DRAFT

Draft Integrated Feasibility Report & Environmental Impact Statement

Rahway River Basin, New Jersey Flood Risk Management Feasibility Study

November 2016

New Jersey Department of Environmental Protection

U.S. Army Corps of Engineers New York District

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EXECUTIVE SUMMARY

This Draft Integrated Feasibility Report and Environmental Impact Statement is for the Rahway River Basin, New Jersey, Flood Risk Management Feasibility Study. The Rahway River Basin is located in northeastern New Jersey. It lies within the metropolitan area of Greater New York City and occupies approximately 15 percent of Essex County, 35 percent of Union County, and 10 percent of Middlesex County. The roughly crescent shaped basin is 83.3 square miles (53,300 acres) in area.

The Rahway River system consists of the Rahway River and four branches. The West Branch flows south from West Orange through South Mountain Reservation and downtown Millburn. The East Branch also originates in West Orange and Montclair and travels through South Orange and Maplewood. These two branches converge near Route 78 in Springfield to form the mainstem of the Rahway River. The Rahway River flows through the municipalities of Springfield, Union, Cranford and Clark before traveling through the City of Rahway. The Rahway River receives the waters of Robinson's Branch and the South Branch in the City of Rahway before it enters the city limits of Linden and Carteret. The Rahway River then flows into the Arthur Kill, which connects Newark Bay with the Raritan and Lower Bays of the New York and New Jersey Harbor.

Problem

The problem this study addresses is fluvial flooding within the Rahway River Basin, which is caused principally by rainfall during storm events. The problem is exacerbated by impervious surface coverage caused by development in the area, resulting in a large increase of stormwater runoff into the Rahway River and its tributaries. The increased runoff coupled with inadequate channel capacities and bridge openings account for most of the flooding problems. Flooding causes negative impacts to life safety and critical infrastructure. Flooded local routes have the potential to block or delay emergency response teams in the area as well as impacting critical infrastructure and facilities. The Cranford First Aid Squad ambulance facility located at 6 Centennial Avenue in Cranford has suffered prior flood damage, notably and most recently from Tropical Storm Irene, from which it was forced to renovate the facility. Measures to reduce flood damages have been sought by local interests for many years

Floods that caused significant damage in the Rahway River Basin are the floods of July 1938, May 1968, August 1971, August 1973, November 1977, January 1979, December 1983, September 1989, June 1992, October 1996, July 1997, Tropical Storm Floyd in September 1999, the April 2007 nor'easter, and Tropical Storm Irene in August 2011. A more comprehensive listing can be found in Section 2.2.1.

Tropical Storm Floyd
Rainfall totals from Tropical Storm Floyd in September 1999 were as high as 12 to 16 inches over portions of New Jersey. Tropical Storm Floyd resulted in new flood peaks of record at sixty or more stream gages within the portions of New Jersey and New York contained by New York District's Civil Works boundaries. Within the Rahway River basin, the total rainfall at Cranford, NJ was 10.82 inches. This resulted in flows approaching the 1% annual chance exceedance flood in portions of the Rahway River Basin.

15-16 April 2007 Nor'easter
The April 2007 nor'easter caused about three to ten inches of rain to fall on the watersheds within the New York District's Civil Works boundaries in April 2007, resulting in new flood peaks of record at ten USGS gages in New Jersey. Within the Rahway River basin, the total rainfall at Cranford was 6.47 inches. This resulted in flows from greater than the 4% annual chance exceedane to 2% annual chance exceedance flood levels in portions of the Rahway River Basin.

Tropical Storm Irene
Significant damages occurred in north and central New Jersey, where flooding was widespread. Severe flooding took place on the Raritan, Millstone, Rockaway, Rahway, Delaware and Passaic Rivers due to record rainfall. The flooding effected roads and ten deaths within the state are attributable to the storm.

The Rahway River Watershed Mayors' Council, a local stakeholder group, made a statement reporting that Tropical Storm Irene impacted 1,600 structures in Cranford, with 300 structures receiving damage to the main floor, and $16.5 million in damages to residences, plus $4 million in damages to two schools. The Mayors' Council statement also indicated that damages totaling $15 million were incurred to 412 structures in Union Township, and that damages totaling $8 million were experienced by more than 80 homes in Springfield Township during Tropical Storm Irene.

In addition to major flooding, the combination of already heavily saturated ground from a wet summer, and heavy wind gusts made New Jersey especially vulnerable to wind damage. One of the hardest hit areas due to high winds was Union County, part of the Rahway River Basin. Fallen trees, many pushed from the soaked ground with their roots attached, blocked vital roads from being accessed by local emergency services. Numerous homes suffered structural damages from the winds, and limbs impacting their roofs. Perhaps the most critical damage however due to wind was fallen wires. Around Union County, fallen wires in combination with flooded electrical substations left parts of Union County, including Cranford, Garwood, and Westfield without power or phone service for nearly a week. In total, approximately 1.46 million customers throughout most of the 21 counties lost power. On 29 August, the governor of New Jersey asked President Obama to expedite release of emergency funds to the state. Eventually all 21 counties became eligible for FEMA aid.

Opportunity

There is an opportunity to reduce the risk of fluvial flooding in the study area through implementation of one or more flood risk management measures. The greatest opportunities for flood risk management lie within the Township of Cranford and the Robinson's Branch in the City of Rahway, two areas within the basin that experienced regular flooding in past storm events.

In 2006 an initial screening of flood damages within the Rahway River Basin led to the identification of the Township of Cranford and the Robinson's Branch in the City of Rahway as two areas within the basin that experienced regular significant flood damages during storm events. As a result of this initial screening and coordination with the non-Federal sponsor and local stakeholders, the main focus of the ongoing study has been on fluvial flooding within Cranford and the Robinson's Branch areas. Additionally, following Tropical Storm Irene in 2011, USACE added the investigation of potential flood storage opportunities upstream of the Township of Cranford that would benefit not only the Township but other municipalities as well.

This Feasibility Study plan formulation considered a range of nonstructural and structural measures to reduce the risk of storm damage in the study area. Through an iterative planning process, potential flood risk management measures were identified, evaluated, and screened. Those remaining were developed into numbered flood risk management alternatives. Based on an evaluation of the costs and benefits of the alternatives, including potential environmental impacts, a plan was identified as the Tentatively Selected Plan (TSP).

The TSP consists of different project elements for the Township of Cranford and the City of Rahway. The alternative that maximized net benefits for each independent reach was selected as an element of the TSP. For Cranford, the TSP elements, identified as Cranford/Upstream Alternative 4a below, consists of channel modifications in the township and outlet modifications at Orange Reservoir, providing flood risk management for Cranford, Millburn and Springfield. For the City of Rahway, the TSP element, identified as Robinson's Branch Alternative 2a below, consists of nonstructural measures for select structures in the 10% annual chance exceedance floodplain. This method is predicated upon the fact that the Cranford and upstream detention areas are geographically and hydrologically separate from the Robinson's Branch. Cranford/Upstream Alternative 4a and Robinson's Branch Alternative 2a are separate incrementally justified elements of the TSP and together maximize net benefits. Please refer to the following section for a more detailed explanation and related information on the TSP.

Project Area

The Rahway River Basin project area lies in portions of Essex, Middlesex and Union Counties in NJ. The project area lies in sections of the Townships of Cranford and West Orange and the City of Rahway. The project area is within the study area and is the area in which the flood risk management project would be constructed.

TENTATIVELY SELECTED PLAN FEATURES

Township of Cranford/Upstream

The TSP consists of project elements in three different areas, the first of which consists of outlet modification to the Orange Reservoir Dam. This provides flood risk management to communities downstream of the dam by allowing water levels in Orange Reservoir to be efficiently drawn down prior to a storm event, creating storage for flood waters in the reservoir. These municipalities consist of Cranford, Millburn, Springfield and Union. The second TSP element consists of channel modification in the Township of Cranford, allowing flood waters to more effectively pass through the damage area. The modifications to the Orange Reservoir Dam and the channel in Cranford collectively provide flood risk management to Cranford. The flow detention capacity of the Orange Reservoir will mitigate the increase in downstream flow caused by deepening and widening the channel in Cranford.

The plan includes two additional 36 in. diameter outlet pipes at the Orange Reservoir dam and controlled outflow two days prior to a storm event. The required drawdown is approximately 15 ft., from a maximum depth of about 30 ft. to a depth of about 15 ft. This plan requires little to no dredging in the reservoir. The dam is approximately 130 years old and will require upgrades to meet USACE dam safety standards.

The channel element of the TSP consists of approximately 8,930 ft of channel modification. The proposed channel modification starts in the vicinity of the footbridge by Nomahegan Park and ends approximately 650 ft. downstream of South Ave. E. The slope is approximately 2.6 ft./mile with a maximum deepening of about 1.9 ft. in the vicinity Hansel Dam. The new trapezoidal channel will consist of a natural channel bed with a 35 to 45 ft. bottom width and side slopes of one vertical on two and a half horizontal (1:2.5). There is some riprap material in a small segment of the river near the Eastman Ave. Bridge at McConnell Park. No dam or bridge removal in the project area is required aside from the potential replacement of the Orange Reservoir dam.

The Orange Reservoir outlet and channel modifications are designed to provide flood risk management for the 4% annual chance exceedance flood (25-yr event) in the Township of Cranford.

City of Rahway/Robinson's Branch

The third element of the TSP consists of nonstructural measures for 21 structures within the 10% annual chance exceedance (10-yr event) floodplain in the Robinson's Branch area. Measures include dry and wet floodproofing, ring walls, elevation and buyouts. Structures within the 10% annual chance exceedance floodplain will be treated to an elevation of one foot above the 1% annual chance exceedance flood event (100-yr event).

Revisions and optimization[1] of the TSP will take place prior to release of the final report. Figure 1 below illustrates the project areas where the TSP elemements are located.

Project Implementation Cost Assumptions

Costs for those alternatives involving modification of the Lenape Park and Orange Reservoir dams include full replacement costs in order to assure that those structures meet USACE dam safety regulations. These costs are included as this study does not include geotechnical borings and dam break analysis of the structures. In addition, costs for those alternatives involving modification of the Lenape Park and Orange Reservoir dams include the creation of a 50 ft no-vegetation buffer from any portion of a dam in order to assure that those structures meet USACE dam safety regulations. Temporary full drawdown of Orange Reservoir would be required during construction.

[1] Optimization determines the scale of the TSP that provides the greatest economic net benefits in terms of flood risk management. This would involve formulating different TSP sizes and analyzing those plans. The version of the plan where net benefits are maximized would become the plan recommended for implementation, if warranted.

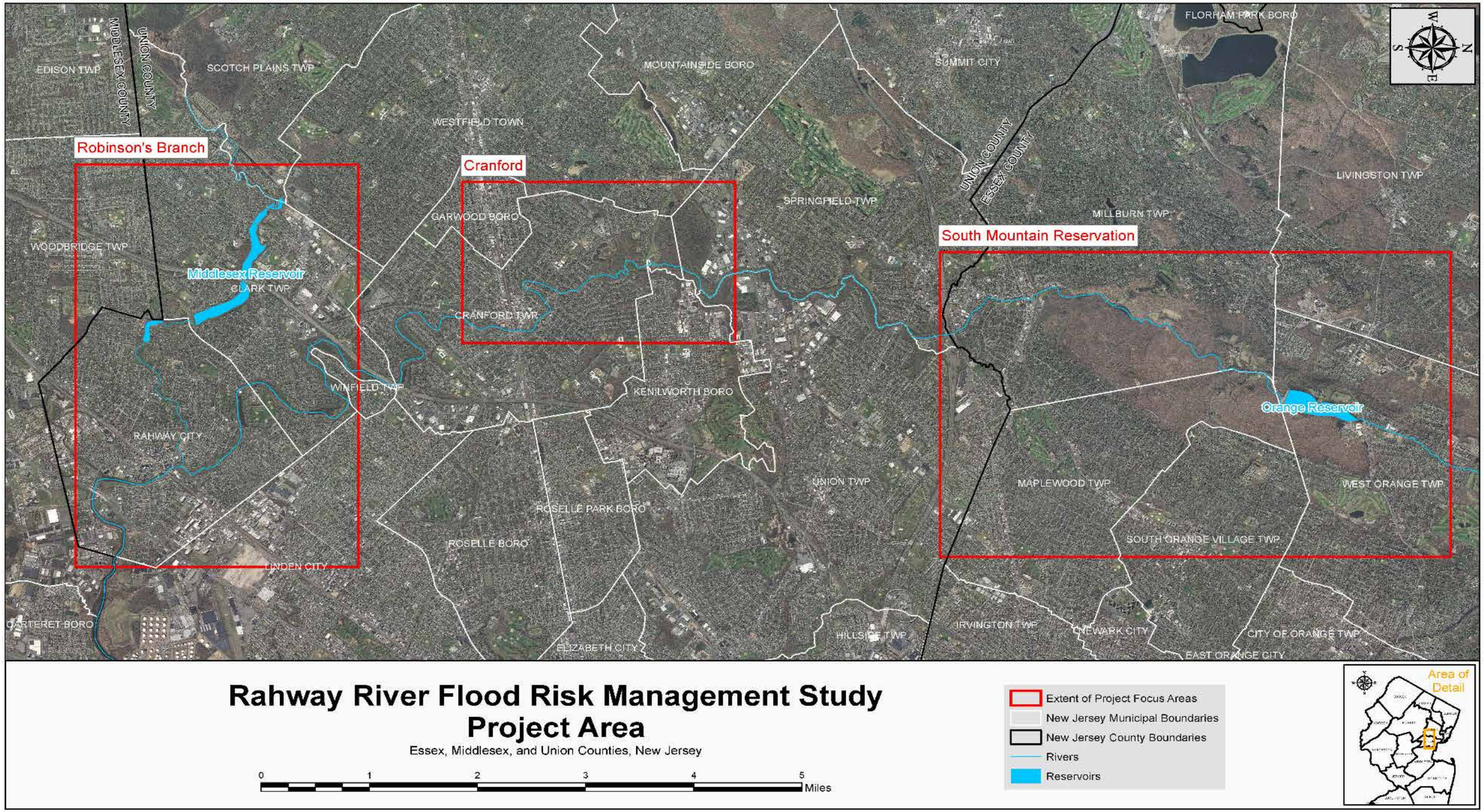

Figure 1. Rahway River Basin Project Areas

The TSP will result in the permanent impact of approximately 1.09 acres of upland forest, 0.13 acres of forested wetland, 8,390 linear feet of the Rahway River, and 15.35 acres of riparian habitat. Additionally, the TSP will have unavoidable impacts to cultural resources, recreational resources and some wildlife habitats. These impacts are related to the specific locations of the proposed project of which is necessary to achieve the flood risk management objectives associated with the TSP. Indiana bat, a Federally endangered species, and northern long-eared bat, a Federally threatened species, have been identified as potentially occurring with the project area. With the implementation of the mitigation measures identified in Table 1, no significant long term adverse impacts to environmental, biological and socioeconomic resources are expected.

Table 1: Summary of Mitigation Measures

Land Use · Most of the construction activity will occur within the existing channel which will help minimize impacts to adjacent land uses. Temporary workspaces along the top of channel will generally be limited to a 15ft clearance from the channel bank. · Disturbed areas will be restored and their use returned to pre-construction land uses.
Soils · Implementation of Erosion and Sediment Control Best Management Practices (BMPs) during construction, including the installation of cofferdams to construct the channel modifications in the Township of Cranford. · Stabilization of the bottom and side slopes of Orange Reservoir while it is drawn down during dam replacement. · Installation of approximately 800 linear ft of riprap along the east (left) bank of the Rahway River along McConnell Park.
Water Resources · Implementation of Erosion and Sediment Control Best Management Practices (BMPs) during construction, including the installation of cofferdams to construct the channel modificaitons in the Township of Cranford. · Mitigation measures specific to the Orange Reservoir pre-construction drawdown: o Performing a slow drawdown of the reservoir prior to construction to minimize erosion and sedimentation downstream of the reservoir; o Stabilizing the Orange Reservoir shoreline and bed with grass seed; o Excavating a channel within the reservoir to maintain flow of the Rahway River through the reservoir; and o Allowing vegetation to grow along the channel to provide shade in order to minimize thermal impacts and eutrophication. · Mitigation measures to be evaluated during optimization for the channel modification in Township of Cranford: o Constructing from one side of bank with preference to preserving vegetation on the western bank to optimize thermal impact reduction. o Constructing the channel in a manner that contains baseflows, maintains velocities to sustain maintain transport. o Restoring the existing substrate by stockpiling the gravel/cobble substrate excavated from the channel during construction and re-installing it once grading is completed.

o Riparian zone re-establishment with native herbaceous, shrub and tree species
Wetlands Compensation of 0.13 acres of forested wetland will be assessed during the PED phase and will include the evaluation of: · Purchase of wetland mitigation credits at a 1:1 mitigation ratio from a NJDEP approved wetland mitigation bank; · Wetland restoration/creation at 2:1 mitigation ratio; or · Wetland enhancement at 3:1 mitigation ratio.
Vegetation · Compensation of 1.09 acres of upland vegetation through either 1:1 creation/restoration or forest enhancement of areas that have been damaged through herbivory. · Compensation of approximately 15.35 acres of riparian zone removal through on-site replanting and potential off –site riparian zone enhancement, restoration or creation. · Use of more mature tree stock to reduce maturation time.
Aquatic Resources and Wildlife · Tree and shrub clearing restriction from 15 March through 30 July to comply with the Migratory Bird Treaty Act · Re-establishment of native herbaceous, shrub and tree species in disturbed areas and in mitigation sites. · Mitigation measures specific to the pre-construction drawdown of the Orange Reservoir Dam: o Conducting a fish salvage will occur prior to drawdown o The drawdown of the Orange Reservoir Dam drawdown for full replacement will occur from mid-September to October to minimize adverse impacts to fish o Completion of drawdown by November 1 to minimize impacts to amphibian and reptile species. · Mitigation specific to the channel modification in the Township of Cranford: o Restoration of existing substrate. o Creation of pools and riffle complexes. o Applying the proposed riprap along Eastman Avenue in a manner that provides foraging and resting habitat for fish and aquatic macroinvertebrates.
Federal and State Endangered, Threatened and Special Concern Species · Implementation of a tree clearing restriction from 1 April through 30 September to protect roosting bat species. · Include tree species used by bats for summer roosting in mitigation plans.
Cultural Resources · The project is expected to have an adverse impact on historic properties, however, additional investigation is required to determine what properties will be impacted. A Programmatic Agreement has been developed for the project that outlines the steps that will be taken to determine adverse effects and the appropriate mitigation measures in consultation with interested parties (see Appendix A). Some mitigation measures to be considered include HABS/HAER documentation of historic structures, archaeological data collection, replacing or providing substitute resources, monitoring during construction, and enhancement of historic districts through signage and public outreach.
Recreation

· Planting native herbaceous, shrubs and trees within the parks after construction. · Erecting temporary fences and other physical barriers to control movement through construction areas and maintain a safe distance for pedestrians. · Installing signage that informs residents and others using the effected recreational spaces of the proposed actions' purpose and closure duration. · Constructing the channel modifications in a manner that maintains water depths to support canoeing/kayaking.
Aesthetics and Scenic Resources · Stabilization of the side slopes and bottom of the Orange Reservoir with grass during construction. · Replanting disturbed areas with native herbaceous, shrub and tree material after construction.
Transportation · Preparation of a Construction Traffic Management Plan. · Routing and scheduling construction vehicles to minimize conflicts with other traffic. · Strategically locating localized staging areas to minimize traffic impacts. · Establishing detours and alternate routes when it is important to close the work area to perform certain construction tasks or when diverting traffic will substantially reduce traffic volumes.
Air Quality · Because the air emissions are below de minimis levels for NOx, VOC, PM2.5 and SO2, no specific mitigation is required. Construction will be performed in compliance with current New Jersey Air Pollution Control requirements (N.J.A.C. 7:27-1-34).
Noise · Construction will occur within the timeframes allowed as per local noise ordinances.

The non-Federal project partner for the study is the New Jersey Department of Environmental Protection (NJDEP). The non-Federal sponsor for project implementation has not been identified at this point in the study, but would be required for project implementation.

PERTINENT DATA

TENTATIVELY SELECTED PLAN FEATURES

Township of Cranford/Upstream

- Outlet modifications consisting of two additional pipes to the Orange Reservoir Dam and controlled outflow two days prior to a storm event provides flood risk management to communities downstream of the dam by allowing water levels in Orange Reservoir to be efficiently drawn down prior to a storm event, creating storage for flood waters in the reservoir. These municipalities consist of Cranford, Millburn, Springfield and Union.
- The second TSP element consists of channel modification in the Township of Cranford, allowing flood waters to more effectively pass through the damage area.
- The modifications to the Orange Reservoir Dam and the channel in Cranford collectively provide flood risk management to Cranford. The flow detention capacity of the Orange Reservoir will mitigate the increase in downstream flow caused by deepening and widening the channel in Cranford.
- The Orange Reservoir outlet and channel modifications are designed to provide flood risk management for the 4% annual chance exceedance flood (25-yr event) in the Township of Cranford.

City of Rahway/Robinson's Branch

- This element of the TSP consists of nonstructural measures for 21 structures within the 10% annual chance exceedance (10-yr event) floodplain in the Robinson's Branch area.
- Measures include dry and wet floodproofing, ring walls, elevation and buyouts.
- Structures within the 10% annual chance exceedance floodplain will be treated to an elevation of one foot above the 1% annual chance exceedance flood event (100-yr event).

Revisions and optimization[2] of the TSP will take place prior to release of the final report. Figure 1 below illustrates the project areas where the TSP elemements are located.

Project Implementation Cost Assumptions

Costs for those alternatives involving modification of the Lenape Park and Orange Reservoir dams include full replacement costs in order to assure that those structures meet USACE dam safety regulations. These costs are included as this study does not include geotechnical borings and dam break analysis of the structures. In addition, costs for those alternatives involving modification of the Lenape Park and Orange Reservoir dams include the creation of a 50 ft no-vegetation buffer from any portion of a dam in order to assure

[2] Optimization determines the scale of the TSP that provides the greatest economic net benefits in terms of flood risk management. This would involve formulating different TSP sizes and analyzing those plans. The version of the plan where net benefits are maximized would become the plan recommended for implementation, if warranted.

that those structures meet USACE dam safety regulations. Temporary full drawdown of Orange Reservoir would be required during construction.

Construction Method: Initial construction of the outlet modifications to Orange Reservoir and the channel modifications in the Township of Cranford are estimated to take from the middle of March 2020 until July 2023. Initial construction of the nonstructural measures along the Robinson's Branch are estimated to take place from March 2020 to December 2020. Construction years are assumed for the economics evaluation in this study, but are subject to report approval scheduled March 2018, acquisition of necessary real estate, project approval and funding requirements, including Federal and non-Federal funds. An average of approximately $27 million in total funding would be required per construction year to meet the construction schedule.

Real Estate Requirements. USACE projects require the non-Federal sponsor provide lands, easements, rights-of-way and relocations, and disposal/borrow areas (LERRDs) for a project. Currently, the TSP will require the non-Federal sponsor to acquire temporary and permanent easements for construction. Details are provided in Appendix E (Real Estate Plan).

PROJECT COST

The costs were developed using the Micro-Computer Aided Cost Estimating System (MCACES), Second Generation (MII) program. The MII cost estimate used RSMeans, MII Cost Libraries, and vendor quotations. The project contingencies were developed through the Abbreviated Risk Analysis (ARA) tool provided by the USACE Mandatory Center of Expertise (cost). The summary of the results of this risk analysis, and more detail on the cost estimate, can be viewed in Appendix D (Cost Engineering).

The project cost estimate is broken out by cost component in Table 2. This includes planning, engineering and design, construction management, interest during construction and operation and maintenance (contingencies are included). The TSP Total Project Cost for Cranford/Upstream Alternative 4a and Robinson's Branch Alternative 2a are $78,157,000 and $10,997,000 respectively. This cost is 65% federally funded and 35% non-federally funded in accordance with the Water Resources Development Act of 1986. Costs in Table 2 will be updated to Fiscal Year (FY) 2017 price levels prior to finalization of the report.

Table 2. TSP Refined Cost Estimate*
(FY16 Price Level, 3.125 % discount rate)

Account/Cost Component	Cranford/ Upstream Alternative 4a	Robinson's Branch Alternative 2a
Total Project Cost		
01 – Lands and Damages	$2,947,000	$526,000
03 – Reservoirs	$55,362,000	$0
06 – Fish & Wildlife Facilities	$6,206,000	$0
09 – Channels & Canals	$2,428,000	$0
18 – Cultural Resource Preservation	$1,768,000	$1,661,000
19 – Buildings, Grounds & Utilities	$0	$7,811,000
30 – Planning, Engineering & Design	$5,694,000	$517,000
31 – Construction Management	$3,752,000	$482,000
Estimated Total Project Cost	**$78,157,000**	**$10,997,000**

*Note: These costs will be revised by further project evaluation, agency reviews, and optimization as the study progresses.

Operation, maintenance, repair, rehabilitation, and replacement (OMRR&R) requirements are considered in the economic analysis for the project. The non-Federal sponsor is responsible for 100% of requirements after receipt of the project. This consists of periodic project inspection and maintenance. The OMRR&R cost is estimated at $258,000/year. All of this cost is for Cranford/Upstream Alternative 4a.

ECONOMIC ANALYSIS

The Costs and Benefits of the TSP are provided in Table 3. Projects costs are annualized over a 50-year period of analysis at the Fiscal Year 2016 (FY16) Federal interest rate for evaluation water resource projects (3.125%). Dividing the annual benefit of the project by the annual cost estimate results in an estimated Benefit-Cost Ratio of 1.4.

Table 3. Refined TSP, Annual Benefit and Cost Summary*

	Cranford Upstream Alternative 4a	Robinson's Branch Alternative 2a	Combined TSP
First Cost	$69,570,000	$10,018,400	$79,588,400
Interest During Construction	$3,790,400	$103,500	$3,893,900
Total Investment Cost	$73,360,400	$10,121,900	$83,482,300
Annual Investment Cost	$2,919,200	$402,800	$3,322,000
Annual O&M	$258,000	$0	$258,000
Annual Cost	$3,177,200	$402,800	$3,580,000
Annual Without Project Damages	$9,773,600	$2,695,800	$12,469,400
Annual With Project Damages	$6,070,300	$1,339,900	$7,410,200
Annual Benefits	$3,703,300	$1,355,900	$5,059,200
Annual Net Benefits	$526,100	$953,100	$1,479,200
Benefit Cost Ratio	1.2	3.4	1.4

(FY16 Price Level, 3.125 % discount rate) *Note: The Benefit-Cost Ratio will be revised by further project evaluation, agency reviews, and optimization as the study progresses.

FEDERAL AND NON-FEDERAL PROJECT COST SHARING

In accordance with the cost share provisions in Section 103 of the Water Resources Development Act (WRDA) of 1986, as amended (33 U.S.C. 2213), project design and implementation are cost shared 65% Federal and 35% non-Federal. The estimated Total Project Cost is $89,154,000, cost-shared $57,950,100 Federal and $31,203,900 non-Federal.

Table 4. Cost Apportionment Table

	Federal	Non-Federal	Total
Initial Project Cost	$57,950,100	$31,203,900	$89,154,000
Real Estate Credit		$3,473,000	$3,473,000
Cash Contribution		$27,730,900	$27,730,900
Total	$57,950,100	$31,203,900	$89,154,000

The non-Federal sponsor is responsible for providing all lands, easements and rights-of-way as part of their portion of the cost-share, in this case estimated at $3,473,000. This can be seen in Table 4 and in combination with the $27,730,900, make up the non-Federal portion of a total of $31,203,900. Further information on real estate can be found in Appendix E – Real Estate Plan.

