offset some of the cumulative effects. Cumulative effects to reptiles and amphibians would be minor.

5.10.3.4 Other Wildlife Species

Small and large mammals associated with affected vegetation types described in the Vegetation section (4.9) would be directly affected by Alternative 3 through the loss of habitat. Mortality of individuals of smaller, less mobile species could also occur during construction of reservoirs, pipelines, and other project components. Cumulative effects on wildlife habitat from Alternative 3 would be similar to those described above for migratory birds. New reservoirs could provide habitat and additional sources of water for various wildlife such as muskrat and beaver, depending on the composition of shorelines and reservoir fluctuations. Projects along the Poudre River that improve riparian habitat for wildlife, would offset some of the cumulative effects. Cumulative effects to general wildlife would be minor.

5.10.3.5 Flow-related cumulative effects on wildlife

The effects from Alternative 3 Future Conditions Effects and Cumulative Effect would be similar to the adverse and beneficial effects presented for Alternative 2 except that Segment B would not benefit from the winter flow augmentation. The combined effects of the RFFAs and Alternative 3 are predicted to further reinforce and/or accelerate the trajectory of wetland and riparian resources along the mainstem described in Section 5.10.1. While declines in river stage may affect wetlands along the banks of the Poudre River under Alternative 3, especially in Segments B and D, the changes in vegetation would be minor because most wetlands along the banks of the mainstem are dominated by reed canarygrass and sandbar willow, two species that can tolerate a range of ground water levels. Projects along the Poudre River that improve riparian habitat would increase habitat for general wildlife, which would offset some of the cumulative effects. Cumulative effects on wildlife species along the Poudre are predicted to be negligible.

5.10.4 Alternative 4

Detailed information on the direct and indirect effects of Alternative 4 on wildlife is provided in Section 4.10.5. The effects of Alternative 4 on wildlife are similar to Alternative 3. Permanent effects are the same for the reservoir sites, conveyance systems, and river segments, with temporary effects varying by less than 1 acre between the two alternatives for all species. Alternative 4 would not include a flow augmentation program that would benefit the Poudre River. Because flow changes on the South Platte River are predicted to be minimal, no cumulative effects on wildlife are expected on the South Platte River. The contributions of the

RFFAs to cumulative effects for Alternative 4 are similar to Alternative 3. Therefore, overall cumulative effects to wildlife for Alternative 4 would be minor.

5.10.5 Climate Change

Climate change has the potential to accelerate the cumulative effects described above. A large volume of scientific information supports the conclusion that global temperatures are increasing and that precipitation trends would change in the future. The warming trend is expected to accelerate in coming decades. In the western United States, longer periods of drought are expected. There is also general agreement by climate scientists that climate change information specific to Colorado indicates that snowpack melting and spring runoff would occur earlier in the year and temperatures would increase by approximately 4°F by 2050, with summers warming more than winters (DiNatale and CDM Smith 2014). Under climate change, warmer temperatures and prolonged drought would affect survival of many species of wildlife. Species composition and distribution would likely change while diversity may decrease. Longer periods of drought may result in the loss of limited or sparsely distributed habitats and the species associated with those habitats, such as seasonal wetlands and ephemeral drainages with riparian habitat. Species adapted to drier and warmer conditions would become more abundant and would move into habitats altered by extended periods of drought. Wildlife communities may change as some species becomes less able to adapt. Some species may adapt by moving up in elevation, while others may move further north.

5.10.6 Impact Summary

Table 5-36 and Table 5-37 summarize the cumulative effects on Wildlife for the NISP alternatives.

Table 5-34. Cumulative effects on wildlife.

Species	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Flow-related effects	Contribute to the current trajectory of wetland and riparian woodland decline from past actions. Negligible effect on wetlands and riparian associated species and fish-eating birds	The combined effects of the RFFAs and Alternative 2 are predicted to further reinforce and/or accelerate the trajectory of wetland and riparian resources along the mainstem described under the No Action Alternative.	The combined effects of the RFFAs and Alternative 3 are predicted to further reinforce and/or accelerate the trajectory of wetland and riparian resources along the mainstem described under the No Action Alternative.	Similar to Alternative 3.
Land based effects	Contribute to cumulative losses of big game seasonal ranges, create new and expand existing movement barriers for big game and other wildlife. Cumulative losses of migratory bird, reptile and amphibian and other wildlife habitat. Some of these cumulative effects would be offset by the construction and expansion of the Cactus Hill Reservoir that would provide new open water habitat for waterfowl as well as foraging habitat for fish-eating birds such as osprey. Drying of irrigated lands would likely contribute to cumulative losses of wetland, irrigated meadow and grassland habitats. Dry up could include reestablishing native vegetation in some areas that would provide habitat for grassland-associated wildlife	Contribute to cumulative losses of big game seasonal ranges, create new and expand existing movement barriers for big game and other wildlife. Cumulative losses of migratory bird, reptile and amphibian and other wildlife habitat. Some of these cumulative effects would be offset by the conversion of construction and expansion of reservoirs that would provide new open water habitat for waterfowl as well as foraging habitat for fish-eating birds such as osprey. The construction of Glade Reservoir and the realignment of U.S. 287 would likely further disrupt east-west movement of deer, elk, and pronghorn. The proposed expansion of Seaman Reservoir would create a larger barrier to movement in the North Fork of the Poudre River. The cumulative effects of the Glade Reservoir and the proposed expansion of the Seaman Reservoir would further restrict deer and elk movements and could contribute to the geographic isolation of these herds.	Contribute to cumulative losses of big game seasonal ranges, create new and expand existing movement barriers for big game and other wildlife. Cumulative losses of migratory bird, reptile and amphibian and other wildlife habitat. Some of these cumulative effects would be offset by the conversion of construction and expansion of reservoirs that would provide new open water habitat for waterfowl as well as foraging habitat for fish-eating birds such as osprey.	Similar to Alternative 3.

Table 5-35. Cumulative effects determination on wildlife from the NISP alternatives.

Habitat Type	Alternative 1	Alternative 2	Alternative 3	Alternative 4
All big game - Regional	Negligible	Negligible	Negligible	Negligible
Elk overall range - Local	NA	Moderate	Moderate	Moderate
Elk winter range - Local	NA	Major	Moderate	Moderate
Elk winter concentration - Local	NA	Major	NA	NA
Mule deer winter range - Local	Moderate	Major	Major	Major
Mule deer winter concentration - Local	Major	Major	Major	Major
Pronghorn winter range - Local	Moderate	Major	Major	Major
Pronghorn winter concentration - Local	NA	Major	Major	Major
White-tailed deer winter range - Local	Moderate	Minor	Major	Major
Migratory birds and raptors	Minor	Minor	Minor	Minor
Reptiles and amphibians	Minor	Minor	Minor	Minor
Other wildlife	Minor	Minor	Minor	Minor
Flow-related cumulative effects on wildlife	Negligible	Negligible	Negligible	Negligible

NA = Not Applicable – there would be no cumulative effect from the alternative.

5.11 SPECIAL STATUS SPECIES

This section provides information on the potential cumulative effects of the alternatives on special status terrestrial species. Cumulative effects to special status species are described for both flow related resources and land-based resources. Flow related resources include species associated with riparian and wetlands habitats that are influenced by flows and may be affected by cumulative changes in the Poudre and South Platte Rivers.

The flow related cumulative effects on wetland and riparian habitats are described in Section 5.9. The current trend leading to shifts in woody riparian species composition along the mainstem is expected to continue and to be affected by the NISP alternatives (Section 4.9.1.1). The combined effects of the RFFAs and NISP alternatives (cumulative effects) are predicted to further reinforce and/or accelerate the previously described trajectory of wetland and riparian resources along the mainstem.

Reasonably foreseeable future actions that would result in cumulative effects on special status species, when combined with the effects of the proposed project, include construction of Chimney Hollow and the expansion of Halligan and Seaman Reservoirs, population growth and urban development, the North 1-25 Transportation improvement project, other construction projects that disturb vegetation resources, oil and gas development, Poudre River regional trail connections, and proposed projects along the Poudre River.

5.11.1 No Action Alternative (Alternative 1)

5.11.1.1 Federally Listed Threatened and Endangered Species

5.11.1.1.1 Preble's Meadow Jumping Mouse

The combined effects of human population growth, commercial and residential development, transportation improvements and water storage and delivery, including temporary impacts to 5 acres of Preble's habitat under the No Action Alternative would result in the direct loss or degradation of habitat, potential mortality from ground-disturbing activities and increased traffic, and creation or expansion of movement barriers. Construction of Chimney Hollow Reservoir would have no effect on Preble's (Reclamation 2011), however enlargement of both Halligan and Seaman Reservoirs would result in inundation and loss of occupied Preble's habitat. In addition, most of the North Fork of the Poudre River from the Halligan Dam to Seaman Reservoir has been designated as critical habitat. The North I-25 improvement project EIS identified about 2 acres of occupied and suitable Preble's habitat would be permanently impacted by the project (CDOT 2011). In its October 5, 2007 Biological Opinion for the Proposed Action, USFWS found that the Project is not likely to jeopardize the continued existence of Preble's (DEIS, Appendix B). Avoidance, minimization and mitigation actions, including implementing the required Reasonable and Prudent Measures described in the Biological Opinion would offset adverse impacts to Preble's. The North I-25 improvement project received a Programmatic Biological Opinion requiring future consultation with USFWS as the project is constructed. Any adverse impacts to Preble's or its habitat would implement similar avoidance, minimization and

mitigation actions as required under the ESA. Halligan and Seaman Reservoirs have not yet completed ESA consultation to address impacts to Preble's or other species protected under the ESA. With proper mitigation and avoidance, the cumulative effect on Preble's for the No Action Alternative and the RFFAs would be negligible.

5.11.1.1.2 Colorado Butterfly Plant

No known populations of Colorado butterfly plant occur in any of the study areas (ERO 2008f, 2014c) and any potential effects of pipeline construction on populations would be avoided. The No Action Alternative would not contribute to the cumulative effects of RFFAs on the Colorado butterfly plant.

5.11.1.1.3 Ute Ladies'-Tresses Orchid

No known populations of Ute ladies'-tresses orchid occur in the Cactus Hill Reservoir or Poudre Valley Canal study areas, or at locations of proposed access roads. Any potential effects of pipeline construction on populations would be avoided. The No Action Alternative would not contribute to the cumulative effects of RFFAs on the Ute ladies-tresses orchid.

5.11.1.2 State Species of Concern

5.11.1.2.1 Bald Eagle

The No Action Alternative would result in the permanent loss of 9 acres and temporary disturbance of 33 acres of bald eagle nest buffer (areas within ½ mile of a bald eagle nest) from construction of Cactus Hill Reservoir and associated facilities, including realignment of Weld County Road 19 (WCR 19). Construction of pump stations and pipelines would result in the permanent loss of 1 acre of bald eagle winter concentration area. Temporary effects on bald eagle winter concentration areas would be 6 acres from realignment of WCR 19. About 65 acres of black-tailed prairie dog colonies that could provide foraging habitat for bald eagles also would be permanently lost under this alternative from inundation of Cactus Hill Reservoir. The No Action Alternative and RFFAs would cumulatively affect bald eagles. Enlargement of Halligan and Seaman Reservoirs would not affect any existing bald eagle nest of roost sites; however, construction of Chimney Hollow Reservoir would result in the loss of 7 acres of bald eagle winter range (Reclamation 2011). The North I-25 improvement project EIS identified about six active bald eagle nest sites within 3-miles of the project (CDOT 2011). Commercial and residential development continues to encroach on bald eagle nest territories and summer/winter foraging areas.

Construction of Cactus Hill Reservoir combined with construction and expansion of other reservoirs in the RFFAs would provide habitat for fish, waterfowl and other bald eagle prey species. Some or all of these reservoirs would likely become new bald eagle winter concentration areas. Cumulative effects on bald eagle would be minor because the No Action Alternative and the RFFAs would temporarily disturb or displace eagles from suitable nesting and wintering habitat, or cause abandonment of individual nest sites, but would not affect populations in northeast Colorado. New habitat associated with reservoir development would offset some of the adverse effects.

5.11.1.2.2 Black-tailed Prairie Dog

The No Action Alternative and RFFAs would result in cumulative effects on prairie dogs. The No Action Alternative would result in the permanent loss of about 65 acres of black-tailed prairie dog habitat from construction of Cactus Hill Reservoir and temporary loss of 6 acres from pipeline construction. Halligan and Seaman Reservoirs are located in rocky foothill habitats and are not likely to support prairie dogs and the Chimney Hollow Reservoir site contains no prairie dog colonies (Reclamation 2011). The North I-25 improvement Project EIS identified about 86 acres of prairie dog colonies within the project area (CDOT 2011). Commercial, residential, and oil and gas development continues to result in the loss or removal of prairie dogs. The No Action Alternative and RFFAs would affect >150 acres of prairie dog colonies. Cumulative effects on black–tailed prairie dog would be moderate because individual colonies would be disturbed, displaced or lost, but populations would not likely be affected in northeast Colorado.

5.11.1.2.3 Swift Fox

The No Action Alternative would result in the permanent loss of about 2,306 acres of swift fox overall range. An additional 106 acres of swift fox overall range would be temporarily affected. Nearly all of these effects would result from construction of Cactus Hill Reservoir. Most of the RFFAs are outside of swift fox range; however residential and commercial development north and east of Greeley and oil and gas development in Larimer and Weld Counties would continue to disturb and displace swift fox. The cumulative effect on swift fox would be moderate because individual pairs or territories would be disturbed, displaced or lost, but the No Action Alternative and RFFAs would not likely affect populations in northeast Colorado.

5.11.1.2.4 Burrowing Owl

Because burrowing owl habitat essentially overlaps black-tailed prairie dog habitat, the cumulative effects on burrowing owl habitat from the No Action Alternative and RFFAs would be similar to those described for the black-tailed prairie dog. The cumulative effect on burrowing owl habitat would be moderate because individual prairie dog colonies providing suitable burrowing owl habitat would be disturbed, displaced or lost, but overall populations in northeast Colorado would not likely be affected.

5.11.1.2.5 Common Gartersnake

Under the No Action Alternative, effects on the common gartersnake would occur from the permanent loss of 32 acres of wetlands, 6 acres of aquatic habitat, and 4 acres of riparian habitat. Enlargement of Halligan and Seaman Reservoirs would inundate streams, wetlands and irrigated meadows that provide gartersnake habitat and construction of Chimney Hollow Reservoir would result in the loss of 50 acres of common gartersnake habitat (Reclamation 2011). The North I-25 improvement project EIS identified about 17 acres of common gartersnake habitat within the project area (CDOT 2011). Commercial and residential development continues to encroach on common gartersnake habitat (Hammerson 1999). The cumulative effects on common gartersnake would be moderate because individuals or small groups of common gartersnake would be disturbed, displace or lost, but losses would not affect populations in northeast Colorado.

5.11.1.2.6 Northern Leopard Frog

Cumulative effects on the northern leopard frog from the No Action Alternative and RFFAs would be similar as those described for common gartersnake. Enlargement of Halligan and Seaman Reservoirs would inundate northern leopard frog habitat and construction of Chimney Hollow Reservoir would result in the loss of 2.5 acres of habitat (Reclamation 2011). The North I-25 improvement Project EIS identified about 17 acres of northern leopard frog habitat within the project area (CDOT 2011). The cumulative effects on northern leopard frog would be moderate because individuals or small groups of northern leopard frog would be disturbed, displace or lost, but losses would not affect populations in northeast Colorado.

5.11.1.2.7 Bell's Twinpod

No suitable habitat for Bell's twinpod or existing populations would be affected by the No Action Alternative. The No Action Alternative would not contribute to the cumulative effects of RFFAs on Bell's twinpod.

5.11.1.3 Flow-related Cumulative Effects on Special Status Species

Operation of the NISP alternatives and RFFAs could indirectly affect wetland and riparian resources along the mainstem by affecting river flows. The analysis in the 2014 Wetlands and Riparian Resources Effects Report (ERO 2014d) found that under the No Action and action alternatives, plains cottonwoods would likely continue to decline along the mainstem because of the current trajectory of decline from past actions, while nonnative species such as green ash, box elder, Siberian elm, Russian olive, and reed canarygrass would persist or increase. These changes would contribute to the established trajectory of vegetation changes described above, but would not affect the overall cover of cottonwoods. A reduction in wetlands could affect northern leopard frog and common garter snake. A shift in tree species composition would reduce the availability of large, mature cottonwoods for bald eagle nesting and roosting. These cumulative effects over time would be negligible because the change in vegetation and habitat is expected to be negligible.

No known populations of Ute ladies'-tresses orchid or Colorado butterfly plant occur along the mainstem. The No Action Alternative is unlikely to contribute to any cumulative effects on the Colorado butterfly plant or Ute ladies'-tresses orchid from changes in flows on the mainstem.

Brassy minnow and common shiner were commonly collected in the Poudre River study area through the 1980's. Brassy minnow recently has been collected in very low numbers but common shiner is likely not currently present. The declines in both species are due to changes in channel morphology, specifically channelization and fragmentation due to migration barriers at diversions (Section 3.12.1.3). Flow-related cumulative effects are not anticipated because changes in Poudre River flow with the No Action Alternative under Alternative 1 Effects would not affect the causes of these species' declines, which are channelization and fragmentation from migration barriers. Iowa darter is present in the study area and recently has been collected in low numbers. The evaluation of habitat availability for Iowa darter indicates negligible impacts for these species in the mainstem with the No Action Alternative.

5.11.2 District's Preferred Alternative (Alternative 2)

Alternative 2 has both a Reclamation Action Option and a No Reclamation Action Option as described in Section 2.5.5.2. The Reclamation Action Option allows storage and/or exchange in C-BT facilities and would include a pipeline to bring water from Glade Reservoir to Horsetooth Reservoir. Under the No Reclamation Action Option, water would be delivered from Glade Reservoir to the Participants through the proposed Carter Pipeline. The options are not discussed separately because there is no difference in effects for special status species with the two options.

5.11.2.1 Federally Listed Threatened and Endangered Species

5.11.2.1.1 Preble's Meadow Jumping Mouse

The effect of Alternative 2 combined with the RFFAs is likely to have an adverse cumulative effect on Preble's. Construction of Chimney Hollow Reservoir would have no effect on Preble's (Reclamation 2011); however, enlargement of both Halligan and Seaman Reservoirs would result in inundation and loss of occupied Preble's habitat. In addition, most of the North Fork of the Poudre River from the Halligan Dam to Seaman Reservoir has been designated as critical habitat. The North I-25 improvement project EIS identified about 2 acres of occupied and suitable Preble's habitat would be permanently impacted by the project (CDOT 2011).

The combined effects of human population growth, commercial and residential development, transportation improvements and water storage and delivery would result in the direct loss or degradation of habitat, potential mortality from ground-disturbing activities and increased traffic, and creation or expansion of movement barriers. The October 5, 2007 Biological Opinion issued by the USFWS found that the Proposed Action is not likely to jeopardize the continued existence of Preble's (DEIS, Appendix B). Avoidance, minimization and mitigation actions, including implementing the required Reasonable and Prudent Measures described in the Biological Opinion would offset adverse impacts to Preble's. The North I-25 improvement project received a Programmatic Biological Opinion requiring future consultation with USFWS as the project is constructed. Any adverse impacts to Preble's or its habitat would implement similar avoidance, minimization and mitigation actions as required under the ESA. Halligan and Seaman Reservoirs have not yet completed ESA consultation to address impacts to Preble's or other species protected under the ESA.

5.11.2.1.2 Colorado Butterfly Plant

Although no known populations of Colorado butterfly plant occur in any of the study areas, potential habitat was identified in the Glade and U.S. 287 study area, and the USFWS has requested that these areas and other potential habitat be resurveyed twice before any construction would occur (USFWS 2007). Alternative 2 is not likely to adversely affect or contribute to the cumulative effects of RFFAs on the Colorado butterfly plant.

5.11.2.1.3 Ute Ladies'-Tresses Orchid

Although no known populations of Ute ladies'-tresses orchid occur in any of the study areas, potential habitat was identified in the Glade and U.S. 287 study area and the USFWS has requested that these areas and other potential habitat be resurveyed twice before any construction

would occur (USFWS 2007). Alternative 2 is not likely to adversely affect or contribute to the cumulative effects of RFFAs on Ute ladies'-tresses orchid.

5.11.2.2 Flow-related Cumulative Effects on Special Status Species

Operation of the NISP alternatives and RFFAs could indirectly affect wetland and riparian resources along the mainstem by affecting river flows. The analysis in the 2014 Wetlands and Riparian Resources Effects Report (ERO 2014d) found that under the No Action and action alternatives, plains cottonwoods would likely continue to decline along the mainstem because of the current trajectory of decline from past actions, while nonnative species such as green ash, box elder, Siberian elm, Russian olive, and reed canarygrass would persist or increase. These changes would contribute to the established trajectory of vegetation changes described above, but would not affect the overall cover of cottonwoods. A reduction in wetlands could affect northern leopard frog and common garter snake. A shift in tree species composition would reduce the availability of large, mature cottonwoods for bald eagle nesting and roosting. The cumulative effects over time would be minor as species loose suitable habitat.

No known populations of Ute ladies'-tresses orchid or Colorado butterfly plant occur along the mainstem. The No Action Alternative is unlikely to contribute to any cumulative effects on the Colorado butterfly plant or Ute ladies'-tresses orchid from changes in flows on the mainstem.

Brassy minnow and common shiner were commonly collected in the study area through the 1980's. Brassy minnow recently has been collected in very low numbers but common shiner is likely not currently present. The declines in both species are due to changes in channel morphology, specifically channelization and fragmentation due to migration barriers at diversions (Section 3.12.1.3). Flow related cumulative impacts are not anticipated as changes in flow with Alternative 2 Cumulative Effects would not affect the causes of these species' declines. Iowa darter is present in the study area and recently has been collected in low numbers. The evaluation of habitat availability for Iowa darter indicates negligible cumulative impacts for these species in most segments of the mainstem with Alternative 2. In the section near Fort Collins (Segment B), the augmented low flows would have a moderate beneficial cumulative impact for darters. In the section near Windsor (Segment D), the changes in flow would have a minor beneficial cumulative impact.

5.11.2.3 State Species of Concern

5.11.2.3.1 Bald Eagle

Glade Reservoir would have no effect on bald eagle nest sites, winter roosts or winter concentration areas; however, construction of Galeton Reservoir and forebay would result in the permanent loss of 34 acres of bald eagle winter concentration area. About 248 acres of prairie dog colonies that could potentially provide foraging habitat for bald eagles also would be permanently lost from construction and inundation of Galeton Reservoir. Enlargement of Halligan and Seaman Reservoirs would not affect any existing bald eagle nest of roost sites, but construction of Chimney Hollow Reservoir would result in the loss of 7 acres of bald eagle

winter range (Reclamation 2011). The North I-25 improvement Project EIS identified 6 active bald eagle nest within 3 mile of the project (CDOT 2011). Commercial and residential development continues to encroach on bald eagle nest territories and summer/winter foraging areas.

Bald eagles are attracted to reservoirs for nesting, wintering and feeding. Reservoirs typically support fish, waterfowl and other prey species, and often support riparian woodlands along the reservoir banks that provide nesting and roosting opportunities for bald eagles (Bryan et al. 1996). Construction of Glade Reservoir combined with construction and expansion of other reservoirs in the RFFAs would provide habitat for fish, waterfowl and other bald eagle prey species. Some or all of these reservoirs would likely become new bald eagle winter concentration areas. The cumulative effects on bald eagle would be minor because Alternative 2 and the RFFAs would temporarily disturb or displace eagles from suitable nesting and wintering habitat, or cause abandonment of individual nest sites but populations in northeast Colorado would not be adversely affected. New habitat associated with reservoir development would offset some of the adverse effects.

5.11.2.3.2 Black-tailed Prairie Dog

Alternative 2 and RFFAs would cumulatively affect prairie dogs. Construction and inundation of Glade Reservoir would result in the permanent loss of about 16 acres and no temporary loss of prairie dog habitat. Construction of Galeton Reservoir would result in the permanent loss of about 248 acres of prairie dog habitat. Halligan and Seaman Reservoirs are located in rocky foothill habitats and are not likely to support prairie dogs and the Chimney Hollow reservoir site contains no prairie dog colonies (Reclamation 2011). The North I-25 improvement Project EIS identified about 86 acres of prairie dogs impacted by the project (CDOT 2011). Commercial and residential development continues to result in the loss or removal of prairie dogs. The cumulative effect on black-tailed prairie dog would be moderate because individual colonies would be disturbed, displaced or lost, but populations in northeast Colorado would not be adversely affected.

5.11.2.3.3 Swift Fox

Inundation of Glade Reservoir under Alternative 2 would have no direct or indirect effects on swift fox. Galeton Reservoir and conveyance systems would permanently effect 1,929 acres within swift fox overall range. Most of the RFFAs are outside of swift fox range; however residential and commercial development north and east of Greeley and oil and gas development in Larimer and Weld Counties would continue to disturb and displace swift fox. The cumulative effect from Alternative 2 and RFFAs on swift fox would be moderate because individual pairs or territories would be disturbed, displaced or lost, but Alternative 2 and the RFFAs would not likely affect overall populations in northeast Colorado.

5.11.2.3.4 Burrowing Owl

Because burrowing owl habitat essentially overlaps prairie dog habitat, the effects on burrowing owl habitat cumulative effects under Alternative 2 would be similar as those described for the prairie dog. However, burrowing owls are typically not attracted to prairie dog colonies near the Colorado Front Range and valleys of the hogbacks (COBBAII 2014). The cumulative effect on

burrowing owl habitat would be moderate because individual prairie dog colonies providing suitable burrowing owl habitat would be disturbed, displaced or lost, but Alternative 2 and RFFAs would not likely affect populations of owls in northeast Colorado.

5.11.2.3.5 Common Gartersnake

Alternative 2 would result in the permanent loss of 42 acres of wetlands, 6 acres of aquatic habitat, and 22 acres of riparian woodland habitat. Enlargement of Halligan and Seaman Reservoirs would inundate streams, wetlands and irrigated meadows that provide gartersnake habitat and construction of Chimney Hollow Reservoir would result in the loss of 50 acres of common gartersnake habitat (Reclamation 2011). The North I-25 improvement project EIS identified about 17 acres of common gartersnake habitat within the project area (CDOT 2011). Commercial and residential development continues to encroach on common gartersnake habitat (Hammerson 1999). Cumulative effects from Alternative 2 and RFFAs would be moderate because individuals or small groups of common gartersnake would be disturbed, displaced or lost, but losses would not affect populations in northeast Colorado.

5.11.2.3.6 Northern Leopard Frog

Cumulative effects on the northern leopard frog from Alternative 2 would be similar to those described for the common gartersnake. The loss of wetland and aquatic habitats would be partially offset by the construction of Glade Reservoir. The cumulative effects on northern leopard frog would be moderate because individuals or small groups of frogs would be disturbed, displaced or lost, but losses would not affect populations in northeast Colorado.

5.11.2.3.7 Bell's Twinpod

Construction and inundation of Glade Reservoir under Alternative 2 would have no effect on Bell's twinpod. Approximately 29 acres of Bell's twinpod habitat would be permanently lost and approximately 45 acres of Bell's twinpod habitat would be temporarily affected by the construction of the U.S. 287 realignment. Both Halligan and Seaman Reservoirs are located within the range of Bell's twinpod. The Nature Conservancy established the Phantom Canyon Preserve, located below Halligan Reservoir, to conserve native vegetation communities, including populations or Bell's twinpod (TNC 2015). No Bell's twinpod are located at Chimney Hallow Reservoir (Reclamation 2011). Alternative 2 and proposed development of the former Holcim property, would likely impact Bell's twinpod habitat, resulting in minor cumulative effects.

5.11.3 Alternative 3

Information on direct and indirect effects on special status species habitat is provided in Section 4.11.4. Special status species habitat would be impacted under Alternative 3 by construction of a 190,000 AF Cactus Hill Reservoir, Galeton Reservoir, inundation by both reservoirs, construction of conveyance systems, lining of the Poudre Valley Canal, and decreased water flows in the Poudre River. Alternative 3 would not include a flow augmentation program that would benefit the Poudre River during winter. Because flow changes on the South Platte River are predicted to be minimal, no cumulative effects on special status species are expected

on the South Platte River. Generally the effects, and subsequently the cumulative effects, on special status species at Cactus Hill Reservoir are greater under Alternative 3 than in the No Action Alternative because of the larger reservoir size (190,000 AF vs. 120,000 AF).

5.11.3.1 Federally Listed Threatened and Endangered Species

5.11.3.1.1 Preble's Meadow Jumping Mouse

Due to a lack of suitable habitat, Alternative 3 would not result in the permanent loss of occupied Preble's habitat and less than 1 acre of temporary effects. As described under the No Action Alternative, Alternative 3 and the RFFAs would have a negligible cumulative effect on Preble's.

5.11.3.1.2 Colorado Butterfly Plant

No known populations of Colorado butterfly plant occur in any of the study areas. Alternative 3 would not contribute to the cumulative effects of RFFAs on the Colorado butterfly plant.

5.11.3.1.3 Ute Ladies'-Tresses Orchid

No known populations of Ute ladies'-tresses orchid occur at the Cactus Hill or Galeton Reservoir sites. Alternative 3 would not contribute to the cumulative effects of RFFAs on the Colorado butterfly plant.

5.11.3.2 Flow-related Cumulative Effects on Special Status Species

Operation of the NISP alternatives and RFFAs could indirectly affect wetland and riparian resources along the mainstem by affecting river flows. The analysis in the 2014 Wetlands and Riparian Resources Effects Report (ERO 2014d) found that under the No Action and action alternatives, plains cottonwoods would likely continue to decline along the mainstem because of the current trajectory of decline from past actions, while nonnative species such as green ash, box elder, Siberian elm, Russian olive, and reed canarygrass would persist or increase. These changes would contribute to the established trajectory of vegetation changes described above, but would not affect the overall cover of cottonwoods. A reduction in wetlands could affect northern leopard frog and common garter snake. A shift in tree species composition would reduce the availability of large, mature cottonwoods for bald eagle nesting and roosting. The cumulative effects on these species would be moderate because of a moderate change in the vegetation along the Poudre River.

No known populations of Ute ladies'-tresses orchid or Colorado butterfly plant occur along the mainstem. The No Action Alternative is unlikely to contribute to any cumulative effects on the Colorado butterfly plant or Ute ladies'-tresses orchid from changes in flows on the mainstem.

Brassy minnow and common shiner were commonly collected in the study area through the 1980's. Brassy minnow recently has been collected in very low numbers but common shiner is likely not currently present. The declines in both species are due to changes in channel morphology, specifically channelization and fragmentation due to migration barriers at diversions (Section 3.12.1.3). Flow related cumulative impacts are not anticipated as changes in flow with Alternative 3 Cumulative Effects would not affect the causes of these species'

declines. Iowa darter is present in the study area and recently has been collected in low numbers. The evaluation of habitat availability for Iowa darter indicates negligible cumulative impacts for these species in most segments of the mainstem with Alternative 3. In the section near Windsor (Segment D), the changes in flow would have a minor beneficial cumulative impact.

5.11.3.3 State Species of Concern

5.11.3.3.1 Bald Eagle

Cumulative effects to bald eagles under Alternative 3 would be similar to those presented for the No Action Alternative (Section 5.11.1) at the Cactus Hill Reservoir site. Alternative 3 would result in the permanent loss of 10 acres and temporary disturbance of 31 acres of bald eagle nest buffer (areas within ½ mile of a bald eagle nest) from construction of Cactus Hill Reservoir and associated facilities, including realignment of WCR 19. About 65 acres of prairie dog colonies that could potentially provide foraging habitat for bald eagles also would be permanently lost. Chimney Hollow Reservoir would result in the loss of 7 acres of bald eagle winter range (Reclamation 2011). The North I-25 improvement Project EIS identified 6 active bald eagle nest within 3 mile of the project (CDOT 2011). Commercial and residential development continues to encroach bald eagle nest territories and summer/winter foraging areas.

Construction of Cactus Hill and Galeton Reservoirs combined with construction and expansion of other reservoirs in the RFFAs would provide habitat for fish, waterfowl and other bald eagle prey species. Some or all of these reservoirs would likely become new bald eagle winter concentration areas. The cumulative effects on bald eagle would be minor because Alternative 3 and the RFFAs would temporarily disturb or displace eagles from suitable nesting and wintering habitat, or cause abandonment of individual nest sites, but populations in northeast Colorado would not be adversely affected. New habitat associated with reservoir development would offset some of the adverse effects.

5.11.3.3.2 Black-tailed Prairie Dog

Alternative 3 would result in the permanent loss of about 65 acres of black-tailed prairie dog habitat from the inundation of Cactus Hill Reservoir and 248 acres from inundation of Galeton Reservoir. Halligan and Seaman Reservoirs are located in rocky foothill habitats and are not likely to support prairie dogs and the Chimney Hollow reservoir site contains no prairie dog colonies (Reclamation 2011). The North I-25 improvement Project EIS identified about 86 acres of prairie dogs impacted by the project (CDOT 2011). Commercial and residential development continues to result in the loss or removal of prairie dogs. The cumulative effect on black-tailed prairie dog would be moderate because individual colonies would be disturbed, displaced or lost, but Alternative 3 and RFFAs would not likely affect populations in northeast Colorado.