Rahway River Basin, New Jersey
Flood Risk Management Feasibility Study

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LIST OF ACRONYMS

Acronym	Title
APE	Area of Potential Effect
BCR	Benefit Cost Ratio
CCC	Civilian Conservation Corps
CERCLIS	Comprehensive Environmental Response, Compensation and Liability Information System
CEQ	Council of Environmental Quality
CNJ	Central Railroad of New Jersey
DIFR/EIS	Draft Integrated Feasibility Report and Environmental Impact Statement
District	United States Army Corps of Engineers, New York District
EIS	Environmental Impact Statement
EPA RBP	Environmental Protection Agency, Rapid Bioassessment Protocol
ESA	Endangered Species Act
ETL	Engineering Technical Letter
FHACA	Flood Hazard Area Control Act
HTRW	Hazardous, Toxic and Radioactive Waste
KCS	Known Contaminated Site
LERRDs	Lands, Easements, Rights of Way, Relocations and Disposal/Borrow Areas
LUSTs	Leaking Underground Storage Tanks
MBTA	Migratory Bird Treaty Act
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
N.J.A.C	New Jersey Administrative Code
NJDEP	New Jersey Department of Environmental Protection
NJDEP BFBM	New Jersey Department of Environmental Protection, Bureau of Freshwater and Biological Monitoring
NJDEP DLUR	New Jersey Department of Environmental Protection, Division of Land Use Regulation
NJDFW	New Jersey Division of Fish and Wildlife
NJSM	New Jersey State Museum
NJSHPO	New Jersey Historic Preservation Office
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NRL	National Register
NWI	National Wetlands Inventory
P&G	Principles & Guidelines
PM	Particulate Matter
RCRA	Resources Conservation and Recovery Act
TSP	Tentatively Selected Plan

USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
WPA	Works Progress Administration
WRDA	Water Resources Development Act

Chapter 1.0 Introduction

1.1 Draft Integrated Feasibility Report and Environmental Impact Statement

The U.S. Army Corps of Engineers (USACE), New York District (District), and the non-Federal sponsor, the NJDEP, prepared this Draft Integrated Feasibility Report and Environmental Impact Statement (DIFR/EIS) for the Rahway River Basin, New Jersey, Flood Risk Management Feasibility Study. This report presents the Tentatively Selected Plan (TSP) for managing flood risk within the Rahway River Basin, New Jersey. The Rahway River Basin is located in portions of Essex, Middlesex and Union Counties. Over the course of the review process, the report will be updated to include input from the NJDEP, as well as local governments, resource agencies, and the public.

The Federal objective of water and related land resources project planning is to contribute to national economic development (NED) consistent with managing and reducing risk to the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements (Principles and Guidelines (P&G), 1983).

Water and related land resources projects are formulated to alleviate problems and take advantage of opportunities in ways that contribute to this objective. Pursuant to this, the DIFR/EIS (1) summarizes the problems, needs, and opportunities for flood risk management in the Rahway River Basin; (2) presents and discusses the results of the plan formulation for flood risk management; (3) identifies specific details of the Tentatively Selected Plan, including inherent risks; (4) and will be used to assist in determining the extent of the Federal interest and local support for the plan.

This DIFR/EIS is being released for concurrent public and agency technical review. USACE has evaluated an array of structural and nonstructural alternatives including levees, floodwalls, channel modifications, structure elevation, flood proofing and buyouts for the identification of the TSP. The TSP will be refined based on comments from public and agency review. It will contain additional feasibility level optimization for the Final Integrated Feasibility Report and environmental analysis conducted for and presented in the Environmental Impact Statement (EIS).

1.2 National Environmental Policy Act Requirements

This Draft Integrated Feasibility Report and Environmental Impact Statement (DIFR/EIS) was prepared pursuant to the National Environmental Policy Act (NEPA), the Council on Environmental Quality's (CEQ) Guidance Regarding NEPA Regulations, and the USACE's Procedures for Implementing NEPA (Engineering Regulation [ER]-200-2-2).

NEPA requires the USACE to integrate environmental values into their decision making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. Federal regulations to implement NEPA are found

in Title 40 Code of Federal Regulations (CFR) Parts 1500-1508. The intent of NEPA is to ensure that information is made available to public officials and citizens about major actions taken by Federal agencies, and to identify and consider public concerns and issues. "*Any environmental document in compliance with NEPA may be combined with any other agency document to reduce duplication and paperwork*" (40 CFR §1506.4). This draft report integrates discussions into the feasibility report that normally would appear in a Final Environmental Impact Statement (FEIS) in the feasibility report. The purpose of an EIS is to aid a Federal agency's compliance with NEPA.

This DIFR/EIS must discuss:

- the need for the proposed action;
- the proposed action and alternatives;
- the probable environmental impacts of the proposed action and alternatives;
- and the agencies and persons consulted during preparation of the DIFR/EIS.

This integrated report is consistent with NEPA statutory requirements. The report reflects an integrated planning process, which avoids, minimizes, and mitigates adverse project effects associated with coastal storm risk management actions. Sections of text marked with an asterisk are applicable to the satisfaction of National Environmental Policy Act (NEPA) requirements.

1.3 Study Purpose

The purpose of the study is to determine if there is a technically feasible, economically justified and environmentally acceptable recommendation for Federal participation in flood risk management for the Rahway River Basin study area in New Jersey. The study will evaluate potential solutions to the frequent fluvial flooding problems within the Rahway River Basin and assess the Federal interest in participating in flood risk management plans. If warranted, the study will identify and recommend a plan in coordination with the NJDEP. The Feasibility Report is intended to constitute a final response to the study authority.

1.4 Study Authority

The study was authorized in a resolution of the Committee on Transportation and Infrastructure of the U.S. House of Representatives. The Rahway River Basin resolution was dated 24 March 1998.

"Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That, the Secretary of the Army review the report of the Chief of Engineers on the Rahway River, New Jersey, published as House Document 67, 89th Congress, and other pertinent reports to determine whether any modifications of the recommendations contained therein are advisable at the present time, in the interest of water resources development, including flood control, environmental restoration and protection and other related purposes."

Additional Study Guidelines. The USACE Headquarters (HQUSACE) and Major Subordinate Command (MSC) have indicated that tidal flooding within the lower portion

of the Rahway River Basin, most recently from Hurricane Sandy (2012), is to be investigated in a separate coastal storm risk management study from this fluvial flood risk management study.

1.5 Non-Federal Sponsor

The Rahway River Reconnaissance Report (905b), dated July 1999, recommended a comprehensive basin-wide study to further examine flood risk management and ecosystem restoration measures in the Rahway River Basin.

Based on the recommendation and approval of the Reconnaissance Report, a Feasibility Cost Sharing Agreement (FCSA) was executed in March 2002 with the New Jersey Department of Environmental Protection (NJDEP) as the non-Federal sponsor. The study is cost shared 50% Federal and 50% non-Federal. The FCSA included the entire basin as the study area.

The NJDEP indicated during the course of the study the need to focus on the flood risk management component of the feasibility study.

1.6 Prior Studies, Reports, and Existing Water Projects

Many USACE reports have been produced for the Rahway River Basin. The three reports listed below are most significant with regard to the evolution of this study and its focus on fluvial flooding.

Robinson's Branch of the Rahway River, Flood Control Study, General Reevaluation Report (GRR), July 1985

This GRR recommended a plan consisting of levees/floodwalls and channel modifications along the Rahway River and Robinson's Branch in the City of Rahway to provide flood risk management for the 1% annual chance of exceedance event. This project did not advance to construction due to lack of funding.

Section 905(b) Reconnaissance Study, Rahway & Woodbridge River Basins, July 1999

The purpose of the 905(b) Reconnaissance Study was to determine if Federal interest for flood risk management existed in the Rahway River Basin, beyond the geographic scope evaluated for the Robinson's Branch GRR. The Draft Reconnaissance Report summarized eleven prior reports completed within the basin since 1962. Two potential projects with positive benefit-cost ratios (BCRs) were also identified in the Draft Reconnaissance Study. The first project was a system of levees, floodwalls, channel modifications, and interior drainage improvements along the Robinson's Branch, previously documented in the GRR referenced above. The second project located along the South Branch in the Township of Woodbridge, entailed regrading the parking lot of a shopping center as an overland flow route. The shopping center has since been replaced by a new commercial development with flood proofing; therefore, this project did not advance to construction due to lack of sufficient damages in the project area necessary for economic justification of the project.

Rahway River Feasibility Study, Initial Screening of Flood Damage Reduction and Restoration Opportunities, September 2006

This report evaluated potential solutions to frequent flooding problems within the Rahway River Basin. The objectives of the report were three-fold:

- To make a basin-wide assessment of flood risk management and environmental restoration needs within the Rahway River Basin;
- To provide an initial screening of Federal interest in flood damage risk management and environmental restoration opportunities; and
- To recommend flood risk management and environmental restoration projects for more detailed study as part of an overall Feasibility Study.

The existing flood risk management and environmental restoration needs were assessed by reviewing prior reports, evaluating flood damage claims filed under the Federal Emergency Management Agency's National Flood Insurance Program, site visits, and discussing flooding concerns with local officials.

The identified flood problem areas underwent a screening to determine which areas should be considered for Federal participation. The criteria for Federal participation included minimum stream discharges, minimum drainage area sizes, and an assessment of previously constructed flood risk management projects within the basin. A preliminary economic analysis was conducted for the flood risk management measures that passed the screening process in order to determine whether a damage area had the potential for economic justification. The without-project damages were estimated using the flood damage analysis model Hyrdrologic Engineering Center – Flood Damage Analysis (HEC-FDA), and likely economic feasibility was determined by comparing project costs to the without-project damages. It was anticipated during this initial screening that actual benefit-cost ratios would be calculated if the recommended projects were studied in greater detail.

The initial screening of flood risk management opportunities identified one flood risk management project with strong potential for economic feasibility within the Rahway River Basin. The project consists of levees, floodwalls, and channel modifications along the Robinson's Branch in the City of Rahway and would have strong likely Federal interest. This project is the same as the one discussed above in the 1985 GRR and the 1999 Reconnaissance Study. A second potential flood risk management project was identified along the Rahway main stem in the Township of Cranford. Although this community currently has the Lenape Park Regional Stormwater Detention Basin and a series of low level levees, the level of flood risk management has been estimated at or below the 2% annual chance of exceedance.

It was recommended that these two potential flood risk management projects be analyzed in greater detail as part of an overall Feasibility Study and that a benefit-cost analysis be performed. The Rahway River Basin, New Jersey feasibility efforts focused analysis on the Town of Cranford and the City of Rahway following the initial screening report.

Federal Projects. A system of levees and pump stations for flood risk management was constructed by USACE in 1974 within the City of Rahway, New Jersey. The project area is located along the right (west) bank of the Rahway River between Monroe Street and Hazelwood Avenue. The project is maintained by the New Jersey State Department of Environmental Protection. This project does not protect the Robinson's Branch area in the City of Rahway discussed in this report. Existing and future projects by USACE and other entities are summarized in Tables 5 to 7.

Identification of these actions were completed through best practice research, the NEPA scoping process and coordination with study stakeholders. In addition, Union County is in the process of updating their Hazard Mitigation Plan (HMP) and has posted the Draft HMP on their website (http://ucnj.org/public-safety/2015-hazard-mitigation-plan-update/). The plan identifies flood risk management measures each municipality has undertaken, is in the process of implementing or will be implementing. For the purposes of the cumulative impact analysis, the actions identified in the Union County Hazard Mitigation Plan are herein incorporated by reference.

Table 5. Existing and Future USACE Actions Within the Rahway River Watershed

Project Name	Description	Location	Status
East Branch Levees	Earthen levees along the east branch Rahway River	South Orange, Essex County	Constructed in 1974.
Levee System	Levees along the right bank of the main Stem Rahway River	City of Rahway, Union County	Constructed in 1966.
Rahway Tidal Coastal Storm Risk Management Feasibility Study	Evaluation of coastal storm risk management measures.	City of Rahway Linden and Town ship of Woodbridge, Union County	Feasibility Study in progress, completion scheduled 2018.
Medwick Tidal Marsh Mitigation Site	Restoration of 15 acres of tidal wetland as mitigation for impacts related to the New York/New Jersey Harbor Deepening	Medwick Park, City of Rahway, Union County	Completed in 2007.
Hudson-Raritan Estuary Restoration Study	Identification and evaluation of potential ecosystem restoration sites within the Hudson-Raritan Estuary watershed.	Hudson-Raritan Estuary, New York and New Jersey. Numerous sites are within the Arthur Kill, which the Rahway River drains into.	Feasibility Study in progress, completion scheduled 2018.

Table 6. Existing/Future Flood Risk Management Projects by Others

Project Name	Description	Location	Responsible Entity	Status
Lenape Park Dam	Dam and 900 ft of embankments within Lenape Park	Springfield and the Township of Cranford, Union County	Union County	Constructed in 1983
Nomahegan Park Levees	Levees, primarily along the left bank of Rahway River	Township of Cranford, Union County	Union County	Unknown
Single Family Home Raising	17 homes raised	Riverside Drive, Township of Cranford, Union County	Federal Emergency Management Agency (FEMA)	Completed 2013
Home Buyout	Acquisition and removal of home within floodplain	1 home in City of Rahway	New Jersey, Blue Acres Program	Agreement signed May 2016.

Table 7. Other Actions Within the Rahway River Basin

Project Name	Type	Description	Location	Responsible Entity	Status
East Branch Rahway River Stream and Wetland Restoration	Ecosystem Restoration	Riparian and wetland restoration within USACE channel modification project.	South Orange, Essex County	City of South Orange	2011
Diamond Mills Pond Repair	Dam rehabilitation	Installation of articulated concrete block, replacement of spillway and 36” sluice gate to control water level.	South Mountain Reservation Millburn Tw Essex County	Essex County	Completed 2012
1,000 Rain Gardens Initiative	Stormwater Management	Installation of rain gardens on public and private properties.	Rahway Watershed	Mayors Council; Association of New Jersey Environmental Commissions	Ongoing
Cranford Municipal Rain Garden	Stormwater Management	Installation of rain garden	Cranford, Union County	Township of Township of Cranford	Completed 2014
Kiwanis Park Rain Gardens/Stormwater Management	Stormwater Management	Installation of rain garden/vegetation	City of Rahway, Union County	City of Rahway	Completed 2015
Fish Ladder at Rahway River Dam	Ecosystem Restoration	Installation of fish ladder to improve fish passage at Rahway River Dam	City of Rahway, Union County	Environmental Protection Agency	Feasibility Report completed in March 2006, has not been implemented.
Fish Ladder at Milton Lake	Ecosystem Restoration	Installation of fish ladder to improve fish passage in Robinson’s Branch	City of Rahway, Union County	Unknown	Unknown

1.7 Study Area

The Rahway River Basin is located in northeastern New Jersey (Figure 1). It lies within the metropolitan area of Greater New York City and occupies approximately 15 percent of Essex County, 35 percent of Union County, and 10 percent of Middlesex County. The basin is 83.3 square miles (53,300 acres) in area and is roughly crescent-shaped. Its greatest width is approximately 10 miles in the east-west direction, from the City of Linden to the City of Plainfield. Its greatest length is approximately 18 miles in a north–south direction, from West Orange to Metuchen.

The Rahway River consists of the mainstem Rahway River and four branches. The West Branch flows south from West Orange through South Mountain Reservation and downtown Millburn. The East Branch also originates in West Orange and Montclair and travels through South Orange and Maplewood. These two branches converge near Route 78 in Springfield to form the mainstem of the Rahway River. The Rahway River flows through the municipalities of Springfield, Union, Cranford and Clark before traveling through the City of Rahway. The Rahway River receives the waters of Robinson's Branch at Elizabeth Avenue between West Grand Avenue and West Main Street and the waters of the South Branch at East Hazelwood Avenue and Leesville Avenue before it leaves the City of Rahway and enters the city limits of Linden and Carteret. The Rahway River then flows into the Arthur Kill.

The study area lies within the 10th Congressional District, which is currently represented by Donald Payne (D-NJ). Figures 2 below illustrates the basin and study area.

Tidal and Fluvial Flooding

The lower portion of the study area is tidally influenced. Following Hurricane Sandy in October 2012, and the passage of Disaster Relief Appropriations Act of 2013, a separate study focusing on tidal flooding in the Rahway River Basin was initiated by separating coastal storm risk management from this existing and ongoing fluvial flood risk management study.

The majority of the tidal and fluvial flood areas in the basin are independent of each other regarding the type of flood risk. Tidal flooding occurs in the City of Rahway and surrounding municipalities but is limited to the lower portion of the basin and does not extend to the Township of Cranford and upstream areas due to changes in elevation and the presence of dams on the Rahway River.

The City of Rahway is effected by both types of flooding. As part of the existing conditions analysis a fluvial and tidal correlation analysis was conducted. The results of that analysis demonstrated a weak correlation between fluvial and tidal (coastal) events. A fluvial alternative will not eliminate the risk of flooding due to a coastal event. Joint Probability flood stage frequency curves were developed for the City of Rahway and all points downstream.

Project Area

Background

At the beginning of the feasibility study, an assessment of the entire basin took place for the purpose of identifying all flood risk management problems and opportunities in the Rahway River Basin (see Figure 2). The Initial Screening Report (2006) documented this assessment, and recommended further investigation in the Township of Cranford and the City of Rahway along the Robinson's Branch, two areas within the basin that experienced regular flooding for past storm events. Due to this initial screening, and through coordination with the non-Federal sponsor and local stakeholders, the main focus of the ongoing study had been on fluvial flooding within the Township of Cranford and the City of Rahway.

After Tropical Storm Irene in August 2011, local stakeholders requested that USACE investigate potential flood storage opportunities outside/upstream of the Township of Cranford that would benefit not only Cranford but other municipalities as well. Two of the areas analyzed for storage developed were the existing Orange Reservoir in the City of Orange and a proposed dry detention basin in South Mountain Reservation along the West Branch of Rahway River. The Project Delivery Team (PDT) had previously identified and analyzed several alternatives for the Township of Cranford but further revised and developed the upstream alternatives based on the request from the local stakeholders.

Project Area Description

Figure 3 shows the projects areas in relation to each other, with the Orange Reservoir project area upstream on the West Branch, followed by the Cranford and Robinson's Branch project areas on the Rahway River.

Specifically, the project area encompasses the Rahway River in Essex and Union Counties and a two mile segment of Robinson's Branch as it nears the confluence of the Rahway River in the City of Rahway. The project area is composed of several regions: 1) the South Mountain Reservation, an Essex County Park, and the Orange Reservoir, owned by the City of Orange; 2) the Township of Cranford portion which includes a three mile segment of the main stem Rahway River from Union County owned Nomahegan and Lenape Parks to Lincoln Avenue; and 3) the City of Rahway portion consisting of a two mile segment of the Robinson's Branch from the Middlesex Reservoir to its confluence with the Rahway River.

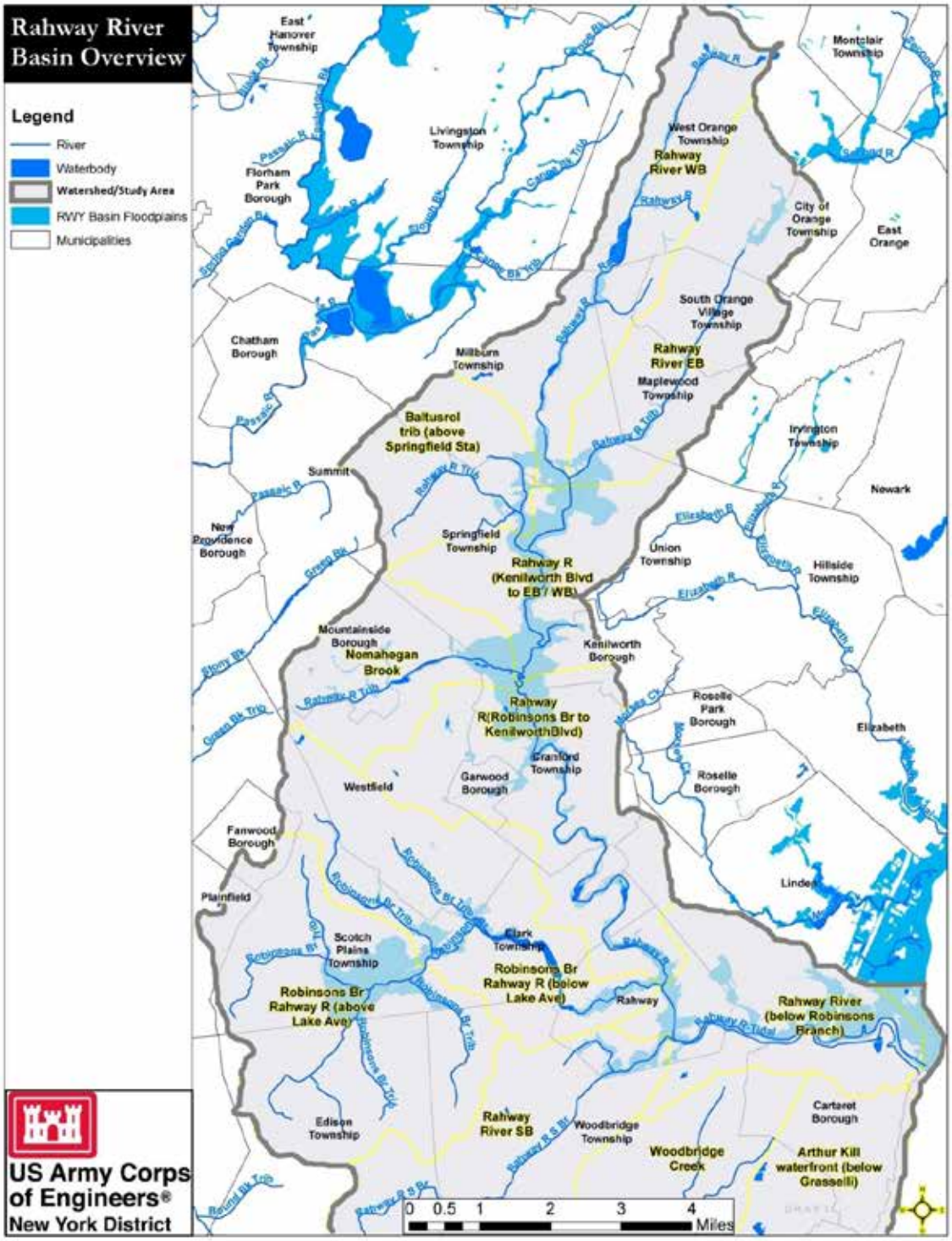

Figure 2. Rahway River Basin/Study Area

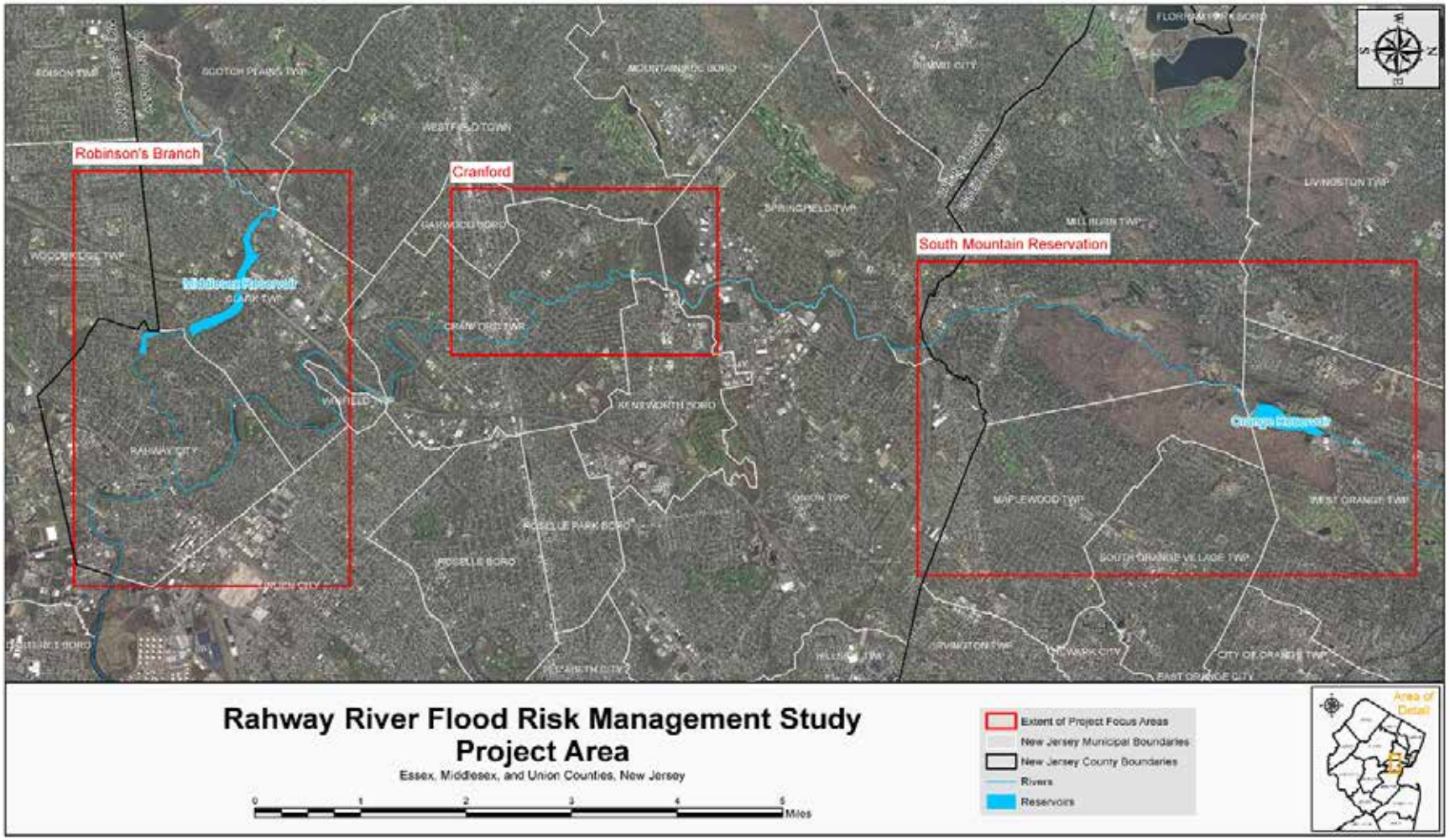

Figure 3. Rahway River Basin Project Areas

1.8 Areas of Controversy*[3]

Members of the public have had opportunities to comment on the development of study alternatives via public information meetings, a formal NEPA scoping period and through study updates electronically mailed to interested parties and posted on the study's webpage. In addition, NJDEP as the non-Federal sponsor, and representatives from municipalities within the project area and Essex and Union Counties have been fully involved in study alternative discussions and public meetings throughout the entire plan formulation process. The USACE also coordinated with representatives from the NJDEP Division of Land Use Regulation, the NJDEP Green Acres Program and the U.S. Fish and Wildlife Service during the plan formulation process.

The public and agency coordination process identified three areas of controversy. The first area of controversy was related to two alternatives that proposed constructing a large dry detention dam within the South Mountain Reservation. The South Mountain Reservation is encumbered under the New Jersey Green Acres law. Coordination with the NJDEP Green Acres Program staff indicated that under the law, an application for a change in use to Green Acres property not related to recreation or open space would be required and could be denied if it was determined that the affected area is irreplaceable for which no compensation would be sufficient for the loss or change. Furthermore, it was determined that it would likely not be possible to achieve the compensation requirements for such a change in use. In addition, public input yielded significant concerns regarding the level of tree removal (approximately 65 acres) and potential significant adverse impact to the aesthetics and character of the Reservation. Ultimately, the two alternatives associated with the dry detention dam within the South Mountain Reservation were removed from consideration due to public and agency concerns and the minimally estimated compensation as well as construction costs that caused the alternative to be economically unjustified.

The second area of controversy involved the proposed removal of the Hansel Dam. Public and stakeholder feedback expressed concern with how the removal of the dam would impact the ability of residents to utilize the river for water dependent recreational activities such as canoeing/kayaking, fishing and ice skating. Based on public stakeholder feedback, alternatives were analyzed with the inclusion of the Hansel Dam.

The third area of controversy is related to the USACE Dam Safety requirement for a 50 ft vegetation free zone as described in Engineering Technical Letter (ETL) 1110-2-583 *Guidelines for Landscape Planting and Vegetation Management at Levees, Embankment Dams and Appurtenant Structures.* Within the 50 ft vegetation free zone, only maintained and approved grasses are permitted. The 50 ft vegetation free zone requirement affects flood risk management alternatives that involved the modifications of the Orange Reservoir, the Lenape Park dam and the Middlesex Reservoir.

Coordination with the USACE Dam Safety Center of Expertise verified that the vegetation free zone for dams is required to keep the dam and embankment structures clear from root

[3] Sections of text marked with an asterisk are applicable to the satisfaction of National Environmental Policy Act (NEPA) requirements. Refer to Section 1.2.

intrusion so the stability of the structure is not undermined or compromised. In addition, the vegetation free zone is required to provide access for inspection, maintenance and emergency vehicles.

For alternatives involving modification of the Lenape Park dam, the 50 ft vegetation free zone would be applied to both sides of the embankments that extend the length of the park, resulting in a large amount of forested acreage (approximately 34 acres) to be removed within the park. During the NEPA Scoping Period, the USACE received comments from both the public and study stakeholders expressing concern about the adverse environmental impacts related to tree removal and how the tree removal would impact the aesthetics and character of the park.

Additionally, study stakeholders expressed concerns regarding compensation for the adverse environmental impacts associated with the vegetation removal. The extent of the compensation required caused these alternatives to be economically unjustified.

Further, the U.S. Fish and Wildlife Service expressed concern for significant adverse effect to the Federally endangered Indiana bat (*Myotis sodalis*) and northern long-eared bat (*Myotis septentrionalis*) resulting from such extensive tree removal and loss of habitat.

Chapter 2.0 Existing Conditions*

Existing conditions serve as the basis for the characterization of problem identification and projection of future without project conditions. Existing conditions are described in this Chapter (setting, significant storms, and assets at risk) and in Chapter 3 (environmental resources).

2.1 Climate

The climate of the Rahway River basin is characteristic of the Middle Atlantic Seaboard. Marked changes of weather are frequent, particularly during the spring and fall. The winters are moderate in both temperature and snowfall. The summers are moderate, with hot sultry weather in mid-summer and frequent thunderstorms. Rainfall is moderate, and well-distributed throughout the year. The relative humidity is high.

Climate change could cause changes to storm impacts. The most likely scenario for the future without project condition would be the continuation of existing environmental conditions and trends within the study area.

2.1.1 Annual (Daily) and Monthly Precipitation

The mean annual precipitation in the Rahway River Watershed is approximately 50.94 inches reported by the 1971-2000 Monthly Normals for the Cranford, New Jersey Station. The observed highest daily value at this station was 9.76 inches (17 September 1999). The monthly extremes were 13.96 inches in July 1975 and 0.45 inches in November 1976. The distribution of precipitation throughout the years is fairly uniform with highest amount occurring during the summer months. The mean annual snowfall is 20.00 inches at Cranford, New Jersey.

2.2 Storm Types

The storms which occur over the northeastern states have their origins in or near the North Atlantic Ocean and may be classified as: extratropical storms; which include thunderstorms, and cyclonic (transcontinental) storms; and tropical storms which include the West Indies hurricanes. There are also nor'easter storms or extratropical storm, which developed due to rapid convective circulation when a tropical marine air mass is lifted suddenly on contact with hills and mountainous terrain, causes heavy rains usually in the summer and fall season. Thunderstorms, resulting from rapid convective circulation, usually in July, are limited in extent and cause local flooding on flash flood prone streams. A cyclonic storm, due to its transcontinental air mass movement with attendant "highs" and "lows," usually occurs in the winter or early spring, and is a potential flood-producer over large areas because of its widespread extent. The West Indies hurricanes of tropical origin proceed northward along the coastal areas, accompanied by extremely violent winds and torrential rains of several days' duration.

A review of storms which have occurred in the northeastern states reveals that the Rahway River basin is located in the center of the North Atlantic storm belt.

2.2.1 Past Storms/Historical Floods

Some of the notable storms which have caused flood conditions in the basin occurred on or between the following dates: 20-24 September 1882, 30 July 1889, 31 July 1901, 25-26 August 1933, March 1936, 17-25 July 1938, 6-8 August 1938, 17-21 September 1938, 9-16 August 1942, 20 May 1943, 18 September 1945, 28 June 1946, 23-25 July 1946, 8 November 1947, August 1955, October 1955, September 1960, 12-13 March 1962, 21-22 September 1966, 28-29 May 1968, August 1969, 26-28 August 1971, 13 September 1971, 2-3 August 1973, July 1975, November 1977, January 1979, June 1992, October 1996, July 1997, Tropical Storm Floyd in September 1999, 15-16 April 2007, and Tropical Storm Irene in 27-28 August 2011.

The interested reader can find brief descriptions of the following major flood- producing storms in the Rahway River basin presented in the *General Design Memorandum, Robinson's Branch of the Rahway River at Rahway, New Jersey Flood Control Study*, Volume 2, dated February 1986: (November 1977, July 1975, August 1973, August 1971, August 1969, May 1968 and July 1938). Two large, recent storms, and the floods that they produced, were used to calibrate the Hydrologic Engineering Center – Hydrologic Modeling System (HEC-HMS hydrologic model: those of the 15-16 April 2007 Nor-easter, and Tropical Cyclone Irene, 27-28 August 2011. Detailed descriptions of these events are given below. A new flood of record occurred after model calibration for the Cranford portion of the analysis. This was Tropical Storm Irene (8/28/2011). A description of this event is included below.

2.2.2 Tropical Storm Floyd (1999)

The eye of Floyd made landfall on September 15th near Cape Fear, North Carolina with Category 2 winds of 105 mph. After crossing eastern North Carolina and Virginia, Floyd weakened to a tropical storm. Its center then moved offshore along the coasts of the Delmarva Peninsula and New Jersey. On September 16th the center of Tropical Storm Floyd moved over Long Island, New York (making landfall again roughly at the Queens-Nassau counties border) and New England, where it became extratropical.

Precipitation from the storm preceded its center reaching the New York City area on September 15th. Rainfall totals from Floyd were as high as 12 to 16 inches over portions of New Jersey, 4 to 8 inches over southeastern New York, and up to 11 inches over portions of New England. The inland flooding from Floyd was a disaster of immense proportions in the Eastern United States, particularly in North Carolina. The 56 USA direct deaths due to Floyd is the largest hurricane death toll since Agnes caused the deaths of 122 people in 1972. Total USA damage estimates range from three to over six billion dollars.

Floyd resulted in new flood peaks of record at sixty or more stream gages within the portions of New Jersey and New York contained by New York District's civil works boundaries. Within the Rahway River basin, the total rainfall at the Township of Cranford was 10.82 inches. Tropical Storm Floyd produced a peak flow at the Springfield USGS gage of 7990 cfs and a peak flow of 5590 cfs at the City of Rahway USGS gage.

2.2.3 April 15-16, 2007 Nor'easter

The April 15-16, 2007 nor'easter dropped about three to ten inches of rain on the watersheds within the New York – New Jersey metropolitan area between the early morning of Sunday April 15 2007 and the early afternoon of Monday April 16th, 2007, resulting in new flood peaks of record at ten USGS gages in New Jersey. This storm produced the worst flooding in the Raritan River basin since Tropical Storm Floyd during September 1999. Bound Brook and Manville were once again hit hard, as were communities on the other side of the Raritan River in Middlesex County. Lincoln Park in the Passaic Basin was also hit hard.

The approximate time distribution of the total rainfall of the April 15-16, 2007 nor'easter was an average of 7 to 7 ½ inches between about 2 a.m. on Sunday, April 15 to 2 p.m. on Monday, April 16, 2007, with most within the 24 hours beginning at 2 a.m. on Sunday the 15th. Greatest hourly amounts were from 0.6 to 0.8 inches at about 2 p.m. on Sunday, April 15, 2007.

Unlike Tropical Storm Floyd, which broke the summer 1999 drought and fell on dry ground, the April 2007 nor'easter caused as much flooding as it did because it was preceded by the smaller March 1-2 and April 12-13, 2007 storms, which created saturated ground conditions.

Within the Rahway River basin, the total rainfall at the Township of Cranford was 6.47 inches. This nor'easter produced a peak flow at the Springfield USGS gage of 5540 cfs and a peak flow of 4910 cfs at the Rahway USGS gage.

2.2.4 Tropical Storm Irene

On 22 August 2011 Tropical Storm Irene made landfall near Punta Santiago, Humacao, Puerto Rico, with estimated sustained winds of 70 mph. Just after its initial landfall, Irene was upgraded to a Category 1 hurricane, the first of the 2011 Atlantic hurricane season.

Moving erratically through the southeast Bahamas over very warm waters, Irene quickly expanded as its outflow aloft became very well established. The cyclone intensified into a Category 3 major hurricane. Early on 27 August, Irene further weakened to a Category 1 hurricane as it approached the Outer Banks of North Carolina. At 7:30 am EDT the same day, Irene made landfall near Cape Lookout, on North Carolina's Outer Banks, with winds of 85 mph. Later on 27 August, Irene re-emerged into the Atlantic near the southern end of the Chesapeake Bay in Virginia. Shortly before sunrise, at about 09:35 UTC on 28 August, Irene made a second landfall at the Little Egg Inlet on the New Jersey shore with winds of 75 mph, and soon after moved over water again. Hours later, Irene weakened to a tropical storm with winds of 65 mph near New York City. Following its 28 August New York landfall, Irene moved northeast over New England, becoming post-tropical over the state of Maine at 11:00 pm EDT.

Significant damages occurred in North and Central New Jersey, where flooding was widespread. Severe river flooding took place on the Raritan, Millstone, Rockaway, Rahway, Delaware and Passaic Rivers due to record rainfall. The highest rainfall recorded

in New Jersey was in Freehold (11.27 inches), followed by Jefferson (10.54 inches) and Wayne (10 inches). The flooding effected roads, including the heavily used Interstate 287 in Boonton where the northbound shoulder collapsed from the force of the Rockaway River, and the Garden State Parkway (GSP), which flooded in the Township of Cranford from the Rahway River and in Toms River near GSP Exit 98. Along the Hudson River, in parts of Jersey City and Hoboken, flood waters rose as much as five feet and the north tube of the Holland Tunnel was briefly closed. In total, ten deaths within the state are attributable to the storm.

The Rahway River Watershed Mayors' Council, a local stakeholder group, made a statement reporting that Tropical Storm Irene impacted 1,600 structures in Cranford, with 300 structures receiving damage to the main floor, and $16.5 million in damages to residences, plus $4 million in damages to two schools. The Mayors' Council statement also indicated that damages totaling $15 million were incurred to 412 structures in Union Township, and that damages totaling $8 million were experienced by more than 80 homes in Springfield Township during Tropical Storm Irene.

In addition to major flooding, the combination of already heavily saturated ground from a wet summer, and heavy wind gusts made New Jersey especially vulnerable to wind damage. One of the hardest hit areas due to high winds was Union County. Fallen trees, many pushed from the soaked ground with their roots attached, blocked vital roads from being accessed by local emergency services. Numerous homes suffered structural damages from the winds, and limbs impacting their roofs. Perhaps the most critical damage however due to wind was fallen wires. Around Union County, fallen wires in combination with flooded electrical substations left parts of Union County, including Cranford, Garwood, and Westfield without power or phone service for nearly a week. In total, approximately 1.46 million customers throughout 21 counties lost power.

Flow Line Computation

The calibrated Hydrologic Engineering Center – River Analysis System (HEC-RAS) models of the Rahway River were used to determine the present and future, without project conditions water surface elevations (WSEs) for the 0.2, 0.4, 1, 2, 4, 10, 20, 50 and 100% chance of annual exceedance events (1, 2, 5, 10, 25, 50, 100, 250, and 500-yr frequency). Table 8 shows the expected increase in WSEs due to urbanization in the next 50 years for the 4%, 1% and 0.2% annual chance of exceedance events (25, 100 and 500-yr). These results demonstrate a minimal increase in flooding due to urbanization of the basin.

Table 8. Difference in WSEs between present and future without project condition

Town	Location	W/O Project Future Increase in WSEs (ft.)		
		4% (25-yr)	1% (100-yr)	0.2% (500-yr)
Springfield/Millburn	Downstream of I-78	0.20	0.15	0.17
Springfield	Just downstream of Morris Ave. Bridge	0.03	0.12	0.03
Springfield	Upstream of Route 22	0.03	0.08	0.03
Cranford	Lenape Park	0.01	0.03	0.01
Cranford	Kenilworth Area	0.04	0.14	0.04
Cranford	Nomahegan Park	0.04	0.10	0.04
Cranford	Below Nomahegan Park - Footbridge	0.04	0.10	0.04
Cranford (Town)	McConnell Park	0.04	0.11	0.04
Cranford (Town)	Hansel Dam Park - Casino Brook Area	0.05	0.10	0.05
Cranford (Town)	From Union Ave. to North Ave. Bridge	0.02	0.07	0.02
Cranford	South Ave. Bridge	0.10	0.13	0.10
Cranford	Just downstream of Lincoln Ave. Bridge	0.13	0.13	0.13

Figures 4 and 5 illustrate the 0.2, 1 and 10% chance of annual exceedance floodplains for the Township of Cranford and Robinson's Branch areas, respectively.

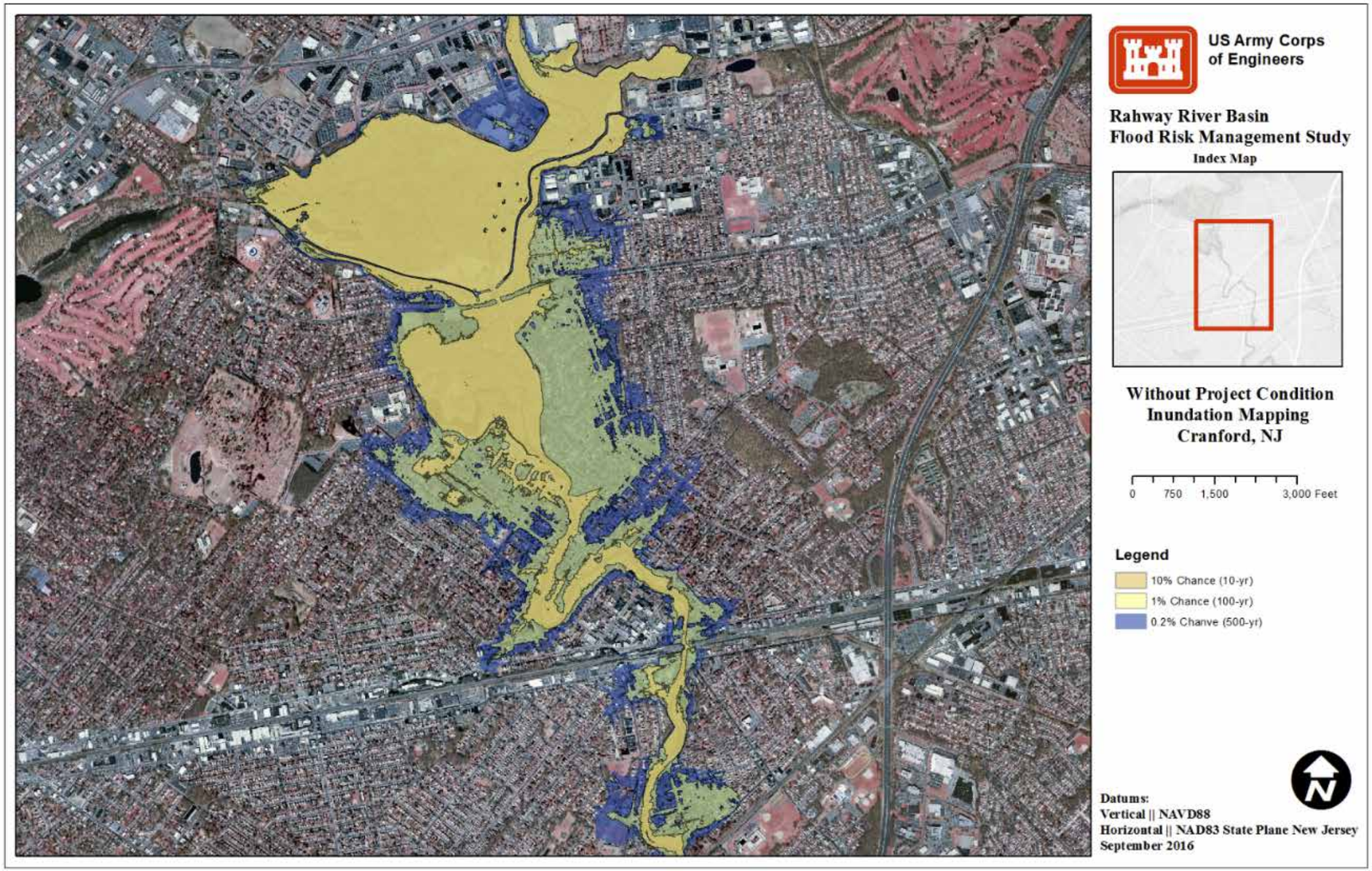

Figure 4. Without Project Condition Inundation Maps in the Township of Cranford

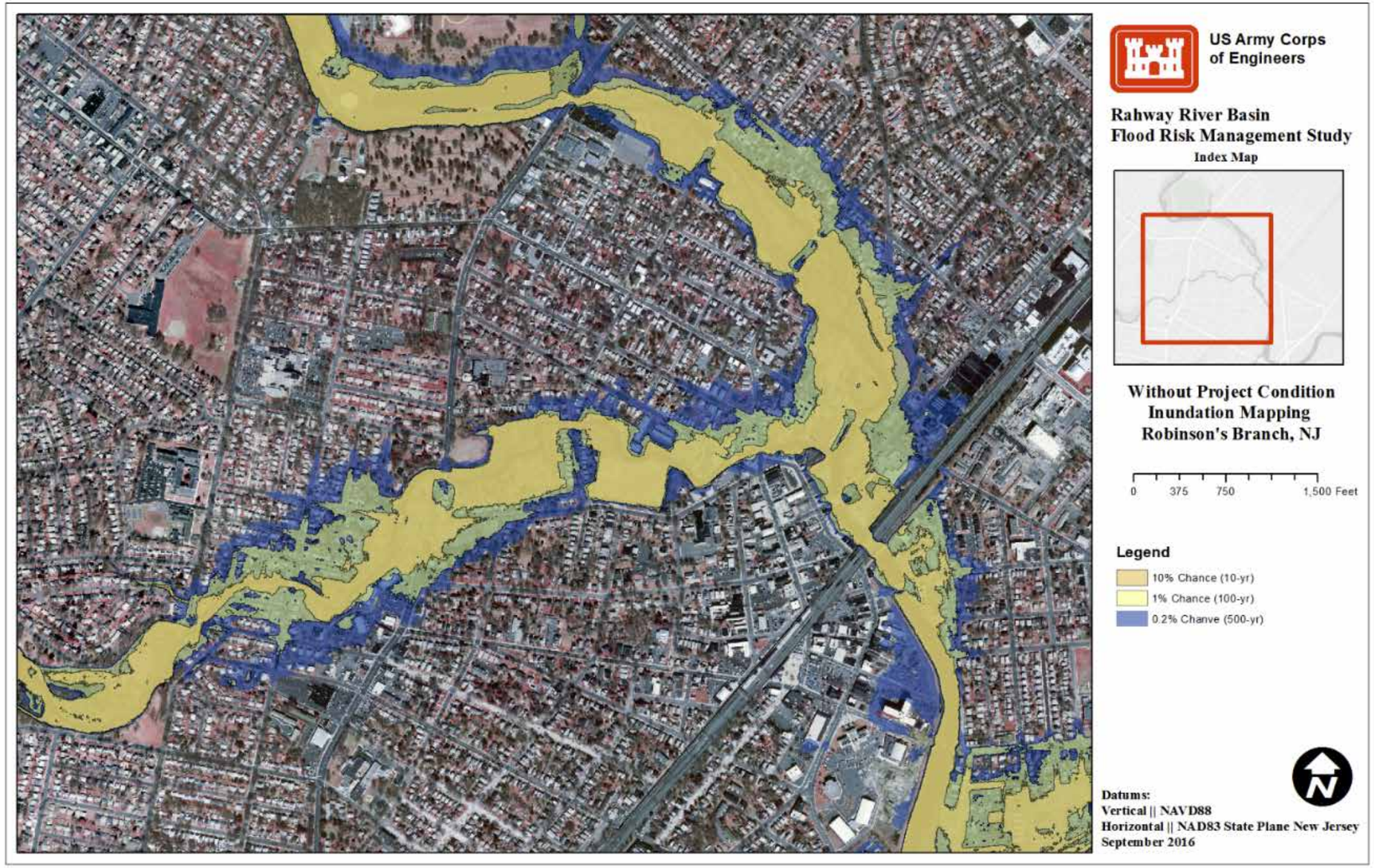

Figure 5. Without Project Condition Inundation Maps in Robinson's Branch

Chapter 3.0 Existing Conditions Affected Environment*

This description of the existing environment conditions is in accordance with the requirements of National Environmental Policy Act (NEPA), and serves as the baseline for Chapter 6: Environmental Effects and Chapter 7: Cumulative Effects of this draft integrated report. Photographs of the project area are located in Appendix F.

3.1 Land Use

Township of Cranford/Upstream

Land use within the northern portion of the project area consists predominantly of the South Mountain Reservation, a 2,047 acre park owned by Essex County located in several municipalities including Maplewood Township, West Orange Township, Millburn Township. The park is bounded by Northfield Avenue to the north, the South Mountain Recreational Complex to the northeast, residential land use on the east and west sides, and urban land use consisting of a mix of residential homes, small businesses and railroad tracks to the south. Land use within the park itself is predominantly recreational, deciduous forests and wetlands (Amy S. Greene Environmental Consultants, Inc., 2007).

County Road 510 bisects South Mountain, and Cherry Lane/Brookside Drive runs through the park in a northerly/southerly direction. Bear Lane and Crest Drive are located on the eastern side of South Mountain and are part of the park infrastructure. Bear Lane leads to the camping sites while Crest Drive is closed to vehicular traffic and mainly serves as a walking and bike path.

Land use in the Township of Cranford consists of parks, lands maintained as open space and predominantly single family homes. Nomahegan and Lenape Parks, owned and operated by Union County, are the two largest parks within the Township of Cranford portion of the project area. Lenape Park lies directly north of Nomahegan Park and is separated from Nomahegan Park by Kenilworth Boulevard. The majority of Lenape Park is forested and mostly used for passive recreation. Lenape Park also serves as a detention basin for flood risk management purposes; the County constructed a dam and levees in 1983 as a means to reduce flooding within the area. A system of levees was also constructed in Nomahegan Park for flood risk management purposes.

City of Rahway/Robinson's Branch

Land use within the Robinson's Branch portion of the project area consists of predominantly residential and business land uses, with several open space/parks, including Kiwanis Park, the Union County Arts Center Park and Milton Lake Park.

3.2 Topography, Geology and Soils

3.2.1 Geology and Topography

The study area is located within the Piedmont Physiographic Provence. The Piedmont Provence is described as gently rolling plains, 200 to 400 ft above sea level, and includes the crescent-shaped Watchung Mountains ranging between 450 to 900 ft above sea level. The underlying geology is mainly shale with siltstones and sandstones occurring infrequently, with the mountains being composed of basalt flows. Glacial deposits overlie

the surface throughout the Piedmont area (Amy S. Greene Environmental Consultants Inc., 2014).

Township of Cranford/Upstream
The South Mountain Reservation portion of the project area is located within the first Watchung Mountain and is characterized by steep terrain with elevations ranging from 300-650 ft above sea level. The gradient of the Rahway River in this area is very steep.

The Cranford portion of the project area is located on the gently sloping plain east of the Watchung Mountains with an average elevation of 82 ft above sea level. In this location, the gradient of the Rahway River flattens to approximately one foot per thousand feet. The gradient of the Rahway River then steepens slightly south of the Nomahegan Park (Union County Planning Board, 1974).

City of Rahway/Robinson's Branch
The Robinson's Branch portion of the project area is characterized as relatively flat with elevation ranges from 10 ft to 150 ft above sea level (Rutgers Cooperative Extension, 2005).

3.2.2 Soils

Township of Cranford/Upstream
Dominant soil types within the South Mountain Reservation include Dunellen sandy loam 3 to 8 percent slopes, Boonton loam 0 to 8 and 8 to 15 percent slopes, and Boonton loam, 15 to 35 percent slopes, extremely stony.

The Dunellen soils series consists of very deep, well drained soils formed in stratified materials. Dunellen soils can be found on outwash plains and stream terraces. The underlying bedrock is red, soft shale or siltstone. They are well drained. (NRCS, 2006)

The Boonton soils consists of deep or very deep moderately well and well drained soils formed in till on uplands. This soil is typically found on gently sloping to very steep uplands and is formed in glacial till composed mostly of red to brown shale, sandstone, basalt and some granitic gneiss (NRCS, 2011)

City of Rahway/Robinson's Branch
Dominant soils along the portions of the Rahway River and the Robinson's Branch within the project area include Fluvaquents, and Udifluvents, and the Haledon-Urban Land-Hasbrouck complex.

Fluvaquents and Udifluvents generally occur on slopes ranging from 0 to 3 percent. Fluvaquents have parent material consisting of recent alluvium and are commonly found on flood plains and in river valleys. The natural drainage class is somewhat poorly drained and is frequently flooded. Parent material of Udifluvents soil consists of alluvium and is typically consistent in outwash plains and floodplains. The drainage class is moderately well drained and is frequently flooded. (NRCS, 2007).

The Haledon-Urban Land- Hasbrouck complex generally has 0 to 8 percent slopes. The Haledon component is on ground moraines on till plains with parent material consisting of coarse-loamy basal till derived from basalt. The natural drainage class is somewhat poorly drained. Parent material of the Hasbrouck component is comprised of fine-loamy eroded and redeposited glacial material over glacial till. Slopes are 0 to 3 percent and the natural drainage class is poorly drained (NRCS 2008). Urban land is classified as land mostly covered by streets, parking lots, buildings and other structures of urban areas with slopes ranging from 0 to 8 percent.

Hydric Soils

Fluvaquents, Udifluvents and the Haledon-Urban Land-Hasbrouck Complex are included on the list of hydric soils for New Jersey developed by the Natural Resources Conservation Service (NRCS). Soils with this classification are those saturated through natural or artificial means sufficiently enough to support the growth and regeneration of hydrophytic vegetation (NRCS 2007).