5.11.3.3.3 Swift Fox

Alternative 3 would result in the permanent loss of about 5,248 acres of swift fox overall range, primarily due to inundation of Cactus Hill and Galeton Reservoirs. Most of the RFFAs are outside of swift fox range; however residential and commercial development north and east of Greeley and oil and gas development in Larimer and Weld Counties would continue to disturb and displace swift fox. The cumulative effect on swift fox would be moderate because

individual pairs or territories would be disturbed, displaced or lost, but populations in northeast Colorado would not likely be adversely affected.

5.11.3.3.4 Burrowing Owl

Because burrowing owl habitat essentially overlaps prairie dog habitat, cumulative effects on burrowing owls from Alternative 3 would be similar as those described for the black-tailed prairie dog. The cumulative effect on burrowing owl habitat would be moderate because individual prairie dog colonies providing suitable burrowing owl habitat would be disturbed, displaced or lost, but Alternative 3 and RFFAs would not likely affect populations of owls in northeast Colorado.

5.11.3.3.5 Common Gartersnake

Alternative 3 would result in the permanent loss of 34 acres of wetlands, 92 acres of aquatic habitat, and 16 acres of riparian habitat that are potentially suitable for the common gartersnake. Enlargement of Halligan and Seaman Reservoirs would inundate streams, wetlands and irrigated meadows that provide gartersnake habitat and construction of Chimney Hollow Reservoir would result in the loss of 50 acres of common garter snake habitat (Reclamation 2011). The North I-25 improvement Project EIS identified about 17 acres of common gartersnake habitat within of the project area (CDOT 2011). Commercial and residential development continues to encroach on common gartersnake habitat (Hammerson 1999). The cumulative effects on common gartersnake would be moderate because individuals or small groups of gartersnakes would be disturbed, displaced or lost, but losses would not affect populations in northeast Colorado.

5.11.3.3.6 Northern Leopard Frog

Cumulative effects on the northern leopard frog from Alternative 3 and RFFAs would be the similar to those described for common gartersnake. Enlargement of Halligan and Seaman Reservoirs would impact streams, wetlands and irrigated meadows that provide northern leopard frog habitat and construction of Chimney Hollow Reservoir would result in the loss of 2.5 acres of habitat (Reclamation 2011). The North I-25 improvement Project EIS identified about 17 acres of common gartersnake habitat within of the project area (CDOT 2011). The cumulative effects on northern leopard frog would be moderate because individuals or small groups of frogs would be disturbed, displaced, or lost, but losses would not affect populations in northeast Colorado.

5.11.3.3.7 Bell's Twinpod

No existing populations or suitable habitat for Bell's twinpod would be affected by Alternative 3. Alternative 3 would not contribute to the cumulative effects of RFFAs on Bell's twinpod.

5.11.4 Alternative 4

Detailed information on the direct and indirect effects of Alternative 4 are provided in Section 4.11. The effects of Alternative 4 on species of concern, both federal and state, are similar to Alternative 3. Permanent effects are the same for reservoir sites, conveyance systems, and river segments and temporary effects vary by less than 1 acre between the two alternatives for all species. Alternative 4 would not include a flow augmentation program that would benefit

the Poudre River. The change in flow on the Poudre would affect fewer acres of sensitive vegetation classes than Alternative 3 and the cumulative effects on species of concern would be minor as species loose suitable habitat over time. Because flow changes on the South Platte River are predicted to be minimal, no cumulative effects on wildlife are expected on the South Platte River. The contribution of the RFFAs to cumulative effects is similar to Alternative 3.

5.11.5 Climate Change

Climate change has the potential to accelerate the cumulative effects described above. A large volume of scientific information supports the conclusion that global temperatures are increasing and that precipitation trends would change in the future. The warming trend is expected to accelerate in coming decades. In the western United States, longer periods of drought are expected. There is also general agreement by climate scientists that climate change information specific to Colorado indicates that snowpack melting and spring runoff would occur earlier in the year and temperatures would increase by approximately 4°F by 2050, with summers warming more than winters (DiNatale and CDM Smith 2014). Under climate change, warmer temperatures and prolonged drought would affect survival of some wildlife species. Species composition and distribution would likely change while diversity may decrease. Longer periods of drought may result in the loss of limited or sparsely distributed habitats and the species associated with those habitats, such as seasonal wetlands and ephemeral drainages with riparian habitat. Species adapted to drier and warmer conditions would become more abundant and would move into habitats altered by extended periods of drought. Communities may change as some species becomes less able to adapt.

5.11.6 Impact Summary

Table 5-36 summarizes the cumulative effects of NISP alternatives on Special Status Species.

Table 5-36. Cumulative effects for special status species.

Species	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Flow-related effects	Contribute to the current trajectory of wetland and riparian woodland decline from past actions. Could affect Preble's, northern leopard frog and common garter snake habitat. Shift in tree species available for bald eagle nesting and roosting to more nonnative tree species such as green ash, box elder, and Siberian elm. Plains cottonwoods would likely continue to decline along the mainstem	The combined effects of the RFFAs and Alternative 2 are predicted to further reinforce and/or accelerate the trajectory of wetland and riparian resources along the mainstem described under the No Action Alternative.	The combined effects of the RFFAs and Alternative 3 are predicted to further reinforce and/or accelerate the trajectory of wetland and riparian resources along the mainstem described under the No Action Alternative.	Similar to Alternative 3.
Land based effects	Contribute to cumulative losses of occupied Preble's habitat, swift fox overall range, prairie dog colonies that provide habitat for other sensitive species such as burrowing owls and ferruginous hawks, wetland and riparian habitat important to northern leopard frog, and common gartersnake, and cumulative disturbance impacts to nesting and roosting bald eagles. Drying of irrigated lands would likely adversely affect common gartersnake and northern leopard frog habitat, and benefit grassland species. Such as prairie dog and burrowing owl. Some cumulative impacts would be offset by the creation of new habitat for Preble's and for bald eagle prey at new and expanded reservoirs	Contribute to cumulative losses of occupied Preble's habitat, swift fox overall range, prairie dog colonies that provide habitat for other sensitive species such as burrowing owls and ferruginous hawks, wetland and riparian habitat important to northern leopard frog, and common gartersnake, and cumulative disturbance impacts to nesting and roosting bald eagles. The construction of Glade Reservoir and the realignment of U.S. 287 and proposed development of the former Holcim property, would likely result in cumulative effects on Bell's twinpod. Some cumulative impacts would be offset by the creation of new habitat for Preble's and for bald eagle prey at new and expanded reservoirs	Contribute to cumulative losses of occupied Preble's habitat, swift fox overall range, prairie dog colonies that provide habitat for other sensitive species such as burrowing owls and ferruginous hawks, wetland and riparian habitat important to northern leopard frog, and common gartersnake, and cumulative disturbance impacts to nesting and roosting bald eagles. Some cumulative impacts would be offset by the creation of new habitat for Preble's and for bald eagle prey at new and expanded reservoirs	Similar to Alternative 3.

Table 5-37. Cumulative effects on special status species habitat from the NISP alternatives.

Habitat	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Preble's meadow jumping mouse	Negligible	Moderate	Negligible	Negligible
Colorado butterfly plant	No effect	Negligible	Negligible	Negligible
Ute ladies'-tresses orchid	No effect	Negligible	Negligible	Negligible
Bald eagle	Minor	Minor	Minor	Minor
Black-tailed prairie dog	Moderate	Moderate	Moderate	Moderate
Swift fox overall range	Moderate	Moderate	Moderate	Moderate
Burrowing owl habitat	Moderate	Moderate	Moderate	Moderate
Common gartersnake	Moderate	Moderate	Moderate	Moderate
Northern leopard frog	Moderate	Moderate	Moderate	Moderate
Bell's twinpod locations	No effect	Minor	Negligible	Negligible
Flow-related Cumulative Effects on Special Status Terrestrial Species	Negligible	Minor	Moderate	Minor
Flow-related Cumulative Effects on brassy minnow and common shiner	No effect	No effect	No effect	No effect
Flow-related Cumulative Effects on Iowa darter	Negligible	Negligible adverse to moderate beneficial (Segment B)	Negligible adverse to minor beneficial (Segment D)	Negligible adverse to minor beneficial (Segment D)

5.12 AQUATIC BIOLOGICAL RESOURCES

This section summarizes the predicted potential aquatic biological resources cumulative effects of the NISP alternatives. The analysis for each alternative focused on the suitability of the habitat and riffle-pool complexes to support higher or lower number and abundance of species of fish, invertebrates, periphyton, and plants or to change the composition of the communities.

In addition, the suitability of a stream to support aquatic resources is also influenced by water quality, geomorphology, and riparian vegetation, so these components of the aquatic environment evaluated in other sections of the SDEIS are also included in the analysis to determine if potential changes resulting from the alternatives would be expected to affect populations of fish, benthic invertebrates, periphyton, and aquatic plants.

The Run 5 series of the CTP hydrologic modeling was used to predict the cumulative effects of NISP and the HSWSPs on flows when combined with the RFFAs as discussed in the CTP Hydrologic Modeling Report (CDM Smith and DiNatale 2013). The RFFAs, along with 2050 municipal and agricultural water demands, define the Future Conditions hydrology (CTP Run 2) and the Future Conditions hydrology with each of the action alternatives individually (NISP Run 4 series), which is used for comparison to determine cumulative effects of both NISP and HSWSPs for the alternatives (NISP Run 5 series). The predicted effects of the RFFAs, action alternatives and cumulative effects and associated trends are traced by comparing CTP Run 2 (Future Conditions) with the Run 4 series (Future Conditions Effects) and then the Run 5 series (Cumulative Effects).

In addition to the flow-related RFFAs incorporated in the CTP hydrologic modeling, other RFFAs have been identified that may affect aquatic biological resources. RFFAs that are intended to or are likely to improve conditions for river corridor riparian (riverine) wetlands, water quality, sedimentation and channel geomorphology and, ultimately, for aquatic biological resources include:

- Poudre River restoration projects by Fort Collins
- Poudre River corridor conservation plans
- Modification of the Fossil Creek Reservoir Diversion and other diversions by Fort Collins to allow fish passage
- Improvements to Lee Martinez Park by Fort Collins
- Fort Collins Poudre River Master Plan
- Stormwater projects by Fort Collins
- Post-fire restoration activities
- Reservoir construction and expansion
- Greeley Poudre River Flood Control and Environmental Restoration Project
- Updates to water quality standards

RFFAs than could likely degrade conditions for aquatic resources include:

- Population growth
- Development along the river corridor

The current trends leading to ongoing channel narrowing, vegetative encroachment, and shifts in woody riparian species composition along the mainstem are expected to continue and to be affected by the NISP alternatives. The combined effects of the RFFAs, NISP alternatives, and the HSWSPs (cumulative effects) are predicted to further reinforce and/or accelerate these trends along the mainstem.

5.12.1 Methods

The methods for predicting cumulative impacts are the same as for Chapter 4 Environmental Consequences - NISP Effects (Section 4.12.1) and are described in detail in the 2015 Aquatic Resources Effects Report (GEI 2015b). Qualitative evaluations of the effects of changes to other resource areas were also considered in the cumulative impact evaluation. The other resource areas include Stream Morphology and Sediment Transport (Section 5.4), Water Quality (Section 5.3) including the Stream Temperature and Dissolved Oxygen Analysis from Hydros (2014a), and Wetlands and Riparian Resources (Section 5.9).

The presentation of fish habitat availability (WUA values) in this chapter is a summary of the type of detailed analysis in GEI (2015b). The measurements that were compared between alternatives for the WUA analyses were minimum WUA and average annual WUA as discussed in greater detail in GEI (2015b). Minimum WUA was chosen because fish populations are generally influenced by extremes in flow and habitat conditions, which can act as a bottleneck to limit population size. The minimum WUA was defined as the day in which the least amount of habitat was available for the year for each species and life stage modeled in each segment. This parameter was calculated for each year type (i.e., median, 20th percentile, and 80th percentile WUA years). The average annual WUA was also calculated for each year type to identify any large changes in habitat availability throughout the year associated with the alternatives.

In this chapter the presentation includes a comparison of minimum and average habitat availability only for fish species and life stages that are predicted to have changes of 10% or greater. A change of 10% or greater was used in the 2015 Aquatic Resources Effects Report (GEI 2015b) to indicate there potentially may be effects to fish populations. The predicted changes for the NISP action alternatives are based on comparisons made under Current Conditions Effects (2010 Poudre River flows - Run 3 series), Future Conditions Effects (2050 Poudre River Flows with RFFAs - Run 4 series), or Cumulative Effects (2050 Poudre River Flows with RFFAs and HSWSPs - Run 5 series). Fish species and life stages with changes for Future Conditions Effects and/or Cumulative Effects greater than 10% are presented in the tables in this chapter. Changes in habitat availability for Current Conditions Effects are not presented in the tables in this chapter however, species and life stages that had changes of 10% or greater for Current Conditions Effects are also included in the tables in order to evaluate whether the

trends continued through Future Conditions Effects and Cumulative Effects. In some cases the trends continued and the changes continued to be greater than 10% and in other cases the changes were less than 10% for Future Conditions Effects and for Cumulative Effects. Comparisons for fish species and life stages with all changes less than 10% for all three sets of effects comparisons are considered to be negligible and are not presented in the tables or discussions in this chapter.

The evaluations in the 2015 Aquatic Resources Effects Report (GEI 2015b) indicate that changes in fish habitat availability with the alternatives would be similar both in flowing sections of the mainstem and at the dry-up points mainly because the changes in flow would occur during spring runoff and not during the drier periods of the year. Therefore, the evaluations in this chapter focus on only the representative hydrologic node in each segment and a separate analysis of dry-up points is not done.

In addition to the fish habitat availability modeling to evaluate differences between alternatives, two other types of analyses were used (GEI 2015b). The first evaluated the availability and spatial arrangement of shallow, slow current velocity (SSCV) habitat that is required for spawning and rearing habitat by many of the warmwater fish present in the study area. The second evaluated specific hydrologic metrics in order to summarize potential changes in flow that might be relevant to fish and invertebrates. Results of these two analyses are also summarized in this chapter as appropriate.

5.12.2 No Action Alternative (Alternative 1)

The No Action Alternative was evaluated under Future Conditions hydrology only, as explained in Section 4.1.2. Hydrology model Run 9a (Alternative 1 Effects) was compared to Future Conditions hydrology to predict how changes in flows in the mainstem of the Poudre River and the South Platte River would affect aquatic biological resources, therefore the effects analyses for the No Action Alternative are presented in this chapter. An evaluation of the No Action Alternative under Cumulative Effects (Run 5) was not conducted.

5.12.2.1 Reservoir Sites

With the No Action Alternative, a 120,000 AF Cactus Hill Reservoir would be created off the channel of the mainstem that would be smaller than for the action alternatives. The creation of Cactus Hill Reservoir would represent a major beneficial impact of the No Action Alternative for aquatic organisms. The reservoir would provide new habitat to sustain populations of a variety of organisms. Cactus Hill Reservoir is not currently proposed to be used for recreation including fishing; however, the reservoir would be suitable for the establishment and management of a recreational fishery that could support populations of both stocked and self-sustaining fish and the reservoir would support a low to medium fishery quality.

Fluctuations in water level, combined with newly inundated vegetation, can lead to elevated levels of methylmercury in fish tissue. This suggests that fish in Cactus Hill Reservoir would have high body burdens of methylmercury, and like many other Front Range reservoirs such as

Horsetooth Reservoir, Cactus Hill Reservoir may eventually have a mercury-based fish consumption advisory.

5.12.2.2 Conveyance Systems

The No Action Alternative is expected to have no impact on aquatic biological resources associated with conveyance systems.

5.12.2.3 River Segments

The No Action Alternative would deliver water to Participants by transferring agricultural water supplies from the Poudre and Big Thompson Basins. Diversions of water from the mainstem would occur primarily in May through August. Most of the water that would be transferred is water that is currently consumptively used for agriculture and would therefore not be a new depletion to the mainstem. However, when feasible, the District would exchange this water up river for diversion to the Poudre Valley Canal, which would divert the water farther up the mainstem than it was historically diverted for irrigation. This would change flows in Segments A, B, and C of the mainstem; flows in Segments D, E, and F as well as in the South Platte River would not be affected by the diversions with the No Action Alternative and would change only minimally due to other factors (Section 5.2.2).

5.12.2.3.1 Poudre River

Segments A, B, and C. With the No Action Alternative, changes in flow and the resulting changes in other aspects of habitat would have an overall negligible to minor adverse impact to aquatic organisms in Segments A, B, and C as explained in more detail in the 2015 Aquatic Resources Effects Report (GEI 2015b). Changes to almost all of the individual components of the aquatic environment in these segments would be negligible but changes to a few others would have minor beneficial or adverse impacts. Spring runoff flows would be reduced, but flow fluctuations and extreme low flows would not change much with the No Action Alternative either in flowing sections or at the dry-up points in Segments A, B, and C. Water quality changes would be negligible. There could be a minor to moderate increase in summer water temperatures that could have an adverse impact on trout. Changes in sedimentation conditions would be negligible, and the spatial variability of riffle-pool complexes would be maintained. Localized channel narrowing and vegetative encroachment would continue.

Most fish species and life stages in Segments A, B, and C would have negligible changes in habitat availability metrics with the No Action Alternative and are not included in Table 5-38, especially in Segment B. Only a few species would have changes in WUA values of 10% or greater for Future Conditions Effects (Table 5-38). As spring flows are reduced from Current Conditions through Future Conditions to Alternative 1 Effects, some species and life stages benefit from the lower peak runoff flows and the resulting increases in minimum habitat availability because high-quality habitat exists for these species at low flows. For longnose dace, the increase in minimum WUA with the No Action Alternative would be 10%, 40%, and 134% for median years in Segment A, Segment B, and Segment C, respectively (Table 5-38), which

would have a minor beneficial cumulative impact. The lower spring flows would result in a 13% to 16% increase in minimum habitat availability for juvenile brown and rainbow trout in 80th percentile years (which correspond to wet years for these life stages) in Segment A and a minor beneficial cumulative impact for this life stage of trout.

Table 5-38. Comparison of habitat availability (WUA in ft^2/1,000 ft) for Current Conditions hydrology, Future Conditions hydrology, and Alternative 1 Effects for fish species in Segments A, B, and C.

Species	Life Stage	Habitat Availability (WUA) Metric	Year Type	WUA Values			
				Current Conditions (Run 1)	Future Conditions (Run 2)	Alternative 1 Effects (Run 9)	
						Value	% Change
Segment A							
Longnose Dace	Adult	Minimum	Median	597	675	739	+10%
			80th Percentile	806	831	995	+20%
Brown Trout	Juvenile	Minimum	80th Percentile	11,364	11,283	13,034	+16%
Rainbow Trout	Juvenile	Minimum	80th Percentile	12,880	12,801	14,524	+13%
Segment B							
Longnose Dace	Adult	Minimum	Median	381	400	562	+40%
Segment C							
Longnose Dace	Adult	Minimum	Median	99	170	399	+134%
Brown Trout	Adult	Average	Median	313	283	230	-19%
			80th Percentile	724	686	610	-11%
Rainbow Trout	Adult	Average	Median	974	938	777	-17%
			80th Percentile	2,020	1,779	1,494	-16%

The No Action Alternative would have little effect on the adult life stage of the two recreationally important species, brown and rainbow trout, in Segments A and B, but in Segment C, the lower runoff flows would reduce average habitat for these species in the spring and early summer. There would be a gradual loss of average habitat availability for brown and rainbow trout with the reductions in spring runoff flows from Current Conditions through Alternative 1 Effects, which results in decreases in average WUA of 11% to 19% (Table 5-38). These two species do not maintain resident, reproducing populations in Segment C but seasonally use the habitat in the segment when temperatures are suitable. The increased temperatures with the No Action Alternative could further limit the time when temperatures are suitable for trout. The lowered spring flows would reduce habitat availability and the seasonal use by these recreationally important species. The No Action Alternative would have a minor adverse impact on trout in Segment C. Losses of some SSCV habitat in Segments A and C would be detrimental in some years but the increase in Segment B would be beneficial in dry years. The negligible to minor changes in fish habitat availability are not expected to result in changes in species composition of the fish community.

Macroinvertebrate community abundance may benefit slightly from lower spring flows and the community may sustain a higher proportion of species that prefer moderate to slow current velocity in Segments A, B, and C. Species composition may change to species more suited to

the altered flow regime, which would be a negligible to minor adverse impact. Similarly, there may be an increase in abundance of periphyton and aquatic plants, including filamentous green algae, and a change to species more suited to the altered flow regime. These changes would be a negligible to minor adverse impact.

Colorado MMI scores for samples in Segment A, B, and C with Current Conditions presented in the 2013 CTP Aquatic Resources Baseline Report (GEI 2013) almost always exceeded the threshold for attaining the aquatic life use. These segments support a high proportion of rheophilic species and many other sensitive species of macroinvertebrates that result in the high MMI scores. The negligible to minor changes in species composition with the No Action Alternative would likely not be sufficient to change MMI scores much; sensitive species including some rheophilic species would still be present, which indicates the community would continue to score above the threshold and indicate attainment.

The mostly negligible and few minor impacts to aquatic resources and their habitat with the No Action Alternative would not cause the crossing of a tipping point in Segments A, B, and C. Segment A would continue to function as a coldwater stream segment supporting coldwater species of fish and macroinvertebrates. Brown trout, longnose dace, and suckers are expected to remain as the dominant fish species. Segment B would continue to function as a warmwater stream segment supporting a wide variety of both coldwater and warmwater species of fish and macroinvertebrates. There would be slight changes in species relative abundance, but brown trout, longnose dace, and suckers are expected to remain as some of the most common fish species along with numerous warmwater species. Segment C would continue to function as a warmwater stream segment supporting a wide variety of warmwater species of fish and macroinvertebrates and seasonally support some trout that move downstream from Segment B. There would be slight changes in species relative abundance with fewer trout in some sections of the segment and in warmer seasons, but the numerous warmwater species would continue to be the dominant component of the fishery.

Segments D, E, and F. Alternative 1 with Future Conditions would result in very little change in flow downstream of the New Cache Canal. Therefore, resulting changes in habitat availability for aquatic organisms in Segments D, E, and F would be much less than 10%. The No Action Alternative would have an overall negligible to minor adverse cumulative impact on aquatic resources in these three segments compared to Future Conditions. Changes to the fish habitat availability components of the aquatic environment in this segment would have negligible impacts but a few other components would have negligible to minor adverse impacts. All changes in WUA metrics would be less than 1% for all species and life stages of fish. The small changes in flow would not substantially change habitat availability for fish or macroinvertebrates or the occurrence of SSCV habitat.

Changes in water quality, water temperatures, riparian vegetation, channel geomorphology, and riffle-pool complexes would be negligible to minor and less than the action alternatives and not have much effect on aquatic organisms. There could be at least some changes in macroinvertebrate species composition from continued sedimentation and the No Action Alternative would have a negligible to minor adverse impact on macroinvertebrates in Segments

D, E, and F although the changes would be less than for the action alternatives. The ongoing encroachment of riparian vegetation, channel narrowing, and increased sedimentation would allow for greater abundance of aquatic plants on channel margins. There also may be changes in periphyton species composition to species more suited to the continued sedimentation, which would be a negligible to minor adverse impact.

There were only three samples scored with the Colorado MMI in Segments E and F with Current Conditions and none in Segment D. Only two of the three scores indicated attainment of the aquatic life use, although one score was just over the threshold for attainment. Segments D, E, and F support a macroinvertebrate community dominated by tolerant species as presented in the 2013 CTP Aquatic Resources Baseline Report (GEI 2013). These segments support at least some sensitive and rheophilic species that result in high MMI scores, but fewer than in upstream segments. The negligible to minor changes in the macroinvertebrate species composition resulting from changes in flow and sedimentation with the No Action Alternative would not change species composition substantially and indicate MMI scores likely would continue to sometimes indicate attainment of the use.

The negligible to minor impacts to aquatic resources and their habitat with the No Action Alternative would not cause the crossing of a tipping point in Segments D, E, and F. Segment D would continue to function as a warmwater stream segment supporting a wide variety of warmwater species of fish including minnows, darters, and suckers and a somewhat degraded community of macroinvertebrates. The fish community has already crossed a tipping point and nonnative species such as carp, largemouth bass, and mosquitofish are common and only a few native species such as white suckers, fathead minnows, and green sunfish continue to be common. There may be slight reductions in fish abundance but the fishery would still contain numerous species of native and introduced warmwater species.

5.12.2.3.2 South Platte River

There would be a negligible impact to aquatic biological resources with Alternative 1 Effects compared to Future Conditions in Segment 1 of the South Platte River. The small changes in flow and negligible impacts to water quality, water temperature and channel geomorphology would result in little change to habitat availability for fish or conditions for macroinvertebrates and plants and there would be negligible impacts to these communities. All changes to WUA metrics for fish would be less than 1%.

The negligible impacts to most components of aquatic resources and their habitat with the No Action Alternative would not cause the crossing of a tipping point in Segment 1 of the South Platte River. This segment would continue to function as a warmwater stream segment supporting a wide variety of warmwater species of fish and a somewhat degraded community of macroinvertebrates. The fish community has a higher proportion of native species compared to the community in the mainstem of the Poudre River. Native minnow species are most common with introduced species present, but usually in relatively low numbers. The negligible impacts to most components of the aquatic environment with the No Action Alternative indicate the fishery would still contain numerous species of native and introduced warmwater species.

There have been several samples scored with the Colorado MMI in Segment 1 with Current Conditions. Most of the sample scores indicated attainment of the aquatic life use. However, the scores were relatively low and a few of the samples scored below the threshold for attainment. This segment supports a community dominated by tolerant species as presented in the 2013 CTP Aquatic Resources Baseline Report (GEI 2013). Segment 1 of the South Platte River supports only a few sensitive and rheophilic species and this resulted in the low MMI scores. The negligible changes in the macroinvertebrate community and species composition with the No Action Alternative would likely continue to result in low MMI scores that sometimes indicate attainment of the use.

5.12.2.4 Cumulative Effects Summary

The No Action Alternative would have negligible to minor impacts to aquatic resource components in the mainstem (Table 5-39). In the South Platte River, the changes in flow would be relatively small and there would be negligible impacts.

Table 5-39. River segments effects summary for Alternative 1.

Segment	Impacts to Aquatic Biological Resource Components – Alternative 1			
	Overall Impact	Fish	Macroinvertebrates	Periphyton and Plants
Mainstem Poudre River				
A	Negligible to Minor Adverse	Negligible impacts to most species/life stages, minor beneficial impact to longnose dace and juvenile trout due to reduced runoff flows	Negligible to minor adverse impact with changes in species composition due to reduced peak flows	Negligible to minor adverse impact with changes in species composition and increases in filamentous green algae due to reduced peak flows
B	Negligible to Minor Adverse	Negligible impacts to most species/life stages, minor beneficial impact to longnose dace due to reduced runoff flows	Negligible to minor adverse impact with changes in species composition due to reduced peak flows	Negligible to minor adverse impact with changes in species composition and increases in filamentous green algae due to reduced peak flows
C	Negligible to Minor Adverse	Negligible impact to most species and minor beneficial impact to longnose dace, minor adverse impact to adult trout with reduced runoff flows and higher temperatures	Negligible to minor adverse impact with changes in species composition due to reduced peak flows	Negligible to minor adverse impact with changes in species composition and increases in filamentous green algae due to reduced peak flows
D	Negligible to Minor Adverse	Negligible impacts	Negligible to minor adverse impact with changes in species composition due to continued sedimentation	Negligible to minor adverse impact with changes in species composition due to continued sedimentation
E	Negligible to Minor Adverse	Negligible impacts	Negligible to minor adverse impact with changes in species composition due to continued sedimentation	Negligible to minor adverse impact with changes in species composition due to continued sedimentation
F	Negligible to Minor Adverse	Negligible impacts	Negligible to minor adverse impact with changes in species composition due to continued sedimentation	Negligible to minor adverse impact with changes in species composition due to continued sedimentation
South Platte River				
1	Negligible	Negligible impacts	Negligible impacts	Negligible impacts

Nuisance Species. The distribution and abundance of nuisance species would not be affected substantially by the No Action Alternative. Common carp and mosquitofish would continue to thrive in the altered habitats of the mainstem. Lower spring runoff flows would be beneficial to these two species, neither of which is adapted to high water velocities. Whirling disease presence and infectivity in the mainstem would likely not change, because water temperatures would not change substantially under this alternative. Didymo blooms could increase slightly near the upstream end of the study area in Segments A, B, and C in response to reduced spring

runoff flows. Higher proportions of fine substrate and only relatively small reductions in the already low spring runoff flows that are typical in the lower segments of the mainstem would not improve conditions for Didymo and make it unlikely that blooms will increase in Segments D, E, or F of the mainstem. New Zealand mud snails were recently found in College Lake in Fort Collins but are currently absent from the remainder of the Poudre Drainage and all of the drainages connected to it through transbasin diversions. This would not change with the No Action Alternative. The prevalence of West Nile virus would not change under the No Action Alternative. The No Action Alternative would not create any new habitat along the mainstem of the Poudre River that would be suitable to support mosquitoes. Mosquitoes would not be expected to live in the proposed reservoir due to the presence of fish and other predators.

Cactus Hill Reservoir would be created under the No Action Alternative, and this reservoir could support aquatic nuisance species. Whirling disease is less likely to become established in Cactus Hill Reservoir than in Glade Reservoir, because Cactus Hill Reservoir would be at a lower elevation and water temperatures could be high enough to reduce whirling disease infectivity. Cactus Hill Reservoir could provide habitat for zebra mussels or quagga mussels, but these species could only be introduced via transfer from contaminated objects such as boats or boating equipment. Public recreation at Cactus Hill Reservoir is not proposed. Current state regulations require boat inspection and disinfection to prevent spread of these species. These practices have minimized the potential for introductions of the mussels into lakes and reservoirs so it is unlikely that they will become established.

5.12.2.5 No Action Irrigated Lands

The No Action Alternative is not expected to have any impact on aquatic biological resources associated with the transfer of water from irrigated lands. The No Action Alternative would dry nearly 219 acres of wetlands, but these would not be riverine wetlands; they would be away from the channel of the mainstem and would not affect aquatic biological resources.

5.12.3 District's Preferred Alternative (Alternative 2)

5.12.3.1 Reservoir Sites

Alternative 2 would include the construction of Glade and Galeton Reservoirs as described previously in Section 4.12.3.1. The creation of Glade Reservoir would represent a major beneficial impact of Alternative 2 for aquatic organisms. The creation of Galeton Reservoir would create new habitat for aquatic resources where none now exists and in this sense would be a benefit. However, the conditions for aquatic resources in the reservoir would likely be poor and the beneficial effect would be minor.

The operations of Glade and Galeton Reservoirs would be similar with Current Conditions Effects, Future Conditions Effects, and Cumulative Effects (with RFFAs and HSWSPs). Therefore, the cumulative effect of the reservoirs would be the same for all three scenarios; a major beneficial effect of Glade Reservoir and a minor beneficial effect of Galeton Reservoir.

Alternative 2 with the No Reclamation Action Option would have no changes in the operation of Horsetooth Reservoir and Carter Lake and there would be no impact on aquatic organisms in these reservoirs. Alternative 2 with the Reclamation Action Option would generally result in less drawdown of Horsetooth Reservoir over the summer and less seasonal fluctuation of water levels as described previously in Section 4.12.3.1. This would have a minor beneficial impact for fish and other aquatic organisms. In Carter Lake, Alternative 2 with the Reclamation Action Option would have a negligible impact because changes in reservoir operation would be small.

5.12.3.2 Conveyance Systems

Alternative 2 combined with the RFFAs and HSWSPs is expected to have no cumulative impact on aquatic biological resources associated with conveyance systems.

5.12.3.3 River Segments

With Alternative 2 with Cumulative Effects, water primarily would be diverted from the mainstem during the high flow months of May and June as discussed in more detail in Section 5.2.3. Alternative 2 includes a flow augmentation program to increase Poudre River streamflows during traditionally low-flow times of the year, especially winter. The augmentation water would be added in the middle of Segment A but the effects would be most noticeable downstream of the Larimer-Weld Canal headgate dry-up point, which is just upstream of Segment B. The augmentation water would be diverted at the Timnath Reservoir Inlet near the downstream end of Segment B.

5.12.3.3.1 Poudre River

Segment A. The changes in flow and resulting changes in aspects of habitat with Alternative 2 with Cumulative Effects would have an overall minor adverse cumulative impact to aquatic organisms compared to Future Conditions hydrology in Segment A. Changes to some individual components of the aquatic environment in this segment would be negligible but changes to others would have minor adverse and minor to moderate beneficial cumulative impacts. Spring runoff flows would be substantially reduced; flow fluctuations and extreme low flows would improve slightly with Alternative 2 with Cumulative Effects. The duration of low flow periods would not change upstream of the point where augmentation flows are added although there may be a few days with lower flow. Downstream of the augmentation point, the extent of low flows would be reduced in magnitude (higher flow) at both flowing sections and at the traditional dry-up points. Water quality changes likely would be negligible to minor. There could be a minor to moderate increase in summer temperatures that could have an adverse cumulative impact on trout. Changes in sedimentation conditions would be minor, and the spatial variability of riffle-pool complexes would be maintained. Ongoing localized channel narrowing and vegetative encroachment would continue.