Prime Farmland Soils

Prime Farmland Soils is defined by the United States Department of Agriculture (USDA) as land that has the best combination of characteristics for producing food. It can have any land use ranging from cultivated land, pastureland, forest, or other; however, it is usually not urban or water areas. The USDA[4] states that, "The soil qualities, growing season, and moisture supply are those needed for the soil to economically produce sustained high yields of crops when proper management, including water management and acceptable farming methods are applied."

Boonton, Dunellen and Haledon soils are designated as Prime Farmland Soils (NRCS, 2016).

3.3 Water Resources

3.3.1 Surface Water

Originating in the Watchung Mountains in Essex County, the Rahway River flows south for approximately 24 miles before discharging into the Arthur Kill strait. The Rahway River has four major tributaries: West Branch, East Branch, South Branch and Robinson's Branch. The West and East Branches converge at the Springfield-Union Township line to form the main stem Rahway River. The South Branch and Robinson's Branch join the main stem at the City of Rahway, where it flows until its confluence with the Arthur Kill. The Rahway River Watershed has a drainage area of 83 square miles.

Township of Cranford/Upstream

The average channel width of the Rahway River within the South Mountain portion of the project area is 20ft. The average depth of the river in this section is approximately six inches. The substrate in this segment of the river is typical of a headwater stream; a combination of large rocks, boulders and cobble. In the Cranford portion of the project area, the channel widens to an average width of 35 ft in Lenape Park and then to an average

[4] *Soil Survey Staff (1993). "Soil Survey Manual". Soil Conservation Service. U.S. Department of Agriculture Handbook 18*

width of 70 ft just below Nomahegan Park. Average depths range from six inches to one foot. The substrate in this segment of the Rahway River is predominantly cobble and gravel with finer silts and clay sediment.

Most of the watershed is heavily urbanized, of which residential housing developments comprise the largest sub-category with remaining uses consisting of recreation, municipal, commercial and industrial. Undeveloped lands consist predominantly of County and municipally owned open space.

Along with receiving point and non-point discharges related to stormwater runoff, the Rahway River has experienced modifications associated with water supply, recreation, flood risk management, development of infrastructure and erosion control. The Rahway River is dammed in 11 locations from the northern portion of the project area through its confluence with the Arthur Kill (Figure 6).

Within South Mountain Reservation, the Rahway River was dammed in three locations to create a series of impoundments. The largest waterbody, the Orange Reservoir, is owned by the City of Orange, and served as the City's water supply until 1999. The Orange Reservoir is currently leased from the City by Essex County and is used for recreational purposes only.

The Orange Reservoir is approximately 0.69 miles long and 0.20 miles wide at its widest point, and has a surface area of approximately 62 acres. At its deepest point, the Orange Reservoir is approximately 30 feet deep. The shoreline consists predominantly of a stone retaining wall. The eastern shoreline is embedded within the mountainside forested with mature deciduous trees, giving the shoreline a natural appearance. The western shoreline is lined with ornamental grasses and small shrubs.

Approximately 1.5 miles south of the Orange Reservoir, the Rahway River was dammed to create the Campbell's and Diamond Mills Ponds.

In the Township of Cranford, a dam (Lenape Park Dam) was installed in the Rahway River at Lenape Park for flood risk management. Approximately 3,500 ft of the left riverbank of the Rahway River from Nomahegan Park to Normandie Place was increased in height by the Township of Cranford to create a small levee to provide flood risk management to the residences on the eastern side of the river. South of Nomahegan Park, numerous bridge crossings have been constructed across the Rahway River and the river banks have been replaced with concrete, mason rock or timber crib retaining walls in multiple locations. In other locations, riprap has been installed along the river banks to prevent erosion. Boat launches along the riverbanks are also located behind several private residences.

City of Rahway/Robinson's Branch

Within the vicinity of the Robinson's Branch, the Rahway River Dam is used by United Water to withdraw approximately 4.85 million gallons of water per day from the river to serve approximately 26,500 customers (United Water, 2016).

The Robinson's Branch originates in the Town of Westfield and flows for approximately 5.5 miles before discharging into the Rahway River. The total drainage area is approximately 22 square miles (Union County Planning Board, 1974). The average width of the stream within the project area ranges between 30-40 ft wide with an average depth of one foot. The substrate is predominantly comprised of sand/gravel.

Land use in the Robinson's Branch is primarily urban, comprising of about 80% of the total land area in the watershed (Rutgers Cooperative Research & Extension, 2005). Similar to the main stem of the Rahway River, the Robinson's Branch has experienced manmade modifications in the form of dams to create the Clark Reservoir and Milton Lake, the construction of bridge crossings and the installation of retaining walls and rip-rap to reduce stream bank erosion. Within the segment of the Robinson's Branch below New Church Street, development has occurred right up to the top of the stream banks.

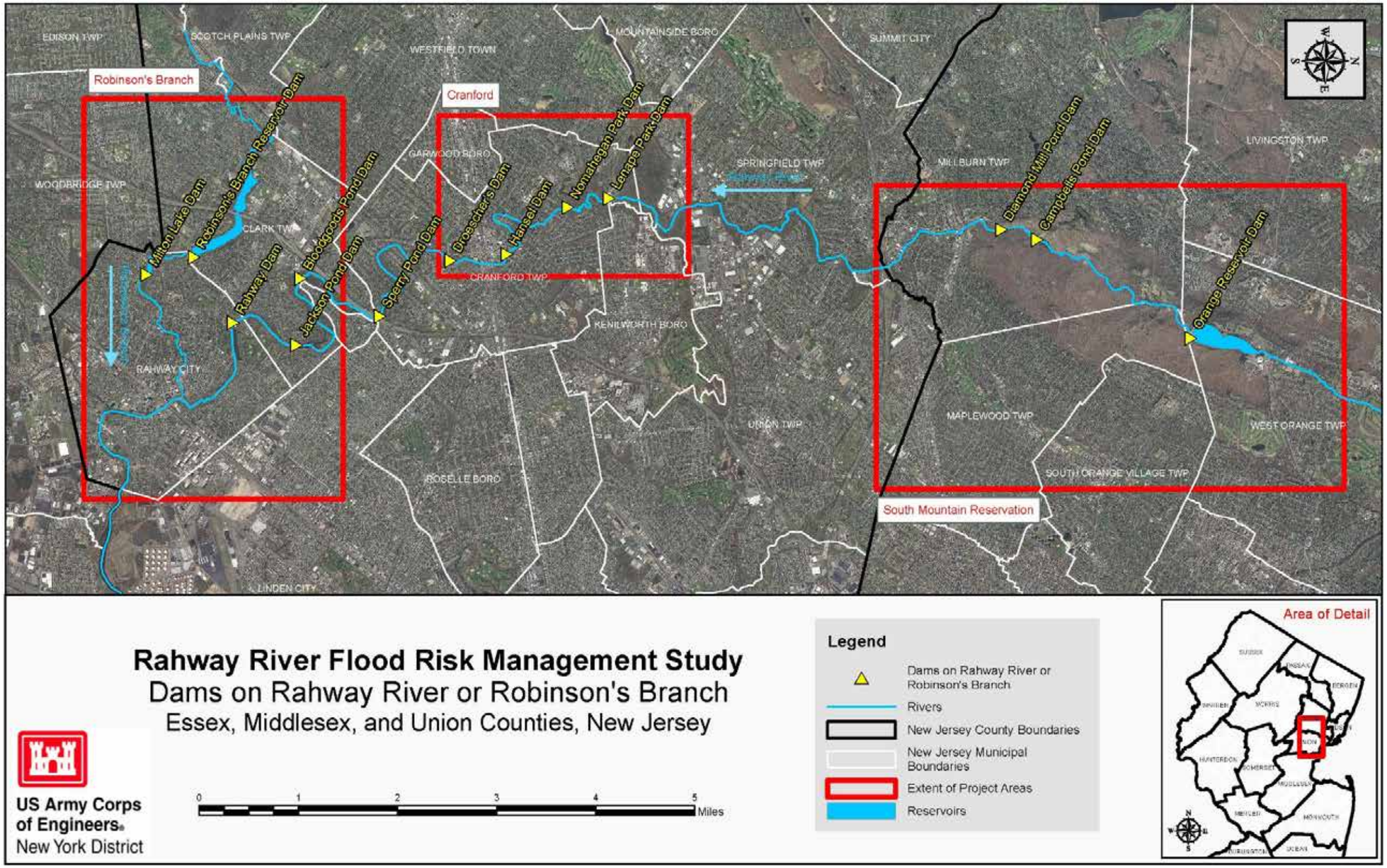

Figure 6. Dams Along the Rahway River and Robinson's Branch

3.3.2 Water Quality and Aquatic Habitat

The portion of the Rahway River within the project area, including Orange Reservoir, and the Robinson's Branch, are designated as FW2-NT or freshwater river not supporting trout spawning (N.J.A.C. 7:9B 2008). By definition, designated uses for FW2 waters include: 1. Maintenance, migration and propagation of the natural and established biota; 2. Primary contact recreation; 3. Industrial and agricultural water supply; 4. Public potable water supply after conventional filtration treatment and disinfection; and 5. Any other reasonable uses. Non-trout waters are those "not generally suitable for trout because of their physical, chemical or biological characteristics but are suitable for a wide variety of other fishes" (NJDEP, 2010).

Segments of the Rahway River and Robinson's Branch within the project area are included on the 303(d) List of Impaired Waters in the New Jersey 2012 Integrated Water Quality Monitoring and Assessment Report. Table 9 lists the impaired segments and cause of the impairments of the Rahway River and Robinson's Branch.

Table 9. Reaches of the Rahway River and Robinson's Branch Designated on the 303(d) List of Impaired Waters (NJDEP 2012)

River Reach	Cause	Source
Rahway River WB	Sulfates Total Dissolved Solids Phosphorus (Total)	Source Unknown Urban Runoff/Storm Sewers
Rahway R (Kenilworth Blvd to EB / WB)	Arsenic Phosphorus (Total)	Industrial Point Source Discharge Urban Runoff/Storm Sewers Agriculture
Rahway R (Robinsons Br to Kenilworth Blvd)	Arsenic Oxygen, Dissolved Phosphorus (Total) Mercury in Fish Tissue	Industrial Point Source Discharge Urban Runoff/Storm Sewers Agriculture Combined Sewer Overflows Atmospheric Deposition – Toxics
Robinsons Br Rahway R (above Lake Ave)	Phosphorus (Total)	Urban Runoff/Storm Sewers
Robinsons Br Rahway R (below Lake Ave)****	Arsenic Phosphorus (Total)	Natural Sources Urban Runoff/Storm Sewers Agriculture Combined Sewer Overflows

The NJDEP Bureau of Freshwater and Biological Monitoring (BFBM) conducts monitoring of surface water quality through a combination of chemical analyses and surveys of macroinvertebrates and/or fish surveys. A NJDEP BFBM macroinvertebrate monitoring station (AMNET0192) is located within the Rahway River immediately above the Orange Reservoir and a fish and macroinvertebrate monitoring station (FIBI020 and ANO194 respectively) is located at the southern portion of Lenape Park just north of Kenilworth Boulevard. The NJDEP BFBM also established a fish and macroinvertebrate monitoring station (FIBI084 and ANO199 respectively) in the Robinsons Branch near Central Avenue in Rahway.

Evaluations of the habitat within the monitoring stations near the Orange Reservoir and within Lenape Park by the NJDEP BFBM during fish and benthic surveys noted characteristics consistent with a stressed aquatic community. These characteristics included lack of stable substrate/cover, unstable river banks, unstable banks and high level of fine sediment embedded in the gravel and cobble substrate. Water chemistry testing indicated a relatively low dissolved oxygen concentration and high conductivity which can be an indicator of a high level of dissolved solids oftentimes attributed to stormwater runoff in urban areas (Vile, September 2011). The habitat assessment conducted at the Robinson's Branch monitoring station noted a lack of a sufficient riparian zone, in addition to an accumulation of debris and trash along the stream banks and streambed. (Vile, March 2011).

The District conducted a stream habitat assessment of the Rahway River and Robinson's Branch in October and November 2015 using the Environmental Protection Agency's Rapid Bioassessment Protocols (EPA RBP) for wadeable streams. This stream assessment method employs a habitat rating scale of optimal, sub-optimal, marginal, or poor as it relates to a river system having the habitat structure required to support and maintain a diverse aquatic resource community. The EPA RBP stream assessment method was selected by the District for use because the NJDEP BFBM utilizes it as part of their fish and macroinvertebrate sampling procedures.

Segments of the Rahway River identified for assessment include a 600 ft portion of the Rahway River below the Orange Reservoir, several sections within Lenape Park totaling 1,100 ft, and a 700 ft section in Nomahegan Park. These segments were selected for evaluation because of their potential for having high habitat value, as well as being within the footprint of several flood risk management alternatives formulated and accessibility to the river/stream systems from publicly owned lands. Figures identifying the locations of areas surveyed and the locations of the survey areas in relation to the NJDEP monitoring stations are included in Appendix A.

All of the segments of the Rahway River assessed were rated sub-optimal. Factors contributing to the sub-optimal rating for the portion of the Rahway River assessed below Orange Reservoir include a lack of variety of flow/depth regimes, moderate amount of sediment deposition, and lack of riffles.

Factors contributing to sub-optimal rating in the portion of the Rahway River in Lenape Park include alterations to the river channel, a high level of embeddedness, a lack of a variety of flow/depth regime that support various aquatic species and their life cycles, moderate level of sediment deposition.

The 2,000 ft segment of the Robinson's Branch assessed by the District was rated marginal. Factors contributing to the rating include the level of alteration to the stream banks, lack of a riparian zone, unstable streambanks, and lack of or unstable substrate.

During a site investigation in August 2016, the southern portion of the reservoir showed signs of eutrophication, and algae was observed on rocks along the shoreline. Aerators are located within the northern portion of the reservoir and were in operation, but do not appear to be sufficient to oxygenate the entire reservoir. The littoral zone is highly compromised as a functioning habitat since it is comprised of the stone retaining walls with riprap toes.

3.3.3 Wetlands

Federal (33 CFR 328.3(b); EO 11990) and State (N.J.A.C. 7:7A1.4) definitions of wetlands are similar, identifying wetlands as "those areas that are inundated or saturated by surface or groundwater 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." As defined above, wetlands generally include swamps, marshes, bogs, and similar areas.

A review of New Jersey's GIS environmental mapping database (NJ Geoweb) and the U.S. Fish and Wildlife Service (USFWS) National Wetland Inventory (NWI) maps was conducted to assess potential wetlands within the project area. Both NJ Geoweb and the USFWS NWI maps indicate the presence of small, fragmented forested wetland complexes along several locations of the Rahway River and the Robinson's Branch within the project area (Figures 7-9). The majority of the Lenape and Nomahegan Parks are identified as forested wetlands.

Formal wetland delineations were not conducted; however, in October/November 2015 the District conducted cursory evaluations in select locations, where preliminary alternatives were proposed to identify potential wetlands. The identification of potential wetlands was based on an assessment of vegetation observed and a superficial evaluation of soil characteristics. Areas evaluated included 3.23 acres around the Rahway River below Orange Reservoir, 8.5 acres within Lenape Park, 3.79 acres in Nomahegan Park and 7.79 acres along Robinson's Branch.

The cursory evaluation identified a potential emergent wetland 0.15 acres in size and a potential forested wetland 0.14 acres in size within the area assessed below the Orange Reservoir. Within the area assessed in Lenape Park, 0.99 acres of potential emergent wetland and 1.59 acres of potential forested wetland were identified. Within the area assessed in Nomahegan Park, 0.17 acres of potential emergent and 1.59 acres of potential forested wetland were identified. Within the area along the Robinson's Branch that was

assessed, 0.24 acres of potential emergent wetlands were identified. These potential wetland areas were limited to small depositional areas along the banks.

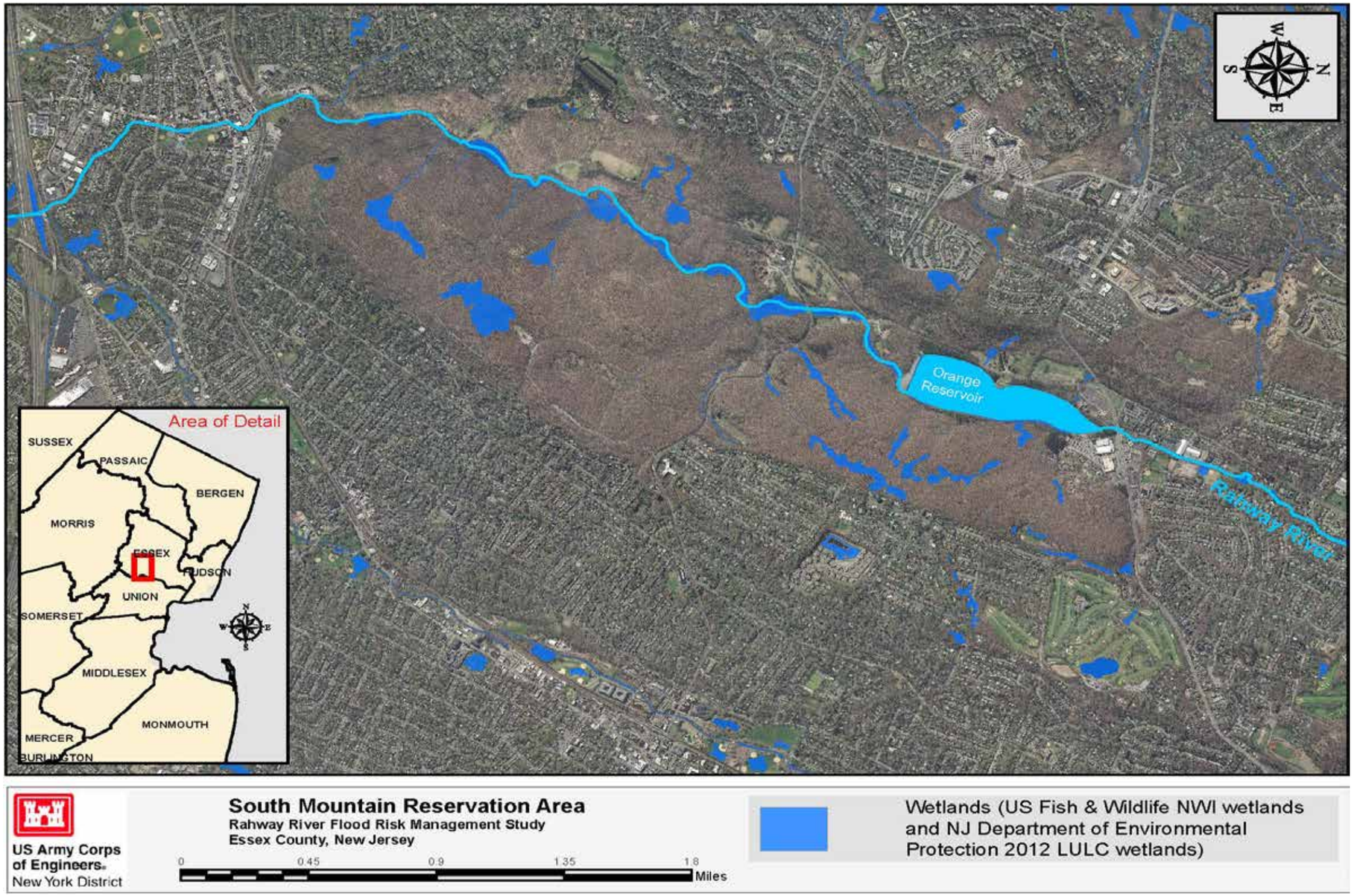

Figure 7. Wetlands Within the South Mountain Portion of the Project Area

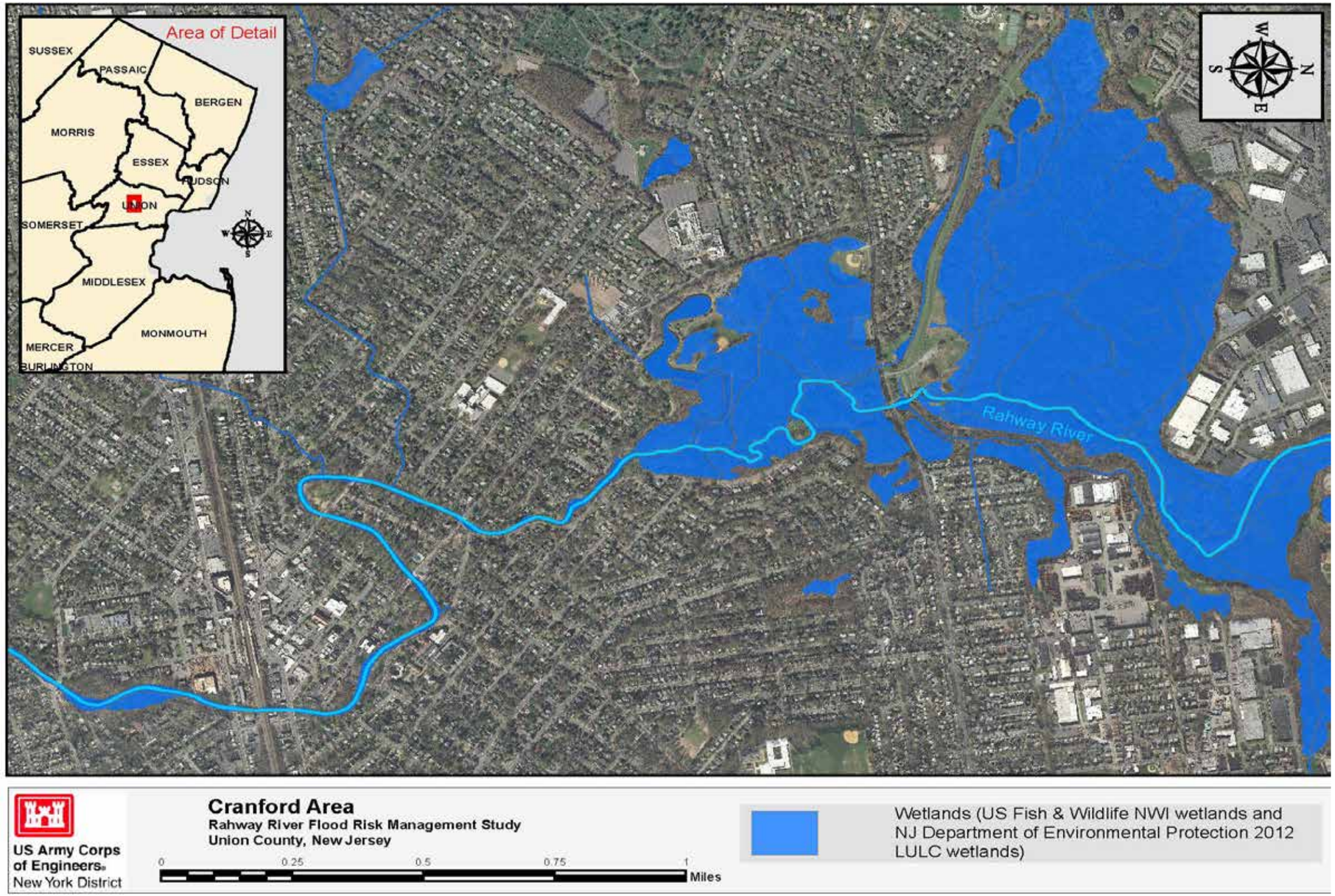

Figure 8. Wetlands Within the Cranford Portion of the Project Area

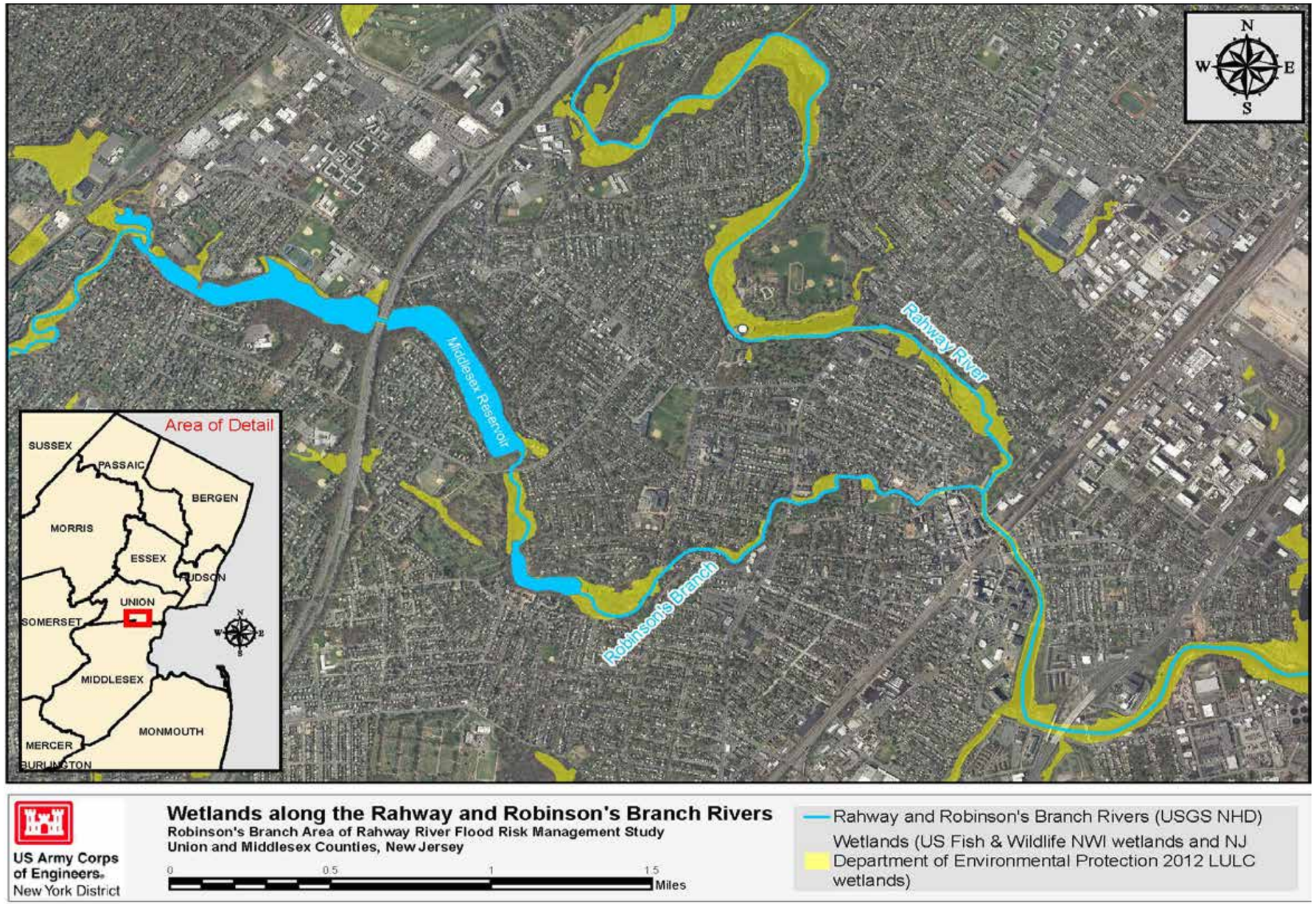

Figure 9. Wetlands Within the Robinson's Branch Portion of the Project Area

3.4 Vegetation

3.4.1 Uplands and Riparian Corridor

Uplands within the South Mountain portion of the project area are comprised of a combination of coniferous and deciduous forests. Coniferous forest species include Norway spruce (*Picea abies*), white pine (*Pinus strubus*), scotch pine (*Pinus sylvestris*), hemlock (*Tsuga canandensis*), and eastern red cedar (*Juniperus virginiana*). Species observed within the deciduous forest below the Orange Reservoir during field investigations include beech (*Fagus grandifolia*), hickory (*Cary sp.)* red maple (*Acer rubrum*), sugar maple (*Acer saccharum*) and red oak (*Quercus rubra*). Understory shrubs observed include honeysuckle (*Lonicera* sp.), arrowood (*Viburnum dentatum*), red osier dogwood (*cornus stoloniferia*) and winged euonymus (*Euonymus* sp.),

With the exception of Lenape and Nomahegan parks, upland vegetation in the Township of Cranford area primarily consists of maintained lawns, ornamental trees and shrubs. Common tree species observed in upland are red maple, hickory, cottonwood (*Populus deltoids*) and tulip tree (*Liriodendron tulipfera*) Understory shrubs observed include honeysuckle, arrowwood and holly (*Ilex* sp.).