The changes in flow would result in a mix of adverse and beneficial impacts to fish species. Longnose dace would have a minor to moderate beneficial cumulative impact from the lower peak runoff flows and the resulting increases in minimum habitat availability up to 69% (Table

5-40) and because high-quality habitat exists for this species at low flows. Alternative 2 would have a minor adverse impact on the adult life stage of the two recreationally important species in Segment A, brown and rainbow trout, due to reductions in habitat during the critical spring period, the decrease in habitat quality with a decrease in high flows, and warmer summer water temperatures despite the gains in some WUA metrics (Table 5-40). However, the lower spring flows would increase habitat availability for juvenile trout, especially in 80th percentile years (which correspond to wet years for this life stage) and a minor beneficial impact. The loss in habitat availability in spring for adult trout likely would have a greater impact than the gain in only some years for juveniles. A loss of SSCV habitat at 20th percentile year (dry year) flows would be detrimental in those years. There are not expected to be changes in species composition of the fish community. Brown trout would continue to be common although the relative abundance of trout may decrease slightly.

Table 5-40. Comparison of habitat availability (WUA in ft^2/1,000 ft) for Current Conditions hydrology, Future Conditions hydrology, Alternative 2 Future Conditions Effects, and Cumulative Effects for fish species in Segment A.

Species	Life Stage	Habitat Availability (WUA) Metric	Year Type	WUA Values					
				Current Conditions (Run 1)	Future Conditions (Run 2)	Alternative 2 Future Conditions Effects (Run 4a)		Alternative 2 Cumulative Effects (Run 5a)	
						Value	% Change	Value	% Change
Longnose Dace	Adult	Minimum	Median	597	675	852	+26%	882	+31%
			80th Percentile	806	831	1,409	+70%	1,403	+69%
			20th Percentile	315	314	352	+12%	494	+57%
Brown Trout	Adult	Minimum	80th Percentile	548	631	524	-17%	627	-1%
			20th Percentile	49	130	130	0%	147	+13%
	Juvenile	Minimum	80th Percentile	11,364	11,283	13,681	+21%	14,101	+25%
Rainbow Trout	Juvenile	Minimum	80th Percentile	12,880	12,801	14,721	+15%	15,229	+19%
			20th Percentile	8,853	9,139	9,647	+6%	9,816	+7%

Negligible impacts are expected for suckers and trout fry and there are no changes in WUA metrics greater than 10% for these two species/life stages and for many WUA metrics for brown and rainbow trout with Alternative 2 with Current Conditions Effects, Future Conditions Effects, or Cumulative Effects and these species and life stages are not included in Table 5-40. However, for many of the individual WUA metrics with changes greater than 10%, WUA values gradually increase from Current Conditions through Future Conditions to Alternative 2 Future Conditions Effects to Alternative 2 Cumulative Effects and in all cases, the WUA value for Cumulative Effects is higher than the value for Current Conditions (Table 5-40). The last incremental change from Alternative 2 Future Conditions Effects to Alternative 2 Cumulative Effects is negligible in most cases.

Macroinvertebrate community abundance may benefit slightly from lower spring flows and augmented low flows downstream of the augmentation point but the community may sustain a

higher proportion of species that prefer moderate to slow current velocity. Species composition may change to species more suited to the altered flow regime, which would be a minor adverse cumulative impact. Similarly, there may be a minor increase in abundance of periphyton and aquatic plants and minor changes to species composition. The increase in filamentous green algae and changes in species composition would be a minor adverse cumulative impact.

Segment B. In Segment B, the effect of Alternative 2 would be an overall moderate beneficial cumulative impact. Changes to many individual components of the aquatic environment in this segment would have moderate beneficial cumulative impacts but other components would have negligible impacts. The augmented winter flows would more than double minimum flows in most years. The occurrence of extreme low flows would be approximately 90% less and the frequency of extreme flow fluctuations would be reduced by nearly half. Water quality changes likely would be negligible to minor. There could be a minor to moderate increase in summer temperatures that could have an adverse impact on trout. Changes in sedimentation conditions would be minor, and the spatial variability of riffle-pool complexes would be maintained. Ongoing localized channel narrowing and vegetative encroachment would continue.

Habitat availability for almost all species of fish would benefit from the augmented flows during the winter, early spring, and other low flow times of the year in sections upstream of the Timnath Reservoir Inlet. Minimum WUA values would increase substantially for every species and most average WUA values would increase as well (Table 5-41). Some species, such as longnose dace and rainbow trout juveniles and fry, would also benefit from the reduced spring flows. Species that use SSCV habitat would also benefit from increases in this habitat in median and low-flow years. Abundance of fish likely would increase and some species that now maintain low population levels may account for a higher proportion of the community. These changes indicate there would be a moderate beneficial impact to the fish community. However, increases in summer temperatures could dampen the benefit to trout.

Table 5-41. Comparison of habitat availability (WUA in ft²/1,000 ft) for Current Conditions Hydrology, Future Conditions hydrology, Alternative 2 Future Conditions Effects, and Cumulative Effects for fish species in Segment B.

Species	Life Stage	Habitat Availability (WUA) Metric	Year Type	WUA Values					
				Current Conditions (Run 1)	Future Conditions (Run 2)	Alternative 2 Future Conditions Effects (Run 4a)		Alternative 2 Cumulative Effects (Run 5a)	
						Value	% Change	Value	% Change
Longnose Dace	Adult	Minimum	Median	381	400	795	+99%	765	+91%
			80th Percentile	963	1,108	1,254	+13%	1,248	+13%
		Average	Median	1,288	1,319	1,455	+10%	1,457	+10%
			20th Percentile	981	1,015	1,278	+26%	1,273	+25%
Suckers	Adult	Minimum	Median	808	960	1,379	+44%	1,344	+40%
			80th Percentile	1,201	1,263	1,472	+17%	1,455	+15%
			20th Percentile	380	409	1,172	+186%	1,172	+186%
		Average	20th Percentile	1,278	1,290	1,503	+17%	1,480	+15%
Darters	Adult	Minimum	Median	557	619	736	+19%	692	+12%
			80th Percentile	842	900	1,105	+23%	1,087	+21%
			20th Percentile	262	282	506	+79%	505	+79%
		Average	Median	1,011	1,037	1,228	+18%	1,217	+17%
			20th Percentile	729	751	977	+30%	963	+28%
Fathead Minnows	Adult	Minimum	Median	745	886	1,165	+32%	1,145	+29%
			80th Percentile	1,077	1,101	1,215	+10%	1,206	+10%
			20th Percentile	351	378	1,067	+182%	1,067	+182%
		Average	80th Percentile	2,355	2,004	1,472	-27%	1,444	-28%
			20th Percentile	1,079	1,089	1,221	+12%	1,213	+11%
Brown Trout	Adult	Minimum	Median	1	1	26	+2,500%	19	+1,800%
			80th Percentile	3	6	71	+1,083%	55	+817%
			20th Percentile	<1	<1	2	+659%	2	+659
		Average	Median	1,036	1,023	873	-15%	778	-24%
			80th Percentile	2,012	1,781	1,601	-10%	1,571	-12%
			20th Percentile	470	487	345	-29%	266	-45%
	Juvenile	Minimum	Median	4,937	5,868	8,528	+45%	8,293	+41%
			80th Percentile	7,320	7,676	9,306	+21%	9,139	+19%
			20th Percentile	2,323	2,502	7,155	+186%	7,155	+186%
		Average	Median	10,284	10,445	11,466	+10%	11,224	+7%
			20th Percentile	7,772	7,838	9,476	+21%	9,207	+17%
Rainbow Trout	Adult	Minimum	Median	1,467	1,670	1,877	+12%	1,831	+10%
			20th Percentile	690	744	1,659	+123%	1,671	+125%
		Average	Median	3,080	3,067	2,589	-16%	2,547	-17%
			80th Percentile	4,454	4,197	3,445	-18%	3,328	-21%
	Juvenile	Minimum	Median	5,189	6,167	8,802	+43%	8,582	+39%
			80th Percentile	7,662	8,004	9,524	+19%	9,370	+17%
			20th Percentile	2,441	2,630	7,505	+185%	7,505	+185%
		Average	20th Percentile	8,369	8,424	9,874	+17%	9,619	+14%
Trout	Fry	Minimum	Median	895	887	906	+2%	973	+10%
			80th Percentile	1,107	1,008	1,124	+11%	1,306	+30%
		Average	80th Percentile	3,752	3,119	2,051	-34%	2,039	-35%
			20th Percentile	944	1,010	1,117	+11%	1,147	+14%

For almost all of the individual WUA metrics, WUA values gradually increase from Current Conditions through Future Conditions to Alternative 2 Future Conditions Effects (Table 5-41). The incremental change between Alternative 2 Future Conditions Effects and Alternative 2 Cumulative Effects is mostly negligible.

Macroinvertebrate community abundance would benefit from lower spring flows and augmented low flows and the community may sustain a higher proportion of species that prefer moderate to slow current velocity. Species composition may change to species more suited to the altered flow regime. The loss of some rheophilic species would be a minor adverse cumulative impact. There may be a minor increase in abundance of periphyton and aquatic plants and minor adverse cumulative impact due to changes in periphyton species composition with altered flows and increases in filamentous green algae.

Segment C. Alternative 2 would have an overall minor adverse cumulative impact to aquatic organisms in Segment C compared to Future Conditions hydrology. Changes to many individual components of the aquatic environment in this segment would have negligible impacts but other components would have minor to moderate adverse impacts. Water quality changes likely would be negligible to minor. There could be a minor increase in summer temperatures in a portion of Segment C near the Boxelder Gage that could have an adverse impact on trout. Changes in sedimentation conditions would be minor, and the spatial variability of riffle-pool complexes would be maintained. Ongoing localized channel narrowing and vegetative encroachment would continue.

The reductions in spring flows would have a negligible to minor beneficial impact on most of the small-bodied fish species as these species have higher habitat availability at relatively low flows and already tolerate the somewhat degraded water quality in this segment. These species would also benefit from small increases in SSCV habitat. Lower frequency of flow fluctuations would also benefit fish. Longnose dace would have a moderate beneficial cumulative impact with greater minimum habitat availability at the lower spring runoff flows (Table 5-42). However, adult trout would experience lower habitat availability with lower spring flows. Reductions in average WUA metrics would be up to 57% (Table 5-42). For brown and rainbow trout, these two species do not maintain resident, reproducing populations in Segment C but seasonally use the habitat in the segment when temperatures are suitable. The increased temperatures with Alternative 2 Cumulative Effects could further limit the time when temperatures are suitable for trout. The lowered spring flows would reduce habitat availability and the seasonal use by these recreationally important species. Alternative 2 would have a moderate adverse cumulative impact on trout. There likely would not be a change in the overall species composition of the fish community with Alternative 2, but the community relative abundance may shift to one more dominated by small-bodied warmwater species with fewer trout.

Table 5-42. Comparison of habitat availability (WUA in ft²/1,000 ft) for Current Conditions hydrology, Future Conditions hydrology, Alternative 2 Future Conditions Effects, and Cumulative Effects for fish species in Segment C.

Species	Life Stage	Habitat Availability (WUA) Metric	Year Type	WUA Values					
				Current Conditions (Run 1)	Future Conditions (Run 2)	Alternative 2 Future Conditions Effects (Run 4a)		Alternative 2 Cumulative Effects (Run 5a)	
						Value	% Change	Value	% Change
Longnose Dace	Adult	Minimum	Median	99	170	378	+122%	543	+219%
			80th Percentile	657	738	788	+7%	748	+1%
			20th Percentile	49	48	48	0%	53	+11%
Suckers	Adult	Minimum	Median	332	439	460	+5%	429	-2%
			80th Percentile	552	687	622	-9%	591	-14%
Darters	Adult	Minimum	Median	281	372	295	-20%	363	-2%
			80th Percentile	467	582	527	-9%	500	-14%
Fathead Minnows	Adult	Minimum	Median	510	675	706	+5%	659	-2%
			80th Percentile	847	1,053	955	-9%	907	-14%
		Average	80th Percentile	1,597	1,544	1,380	-11%	1,375	-11%
Sand Shiners	Adult	Minimum	Median	870	1,152	914	-21%	1,125	-2%
			80th Percentile	1,447	1,797	1,631	-9%	1,549	-14%
Brown Trout	Adult	Average	Median	313	283	130	-54%	122	-57%
			80th Percentile	724	686	463	-33%	454	-34%
			20th Percentile	87	46	24	-47%	21	-53%
Rainbow Trout	Adult	Minimum	Median	252	333	349	+5%	325	-2%
			80th Percentile	418	521	471	-10%	448	-14%
		Average	Median	974	938	699	-25%	687	-27%
			80th Percentile	2,020	1,779	1,273	-28%	1,251	-30%

For the species other than trout, many of the WUA metrics would have changes less than 10% for Current Conditions hydrology through Cumulative Effects and are not presented in Table 5-42. There are a few WUA metrics with changes less than 10% for Future Conditions Effects and Cumulative Effects that did not continue trends of greater changes with Current Conditions Effects. For the WUA metrics that do change by more than 10%, many of the individual WUA values gradually increase from Current Conditions through Future Conditions to Alternative 2 Future Conditions Effects (Table 5-42). The incremental change between Alternative 2 Future Conditions Effects and Alternative 2 Cumulative Effects is small in most cases.

For brown and rainbow trout, the reductions in runoff flows from Current Conditions through Future Conditions to Cumulative Effects results in a continual decline in WUA values, especially average values (Table 5-42). The incremental change between Alternative 2 Future Conditions Effects and Alternative 2 Cumulative Effects is small for trout as well.

Macroinvertebrate community abundance may benefit slightly from lower spring flows and the community may sustain a higher proportion of species that prefer moderate to slow current velocity. Species composition may change to species more suited to the altered flow regime, which would be a minor adverse cumulative impact. Similarly, there may be a minor increase in abundance of periphyton, including filamentous green algae, and aquatic plants and changes to species composition with the altered flows and minor adverse cumulative impact.

Segment D. Alternative 2 would have an overall negligible to minor adverse cumulative impact in Segment D. Changes to some individual components of the aquatic environment in this segment would have minor beneficial impacts but other components would have negligible impacts. The reductions in spring flows in June would extend the period of very low flows in this segment from May through August. Water quality and water temperature changes likely would be negligible to minor. Decreases in fluctuations and slight increases in flow at the dry-up point would also be beneficial. Sedimentation, channel narrowing and vegetative encroachment would worsen with Alternative 2 Cumulative Effects. Riffle-pool complexes would continue to be altered with fewer deep pools and more uniform habitat and this would be a moderate adverse cumulative impact.

Alternative 2 Cumulative Effects would have a minor beneficial cumulative impact with increases in minimum habitat availability for some of the small-bodied fish species including longnose dace and darters (Table 5-43). For the other species there would be negligible impacts with changes in WUA metrics of greater than 10% in only a few year types or inconsistent increases and decreases. The fish species present in Segment D already tolerate the somewhat degraded habitat and water quality in this segment and there would be no changes in the number of species in this segment with the small changes in water quality or water temperature. Small increases in main-channel SSCV habitat would likely allow habitat generalists such as fathead minnows to increase their spawning success. Increased sedimentation would dampen the beneficial effects for fish.

Table 5-43. Comparison of habitat availability (WUA in ft^2/1,000 ft) for Current Conditions hydrology, Future Conditions hydrology, Alternative 2 Future Conditions Effects, and Cumulative Effects for fish species in Segment D.

Species	Life Stage	Habitat Availability (WUA) Metric	Year Type	WUA Values					
				Current Conditions (Run 1)	Future Conditions (Run 2)	Alternative 2 Future Conditions Effects (Run 4a)		Alternative 2 Cumulative Effects (Run 5a)	
						Value	% Change	Value	% Change
Longnose Dace	Adult	Minimum	Median	179	192	394	+105%	264	+38%
			80th Percentile	617	497	720	+45%	638	+28%
			20th Percentile	46	45	40	-11%	44	-3%
Suckers	Adult	Minimum	Median	957	1,136	1,132	<-1%	1,012	-11%
			20th Percentile	289	230	290	+26%	290	+26%
Darters	Adult	Minimum	Median	770	668	783	+17%	629	-6%
			80th Percentile	1,186	1,191	1,313	+10%	1,286	+8%
			20th Percentile	295	234	295	+26%	295	+26%
Fathead Minnows	Adult	Minimum	20th Percentile	515	409	515	+26%	515	+26%
		Average	80th Percentile	2,890	2,766	2,501	-10%	2,487	-10%
Sand Shiners	Adult	Minimum	Median	2,337	2,271	3,105	+37%	2,134	-6%
			20th Percentile	865	863	1,047	+21%	948	+10%

For the few WUA metrics with changes greater than 10%, values for Alternative 2 Future Conditions Effects in almost all cases are higher than for Future Conditions and are generally as

high as or higher than for Current Conditions (Table 5-43). In these cases, the reductions in spring runoff with Alternative 2 result in flows that have relatively high habitat availability for most fish species. The changes in WUA metrics with Alternative 2 Cumulative Effects still would result in some increases in WUA metrics compared to Future Conditions hydrology, but the increases are much smaller because Cumulative Effects would reduce flows in June below levels during other parts of the year and would result in lower minimum WUA values than for Alternative 2 Future Conditions Effects.

The macroinvertebrate community may sustain a slightly higher proportion of species that prefer moderate to slow current velocity. Species composition may change to species more suited to the altered flow regime and increased sedimentation, which would be a minor adverse cumulative impact. Similarly, there may be a minor increase in abundance of periphyton and aquatic plants and changes in species composition with the altered flow and increased sedimentation. There would be a minor adverse cumulative impact due to predicted changes in periphyton species composition and increases in filamentous green algae.

Segment E. Alternative 2 would have an overall minor adverse cumulative impact on the aquatic biota in Segment E. Changes to some individual components of the aquatic environment in this segment would have negligible impacts but other components would have minor adverse impacts. Similar to Segment D, in Segment E the reductions in spring flows in June would extend the period of low and intermediate flows from May through August. Water quality and water temperature changes likely would be negligible to minor. Sedimentation, channel narrowing and vegetative encroachment would worsen with reduced spring flows with Alternative 2 Cumulative Effects. Riffle-pool complexes would continue to be altered with fewer deep pools and more uniform habitat and this would be a moderate adverse cumulative impact.

The changes in flow would not have much effect on minimum habitat availability for most fish species and there are only a few WUA metrics with changes greater than 10% (Table 5-44). There would be only negligible changes in habitat availability for fish and in SSCV habitat and these changes would be short-term and occur infrequently. The species present in Segment E already tolerate the somewhat degraded habitat and water quality in this segment and there would be no changes in the number of species in this segment. However, increased sedimentation may result in a minor adverse cumulative impact on fish.

Table 5-44. Comparison of habitat availability (WUA in ft^2/1,000 ft) for Current Conditions hydrology, Future Conditions hydrology, Alternative 2 Future Conditions Effects, and Cumulative Effects for fish species in Segment E.

Species	Life Stage	Habitat Availability (WUA) Metric	Year Type	WUA Values					
				Current Conditions (Run 1)	Future Conditions (Run 2)	Alternative 2 Future Conditions Effects (Run 4a)		Alternative 2 Cumulative Effects (Run 5a)	
						Value	% Change	Value	% Change
Longnose Dace	Adult	Minimum	Median	190	221	237	+7%	239	+8%
			20th Percentile	145	152	133	-12%	135	-11%
Darters	Adult	Average	80th Percentile	1,376	1,294	1,148	-11%	1,130	-13%
Fathead Minnows	Adult	Average	80th Percentile	3,267	2, 839	2,007	-29%	1,899	-33%
Sand Shiners	Adult	Average	80th Percentile	4,892	4,590	3,988	-13%	3,911	-15%

For the few WUA metrics with changes greater than 10%, the reductions in spring flows would mostly result in WUA values gradually decreasing from Current Conditions through Future Conditions to Alternative 2 Future Conditions Effects and Cumulative Effects (Table 5-44). The incremental change between Alternative 2 Future Conditions Effects and Alternative 2 Cumulative Effects is small.

For macroinvertebrates, the increased sedimentation and lowered minimum flows may result in a community with fewer sensitive species and a shift away from rheophilic species that prefer faster currents. Species composition may change to species more suited to the altered flow regime, which would be a minor adverse cumulative impact. Similarly, there may be a minor increase in abundance of periphyton and aquatic plants and minor adverse cumulative impact from changes in species composition and increases in filamentous green algae due to the altered flow regime and increased sedimentation.

Segment F. Alternative 2 would have a minor adverse cumulative impact on the aquatic biota in Segment F. Changes to some individual components of the aquatic environment in this segment would have negligible impacts but other components would have minor adverse impacts. Similar to Segment D and E, in Segment F the reductions in spring flows in June would extend the period of low and intermediate flows from May through August. Water quality and water temperature changes likely would be negligible to minor. Sedimentation, channel narrowing and vegetative encroachment would worsen with reduced spring flows with Alternative 2 Cumulative Effects. Riffle-pool complexes would continue to be altered with fewer deep pools and more uniform habitat and this would be a moderate adverse cumulative impact.

For most WUA metrics, there would be negligible changes. The few reductions in fish habitat availability would be limited to June of 80th percentile years (Table 5-45) when habitat availability is already relatively high and would have little effect on fish species. However, increased sedimentation may result in a minor adverse cumulative impact to fish. The species present in Segment F already tolerate the somewhat degraded habitat and water quality in this segment and there would be no changes in the number of species in this segment.

Table 5-45. Comparison of habitat availability (WUA in ft^2/1,000 ft) for Current Conditions hydrology, Future Conditions hydrology, Alternative 2 Future Conditions Effects, and Cumulative Effects for fish species in Segment F.

Species	Life Stage	Habitat Availability (WUA) Metric	Year Type	WUA Values					
				Current Conditions (Run 1)	Future Conditions (Run 2)	Alternative 2 Future Conditions Effects (Run 4a)		Alternative 2 Cumulative Effects (Run 5a)	
						Value	% Change	Value	% Change
Suckers	Adult	Average	80th Percentile	2,068	1,960	1,587	-19%	1,556	-21%
Darters	Adult	Minimum	80th Percentile	455	334	401	+20%	359	+7%
		Average	80th Percentile	1,467	1,288	921	-28%	890	-31%
Fathead Minnows	Adult	Average	80th Percentile	5,814	5,305	3,353	-37%	3,214	-39%
Sand Shiners	Adult	Average	80th Percentile	6,823	6,308	4,758	-25%	4,636	-27%

Similar to the results for Segment E, in Segment F, the reductions in spring flows would mostly result in WUA values gradually decreasing from Current Conditions through Future Conditions to Alternative 2 Future Conditions Effects and Cumulative Effects (Table 5-45). The incremental change between Alternative 2 Future Conditions Effects and Alternative 2 Cumulative Effects is small.

For macroinvertebrates, the increased sedimentation and lowered spring flows may result in a community with fewer sensitive species and a shift away from species that prefer faster currents In Segment F, species composition may change to species more suited to the altered flow regime, which would be a minor adverse cumulative impact. Similarly, there may be a minor increase in abundance of periphyton and aquatic plants and changes to species composition and a minor adverse cumulative impact with reduced spring flows and increased sedimentation.

Colorado MMI scores for samples in Segment A, B, and C with Current Conditions presented in the 2013 CTP Aquatic Resources Baseline Report (GEI 2013) almost always exceeded the threshold for attaining the aquatic life use. These segments support a high proportion of rheophilic species and many other sensitive species of macroinvertebrates that result in the high MMI scores. The changes in species composition with Alternative 2 Cumulative Effects would likely not be sufficient to change MMI scores much; sensitive species including some rheophilic species would still be present, which indicates the community would continue to score above the threshold and indicate attainment.

There were only three samples scored with the Colorado MMI in Segments E and F with Current Conditions and none in Segment D. Only two of the three scores indicated attainment of the aquatic life use, although one score was just over the threshold for attainment. Segments D, E, and F support a macroinvertebrate community dominated by tolerant species as presented in the 2013 CTP Aquatic Resources Baseline Report (GEI 2013). These segments support at least some sensitive and rheophilic species that result in high MMI scores, but fewer than in upstream segments. The negligible to minor changes in the macroinvertebrate species composition resulting from changes in flow and sedimentation with Alternative 2 Cumulative Effects would not change

species composition substantially and indicate MMI scores likely would continue to sometimes indicate attainment of the use.

In the six individual segments of the mainstem the mostly negligible to minor cumulative impacts to aquatic resources and their habitat with Alternative 2 Cumulative Effects would not cause the crossing of tipping points in the mainstem. Segment A of the mainstem would continue to function as a coldwater stream segment supporting coldwater species of fish and macroinvertebrates. There would be slight changes in species relative abundance, but brown trout, longnose dace, and suckers are expected to remain as the dominant fish species. Segment B would continue to function as a warmwater stream segment supporting a wide variety of both coldwater and warmwater species of fish and macroinvertebrates. There would be slight changes in species relative abundance, but brown trout, longnose dace, and suckers are expected to remain as some of the most common fish species along with numerous warmwater species. Segment C would continue to function as a warmwater stream segment supporting a wide variety of warmwater species of fish and macroinvertebrates and seasonally support some trout that move downstream from Segment B. There would be slight changes in species relative abundance with fewer trout in some section of the segment and in warmer seasons, but the numerous warmwater species would continue to be the dominant component of the fishery.

Segments D, E, and F would continue to function as warmwater stream segments supporting a wide variety of warmwater species of fish and a somewhat degraded community of macroinvertebrates. The fish community has already crossed a tipping point and nonnative species such as carp, gizzard shad, largemouth bass, and mosquitofish are common and only a few native species such as white suckers, fathead minnows, and green sunfish continue to be common. There may be slight reductions in fish abundance but the fishery would still contain numerous species of native and introduced warmwater species.

5.12.3.3.2 South Platte River

Alternative 2 would have a negligible cumulative impact on the aquatic resources in Segment 1 of the South Platte River. Changes in water quality, water temperatures, riparian vegetation, and channel geomorphology in the South Platte River would be small and not have much effect on aquatic organisms. The small changes in flow would have little effect on habitat availability for white suckers, sand shiners, and red shiners and result in negligible cumulative impacts. There could be a minor adverse impact on plains killifish due to reductions in habitat availability in winter and during spring runoff for this species of special concern in Colorado. There is expected to be a negligible impact on the macroinvertebrate and plant communities in the South Platte River.

There have been several samples scored with the Colorado MMI in Segment 1 with Current Conditions. Most of the sample scores indicated attainment of the aquatic life use. However, the scores were relatively low and a few of the samples scored below the threshold for attainment. This segment supports a community dominated by tolerant species as presented in the 2013 CTP Aquatic Resources Baseline Report (GEI 2013). Segment 1 of the South Platte River supports only a few sensitive and rheophilic species and this resulted in the low MMI scores. The negligible changes in the macroinvertebrate community and species composition with

Alternative 2 Cumulative Effects would likely continue to result in low MMI scores that sometimes indicate attainment of the use.

The negligible impacts to most components of aquatic resources and their habitat with Alternative 2 Cumulative Effects would not cause the crossing of a tipping point in Segment 1 of the South Platte River. This segment would continue to function as a warmwater stream segment supporting a wide variety of warmwater species of fish and a somewhat degraded community of macroinvertebrates. The fish community has a higher proportion of native species compared to the community in the mainstem of the Poudre River. Native minnow species are most common with introduced species present, but usually in relatively low numbers. The negligible cumulative impacts to most components of the aquatic environment with Alternative 2 indicate the fishery would still contain numerous species of native and introduced warmwater species.

5.12.3.4 Cumulative Effects Summary

Alternative 2 Cumulative Effects would have minor adverse cumulative impacts to most aquatic resource components in the mainstem (Table 5-46). In Segment B there would be a moderate beneficial cumulative impact with augmented low flows. In the South Platte River, the changes in flow would be relatively small and there would be a negligible cumulative impact.

Table 5-46. River segments Cumulative Effects summary for Alternative 2.

Segment	Impacts to Aquatic Biological Resource Components Alternative 2 Cumulative Effects			
	Overall Impact	**Fish**	**Macroinvertebrates**	**Periphyton and Plants**
Mainstem Poudre River				
A	Minor Adverse	Negligible impacts to most species/life stages, minor adverse impact to adult trout and minor to moderate beneficial impact to longnose dace and juvenile trout due to reduced runoff flows	Minor adverse impact with changes in species composition due to reduced peak flows	Minor adverse impact with increases in filamentous green algae and changes in species composition due to reduced peak flows
B	Moderate Beneficial	Minor to moderate beneficial impact to most species of fish with augmented low flows	Beneficial impact to abundance, minor adverse impact with changes in species composition due to reduced peak flows	Minor adverse impact with increases in filamentous green algae and changes in species composition due to reduced peak flows
C	Minor Adverse	Negligible impacts to most species/life stages, moderate adverse impact to adult trout due to reduced runoff flows and higher temperatures, moderate beneficial impact to longnose dace	Minor adverse impact with changes in species composition due to reduced peak flows	Minor adverse impact with increases in filamentous green algae and changes in species composition due to reduced peak flows
D	Negligible to Minor Adverse	Minor beneficial impact to some species with reductions in runoff flows, negligible impact to others	Minor adverse impact with changes in species composition due to increased sedimentation and reduced peak flows	Minor adverse impact with changes in species composition and increases in filamentous green algae due to increased sedimentation and reduced peak flows
E	Minor Adverse	Minor adverse impact to most species with increased sedimentation	Minor adverse impact with changes in species composition due to increased sedimentation and reduced peak flows	Minor adverse impact with changes in species composition and increases in filamentous green algae due to increased sedimentation and reduced peak flows
F	Minor Adverse	Minor adverse impact to most species with increased sedimentation	Minor adverse impact with changes in species composition due to increased sedimentation and reduced peak flows	Minor adverse impact with changes in species composition and increases in filamentous green algae due to increased sedimentation and reduced peak flows
South Platte River				
1	Negligible	Negligible impacts to most species	Negligible impacts	Negligible impacts

Nuisance Species. Similar to the effects for the No Action Alternative, the distribution and abundance of nuisance species would not be affected substantially by Alternative 2 Cumulative Effects. Common carp and mosquitofish would continue to thrive in the altered habitats of the mainstem. Lower spring runoff flows would be beneficial to these two species, neither of which is adapted to high water velocities. Whirling disease presence and infectivity in the mainstem would likely not change, because water temperatures would not change substantially under this alternative. Didymo blooms could increase slightly near the upstream end of the study area in Segments A, B, and C in response to reduced spring runoff flows. Higher proportions of fine substrate and only relatively small reductions in the already low spring runoff flows that are typical in the lower segments of the mainstem would not improve conditions for Didymo and make it unlikely that blooms will increase in Segments D, E, or F of the mainstem. New Zealand mud snails were recently found in College Lake in Fort Collins but are currently absent from the Poudre Drainage and all of the drainages connected to it through transbasin diversions. This would not change with Alternative 2. The prevalence of West Nile virus would not change under Alternative 2. Alternative 2 would not create any new habitat along the mainstem of the Poudre River that would be suitable to support mosquitoes. Mosquitoes would not be expected to live in the two proposed reservoirs due to the presence of fish and other predators.

The creation of Glade Reservoir could increase habitat for aquatic nuisance species. Whirling disease would likely become established in Glade Reservoir as whirling disease positive fish enter the reservoir through the Poudre Valley Canal. Common carp may also become established in Glade Reservoir. Glade Reservoir could provide habitat for zebra mussels or quagga mussels, but these species could only be introduced via transfer from contaminated objects such as boats or boating equipment. Current state regulations require boat inspection and disinfection to prevent spread of these species. These practices have minimized the potential for introductions of the mussels into lakes and reservoirs so it is unlikely that they would become established in Glade Reservoir.

5.12.4 Alternative 3

5.12.4.1 Reservoir Sites

Alternative 3 would include the construction of Cactus Hill and Galeton Reservoirs as described previously in Section 4.12.4.1. The creation of a 190,000 AF Cactus Hill Reservoir would represent a major beneficial impact of Alternative 3 for aquatic organisms. The creation of Galeton Reservoir would create new habitat for aquatic resources where none now exists and in this sense would be a benefit. However, the conditions for aquatic resources in the reservoir would likely be poor and the beneficial impact would be minor. With Alternative 3, there would be no changes in the operation of Horsetooth Reservoir. Alternative 3 would have no impact on Horsetooth Reservoir or Carter Lake.

The operations of Cactus Hill and Galeton Reservoirs would be similar with Current Conditions Effects, Future Conditions Effects, and Cumulative Effects (with RFFAs and HSWSPs). Therefore, the cumulative effect of the reservoirs would be the same for all three scenarios; a

major beneficial effect of Cactus Hill Reservoir and a minor beneficial effect of Galeton Reservoir.

5.12.4.2 Conveyance Systems

Alternative 3 combined with the RFFAs and HSWSPs is expected to have no cumulative impact on aquatic biological resources associated with conveyance systems.

5.12.4.3 River Segments

Alternative 3 is very similar to Alternative 2 and includes diversions of water from the mainstem just downstream of the North Fork. Water primarily would be diverted from the mainstem during the high flow months of May and June. Alternative 3 would divert on average about 5,500 to 6,000 AFY more water from the Poudre River than Alternative 2 to compensate for increased reservoir evaporation from Cactus Hill Reservoir and conveyance loss. Additionally, Alternative 3 does not include the flow augmentation program that is proposed under Alternative 2 because there would be no infrastructure to make flow releases from Cactus Hill Reservoir to the Poudre River.

5.12.4.3.1 Poudre River

Alternative 3 Cumulative Effects would be similar to those previously presented for Alternative 2 (Section 4.12.3.3.1) compared to Future Conditions hydrology in all segments except for Segment B of the mainstem. This would include mostly negligible to minor adverse impacts to aquatic resources in Segments A, C, D, E, and F of the mainstem, as described for Alternative 2.

Segment B. Alternative 3 Cumulative Effects would have an overall moderate adverse cumulative impact to aquatic organisms compared to Future Conditions hydrology in Segment B. Changes to some individual components of the aquatic environment in this segment would have minor to moderate adverse impacts but other components would have negligible impacts. Spring runoff flows would be substantially reduced, but extreme low flows would not change much with Alternative 3. Water quality changes likely would be negligible to minor. There could be a minor to moderate increase in summer temperatures that could have an adverse impact on trout. Changes in sedimentation conditions would be minor, and the spatial variability of riffle-pool complexes would be maintained. Ongoing localized channel narrowing and vegetative encroachment would continue.

Longnose dace would benefit from the lower peak runoff flows and the resulting increase in minimum habitat availability (Table 5-47) and there would be a moderate beneficial cumulative impact for this species. Alternative 3 would have a moderate adverse cumulative impact on the two recreationally important species in Segment B, brown and rainbow trout, due to reductions in habitat availability for adults during the critical spring period and warmer summer water temperatures. Brown and rainbow trout adults would have reductions in average WUA metrics of 16% to 51% (Table 5-47). Brown trout is one of the most common species in Segment B and the effects to this species would have a moderate adverse impact on the fishery. Negligible impacts are expected for suckers, darters, and juvenile trout of both species. In most years,

SSCV habitat would increase slightly under Alternative 3; the small increases could be beneficial. There are expected to be no changes in the species composition of the fish community although the relative abundance may shift with reductions in brown trout.

Table 5-47. Comparison of habitat availability (WUA in ft^2/1,000 ft) for Current Conditions hydrology, Future Conditions hydrology, Alternative 3 Future Conditions Effects, and Cumulative Effects for fish species in Segment B.

Species	Life Stage	Habitat Availability (WUA) Metric	Year Type	WUA Values					
				Current Conditions (Run 1)	Future Conditions (Run 2)	Alternative 3 Future Conditions Effects (Run 4b1)		Alternative 3 Cumulative Effects (Run 5b1)	
						Value	% Change	Value	% Change
Longnose Dace	Adult	Minimum	Median	381	400	821	+105%	786	+96%
			80th Percentile	963	1,108	1,247	+13%	1,250	+13%
		Average	20th Percentile	981	1,015	1,119	+10%	1,059	+4%
Suckers	Adult	Minimum	20th Percentile	380	409	495	+21%	381	-7%
Darters	Adult	Minimum	20th Percentile	262	282	341	+21%	263	-7%
		Average	Median	1,011	1,037	1,142	+10%	1,105	+6%
			20th Percentile	729	751	827	+10%	770	+3%
Fathead Minnows	Adult	Minimum	20th Percentile	351	378	457	+21%	351	-7%
		Average	80th Percentile	2,355	2,004	1,406	-30%	1,396	-30%
Brown Trout	Adult	Average	Median	1,036	1,023	809	-21%	716	-30%
			80th Percentile	2,012	1,781	1,522	-15%	1,498	-16%
			20th Percentile	470	487	302	-38%	237	-51%
	Juvenile	Minimum	20th Percentile	2,323	2,502	3,027	+21%	2,328	-7%
Rainbow Trout	Adult	Minimum	20th Percentile	690	744	899	+21%	692	-7%
		Average	Median	3,080	3,067	2,481	-19%	2,436	-21%
			80th Percentile	4,454	4,197	3,345	-20%	3,284	-22%
			20th Percentile	2,123	2,080	1,824	-12%	1,749	-16%
	Juvenile	Minimum	20th Percentile	2,442	2,630	3,181	+21%	2,447	-7%
Trout	Fry	Minimum	80th Percentile	1,107	1,008	1,161	+15%	1,228	+22%
		Average	80th Percentile	3,752	3,119	2,065	-34%	2,158	-31%

For most fish species and life stages other than for adult trout, many WUA metrics would not change by more than 10% for Alternative 3 Current Conditions Effects, Future Conditions Effects and Cumulative Effects and are not presented in Table 5-47. For the metrics that do change substantially, there are generally increasing WUA values from Current Conditions hydrology through Future Conditions hydrology to Alternative 3 Future Conditions Effects (Table 5-47) with the reductions in spring runoff flows. This results in gains in WUA values of 10% to 30% for many species for Alternative 3 Future Conditions Effects. For adult brown and rainbow trout, the opposite is true and lower spring flows would reduce WUA values from Current Conditions through Future Conditions. For the increment between Alternative 3 Future Conditions Effects to Alternative 3 Cumulative Effects, the further reduction in spring flows reduces WUA values for almost all species and life stages (Table 5-47). For most species and life stages, this would result in a negligible reduction in habitat availability for Cumulative Effects, but for adult trout, the reductions would be greater.

Macroinvertebrate community abundance may benefit slightly from lower spring flows and the community may sustain a higher proportion of species that prefer moderate to slow current velocity. Species composition may change to species more suited to the altered flow regime, which would be a minor adverse cumulative impact. Similarly, there may be a minor increase in abundance of periphyton and aquatic plants and minor adverse cumulative impact due to changes in periphyton species composition and increases in filamentous green algae.

Colorado MMI scores for samples in Segment B with Current Conditions presented in the 2013 CTP Aquatic Resources Baseline Report (GEI 2013) always exceeded the threshold for attaining the aquatic life use. Segment B supports a high proportion of rheophilic species and many other sensitive species of macroinvertebrates that result in the high MMI scores. The changes in species composition with Alternative 3 Cumulative Effects would likely not be sufficient to change MMI scores much; sensitive species including some rheophilic species would still be present, which indicates the community would continue to score above the threshold and indicate attainment.

The negligible to moderate adverse impacts to aquatic resources and their habitat with Alternative 3 Cumulative Effects would not cause the crossing of a tipping point in Segment B. Segment B would continue to function as a warmwater stream segment supporting a wide variety of both coldwater and warmwater species of fish and macroinvertebrates. There would be slight changes in species relative abundance, but brown trout, longnose dace, and suckers are expected to remain as some of the most common fish species along with numerous warmwater species.

5.12.4.3.2 South Platte River

Alternative 3 Cumulative Effects would be similar to those previously presented for Alternative 2 (Section 5.12.3.3.2) compared to Future Conditions hydrology in the South Platte River. This would include a negligible cumulative impact on aquatic biological resources in the South Platte River, as described for Alternative 2.

5.12.4.4 Cumulative Effects Summary

Alternative 3 Cumulative Effects would be minor adverse to most aquatic resource components in the mainstem (Table 5-48). In Segment B there would be an overall moderate adverse cumulative impact. In the South Platte River, the changes in flow would be relatively small and there would be a negligible cumulative impact.

Table 5-48. River segments cumulative effects summary for Alternative 3.

Segment	Impacts to Aquatic Biological Resource Components Alternative 3 Cumulative Effects			
	Overall Impact	Fish	Macroinvertebrates	Periphyton and Plants
Mainstem Poudre River				
A	Minor Adverse	Negligible impacts to most species/life stages, minor adverse impact to adult trout and minor to moderate beneficial impact to longnose dace and juvenile trout due to reduced runoff flows	Minor adverse impact with changes in species composition due to reduced peak flows	Minor adverse impact with increases in filamentous green algae and changes in species composition due to reduced peak flows
B	Moderate Adverse	Negligible impacts to most species/life stages, moderate adverse impact to adult trout due to reduced runoff flows, moderate beneficial impact to longnose dace	Minor adverse impact with changes in species composition due to reduced peak flows	Minor adverse impact with increases in filamentous green algae and changes in species composition due to reduced peak flows
C	Minor Adverse	Negligible impacts to most species/life stages, moderate adverse impact to adult trout due to reduced runoff flows and higher temperatures, moderate beneficial impact to longnose dace	Minor adverse impact with changes in species composition due to reduced peak flows	Minor adverse impact with increases in filamentous green algae and changes in species composition due to reduced peak flows
D	Negligible to Minor Adverse	Minor beneficial impact to some species with reductions in runoff flows, negligible impact to others	Minor adverse impact with changes in species composition due to increased sedimentation and reduced peak flows	Minor adverse impact with changes in species composition and increases in filamentous green algae due to increased sedimentation and reduced peak flows
E	Minor Adverse	Minor adverse impact to most species with increased sedimentation	Minor adverse impact with changes in species composition due to increased sedimentation and reduced peak flows	Minor adverse impact with changes in species composition and increases in filamentous green algae due to increased sedimentation and reduced peak flows
F	Minor Adverse	Minor adverse impact to most species with increased sedimentation	Minor adverse impact with changes in species composition due to increased sedimentation and reduced peak flows	Minor adverse impact with changes in species composition and increases in filamentous green algae due to increased sedimentation and reduced peak flows
South Platte River				
1	Negligible	Negligible impacts to most species	Negligible impacts	Negligible impacts

Nuisance Species. Alternative 3 Cumulative Effects would have similar impacts to the distribution and abundance of nuisance species as that previously presented for Alternative 2 (Section 5.12.3.4). Cactus Hill Reservoir could support nuisance species similar to the conditions previously described for Glade Reservoir. Whirling disease is less likely to become established in Cactus Hill Reservoir than in Glade Reservoir, because Cactus Hill Reservoir would be at a lower elevation and water temperatures could be high enough to reduce whirling disease infectivity.

5.12.5 Alternative 4

5.12.5.1 Reservoir Sites

Alternative 4 would have the same reservoirs as Alternative 3 and would have similar cumulative impacts at the reservoir sites as previously described for Alternative 3 (Section 4.12.4.1).

5.12.5.2 Conveyance Systems

Alternative 4 combined with the RFFAs and HSWSPs is expected to have no cumulative impact on aquatic biological resources associated with conveyance systems.

5.12.5.3 River Segments

Alternative 4 would be similar to Alternative 3 in many respects but there would be an additional point of diversion. For Alternative 4, approximately 75% of the water would be diverted from the mainstem at the Poudre Valley Canal, the same location as other alternatives, but about 25% of the water would be diverted at the New Cache Canal east of I-25 and east of Fort Collins. Relative to Alternatives 2 and 3, this would allow more water to flow through the Fort Collins area before being diverted. Water primarily would be diverted from the mainstem during the high flow months of May and June. Like Alternative 3, Alternative 4 would divert on average about 5,500 to 6,000 AFY more water from the Poudre River than Alternative 2 to compensate for increased reservoir evaporation from Cactus Hill Reservoir and conveyance loss. Alternative 4 also does not include the flow augmentation program that is proposed under Alternative 2 because there would be no infrastructure to make flow releases from Cactus Hill Reservoir to the Poudre River.

5.12.5.3.1 Poudre River

Segment A. With Alternative 4 Cumulative Effects, the changes in flow and resulting changes in other aspects of habitat would have an overall minor adverse cumulative impact to aquatic organisms compared to Future Conditions hydrology in Segment A. Changes to some individual components of the aquatic environment in this segment would be negligible but changes to others would have minor adverse and minor beneficial cumulative impacts. Water quality changes likely would be negligible to minor. There could be a minor to moderate increase in summer temperatures that could have an adverse impact on trout. Changes in sedimentation

conditions would be minor, and the spatial variability of riffle-pool complexes would be maintained. Ongoing localized channel narrowing and vegetative encroachment would continue.

The changes in flow would result in a mix of adverse and beneficial impacts to fish species. Longnose dace would have a minor to moderate beneficial cumulative impact from the lower peak runoff flows and the resulting increase in minimum habitat availability and because high-quality habitat exists for this species at low flows. Alternative 4 would have a minor adverse cumulative impact on the adult life stage of the two recreationally important species in Segment A, brown and rainbow trout, due to reductions in habitat during the critical spring period, the decrease in habitat quality with a decrease in high flows, and warmer summer water temperatures. Juvenile brown and rainbow trout would have a minor beneficial cumulative impact with greater habitat availability at the reduced spring flows. Negligible impacts are expected for suckers and trout fry. A loss of SSCV habitat at 20th percentile year (dry year) flows would be detrimental in those years. There are not expected to be changes in species composition of the fish community. Brown trout would continue to be common although the relative abundance of trout may decrease slightly.

Most species and life stages would have negligible changes in WUA metrics for Alternative 4 with Current Conditions Effects, Future Conditions Effects and Cumulative Effects in Segment A and are not included in Table 5-49. There would be only a few WUA metrics for longnose dace and brown trout with substantial changes for one or more of the comparisons (Table 5-49). In most cases, there would be increases in WUA from Current Conditions hydrology through Future Conditions hydrology and Alternative 4 Future Conditions Effects to Cumulative Effects. The incremental change in WUA metrics from Alternative 4 Future Conditions Effects to Alternative 4 Cumulative Effects would be small for longnose dace, but for brown trout there would be larger increases due to small increases in flow in winter due to factors other than the project when habitat availability is relatively low.

Table 5-49. Comparison of habitat availability (WUA in ft^2/1,000 ft) for Current Conditions hydrology, Future Conditions hydrology, Alternative 4 Future Conditions Effects, and Cumulative Effects for fish species in Segment A.

Species	Life Stage	Habitat Availability (WUA) Metric	Year Type	WUA Values					
				Current Conditions (Run 1)	Future Conditions (Run 2)	Alternative 4 Future Conditions Effects (Run 4b2)		Alternative 4 Cumulative Effects (Run 5b2)	
						Value	% Change	Value	% Change
Longnose Dace	Adult	Minimum	Median	597	675	769	+14%	800	+19%
			80th Percentile	806	831	1,179	+42%	1,164	+40%
			20th Percentile	315	314	346	+10%	415	+32%
Brown Trout	Adult	Minimum	80th Percentile	548	631	525	-17%	627	-1%
			20th Percentile	49	130	130	0%	147	+13%

Segment B. Alternative 4 Cumulative Effects would have an overall negligible to minor adverse impact to aquatic organisms compared to Future Conditions hydrology in Segment B. Changes to many individual components of the aquatic environment in this segment would be negligible but

other components would have minor adverse impacts. The reductions in runoff flows, slightly fewer extremely low flow days, and slightly fewer extreme flow fluctuations are less for Alternative 4 than for Alternatives 2 and 3 and would not be sufficient to have much effect. Water quality changes likely would be negligible to minor. There could be a minor to moderate increase in summer temperatures that could have an adverse impact on trout, but the effect would be less than for Alternatives 2 and 3. Changes in sedimentation conditions would be minor, and the spatial variability of riffle-pool complexes would be maintained. Ongoing localized channel narrowing and vegetative encroachment would continue.

Longnose dace would have a minor beneficial cumulative impact from the lower peak runoff flows and the resulting increase in minimum habitat availability (Table 5-50). Alternative 4 would have a negligible cumulative impact on habitat availability for all other species and life stages of fish. For fathead minnows and trout fry, reductions in average habitat availability in 80th percentile years (which correspond to wet years for these species and life stages) would occur when availability is relatively high and have little effect. SSCV habitat would not change substantially under Alternative 4 in median years although there would be reductions in wet and dry years. There are expected to be no changes in the species composition of the fish community.

Table 5-50. Comparison of habitat availability (WUA in ft^2/1,000 ft) for Current Conditions hydrology, Future Conditions hydrology, Alternative 4 Future Conditions Effects, and Cumulative Effects for fish species in Segment B.

Species	Life Stage	Habitat Availability (WUA) Metric	Year Type	WUA Values					
				Current Conditions (Run 1)	Future Conditions (Run 2)	Alternative 4 Future Conditions Effects (Run 4b2)		Alternative 4 Cumulative Effects (Run 5b2)	
						Value	% Change	Value	% Change
Longnose Dace	Adult	Minimum	Median	381	400	540	+35%	526	+32%
			80th Percentile	963	1,108	1,102	-1%	1,105	<-1%
Darters	Adult	Minimum	Median	557	619	550	-11%	542	-13%
Fathead Minnows	Adult	Average	80th Percentile	2,355	2,004	1,466	-27%	1,439	-28%
Rainbow Trout	Adult	Average	80th Percentile	4,454	4,197	3,952	-6%	3,921	-7%
Trout	Fry	Average	80th Percentile	3,752	3,119	2,112	-32%	2,120	-32%

Similar to the results in Segment A, in Segment B, most species and life stages would have negligible changes in WUA metrics for Alternative 4 Current Conditions Effects, Future Conditions Effects and Cumulative Effects and are not presented in Table 5-50. The few species with more substantial changes would have only a small incremental change between Alternative 4 Future Conditions Effects and Cumulative Effects (Table 5-50).

Segment C. Alternative 4 Cumulative Effects would be overall negligible to minor adverse to aquatic organisms in Segment C compared to Future Conditions hydrology. Changes to many individual components of the aquatic environment in this segment would have negligible impacts but other components would have minor adverse impacts. Water quality changes likely would be negligible to minor. There could be a minor increase in summer temperatures in a portion of

Segment C near the Boxelder Gage that could have an adverse impact on trout. Changes in sedimentation conditions would be minor, and the spatial variability of riffle-pool complexes would be maintained. Ongoing localized channel narrowing and vegetative encroachment would continue.

The reductions in spring flows would have a negligible cumulative impact on suckers, darters, sand shiners, and fathead minnows as these species have higher habitat availability at relatively low flows. SSCV habitat would not change substantially. Longnose dace would benefit to a small degree with greater habitat availability at the lower spring runoff flows. However, trout would experience lower habitat availability with lower spring flows in early spring months. For brown and rainbow trout, these two species do not maintain resident, reproducing populations in Segment C (GEI 2013), but seasonally use the habitat in the segment when temperatures are suitable. The lowered spring flows would reduce habitat availability and the seasonal use by these recreationally important species. The increased temperatures with Alternative 4 could further limit the time when temperatures are suitable for trout. Alternative 4 would have a minor adverse cumulative impact on trout. There likely would not be a change in the overall species composition of the fish community with Alternative 4, but the community relative abundance may shift to one more dominated by small-bodied warmwater species with fewer trout.

Similar to the results in Segments A and B, in Segment C, most species and life stages would have negligible changes in WUA metrics for Alternative 4 Current Conditions Effects, Future Conditions Effects and Cumulative Conditions Effects and are not included in Table 5-51. However, in Segment C, the species with more substantial changes generally have a substantial incremental reduction in WUA values between Alternative 4 Future Conditions Effects and Cumulative Effects (Table 5-51). In many cases, this is a difference in minimum WUA in 20th percentile years (which correspond to dry years for these species) due to one day of slightly higher flow with Alternative 4 Future Conditions Effects that does not occur with Alternative 4 Cumulative Effects. In other respects, there is not much difference in habitat availability for most species between Future Conditions hydrology, Alternative 4 Future Conditions Effects, and Alternative 4 Cumulative Effects.

Table 5-51. Comparison of habitat availability (WUA in ft^2/1,000 ft) for Current Conditions hydrology, Future Conditions hydrology, Alternative 4 Future Conditions Effects, and Cumulative Effects for fish species in Segment C.

Species	Life Stage	Habitat Availability (WUA) Metric	Year Type	WUA Values					
				Current Conditions (Run 1)	Future Conditions (Run 2)	Alternative 4 Future Conditions Effects (Run 4b2)		Alternative 4 Cumulative Effects (Run 5b2)	
						Value	% Change	Value	% Change
Longnose Dace	Adult	Minimum	Median	99	170	288	+69%	249	+46%
			20th Percentile	49	48	43	-10%	57	+19%
Suckers	Adult	Minimum	20th Percentile	144	119	145	+22%	119	0%
Darters	Adult	Minimum	20th Percentile	116	101	123	+22%	101	0%
Fathead Minnows	Adult	Minimum	20th Percentile	221	183	223	+22%	183	0%
		Average	80th Percentile	1,597	1,544	1,378	-11%	1,377	-11%
Sand Shiners	Adult	Minimum	Median	870	1,152	1,133	-2%	989	-14%
Brown Trout	Adult	Average	Median	313	283	273	-4%	263	-7%
			20th Percentile	87	46	56	+22%	52	+13%
Rainbow Trout	Adult	Minimum	20th Percentile	109	90	110	+22%	90	0%
		Average	80th Percentile	2,020	1,779	1,491	-16%	1,474	-17%

In Segments A, B, and C, macroinvertebrate community abundance may benefit slightly from lower spring flows and the community may sustain a higher proportion of species that prefer moderate to slow current velocity. Species composition may change to species more suited to the altered flow regime, which would be a minor adverse cumulative impact. Similarly, there may be a minor increase in in abundance of periphyton and aquatic plants and minor adverse cumulative impact due to changes in periphyton species composition and increases in filamentous green algae.

Segments D, E, and F. The differences in hydrology between Alternative 2, Alternative 3, and Alternative 4 would be minimal on most days in Segments D, E, and F of the mainstem. The resulting differences in habitat availability for fish and macroinvertebrates between the three alternatives would also be minimal. Water quality is not expected to be very different between the three alternatives. Therefore, Alternative 4 Cumulative Effects would be similar to those previously presented for Alternatives 2 (Section 4.12.3.3.1) and Alternative 3 (Section 4.12.4.3.1) in Segments D, E, and F. This would include negligible to minor adverse impacts to aquatic resources in these segments of the mainstem.

5.12.5.3.2 South Platte River

Alternative 4 Cumulative Effects would be similar to those previously presented for Alternatives 2 (Section 5.12.3.3.2) and Alternative 3 (Section 5.12.4.3.2) in the South Platte River. This would include a negligible cumulative impact in the South Platte River.

5.12.5.4 Cumulative Effects Summary

Alternative 4 Cumulative Effects would be negligible to minor adverse to most aquatic resource components in the mainstem (Table 5-52). Changes in fish habitat availability would mostly be negligible while there would be minor adverse impacts with changes in macroinvertebrate and periphyton species composition. In the South Platte River, the changes in flow would be relatively small and there would be a negligible impact.

Table 5-52. River segments cumulative effects summary for Alternative 4.

Segment	Impacts to Aquatic Biological Resources Components Alternative 4 Cumulative Effects			
	Overall Impact	**Fish**	**Macroinvertebrates**	**Periphyton and Plants**
Mainstem Poudre River				
A	Minor Adverse	Negligible impacts to suckers and trout fry, minor adverse impact to adult trout and minor to moderate beneficial impact to longnose dace and juvenile trout due to reduced runoff flows	Minor adverse impact with changes in species composition due to reduced peak flows	Minor adverse impact with increases in filamentous green algae and changes in species composition due to reduced peak flows
B	Negligible to Minor Adverse	Negligible impact to most species/life stages, minor beneficial impact to longnose dace with reduced runoff flows	Minor adverse impact with changes in species composition due to reduced peak flows	Minor adverse impact with increases in filamentous green algae and changes in species composition due to reduced peak flows
C	Negligible to Minor Adverse	Negligible impact to most species, minor adverse impact to adult trout due to reduced runoff flows and higher temperatures	Minor adverse impact with changes in species composition due to reduced peak flows	Minor adverse impact with increases in filamentous green algae and changes in species composition due to reduced peak flows
D	Negligible to Minor Adverse	Minor beneficial impact to some species with reductions in runoff flows, negligible impact to others	Minor adverse impact with changes in species composition due to increased sedimentation and reduced peak flows	Minor adverse impact with changes in species composition and increases in filamentous green algae due to increased sedimentation and reduced peak flows
E	Minor Adverse	Minor adverse impact to most species with increased sedimentation	Minor adverse impact with changes in species composition due to increased sedimentation and reduced peak flows	Minor adverse impact with changes in species composition and increases in filamentous green algae due to increased sedimentation and reduced peak flows
F	Minor Adverse	Minor adverse impact to most species with increased sedimentation	Minor adverse impact with changes in species composition due to increased sedimentation and reduced peak flows	Minor adverse impact with changes in species composition and increases in filamentous green algae due to increased sedimentation and reduced peak flows
South Platte River				
1	Negligible	Negligible impacts to most species	Negligible impacts	Negligible impacts

Nuisance Species. Impacts to nuisance species for Alternative 4 would be similar to those previously presented for Alternative 3 (Section 5.12.4.4).

5.12.6 Climate Change

The hydrology in the Poudre River Basin may be affected by climate change. Large-scale hydrologic predictions for the North American Great Plains suggest that streams will become more hydrologically variable (Covich et al. 1997; IPCC 2007). Based on an analysis of the Poudre Basin (DiNatale and CDM Smith 2014), winter flows will be slightly higher than under Current Conditions, peak runoff will occur earlier in the year and will be characterized by lower flows, and summer flows will likely decrease as well (DiNatale and CDM Smith 2014). In the western United States, longer periods of drought are expected. Human response to the effects of climate change likely will result in further changes to the hydrograph (Vörösmarty et al. 2000). Increased municipal and agricultural water demand is likely (DiNatale and CDM Smith 2014) and could decrease streamflows and increase hydrologic variability. The large-scale predictions for the North American Great Plains and the regional predictions for the Poudre Basin suggest that the mainstem and its tributaries could likely become more hydrologically variable, thus creating a more uncertain environment for resident aquatic life. Ambient air temperature increases of 2˚F to 5˚F are also expected for the basin, which could result in increases in water temperature. These changes have the potential to affect aquatic life in the mainstem. Predicted increases in summer temperatures and longer periods of drought would likely accelerate the trends in channel narrowing, vegetative encroachment, changes in riffle-pool complexity, and increases in sedimentation, especially in Segments D, E, and F of the mainstem.

Environments with high hydrologic variability or high levels of flow disturbance tend to have lower numbers of species and simpler food webs than hydrologically stable systems (Sabo et al. 2010), and increases in hydrologic variability can change aquatic communities by selecting against species with specialized environmental requirements (Ficke et al. 2007). However, flow variation in the Poudre Basin is already extreme as a result of water management, and the remaining native fishes in the basin are adapted to highly unpredictable flow regimes (GEI 2013). As a result, there are expected to be only limited changes in species composition due to climate-induced changes in the flow regime. However, an increase in flow variability, particularly during spring when eggs, larvae, and other vulnerable life stages are present, could reduce reproductive success of the species present in the Poudre Basin.

Temperature changes may or may not occur in the mainstem, but higher water temperatures could affect the distribution of trout along the river. Temperature exceedances already occur occasionally in Segment B and in Segment C (Hydros 2014a; GEI 2013), so Current Conditions are already sometimes stressful to trout. Increases in temperature in response to a warmer climate could result in an upstream movement of the lower boundary of trout distribution in the mainstem. Trout may have less seasonal use in Segment C of the mainstem, and in Segment B populations could be reduced, especially in the sections on the eastern edge of Fort Collins. Temperature increases may have less effect on the distribution of warm water species throughout the mainstem as these species likely will tolerate the warmer temperatures.

5.12.7 Impact Summary

The No Action Alternative was evaluated under Future Conditions hydrology only. An evaluation of the No Action Alternative under Cumulative Effects was not conducted.

All three action alternatives and the No Action Alternative would reduce spring flows. However, the locations of the diversions would vary by alternative, with Alternatives 1, 2 and 3 diverting at the Poudre Valley Canal and Alternative 4 comprising about 75% diversion at the Poudre Valley Canal and approximately 25% diversion at the New Cache Canal. Alternative 2 would augment winter flows in the lower portion of Segment A and through almost all of Segment B. Alternatives 3 and 4 would divert on average about 5,500 to 6,000 AFY more water from the Poudre River than Alternative 2 to compensate for increased reservoir evaporation from Cactus Hill Reservoir and conveyance loss. Additionally, Alternatives 3 and 4 do not include the Poudre River flow augmentation program that is proposed under Alternative 2. These differences among alternatives would change the impact intensity in Segments A, B, and C of the mainstem (Table 5-53).

Table 5-53. Summary of river segments cumulative effects intensity among alternatives for aquatic biological resources.

Segment	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Mainstem Poudre River				
Segment A	Negligible/Minor Adverse	Minor Adverse	Minor Adverse	Minor Adverse
Segment B	Negligible/Minor Adverse	Moderate Beneficial	Moderate Adverse	Negligible/Minor Adverse
Segment C	Negligible/Minor Adverse	Minor Adverse	Minor Adverse	Negligible/Minor Adverse
Segment D	Negligible/Minor Adverse	Negligible/Minor Adverse	Negligible/Minor Adverse	Negligible/Minor Adverse
Segment E	Negligible/Minor Adverse	Minor Adverse	Minor Adverse	Minor Adverse
Segment F	Negligible/Minor Adverse	Minor Adverse	Minor Adverse	Minor Adverse
South Platte River				
Segment 1	Negligible	Negligible	Negligible	Negligible
Reservoirs				
Glade	N/A	Major Beneficial	N/A	N/A
Cactus Hill	Major Beneficial	N/A	Major Beneficial	Major Beneficial
Galeton	N/A	Minor Beneficial	Minor Beneficial	Minor Beneficial
Horsetooth	Negligible	Negligible (Minor Beneficial with Reclamation Action Option)	Negligible	Negligible
Carter	Negligible	Negligible	Negligible	Negligible

The No Action Alternative would divert less water than the three action alternatives and would have lower impact intensity than the action alternatives (Table 5-53). The No Action Alternative would have negligible to minor impacts in all six segments of the mainstem. In Segment B, Alternative 2 would have a moderate beneficial impact on aquatic biological resources mainly

due to augmented flows in winter, early spring, and in September. In this segment, Alternative 3 would have a moderate adverse impact due to reductions in runoff flows and no winter flow augmentation. Alternative 4 would result in a minor adverse impact in Segment A with reduced runoff flows and result in negligible to minor cumulative impacts to Segments B and C by allowing approximately 25% of the water that would have been diverted at the Poudre Valley Canal (with Alternatives 2 and 3) to flow through these segments before being diverted at the New Cache Canal. All three action alternatives would have similar negligible to minor adverse cumulative impacts in Segment D and minor adverse cumulative impacts in Segments E and F of the mainstem and negligible impacts in the South Platte River.

All four alternatives would also include the construction of a 170,000 AF Glade Reservoir (Alternative 2) or a 190,000 AF Cactus Hill Reservoir (Alternatives 3 and 4) or a 120,000 AF Cactus Hill Reservoir (No Action Alternative) which would be a major beneficial impact to aquatic biological resources. The three action alternatives would also have a minor beneficial impact with the construction of Galeton Reservoir.

RFFAs. Several RFFAs are intended to improve riparian and instream habitat conditions and could help reduce predicted Cumulative Effects. The proposed Poudre River corridor restoration and conservation projects by Fort Collins and Greeley could improve habitat conditions over many miles of the mainstem and improve habitat availability for many different species of aquatic organisms. Some of these projects have an objective of reconnecting the Poudre River floodplain with high flows in the river through reaches of Fort Collins which could improve spawning and rearing habitat availability (SSCV habitat) for some of the native small-bodied fish species. Stormwater projects and post-fire restoration as well as updates to water quality standards could lead to improved water quality in the mainstem. This could benefit the species of aquatic organisms in the river and may allow some sensitive species to become re-established. Improvements to diversion structures to allow upstream fish passage could also benefit some species of fish that migrate to different sections of the river.

Population growth and development would continue along the mainstem corridor along with the associated impacts to riparian areas. This may make worse the existing impacts to riparian vegetation, water quality, sedimentation, and channel geomorphology and have an adverse effect on aquatic organisms.

5.13 TRAFFIC AND TRANSPORTATION

This section summarizes the potential land-based cumulative effects predicted to occur on traffic and transportation. Reasonably foreseeable future actions that would result in cumulative effects on traffic and transportation, when combined with the effects of the alternatives, include population growth and urban development and oil and gas development. Municipalities, CDOT, and counties would need to accommodate growth with changes in the transportation system. Specific plans for accommodating changing transportation needs in the areas affected by the NISP alternatives include the North I-25 improvement project.

5.13.1 No Action Alternative (Alternative 1)

Information on direct effects on traffic and transportation under the No Action Alternative is provided in Section 4.13.2. Most direct effects on transportation would occur in the area surrounding the Cactus Hill Reservoir site. Population growth and land development would increase traffic near the Cactus Hill Reservoir site. Typically, traffic increases annually 1% to 2% and would affect area roads near the Cactus Hill Reservoir site. Traffic increases are expected to be negligible and cumulative effects on traffic and transportation would be minor.

5.13.2 District's Preferred Alternative (Alternative 2)

Information on direct effects on traffic and transportation for Alternative 2 is provided in Section 4.13.3. No county roads would be affected by construction of Glade Reservoir but population growth and land development would increase traffic on U.S. 287 and other area roads. Increases in population would also increase recreational use at the reservoir, which would alter traffic patterns at Glade Reservoir. Population increases would increase traffic in the Glade Reservoir study area as well. Traffic in the vicinity of the Galeton Reservoir site may increase in the future with ongoing oil and gas development. However, traffic in the vicinity of the proposed Galeton Reservoir is expected to remain rural. The reservoir would not be open to public recreation and is not expected to increase traffic in the area. With the combination of direct effects, cumulative effects on traffic are expected to be minor.

5.13.3 Alternative 3

Information on direct effects on traffic and transportation for Alternative 3 is provided in Section 4.14.3. Cumulative effects for Alternative 3 would be similar to those described for Cactus Hill under the No Action Alternative and for Galeton Reservoir under Alternative 2.

5.13.4 Alternative 4

Information on direct effects on traffic and transportation for Alternative 4 is provided in Section 4.15.3. Cumulative effects for Alternative 4 would be similar to those described for Cactus Hill under the No Action Alternative and for Galeton Reservoir under Alternative 2.

5.13.5 Climate Change

Climate change is not expected to have any effect on traffic and transportation.

5.13.6 Impact Summary

The cumulative effects for traffic and transportation for all alternatives would be minor.