The majority of the uplands within the Robinson's Branch portion of the project area consists of residential and commercial development. Vegetated uplands are mostly maintained lawns dominated by a variety of common native and nonnative grass species.

The New Jersey Flood Hazard Area Control Act Rules, N.J.A.C. 13 (FHACAR) establishes and requires the preservation of riparian zones. The width of the established riparian zone is based on the environmental resources being protected and can range from 50, 150 or 300 ft as measured from the side of surface waters. Given that the Rahway River and Robinson's Branch are designated FW2-NT, the riparian zone is 50 ft as described in N.J.A.C. 7:13-4.1. 3.

Given the lack of development in the South Mountain Reservation, the riparian zone within the South Mountain portion of the project area exceeds the regulated riparian zone and consists mainly of deciduous trees such as beech, red oak, and red maple.

With the exception of Lenape and Nomahegan Parks, the riparian zone within the Cranford portion of the project area ranges from 15 to 50 ft due to development. In many locations, the riparian zone has been subject to disturbance which has allowed invasive species such as Japanese knotweed to establish.

Within the Robinson's Branch portion of the project area, development occurs right up to the streambank, thus limiting the riparian zone to a width ranging from 50 to 5 ft with some portions from 25 to 10 ft. Development within the last 2,000 ft of the stream prior to its confluence with the Rahway River occurs right up to banks, limiting the width of the riparian zone from 25 down to 5 ft.

In many locations of both the Cranford and Robinson's Branch portions of the project area, the riparian zone consists of Japanese knotweed, which is an invasive species.

Common tree and shrub species observed within the riparian zone within all portions of the project area during field investigations include American elm (*Ulmus Americana*), red maple (*Acer rubrum*), silver maple (*Acer saccharium*), sycamore (*Platanus occidentalis*), arrowwood (*Viburnum dentatum*), and dogwood (*Cornus* sp.)

Invasive plant species observed within all portions of the project area include Norway maple (*Acer platanoides*) Japanese knotweed (*Fallopia japonica*), Japanese hops (*Humulus japonicus*), multiflora rose *(Rosa multiflora*), garlic mustard (*Allaria petiolata*), and mugwort (*Artesemia vulgaris*). Japanese knotweed was particularly prevalent along the banks of the Rahway River in Lenape Park and other previously disturbed portions of the riverbanks in the Cranford.

A full list of vegetation observed during field surveys is included in Appendix A.

3.4.2 Wetlands

Wetland vegetation species observed within the Orange Reservoir portion of the project area include jewelweed (*Impatiens capensis),* reed canary grass *(Phalaris arundinacea*), sensitive fern (*Onoclea sensiblis*) cinnamon fern (*Osmundastrum cinnamomeum*), creeping jenny (*Lysimachia nummularia*), and cattail (*Typha sp.*).

Plant species observed in the potential emergent wetland area in Lenape Park include creeping jenny, cinnamon fern, cattail, reed canary grass (*Phalaris arundinacea*), soft rush (*Juncus effuses*) and common reed (*Phragmites australis*). The potential forested wetland within Lenape Park was dominated by sycamore (*Platanus occidentalis*), sweetgum (*Liquidambar styraciflua*), dogwood (*Cornus sp.*), and pin oak (*Quercus palustris*)

The potential emergent wetland areas within Robinson's Branch were dominated by jewel weed and Pennsylvania knotweed (*Polygonum Pennsylvanica*).

3.5 Aquatic Resources and Wildlife

3.5.1 Fish

Fish collected by the NJDEP BFBM at the monitoring station in Lenape Park during their most recent survey include (in order of abundance) tessellated darter (*Etheostoma olmstedi*), white sucker (*Catostomus commersoni*), spottail shiner (Notropis hudsonius), banded killifish (*Fundulus diaphanous*), American eel (*Anguilla nostrate*), blacknose dace (*Rhinichthys atratulus*), bluegill (*Lepomis macrochirus*), golden shiner (*Notemigonus crysoleucas*), redfin pickerel (*Esox americanus*), mummichog (*Fundulus heteroclitus*), green sunfish (*Lepomis cyanellus*), largemouth bass (*Micropterus salmoides*), pumpkinseed (*Lepomis gibbosus*), creek chub (*Semotilus atromaculatus*), western mosquitofish (*Gambusia affinis*), oldfish (*Carassius auratus*), yellow bullhead (*Ameiurus natalis*), and redbreast sunfish (*Lepomis auritus*). The majority of the species caught are predominantly tolerant of degraded water quality conditions and are generalist feeders, which supports NJDEP's assessment that the Rahway River has water quality degradation issues (Vile, September 2011).

In addition, the New Jersey Division of Fish and Wildlife (NJDFW) stocks portions of the Rahway River within the project area, and Milton Lake, with trout. Rainbow trout (*Oncorhynchus mykiss*) were utilized in Spring 2016, but brown, rainbow and brook trout have also been used in the past.

The New Jersey Division of Fish and Wildlife conducted shoreline seining of the Orange Reservoir in 2013. Species caught included largemouth bass, bluegill, yellow perch (*Perca flavescens*) and white perch (*Morone Americana*) (M. Boriek, personal communication, 29 August 2016). It is also assumed that fish species that utilize the portion of the Rahway River above the reservoir would be present in the reservoir. Fish species that that have been caught in the reservoir include largemouth bass, bluegill and rainbow trout (Fishing-Crew.com, undated).

Fish collected by the NJDEP BFBM at the monitoring station in Robinson's Branch in their most recent surveys include (in order of abundance caught) American eel, redbreast sunfish, banded killifish, white sucker, tessellated darter, bluegill, spottail shiner, pumpkinseed, golden shiner, green sunfish, brown bullhead (*Ameiurus nebulosus*), and blacknose dace (Vile, March 2011).

3.5.2 Aquatic Macroinvertebrates

Macroinvertebrates collected by the NJDEP BFBM in their most recent survey at the survey station (ANO192) immediately above Orangr Reservoir include oligochaete worms: (Nais), (Limnodrilus), (Enchytraeidae), non-biting midges (Orthocladius), (Tanytarsus), (Paratendipes), (Phaenopsectra),(Stictochironomus), (Cricotopus), (Glyptotendipes), damselfly (Ischnura), freshwater snail (Planorbidae), freshwater crustaceans (Caecidotea) , (Gammarus) and caddisfly (Hyrdopsyche). The dominant species collected (Orthocladius, Dicrotendipes, Tanytarsus and Ischnura) have a high tolerance to pollution (Milller 2012).

Macroinvertebrates collected by NJDEP BFBM in their most recent survey at the survey station (ANO194) between Lenape and Nomahegan Parks include non-biting midge (*Cryptochironomous*), (*Cricotopus*), (*Nanocladius*) (*Paratendipes*), (*Polypedilum*), (*Rheotanytarsus*) (*Tanytarsus*), (*Saetheria*), (*Dicrotendipes*) oligochaete worms (*Nais*), (*Limnodrilus*), (*Stylodrilus*), blackfly (*Simulium*) freshwater crustacean (*Gammarus*), water beetles (*Ancyronyx*), caddisfly (*Cheumatopsyhce*) (EPT organism). The dominant species collected (*Nais,Cricotopus, Polypedilium* and *Limnodrilus*) have a moderate to high tolerance to pollution (Miller 2012).

Macroinvertebrates collected by the NJDEP BFBM in their most recent survey at the monitoring station (ANO 199) located in the Robinson's Branch include, non-biting midge (*Polypdilum*), (*Dicrotendipes*), (*Chironomus*), (*Rheotanytarsus*) freshwater crustacean (*Caecidotea*), (*Gammarus*) mayfly (*Stenacron*) (EPT) slavina, freshwater snail (*Amnicola*), (*Gyraulus*),caddisfly (*Ceraclea*), beetle (*Peltodytes*), (*Stenelmis*) freshwater clam (*Pisidium*), and freshwater worm (*Prostoma*). Similar to the results of the sampling efforts in the Rahway River, the two dominant species collected (*Nais and Polypedilum*) are tolerant of pollution (Miller, 2012).

3.5.3 Birds

The study area lies within the Atlantic Flyway, which is a migration route for over 400 bird species. It is expected that the larger parks within the project area, such as South Mountain Reservation, Lenape Park and Nomahegan Park, would support the greatest diversity of bird species given the lack of disturbance to these areas as well as the different habitat types within them. For example, approximately 140 species of birds have been documented at Lenape Park and 200 species at South Mountain Reservation (Friends of Lenape Park and Union County DPF, 2007)(Amy S. Greene Consultants, Inc. 2007).

Common bird species that could occur within the more urban portions of the project area include mourning dove (*Zenaida macroura*), American robin (*Turdus migratorius*), northern mockingbird (*Mimus polyglottos*), grey catbird (*Dumetella carolinensis*), American goldfinch (*Carduelis tristis*), house finch (*Carpodacus mexicanus*), blue jay (*Cyanocitta cristata*), American crow (*Corvus brachyrhynchos*), northern cardinal (*Cardinalis cardinalis*), European starling (*Sturnus vulgaris*), mallard duck (*Anas platyrhynchos*), Canada goose (*Branta Canadensis*), downy woodpecker (*Picoides pubescens*), tufted titmouse (*Baeolophus bicolor*), black capped chickadee (*Poecile atricapillus*), and house wren (*Troglodytes aedon*) (Township of Cranford, 2003); Amy S. Greene Enviromental Consultants, Inc., 2007).

3.5.4 Mammals

Mammal species that inhabit the study area include raccoon (*Procyn lotor*), chipmunk (*Tamias striatus*), red fox (*Vulpes vulpes*), woodchuck (*Marmota monax*), white tailed deer (*Odocoileus virginianus*), and muskrat (*Ondatra zibethicus*), eastern gray squirrel (*Sciurus carolinenensis*); opossum (*Didelphis marsupialis*), (Township of Cranford, 2003). Black bear (*Ursus americanus*) have been observed in South Mountain Reservation. Coyote (*Canis latrans*), otter (*Lontra Canadensis*) and mink (*Neovison vison*) have been observed in Lenape Park (Cranford Environmental Commission, 15 July 2015).

3.5.5 Reptiles and Amphibians

Site specific surveys were not conducted to identify reptile and amphibian species. However, based on observations made during flora and fauna investigations by others in Lenape Park, species such as northern gray tree frog (*Hyla versicolor*), bullfrog (*Rana catesbeiana*), green frog (*Rana clamitans melanota*), eastern garter snake (*Thamnophis sirtalis sirtalis*), eastern box turtle (*Terrapene Carolina Carolina*), snapping turtle (*Chelydra serpentine*), northern water snake (*Nerodia sipedon*), northern brown snake (*Storeria dekayi dekayi*), eastern painted turtle (*Chrysemys picta*), eastern redback salamander (*Plethodon cinereus*) were identified (Union County, 2005). Given the similar habitat types as Lenape Park, it is expected that the South Mountain Reservation portion of the project area would support similar species.

Due to the fact that the Robinson's Branch portion of the project area is more urbanized, reptile and amphibian species that are more adapted to this type of environmental setting, and presumed to occur, include the bullfrog, eastern garter snake and snapping turtle.

3.6 Threatened and Endangered Species

Section 7 of the Endangered Species Act (ESA) requires a Federal agency to ensure that any action authorized, funded or carried out by the agency does not jeopardize the continued existence of Federally-listed endangered and threatened species or result in the destruction or adverse modification of designated critical habitat of the Federally-listed species.

State-listed endangered, threatened and special concern species are protected under the New Jersey Endangered Species Conservation Act of 1973.

3.6.1 Federal Endangered, Threatened and Special Concern Species

The District has completed initial coordination with the U.S. Fish and Wildlife Service (USFWS) through the preparation of a Planning Aid Letter (PAL). Based on this initial coordination, the USFWS identified the Federally endangered Indiana bat (*Myotis sodalis*) and the Federally threatened northern long-eared bat (*Myotis septentrionalis*) within the project area. The PAL also noted the potential presence of bog turtle (*Clemmys muhlenbergii*) within the portion of the Robinson's Branch project area.

The USFWS noted a bald eagle nest site within three miles of the project area and the presence of suitable foraging habitat throughout the project area. Although the bald eagle was removed from the Federal List of Endangered and Threatened Wildlife in 2007, it remains protected through the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. A survey of bald eagle nests conducted by NJDEP Division of Fish and Wildlife Endangered Species staff in 2015 did not note the nest cited in the PAL. Active nests that were closest to the project area were located in Linden, Parsippany and Kearny (Smith and Clark, 2015). The list of birds observed within Lenape Park includes bald eagle, although it was noted as rare/historical occurrence (Friends of Lenape Park & Union County DPW, 2007).

Information provided in the PAL was further supplemented by a review of the "New Jersey Municipalities with Hibernation or Maternity Occurrence of Indiana bat or Northern Long-eared bat" list (USFWS, August 2015). Based on this list, a known Indiana bat maternity colony is located in Millburn Township, and other known maternity colonies for both Indiana bat and northern long-eared bat are located within eight miles of the Township of Cranford.

In addition, the USFWS is currently evaluating the little brown bat (*Myotis lucifugus*), and the tricolored bat (*Perimyotis subflavus*) to determine if listing under the Endangered Species Act (ESA) is warranted.

<u>Indiana bat</u>

Indiana bats spend the winter hibernating in caves and mines; with hibernation beginning in late October and emergence occurring typically in April. The Hibernia Mine located in Hibernia, NJ is a known Indiana bat hibernaculum and is located approximately 21 miles from the project area.

During the summer months, numerous female bats roost together in maternity colonies under the loose bark of dead or dying trees within riparian, flood plain and upland forests. Maternity colonies use multiple roosts in both living and dead trees. Adult males usually roost in trees near maternity roosts, but some males remain near hibernaculum.

Tree species commonly used as roost sites include American elm (*Ulmus Americana*), slippery elm (*Ulmus rubra*), shagbark hickory (*Carya ovata*) silver maple (*Acer saccharinum*), and green ash (*Fraxinus pennsylanica*). Adult males usually roost in trees near maternity roosts, but some remain near the hibernaculum.

Preferred foraging areas are streams, associated flood plain forests, and impounded bodies of water such as ponds and reservoirs. However, they have been observed in upland forests, pastures and clearings with early successional vegetation, cropland borders, and wooded fencerows (USFWS 2007).

Northern Long-Eared Bat

Similar to the Indiana bat, northern long-eared bats hibernate in caves and abandoned mines, with hibernation generally beginning in October/November and emergence typically occurring in April. Northern long-eared bats roost singly or in colonies underneath bark, in cavities or in crevices of both live and dead trees. Unlike Indiana bats, northern long-eared bats have also been observed in manmade structures such as buildings, barns, sheds, cabins, under eaves of buildings and bat houses. Preferred foraging areas are in forested habitats. (USFWS, 2015)

3.6.2 State Endangered, Threatened and Special Concern Species

Identification of State endangered, threatened and special concern species occurring within the project area is based on review of NJ-Geoweb, the PAL, and from input by interested parties during the NEPA Scoping Period. Species are listed in Table 10. Although not identified as occurring in the project area, the bald eagle is listed as state endangered during the breeding season and threatened during the non-breeding season.

Table 10. State Endangered, Threatened and Special Concern Species

Latin Name	Common Name	Listing Status
Accipter gentilis	Northern goshawk	Endangered
Asio flammeus	Short-eared owl	Endangered
Haliaeetus leucocephalus	American bald eagle	Endangered
Myotis sotoris	Indiana bat	Endangered
Podilymbus podiceps	Pied-billed grebe	Endangered
Ammodramus savannarum	Grasshopper sparrow	Threatened
Bubulcus ibis	Cattle egret	Threatened
*Buteo lineatus**	Red-shouldered hawk	Threatened
Dolichonyx oryzivorus	Bobolink	Threatened
Eremophila alpestris	Horned lark	Threatened
Falco sparverius	American kestrel	Threatened

Melanerpes erythrocephalus	Red-headed woodpecker	Threatened
Nycticorax nycticorax	Black-crowned night heron	Threatened
Pandion haliaetus	Osprey	Threatened
Strix varia	Barred owl	Threatened
Accipiter cooperii	Cooper's hawk	Special Concern
Accipiter striatus	Sharp-shinned hawk	Special Concern
Ardea herodias	Great blue heron	Special Concern
Chordeiles minor	Nighthawk	Special Concern
Egretta caerulea	Little blue heron	Special Concern
Plegadis falcinellus	Glossy ibis	Special Concern
Sturnella magna	Eastern meadowlark	Special Concern

* Confirmed breeding in Lenape Park

3.7 Socioeconomics

3.7.1 Demographics and Land Use

Township of Cranford

The Township of Cranford has a total area of 4.87 square miles and is located in central Union County, New Jersey. Major transportation routes passing through Cranford include Route 28 and the Garden State Parkway, as well as a NJ Transit Rail Line, including a commuter station. The 2010 U.S. Census listed the Township of Cranford's population as 22,625, reflecting an increase of 47 (+0.2%) from the 22,578 counted in the 2000 U.S. Census. Population under age 5 is 5.7% and 65years and over is 17.2% (US Census 2010). The racial makeup is 86.8% white, 6.8% Hispanic, 2.8% Asian, and 2.5% black (US Census 2014). The median household income is $116,276, and the per capita income is $48,943. The three predominant occupations are management, business, science, and arts (52.7%), sales and office (25.4%), and service (11.6%) (US Census 2014).The U.S. Census 2010-2014 American Community Survey 5-Year Estimates lists 2.2% of the township as below the poverty line. Land use is summarized in Table 11.

Borough of Kenilworth

The Borough of Kenilworth has a total area of 2.161 square miles and is located between Routes 22 and 28 in Union County, New Jersey. The 2010 U.S. Census listed the Township of Kenilworth's population as 7,914, reflecting an increase of 239 (+3.11%) from the 7,675 counted in the 2000 U.S. Census. Population under age 5 is 5.1% and 65years and over is 15.6% (US Census 2010). The racial makeup is 86.8% white, 6.5% Hispanic, 2.8% Asian, 2.5% black. (US Census 2014). The median household income is $100,680, and the per capita income is $41,792. The three predominant occupations are sales and office (33.7%), management, business, science, and arts (32.6%), and service (15.9%) (US Census 2014). The U.S. Census 2010-2014 American Community Survey 5-Year Estimates lists 5.3% of the city as below the poverty line. Land use is summarized in Table 11.

City of Rahway

The City of Rahway has a total area of 4.03 square mile and is located in southeastern Union County, New Jersey. Major transportation routes in Rahway include Route 1 and Route 27, and there is a railway station for the NJ Transit Northeast Corridor line. The 2010 U.S. Census listed the City of Rahway's population as 27,346, reflecting an increase of 846 (+3.2%) from the 26,500 counted in the 2000 U.S. Census. Population under 5 years is 5.9%, and 65 years and over is 13.5% (US Census 2010). The racial makeup is 40.3% white, 29.6% black, 23.5% Hispanic and 4.2% Asian (US Census, 2014). The median household income is $59,076, and the per capita income is $28,994. The three predominant occupations are management, business, science, and arts (33.9%), sales and office (30%), and service (17.2%) (US Census 2014).The U.S. Census 2010-2014 American Community Survey 5-Year Estimates lists 9.6% of the city as below the poverty line. Land use is summarized in Table 11.

Township Of Springfield

The Township of Springfield has a total area of 5.2 square miles and is located along the northern border of Union County, New Jersey. Major thoroughfares include Interstate 78, Route 28 and Route 22. The 2010 U.S. Census listed the Township of Springfield's population as 15,817, reflecting an increase of 1,388 (+9.6%) from the 14,429 counted in the 2000 U.S. Census. Population under 5 years is 6.0%, and 65 years and over is 14.7% (US Census 2010). The racial makeup is 75.4% white, 9.6% Hispanic, 7.6% Asian, 6.1% black (US Census, 2014). The median household income is $100,461, and the per capita income is $50,478. The three predominant occupations are management, business, science, and arts (54.3%), sales and office (27.9%), and service (7.3%) (US Census 2014).The U.S. Census 2010-2014 American Community Survey 5-Year Estimates lists 5.2% of the township as below the poverty line. Land use is summarized in Table 11.

Township of Union

The township of Union has a total area of 9.09 square miles and is located in northern Union County, New Jersey. Major transportation elements include Routes 22 and 82, Interstate 78, the Garden State Parkway and a NJ Transit rail station. The 2010 U.S. Census listed the Township of Union's population as 56,642, reflecting an increase of 2,237 (+4.1%) from the 54,405 counted in the 2000 U.S. Census. Population under 5 years is 5.4%, and 65 years and over is 14% (US Census 2010). The racial makeup is 44.1% white, 28.2% black, 14.9% Hispanic and 10.5% Asian (US Census, 2014). The median household income is $73,249, and the per capita income is $33,405. The three predominant occupations are management, business, science, and arts (41.9%), sales and office (26.4%), and service (15.4%) (US Census 2014).The U.S. Census 2010-2014 American Community Survey 5-Year Estimates lists 7.9% of the city as below the poverty line. Land use is summarized in Table 11.

Township of Millburn

The township of Millburn has a total area of 9.876 square miles and is located in southwestern Essex County, New Jersey. Major transportation routes include Routes 24, 124 and Interstate 78, and there are two NJ Transit Rail Line commuter stations. The 2010 U.S. Census listed the Township of Millburn's population as 20,149, reflecting an increase of 384 (+1.9%) from the 19,765 counted in the 2000 U.S. Census. Population under 5

years is 6.2%, and 65 years and over is 11.3% (US Census 2010). The racial makeup is 77.4% white, 15.6% Asian, 3.5% Hispanic, and 1.5% black (US Census 2014). The median household income is $165,944, and the per capita income is $48,943. The three predominant occupations are management, business, science, and arts (68.0%), sales and office (21.1%), and service (7.7%) (US Census 2014).The U.S. Census 2010-2014 American Community Survey 5-Year Estimates lists 3.1% of the township as below the poverty line. Land use is summarized in Table 12.

Township of West Orange

The Township of West Orange has a total area of 12.171 square miles and is located in central Essex County, New Jersey. Major transportation elements include Interstate 78 and the Garden State Parkway. The 2010 U.S. Census listed the Township of West Orange's population as 46,207, reflecting an increase of 1,264 (+2.8%) from the 44,943 counted in the 2000 U.S. Census. Population under 5 years is 6.6%, and 65 years and over is 15.9% (US Census 2010). The racial makeup is 57.1% white, 26.6% black, 16.2% Hispanic and 8.0% Asian (US Census, 2010). The median household income is $90,031, and the per capita income is $43,670. The three predominant occupations are management, business, science, and arts (47.1%), sales and office (24.1%), and service (15.2%) (US Census 2014).The U.S. Census 2010-2014 American Community Survey 5-Year Estimates lists 6.1% of the city as below the poverty line.

As indicated below municipalities within the project area have little undeveloped land, ranging from essentially none to a few percent of the total area within each municipality.

Table 11. Union County Land Use for Selected Municipalities

Union County Land Use (NJDEP GIS, 2007)										
	Rahway City		Cranford Township		Kenilworth Borough		Springfield Township		Union Township	
Land Cover Class	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total
Agriculture	0	0%	6.29	0.20%	0%	0%	18.66	0.56%	0	0%
Barren Land	43.32	1.67%	9.52	0.31%	0	0%	108.46	3.28%	6.49	0.11%
Forest	72.21	2.79%	260.64	8.36%	124.95	9.08%	554.74	16.77%	405.77	6.98%
Urban	2298.78	88.86%	2613.87	83.85%	1210.47	87.93%	2432.94	73.55%	5117.59	88.06%
Water	88.95	3.44%	57.22	1.84%	8.11	0.59%	25.6	0.77%	33.4	0.58%
Wetlands	82.92	3.21%	169.95	5.45%	33.15	2.41%	167.49	5.06%	247.89	4.27%

Table 12. Millburn Township Land Use

Land Use of Millburn Township (NJPEP GIS 2007)		
Land Use Class	Acres	Percent of Total
Agriculture	3.91	0.06%
Cemetery	10.78	0.17%
Commercial Services	374.69	5.92%
Forest	1481.24	23.42%
Other Urban or Altered Land	72.42	1.15%
Recreational Land	438.59	6.93%
Residential	2914.58	46.08%
Transportation/Communications/Utilities	198.94	3.15%
Water	357.79	5.66%
Wetlands	471.54	6.60%

Most of the watershed is heavily urbanized, of which residential housing developments comprise the largest sub-category with remaining uses consisting of recreation, municipal, commercial and industrial. Undeveloped lands consist predominantly of County and municipally owned open space.

3.7.2 Environmental Justice

The Environmental Protection Agency defines Environmental Justice as 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 polices. Fair treatment means no group of peoples should bear a disproportionate share of the negative environmental consequences resulting from industrial, governmental and commercial operations or policies"

Executive Order 12898, "Federal Actions to address Environmental Justice in Minority and Low Income Populations" mandates that each federal agency identify and address potential disproportionately high and adverse effects of its activities, programs, and policies on minority populations and low income populations. Specifically, the adverse effects that pertain to human health and the environment must be identified and addressed. According to EO 12898, minority populations exist where the percentage of minorities exceeds 50% or where the minority population percentage in the effected area is meaningfully greater than in the general population. EO 12898 does not provide criteria to determine if an affected area consists of a low-income population.

A cursory analysis was conducted to determine the potential applicability of Environmental Justice issues. The analysis took into account a comparison of the percentage of low income and minority populations occurring in each municipality within the counties in which they are located. Those municipalities where the combined minority populations and/or the low income populations are higher than the County are subject to Environmental Justice considerations.

Essex County has a combined minority (Asian, black and Hispanic) population of 65.3% with 17.2% of County residents living below the poverty line. West Orange has a combined minority population of 50.6% with 15.8% of its residents living below the poverty line. Millburn Township has a combined minority population of 20.6% with 3.1% of its residents living below the poverty line. Although the City of Orange is outside the project area, because it owns the Orange Reservoir, it was included in the cursory Environmental Justice analysis. The combined minority population is 95% with 25.8% of City residents living below poverty line.

Union County has a combined minority population of 54% and 11.1% of County residents living below the poverty line. Springfield Township has a combined minority population of 20.8% with 5.2% of its residents living below the poverty line. The Township of Cranford has a combined minority population of 12.1% with 2.2% of its residents living below the poverty line. The City of Rahway has a combined minority population of 57.3% and 9.6% of its residents living below the poverty line.

Based on the cursory analysis, West Orange[5], the City of Orange and the City of Rahway meet the criteria for Environmental Justice considerations.

3.8 Hazardous, Toxic and Radioactive Waste

As part of the overall study a Phase One Environmental Assessment was conducted. The goal of this assessment was to identify the number and relative location of environmentally impacted sites within the project area. In addition to the main channel, the project area includes two Union County parks; Lenape and Nomahagen Parks.

As part of the parameters of the Phase One Assessment, a review of existing government databases listing known, pending and closed impacted site was consulted. The databases utilized were the NJDEP Known Contaminated Sites (KCS) list, the Resource and Conservation Recovery Act (RCRA) List and the Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) databases maintained by the US Environmental Protection Agency (USEPA) Region Two. The area of interest for this assessment was defined as 1/8 mile on either side of the Rahway River and Robinson's Branch within the project area. The narrow search area was used because of the high density of residential and commercial development along the stream banks.

Within the NJDEP KCS list are three categories of sites: Known/Active, Pending and Closed. The database search focused on known and pending sites. Closed sites were excluded. NJDEP policies and guidelines identify closed sites as complete and resolved, referring to sites that have achieved clean-up criteria levels, hence no reason for USACE to list them.

Many of the active sites were being remediated by the responsible party. Remediation efforts include, but are not limited to, excavation and removal off site of impacted soil, installation of monitor wells, pumping impacted groundwater through a filter system and/or implementing in-situ soil treatment to biodegrade hydrocarbon based compounds. These

[5] The Township of West Orange is included as it holds the project element of Orange Reservoir.

sites may be on the active list for several years before remedial efforts are determined successful by NJDEP.

Township of Cranford/Upstream

A total of 28 active and pending sites were located in the Township of Cranford, Springfield, and Kenilworth. Twenty-one of these sites are located within the Township of Cranford with the majority of these sites within its central commercial area and consist of leaking underground storage tanks (LUSTs) at private residents, commercial structures and municipal buildings.

Sites outside the central commercial area include the Trap and Skeet range in Lenape Park. The site was inspected by the USEPA, Region 2, for soil contamination from lead shot. Laboratory analysis of soil samples from the former range went as high as 250,000 parts per million. The range is currently closed with no plans to re-open it. Presently there are no discussions on whether to excavate or place a soil cap on the site. The remainder of the sites include commercial (former gas stations, machine shops, etc) and residential sites in Springfield and Keniworth.

City of Rahway/Robinson's Branch

There are 27 active or pending sites identified primarily in the City of Rahway. Of these sites, two are pending and both of them are located along the Robinsons Branch. One is a former gasoline station the other is a private residence. Two active sites include a former auto dealership and dry cleaners. Currently the City of Rahway has delineated an area of the central business district as a Brownfields redevelopment zone. The zone encompasses land on both sides of the river. The area has been intensely developed since the late 19th century and is the site of multiple businesses (machine shops, small factories, assembly plants). Redevelopment plans are still in the discussion stage.

Eight of the sites are clustered within a one half mile stretch of the Rahway River as it flows through the City of Rahway central business district. Of these eight sites, one is a former coal gas plant site, another is a former dry cleaner, the remaining sites are vacant lots or closed businesses where the responsible party is involved in site clean-up operations.

Ten sites are located further downstream of the confluence of the main stem Rahway River and Robinsons Branch. All of these sites are industrial facilities, gasoline stations, warehouses and other commercial establishments. These locations are currently in remediation with the work being conducted by site owners/responsible parties with oversite by NJDEP Licensed Site Professionals.

There are two active sites two and a half miles upstream on the Robinsons Branch, located in Clark Township. One is a gasoline station, the other a public school. These are currently in managed remediation phase.

Downstream in the City of Rahway are three sites; the former coal gas site on the Robinsons Branch and two river-side locations of hydrocarbon impacted soil directly on the river. One of these sites, Lower Street Green Acres Acquisition Project had sample coring take

place on it in 2003. At that time oil product was observed flowing off the stream bank into the river. This was reported to the NJDEP. These sites and their on-going impact to the waters of the Rahway River and Robinsons Branch will have to be addressed in greater detail when plans for flood protection structures are drawn up for this area.

Plans will be formulated to avoid HTRW-contaminated areas where practicable in accord with ER 1165-2-132 (HTRW Guidance for Civil Works Projects, USACE 1992).

3.9 Cultural Resources

As an agency of the Federal government, the District has certain responsibilities regarding the identification and protection of cultural resources. The Federal statutes and regulations authorizing the District to undertake these responsibilities include Section 106 of the National Historic Preservation Act, as amended, and the Advisory Council on Historic Preservation Guidelines for the Protection of Cultural and Historic Properties (36 CFR Part 800). The Area of Potential Effect (APE) consists of areas that will be directly affected by the proposed undertaking as well as those areas that are effected visually. The District is required to identify historic properties within the APE and determine if the proposed project will have an effect on those properties. The District must allow the relevant State Historic Preservation Office, Federally-recognized Tribes, the Advisory Council on Historic Preservation and the public an opportunity to comment on the its determination of effect. The District initiated identification of historic properties during the alternatives development and analysis phase of the feasibility study by conducting cultural resources investigations to provide cultural and historical context and baseline information for the project.

3.9.1 Prehistory and Early Settlement

The prehistory of northeastern North America is marked by three major periods spanning approximately 14,000 years. The earliest of these periods is the Paleo-Indian, which lasted from 12,000 BC to 8,000 BC. Living in seasonal camps near fresh water sources, Paleo-Indians subsisted by hunting and gathering. This period was followed by the Archaic period, which lasted from 8,000 BC to 1,000 BC and was characterized by seasonally occupied campsites and seasonal villages. The Archaic subsistence system was hunting and gathering with possibly incipient horticulture toward the end of the period. After 1,000 BC, Native Americans of the Woodland period lived in seasonally occupied villages and campsites and subsisted by hunting, gathering, and, horticulture. Ceramics were first made in northeastern North America during the Woodland period (Nolte et. al. 2013a&b).

European occupation of the Rahway area began in 1664 when English speculators from New England and Long Island purchased large tracts of land from the Native Americans. At the time of European settlement, the portion of New Jersey that included what is now Union County was occupied by the Unami subgroup of the Lenape. On December 1, 1664, Governor Nicolls issued a patent to Baker, Ogden, Bayly, and Watson for a substantial tract of land lying between the Raritan and Passaic Rivers. The Elizabethtown Patent extended from the mouth of the Raritan River to the mouth of the Passaic River (approximately 17 miles) and 34 miles into the backcountry. The tract consisted of approximately 500,000 acres, including all of present-day Union County, the present site

of the City of Rahway and the northern branch of the Rahway River, and portions of Essex, Middlesex, Morris, and Somerset counties (Nolte et. al. 2013a&b).

3.9.2 History of Cranford

Shortly after initial settlement of the area several mills were built along the Rahway River in what would become Cranford. John Crane was one of the first to purchase land in 1714 and after building a dam just north of what is now Union Avenue, he erected a sawmill and a gristmill. Crane's children constructed homes near the mills and a community began to develop there. The circuitous Rahway River provided power for several rural industrial operations. For example, Benjamin Williams operated a sawmill intermittently on west side of the Rahway River near Cranford during the Revolutionary War and owned land on both sides of the river. The mill stayed in the family for multiple generations and was rebuilt once. Droescher's Mill, as it is now called, is listed on the National Register of Historic Places and is considered one of the oldest continuously operated commercial buildings in New Jersey. Aside from water powered mills, the primary economy of the area in the eighteenth and the early part of the nineteenth century focused on farming and fruit orchards.

By 1834, approximately 20 mills were operating along the Rahway River, processing a variety of products including lumber, grain, wool, cotton, and paper. One of the earliest routes between New York and Philadelphia—the Old York Road—passed through Cranford. In the mid-nineteenth century Alden Bigelow, of Dayton, Eastman, and Bigelow, purchased Josiah Crane's 37-acre farm to build a housing development. Main Street became Union Avenue and the farm was divided into residential lots. The CNJ Main Line Corridor, a rail line that was originally developed as a competitor to the Morris Canal for transporting coal from the Lehigh Valley in Pennsylvania to the harbors and New York City, was important in the development of transportation and commerce for the area and the state, and it greatly influenced residential growth and he development of Cranford. In addition to its freight-carrying operations, the CNJ also served as a passenger line, spurring the growth of communities in proximity to it, especially after 1861 when a railroad bridge was completed across Newark Bay, which provided access for travelers from New York City. Around this time improved ferry service along with train travel brought New York City within an hour's commute of large portions of the county. The railroad built handsome passenger stations in the communities that lined their rights-of-way and established schedules to accommodate the commuter. A train station was constructed in Cranford in 1865. The CNJ was even a land developer, buying farm land and subdividing it into house lots (Nolte et. al. 2013a).

By 1868, Cranford had a population of approximately 600. North and South avenues were laid out in 1871 and 1872 and the road to Springfield along the east bank of the river was renamed Riverside Drive. Streetlights were installed by 1884. At that time, the Rahway River was the center of the area's recreational activities and residences along the river erected docks and boathouses to access the Rahway. The Cranford Canoe Club was established in those years and the summers were marked by extensive river carnivals and regattas. These carnivals resulted in Cranford adopting the slogan "the Venice of New Jersey" for itself (Nolte et. al. 2013a).

In 2016, as the feasibility study progressed and modifications to the Orange Reservoir Dam were being evaluated as a likely element of the selected alternative, the District completed the survey titled, *Phase I Cultural Resources Investigation of the Orange Reservoir and Dam, West Orange, Essex County, New Jersey for the Rahway River Flood Risk Management and Ecosystem Restoration Project* (Scarpa 2016). This survey evaluated the Orange Reservoir and Dam for its eligibility for the NRHP, reviewed the surrounding area for structures requiring architectural assessment, and considered the archaeological sensitivity of the study area. The investigation included a site visit to the reservoir and research at the New Jersey State Museum (NJSM), the New Jersey Historic Preservation Office (NJHPO), the West Orange Public Library, and Essex County's Department of Parks, Recreation, and Cultural Affairs.

Immediately surrounding the Reservoir to the east, west and south is the National Register eligible South Mountain Reservation Historic District (Figure 11). The Orange Reservoir and Dam was determined to be potentially eligible for listing on the NRHP. Further research is required to complete a determination of eligibility on this property. An intensive-level architectural survey has been recommended. A review of local histories, historic maps, survey data, and records held at the NJSHPO and the New Jersey State Museum (NJSM) indicated that the potential for prehistoric and historic archaeological resources at the Orange Reservoir is high. However, the ground within the study area has been disturbed by events such as the construction of the reservoir itself, later modifications to the dam, and very recent construction of the walking path surrounding the reservoir. Archaeological investigations are recommended to determine the presence or absence of significant archaeological deposits. The survey also recommended development of a testing plan to address the potential for deeply buried prehistoric deposits beneath fill and also archaeological deposits relating to the construction of the dam and reservoir and other post construction activities centered on the reservoir

3.9.3 History of West Orange

The Township of West Orange was originally part of Newark Township when it was formed in 1693. The settlers who ventured out from the Newark settlement in the 1700's were primarily employed in agrarian business as well as quarrying. In 1806 a portion of Newark was annexed to form Orange Township. West Orange was formed from Orange in 1863. The area was sparsely populated during the first half of the nineteenth century. Local industry included sandstone quarrying, tanning, and shoe and hat manufacture. The late nineteenth century saw rapid population growth in West Orange. The unspoiled natural setting of the Watchung Valley and the rugged terrain of the Watchung Mountains with breathtaking views of the city and surrounding countryside offered a quiet and peaceful location for businessmen and their families to live that was both a getaway from the bustle of the city and a sense of community for likeminded intellectuals and the affluent. Llewellyn Park, a 425-acre gated residential community of country estates and one of the first planned communities in the country was founded in West Orange in1857. In 1887 the Essex County Country Club was established in West Orange and soon had an active membership and a large golf course along Pleasant Valley Way. Many fine homes were

built in the immediate vicinity of the Country Club and the area became known at Hutton Park (Scarpa 2016).

In 1863, the population of West Orange was 1,755 and by 1936 it had grown to 29,321. This population boom led to a need and desire for public utilities and amenities for the Township and the surrounding municipalities. Rail lines and trolley lines were added and sewers and water mains were laid. Between 1880 and 1910 the community had established its first high school, a police department, a fire department and a water supply system. The Orange Reservoir was constructed in 1883 to supply water to the City of Orange. In 1895, the South Mountain Reservation was established by the Essex County Parks Commission for the purpose of public use and recreation. The park was designed by the Olmstead Brothers and the designs were developed and constructed beginning at the turn of the century and continuing through the 1930's when the Civilian Conservation Corps (CCC) and the Works Progress Administration (WPA) were hired to make additional improvements. Many of the existing structures within the park system are the work of the CCC. The Orange Reservoir was constructed prior to the design of the South Mountain Reservation and although it was included as part of the original design concept, the reservoir was never developed as a feature of the park. Even so, the reservoir's surrounding environs were shaped by the development of the South Mountain Reservation over the years. The South Mountain Arena was constructed in 1958, the Turtle Back Zoo was constructed in 1962, and a mini-railroad, which still runs along its original track, was constructed in 1963 along the eastern side of the reservoir. In late 1999 use of the reservoir for water supply was discontinued and Essex County leased the property from the City of Orange and has adapted the reservoir for recreation in recent years (Scarpa 2016).

3.9.4 History of the City of Rahway

In 1680 settlers from Elizabethtown and Woodbridge began acquiring land in the Rahway area. One settlement, called Rawack, was developed on the Elizabethtown side of Robinson's Branch, and a second settlement, known as Bridgetown or Lower Rahway, formed on the Woodbridge side in the area of present-day Main Street. Early pioneers erected several mills that took advantage of the Rahway River. The earliest mill in Rahway was built by John Marsh in 1688 on the right side of the Rahway River just above the present railroad bridge. Roads as well as water provided transportation to the early settlement. Seventeenth century documents refer to a place where the road from Elizabethtown to Woodbridge spanned the river. That route was referred to as the King's Highway, and followed what is now St. George's Avenue which crosses through the City of Rahway. The Rahway River valley continued to develop along St. George's Avenue during the eighteenth century and by 1770 five well-known travelers' inns were in operation in Rahway (Nolte et. al. 2013).

At the outbreak of the American Revolution, the dominant sentiments in the Rahway area supported the rebels, but many of the leading citizens, especially those who lived near Elizabeth, the provincial capital, sided with the British. Many Tories were compelled to leave and took up residence in British-occupied New York. Battles at Long Island (Brooklyn) in August 1776 and White Plains in October caused the Americans to retreat across New Jersey into Pennsylvania, allowing the British to occupy the area. In December

of 1776, approximately 500 British troops headquartered in Rahway. Washington's surprise crossing of the Delaware into New Jersey on Christmas 1776 led to British defeats at the battles of Trenton and Princeton. Directly following these battles both American and British forces moved back and forth across central New Jersey engaging in small skirmishes and battles. Two substantial actions reportedly occurred near Rahway (Nolte et. al. 2013).

By the end of the eighteenth century, numerous communities had grown into townships within Elizabethtown including Springfield (1793), Westfield (1794), Rahway (1804), Union (1808), and New Providence (1809). During the early nineteenth century, the Rahway River was an important thoroughfare for the shipping of manufactured goods and agricultural products to New York. The business district at Lower Rahway thrived and a major stimulus to the development of commerce and industry was the construction of the New Jersey Railroad and Transportation Company line in the early 1830s. Other rail lines would follow. Regular railroad service to the village of Rahway was established by 1835 (Nolte et. al. 2013).

By the early nineteenth century, manufacturing and commercial activities spurred economic growth near the village of Rahway. In addition to various mills, brick making had become a major enterprise, and a portion of Rahway became known as Bricktown. In addition to brick making, 35 carriage factories were located in the village. Through this period, Rahway's center continued to be located west of the river, while the area along the eastern bank remained largely undeveloped (Nolte et. al. 2013).

3.9.5 History of the Union County Parks System

Suggestions for a park comprising land around the Rahway River began emerging during the early post-World War I period as citizens became concerned about the degradation of the river by pollution from increased industrial activity. In 1921, H.S. Chatfield, Chairman of the Union County Parks Commission, engaged Olmsted Brothers Landscape Architects of Brookline, Massachusetts as consultants for the creation of a county-wide system of public parks. The firm made preliminary recommendations for the system as a whole and contributed designs for many of its individual units that were later realized to a greater or lesser extent. The Union County Parks System and the Rahway River Parkway would be born from this initial effort. In 1922 land acquisition for the park system commenced and by September 1925 the commission had acquired 2,000 acres for park development through donations, purchases, and condemnations. The first donation was made by the Wheatena Company in January 1922: four acres along the Rahway River. These would be used to form Wheatena Park in the City of Rahway (Nolte et. al. 2013).

Development of the park system slowed during the Depression of the 1930s. The federal government helped spur on the development of the parks system through a variety of New Deal programs. These were the Civil Works Administration, the Works Progress Administration, the Public Works Administration, and the Civilian Conservation Corps. After World War II, the park system continued to lose and gain acreage as the state adapted to the emergence of the automobile as the primary mode of transportation and redirected the use of open space toward the development of roads and turnpikes. Over the last decades

of the twentieth century Union County has continued to increase the number of acres within the park system, increasing from 5,200 acres of parkland in 1972 to 5,574.3 acres in 1990 (Nolte et al. 2013b).

The Rahway River Parkway was determined individually eligible for the National Register of Historic Places in 2002. Rahway River Parkway is defined by the Determination of Eligibility (DOE) as a system of parks and open spaces along the banks of the Rahway River bounded to the north by Springfield Avenue in Springfield Township, and to the south by Elizabeth Avenue in the City of Rahway. In 2005 the Union County Parks System Historic District was determined eligible for the NRHP. The Rahway River Parkway is considered a contributing element of the Union County Parks System Historic District. In the Cranford portion of the study area the District includes Lenape Park, Nomahegan Park, the McConnell Park section of the Rahway River Parkway, the Sperry Park section of the Rahway River Parkway, and the Cranford section of the Rahway River Parkway which includes Lincoln Park, Droescher's Mill, Memorial Park, Hampton Park, Girl Scout Park, and Hanson Park. In the Robinsons Branch study area the Parkway includes the Rahway River Park, Bezega Park, Wheatena Park, Verterans Memorial Field, Rahway Kiwanis Park, and Milton Lake Park. In addition to the individual parks, the historic district boundaries include the Parkway corridor that runs continuously along the River (Figures 10 – 12).

3.9.6 Cultural Resources Investigations

Township of Cranford/Upstream

In 2013 and 2016, in compliance with Section 106 responsibilities, cultural resources investigations were carried out for the Cranford and Robinson's Branch study areas to identify historic properties and areas of archaeological sensitivity. The survey titled, *Phase IA Cultural Resources Investigation of the Rahway River Flood Risk Management and Ecosystem Restoration Project, Townships of Cranford, Springfield, Union, and Westfield and Borough of Kennilworth, Union County, New Jersey* focused on the Cranford study area and did not include the Orange Reservoir or South Mountain Detention Basin (Nolte et. al. 2013a). The study included a review of previous research, historic maps, and relevant National Register of Historic Places (NRHP) nomination forms and data on file at the New Jersey Historic Preservation Office (NJSHPO), an archaeological sensitivity assessment, and an architectural inventory.

A total of 124 individual architectural resources were recorded within the study area in the Townships of Springfield, Union, and Cranford, and the Borough of Kenilworth, Union County, New Jersey, with the majority of the resources located in Cranford. Each of the historic resources were photographed and subject to a preliminary assessment. Four National Register-eligible (NRE) historic districts were located within the study area: the North Cranford Historic District (Identification [ID] #3838), Cranford; the Central Railroad of New Jersey (CNJ) Main Line Corridor Historic District (ID #3500), Cranford; the Rahway River Parkway Historic District (ID #4079), Springfield, Kenilworth, and Cranford; and the Union County Park System Historic District (ID #4424), Springfield, Kenilworth, and Cranford (Figure 10). Several of these historic districts overlap each other, and the individually eligible Rahway River Parkway Historic District is actually contained

within the Union County Park System Historic District. One property within the study area is individually listed on the National Register (NRL): Droescher's Mill (NR #7400192) at 347 Lincoln Avenue in Cranford. An architectural survey was recommended to evaluate many of the historic structures that were recommended eligible for the NRHP and to address the boundaries of historic districts and individual contributing elements for eligibility for the NRHP.

The archaeological sensitivity assessment conducted as part of the Phase IA study consisted of historic map analysis, review of archaeological contexts for Union County, review of known archaeological sites in the area and surface reconnaissance in the study area. Five archaeological sites are located within 1 mile of the study area. One prehistoric archaeological site was located within the study area along the Rahway River just south of Nomahegan Park. Two more archaeological sites reportedly exist along the River bank within the study area but the exact location is unclear from the site forms. Nearly all of the study area was determined to be sensitive for historical and prehistoric archaeological resources. Shovel testing was recommended for all areas where there may be below ground impacts. Deep testing strategies have been recommended for areas where the ground surface has been artificially elevated with the understanding that some fill, having been added for construction of historic homes along the River, may also contain historic materials.

City of Rahway/Robinson's Branch

A survey titled, *Reconnaissance-Level Cultural Resources Investigation for the Rahway River Flood Risk Management and Ecosystem Restorations Project, Robinsons Branch Section, Township of Clark and City of Rahway, Union County, and Township of Woodbridge, Middlesex County, New Jersey* was also completed in 2013 (Nolte et. al. 2013b)**.** The study area consisted of a 500-foot buffer surrounding a 2 mile long segment of the Robinson's Branch of the Rahway River and a 1-mile long stretch of the Rahway River in the City of Rahway. As part of the investigation, previous investigations of the area were reviewed, a historical and cultural context of the project area was developed; all previously identified cultural resources within the study area were enumerated; the archaeological sensitivity of the area was assessed; and above-ground cultural resources in the study area were discussed generally.

The researchers did not conduct a formal architectural investigation for the entire study area. However, a number of the resources observed in the study area were identified as potentially eligible. In addition to individual historic properties, six historic districts were identified within the study area; the Rahway River Parkway Historic District (ID #4079), Union County Park System Historic District (ID #4424), Upper Rahway Historic District (ID #4948), Lower Rahway Historic District/Main Street (ID #2711), Regina Historic District (ID #4048), and the Pennsylvania Railroad Historic District (ID #4568). At the nexus of the Upper Rahway Historic District, the Lower Rahway Historic District, and the Regina Historic District at Irving Street, along Central Avenue, Hamilton Street and Coach Street, lies the municipally designated "Arts District," at the heart of which lies the Rahway Theater (NR #860001509; ID #2714) (Figure 11). Many of these historic districts overlap each other. An architectural survey was recommended to evaluate many of the historic

resources that were identified and to address the boundaries of historic districts and individual contributing elements for eligibility for the NRHP.

Nine archaeological sites have been recorded within 1-mile of the study area. None of the archaeological sites were located within the study area The map analysis, review of prehistoric and historic contexts of Union County, the review of known nearby archaeological sites, and the results of archaeological surface reconnaissance indicate that, with the exception of certain areas that have been identified as recently disturbed, the Robinson's Branch study area is archaeologically sensitive.