5.14 AIR QUALITY

This section summarizes the potential cumulative effects to air quality within the cumulative effects study area. Growth and development, including the construction of the HSWSPs and the North I-25 improvement project, are RFFAs, that when combined with the NISP alternatives, would have the potential to have cumulative effects on air quality. Cumulative effects on air quality can potentially result from short-term direct effects associated with construction activities (e.g., emissions from construction equipment, workers' vehicles, delivery vehicles, and fugitive dust) or from long-term indirect effects such as those caused by population growth, changes to transportation (e.g., the realignment of U.S. 287 and the I-25 North Traffic Improvements) or from project operations (e.g., emissions associated with pumping). Potential short-term and long-term cumulative effects on air quality are discussed below for each of the alternatives. CEQ issued draft proposed guidance addressing GHG emissions in NEPA documents on December 24, 2014, with public comments due on February 23, 2015. The NISP FEIS will address estimated carbon dioxide emissions associated with construction following the final CEQ guidance.

5.14.1 No Action Alternative (Alternative 1)

Information on effects on air quality under the No Action Alternative is provided in Section 4.14.2. Most direct effects on air quality with the No Action Alternative would be short-term and would be associated with the construction of Cactus Hill Reservoir and associated facilities. During the period of construction the No Action Alternative is predicted to have average annual emissions of NO_x greater than the conformity *de minimis* level of 100 tons/year for the ozone nonattainment area. Future growth in the region is likely to contribute additional air pollutants during this same time period. The increases in emissions are considered a minor cumulative effect because they would be short-term and the alternative would need to undergo a general conformity analysis that would consider other regional contributions to ensure that the region remains in compliance with NAAQs.

The No Action Alternative would also involve the transfer of water from 64,200 acres of irrigated lands for use by the NISP Participants. The transfer of irrigation water has the potential to increase fugitive dust in the region until the lands are revegetated. The increased potential for fugitive dust in the region from this and the RFFAs would be a moderate short-term cumulative effect, particularly when combined with climate change and considering the large area that would be subject to the transfer of irrigation water.

5.14.1.1 Long-Term Emissions of Carbon Dioxide

Long-lived GHGs, such as carbon dioxide, trap heat in the atmosphere and contribute to climate change. One of the sources of carbon dioxide is the combustion of carbon fuels for energy production. The No Action Alternative is predicted to have annual emissions of 45,944 English tons of carbon dioxide at full project utilization. Future growth and development in the region is likely to contribute additional carbon dioxide emissions. The operation of the No Action

Alternative, combined with future development and growth in the area, would contribute to increases in the emissions of carbon dioxide. The cumulative effects of the carbon dioxide emissions on climate change are unknown.

5.14.2 District's Preferred Alternative (Alternative 2)

Information on direct effects on air quality for Alternative 2 is provided in Section 4.14.3. Most direct effects on air quality would occur with the construction of Glade and Galeton Reservoirs and associated facilities and the realignment U.S. 287. During the period of construction, Alternative 2 is predicted to have average annual emissions of NO_x greater than the conformity *de minimis* level of 100 tons/year for the ozone nonattainment area. Future growth and development in the region is likely to contribute additional air pollutants during this same time period. The increases in emissions are considered a minor cumulative effect because they would be short-term and the alternative would need to undergo a general conformity analysis that would consider other regional contributions to ensure that the region remains in compliance with NAAQs.

5.14.2.1 Long-Term Emissions of Carbon

Alternative 2 Reclamation Action Option is predicted to have annual emissions of 37,259 English tons of carbon dioxide, and the Alternative 2 No Reclamation Action Option is predicted to have annual emissions of 47,677 English tons of carbon dioxide at full project utilization. Future growth and development in the region is likely to contribute additional carbon dioxide emissions. The operation of Alternative 2, combined with future development and growth in the area, would contribute to the increase in the emissions of carbon dioxide. The cumulative effects of the carbon dioxide emissions on climate change are unknown.

5.14.3 Alternative 3

Information on direct effects on air quality for Alternative 3 is provided in Section 4.14.4. Most direct effects on air quality would occur with the construction of Cactus Hill and Galeton Reservoirs. During the period of construction, Alternative 3 is predicted to have average annual emissions of NO_x greater than the conformity *de minimis* level of 100 tons/year for the ozone nonattainment area. Future growth in the region is likely to contribute additional air pollutants during this same time period. The increases in emissions are considered a minor cumulative effect because they would be short-term and the alternative would need to undergo a general conformity analysis that would consider other regional contributions to ensure that the region remains in compliance with NAAQs.

5.14.3.1 Long-Term Emissions of Carbon

Alternative 3 is predicted to have annual emissions of 45,944 English tons of carbon dioxide at full project utilization. Future growth and development in the region is likely to contribute

additional carbon dioxide emissions. The operation of the Alternative 3, combined with future development and growth in the area, would contribute to the increase in the emissions of carbon dioxide. The cumulative effects of the carbon dioxide emissions on climate change are unknown.

5.14.4 Alternative 4

Information on direct effects on air quality for Alternative 4 is provided in Section 4.14.5. Cumulative effects on air quality for Alternative 4 would be similar to those described for Alternative 3.

5.14.4.1 Long-Term Emissions of Carbon

Alternative 4 would have a slightly greater annual emission of carbon dioxide of 50,122 English tons at full project utilization. The cumulative effects of the carbon dioxide emissions on climate change are unknown.

5.14.5 Climate Change

Climate change has the potential to affect future air quality in a variety of ways within the cumulative effects study area. A large volume of scientific information supports the conclusion that global temperatures are increasing and that precipitation trends would change in the future. The warming trend is expected to accelerate in coming decades. In the western United States, longer periods of drought are expected. There is also general agreement by climate scientists that climate change information specific to Colorado indicates that temperatures would increase by approximately 4°F by 2050, with summers warming more than winters (DiNatale and CDM Smith 2014). Increases in the frequency and duration of droughts would likely increase periodic fugitive dust in the region. Construction of any of the alternatives would contribute to the potential for fugitive dust, as could exposed reservoir shorelines during periods of reservoir draw down. The transfer of water from 64,200 acres of irrigated lands associated with the No Action Alternative has the potential to be a major contributor to the potential for fugitive dust in the region before the areas become vegetated.

Warmer temperatures associated with climate change are predicted to increase the frequency of days with unhealthy levels of ground-level ozone. Ground-level ozone is formed when air pollutants such as CO, NOx, and VOCs, are exposed to each other in sunlight. Because warm, stagnant air tends to increase the formation of ozone, climate change is likely to increase the number of days with poor air quality (http://www.epa.gov/climatechange/impacts-adaptation/health.html). The north Front Range was classified as a “marginal” ozone nonattainment area by the EPA effective July 20, 2012. Construction equipment would contribute to the short-term production of emissions that comprise ozone (Section 4.14). These short-term construction emissions could aggravate ozone levels within the north Front Range nonattainment area and the effects of climate change could worsen the construction-related effects. Given the predictions of increased levels of ground-level ozone in already-polluted areas

due to climate change, short-term construction emissions from any of the alternatives could contribute to short-term ozone exceedances when combined with other emissions in the area. This would be a moderate cumulative effect because the effect would be short-term associated with construction and short-term meteorological events.

5.14.6 Impact Summary

Table 5-54 summarizes the effects determinations for cumulative effects on air quality. All of the alternatives would contribute emissions during construction and are predicted to have average annual emissions of NO_x greater than the conformity *de minimis* level of 100 tons/year for the ozone nonattainment area during the period of construction. The construction emissions combined with future growth and development in the region and climate change are predicted to aggravate ozone levels within the north Front Range nonattainment area and have short-term increases in the number of days with poor air quality.

The potential for fugitive dust-related cumulative effects would increase with climate change. Construction of any of the alternatives would contribute to the potential for fugitive dust. Exposed reservoir shorelines would also contribute to fugitive dust when water levels at reservoirs are low. The transfer of water from 64,200 acres of irrigated lands associated with the No Action Alternative has the potential to be a major contributor to the potential for fugitive dust in the region, particularly when combined with a predicted increase in the frequency and duration of regional droughts associated with climate change.

All of the alternatives combined with future growth and development in the region would contribute to GHGs and climate change. All of the alternatives involve pumping and the consumption of electrical energy to convey water. The pumping and use of electrical energy would result in the associated emission of carbon dioxide (Section 4.14). Operation of the alternatives would contribute to the emission of GHGs for the lifetime of the project and would contribute to climate change. The estimated electrical energy used by the alternatives would be about 0.1% of the energy used in Colorado in 2012 (Section 4.22). This contribution to climate change would be a minor cumulative effect because the effect would be relatively small compared with the regional total annual emissions of GHGs. The No Action Alternative would have the least predicted annual carbon dioxide emissions and Alternative 4 would have the greatest predicted annual carbon dioxide emissions.

Table 5-54. Cumulative effects to air quality.

Alternative	Predicted Air Quality Effects
Alternative 1 No Action	When combined with RFFAs and climate change, construction over an estimated 5.9 years would have a short-term minor impact on air quality. Average annual emissions of NO_x are predicted to be greater than the conformity *de minimis* level of 100 tons/year for the ozone nonattainment area. The transfer of water from 64,200 acres of irrigated agricultural lands could cause a moderated cumulative effect due to short-term increase in fugitive dust until lands are revegetated. Operations would contribute to the increase in the regional emissions of carbon dioxide. The cumulative effects on air quality would be minor because the incremental increase in carbon dioxide emissions would be relatively minor compared with the regional total annual emissions of GHGs.
Alternative 2 Reclamation Action Option	When combined with RFFAs and climate change, construction would have a short-term minor impact on air quality. Exposed reservoir shorelines could periodically contribute to local fugitive dust. Operations would contribute to the increase in the regional emissions of carbon dioxide. The cumulative effects on air quality would be minor because the incremental increase in carbon dioxide emissions would be relatively minor compared with the regional total annual emissions of GHGs.
U.S. 287	When combined with RFFAs and climate change, construction would have a short-term minor impact on air quality.
Alternative 2 No Reclamation Action Option	Operations would contribute to the increase in the regional emissions of carbon dioxide. The cumulative effects on air quality would be minor because the incremental increase in carbon dioxide emissions would be relatively minor compared with the regional total annual emissions of GHGs.
U.S. 287	When combined with RFFAs and climate change, construction would have a short-term minor impact on air quality.
Alternative 3	When combined with RFFAs and climate change, construction over an estimated 8 years would have a short-term minor impact on air quality. Average annual emissions of NO_x are predicted to be greater than the conformity *de minimis* level of 100 tons/year for the ozone nonattainment area. Exposed reservoir shorelines could periodically contribute to local fugitive dust. Operations would contribute to the increase in the regional emissions of carbon dioxide. The cumulative effects on air quality would be minor because the incremental increase in carbon dioxide emissions would be relatively minor compared with the regional total annual emissions of GHGs.
Alternative 4	Similar to Alternative 3.

5.15 NOISE

This section summarizes the potential land-based cumulative effects predicted to occur from noise. Most direct noise effects for the alternatives would occur due to construction and would be short-term, localized increases. Because of the location of many of the RFFAs (construction of Chimney Hollow Reservoir, the expansion of Halligan and Seaman Reservoirs, and construction of the North 1-25 Transportation improvement project), they would not contribute to the cumulative effect on localized noise levels. The only RFFA that could potentially contribute to cumulative effects on localized noise levels would be if construction occurred around the reservoir sites or along the conveyance systems while the reservoirs, conveyance systems or appurtenant facilities were being constructed. Since the direct effects from noise for each alternative are expected to be minor and it is unknown if other development would occur during construction of reservoirs or conveyance systems, cumulative effects on noise levels would be minor for all alternatives.

5.16 RECREATION

This section summarizes the predicted potential cumulative effects of the NISP alternatives on recreation resources, when combined with the effects of past and present actions and RFFAs. The RFFAs that may result in cumulative effects on recreation include the following:

- Population growth in the Northern Front Range – which would likely expand the demand for and use of recreation resources
- Commercial and residential development along the Poudre River in Fort Collins
- Implementation of the Halligan and Seaman water supply projects, which could result in changes to flows on the Poudre River, thus potentially affecting flow-based recreation
- Donation of 31 acres of land for habitat restoration and Natural Area management
- Poudre Trail Connections – including the extension of the Poudre River Trail to the southeast to Timnath, connections between Timnath and Windsor, and from Greeley to the South Platte River
- Poudre River Restoration Projects – including habitat enhancement and flow management options through Fort Collins
- Poudre River Corridor Conservation Plans – including the conservation of additional land along the Poudre River
- Greeley Poudre River Flood Control and Environmental Restoration Project – including wetland and riparian restoration projects through Greeley
- Fort Collins Poudre River Master Plan – including the construction of a whitewater park and other in-river and bankside recreation and access

5.16.1 Methods

Both water- and land-based recreation resources, including activities such as boating, fishing, hiking, cycling, camping, picnicking, wildlife watching, hunting, and other potential recreational opportunities, were inventoried in the NISP study areas. Potential cumulative effects were estimated based on the incremental effect (beneficial or adverse) of the NISP alternatives when combined with the effects of the RFFAs listed above. The direct and indirect effects of the NISP alternatives on recreation resources are presented in Section 4.16, with exception of the indirect effects for the No Action Alternative for the Poudre River mainstem. As explained in Section 4.16.2, the indirect effects analysis for the No Action Alternative was conducted under Future Conditions hydrology only and is presented in this section.

Changes in river flows were predicted using CTP hydrology modeling by comparing various model runs. As described in Section 5.1, the following terms are used to describe the hydrologic model runs when discussing predicted effects for the flow-related resources:

- Current Conditions (2010 flows - Run 1)
- Future Conditions (2050 flows with RFFAs - Run 2)
- Current Conditions Effects (2010 flows with NISP action alternatives - Run Series 3)

- Future Conditions Effects (2050 flows with RFFAs + NISP action alternatives - Run Series 4)
- Cumulative Effects (2050 flows with RFFAs + HSWSPs + NISP action alternatives - Run Series 5)
- Alternative 1 Effects (2050 flows with RFFAs + No action Alternative - Run 9a)

Methods used to assess the cumulative effects are similar to those described in Section 4.16.1 Water-based cumulative effects are only considered for Segment B (represented by Martinez Park) because the other segments did not have a magnitude of direct or indirect effects on fishing and boating great enough to result in cumulative effects. For the effects analysis for boating in Segment B through Fort Collins, daily flows were used to assess the change in the number of days for which flows would be greater than 150 cfs for each alternative during the period of record (Appendix B in CDM Smith 2014a). Effects on recreational fishing opportunities were primarily based on the findings of the aquatic resources analysis (2015 Aquatic Resources Effects Report, GEI 2015b) along with the known value and importance of various water bodies for recreational fishing.

5.16.2 No Action Alternative (Alternative 1)

5.16.2.1 Cactus Hill Reservoir and Conveyance Systems

RFFAs and the construction of Cactus Hill Reservoir and new water conveyance systems under the No Action Alternative would not result in cumulative effects to recreation resources because Cactus Hill Reservoir would not contribute to recreation resources. The exact location and extent of direct effects on recreation resources from conveyance systems are unknown but direct effects are expected to be short-term and negligible and not contribute to cumulative effects.

5.16.2.2 Poudre River

Cumulative effects to recreation opportunities are expected to occur in Segment B through Fort Collins, which is popular for boating (canoeing and kayaking) and is the location of a proposed whitewater park.

Under the No Action Alternative, median monthly flows in Segment B would be decreased by about 100 cfs in June, with little change in other months. Target flows for quality boating opportunities are at or above 150 cfs. Changes in the number of days that target flows are met, under the various modeling runs that pertain to the No Action Alternative, are summarized in Table 5-55.

Table 5-55. Average number of days above 150 cfs at the Lincoln Street Gage for the period of record (1979-2005) – No Action Alternative.

	May	June	July	August	September
Current Conditions Hydrology	16	23	11	4	0
Future Conditions Hydrology	16	22	12	4	0
Alternative 1 Effects	15	20	11	4	0
Difference: Run 2 vs. 9a[1]	-1	-2	-1	0	0

[1]The difference is calculated by comparing Future Conditions hydrology to Alternative 1 Effects. A negative number is a decrease in the number of days compared with Future Conditions hydrology.
Average values are rounded to the nearest full day.

Compared to Future Conditions hydrology, Alternative 1 Effects would result in one fewer day in May and July and two fewer days in June (on average) when target flows are met (with no other change during August and September), resulting in a negligible cumulative effect to boating opportunities in Segment B under the No Action Alternative.

Several RFFAs are expected to benefit water-based recreational resources along the Poudre River through Fort Collins. These include the Poudre River restoration projects that would potentially reduce or eliminate low flows, and other channel and habitat improvements, and the Fort Collins Poudre River Master Plan, which would establish a whitewater park, remove the Coy Ditch diversion, and improve in-river and bankside recreation in the downtown river corridor. The benefits of these projects, if completed successfully, would offset or potentially mitigate the negligible adverse effects of the No Action Alternative on boating through Fort Collins and would augment the beneficial effects to fishing. Overall, the cumulative effect of the No Action Alternative on water-based recreation in the Poudre River corridor would be negligible.

Several identified RFFAs influence land-based recreation opportunities along the Poudre River corridor. The extension of the Poudre River Trail from Fort Collins to Timnath, Windsor, and Greeley would continue to benefit the overall quality and availability of recreation along this corridor over the long term. In addition, the additional conservation of land and establishment of new Natural Areas along the river would provide additional opportunities for trail-based recreation and passive enjoyment of the natural river setting. However, these foreseeable benefits to recreation along the Poudre River may be offset by ongoing population growth along the Northern Front Range, which would likely expand the demand for and use of these recreation resources and may diminish the quality of some recreation experiences. Overall, the cumulative effect of the No Action Alternative on land-based recreation in the Poudre River corridor would be negligible.

5.16.2.3 South Platte River

No recreational uses or facilities along the South Platte River would be directly or indirectly affected by the No Action Alternative; therefore, no cumulative effects would occur.

5.16.3 District's Preferred Alternative (Alternative 2)

5.16.3.1 Reservoir Sites and Conveyance Systems

The Glade Reservoir and Chimney Hollow Reservoir may provide similar beneficial recreation opportunities; however, any cumulative effects would be negligible due to the distance between the reservoirs and the unknown permitted recreational uses at both reservoirs. Other RFFAs would not result in cumulative effects to recreation because recreational opportunities are not planned as part of the Halligan and Seaman Reservoirs expansion. The exact location and extent of direct effects on recreation resources from conveyance systems are unknown, but direct effects are expected to be short-term and negligible and not contribute to cumulative effects.

5.16.3.2 Poudre River

Cumulative effects to recreation opportunities are expected to occur in Segment B through Fort Collins, which is popular for boating (canoeing and kayaking) and is the location of a proposed whitewater park.

Under Alternative 2, the median monthly flows in Segment B would considerably decrease (by between 50 and 150 cfs) in May, June, and July under Alternative 2 Future Conditions Effects (Run 4a) and Alternative 2 Cumulative Effects (Run 5a). Target flows for quality boating opportunities are at or above 150 cfs. Changes in the number of days that target flows are met, under the various modeling runs that pertain to Alternative 2, are summarized in Table 5-56.

Table 5-56. Average number of days above 150 cfs at the Lincoln Street Gage for the period of record (1979-2005) – Alternative 2.

Alternative 2	May	June	July	August	September
Current Conditions Hydrology	16	23	11	4	0
Future Conditions Hydrology	16	22	12	4	0
Future Condition Effects	9	17	8	1	0
Cumulative Effects	8	17	7	1	0
Future Conditions Hydrology vs. Future Conditions Effects Incremental Effect[1]	-7	-5	-4	-3	0
Future Conditions Hydrology vs. Cumulative Effects Incremental Effect[1]	-8	-5	-5	-3	0

[1]The incremental effects are calculated by comparing Future Conditions hydrology (Run 2) to Future Conditions Effects and Cumulative Effects (CTP Runs 4a and 5a). A negative number is a decrease in the number of days compared with Future Conditions.

Average values are rounded to the nearest full day.

Future Conditions Effects and the incremental effect of adding the HSWSPs (Cumulative Effects) for Alternative 2 are based on comparisons of model Run 4a to Run 2 and Run 5a to Run 2, respectively:

- Alternative 2 Future Conditions Effects would result in between 3 and 7 fewer days per month (May – August) when target flows are not met (a total of 19 fewer days during the summer recreation season), resulting in a major adverse effect to boating opportunities.
- Alternative 2 Cumulative Effects would result in between 3 and 8 fewer days in May through August (a total of 21 fewer days during the summer recreation season), resulting in major adverse cumulative effect to boating opportunities.

Predicted flow changes would result in minor to moderate beneficial cumulative effects to fishing in Segment B from flow-related RFFAs, Poudre River corridor improvements, and augmented winter flows that would improve habitat conditions for aquatic organisms (GEI 2015b). Other segments (A and C) have minor adverse cumulative effects on fishing from reduced spring runoff that would affect brown trout.

Several RFFAs are expected to benefit water-based recreational resources along the Poudre River through Fort Collins. These include the Poudre River restoration projects that are working to reduce or eliminate low flows, and other channel and habitat improvements, and the Fort Collins Poudre River Master Plan, which would establish a whitewater park, remove the Coy Ditch diversion, and improve in-river and bankside recreation in the downtown river corridor. The benefits of these projects, if completed successfully, would offset or potentially mitigate the adverse effects of Alternative 2 on boating through Fort Collins, and would further augment the beneficial effects to fishing. The cumulative effect of Alternative 2, when combined with the benefits of river-based RFFAs in Fort Collins, would be minor adverse effects to boating and moderate benefits to fishing.

Several identified RFFAs influence land-based recreation opportunities along the Poudre River corridor. The extension of the Poudre River Trail from Fort Collins to Timnath, Windsor, and Greeley would continue to benefit the overall quality and availability of recreation along this corridor over the long term. In addition, the additional conservation of land and establishment of new Natural Areas along the river would provide additional opportunities for trail-based recreation and passive enjoyment of the natural river setting. However, these foreseeable benefits to recreation along the Poudre River may be offset by ongoing population growth along the Northern Front Range, which would likely expand the demand for and use of these recreation resources and may diminish the quality of some recreation experiences. Overall, the cumulative effect of Alternative 2 on land-based recreation in the Poudre River corridor would be negligible for the above reasons.

5.16.3.3 South Platte River

Alternative 2 would not result in cumulative effects to recreation along the South Platte River because there would be no direct or indirect recreation effects along the South Platte River.

5.16.4 Alternative 3

5.16.4.1 Reservoir Sites and Conveyance Systems

The RFFAs combined with the construction of Cactus Hill and Galeton Reservoirs under Alternative 3, as well as the conveyance system in this alternative, would not result in cumulative effects to recreation because Cactus Hill and Galeton Reservoirs would not provide recreational opportunities. The exact location and extent of direct effects on recreation resources from conveyance systems are unknown but direct effects are expected to be temporary and negligible and not contribute to cumulative effects.

5.16.4.2 Poudre River

Potential cumulative effects to recreation opportunities are expected to occur in Segment B through Fort Collins, which is popular for boating (canoeing and kayaking) and is the location of a proposed whitewater park.

Under Alternative 3, the median monthly flows in Segment B would considerably decrease (by between 50 and 150 cfs) in May, June, and July under Alternative 3 Future Conditions Effects and Alternative 3 Cumulative Effects. Target flows for quality boating opportunities are at or above 150 cfs. Changes in the number of days that target flows are met, under the various modeling runs that pertain to Alternative 3, are summarized in Table 5-57.

Table 5-57. Average number of days above 150 cfs at the Lincoln Street Gage for the period of record (1979-2005) – Alternative 3.

Alternative 3	May	June	July	August	September
Current Conditions Hydrology	16	23	11	4	0
Future Conditions Hydrology	16	22	12	4	0
Future Condition Effects	9	16	6	1	0
Cumulative Effects	7	16	7	1	0
Future Conditions Hydrology vs. Future Conditions Effects Incremental Effect[1]	-7	-6	-6	-3	0
Future Conditions Hydrology vs. Cumulative Effects Incremental Effect[1]	-9	-6	-5	-3	0

[1]The incremental effects are calculated by comparing Future Conditions hydrology (Run 2) to Future Conditions Effects and Cumulative Effects (CTP Runs 4b1 and Run 5b1). A negative number is a decrease in the number of days compared with Future Conditions.

Average values are rounded to the nearest full day.

Future Conditions Effects and the incremental effect of adding the HSWSPs (Cumulative Effects) for Alternative 3 are based on comparisons of model Run 4b1 to Run 2, and Run 5b1 to Run 2, respectively:

- Alternative 3 Future Conditions Effects would result in between 3 and 7 fewer days per month (May – August) when target flows are not met (a total of 22 fewer days during the summer recreation season), resulting in a major adverse cumulative effect to boating opportunities.
- Alternative 3 Cumulative Effects would result in between 3 and 9 fewer days per month (with a total of 23 fewer days during the summer recreation season), resulting in a major adverse cumulative effect to boating opportunities.

Predicted flow changes for Alternative 3 and flow-related RFFAs would have a moderate adverse cumulative effect to fishing in Segment B, due to flow reductions and associated impacts to aquatic organisms (GEI 2015b). The proposed improvements along the Poudre River would offset effects, reducing the overall cumulative effect.

Similar to Alternative 2, several RFFAs are expected to benefit water-based recreational resources along the Poudre River through Fort Collins. The benefits of these projects, if completed successfully, would offset or potentially mitigate the adverse effects of Alternative 3 on boating and fishing. The cumulative effect of Alternative 3 on boating and fishing, when combined with the benefits of river-based RFFAs in Fort Collins, would be minor to moderate.

Similar to the Alternative 2, the cumulative effect of Alternative 3 on land-based recreation in the Poudre River corridor would be negligible because several identified RFFAs influence land-based recreation opportunities along the Poudre River corridor. The extension of the Poudre River Trail from Fort Collins to Timnath, Windsor, and Greeley would continue to benefit the overall quality and availability of recreation along this corridor over the long term. In addition, the additional conservation of land and establishment of new Natural Areas along the river would provide additional opportunities for trail-based recreation and passive enjoyment of the natural river setting. However, these foreseeable benefits to recreation along the Poudre River may be offset by ongoing population growth along the Northern Front Range, which would likely expand the demand for and use of these recreation resources and may diminish the quality of some recreation experiences.

5.16.4.3 South Platte River

No recreational uses or facilities along the South Platte River would be directly or indirectly affected by Alternative 3; therefore, no cumulative effects would occur.

5.16.5 Alternative 4

5.16.5.1 Reservoir Sites and Conveyance Systems

The RFFAs combined with the construction of Cactus Hill and Galeton Reservoirs under Alternative 4, as well as the conveyance system in this alternative, would not result in cumulative effects to recreation because Cactus Hill and Galeton Reservoirs would not provide recreational opportunities. The exact location and extent of direct effects on recreation resources

from conveyance systems are unknown, but direct effects are expected to be temporary and negligible and not contribute to cumulative effects.

5.16.5.2 Poudre River

Potential cumulative effects to recreation opportunities are expected to occur in Segment B through Fort Collins, which is popular for boating (canoeing and kayaking) and is the location of a proposed whitewater park.

Under Alternative 4, the median monthly flows in Segment B would decline by about 50 cfs in May and June, and would increase slightly in July, with no discernible change in August and September, based on comparisons of Alternative 4 Future Conditions Effects and Alternative 4 Cumulative Effects. Target flows for quality boating opportunities are at or above 150 cfs. Changes in the number of days that target flows are met, under the various modeling runs that pertain to Alternative 4, are summarized in Table 5-59.

Table 5-58. Average number of days above 150 cfs at the Lincoln Street Gage for the period of record (1979-2005) – Alternative 4.

Alternative 4	May	June	July	August	September
Current Conditions Hydrology	16	23	11	4	0
Future Conditions Hydrology	16	22	12	4	0
Future Condition Effects	15	22	12	4	0
Cumulative Effects	14	22	12	4	0
Future Conditions Hydrology vs. Future Conditions Effects Incremental Effect[1]	-1	0	0	0	0
Future Conditions Hydrology vs. Cumulative Effects Incremental Effect[1]	-2	0	0	0	0

[1]The incremental effects are calculated by comparing Future Conditions hydrology (Run 2) to Future Conditions Effects and Cumulative Effects (Run 4b2 and Run 5b2. A negative number is a decrease in the number of days compared with Future Conditions.

Average values are rounded to the nearest full day.

Future Conditions Effects and incremental effect of adding the HSWSPs (Cumulative Effects) for Alternative 4 are based on comparisons of model Run 4b2 to Run 2, and Run 5b2 to Run 2, respectively:

- Alternative 4 Future Conditions Effects would result in 1 less day in May when target flows are not met, with no change during the remainder of the May – September season. This would have a negligible cumulative effect on boating opportunities.
- Alternative 4 Cumulative Effects would result in 2 fewer days in May when target flows are not met, with no change during the remainder of the season. This would have a negligible cumulative effect on boating opportunities.

The cumulative impact of predicted flow changes on aquatic organisms and, therefore, fishing opportunities in Segment B, would be negligible to minor because of reduced spring runoff that would affect brown trout.

Similar to Alternatives 2 and 3, several RFFAs are expected to benefit water-based recreational resources along the Poudre River through Fort Collins. The benefits of these projects, if completed successfully, would offset or potentially mitigate the adverse effects of Alternative 3 on boating and fishing. The cumulative effect of Alternative 3 on recreation, when combined with the benefits of river-based RFFAs in Fort Collins, would be a negligible benefit to both boating and fishing.

The cumulative effect of Alternative 4 on land-based recreation in the Poudre River corridor would be negligible because several identified RFFAs influence land-based recreation opportunities along the Poudre River corridor. The extension of the Poudre River Trail from Fort Collins to Timnath, Windsor, and Greeley would continue to benefit the overall quality and availability of recreation along this corridor over the long term. In addition, the additional conservation of land and establishment of new Natural Areas along the river would provide additional opportunities for trail-based recreation and passive enjoyment of the natural river setting. However, these foreseeable benefits to recreation along the Poudre River may be offset by ongoing population growth along the Northern Front Range, which would likely expand the demand for and use of these recreation resources and may diminish the quality of some recreation experiences.

5.16.5.3 South Platte River

No recreational uses or facilities along the South Platte River would be directly or indirectly affected by Alternative 4; therefore, no cumulative effects would occur.

5.16.6 Climate Change

Climate change has the potential to accelerate some of the cumulative effects described above. A large volume of scientific information supports the conclusion that global temperatures are increasing and that precipitation trends would change in the future. The warming trend is expected to accelerate in coming decades. In the western United States, longer periods of drought are expected. There is also general agreement by climate scientists that climate change information specific to Colorado indicates that snowpack melting and spring runoff would occur earlier in the year and temperatures would increase by approximately 4°F by 2050, with summers warming more than winters (DiNatale and CDM Smith 2014).

Based on an analysis of the Poudre Basin (DiNatale and CDM Smith 2014), winter flows could be slightly higher than under Current Conditions hydrology, peak runoff could occur earlier in the year and could be characterized by lower flows, and summer flows could likely decrease as well (DiNatale and CDM Smith 2014). Increased municipal and agricultural water demand is likely (DiNatale and CDM Smith 2014) and could decrease streamflows and increase hydrologic variability. However, flow variation in the Poudre Basin is already extreme as a result of water

management, and the remaining native fishes in the basin are adapted to highly unpredictable flow regimes (GEI 2013). As a result, there are expected to be only limited changes in species composition due to climate-induced changes in the flow regime. Temperature changes may or may not occur in the mainstem, but higher water temperatures could affect the distribution of trout along the river. Temperature increases may have less effect on the distribution of warm water species throughout the mainstem as these species likely will tolerate the warmer temperatures. Under climate change, adverse effects to boating along the Poudre River are expected to be exacerbated due to reduced summer flows and increased overall variability. Climate change may also affect fishing opportunities, due to increased temperatures and flow variability and the long-term effects on aquatic species.

5.16.7 Impact Summary

The cumulative effects of the alternatives on recreation resources, when combined with water and land-based RFFAs, are summarized in Table 5-59.

Table 5-59. Summary of recreation cumulative effects.

Potential Effect	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Reservoirs, Conveyance Systems, and South Platte River	No cumulative effects to recreation	No cumulative effects to recreation	No cumulative effects to recreation	No cumulative effects to recreation
Change in Poudre River Boating Flows (> 150 cfs)	4 fewer boating days Negligible cumulative effect	Up to 21 fewer boating days Major adverse cumulative effect	Up to 21 fewer boating days Major adverse cumulative effect	2 fewer boating days Negligible cumulative effect
Cumulative Effects on Fishing	No effect	Moderate beneficial effects on Segment B (due to augmented winter flows); minor adverse effects on other segments	Moderate adverse effects	Negligible to minor effects
Land-based Cumulative Effects along Poudre River Corridor	Negligible	Negligible	Negligible	Negligible

5.17 LAND USE

This section summarizes the potential cumulative effects predicted to affect land use. RFFAs that when combined with the NISP alternatives that would result in cumulative effects on land use, include population growth, urban development, the North I-25 improvement project, and oil and gas development. The trend in the region has been toward increased urbanization and reduced agricultural lands.

5.17.1 No Action Alternative (Alternative 1)

Information on direct effects on land use under the No Action Alternative is provided in Section 4.17.3. Most direct effects on land use associated with the No Action Alternative would be at Cactus Hill Reservoir. Future residential development in response to population growth is likely to occur throughout the cumulative effects study area. The construction of Cactus Hill Reservoir and its associated facilities combined with future residential development in the cumulative effects study area would contribute to the ongoing regional trend of reduced agricultural lands. The No Action Alternative would also involve the transfer of water from 64,200 acres of irrigated lands for use by the NISP Participants. The transfer would not eliminate these lands from agricultural uses but would change the type of agriculture feasible on these lands. Oil and gas development and the North I-25 improvement project would also contribute to the conversion of agricultural land to other uses. These changes in land use along with other lands converted from agriculture to urban development are considered a moderate effect because of the sizable land area that would be involved in the transfer of water from irrigated agricultural lands.

5.17.2 District's Preferred Alternative (Alternative 2)

Information on direct effects on land use for Alternative 2 is provided in Section 4.17.4. In combination with the RFFAs, the construction of Glade and Galeton Reservoirs and the realignment U.S. 287 would contribute to the ongoing regional trend of reduced agricultural lands. Proposed residential development in the cumulative effect study area would also change current land uses. In September 2005, Holcim (U.S.), Inc. auctioned approximately 3,080 acres of property located mostly east of the proposed realignment for U.S. 287. Most of the auctioned property includes 35-acre or greater parcels for residential development. The plat approved by Larimer County includes about 60 residential parcels, some of which occur near the proposed realignment for U.S. 287. Glade Reservoir would also contribute to the region's parks and open space lands because it would be open to public recreation. Oil and gas development in the vicinity of the proposed Galeton Reservoir is expected to continue to have local effects on land uses for at least the next 20 years. The construction of Galeton Reservoir would further contribute to regional land use changes. Cumulative effects on land use for Alternative 2 are expected to be minor relative to the larger regional trend of increased development of rural agricultural lands.

5.17.3 Alternative 3

Information on direct effects on land use for Alternative 3 is provided in Section 4.17.5. Most direct effects on land use would be at Cactus Hill Reservoir and Galeton Reservoir. Residential development in response to population growth is likely to increase in the cumulative effects study area. The construction of Cactus Hill Reservoir and its associated facilities combined with future residential development in the cumulative effects study area would contribute to the ongoing regional trend of reduced agricultural lands. Effects associated with the construction of Galeton Reservoir are discussed under Alternative 2. Cumulative effects on land use for Alternative 3 are expected to minor relative to the larger regional trend of increased development of rural agricultural lands.

5.17.4 Alternative 4

Information on direct effects on land use for Alternative 4 is provided in Section 4.17.6. Cumulative effects on land use for Alternative 4 would be similar to those describe for Alternative 3.

5.17.5 Climate Change

Climate change is not expected to have an effect on future land use.

5.17.6 Impact Summary

The cumulative effects for land use for all action alternatives would be minor relative to the larger regional trend of increased development of rural agricultural lands. For the No Action Alternative, the changes in land use are considered moderate because of the sizable land area that would be involved in the transfer of water from irrigated agricultural lands. Cumulative effects for Alternatives 2, 3, and 4 would be minor. All of the alternatives are in response to current and projected population growth, and the alternatives would not have an incremental effect on population growth.

5.18 VISUAL RESOURCES AND AESTHETICS

This section summarizes the potential land-based and flow-based cumulative effects predicted to occur on visual resources. Because of the location of land-based RFFAs, none of them would result in cumulative effects on visual resources near project components except for residential development near the reservoirs, which is discussed below for each alternative, and oil and gas development near Galeton Reservoir. Many of the Participants in the NISP cumulative effects study area have planning boundaries that have projected growth. The urban growth within the planning boundaries would not be in the same location as project components and would not contribute to the cumulative effects on visual resources. Poudre River restoration projects, the Fort Collins Poudre River Master Plan, proposed Poudre River corridor conservation plans, proposed Poudre Trail connections, commercial and residential development along the Poudre River in Fort Collins, and the Greeley Poudre River Flood Control and Environmental Restoration Project are RFFAs that could affect visual resources along the Poudre River. The Halligan and Seaman Reservoirs do not contribute to land-based cumulative effects because they are not in the cumulative effects study area but they do contribute to the flow-related cumulative effects. Cumulative effects from changes in flow on the Poudre River from flow-related RFFAs are discussed for each alternative.

5.18.1 No Action Alternative (Alternative 1)

Information on direct effects on visual resources under the No Action Alternative is provided in Section 4.18.2.

5.18.1.1 Cactus Hill Reservoir

Continued population growth and accompanying commercial and residential development is expected to occur in the region, which would result in changes to visual resources. Cactus Hill Reservoir would contribute to these future visual changes. The Cactus Hill Reservoir and dam along with nearby development would create a district contrast to the existing grassland habitat and other natural areas that currently exist. The cumulative effect on visual resources would be moderate because of the change in the current viewshed near Cactus Hill Reservoir.

5.18.1.2 Poudre River

The cumulative effects on stage from streamflow changes are discussed in more detail in Section 5.9.3.2. Flows in the Poudre River are highly variable and reduced flows associated with cumulative effects for the No Action Alternative may not be noticed by the majority of Poudre River trail users and other viewers of the river. Viewers would likely have difficulty determining if flow variations are naturally occurring or are attributed to flow changes from the No Action Alternative and RFFAs. Most changes in flow would occur during peak flows when the visual effects of reduced flow would be less noticeable and the reduction may be desirable. Cumulative effect flow changes are not expected to have an adverse effect on riparian vegetation along the

Poudre River other than to contribute to the trajectory of vegetation changes already occurring (see Section 5.9.3.2.4). The flow changes and associated visual effects with the No Action Alternative and RFFAs would be negligible.

5.18.1.3 South Platte River

The No Action Alternative with Future Conditions would on an average annual basis reduce flows on the South Platte River by less than 10% and the stage reductions are predicted to be small (up to 0.33 feet). The cumulative effect on visual resources on the South Platte River would be negligible.

5.18.2 District's Preferred Alternative (Alternative 2)

Information on direct effects on visual resources for Alternative 2 is provided in Section 4.18.3. Alternative 2 includes a No Reclamation Action Option and Reclamation Action Option as described in Section 2.5.5. Cumulative effects associated with changes in streamflows are predicted to be the same for the Reclamation Action and No Reclamation Action Options.

5.18.2.1 Glade Reservoir

Within the Glade Reservoir study area, the Poudre River State Trust Land (Trust Land) area west of, and adjacent to, the proposed dam and reservoir would require a new access road. The road is currently used for hunting access and environmental studies by a variety of users. Because use of the Trust Land area would remain unchanged, the new road would be similar to the existing road in size and material. The new road would likely appear similar, if not identical, to other visible roads, except U.S. 287, in the cumulative effects study area. Additionally, more single-family homes may be built on undeveloped lots within an existing residential land development northwest of the proposed reservoir. The cumulative effects on visual resources at Glade Reservoir and the proposed development would be major because they would create a high degree of contrast to the surrounding natural habitat features. New development near the U.S. 287 would affect the visual resources in the area. The predicted direct effects of Alternative 2 on visual resources are expected to be major within the U.S. 287 realignment area; therefore, the cumulative effects would also be major.

5.18.2.2 Galeton Reservoir

Ongoing oil and gas development in the region is anticipated to continue over the near-term. Oil and gas pads, roads, and collection and conveyance systems will continue to disturb lands and affect visual resources in the area around Galeton Reservoir. When Galeton Reservoir and dam combine with the effects of oil and gas development to create contrast with the existing natural landscape and greater fragmentation, the cumulative effects are expected to be major.

5.18.2.3 Poudre River

The cumulative effects on stage from streamflow changes are discussed in more detail in Section 5.9.4. Alternative 2 includes a No Reclamation Action Option and Reclamation Action Option as described in Section 2.5.5. Effects to flow-related visual resources are predicted to be the same for the Reclamation Action and No Reclamation Action Options. Flows in the Poudre River are highly variable and reduced flows associated with cumulative effects under Alternative 2 may not be noticed by the majority of Poudre River trail users and other viewers of the river. Most viewers would have difficulty determining if flow variations are naturally occurring or are attributed to flow changes from Alternative 2 and RFFAs. Most changes in flow would occur during peak flows when the visual effects of reduced flow would be even less noticeable and the reduction may be more desirable. Cumulative effect flow changes are not expected to have an adverse effect on riparian vegetation along the Poudre River except potentially at Martinez Park (representative of Segment B) and Eastman Park (representative of Segment D) and to contribute to the trajectory of vegetation changes already occurring. Vegetation changes at Martinez Park and Eastman Park would be minor because most wetlands along the banks of the mainstem are dominated by reed canarygrass and sandbar willow, two species that can tolerate a range of ground water levels. Most visitors would not perceive the change in species composition. The flow changes, vegetation changes and associated visual effects with Alternative 2 and RFFAs would be negligible at all segments except Segment B and D, which would have minor visual effects.

Several RFFAs including proposed Poudre River restoration projects, the Fort Collins Poudre River Master Plan, proposed Poudre River corridor conservation plans, proposed Poudre Trail connections, commercial and residential development along the Poudre River in Fort Collins, and the Greeley Poudre River Flood Control and Environmental Restoration Project could change and improve visual resources along the Poudre River.

5.18.2.4 South Platte River

Alternative 2 with cumulative effects would on an average annual basis reduce flows on the South Platte River by less than 10% and the stage reductions are predicted to be small (up to 0.33 feet). The cumulative effect on visual resources on the South Platte River would be negligible.

5.18.3 Alternative 3

Information on direct effects on visual resources for Alternative 3 is provided in Section 4.18.4.

5.18.3.1 Cactus Hill Reservoir

The cumulative effects on visual resources at Cactus Hill Reservoir are similar to those for the No Action Alternative (Section 5.18.1.1), even though Cactus Hill Reservoir would be larger for Alternative 3.

5.18.3.2 Galeton Reservoir

The cumulative effects on visual resources at Galeton Reservoir are similar to those for Alternative 2.

5.18.3.3 Poudre River

The cumulative effects on stage from streamflow changes are discussed in more detail in Section 5.9.5. Flows in the Poudre River are highly variable and reduced flows associated with cumulative effects under Alternative 3 may not be noticed by the majority of Poudre River trail users and other viewers of the river. Most viewers would have difficulty determining if flow variations are naturally occurring or are attributed to flow changes from Alternative 3 and RFFAs. Most changes in flow would occur during peak flows when the visual effects of reduced flow would be even less noticeable and the reduction may be more desirable. Cumulative effect flow changes are not expected to have an adverse effect on riparian vegetation along the Poudre River except potentially at Martinez Park (representative of Segment B), Archery Site (representative of Segment C), Eastman Park (representative of Segment D), and 59th Avenue (representative of Segment E) and to contribute to the trajectory of vegetation changes already occurring (see Section 4.9.1.1). Vegetation changes at Segments B, C, D, and E would be minor because most wetlands along the banks of the mainstem are dominated by reed canarygrass and sandbar willow, two species that can tolerate a range of ground water levels. Most visitors would not perceive the change in species composition. The flow changes, vegetation changes and associated visual effects with Alternative 3 and RFFAs would be negligible at Segments A and F, and minor at Segment B, C, D, and E.

Several RFFAs including proposed Poudre River restoration projects, the Fort Collins Poudre River Master Plan, proposed Poudre River corridor conservation plans, proposed Poudre Trail connections, commercial and residential development along the Poudre River in Fort Collins, and the Greeley Poudre River Flood Control and Environmental Restoration Project could change and improve visual resources along the Poudre River.

5.18.3.4 South Platte River

Alternative 3 with cumulative effects would on an average annual basis reduce flows on the South Platte River by less than 10% and the stage reductions are predicted to be small (up to 0.33 feet). The cumulative effect on visual resources on the South Platte River would be negligible.

5.18.4 Alternative 4

Information on direct effects on visual resources for Alternative 4 is provided in Section 4.18.5.

5.18.4.1 Cactus Hill Reservoir

The cumulative effects on visual resources at Cactus Hill Reservoir are similar to those for Alternative 3 (Section 5.18.3.1).

5.18.4.2 Galeton Reservoir

The cumulative effects on visual resources at Galeton Reservoir are similar to those for Alternatives 2 and 3.

5.18.4.3 Poudre River

The cumulative effects on stage from streamflow changes are discussed in more detail in Section 5.9.6. Flows in the Poudre River are highly variable and reduced flows associated with cumulative effects under Alternative 4 may not be noticed by the majority of Poudre River trail users and other viewers of the river. Most viewers would have difficulty determining if flow variations are naturally occurring or are attributed to flow changes from Alternative 4 and RFFAs. Most changes in flow would occur during peak flows when the visual effects of reduced flow would be even less noticeable and the reduction may be more desirable. Cumulative effect flow changes are not expected to have an adverse effect on riparian vegetation along the Poudre River except potentially at Martinez Park (representative of Segment B) and Eastman Park (representative of Segment D) and to contribute to the trajectory of vegetation changes already occurring (see Section 4.9.1.1). Vegetation changes at Martinez Park and Eastman Park would be minor because most wetlands along the banks of the mainstem are dominated by reed canarygrass and sandbar willow, two species that can tolerate a range of ground water levels. Most visitors would not perceive the change in species composition. The flow changes, vegetation changes and associated visual effects with Alternative 4 and RFFAs would be negligible at all segments except Segment B and D, which would have minor visual effects.

Several RFFAs including proposed Poudre River restoration projects, the Fort Collins Poudre River Master Plan, proposed Poudre River corridor conservation plans, proposed Poudre Trail connections, commercial and residential development along the Poudre River in Fort Collins, and the Greeley Poudre River Flood Control and Environmental Restoration Project could change and improve visual resources along the Poudre River.

5.18.4.4 South Platte River

Alternative 4 with cumulative effects would on an average annual basis reduce flows on the South Platte River by less than 10% and the stage reductions are predicted to be small (up to 0.33 feet). The cumulative effect on visual resources on the South Platte River would be negligible.

5.18.5 Climate Change

A large volume of scientific information supports the conclusion that global temperatures are increasing and that precipitation trends would change in the future. The warming trend is expected to accelerate in coming decades. In the western United States, longer periods of drought are expected. There is also general agreement by climate scientists that climate change information specific to Colorado indicates that snowpack melting and spring runoff would occur earlier in the year and temperatures would increase by approximately 4°F by 2050, with

summers warming more than winters (DiNatale and CDM Smith 2014). Under climate change, peak flows at most points in the basin below the canyon mouth are predicted to occur earlier and be reduced compared to Current Conditions. The reduced peak flows would likely not be perceptible by visitors along the Poudre River and would be a negligible effect.

The predicted changes in flow amounts and timing, increases in summer temperatures, and longer periods of drought with climate change would accelerate the trajectory described for wetland and riparian resources along the mainstem (Section 5.9). Additionally, higher temperatures would lead to increased transpiration for wetland and riparian vegetation which, when combined with less inundation and lower ground water levels, would likely stress wetland and riparian vegetation and would likely lead to "drying" of the wetland and riparian areas under cumulative effects and changes to the plant communities that were better adapted to the more frequent warmer and dryer conditions. Additionally, these conditions could provide opportunities for colonization and spread of non-native plants.

5.18.6 Impact Summary

The cumulative effects determinations for visual resources are summarized in Table 5-60.

Table 5-60. Visual resources effects determination for cumulative effects.

Study Area	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Glade Reservoir	NA	Major	NA	NA
U.S. 287 realignment	NA	Major	NA	NA
Galeton Reservoir	N/A	Major	Major	Major
Cactus Hill Reservoir	Moderate	NA	Moderate	Moderate
Poudre River	Negligible for all segments	Negligible for Segments A, C, E, and F; minor for B and D	Negligible for Segments A and F; minor for B, C, D, and E	Negligible for Segments A, C, E and F; minor for B and D
South Platte River	Negligible	Negligible	Negligible	Negligible

NA – Not a component of the alternative.

5.19 CULTURAL, HISTORICAL, AND PALEONTOLOGICAL RESOURCES

This section summarizes the potential land-based cumulative effects predicted to occur within the study area on cultural, historical, and paleontological resources. RFFAs that would result in cumulative effects on cultural, historical, and paleontological resources, when combined with the effects of the proposed project, include construction of Chimney Hollow Reservoir (Windy Gap Firming Project), the expansion of Halligan and Seaman Reservoirs, population growth and urban development, the North I-25 improvement project, other construction projects with ground disturbance, and oil and gas development. Forty cultural sites, which are either eligible or potentially eligible for inclusion in the NRHP, are within the Chimney Hollow Reservoir Area of Potential Effect (Reclamation 2011). Of the 40 sites, 16 are within the reservoir study area and could be impacted by construction and inundation. The expansion of the Halligan and Seaman Reservoirs could result in additional impacts to cultural resources. The preferred alternative of the North I-25 improvement project would have some adverse effects on cultural resources, all of which would be mitigated (CDOT 2011).

Population growth and associated commercial and residential development in the region have the potential to affect cultural and paleontological resources. The Participants in the NISP cumulative effects study area have planning boundaries that have projected growth, which is likely to occur with or without the implementation of NISP. Many of the land use changes and surface disturbances would occur without federal actions and would not have requirements to address and mitigate effects to cultural resources. The loss of unrecorded cultural and paleontological resources would be an unknown effect.

Cumulative effects on cultural and paleontological resources are difficult to evaluate and quantify the location of buried resources, and numbers are unknown. Many of the past, present, and future ground-disturbing activities have occurred, or will occur, on private land where cultural, historical, or paleontological resource impact assessment and mitigation may not be required, resulting in an irretrievable loss of resources. Those projects that are subject to Federal, State, or local government cultural, historical, or paleontological resource requirements can be assessed and mitigated but would add to the incremental cumulative effect to resources in the region.

The NISP with RFFAs would involve ground-disturbing activities in the Front Range that could impact cultural resources through direct impacts to prehistoric or historic sites or fossil localities, or also by impacting the setting or context of cultural or historical properties. Changes in flows on the Poudre and South Platte Rivers are not expected to have an effect on cultural, historical, or paleontological resources. Cumulative effects on cultural and historical resources for each alternative are discussed in the sections below.

Cumulative impacts on paleontological resources are difficult to evaluate and quantify because paleontological resources include both known fossil localities and resources whose precise locations are unknown because they are preserved beneath the ground surface in bedrock and surficial deposits. The incremental loss of paleontological resources over a period of time as a

result of project-related ground disturbance in the cumulative impacts study area has the potential to result in significant cumulative impacts because it could result in the destruction of non-renewable paleontological resources and irretrievable loss of scientific information. Paleontological monitoring and impact mitigation would be implemented prior to and during Project construction; therefore, fossils would be protected and information gained. With the implementation of monitoring and mitigation, the cumulative impacts to paleontological resources resulting from Project construction would be negligible. Further, any scientifically significant fossils discovered prior to or during ground disturbances related to Project construction would benefit the scientific community through an increase in knowledge associated with the fossils. The cumulative effects on paleontological resources would be negligible for each alternative for the above reasons and are not discussed below.

5.19.1 No Action Alternative (Alternative 1)

Information on direct effects to cultural and historical resources under the No Action Alternative is provided in Section 4.19.2. No direct effects on cultural or historical resources were identified at Cactus Hill Reservoir and effects from other project components are unknown. Because the No Action Alternative combined with RFFAs could potentially affect a substantial amount of cultural and historical resources and many of the effects associated with non-federal actions may not be mitigated, the cumulative effects on cultural and historical resources for the No Action Alternative could be major.

5.19.2 District's Preferred Alternative (Alternative 2)

Information on direct effects on cultural and historical resources for Alternative 2 is provided in Section 4.19.3. Direct effects on cultural or historical resources would occur at Glade and Galeton Reservoirs, to include the U.S. 287 realignment at Glade, and would be greater than the other alternatives. The potential cultural resource effects from the land-based RFFAs are described above. Alternative 2 combined with RFFAs could potentially affect a substantial amount of cultural and historical resources. Since many of the effects associated with the RFFAs are for non-federal actions that may not be mitigated and the direct effects from Alternative 2 at Glade and Galeton Reservoirs were determined to be major, the cumulative effects on cultural and historical resources would be major.

5.19.3 Alternative 3

Information on direct effects on cultural and historical resources for Alternative 3 is provided in Section 4.19.4. Direct effects on cultural or historical resources would occur at Galeton Reservoir. The potential cultural resource effects from RFFAs are described in Section 5.19.1. Because Alternative 3 combined with RFFAs could potentially affect a substantial amount of cultural and historical resources, many of the effects associated with non-federal actions may not be mitigated, and effects from Alternative 3 at Galeton Reservoir were determined to be major, the cumulative effects on cultural and historical resources would be major.

5.19.4 Alternative 4

Information on direct effects on cultural and historical resources for Alternative 4 is provided in Section 4.19.5. Direct effects on cultural or historical resources would occur at Galeton Reservoir. The potential cultural resource effects from RFFAs are described in Section 5.19.1. Because Alternative 4 combined with RFFAs could potentially affect a substantial amount of cultural and historical resources, many of the effects associated with non-federal actions may not be mitigated, and effects from Alternative 4 at Galeton Reservoir were determined to be major, the cumulative effects on cultural and historical resources would be major.

5.19.5 Climate Change

Climate change is not expected to have an effect on cultural, historical, or paleontological resources.

5.19.6 Impact Summary

The cumulative effects determinations for cultural, historical, and paleontological resources are summarized in Table 5-61.

Table 5-61. Cultural, historical, and paleontological resources effects determination for cumulative effects.

Study Area	Alternative 1	Alternative 2 Reclamation Action	Alternative 2 No Reclamation Action	Alternative 3	Alternative 4
Cultural and historical resources	Major	Major	Major	Major	Major
Paleontological	Negligible	Negligible	Negligible	Negligible	Negligible

5.20 SOCIOECONOMICS

This section summarizes projected cumulative effects of the NISP alternatives, in combination with other RFFAs, on socioeconomic resources. Socioeconomic conditions within the Study area, within the Poudre River Communities and within the broader socioeconomic study area may be affected by RFFAs that are both land-based and flow-related.

Land-based RFFAs that would contribute to cumulative effects on socioeconomic resources (when combined with the effects of the proposed project) include population growth and urban development, land development in proximity to the proposed realignment alternative for U.S. 287, planned Poudre Trail connections, the Greeley Poudre River Flood Control and Environmental Restoration Project, and the Fort Collins Poudre River Master Plan.

Flow-related RFFAs were incorporated into cumulative effects runs for the CTP hydrologic modeling (CDM Smith and DiNatale 2013).

5.20.1 No Action Alternative (Alternative 1)

5.20.1.1 Cumulative Effects within the Study Area

5.20.1.1.1 Population Growth

As described in Section 4.20.2.1.2, the No Action Alternative, like the action alternatives, was formulated to meet a portion of the need for municipal water supply based on current population and anticipated future population growth in the NISP Participants' service areas. Population and economic growth within the Study area is likely to be similar under any of the alternatives (including the No Action Alternative), with or without the RFFAs.

5.20.1.1.2 Water Rates and Affordability

The primary RFFA that would affect future water rates and affordability is continued population growth, and corresponding increases in water demands, within the service areas of the NISP Participants. The evaluation of the effects of the No Action Alternative on water rates and affordability provided in Section 4.20.2.1.1 incorporated the projected population growth in each of the NISP Participants' service areas (as projected in HE 2011 and confirmed by BBC). Both the revenues associated with new customers (from rates and connection charges) and the projected additional costs of developing supplies (including NISP and other new supplies) and providing service to new customers, were incorporated in that analysis.

As described in more detail in Section 4.20.2.1.1, the No Action Alternative is projected to have a moderate to major impact on the costs and affordability of water service in the Study area. The degree of impact would vary among the Participants and their customers.

5.20.1.2 Cumulative Effects within the Poudre River Communities

5.20.1.2.1 Cumulative Effects on Recreation-related Economy

The 2014 Water Resources Report predicts that future average flows through Fort Collins under the No Action Alternative with flow-related RFFAs would be 20% to 30% lower during the month of June than projected future average flows with the RFFAs but without the No Action Alternative (CDM Smith 2014a). There is little difference in projected flows during other months of the year between the No Action Alternative with the RFFAs and the No Action Alternative by itself. Compared to Current Conditions hydrology, the RFFAs are projected to reduce future June flows by approximately 3%, and future May flows by approximately 12%, on average. Based on these comparisons, flow-related RFFAs would add to the impacts of the No Action Alternative on Poudre River flows through Fort Collins during the early portion of the recreation season. However, these reductions are likely to have no more than a negligible impact on river-based recreation value. Boaters generally require at least 100 to 150 cfs to use the river, and flows above these minimum thresholds would be maintained.

5.20.1.2.2 Cumulative Effects on Property Values and Risks

In combination with flow-related RFFAs, the No Action Alternative is projected to have no impact on property values or risks in the Poudre River Communities. The general trend of increasing sedimentation of the Poudre River channel downstream of I-25 is projected to continue, with a corresponding gradual increase in the potential risk of damages from a 100-year flood-type event (ACE 2014). However, the No Action Alternative would have the least impact in accelerating that trend among the NISP alternatives.

5.20.1.2.3 Cumulative Effects on Water and Wastewater Treatment Costs

The No Action Alternative, in combination with flow-related RFFAs, is projected to have no effects on the cost of water treatment or the design and operational requirements for any of the seven waste water treatment plants that discharge to the Poudre River (ERO and Tetra Tech 2015).

5.20.1.3 Cumulative Effects within the Broader Study Area

5.20.1.3.1 Cumulative Effects on Agricultural Economy

As described in Section 4.20.2.3.1, the relatively large magnitude of potential water transfers under the No Action Alternative would likely result in a moderate to major impact on the irrigated agricultural economy in the study area. Future population growth and urban development in the Front Range is likely to result in the loss of additional acres of irrigated agriculture and further impacts on the irrigated agricultural economy, resulting in an even greater impact.

5.20.1.4 Environmental Justice

The environmental justice evaluation for the cumulative effects of the No Action Alternative would not be directly affected by the land-based or flow-related RFFAs. Farm workers may be disproportionately comprised of minority and low income individuals and would not be

compensated for potential adverse indirect impacts on their employment or income due to water transfers under this alternative.

5.20.2 District's Preferred Alternative (Alternative 2)

5.20.2.1 Cumulative Effects within the Study Area

5.20.2.1.1 Population Growth

Alternative 2, like the other alternatives, was formulated to meet a portion of the need for municipal water supply based on current population and anticipated future population growth in the NISP Participants' service areas. Population and economic growth within the Study area are expected to be similar under any of the alternatives, with or without the RFFAs.

5.20.2.1.2 Water Rates and Affordability

The primary RFFA that would affect future water rates and affordability is continued population growth, and corresponding increases in water demands, within the service areas of the NISP Participants. The evaluation of the effects of Alternative 2 on water rates and affordability provided in Section 4.20.3.1.1 incorporated the projected population growth in each of the NISP Participants' service areas (as projected in HE 2011 and confirmed by BBC). Both the revenues associated with new customers (from rates and connection charges) and the additional costs of developing supplies (including NISP and other supplies) and providing service to new customers, were incorporated in that analysis.

As described in more detail in Section 4.20.3.1.1 Alternative 2 – Reclamation Action Option is projected to have a minor impact on the costs and affordability of water service in the Study area for most of the Participants. Alternative 2 – No Reclamation Action Option is projected to have a minor to moderate impact on the costs and affordability of water service in the Study area. The degree of impact would vary among the Participants and their customers.

5.20.2.2 Cumulative Effects within the Poudre River Communities

5.20.2.2.1 Cumulative Effects on Recreation-related Economy

As described in Section 4.20.3.2.1, Alternative 2 is projected to result in a major impact on boating recreation value in Fort Collins and a moderate impact on the recreational value of the Poudre River Trail in Fort Collins. The projected impact to boating recreation value is due to projected reductions in flows during May and July, which would result in median daily flows below the 100 to 150 cfs approximate minimum flow range necessary to sustain boating activity in this reach. With flow-related RFFAs, projected median flows in this reach would be slightly higher in May and July than without the RFFAs, but would remain below 100 cfs. Median flows during June would be reduced from about 275 cfs (Alternative 2 with Current Conditions hydrology) to about 201 cfs (Alternative 2 with future hydrology), but would remain above the 100 to 150 cfs minimum necessary for boating. Cumulatively, flow-related impacts on boating recreation values would be major.

As part of the Fort Collins Poudre River Master Plan, the City of Fort Collins plans to construct a whitewater park in downtown Fort Collins. Under favorable hydrologic conditions, development of the whitewater park should increase boating activity along this reach of the Poudre River, and corresponding boating recreation value. Because Alternative 2 is projected to shorten the boating season in this area due to reduced flows in May and July, the cumulative impact on recreation values with the whitewater park in place is likely to be larger than the estimated $241,000 impact from Alternative 2 alone on annual boating recreation value (without the whitewater park) described in Section 4.20.3.2.1.

Planned Poudre Trail connections may increase future use of the Poudre Trail. As described in Section 4.20.3.2.1, the quality of the Poudre Trail experience could be incrementally diminished under Alternative 2 because of public concern that the River's condition would be less "natural" as a result of the increased peak period diversions. However, since reduced flows may not be noticed by the majority of Poudre River Trail users because they typically occur during high flow periods and visual impacts are expected to be minimal, the cumulative effect on recreation values for trail users would likely remain moderate. If future Poudre Trail connections increase use of the trail, the cumulative impact on recreation value could be larger than the estimated impact of $784,500 per year for Alternative 2 alone.

5.20.2.2.2 Cumulative Effects on Property Values and Risks

Section 4.20.3.2.2 noted that Alternative 2 may have a minor adverse effect on future flood risk and flood damages under a 100-year flood event downstream of I-25 and a minor benefit on future flood risk and flood damages under a 25-year flood event. Relative to floodplain ratings or values, the increase in flooding downstream of I-25 would not change the floodplain rating (zone designation) within existing flood prone areas, but may increase the limits of this flood zone. Increases in floodplain stage can affect insurable structures and may adversely affect the cost of flood insurance. The Greeley Poudre River Flood Control and Environmental Restoration Project could reduce the potential for flood damage in part of this area, potentially reducing the cumulative effects from the RFFAs combined with Alternative 2.

Alternative 2 may have an adverse impact on riparian and wetland plant communities that are shallowly rooted, associated with shallow alluvial ground water levels, and occur close to the riverbank. Future flow-related RFFAs are likely to add to this adverse effect. However, since this effect would be limited to about 10 acres out of the 2,500 acres that make up the overall riparian area along the river (ERO 2014d) (less than 1%), the cumulative effect would likely remain a minor adverse impact on property values closest to the affected area.

5.20.2.2.3 Cumulative Effects on Water and Wastewater Treatment Costs

Alternative 2 with RFFAs is anticipated to have no effects on either the required chemical dosages for removing total organic carbon or the treated water quality at Greeley's Bellvue Water Treatment Plant or the water treatment plants that rely on supplies from Horsetooth Reservoir. There would be no effect on downstream water treatment costs (ERO and Tetra Tech 2015).

Alternative 2 with RFFAs would also not affect the cost of construction or operations for the downstream waste water treatment plants. These plants will face major changes in the future in

order to meet future and chronic ammonia removal requirements. These improvements will be necessary with or without implementation of Alternative 2 or the RFFA's (ERO and Tetra Tech 2015).

5.20.2.2.4 Other Cumulative Socioeconomic Effects on Poudre River Communities

As described in Section 4.20.3.2.4, economic development and the overall economy in Fort Collins is unlikely to be affected by reductions in peak flows associated with Alternative 2. However, Fort Collins residents also appear to have substantial non-use values associated with flow conditions in the Poudre River (Loomis 2008). With flow-related RFFAs, peak flows along the Poudre River would be further reduced under Alternative 2, potentially increasing the cumulative effect on these non-use values.

5.20.2.3 Cumulative Effects within the Broader Study Area

5.20.2.3.1 Other Regional Recreation Resources

Alternative 2 would provide additional benefits from regional recreation resources due to the development of Glade Reservoir. In Section 4.20.3.3.1, the annual value of recreation at Glade Reservoir, at full development, was projected to be approximately $13.2 million. The RFFA of future population growth and urban development in Northern Colorado is likely to continue to increase the demand for recreation facilities and could increase the recreational value that Glade Reservoir would provide. Recreation facilities are not anticipated to be a part of other reasonably foreseeable water resource developments in Northern Colorado, such as expansion of Seaman or Halligan Reservoirs.

5.20.2.3.2 Cumulative Effects on Agricultural Economy

Alternative 2, as well as Alternatives 3 and 4, would include the exchange of Poudre River water currently used by agriculture for water supplies from the South Platte River through the SPWCP. The SPWCP would result in increased levels of salinity in irrigation water. Under average conditions, the SPWCP would not affect crop yields. Under maximum effect conditions (a high proportion of SPWCP supplies relative to native water supplies and low rainfall), yield reductions for dry beans and vegetables could result in decreased annual production value of about $487,000 (in 2010 dollars), about 1% of total production value of the affected acreage. Cumulative effects with RFFAs would be similar to the estimated direct effects described in Section 4.20.3.3.2. Compared to the scale of existing economic activity related to irrigated farming in the study area, the maximum effect scenario would be a minor impact.

5.20.2.3.3 Cumulative Socioeconomic Impacts of U.S. 287 Relocation

The District's Proposed Action would require the relocation of about 7 miles of U.S. 287, a portion of which would be inundated by the proposed Glade Reservoir. Realignment of U.S. 287 would likely improve access to nearby properties, but would also affect their current, remote character. Future land development in this area is also likely to reduce the current, remote character of the homes in this area.