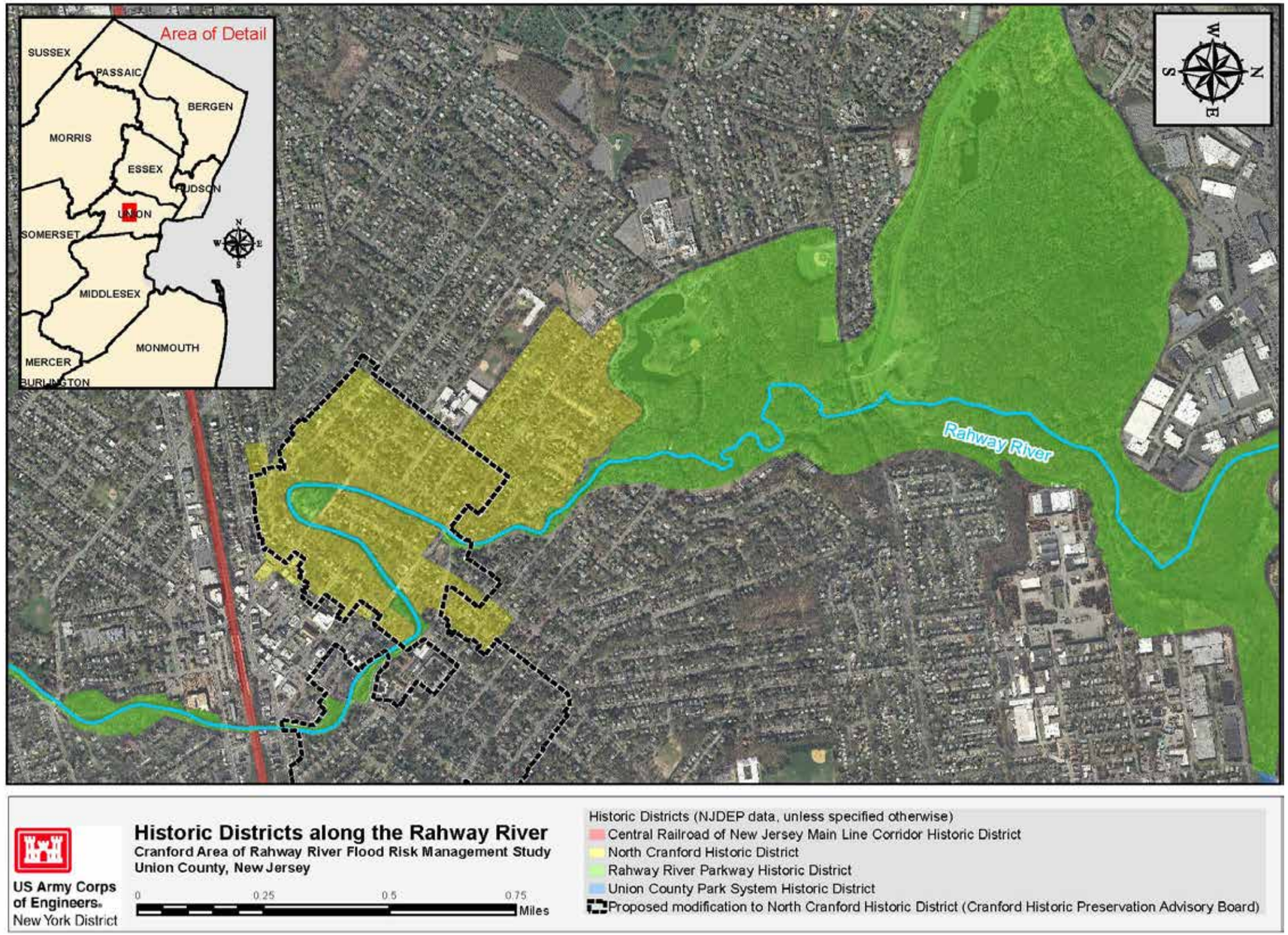

Figure 10. Historic Districts Within the Township of Cranford

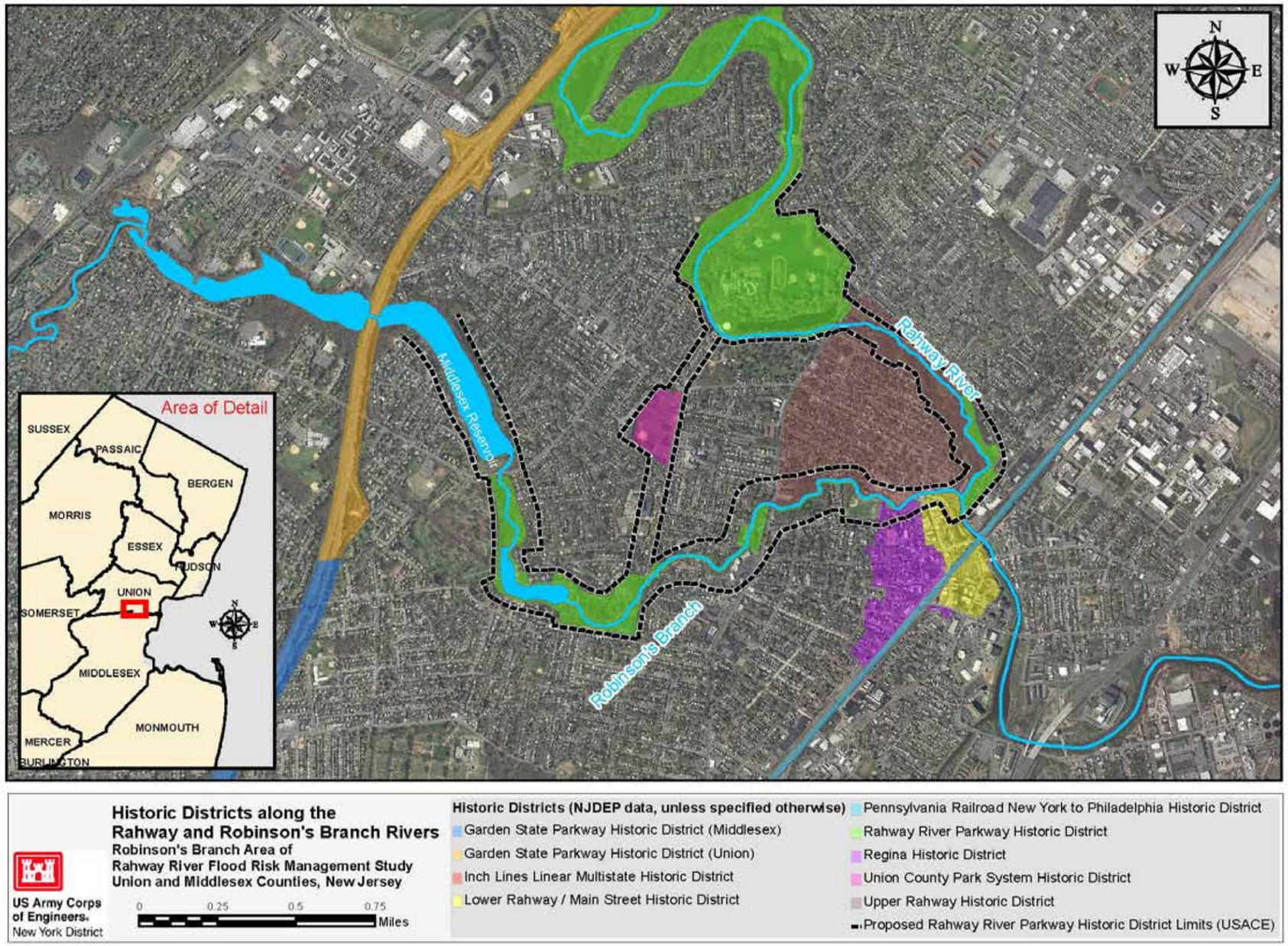

Figure 11. Historic Districts Within the Robinson's Branch

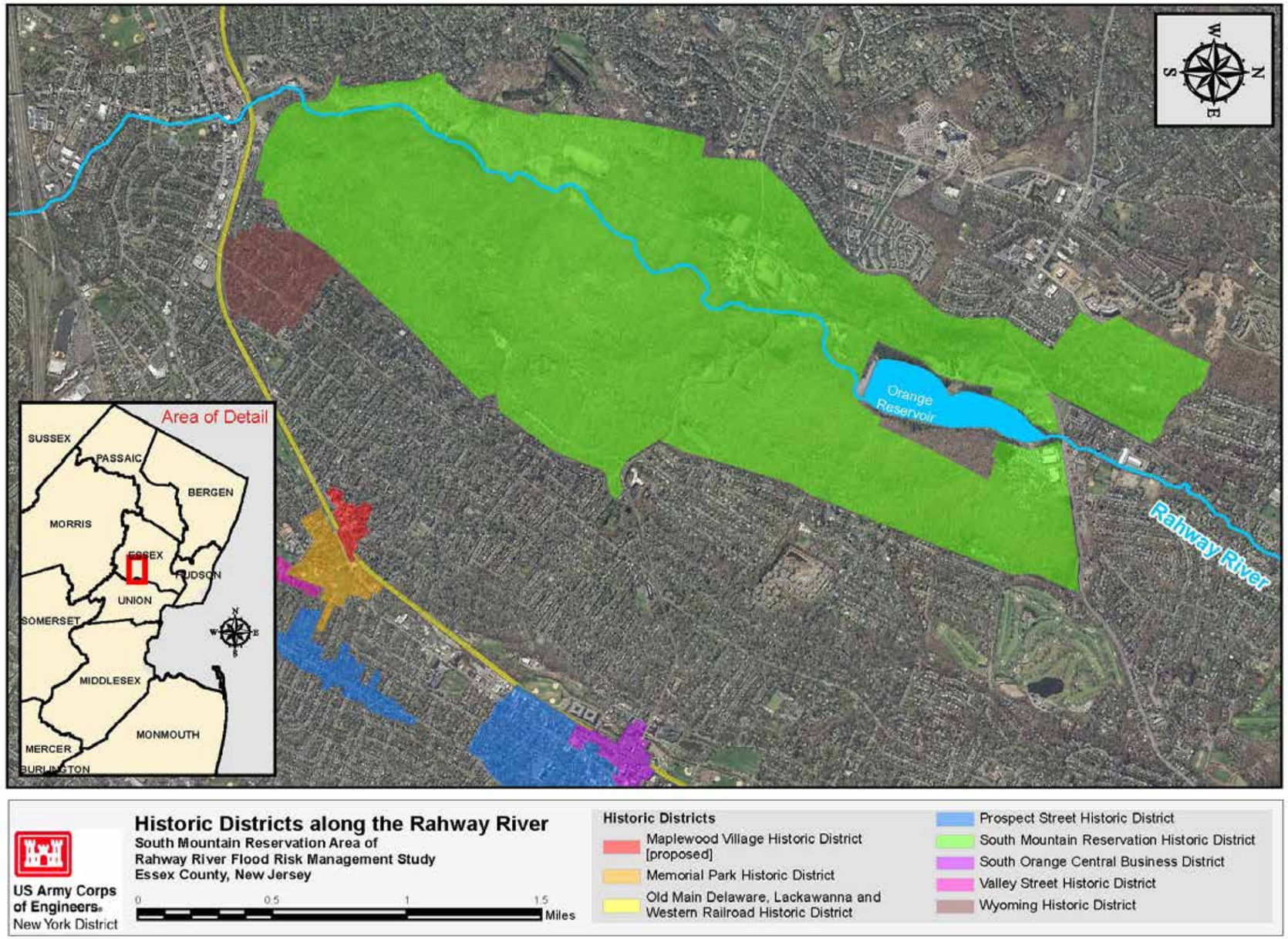

Figure 12. Historic Districts Within the South Mountain Reservation

3.10 Recreation

Township of Cranford/Upstream

Recreational activities within the South Mountain Reservation and Cranford portions of the project area are varied and include those centered on the Rahway River, as well as the network of parks and open spaces. Water-based activities along the Rahway River include fishing, canoeing and kayaking. Fishing access locations identified by the New Jersey Division of Fish and Wildlife along the Rahway River include immediately below Diamond Mills Pond, the pond in Nomahegan Park, the eastern side of Nomahegan along Riverside Drive, and immediately above Droescher's Mill Park (Figures 13-14) (NJDFW, 2016).

Canoeing and kayaking in the Rahway River predominantly occur within the Cranford portion of the project area. The Township of Cranford operates a canoe club where individuals can rent canoes to traverse along an approximate one mile segment of the river from the lower portion of Nomahegan Park to Hansel Dam. Annual events along the river held by the Township of Cranford include Fourth of July canoe races and rubber duck races in October in Sperry Park.

The largest parks within the South Mountain and Cranford portions of the project area include the South Mountain Reservation, Lenape Park and Nomahegan Park. Recreational components within South Mountain Reservation include passive and active features. The main recreational complex is located in the northern portion of the park and is comprised of the Orange Reservoir, the Turtle Back Zoo, the Richard J. Cody Arena, and McLoone's Boathouse restaurant.

Essex County completed major renovations of the Orange Reservoir involving the installation of a picnic pavilion, a floating dock containing paddle boats that can be rented to paddle around the reservoir in 2013, and the installation of a footbridge on the southeastern side of the reservoir to create a 1.75 mile trail around the reservoir in 2014. Essex County holds annual fishing derbies at the reservoir.

Additional active recreational elements within the South Mountain Reservation include a dog park, an archery range, and a Girl Scout camping area. Passive recreation features of the park include 19 miles of hiking and walking trails, 27 miles of carriage roads, picnic areas that are interspersed throughout the park, and several camping sites on the eastern side of the park.

Lenape Park contains hiking and biking trails and is frequently used for bird watching and bird counting events. Recreational components of Nomahegan Park include several baseball and soccer fields, two ponds for fishing, a playground, picnic areas and walking/hiking trails.

Both the Lenape and Nomahegan Parks are part of the East Coast Greenway. The East Coast Greenway is an initiative established by the non-profit organization East Coast Greenway Alliance to create a regional bike path along the east coast of Canada and the United States (East Coast Greenway, 2016).

Six smaller parks under three acres in size are located adjacent to the Rahway River in the Township of Cranford (Figure 13). These parks, their features and any special events or activities held within these parks, are identified in Table 13.

Table 13. Additional Parks and Open Space in Cranford

Park Name	Park Features	Special Events/Activities
Hampton Park	Walking path; benches	N/A
Hanson Park	Walking path; picnic tables; gazebo; small outdoor theater	Yoga; walking; concerts; rain garden
Sperry Park	Walking Paths, benches, fishing access	Cranford annual rubber duck race
Crane's Park	September 11th Memorial, benches, walking path	N/A
McConnell Park	Picnic tables	N/A
Droescher's Mill Park	Maintained as open space	N/A

City of Rahway/Robinson's Branch

Parks and open space along the Robinson's Branch portion of the project area include Kiwanis Park, the Union County Arts Center Park and Milton Lake Park. Union County Arts Center Park is kept as open space. Union County completed construction of a rain garden in Kiwanis Park in 2015 to reduce stormwater runoff. Recreational features at Milton Lake Park include a large reservoir that supports fishing, canoeing, kayaking and ice skating.

3.10.1 Green Acres Program

The Green Acres Program, created in 1961 and administered by the New Jersey Department of Environmental Protection, provides funds for the State or local municipalities through financial assistance by the State to acquire and maintain lands for the purposes of recreation. A review of the Green Acres Program Open Space Database indicates that the majority of the parks and open space areas within the project area are encumbered by Green Acres rules (Figures 13-15).

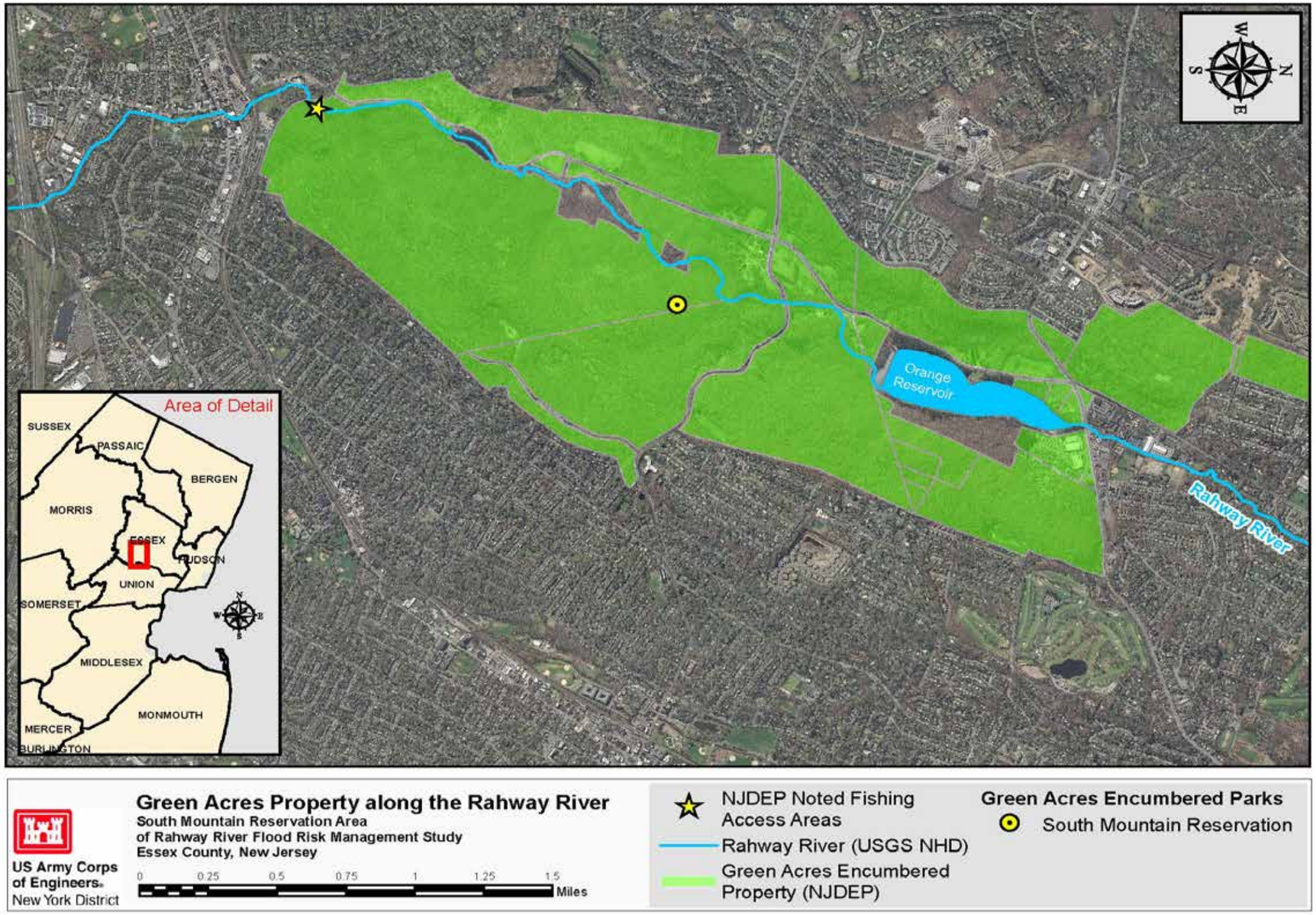

Figure 13. Green Acres Encumbered Lands Within the South Mountain Reservation

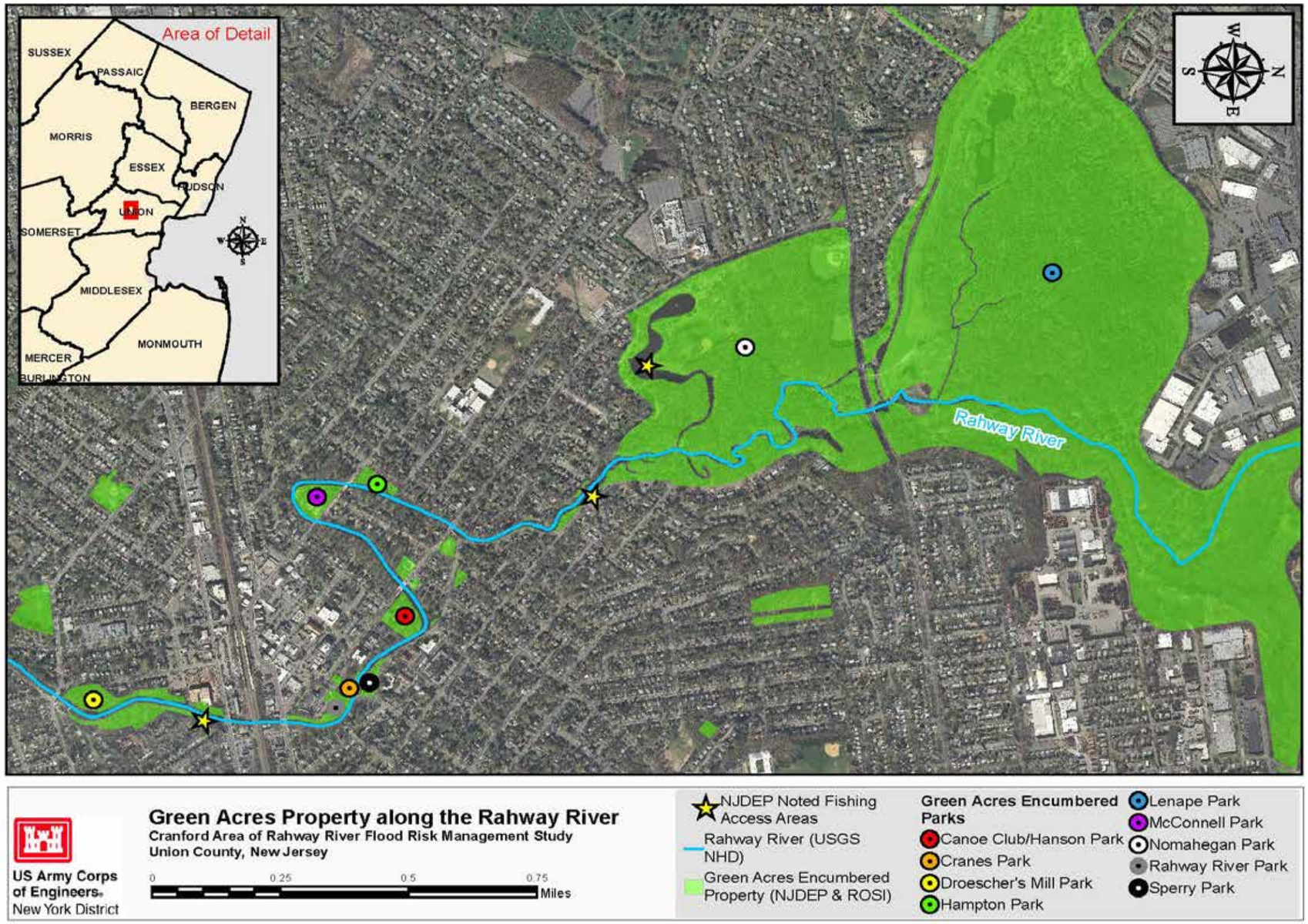

Figure 14. Green Acres Encumbered Lands Within the Township of Cranford

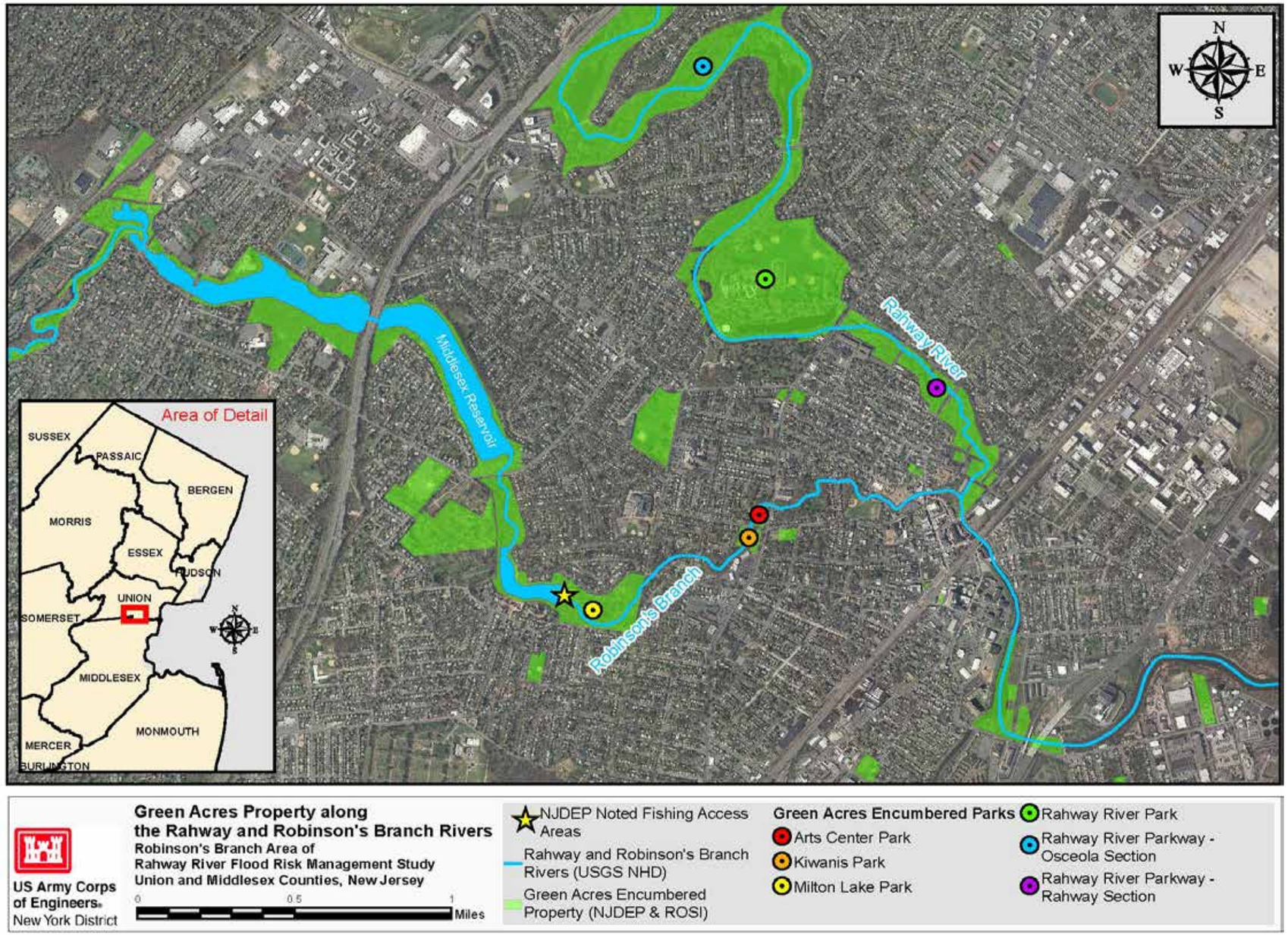

Figure 15. Green Acres Encumbered Lands Within Robinson's Branch

3.11 Aesthetics and Scenic Resources

The parks and open space within the project area, particularly the larger parks, are a regionally significant resource within the project area. The importance of the park system within the project area is underscored by the fact that historically, the lands were specifically acquired in response to concerns of over development and environmental pollution. Currently, they represent a relatively wild, undisturbed space enveloped by an urbanized setting.

In regards to scenic resources of national significance, one of the two designated routes mapped by the National Park Service for the Washington-Rochambeau National Historic Trail is located within South Mountain and Cranford portions of the project area. There are no scenic byways, National Wildlife Refuges, National Parks, National Forests, National Natural Landmarks or National Heritage sites within one mile of the project area. Neither the Rahway River nor Robinson's Branch are associated tributaries area are listed as wild, scenic or recreation rivers.

Township of Cranford/Upstream

The aesthetic quality and value of the project area varies greatly, and is influenced by a number of factors. The visual setting of the northern portion of the project area is dominated by the South Mountain Reservation and the Orange Reservoir. Because it is situated between the first and second Watchung Mountains, trails along the highest elevations within the Reservation offer vistas of New York City, Staten Island and suburbs of New Jersey. Natural features of visual interest include waterfalls, millponds, and headwater streams. The Orange Reservoir is tucked into a forested hill, giving the impression of being at a pristine woodland lake when looking in a easterly/southeasterly direction. The perspective when looking to the west from the eastern shoreline provides views of the floating dock,and boathouse in the forefront of a tree lined background.

The South Mountain and Lenape Park are particularly valued by residents as evidenced by the amount of feedback received by the District from interested parties expressing concern of how preliminary flood risk management alternatives would effect the aesthetic character of these parks.

The visual setting within the Township of Cranford is influenced by the Lenape and Nomahegan Parks, single family residences and Cranford's Business District. The topography in both parks is flat, therefore, sweeping vistas similar to the Orange Reservoir are not present. However, both offer views of relatively undisturbed floodplain forests and unmodified segments of the Rahway River and/or small tributaries. The Nomahegan Park contains a moderately sized lake that provides visual interest. Downstream of the two parks, the visual setting transitions to one that is characterized by moderate density development comprised of single family residences that evolves into the Township of Cranford business district. Within this section, cultural points of visual interest within the Cranford section of the project area include Droescher's Mill and the Crane's- Phillips House, both listed on the National Register of Historic Places. Intermingled with the developed areas throughout the Cranford portion of the project area are the six smaller parks identified in Table 10 that provide views of the Rahway River.

City of Rahway/Robinson's Branch

The visual setting of the Robinson's Branch portion of the project area is characterized by moderate to high-density development along the Rahway River and Robinson's Branch. The viewsheds outward from any given point within the project area are of a developed area. The project area is a residential, and commercial, and most of the land along the rivers is highly developed with properties and lots built right up to the rivers' edges. Aesthetic and scenic resources in the project area consist primarily of tree-lined and vegetated segments of the Sheldrake and Mamaroneck rivers. Milton Lake Park and the Kiwanis and Arts Center parks provide green spaces with views of the lake and/or Robinson's Branch.

3.12 Transportation

Transportation resources within the project area include a system of collector and arterial public roads that provide rapid access to the freeway/expressway systems in the immediate vicinity of the project area. Limited access highways within the project area include Interstate Highways Route 280 and Route 78, the Garden State Parkway, and U.S. Highway Route 22.

Public transportation systems are well developed in the project area with the New Jersey Transit Morris-Essex, Gladstone and Raritan Valley and Northeast Corridor Rail Lines providing rail service to New York City, and Newark and Hoboken New Jersey. New Jersey Transit also provides bus service along Routes 28 and 22 with bus stops directly to NYC from the municipalities in the project area.

3.13 Air Quality

The Clean Air Act (CAA), as amended, assigns the USEPA responsibility to establish primary and secondary National Ambient Air Quality Standards (NAAQS) that specify acceptable concentration levels of six criteria pollutants: particulate matter (measured as both particulate matter less than 10 microns in diameter (PM10) and particulate matter less than 2.5 microns in diameter (PM 2.5), sulfer dioxide (SO2), carbon monoxide (CO), oxides of nitrogen (Nox), ozone (O3) and lead. Short-term NAAQS (1-, 8- and 24-hour periods) have been established for regulated emissions contributing to acute health effects, while long term NAAQS (annual averages) have been established for those emissions contributing to chronic health effects.

Federal regulations designate Air Quality Control regions (AQXRs) in violation of the NAAQS as nonattainment areas. Federal regulations designate AQCRS with levels below the NAAQS as nonattainment and have been redesigned to attainment for a probation period through implementation of maintenance plans. According to the severity of the pollution problem, ozone and PM10 nonattainment areas can be categorized as marginal, moderate, serious, severe or extreme.

Essex and Union Counties are located in the New York-New Jersey-Long Island Air Quality Control Region. Similar to most urban industrial areas, emissions from automobiles, manufacturing processes, utility plants, and refineries have impacted air quality in the project area. Based on the NAAQS for this region Essex and Union Counties

are designated as moderate non-attainment areas for ozone, and as a maintenance area for carbon monoxide.