As described in Section 4.20.3.3.3, two businesses at Ted's Place (at the current intersection of U.S. 287 and State Highway 14) would likely be adversely affected by the proposed relocation of

U.S. 287, though both businesses might experience some offsetting positive benefits from recreational visitors to the proposed Glade Reservoir. Future land development in this area might provide additional customers for these businesses and further offset any negative impacts due to U.S. 287 relocation.

5.20.2.4 Environmental Justice

Within the Poudre River communities, only the City of Greeley has a substantially larger share of minority and/or low income residents than average across the State of Colorado as a whole. Based on the current trajectory regarding geomorphology in the Poudre River, properties in, or immediately adjacent to, the 100-year floodplain in Greeley would likely experience gradual increases in flood risk due to increased sedimentation of the Poudre River channel even in the absence of any of the NISP alternatives. Alternative 2, like the other NISP action alternatives, is predicted to reinforce or accelerate this trend and associated risks of increased damage from a 100-year flood in this area. The cumulative effect on flood risk to these potentially low income and minority communities could be reduced, however, by the planned Greeley Poudre River Flood Control and Environmental Restoration Project.

5.20.3 Alternative 3

5.20.3.1 Cumulative Effects within the Study area

5.20.3.1.1 Population Growth

Alternative 3, like the other alternatives, was formulated to meet a portion of the need for municipal water supply based on current population and anticipated future population growth in the NISP Participants' service areas. Population and economic growth within the Study area are expected to be similar under any of the alternatives, with or without the RFFAs.

5.20.3.1.2 Water Rates and Affordability

The primary RFFA that would affect future water rates and affordability is continued population growth, and corresponding increases in water demands, within the service areas of the NISP Participants. The evaluation of the effects of Alternative 3 on water rates and affordability provided in Section 4.20.4.1.1 incorporated the projected population growth in each of the NISP Participants' service areas (as projected in HE 2011 and confirmed by BBC). Both the revenues associated with new customers (from rates and connection charges) and the additional costs of developing supplies (including NISP and other supplies) and providing service to new customers, were incorporated in that analysis.

As described in more detail in Section 4.20.4.1.1, Alternative 3 would have a minor to moderate impact on the costs and affordability of water service in the Study area. The degree of impact would vary among the Participants and their customers.

5.20.3.2 Cumulative Effects within the Poudre River Communities

5.20.3.2.1 Cumulative effects on Recreation-related Economy

The cumulative effect of Alternative 3 on flow through the Poudre River communities, and the economic value of recreation, would be somewhat larger than the cumulative impacts of Alternative 2 because upstream diversions to the proposed Cactus Hill facility would be greater than diversions to the proposed Glade facility to compensate for greater transit and evaporative losses. Also, Alternative 3 does not provide for flow augmentation through the City of Fort Collins during the winter months. From an economic standpoint, however, the cumulative effects of Alternative 3 would be similar to Alternative 2. There would likely continue to be enough flow during June to support boating activity, but flow levels in May and July would likely fall below the 100 to 150 cfs minimum flow range necessary to sustain boating activity in this reach.

Construction of the whitewater park (part of the Fort Collins Poudre River Master Plan) would likely lead to additional cumulative impacts under Alternative 3 because that development would increase boating activity (and boating recreation economic value) under more favorable hydrologic conditions. Cumulatively, flow-related impacts on boating recreation values would be major.

Planned Poudre Trail connections may increase future use of the Poudre Trail. As described in Section 4.20.3.2.1, the quality of the Poudre Trail experience could be incrementally diminished under Alternative 3 because of public concern that the River's condition would be less "natural" as a result of the increased peak period diversions. However, since reduced flows may not be noticed by the majority of Poudre River Trail users because they typically occur during high flow periods and visual impacts are expected to be minimal, the cumulative effect on recreation values for trail users would likely remain moderate.

Cumulatively, the effects of Alternative 3 and the RFFAs would include a major impact on boating recreation value in Fort Collins and a moderate impact on the recreational value of the Poudre River Trail in Fort Collins.

5.20.3.2.2 Cumulative Effects on Property Values and Risks

Alternative 3 with cumulative effects are predicted to gradually shift the species composition of about 148 acres of riparian and wetland plant communities in Segments B, C, D and E that are shallowly rooted, associated with shallow alluvial ground water levels, and occur close to the riverbank. The predicted shift in species composition would not be noticeable to most viewers and would potentially affect about 6% of the overall riparian area along the river from the canyon mouth to the confluence with the South Platte River. This cumulative effect would result in a minor adverse impact on property values closest to the affected area. Cumulative effects of Alternative 3 on potential flood risk and damages downstream of I-25, and on property values, would be similar to cumulative effects from Alternative 2. Relative to floodplain ratings or values, the increase in flooding downstream of I-25 would not change the floodplain rating (zone designation) within existing flood prone areas, but may increase the limits of this flood zone. Increases in floodplain stage can affect insurable structures and may adversely affect the cost of flood insurance. The Greeley Poudre River Flood Control and Environmental Restoration

Project could reduce the potential for flood damage in part of the downstream area, potentially reducing the cumulative effects relative to the effects of Alternative 3 alone.

5.20.3.2.3 Cumulative Effects on Water and Wastewater Treatment Costs

Alternative 3 with RFFAs is anticipated to have no effects on either the required chemical dosages for removing total organic carbon or the treated water quality at Greeley's Bellvue Water Treatment Plant or the water treatment plants that rely on supplies from Horsetooth Reservoir. There would be no effect on downstream water treatment costs (ERO and Tetra Tech 2015).

5.20.3.2.4 Other Socioeconomic Effects on Poudre River Communities

As discussed previously in section 4.20.3.4, there is no evidence of a systematic relationship between flow levels in the Poudre River and overall Fort Collins economic conditions. Economic development and the overall economy in Fort Collins are unlikely to be affected by cumulative reductions in peak flows associated with Alternative 3. However, similar to Alternative 2, there could be a moderate cumulative impact to the non-use values Fort Collins residents have in relation to peak flows in the Poudre River under Alternative 3.

5.20.3.3 Cumulative Effects within the Broader Study Area

5.20.3.3.1 Other Regional Recreation Resources

As noted in Section 4.20.4.3.1, Alternative 3 would use a 190,000-AF Cactus Hill Reservoir rather than Glade Reservoir for storage of diverted Poudre River flow. There is not anticipated to be a recreation component to Cactus Hill Reservoir. As a result, there would be no cumulative regional recreation benefit associated with this facility.

5.20.3.3.2 Cumulative Effects on Agricultural Economy

Alternative 3 includes the exchange of South Platte River water supplies for irrigators' supplies from the Poudre River through the SPWCP. The cumulative effects for all action alternatives would be similar, since they all involve construction and operation of the SPWCP. Alternative 3 could result in a minor adverse cumulative impact to irrigated crop production and the regional agricultural economy as described in Section 5.1.2.3.2.

5.20.3.3.3 Cumulative Socioeconomic Impacts of Road Relocation

U.S. 287 would not be relocated under Alternative 3, since Glade Reservoir would not be developed. Three segments of two, two-lane roads in Weld County, totaling 10.3 road miles, would be relocated due to the development of Cactus Hill Reservoir. No cumulative socioeconomic effects are anticipated from these road relocations.

5.20.3.4 Environmental Justice

Alternative 3, like the other NISP action alternatives, is predicted to reinforce or accelerate the trend of increasing sedimentation of the Poudre River channel and associated risks of increased damage from a 100-year flood in the City of Greeley, which is the only one of the Poudre River communities with a substantially larger share of minority and/or low income residents than

average across the State of Colorado as a whole. The cumulative effect on flood risk for potentially low income and minority communities in this area could be reduced by the planned Greeley Poudre River Flood Control and Environmental Restoration Project.

5.20.4 Alternative 4

5.20.4.1 Cumulative Effects within the Study area

5.20.4.1.1 Population Growth

Alternative 4, like the other alternatives, was formulated to meet a portion of the need for municipal water supply based on current population and anticipated future population growth in the NISP Participants' service areas. Population and economic growth within the Study area are expected to be similar under any of the alternatives, with or without the RFFAs.

5.20.4.1.2 Water Rates and Affordability

The primary RFFA that would affect future water rates and affordability is continued population growth, and corresponding increases in water demands, within the service areas of the NISP Participants. The evaluation of the effects of Alternative 4 on water rates and affordability provided in Section 4.20.5.1.1 incorporated the projected population growth in each of the NISP Participants' service areas (as projected in HE 2011 and confirmed by BBC). Both the revenues associated with new customers (from rates and connection charges) and the additional costs of developing supplies (including NISP and other supplies) and providing service to new customers, were incorporated in that analysis.

As described in more detail in Section 4.20.4.1.1, Alternative 4 would have a moderate impact on the costs and affordability of water service in the Study area. The degree of impact would vary among the Participants and their customers.

5.20.4.2 Effects within the Poudre River Communities

5.20.4.2.1 Cumulative Effects on Recreation-related Economy

Alternative 4 is designed to allow some flow to pass through the Fort Collins area and be diverted lower on the river at the New Cache Canal headgate. With flow-related RFFAs, this would maintain river flows through the City of Fort Collins at slightly lower volumes than the No Action Alternative but at higher volumes than Alternatives 2 and 3. May through July flow levels would be maintained above 150 cfs under average year hydrologic conditions, maintaining acceptable river-based recreation through Fort Collins throughout the peak summer period. Alternative 4 with the flow-related RFFAs would have a negligible cumulative effect on recreation values for boating, fishing, and Poudre Trail activities.

5.20.4.2.2 Cumulative Effects on Property Values and Risks

The cumulative effect of Alternative 4 with the flow-related RFFAs is predicted to shift the species composition of about 30 acres of riparian and wetland plant communities in Segments B and D that are shallowly rooted, associated with shallow alluvial ground water levels, and occur

close to the riverbank. The predicted shift in species composition would not be noticeable to most viewers and would potentially affect about 1% of the overall riparian area along the river (ERO 2014d). The cumulative effect would likely be a minor adverse impact on property values closest to the affected area because the shift in species would be gradual, not noticeable to most viewers and would comprise a small percentage of the overall riparian resources. Like the other action alternatives, Alternative 4 may have a minor adverse effect on future flood risk and flood damages under a 100-year flood event downstream of I-25 and provide a minor benefit on future flood risk and flood damages under a 25-year flood event. Relative to floodplain ratings or values, the increase in flooding downstream of I-25 would not change the floodplain rating (zone designation) within existing flood prone areas, but may increase the limits of this flood zone. Increases in floodplain stage can affect insurable structures and may adversely affect the cost of flood insurance. The Greeley Poudre River Flood Control and Environmental Restoration Project could reduce the potential for flood damage in part of the downstream area, potentially reducing the cumulative effects from Alternative 4.

5.20.4.2.3 Cumulative Effects on Water and Wastewater Treatment Costs

Alternative 4 with RFFAs is anticipated to have no effects on either the required chemical dosages for removing total organic carbon or the treated water quality at Greeley's Bellvue Water Treatment Plant or the water treatment plants that rely on supplies from Horsetooth Reservoir. There would be no effect on downstream water treatment costs (ERO and Tetra Tech 2015).

5.20.4.2.4 Other Socioeconomic Effects on Poudre River Communities

As discussed previously in section 4.20.3.4, there is no evidence of a systematic relationship between flow levels in the Poudre River and overall Fort Collins economic conditions. Economic development and the overall economy in Fort Collins are unlikely to be affected by cumulative reductions in peak flows associated with Alternative 4. Since Alternative 4 would have much smaller cumulative impacts on peak flows for the Poudre River through Fort Collins than other action alternatives, Alternative 4 would also be unlikely to have a cumulative effect on the non-use values of Fort Collins residents associated with the Poudre River.

5.20.4.3 Effects within the Broader Study Area

5.20.4.3.1 Other Regional Recreation Resources

Like Alternative 3, Alternative 4 would use a 190,000-AF Cactus Hill Reservoir rather than Glade Reservoir for storage of diverted flow from the Poudre River. There would be no cumulative regional recreation benefit associated with this facility.

5.20.4.3.2 Cumulative Effects on Agricultural Economy

Alternative 4 includes the exchange of South Platte River water supplies for irrigators' supplies from the Poudre River through the SPWCP. The cumulative effects for all action alternatives would be similar, since they all involve construction and operation of the SPWCP. Alternative 4 could result in a minor adverse cumulative impact to irrigated crop production and the regional agricultural economy.

5.20.4.3.3 Socioeconomic Impacts of Road Relocation

U.S. 287 would not be relocated under Alternative 4 and no substantial cumulative socioeconomic effects are anticipated from the relocations of three segments of two, two-lane roads in Weld County for the development of Cactus Hill Reservoir.

5.20.4.4 Environmental Justice

Alternative 4, like the other NISP action alternatives, is predicted to reinforce or accelerate the trend of increasing sedimentation of the Poudre River channel and associated risks of increased damage from a 100-year flood in the City of Greeley, which is the only one of the Poudre River communities with a substantially larger share of minority and/or low income residents than average across the State of Colorado as a whole. Alternative 4, however, would have less effect in increasing sedimentation than the other NISP action alternatives. The cumulative effect on flood risk for potentially low income and minority communities in this area could be reduced by the planned Greeley Poudre River Flood Control and Environmental Restoration Project.

5.20.5 Climate Change

Climate change has the potential to accelerate some of the cumulative effects described above. A large volume of scientific information supports the conclusion that global temperatures are increasing and that precipitation trends would change in the future. The warming trend is expected to accelerate in coming decades. In the western United States, longer periods of drought are expected. There is also general agreement by climate scientists that climate change information specific to Colorado indicates that snowpack melting and spring runoff would occur earlier in the year and temperatures would increase by approximately 4°F by 2050, with summers warming more than winters (DiNatale and CDM Smith 2014). Under climate change, peak flows at most points in the basin below the canyon mouth are predicted to occur earlier and be reduced compared to Current Conditions hydrology. These predicted changes in flow amounts and timing, increases in summer temperatures, and longer periods of drought could increase the projected cumulative impacts on recreation values associated with the NISP alternatives by leading to further deterioration in flow conditions for boating in Fort Collins and further diminishing the peak flow regime valued by Fort Collins residents. Climate change could also affect water rates and affordability, if the yield from existing water resources is reduced and demand increases during hotter and drier summers.

5.20.6 Impact Summary

As described in this section, socioeconomic conditions within the study area, within the Poudre River Communities and within the broader socioeconomic study area may be affected by other RFFAs, in combination with the direct effects of the NISP alternatives. Table 5-62 summarizes the interaction of land-based and flow-related RFFAs with the NISP alternatives, and projected cumulative effects on socioeconomic resources.

Table 5-62. Summary of projected cumulative effects on socioeconomic resources.

Study Area/Socioeconomic Resources	Alternative 1	Alternative 2 Reclamation Action	Alternative 2 No Reclamation Action	Alternative 3	Alternative 4
Study Area					
Water Rates/Affordability	Projected future growth was built into the financial effects analysis described in Chapter 4. Cumulative effects are the same as effects described in Chapter 4.				
Population Growth	All alternatives were formulated to meet current and projected future needs. Population growth is expected to be the same under all alternatives.				
Poudre River Communities					
Recreation Resources	No direct or cumulative effect	Flow-related RFFAs and development of whitewater park would increase impact on boating recreation value. Increase in Poudre Trail use due to Poudre Trail connections could increase impact on Poudre Trail economic values.			Negligible
Property Values	No effect	Cumulative effects on potential flood risk downstream of I-25 might be reduced by Greeley Poudre River Flood Control Project.			
Water/Wastewater Treatment Costs	No effect	No effect	No effect	No effect	No effect
Other Socioeconomic Effects	No effect	Flow-related RFFAs could marginally increase impact on non-use values associated with Poudre River for Fort Collins residents.			No effect
Broader Study Area					
Regional Recreation Resources	No effect	Future regional population growth could increase recreational value from Glade Reservoir.		No effect	No effect
Irrigated Agriculture-related Economy	Future urban development likely to add to major impact due to dry-up of irrigated lands	Cumulative effects from additional salinity in irrigation water supply would be the same as direct effects.			
Road Relocation Effects	No effect	Cumulative effects similar to direct effects.		No effect	No effect

5.21 HAZARDOUS MATERIALS

This section summarizes the potential land-based cumulative effects predicted to occur from hazardous materials as a result of implementing a NISP alternative. Because effects on hazardous material sites are location specific and the RFFAs do not overlap in location with known or potential hazardous material sites, they would not contribute to the cumulative effect on localized hazardous material sites, with the exception of oil and gas development. Oil and gas development will likely continue in the area surrounding Galeton Reservoir. Although spills have occurred in the past, they were remediated and the incidents were closed. If oil and gas drilling occurs with the same safety record and remediation as what has previously occurred in the Galeton Reservoir study area, the cumulative effect would be negligible from future spills.

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CHAPTER 6

CONSULTATION AND COORDINATION

CHAPTER 6

CONSULTATION AND COORDINATION

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Chapter 6. Consultation and Coordination

6.1 AGENCY AND PUBLIC PARTICIPATION SUMMARY

This chapter presents information on consultation and coordination by the Corps with agencies and the public for the DEIS and SDEIS and a list of preparers and contributors for the SDEIS.

6.1.1 Draft EIS

6.1.1.1 Scoping

As required by the National Environmental Policy Act of 1969, as amended (NEPA), the U.S. Army Corps of Engineers (Corps) has provided for an open dialogue that was initiated early in the Environmental Impact Statement (EIS) process to determine the scope of significant issues to be addressed in the document. Scoping is not a single, isolated action, but an ongoing process. The scoping process helps to:

- Inform the public and the affected agencies about the background, purpose, and features of the proposed project
- Objectively identify public issues and concerns about the Proposed Action
- Gather additional information about the issues
- Identify a reasonable range of alternatives and potential impacts to be addressed

Chapter 6 of the DEIS presents the issues and concerns related to NISP identified through agency and public scoping undertaken by the Corps for the DEIS. Section 6.1.1.1 of the DEIS lists the locations and dates of the public scoping meetings and Section 1.9.1 of the DEIS presents the key issues identified from the scoping process.

6.1.1.2 Cooperating Agency Review of Preliminary DEIS

During January and February 2008, the Corps solicited comments on the Preliminary DEIS from the Cooperating Agencies. The Corps considered and incorporated many of the agencies' recommendations into the DEIS.

6.1.1.3 DEIS Public Hearings and Comment Period

In April 2008, the Corps published the DEIS for public and agency review, the advertisement for which included the following:

- A **Notice of Availability** of the DEIS and related public hearings was published in the *Federal Register* under Department of Defense, Department of the Army, Corps of Engineers on April 30, 2008
- A **Public Notice**, dated April 30, 2008, for the availability of the DEIS and Section 404 permit application, and the dates and locations of the public hearings were posted on the Corps website and mailed to all registered attendees at the public scoping meetings and other interested parties
- At three **Public Open Houses and Hearings** oral and/or written comments on the DEIS were taken:
  - June 16, 2008 at the Hilton Fort Collins, Fort Collins, Colorado (added after original public notice)
  - June 17, 2008 at the Fort Collins Senior Center, Fort Collins Colorado
  - June 19, 2008 at the University of Northern Colorado University Center, Greeley, Colorado

The April 30, 2008 public notice established a 90-day comment period for the DEIS and Section 404 permit application. The Corps issued a public notice on July 3, 2008 extending the comment period an additional 45 days to September 13, 2008. Throughout the comment period, the public was encouraged to comment on the DEIS by sending comments to:

Chandler Peter, NISP EIS Project Manager
U.S. Army Corps of Engineers, Omaha District
Denver Regulatory Office
9307 South Wadsworth Boulevard
Littleton, CO 80128
Fax: 303-979-0602
Email: chandler.j.peter@usace.army.mil

Copies of the DEIS were made available during the comment period at the following locations:

- Colorado State University Morgan Library, 501 University Avenue, Fort Collins, CO 80523
- Fort Collins Regional Library District, 201 Peterson Street, Fort Collins, CO 80524
- Fort Collins Regional Library District–Front Range Community College-Larimer Campus, 4616 S. Shields Street, Fort Collins, CO 80526
- University of Northern Colorado James A. Michener Library, Greeley, CO 80639
- Greeley City Manager's Office, 1000 10th Street, Greeley, CO 80631
- Windsor Recreation Center, 250 11th Street, Windsor, CO 80550
- Northern Colorado Water Conservancy District, 220 Water Avenue, Berthoud, CO 80513
- U.S. Army Corps of Engineers, Denver Regulatory Office, 9307 S. Wadsworth Boulevard, Littleton, CO 80128

The NISP DEIS and supporting documents were made available on the Corps website at: https://www.nwo.usace.army.mil/html/od-tl/pn/tlpublicnotices.html. Additionally, compact

disks of the DEIS were provided upon request. Per 40 CFR Section 1502.10 and in support of Section 1502.19, Table 6-1 lists the agencies, organizations, and persons to whom hard copies and compact disks of the DEIS were sent in addition to the repositories listed above where copies of the DEIS were made available during the comment period for public review.

Table 6-1. Agencies, organizations, and persons to whom hard copies and compact disks of the DEIS were provided.

Federal Agencies
U.S. Bureau of Reclamation, Eastern Colorado Area Office U.S. Army Corps of Engineers, Omaha District, Denver Regulatory Office U.S. Environmental Protection Agency, Region 8 U.S. Environmental Protection Agency, Washington D.C. U.S. Fish and Wildlife Service, Colorado Field Office
State Agencies
Colorado Department of Transportation, Region 4
Local Government
Larimer County
Organizations
Northern Colorado Water Conservancy District
Project Team
ERO Resources Corporation GEI HDR Engineering, Inc.

6.1.1.4 Comments Received on the DEIS

All written and public hearing oral comments received on the DEIS during the public comment period were reviewed and considered in preparation of the SDEIS. The Corps received approximately 675 letters, emails, and oral statements on the DEIS. Comments on the SDEIS and responses to substantive comments will be included in the FEIS.

6.1.2 Supplemental Draft EIS

6.1.2.1 Scoping

A Notice of Intent to prepare the SDEIS was published in the *Federal Register* under Department of Defense, Department of the Army, Corps of Engineers on February 17, 2009. Substantive comments on the DEIS and discussions with the cooperating agencies informed the studies and analyses for the SDEIS. The Executive Summary of the SDEIS summarizes the major issues informed by comments on the DEIS that are addressed in the SDEIS.

6.1.2.2 Cooperating Agency Review of Preliminary Draft SDEIS

The Corps provided drafts of the preliminary SDEIS chapters to the cooperating agencies for a 30-day review and comment period as follows:

- Chapters 1 and 2, June 25, 2015
- Chapter 3, November 21, 2015
- Chapter 4, February 17, 2015
- Chapter 5, March 12, 2015

The Corps considered and incorporated many of the agencies' recommendations into the SDEIS.

6.2 CONSULTATION

Table 6-1 in the DEIS lists the government agencies, businesses, organizations, and individuals contacted or consulted during the preparation of the DEIS and SDEIS. Subsequent to the DEIS the Corps coordinated with the U.S. Geological Survey regarding the selection of the 2-D modeling sites and had discussions with Western Resource Advocates regarding alternatives development and analysis. Technical input regarding the alternatives was provided by the District and its consultants. The following agencies participated in the EIS process as cooperating agencies (40 CFR 1501.6 and 1508.5):

- Bureau of Reclamation
- U.S. Fish and Wildlife Service
- Environmental Protection Agency
- State of Colorado (Parks and Wildlife, Department of Transportation, Department of Natural Resources, and Department of Public Health and Environment)
- Larimer County

The respective actions and roles of the cooperating agencies in the EIS process are presented in Section 1.1.1 of the DEIS and Section 1.2 of the SDEIS.

As part of the SDEIS process, the Corps provided draft technical reports and draft chapters of the SDEIS to the cooperating agencies for their review and comment, and responded in writing to comments on the draft technical reports. Throughout the development of the SDEIS, the Corps consulted with the EPA and CDPHE regarding the assessment of potential water quality effects of the alternatives through numerous meetings and correspondences. Agency comments on the draft technical reports and preliminary draft SDEIS were considered and used to revise the documents.

At the time of the publication of the DEIS, the Corps had completed consultation with the USFWS under Section 7 of the Endangered Species Act regarding impacts to federally listed species from the proposed action, and the USFWS issued a Biological Opinion based on the effects described in the Biological Assessment (Appendix B of the DEIS). Since the publication of the DEIS, changes have been made to the proposed action, and depending on predicted project effects and comments received on the SDEIS, additional changes may be made to the proposed action after the closure of the SDEIS public comment period. The Corps will prepare a Supplemental Biological Assessment that addresses changes to the proposed action that could have effects on federally listed species and/or designated critical habitat and will reinitiate

consultation with the USFWS as required by the Endangered Species Act. These actions will take place either prior to issuance of the FEIS or a ROD.

6.2.1 Native American Tribe Coordination

Coordination with an Indian tribe recognizes the government-to-government relationship between the federal government and sovereign tribal groups. The Corps, in the context of the NISP EIS, considered the potential for historic properties of religious and cultural significance to tribes be located in the area within ancestral, aboriginal, or ceded lands beyond modern reservation boundaries that could be affected by the alternatives. As part of the DEIS process, 47 tribes and councils were contacted in writing regarding Native American concerns as required by 36 CFR 800.2(C)(3). Table 6-1 of the DEIS lists the tribes and councils contacted. The draft Programmatic Agreement (PA) addresses historic properties of religious and cultural significance to the tribes. Based on interest from the 47 tribes and councils contacted, 17 of the tribes were proposed as signatories to the PA (Appendix C of the DEIS). Prior to publication of the FEIS, the Corps will reinitiate coordination with the 47 tribes to ensure all interested tribes have an opportunity to be involved in development of the final PA.

6.3 OTHER PERMITS AND APPROVALS

In addition to the required federal authorizations and actions described in Section 1.2, construction of the alternatives would also require a variety of permits and approvals from state and local governments (Table 6-2 of the DEIS). Subsequent to the NISP DEIS, Larimer County initiated the process of adopting 1041 regulations for domestic water supply storage reservoirs. If the Corps permitted Alternative 2, the construction of Glade Reservoir may require a 1041 permit from Larimer County or alternatively, the County and the District may enter into an intergovernmental agreement that would specify the permitting process required by the County for Glade Reservoir and associated facilities located in Larimer County. Other authorizations by Larimer County could include approval of site plans and building permits.

6.4 PREPARERS AND CONTRIBUTORS

The NISP DEIS and SDEIS were prepared by ERO Resources Corporation, a third-party contractor, working under direction of and cooperation with the U.S. Army Corps of Engineers, Omaha District, the lead federal agency. Table 6-2 provides the names and organizations of the individuals who were principally involved in preparing the SDEIS. Table 6-3 of the DEIS provides the names and organizations of the individuals who were principally involved in preparing the DEIS.

Table 6-2. List of SDEIS preparers and contributors.

Name/Title	Responsibilities	Education	Experience
U.S. Army Corps of Engineers			
Catherine Blackwell	Project Manager	M.S. Civil Engineering B.S. Crop and Soil Science	15 years
Tim Carey	EIS Coordinator	B.S. Natural Resource Management	39 years
Chandler Peter	Project Manager NEPA/EIS 404(b)(1) Coordinator	B.S. Biology	27 years
Northern Colorado Water Conservancy District			
Carl Brouwer	Project Manager	M.S. Civil Engineering – Water Resources Planning and Management B.S. Civil Engineering	28 years
Don Carlson	Assistant General Manager	M.S. Environmental Engineering B.S. Agricultural Engineering	41 years
Andy Pineda	Water Resources Department Manager	B.S. Agricultural Engineering	34 years
Esther Vincent	Water Quality Manager	M.S. Civil Engineering-Water Resources and Environment	16 years
Gerald Gibbens	Project Manager/Water Resources Engineer	M.S. Civil Engineering – Water Resources Planning and Management B.S. Civil Engineering	22 years
Luke Shawcross	Water Resources Engineer	M.E. Civil Engineering – Water Resources Engineering B.S. Civil Engineering	12 years
Brian Werner	Public Information Officer	M.A. History B.A. History	32 years
ERO Resources Corporation			
Steve Dougherty Senior Ecologist	Project Manager	Graduate Studies Environmental Science B.S. Biology	39 years
Leigh Rouse Ecologist	Assistant Project Manager, Vegetation	M.S. Botany B.A. Environmental, Population, and Organismic Biology	16 years
Karen Baud Wildlife Biologist	Wildlife and Species of Concern	M.A. Biology B.A. Biology	17 years
Kay Wall Technical Editor	Technical Editor	B.A. Behavioral Science	32 years
Mark DeHaven Senior Natural Resource Specialist	Water Quality	M.S. Natural Resource Development B.A. Business Administration	36 years

Name/Title	Responsibilities	Education	Experience
Brian Olmsted Geochemist	Hazardous Sites and TCE Plume	M.S. Geochemistry B.S. Geology	12 years
Barbara Galloway Senior Hydrologist	Water Quality, Water Resources, and Stream Morphology	M.S. Water Resources B.A. Biology and Environmental Conservation	30 years
Michael Galloway Senior Hydrogeologist	Ground Water	M.S. Geology B.S. Geology	43 years
Denise Larson Ecologist	Wetlands, Vegetation and Plant Species of Special Concern	M.A. Biology and Plant Ecology B.A. Biology	21 years
David Hesker Graphic Designer	Graphic Design GIS	B.A. Fine Arts GIS Certificate	24 years
Wendy Hodges GIS Specialist	GIS and Maps	M.E.P.M. Master of Environmental Policy and Management B.S. Natural Science	7 years
Clint Henke Natural Resource Specialist	Wetland and Wildlife Field Surveys	M.S. Environmental Sciences B.S. Biology	13 years
Ron Beane Wildlife Biologist	Wildlife Field Surveys and Technical Peer Review	M.A. Biology B.S. Wildlife Biology	34 years
Sean Larmore Senior Archaeologist	Cultural Resources	M.A. Anthropology B.A. Anthropology	20 years
Steve Butler Natural Resource Specialist	Wildlife and Species of Concern	M.E.M. Water and Air Resources B.S. Biology	18 years
Moneka Worah Natural Resource Specialist	Wetland and Wildlife Field Surveys	B.A. Environmental Studies	10 years
Richard Trenholme Resource Scientist	Alternatives Development and SDEIS preparation	B.S. Agronomy	37 years
Craig Sovka Geologist	Geology and Soils	B.S. Geology	22 years
Headwaters Corporation			
Seth Turner Senior Water Resources Engineer	Water Resources and hydrology	M.S. Civil Engineering B.S. Agricultural Engineering	13 years
Muller Engineering			
Gray Clark	U.S. 287 Relocation	M.B.A. B.S. Civil Engineering	27 years
Rocky Mountain Paleontology			
Paul Murphey	Paleontological Resources	Ph.D. Paleontology M.S. Geological Sciences (Paleontology) B.A. Anthropology/ Biology	20 years

Name/Title	Responsibilities	Education	Experience
Colorado Department of Transportation			
Carol Parr	Region 4 Coordinator	M.N.S. Biology B.S. Biology	32 years
Holdeman Landscape Architecture, Inc.			
Mark Holdeman Landscape Architect	Visual Resources	B.A. Landscape Architecture Registered Landscape Architect in Kansas, New Mexico, and Wyoming	32 years
BBC Research & Consulting			
Douglas Jeavons	Socioeconomics	M.A. Economics B.A. International Affairs	25 years
Janet Clements	Socioeconomics	M.S. Agricultural Economics B.S. Sustainable Resource Management	4 years
Josh Sidon	Socioeconomics	Ph.D. Economics M.S. Economics B.S. Civil Engineering	5 years
Mollie Fitzpatrick	Socioeconomics	M.S. Economics B.S. Recreation, Park and Tourism Sciences	4 years
Honey Creek Resources			
George Oamek	Socioeconomics	Ph.D. Agricultural Economics M.S. Agricultural Economics B.S. Agricultural Economics	32 years
Kristen Gibbs Economist	Socioeconomics	B.S. Agricultural Economics	8 years
Trout, Raley, Montaño, Witwer & Freeman, P.C.			
Deb Freeman	Legal	J.D. B.A. History	32 years
Peggy E. Montaño	Legal	J.D. B.A. Political Science	34 years
CEC/GEI			
Don Conklin Aquatic Ecologist	Aquatics Resources	M.S. Water Resources Management B.S. Biology	32 years
Ashley Ficke Aquatic Ecologist	Aquatics Resources	Ph.D. Fishery Biology M.S. Fish, Wildlife & Conservation B.S. Fish &Wildlife Biology	15 years
Nick Miller Civil Engineer	Construction Analysis and Air Quality	M.S. Civil Engineering B.S. Civil Engineering	11 years
Jason Mullen Aquatic Ecologist	Aquatics Resources	M.S. Fish & Wildlife Management B.S. Biology	7 years

Name/Title	Responsibilities	Education	Experience
Suzanne Pargee Water Quality Specialist/Ecotoxicologist	Aquatics Resources and Water Quality	M.S. Environmental Science B.S. Oceanography	15 years
Craig Wolf Aquatic Ecologist	Aquatics Resources and Water Quality	M.S. Ecology B.S. Environmental, Population and Organismic Biology	19 years
DiNatale Water Consultants			
Matt Bliss Senior Engineer	Water Resources and Hydrologic Modeling	M.S. Civil Engineering B.S. Mathematics	10 years
Kelly DiNatale Sr. Technical Director	Water Resources and Hydrology	M.S. Civil Engineering Bachelor of Urban Design	34 years
CDM Smith			
Mark McCluskey Senior Water Resources Engineer	Water Resources and Hydrologic Modeling	M.S. Water Resources Engineering B.S. Civil Engineering – Water Resources	17 years
Alexandra Bowen Water Resources Engineer	Water Resources and Hydrologic Modeling	B.S. Earth and Environmental Engineering B.A. Liberal Arts	7 years
Robert Glenn Water Resources Engineer	Water Resources and Hydrologic Modeling	M.S. Civil and Environmental Engineering B.S. Civil Engineering	3 years
Jordan Dimick Water Resources Engineer	Water Resources and Hydrologic Modeling	M.S. Hydrology B.S. Geophysical Engineering	7 years
Mark Hoener Water Resources Engineer	Water Resources and Hydrologic Modeling	M.S. Civil Engineering B.S. Civil Engineering	6 years

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CHAPTER 7

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WQCC - see Water Quality Control Commission

WRA - see Western Resource Advocates

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GLOSSARY

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Acre-foot (AF). The amount of water that would cover 1 acre with 1 foot of water. One AF is equal to 0.326 million gallons (mg).

Adjudicated water rights. Water rights that are either an absolute water right, a conditional water right, a finding of reasonable diligence, an exchange, an augmentation plan, a change of water right, or a right to withdraw tributary water or ground water that is outside of a designated ground water basin.

Adjudication date. The date when the Court enters a decree confirming a water right.

Aggradation. The increase in land elevation due to sediment deposition. Aggradation occurs in areas in which the supply of sediment exceeds the capacity of the system to transport the sediment.

Allottees. Shareholders in a ditch company, the C-BT system, special water district or other mutual water supply entity.

Alluvial aquifer. A permeable formation that forms naturally underground by deposition of weathered material such as sand and silt particles and stores or conducts ground water to wells and springs. Water flow in these types of aquifers is very slow.

Alluvial ground water. Shallow ground water aquifer associated with a stream channel. In Colorado, alluvial ground water is considered a tributary water source.

Annual firm yield. Also firm yield or dry-year firm yield. The annual yield that is available during a defined drought period. The defined drought period is the drought period in the hydrologic record developed for hydrologic modeling (for NISP, the defined drought period is 1954, 1955, and 1956).

Annual yield. The amount of water that is available during a given year. The annual yield may vary from year-to-year.

Appropriation date. The date when the placement of a specified portion of the previously unappropriated waters of the state can be put to beneficial use pursuant to the procedures prescribed by law.

Approved Jurisdictional Determination. An official Corps determination that jurisdictional waters of the U.S. are either present or absent on a particular site. An approved jurisdictional determination (JD) precisely identifies the limits of those waters on the project site determined to be jurisdictional under the Clean Water Act.

Average yield. The yield available during an average water year.

Bald eagle active nest. A specific location in which a pair of bald eagles have at least attempted to nest within the last 5 years. Any nest location that can be directly tied to courtship, breeding, or brooding behavior is considered active. A buffer zone extends 0.5 mile around a known active nest.

Bald eagle communal roost. Groups of trees or individual trees used by more than 15 eagles for diurnal and/or nocturnal perches.

Bald eagle roost site. Groups of trees or individual trees that provide diurnal and/or nocturnal perches for less than 15 wintering bald eagles; includes a buffer zone extending 0.25 mile around these sites. These trees are usually the tallest available trees in the wintering area and are primarily located in riparian habitats.

Bald eagle winter concentration areas. Areas (e.g., trees and islands) within an existing winter range where eagles concentrate between November 15 and April 1. These areas may be associated with roost sites.

Bald eagle winter range. Areas where bald eagles have been observed between November 15 and April 1.

Bed material load. The portion of the sediment that is transported by a stream or river that contains material derived from the bed. Bed material load typically consists of the entire bed load, and the proportion of the suspended load that is represented in the bed sediments. Its importance lies in that its composition is that of the bed, and the material in transport can therefore be actively interchanged with the bed. For this reason, bed material load exerts a control on river channel morphology.

Bedrock aquifer. A geologic bedrock unit that has the porosity and permeability to release water in quantities sufficient to supply reasonable amounts of water to wells.

Biogeomorphic feedback. The interactions between organisms and the development of landforms. Organisms can affect geomorphic processes in a variety of ways. As used in the SDEIS, it refers to the interaction of riparian and wetland vegetation, primarily reed canarygrass, and its interaction with flooding and sediment deposition that adds to or accelerates aggradation by trapping sediment along the river banks.

C-BT quota. The AF per C-BT unit or share.

C-BT share or C-BT unit. A share in, or unit of, the C-BT project. A C-BT share or unit ranges from 0.5 AF to 1.0 AF depending on the year. The District estimates that the firm yield of a C-BT unit is 0.6 AF and the average yield of a unit is 0.7 AF.

C-BT. Colorado Big-Thompson project.

Channel Contraction. The loss of channel capacity associated with net bed material deposition (aggradation). As described in the SDEIS, this is a trend on the Poudre River downstream of I-25 where sediment supply exceeds sediment transport capacity and has resulted in a reduction in channel size and capacity due to ongoing aggradation, and narrowing of the channel due to the encroachment of vegetation in areas of aggradation.

Colorado-Big Thompson Project (C-BT). C-BT diverts Colorado River water through a transmountain diversion (the Alva B. Adams Tunnel) to farms and cities in northeastern Colorado. The C-BT is a complex system of reservoirs, pumps, pipelines, canals, and other water structures for collecting and distributing water and generating hydroelectric power. The project was constructed in 1957.

Combined firm yield. The firm yield for more than one entity (in this case, the NISP Participants).

Common Technical Platform (CTP). The CTP involves development of common protocols by which data are collected, a common analytical approach is used, and data are shared between the NISP and Halligan-Seaman Water Supply Projects (HSWSPs) EISs. In 2009, the Corps decided that a CTP would be developed for several key resources potentially affected by the proposed NISP and HSWSPs. A CTP was developed for hydrologic modeling and baseline reports for the flow-related resources associated with the Poudre River (water quality, stream morphology and sediment transport, wetland and riparian resources, and aquatic biological resources).

Conditional storage right. See conditional water right. A right to perfect a water right with a certain priority upon completion of a storage vessel such as a reservoir.

Conditional water right. A right to perfect a water right with a certain priority upon the completion, with reasonable diligence, of the appropriation upon which such water right is to be based.

Consumptive use. Consumptive use is the amount of water that does not return to its source after it has been diverted and put to beneficial use. Examples include water for drinking and water taken up by growing crops. Not all water is physically consumed when it is diverted. Unconsumed water that returns to a water supply through a municipal or industrial wastewater system or an irrigation system's tailwater is called return flow. Return flows are then available for other downstream water users.

Cooperating agency. A federal, state, tribal, or local agency having special expertise with respect to an environmental issue or jurisdiction by law may be a cooperating agency in the NEPA process. A cooperating agency has the responsibility to assist the lead agency by participating in the NEPA process at the earliest possible time, by participating in the scoping process, in developing information and preparing environmental analyses including portions of the EIS in which the cooperating agency has special expertise, and in making available staff support at the lead agency's request to enhance the lead agency's interdisciplinary capabilities.

Cubic feet per second (cfs). One cubic foot of water passing by a single point for one second. It is the standard unit of measure for flowing water. A flow rate of 1 cfs means that 7.48 gallons passed by a point of reference in 1 second or 448.8 gallons of water in 1 minute.

Cultural resources. Those fragile and nonrenewable remains of human activity, occupation, or endeavor reflected in districts, sites, structures, buildings, objects, artifacts, ruins, works of art, architecture, and natural features that were of importance in human events.

Cumulative Effects. When capitalized in the NISP EIS, Cumulative Effects refers to the predicted effects on a resource when considering how a NISP alternative and the HSWSPs would affect the modeled Future Conditions hydrology (2050 flows with RFFAs + HSWSPs + NISP alternatives - Run Series 5). When lower case, cumulative effects refers to the impact on the environment that results from the incremental impact of the action when added to other past, present, and RFFAs regardless of what agency (federal or nonfederal) or person undertakes such other actions (40 CFR Part 1508.7).

Current Conditions Effects. The predicted effects to a resource considering how a NISP alternative would affect the modeled Current Conditions hydrology (2010 flows with NISP alternatives - Run Series 3).

Current Conditions. CTP hydrologic modeling (Run 1) that uses 1950 to 2005 monthly naturalized streamflows with 2010 demands, infrastructure, and operations to estimate 56 years of Poudre River streamflows under a "current conditions" scenario without the proposed NISP and HSWSPs, RFFAs that are independent of NISP and the HSWSPs, or any other future conditions. Run 1 is not intended to replicate historical hydrology and, therefore, Run 1 simulation results (e.g., streamflows, diversions, and reservoir operations) should not be expected to exactly match recorded historical high flows, low flows, flood volumes or flow rates, or other significant hydrologic events that occurred at a particular time during the study period. Rather, based on the assumption that the variability of historical naturalized flows is representative of the expected variability of recent naturalized flows, Run 1 provides an estimate of how 2010 demands and operations would have affected water rights yields and streamflows given historical water availability (i.e., naturalized flows). This common approach to river basin modeling provides a representation of ongoing water system operations under variable naturalized streamflow conditions and provides a basis for identifying the impacts associated with the proposed NISP and HSWSPs. For specialized resource analyses, their current conditions are based upon the Run 1 monthly results, which are disaggregated to daily flow values for the period 1980 to 2005 (see daily disaggregation).

CWCWD. Central Weld County Water District.

Daily disaggregation. A process by which historical daily flow patterns are applied to modeled monthly volumetric streamflows to develop modeling estimates of daily streamflows that reflect the range and variability of historical daily streamflows.

Daily Maximum Temperature (DM). The highest 2-hour average water temperature measured by a continuous recorder during a given 24-hour period. This is determined using a rolling 2-hour maximum temperature. For example, if the recorder collects data every 15 minutes, a 2-hour maximum can be determined on every data point after the initial 2 hours of collection.

Dead pool. The lowest portion of the reservoir, which is below the elevation of the outlet and, therefore, cannot be drained by the outlet works.

Depressional wetland. A hydrogeomorphic class of wetlands evaluated for wetland functions for the EIS. The hydrogeomorphic classification system places an emphasis on geomorphic and hydrologic attributes, rather than using a system that is limited to biotic characteristics. Depressional wetlands occur in topographic depressions. Dominant water sources are precipitation, ground water discharge, and both interflow and overland flow from adjacent uplands. The direction of flow is normally from the surrounding uplands toward the center of the depression. Elevation contours are closed, thus allowing the accumulation of surface water. Depressional wetlands may have any combination of inlets and outlets or lack them completely. Dominant hydrodynamics are vertical fluctuations, primarily seasonal. Depressional wetlands may lose water through intermittent or perennial drainage from an outlet, by

evapotranspiration, and, if they are not receiving ground water discharge, may slowly contribute to ground water.

Detection limits. The lowest quantity of a substance that can be distinguished from the absence of that substance (a blank value) within a stated confidence limit (generally 1%). The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the parameter concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the parameter. The reporting limit (RL) is defined as the minimum value below which data are documented as nondetects or the minimum value of the instrument calibration range. RLs can also be defined as a set multiplier of the MDL. Concentrations between the method detection limit and reporting limit are reported as having estimated concentrations.

Dissolved oxygen. Refers to the level of free noncompound oxygen present in water or other liquids. It is an important parameter in assessing water quality because of its influence on the organisms living within a body of water.

District. Northern Colorado Water Conservancy District.

Dry year firm yield. Firm yield.

Dry year lease. A water right owner leases water to another user during a dry year.

Dry year transfer. A temporary transfer of water for dry year water supply. Also known as temporary transfers, dry year transfers are implemented as part of a water rights option agreement between a lessor and a lessee.

Eaton. Town of Eaton.

Environmental justice. The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

Ephemeral. An ephemeral stream has flowing water only during, and for a short duration after, precipitation events in a typical year. Ephemeral streambeds are located above the water table year-round. Ground water is not a source of water for the stream. Runoff from rainfall is the primary source of water for streamflow.

Epilimnion. The top layer of water in a reservoir (see metalimnion).

Ephemeroptera, Plecoptera, Trichoptera (EPT) taxa. Taxa that are aquatic invertebrates that include mayflies, stoneflies, and caddis flys.

Erie. Town of Erie.

Evans. City of Evans.

Exchange. An agreement between parties where water can be diverted or stored at one point in exchange for an equivalent amount of water being released or bypassed at another point on a river system.

Existing conditional water right. A right to perfect a water right with a certain priority upon completion, with reasonable diligence, of the appropriation upon which the water right is to be based.

Exotic vegetation or wildlife. Plant or animal species not native to a particular location.

FCLWD. Fort Collins-Loveland Water District.

Federal action. An action by a federal agency. Federal actions may include supplying funding for a project, authorizing or permitting a project, or undertaking or sponsoring a project.

Field eligible (for listing in the National Register of Historic Places). Historical or archaeological resources that are recommended by a cultural resource specialist as potentially eligible for listing in the National Register of Historic Places. The recommendation is considered preliminary until review and consultation by the State Historic Preservation Office at which time a determination of eligibility is provided.

Firm supply. Firm yield.

Firm yield. Also firm annual yield or dry-year firm yield. The annual yield that is available during a defined drought period. The defined drought period is the drought period in the hydrologic record developed for hydrologic modeling. For NISP, the defined drought period is 1954, 1955, and 1956.

Flow-related resources. The resources for which the CTP hydrologic modeling was used to determine current conditions and predict impacts associated with the alternatives. The flow-related resources include water quality, stream morphology and sediment transport, alluvial ground water, wetland and riparian resources, and aquatic biological resources.

Fluvial. Found in rivers or streams.

Fort Lupton. City of Fort Lupton.

Fort Morgan. City of Fort Morgan.

Future Conditions Effects. The predicted effects to a resource when considering how a NISP alternative would affect the modeled Future Conditions hydrology (2050 flows with RFFAs and NISP alternatives - Run Series 4).

Future Conditions. CTP hydrologic modeling (Run 2) that uses 1950 to 2005 monthly naturalized streamflows with projected 2050 demands, infrastructure, and operations (including RFFAs that are independent of the proposed NISP and HSWSPs) to estimate 56 years of Poudre River streamflows under a “future conditions” scenario without the proposed NISP and HSWSPs. Based on the assumption that the variability of historical naturalized flows is representative of the expected variability of future naturalized flows, Run 2 provides an estimate of how anticipated future 2050 demands and operations would affect water rights yields and streamflows given a repeat of historical water availability (i.e., naturalized flows). This approach to river basin modeling provides a representation of the impacts of RFFAs under the varied naturalized flow conditions of the recent past and provides a basis for identifying the impacts associated with the proposed NISP and HSWSPs in addition to the impacts of

the RFFAs. For specialized resource analyses, the Run 2 monthly results are disaggregated to daily flow values for the period 1980 to 2005 (see daily disaggregation).

Gaining reach. Stream or river reaches that receive water from an underlying aquifer.

Ground water. Water found underground in porous rock strata and soils.

HEC-RAS. A computer program that models the hydraulics of water flow through natural rivers and other channels. The program is one-dimensional, meaning that there is no direct modeling of the hydraulic effect of cross section shape changes, bends, and other two- and three-dimensional aspects of flow. The program was developed by the Corps to manage the rivers, harbors, and other public works under their jurisdiction; it has found wide acceptance by many others since its public release in 1995.

Hypolimnion. The bottom layer of water in a reservoir (see metalimnion).

Independent utility. A test to determine what constitutes a single and complete project in the Corps regulatory program. A project is considered to have independent utility if it would be constructed absent the construction of other projects in the project area. Portions of a multiphase project that depend upon other phases of the project do not have independent utility. Phases of a project that would be constructed even if the other phases are not built can be considered separate, single, and complete projects with independent utility.

Indirect economic impact. The change in sales, income, or employment within the local region in industries that supply goods and services to directly affected businesses.

Induced impact. The change in sales within the local impact region that result from changes in local household spending of income (on housing, utilities, groceries, etc.) earned in the tourism, construction, and other supporting industries.

Input-output analysis. An analysis of the flows of economic activity between sectors that captures what each sector must purchase from every other sector to produce a dollar's worth of goods or services.

Intermittent. An intermittent stream or drainage has flowing water during certain times of the year, when ground water provides water for streamflow. During dry periods, intermittent streams may not have flowing water. Runoff from rainfall is a supplemental source of water for streamflow.

Junior water right. Water rights that were obtained more recently and, therefore, are junior in priority to older or more senior water rights.

Lafayette. City of Lafayette.

LHWD. Lefthand Water District.

Losing reach. Stream or river reaches that feed water to an underlying aquifer.

LTWD. Little Thompson Water District.

M&I. Municipal and industrial water rights or water uses.

Macroinvertebrate Multimetric Index (MMI). The Colorado MMI was developed for and is used by the Colorado Water Quality Control Division. The MMI is used by the CDPHE to determine aquatic life use attainment in streams.

Mainstem. The Poudre River from the mouth of the Poudre Canyon (approximate downstream limit of the Poudre Canyon where the river transitions from the confinement of the canyon to an unconfined alluvial channel) to the confluence with the South Platte River. The mainstem is about 55 miles long and is the study area for the flow-related resources for the NISP SDEIS.

Maximum contaminant level. The legal threshold limit on the amount of a hazardous substance that is allowed in drinking water under the Safe Drinking Water Act. The limit is usually expressed as a concentration in milligrams or micrograms per liter of water.

Maximum Weekly Average Temperature (MWAT). The largest mathematical mean of multiple, equally spaced, daily temperatures over a 7-day consecutive period, with a minimum of three data points spaced equally through the day. The MWAT is calculated by averaging all temperature data points collected during a calendar day, and then averaging the daily average temperatures for 7 consecutive days. This 7-day averaging period is a rolling average (i.e., on the eighth day, the MWAT is the average of the daily averages of days 2 through 8). The MWAT value reported is the highest of all the rolling 7-day averages throughout the month.

Mesic. Of, characterized by, or adapted to a moderately moist habitat.

Metalimnion. Also referred to as a thermocline, is a thin but distinct middle layer in a reservoir in which temperature changes more rapidly with depth than it does in the layers above or below. Depending largely on season, latitude, and turbulent mixing by wind, thermoclines may be a semipermanent feature of the water body in which they occur or they may form temporarily in response to phenomena such as the radiative heating/cooling of surface water during the day/night. Factors that affect the depth and thickness of a thermocline include seasonal weather variations, latitude, and local environmental conditions.

Method detection limit (MDL). The minimum concentration of a substance that can be measured and reported with 99% confidence that the parameter concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the parameter.

Mitigation measure. A measure taken to avoid, minimize, or compensate for the adverse impacts resulting from an action or activity.

MODSIM. A general purpose simulation model for evaluating the operations of river and reservoir systems including the historical operation and administration of major direct flow and water storage rights.

Moisture regime. Moisture regime refers to the amount of moisture typically in the soil in a given area. For example, areas with aquic moisture regimes (wetlands) are located in depressions or other areas where surface or ground water is abundant in the soil.

Mule deer winter concentration areas. That part of the winter range where densities are at least 200% greater than the surrounding winter range density.

Mule deer winter range. That part of the overall range where 90% of the individuals are located during the average 5 winters out of 10.

National Heritage Areas (NHAs). Designated by Congress as places where natural, cultural, and historic resources combine to form a cohesive nationally important landscape. Through their resources, NHAs tell nationally important stories that celebrate our nation's diverse heritage. NHAs are lived-in landscapes.

National Register of Historic Places (NRHP). A listing of architectural, historical, archaeological, and cultural sites of local, state, or national significance, established by the National Historic Preservation Act of 1966, as amended (NHPA) and maintained by the National Park Service.

Native flows. Historical streamflow levels that are representative of flows prior to any water projects that remove or add water to the river.

Naturalized streamflows. Historical gaged streamflows that are adjusted to remove the influence of human activities such as transbasin imports, ditch and pipeline diversions (including associated return flows), and upstream reservoir operations (storage, releases, and evaporation). In the CTP hydrologic modeling, the naturalized streamflows at the Poudre River at Canyon Mouth near Fort Collins Gage (USGS 06752000, DWR CLAFTCCO) represent the dominant water supply driving the allocation of water in the Poudre River Basin. These naturalized streamflows are disaggregated to 11 upstream tributary basins in the mountainous upper part of the Poudre River Basin and effectively represent precipitation and snowmelt runoff in the absence of human changes to the river system and available water supply at the locations of several mountain reservoirs. The monthly CTP model components are executed using a naturalized flow dataset for the period 1950 to 2005, which assumes the variability of past hydrology is representative of the variability likely to be observed in current and future hydrology. This assumption is consistent with analyses being completed for all water supply projects in Colorado that are undergoing NEPA regulatory review for EISs led by the U.S. Army Corps of Engineers Omaha District.

NCWCD. Northern Colorado Water Conservancy District, also referred to as "District."

New firm yield. A new firm water supply (see firm yield).

New reliable municipal water supply. A new source of water for municipal uses.

No injury rule. Under the doctrine of prior appropriation, junior appropriators may not impair the water rights of senior appropriators. Junior appropriators are also protected from the actions of senior appropriators to the extent that juniors are entitled to the continued maintenance of stream conditions (e.g., timing and rates of flows and water quality) as they existed at the time of the junior appropriation. Should a senior appropriator seek to change the point of diversion, time, place, or purpose of use, steps such as the mitigation of return flows must be taken to ensure that the junior appropriator's ability to divert water is not diminished.

Officially eligible (for listing in the NRHP). Historic or archaeological resources that have an official determination of eligibility from the State Historic Preservation Office.

Overall range. The area that encompasses all known seasonal activity areas within the observed range of a species.

Paleontological resource. A site containing nonhuman life of past geological periods, usually in the form of fossil remains.

Palustrine emergent wetland. A wetland dominated by trees, shrubs, and herbaceous vegetation. May include wet meadows, swamps, bogs, and fens.

Perennial stream. A perennial stream has flowing water year-round during a typical year. The water table is located above the stream bed for most of the year. Ground water is the primary source of water for streamflow. Runoff from rainfall is a supplemental source of water for streamflow.

Periphyton. A complex mixture of algae, cyanobacteria, heterotrophic microbes, and detritus that is attached to submerged surfaces in most aquatic ecosystems. It serves as an important food source for invertebrates and some fish.

Phreatophyte. Any plant species that obtains a significant portion of the water that it needs to survive from the zone of saturation or the capillary fringe above the zone of saturation. These species are found in riparian ecosystems and other areas characterized by shallow ground water, such as bottomlands.

Poudre River study sites. The mainstem of the Poudre River was divided into six representative segments to collect baseline data on aquatic resources, ground water, water quality, stream morphology, and wetland and riparian vegetation. Segment selection was determined based on discussions between the Corps, U.S. Geological Survey, and NISP third-party contractors. Within each segment, study sites considered representative of the aquatic biological resources, riparian vegetation, wetlands, and river geomorphology were selected for intensive data collection and these are referred to as the Poudre River study sites throughout the SDEIS.

Prior appropriation. The water law doctrine that confers priority to use water from natural streams based upon when the water rights were acquired. Water rights in Colorado and other western states are confirmed by court decree; holders of senior rights have the first claim to withdraw water over holders who have filed later claims (also called junior water rights).

Priority of water right. The ranking of a water right vis-à-vis all other water rights drawing on the stream system.

Priority system. The priority system was established when Colorado was still a territory to solve disputes over ownership and water use. The system prioritizes water use based upon who used water first. Those who put water to beneficial use first retain the senior right to continue using that water before newer users. When there is not enough water to satisfy all of the water users, the junior, or most recent user, must curtail or forego use until senior rights are fulfilled.

Project area. The counties and drainage basins in which the Participants are located.

Project concept. For purposes of the NISP EIS, a source of potential water supplies able to meet a substantial portion of the NISP Participants' requests. Concepts include such things as construction of new reservoirs, new water rights, transfer of agricultural water rights, and use of existing reservoirs or enlargement of existing reservoirs. Concepts were used to develop potential alternatives for the EIS.

Project element. For purposes of the NISP EIS, a project element is a specific structure such as the Glade Reservoir, a specific water right, or a specific gravel pit. Elements were used to develop potential alternatives for the EIS.

Pronghorn severe winter range. Winter range where 90% of the individuals are located when the annual snowpack is at its maximum and/or temperatures are at a minimum in the 2 worst winters out of 10.

Pronghorn winter concentration area. Winter range where pronghorn densities are at least 200% greater than the surrounding winter range density.

Qualitative. A form of assessment that analyzes the impacts in a descriptive manner (e.g., low, moderate, or high).

Quantitative. A form of impact assessment that analyzes the impacts using numerical metrics (e.g., acres or cfs).

Quota. The portion of the C-BT that a shareholder (or allottee) is entitled to in a given year.

Recreational visit. A measurement used to count visitors. One recreational visit is equal to one person participating in any recreational activity during a visit to a recreation area. This includes activities such as sightseeing, touring, and driving, and is not directly related to any specific period.

Reophilic. A species preferring or living in flowing water, typically in swiftly flowing water (e.g., inhabiting riffles in streams and rivers).

Reporting limit (RL). The minimum value below which data are documented as non-detects or the minimum value of the instrument calibration range. RLs can also be defined as a set multiplier of the MDL (i.e., 3xMDL). Concentrations between the MDL and RL are reported as having estimated concentrations.

Return flow. Water that returns to streams and rivers after it has been applied to beneficial use. Return flows may return as surface flow or as an inflow of tributary ground water.

Reusable return flow. Return flows that the owner of a water right has the right to reuse.

Reverse osmosis. The process where a solvent (water) is passed through a semipermeable membrane that retains solutes (impurities) on one side and allows the pure solvent to pass through using the application of pressure. This process is used to purify water.

Riparian. Areas along creeks or streams and between the aquatic and terrestrial environment.

Riverine wetland. A hydrogeomorphic class of wetlands evaluated for wetland functions for the EIS. The hydrogeomorphic classification system places an emphasis on geomorphic and hydrologic

attributes, rather than using a system that is limited to biotic characteristics. Riverine wetlands occur in floodplains and riparian corridors in association with stream channels. Dominant water sources are often overbank flow from the channel or subsurface hydraulic connections between the stream channel and wetlands. However, sources may be interflow and return flow from adjacent uplands, occasional overland flow from adjacent uplands, tributary inflow, and precipitation.

Secondary economic impact. The change in economic activity that results from subsequent rounds of respending tourism dollars or direct road construction expenditures. Secondary impacts may be further divided into indirect or induced impacts.

Section 404 permit. An authorization granted by the Corps under Section 404 of the Clean Water Act to place dredge or fill material in a water of the U.S.

Sedimentation. The transport of sediment into a water body.

Senior water right. Under the prior appropriation doctrine, water rights are allocated on a "first in time, first in right" basis. That is, the first person in time to put water to a beneficial use is granted the earliest priority water right. The early appropriations are referred to as "Senior Water Rights." A senior water right has an early appropriation date (usually in the late-1800s), a lower administration number, and priority relative to other water rights. The lower the priority, the more senior the water right. In the Poudre River Basin, senior water rights are those with water district priorities lower than 97 (which corresponds to the North Poudre Canal 614 cfs right, with an appropriation date of February 1, 1880, and administration number 18989, according to SPDSS memos documenting District 3 and NPIC).

Simple average. The arithmetic mean, or average, of a set of quantities.

Slump. A shifting in the ground, often caused by water intrusion on a steep slope.

Special status species. Federally listed threatened and endangered species; species listed by the CPW as Colorado state threatened, endangered, and other species of concern; and species ranked as rare, vulnerable, or imperiled in the state by the Colorado Natural Heritage Program (CNHP).

Specific conductance. Measure of the ability of a water to conduct an electrical current, expressed in micromhos per centimeter at 25°C.

Spells analysis. This analysis combines elements of the flow duration analysis and flood frequency analysis. It is different than a flow duration analysis in that the spells analysis considers individual flow events rather than combining them. The spells analysis is different from a flood frequency analysis in that the spells analysis considers the duration of individual flood events, not just their occurrence. The spells analysis was used in the assessment of effects to stream morphology and riparian vegetation.

Storage right. A storage right is a type of water right that is measured in terms of volume. Storage rights allow a water user to store water for later beneficial use.

Storage-to-yield ratio. The storage-to-yield ratio is the relationship between the amount of storage necessary to provide for a given amount of firm yield.

Structural diversity. The diversity of heights and growth forms of vegetation in a stand. Also includes standing and fallen dead vegetation.

Supply limited. A supply limited river is one where the sediment in transport is limited by the sediment delivered to the river from the adjacent watershed.

Surface water. Water that flows on the surface, either in streams or as surface runoff across the ground.

SWSI (Statewide Water Supply Initiative). A study commissioned by the Colorado Water Conservation Board to quantify current and future water demand and supply to evaluate options for water management including conservation. This effort focused on Yampa/White/Green, Colorado, Gunnison, Dolores/San Juan, Rio Grande, Arkansas, South Platte, and North Platte River Basins.

Take (as defined by Colorado Statute 33). To acquire possession of wildlife; but such term shall not include the accidental wounding or killing of wildlife by a motor vehicle, vessel, or train. "Possession" means either actual or constructive possession of, or any control over, the object referred to.

Take (as defined by the ESA). To harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct; may include significant habitat modification or degradation if it kills or injures wildlife by significantly impairing essential behavioral patterns including breeding, feeding, or sheltering.

Total dissolved solids (TDS). Combined content of all inorganic and organic substances contained in a liquid that are present in a molecular, ionized, or microgranular form. Primary sources of TDS are agricultural run-off, leaching of soil contamination, and point-source water pollution discharge from industrial or sewage treatment plants.

Total water delivery. The amount of water that must be delivered to meet a Participant's water need.

Total water requirement. The total water required to meet a Participant's (or municipality or user) water need, including potable and nonpotable water. The total water requirement may be larger than the total water demand because it includes estimates of some of the system losses and other variables.

Trajectory. As used in the SDEIS, trajectory refers to a path or long-term trend for a resource or group of resources, including the historic response of the resource to the environment over time. In the SDEIS, trajectory or trend is most frequently used to describe the projected path for channel morphology, sediment transport, and wetland and riparian resources associated with the mainstem of the Poudre River.

Transbasin/transmountain diversion. A transbasin diversion is the removal of water from one river basin and delivery of that water to another river basin. A transmountain diversion is the removal and transport of water across the Continental Divide. These water diversions are 100% consumptive since no water from the diversion will return to the basin of origin's waters as return flow.

Transfer. The sale and/or purchase of a water right.

Transport limited. A transport or capacity limited river is one where the sediment in transport is limited by the hydraulic capacity of the stream to transport the sediment delivered to the river.

Tri-Districts. A collective of three water districts including the FCLWD, the East Larimer County Water District (ELCO), and the North Weld County Water District (NWCWD).

Two–dimensional (2-D) modeling. A 2-D depth averaged finite element hydrodynamic model that has been customized for fish habitat evaluation studies. For the CTP and the NISP SDEIS, supplemental 2-D data of fish habitat information was collected in 2009 at six Poudre River study sites along the mainstem to replace the 1-D (1-dimensional data collection) fish habitat information used in the NISP DEIS. The 2-D fish habitat modeling simulates and represents habitat for specific segments of a river that represent different sections with similar flow, channel characteristics, and biological conditions within the segments. This was done in response to comments on the NISP DEIS and to be consistent with data available on the North Fork.

Unappropriated water. Water that has not been placed in beneficial use by being diverted, stored, or captured.

Upland. Hills, plains, mesas, or other areas not in riparian or wetland areas, and where the vegetation is not supplied by hydrology from a stream or drainage.

Vegetation encroachment. The establishment of vegetation in portions of the historical active channel that were previously unvegetated. The establishment of vegetation in areas of the formerly active channel can contribute to aggradation and channel contraction.

Vegetation type. A plant community with immediately distinguishable characteristics based upon and named after the apparent dominant plant species.

Visual resources. The visible physical features on a landscape (e.g., topography, water, vegetation, animals, structures, and other features) that comprise the scenery of the area.

Water delivery. The amount of water delivered to a water user.

Water demand. The amount of water that municipalities or regions require for everyday functioning.

Water requirement. The amount of water required to achieve a specific delivery goal. Water requirements include system losses and evaporation, and generally are larger than the delivery goal. Water requirements are based on, but may not be equal to use, demand, and delivery goals.

Water right. A right to use, in accordance with its priority, a portion of the waters of the state by reason of the appropriation of the same.

Water use benchmark. Metrics of water use benchmarks are used to compare a community or water user's water use with another representative community or standard.

Waters of the U.S. As defined in the Clean Water Act, all waters that are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters that are subject to the ebb and flow of the tide. This also includes all interstate waters and interstate wetlands. The term also includes all other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation, or destruction of which could affect interstate or foreign commerce.

Wetland functions. The normal activities or actions that occur in wetland ecosystems. Wetland functions result directly from the characteristics of a wetland ecosystem and the surrounding landscape and their interaction.

Wetland. Area near the margin between water and land (such as swamps and marshes) that is wet enough to support plant growth typically found in saturated soil conditions. The Corps and EPA define wetlands as "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas" (33 CFR 328.3(b)).

White-tailed deer concentration area. Corridors of riparian habitat that support higher populations of white-tailed deer, serve as travel corridors, and are considered critical habitat for white-tailed deer.

Windy Gap Firming Project (WGFP). A project operated by the District that collects and stores water on the western slope and delivers it to the Windy Gap project participants.

Yield. The amount of water that a water right supplies under a defined scenario.

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