3.13.1 Green House Gases and Climate Change

Greenhouse gases (GHGs) are components of the atmosphere that trap heat relatively near the surface of the earth and therefore contribute to the greenhouse effect and climate change. Most GHGs occur naturally in the atmosphere, but increases in their concentration result from human activities such as the burning of fossil fuels. Global temperatures are expected to continue to rise as human activities continue to add carbon dioxide (CO2), methane, nitrous oxide, and other greenhouse (or heat-trapping) gases to the atmosphere. Whether or not rainfall will increase or decrease remains difficult to project for specific regions (USEPA 2013c and Intergovernmental Panel on Climate Change [IPCC] 2007).

The CEQ released final guidance in August 2016 regarding how Federal agencies should consider GHG emissions and climate change in NEPA analyses. Although the guidance does not establish a specific threshold for GHG emissions as "significantly" affecting the quality of the human environment or give greater consideration of the effects of GHG emissions and climate change over the other effects of the human environment. However, the guidance does reference rule published in October 2009 by the U.S. EPA outlining mandatory reporting of GHG from sources that emit 25,000 metric tons or more of carbon dioxide per year.

3.14 Noise

Noise is generally defined as unwanted sound. The day-night noise level (Ldn) is widely used to describe noise levels in any given community (USEPA 1978). The unit of measurement for Ldn is the "A"-weighted decibel (Dba), which closely approximates the frequency responses of human hearing.

The primary source of noise in the project area is vehicular traffic on local roadways, local construction projects that may be underway, and operation of businesses. Although noise level measurements have not been obtained in the project area, they can be approximated based on existing land uses. The typical Ldn in residential areas similar to the project area ranges from 39 to 59 Dba (USEPA 1978). The project area is characterized as residential and business development, therefore existing sound levels are likely within this range.

Chapter 4.0 Plan Formulation

The 1983 Economic and Environmental Principles and Guidelines for Water and Related Land Implementation Studies (Principles and Guidelines) laid out an iterative 6-step planning process used for all USACE Civil Works studies in developing and evaluation of alternatives. For flood risk management problems, the study team develops and evaluates potential alternatives consistent with USACE policy, regulations, and guidance. From the range of alternatives compared, the team will identify the plan with the highest net National Economic Development (NED) benefits while protecting the Nation's environment.

4.1 Problem and Opportunity Statement

The problem and opportunity statements and discussion provided below set the focus of the feasibility study. These statements are developed at the start of the study and lead to the identification of the study objectives.

Problem

The water resources problem to be solved is fluvial flooding in the study area. Flooding within the Rahway River Basin is caused principally by rainfall during storm events. The problem is exacerbated by impervious surface coverage in the area which has resulted in a large increase of stormwater runoff into the Rahway River and its tributaries. The increased runoff coupled with inadequate channel capacities and bridge openings account for most of the flooding problems. Flooding causes negative impacts to life safety and critical infrastructure. Flooded local routes have the potential to block or delay emergency response teams in the area as well as impacting critical infrastructure and facilities. The Cranford First Aid Squad ambulance facility located at 6 Centennial Avenue in Cranford has suffered prior flood damage, notably and most recently from Tropical Storm Irene, from which it was forced to renovate the facility. Measures to reduce flood damages have been sought by local interests for many years.

Storm Events

Descriptions of notable recent storm events in the Rahway River Basin which caused significant damage are below. These include Tropical Storm Floyd in September 1999, 15-16 April 2007 and Tropical Storm Irene in 27-28 August 2011.

Tropical Storm Floyd

Rainfall totals from Tropical Storm Floyd in September 1999 were as high as 12 to 16 inches over portions of New Jersey, 4 to 8 inches over southeastern New York, and up to 11 inches over portions of New England. Tropical Storm Floyd resulted in new flood peaks of record at sixty or more stream gages within the portions of New Jersey and New York contained by New York District's Civil Works boundaries. Within the Rahway River basin, the total rainfall at Cranford, NJ was 10.82 inches. This resulted in flows approaching the 100 year level in portions of the Rahway River Basin.

15-16 April 2007 Nor'easter

The April 2007 nor'easter caused about three to ten inches of rain to fall on the watersheds within the New York District's Civil Works boundaries in April 2007, resulting in new

flood peaks of record at ten USGS gages in New Jersey. The approximate total rainfall of the April 2007 nor'easter over the watersheds of the New York District was an average of 7 to 7 ½ inches. Within the Rahway River basin, the total rainfall at Cranford was 6.47 inches. This resulted in flows from greater than the 4% annual chance exceedane to 2% annual chance exceedance flood levels in portions of the Rahway River Basin.

Tropical Storm Irene

Significant damages occurred in north and central New Jersey, where flooding was widespread. Severe flooding took place on the Raritan, Millstone, Rockaway, Rahway, Delaware and Passaic Rivers due to record rainfall. The flooding effected roads and ten deaths within the state are attributable to the storm.

The Rahway River Watershed Mayors' Council, a local stakeholder group, made a statement reporting that Tropical Storm Irene impacted 1,600 structures in Cranford, with 300 structures receiving damage to the main floor, and $16.5 million in damages to residences, plus $4 million in damages to two schools. The Mayors' Council statement also indicated that damages totaling $15 million were incurred to 412 structures in Union Township, and that damages totaling $8 million were experienced by more than 80 homes in Springfield Township during Tropical Storm Irene.

In addition to major flooding, the combination of already heavily saturated ground from a wet summer, and heavy wind gusts made New Jersey especially vulnerable to wind damage. One of the hardest hit areas due to high winds was Union County, part of the Rahway River Basin. Fallen trees, many pushed from the soaked ground with their roots attached, blocked vital roads from being accessed by local emergency services. Numerous homes suffered structural damages from the winds, and limbs impacting their roofs. Perhaps the most critical damage however due to wind was fallen wires. Around Union County, fallen wires in combination with flooded electrical substations left parts of Union County, including Cranford, Garwood, and Westfield without power or phone service for nearly a week. In total, approximately 1.46 million customers throughout most of the 21 counties lost power. On 29 August, the governor of New Jersey asked President Obama to expedite release of emergency funds to the state. Eventually all 21 counties became eligible for FEMA aid. Figures 16 and 17 show residual flood waters in the Township of Cranford after Tropical Storm Irene causing widespread flooding within the study area.

Opportunity

There is an opportunity to reduce the risk of fluvial flooding in the study area through implementation of one or more flood risk management measures. The greatest opportunities for flood risk management lie within the Township of Cranford and the Robinson's Branch in the City of Rahway, two areas within the basin that experienced regular flooding in past storm events. Without-project annual damages for the Township of Cranford and other upstream municipalities combined have been calculated at $9,773,630 while the Robinson's Branch area without-project annual damages have been calculated at $2,695,830. More information on without-project annual damages can be found in Section 4.4.3 and in Appendix B – Economics.

Figure 16. First Aid Squad in Cranford (Tropical Storm Irene – 2011)

Figure 17. Cranford Business District (Tropical Storm Irene – 2011)

4.2 Planning Goals/Objectives

Study goals and objectives were developed to comply with the study authority and to respond to study area problems. Planning objectives were identified based on the problems, needs and opportunities as well as existing physical and environmental conditions present in the study area. The main goal is Contribute to National Economic Development (NED) by reducing the frequency and severity of fluvial flood damages within the study area, consistent with the nation's environment, pursuant to national environmental statutes, applicable executive orders and other Federal planning requirements. The main Federal objective is to reduce the frequency and severity of fluvial flood damages within the main damage centers of the Township of Cranford and the City of Rahway. Recommended plans should avoid, minimize, and then mitigate, if necessary, adverse project impacts to the environment. They should also avoid adverse social impacts and meet local preferences to the fullest extent possible.

The goals and objectives of the Rahway River Basin Feasibility Study are:

Goals

- Contribute to National Economic Development (NED) by reducing the risk of fluvial flood damage.
- Reduce the risks to life safety within the study area.
- Provide a plan that is compatible with future flood risk management and economic development opportunities.
- Where possible flood risk management alternatives should benefit environmental resources.

Objectives

- Reduce the risk of damages to property and dangers to life safety resulting from fluvial flooding within the main damage centers of the Township of Cranford and the Robinson's Branch area in the City of Rahway.
- Increase public awareness to the risk of flooding from the Rahway River.

4.3 Planning Constraints

Unlike planning objectives that represent desired positive changes, planning constraints represent restrictions that should not be violated. Further, plan formulation must provide safe conditions in the interest of public safety and be socially acceptable to the community. Planning constraints considered to this point are as follows:

Constraints

- *Formulation (Levees/Floodwalls)**:*** High density residential and commercial development along the stream banks may preclude construction of levees and floodwalls in certain areas due to high real estate costs.
- *Green Acres:* Portions of land in the study area are encumbered by the NJDEP Green Acres Program, particularly the Orange Reservoir and portions of the Township of Cranford. Plans will be formulated to minimize and/or mitigate impacts. Refer to Section 3.10.1.

Considerations

- *Upstream v. Downstream:* Construction of Cranford/Upstream features may result in minimal reductions of water surface elevation levels downstream in the Robinson's Branch area. Although this minimal reduction does not affect plan selection future analysis will take this factor into account.
- *Environmental and Cultural Resources:* Alternatives should be designed to avoid or minimize negative impacts to these resources, to the maximum extent practical.
- *Flood Heights:* The 1% annual chance exceedance flood flow water surface elevation should not increase more than 0.2 feet with a flood risk management alternative in place. This is in accordance with the rules and regulations of the New Jersey Flood Hazard Area Control Act.
- *Flood Heights:* The industry standard is not to induce any additional flood damages to any areas beyond the limits of the Flood Risk Management Project.

4.4 Future Without Project Condition

The future without project condition serves as the base condition to use as a comparison for all the other alternatives. The future without project condition within the period of analysis (2023-2073) are identified as continued damages to structures, content, vehicles, infrastructure, life safety and quick access to emergency services from future storm events. This will result in continued maintenance and reconstruction of private armoring (bulkheads) and repairs to houses and roads following storm events.

4.4.1 FWOP/ No Action Plan

The future without project condition serves as the base condition to use as a comparison for all other alternatives. The future without project condition within the period of analysis is identified. Relevant resources of the area and the No Action alternative are succinctly described as required by NEPA. The No Action alternative and the plan formulation "Future Without-Project" setting are equivalent.

Land Use

In the short-term, selecting the No Action alternative would not change land use, land cover and zoning in the project area. However, in the long term, flood damage to properties abutting the Rahway River and Robinson's Branch, particularly in flood prone areas are likely to sustain continued damage during future storm events. Without proactively addressing flood risks, costly damages will continue to accrue and some businesses and residences may eventually be abandoned, property values may decrease, or development may be prohibited, all of which could lead to changes in land use, cover or zoning.

4.4.2 Environmental Without Project Conditions

<u>Topography, Geology and Soils</u>

The No Action alternative would not result in any change to the topographic and geologic resources within the project area. However, without any flood improvements, flooding, erosion, sedimentation and scour will continue in the long-term.

Water Resources

Under the No Action alternative, water quality and habitat would remain unchanged unless others take restorative actions to enhance aquatic habitat and water quality. In addition, there will be no changes to wetland communities within the project area.

Vegetation

The No Action alternative would have no effect on the plant communities that occur within the project area. There are no short or long-term disturbance to any vegetation and thus upland and wetland communities would remain as they are expect for changes associated with natural disturbance events – including future flooding events- and community succession.

Fish and Wildlife

Under the No Action alternative, fish and wildlife utilization of the project areas will be consistent with current conditions. The same is true for any state and/or federal endangered, threatened or special concern species that may occur within the project area.

Cultural Resources

Under the No Action Plan, continued flooding in the parks and historic neighborhoods would likely result in deterioration of historic resources leading to their degradation and possible loss.

Recreation

Parks and water dependent recreational opportunities within the project would remain the same under the No Action alternative. However, flood events could impact usability of the open space/park adjacent to the Rahway River and Robinson's Branch through inundation or deposition of debris that could result on park closures.

Aesthetics and Scenic Resources

Under the No Action Alternative, aesthetic and scenic resources would remain unchanged from current conditions.

Hazardous, Toxic and Radioactive Waste

The No Action alternative would not change the HTRW conditions within the area.

Air Quality

Ambient air quality would remain unchanged when compared to existing conditions under the No Action alternative. The No Action alternative would not result in any loss of vegetation, including trees, and would not likely result in the reduction of carbon sequestration or energy use. However, older trees that have reached the end of their life span, subject to insect damage or lack of maintenance, may be more susceptible to loss during storm or flood events.

Noise

Under the No Action alternative, noise conditions would remain unchanged when compared to existing conditions.

4.4.3 Economic Without Project Conditions

Because the study and project areas are well developed, there is little opportunity for new expansion. The total value of the existing residential and commercial inventory in the study area is estimated to be approximately $1.4 billion. There are a few vacant parcels, which are among the most severely eroded properties as they do not have bulkheads.

4.4.4 Estimate of Future Without Project Damages

The Hydrologic Engineering Center – Flood Damage Analysis (HEC-FDA) model model links the predictive capability of hydraulic modeleing with project area infrastructure information, structure and content damage functions, and economic valuations to estimate the damages and benefits of alternatives within the project area. HEC-FDA fully incorporates risk and uncertainty, and is used to simulate future flood damages at existing and future years and to compute accumulated present worth damages. HEC-FDA is an event-driven life-cycle model that estimates damages and associated costs over the 50-year period of analysis based on storm probabilities and other factors. Damages or losses include depreciated structure value, content and vehicle damage.

Future Without Project Condition Damages. The HEC-FDA model was used to estimate damages to the assets in the study area over the 50 year period of analysis with no Federal action (i.e. the "future without project condition" (FWOP)). Detailed information on the damage inventory, damage calculations, and HEC-FDA are provided in Appendix B (Economics).

Township of Cranford/Upstream

In total 3,365 structures in the project area were identified and subjected to the inventory process for the purposes of damage estimation. Table 14 presents a summary of the numbers of structures experiencing damage at selected annual chance exceedance events across the whole study area, broken down by damage category. Note that Table 14 was compiled without the application of risk and uncertainty to water surface elevations or structure elevations in the HEC-FDA model. Table 15 presents a summary of the distribution of building types in the study area and total depreciated structure replacement values at October FY15 price levels by damage categories and municipalities.

Table 14. Summary of Damaged Structures by Flood Event (Cranford/Upstream)

Damage Category	Annual Chance Exceedance Event						
	50% (2-yr)	20% (5-yr)	10% (1-yr)	4% (25-yr)*	2% (50-yr)	1% (100-yr)	<1% (>100-yr)
Residential	20	35	107	410	803	1,270	3,,043
Apartment	2	3	3	7	11	12	47
Commercial	2	6	15	42	63	87	221
Industrial	0	0	0	5	6	7	12
Institutional	0	0	0	0	1	4	13
Municipal	0	1	1	3	10	10	22
Utility	0	1	1	4	5	5	7
Total	*24*	*46*	*127*	471	*899*	*1,395*	*3,365*

*TSP level of design

Table 15. Summary of Structure Inventory (Cranford/Upstream)

Damage Category	Municipality					
	Cranford	**Kenilworth**	**Springfield**	**Union**	**Millburn**	**Totals**
Residential #	1,265	146	718	540	374	**3,043**
Residential Value	$382,844,000	$29,799,000	$170,083,000	$126,986,000	$94,921,000	**$804,633,000**
Apartment #	0	0	18	10	19	**47**
Apartment Value	$0	$0	$28,233,000	$17,079,000	$23,794,000	**$69,107,000**
Commercial #	48	5	23	15	130	**221**
Commercial Value	$24,995,000	$4,023,000	$74,461,000	$146,661,000	$161,791,000	**$411,931,000**
Industrial #	0	1	3	8	0	**12**
Industrial Value	$0	$911,000	$3,418,000	$18,939,000	$0	**$23,268,000**
Municipal #	10	0	9	0	3	**22**
Municipal Value	$23,913,000	$0	$49,789,000	$0	$1,275,000	**$714,061,000**
Institutional #	1	0	1	0	11	**13**
Institutional Value	$5,465,000	$0	$5,201,000	$0	$153,001,000	**$26,731,000**
Utility #	5	0	1	0	1	**7**
Total #	**1,329**	**152**	**773**	**573**	**538**	**3,365**
Total Value	**$437,217,000**	**$34,733,000**	**$331,185,000**	**$309,665,000**	**$297,846,000**	**$1,410,646,000**
% of Total #	**39%**	**5%**	**23%**	**17%**	**16%**	**100%**
% of Total Value	**31%**	**2%**	**23%**	**22%**	**21%**	**100%**

Using HEC-FDA, Average Annual Damages (AAD) were calculated for the without-project base year (2023) and the future condition, and Equivalent Annual Damages (EAD) were calculated for the 50-year period of analysis, using the 2016 fiscal year USACE project evaluation and federal plan formulation discount rate of 3.125%. The total equivalent annual damage resulting in these calculations is approximately $9,774,000. A summary of the total equivalent annual damages for the without-project condition by municipality is presented in Table 16.

Table 16. Summary of Without-Project Equivalent Annual Damage (Cranford/Upstream)

Municipality	Total Damage	% of Total
Cranford	$3,061,550	31%
Kenilworth	$161,040	2%
Springfield	$1,241,360	13%
Union	$1,606,000	16%
Millburn	$3,703,680	38%
Total	*$9,773,630*	*100%*

Price level: October 2015, 3.125% Discount rate.

City of Rahway/Robinson's Branch

In total 933 structures in the project area were identified and subjected to the inventory process for the purposes of damage estimation. Table 17 presents a summary of the distribution of building types in the study area and total depreciated structure replacement values at October FY15 price levels by damage categories and municipalities.

Table 17. Summary of Structure Inventory (Robinson's Branch)

Damage Category	Municipality
	Rahway
Residential #	751
Residential Value	$198,989,000
Apartment #	85
Apartment Value	$219,829,000
Commercial #	76
Commercial Value	$79,106,000
Industrial #	4
Industrial Value	$19,324,000
Municipal #	6
Municipal Value	$1,383,000
Institutional #	7
Institutional Value	$4,517,000
Utility	4
Total #	**933**
Total Value	**$523,148,000**

Using HEC-FDA, Average Annual Damages (AAD) were calculated for the without-project base year (2023) and the future condition, and Equivalent Annual Damages (EAD) were calculated for the 50-year period of analysis, using the 2016 fiscal year USACE project evaluation and federal plan formulation discount rate of 3.125%. The total equivalent annual damage resulting in these calculations is approximately $9,774,000. A summary of the total equivalent annual damages for the without-project condition by municipality is presented in Table 18.

Table 18. Summary of Without-Project Equivalent Annual Damage (Robinson's Branch)

Municipality	Total Damage
Rahway	$2,695,830

Price level: October 2015, 3.125% Discount rate.

Inspection of the results shows that 38% of the without-project condition damages are being incurred by structures considered to be primarily flooded in the Millburn section of the Rahway River through the study area, with 31% incurred in Cranford, despite Cranford containing a greater share of the structures in the inventory (both in terms of number and value) than Millburn. It is also apparent that commercial and residential damages are approximately equal, despite the overwhelming preponderance of residential structures in the study area. It is worth noting, however, that the average structure value of commercial structures in the study area is more than five times that for residential structures.

4.5 Key Uncertainties

Limitations to the quantity and quality of information result in uncertainties. Two uncertainties in this phase of the planning process are:

Orange Reservoir: Alternatives that include modification of the Orange Reservoir dam as a plan element assume full cost to replace the dam in order to bring the dam into compliance with USACE Dam Safety standards. The full scope and range of modification and repairs needed to use Orange Reservoir Dam for Flood Risk Management is not fully known at this time. Investigations to determine the scope and range of modifications necessary to bring the dam into compliance with USACE Dam Safety standards along with the appropriate construction techniques will be determined in the Preconstruction Engineering Design (PED) Phase. While full replacement of the dam and a complete draining of Orange Reservoir is unlikely, costs to replace the dam and drain Orange Reservoir were assumed as a worst case, high cost scenario. Implementation of plan elements involving the Orange Reservoir dam will likely include some type of coffer dam in conjunction with lowering the reservoir to perhaps half of its current depth for one or two construction seasons (1.5 years). This conservative assumption may lead to understatement of net benefits of any alternatives that include modifications to Orange Reservoir.

Upstream v. Downstream: Upstream alternatives may effect water surface elevation levels and flows within the downstream Robinson's Branch area. Upstream alternatives that include detention as a feature such as Orange Reservoir could provide benefits within the Robinson's Branch area. The effect of upstream flood risk management upon the Robinson's Branch alternatives is unknown. One HEC-RAS model is being used for the basin. Robinson's Branch alternative plans will be scoped with hydrology and hydraulics taken into account.

4.6 Management Measures – Screening of Candidate Measures

For the initial iteration of the planning process potential measures were formulated and screened. In general, measures are types of actions that accomplish the study objectives when implemented. Strategies to address fluvial flood risk include structural measures,

nonstructural measures, and no action. To enact these strategies, nonstructural measures (actions to reduce flood damages without significantly altering the nature or extent of flooding) and structural measures (physical modifications designed to reduce the frequency of damaging levels of flood inundation) were examined. These measures can be used individually or combined with other management measures to form alternative plans. The list of measures considered was derived from a variety of sources including experience from prior studies and coordination with the NJDEP and local stakeholders.

No-Action

The "No Action" alternative serves to establish what existing and future without project conditions in the area might be, acts as a baseline to which all other alternatives are compared and is a requirement of the NEPA process. With the No Action Plan, it is assumed that no project would be implemented.

Nonstructural Measures

Nonstructural measures included for consideration in alternative plan formulation include elevation (raising), flood proofing, buyouts and flood warning systems. Unlike structural measures, these features seek to provide flood risk management to individual structures within the floodplain.

- *Property Buy-Outs.* Buy-outs involve the acquisition of property and its structures and/or the purchase of development rights. A buy-out plan would result in the permanent evacuation of the floodplain in areas of frequent and severe inundation. Development in the areas would cease and structures would be demolished or relocated. A buy-out plan would be successful in re-establishing and maintaining a natural state of the floodplain for purposes that would not be jeopardized by the flood hazard. However, this type of program causes emotional hardship, involves expensive relocation costs, and results in the loss of a community/local tax base.
- *Elevating Structures.* Elevating structures is the process of raising the main living area above the level of the most severe and recurrent floods. Usually, structures are held by hydraulic jacks and temporary supports while a new or extended foundation of piers, posts, columns, or pilings are constructed. After the structure is elevated, only the foundation would remain exposed to flooding.
- *Flood proofing Buildings.* Flood proofing is the process of making adjustments in the design or construction of buildings to reduce potential flood damages. Buildings could be dry or wet flood proofed. Dry flood proofing would provide flood risk management to a building by sealing its exterior walls and providing removable shields at structure openings to prevent the influx of floodwaters. Wet flood proofing would provide flood risk management to a building by allowing floodwaters to enter and exit freely, which reduces the load imposed on the structure.
- *Flood Warning System.* In situations where a structural or nonstructural flood damage reduction project is not feasible, a flood warning system may provide some relief to those located within an area subject to flood damages. Even in areas that can claim benefits from a completed project, a flood warning system can afford residents advance warning of what is to come and allow them time to make

appropriate preparations. While a flood warning system does not prevent flooding and does not reduce damage to property that is left in the path of floodwaters, it can provide an aid in reducing property loss and increasing the safety of individuals. With the use of a flood warning system, property, such as motor vehicles, can be relocated to higher ground in time to prevent damage from rising waters. In addition, moveable items can be taken to higher floors within structures, where they will not be impacted. Finally, residents will have time to leave the area, if necessary, for their own safety. Elaborate flood warning systems can be designed and implemented for a particular location.

Structural Measures

Structural features reduce flood risk by modifying the characteristics of the flood. They are often employed to reduce peak flows (flood storage); direct floodwaters away from flood prone property (flood barriers); or facilitate the flow of water through or around an area (channel modifications or diversions). All of these features have the potential to reduce flood damages; however, not all may be economically justified. Structural measures considered in the formulation of alternative plans include diversion culverts, levees/floodwalls, channel modifications, detention basins and clearing and snagging. These structural measures and the results of the initial screening are described below.

- *Floodwalls.* Floodwalls are structures composed of steel, concrete, rock, or aluminum, and are used when residential properties directly abut a channel or the shoreline and there is not enough space to construct a levee, or in cases where storm induced floods are too severe for a levee. Interior drainage facilities, located on the landward side of the floodwall, would be needed to collect, control, and disperse water trapped behind the barriers. Otherwise, floodwaters would pond behind the barrier.
- *Road Raising*. Roads that currently experience flooding during storms due to tidal waters or surface runoff would be elevated to heights that would minimize or eliminate the impacts of such events.
- *Levees.* Levees are typically low, wide earthen embankments built to retain floodwater inside a channel. Interior drainage facilities, located on the landward side of the levees, would be needed to collect, control, and disperse water trapped behind the barriers. Otherwise, floodwaters would pond behind the barrier and potentially breach the levee.
- *Storm Gates.* Storm gates are used to alleviate the inundation of landward areas as floodwaters enter canals and creeks. During flood events, storm gates placed across waterways would be closed, and high flows in the creeks would be pumped around the closure.
- *Channel Modification.* Modification of the cross-section of a channel of water along a length or lengths of that channel can sometimes improve flow and reduce or prevent fluvial flooding.
- *Barriers (aka. Ringwall).* Barriers usually surround the building(s) and are sometines used where nonstructural measures are not feasible.

4.7 Initial Alternatives Array – Evaluation of Measures

The flood risk management measures described above were screened based on the degree to which they met the project objectives and minimized or avoided project constraints. Specifically, measures were evaluated based on their ability to reduce storm induced damages to the project areas. The screening of measures is documented in Table 19. Those measures that are not entirely screened out are carried forward for more detailed analysis as alternative plan components.

Table 19. Evaluation of Initial Alternatives

Measure	Outcome	Challenges	Retained for Further Study?
No Action	· Existing economic, social, and environmental conditions and trends within the effected area continue with no recommended Corps project.	· Continued potential for loss of life and physical, as well as environmental, damage to study area communities in the occurrence of significant flooding. · Significant flooding can result in municipal infrastructure damage, loss of jobs, and closure of businesses.	· Yes, per NEPA and ER 1105-2-100, the No Action Plan is the basis for comparison.
Channelization	· Increase conveyance capacity of stream. · Help reduce water surface elevations and flood damages throughout the basin. · Reduce channel blockages resulting from high sediment loads and bank material transported during flood events.	· Destruction of wetlands and impacts to jurisdictional waters. Full environmental assessment and impact analysis is required. This could result in high environmental mitigation costs. · Costs for acquisition of real estate interests may be high. · Additional exploration for potential cultural and historic resources needs to be completed. Significant cultural resource mitigation costs may be required.	· Yes, while costs may be high, this measure has the potential for economic justification and will meet the planning objectives to reduce flood impacts in the basin.
Diversion Culvert	· Increase conveyance capacity of stream.	· A hydraulically suitable location is required between the Rahway	· No, this measure will not meet the planning objectives to reduce flood impacts in the basin as it

Measure	Outcome	Challenges	Retained for Further Study?
	· Help reduce water surface elevations and flood damages throughout the section of basin downstream of Rt. 46.	River and another body of water or storage area. · Impact on flood risk reduction would be limited. · Costs for excavation/construction, road work, transportation disruption , utility relocation and acquisition of real estate interests would be high. · Additional exploration for potential cultural and historic resources needs to be completed. Significant cultural resource mitigation costs may be required.	does not have the potential for economic justification and would not have a significant impact on flood risk reduction.
Levee / Floodwall	· Help reduce flood damages throughout the basin by provide flood risk management to areas traditionally sustaining flood damages from overbank flooding.	· Destruction of wetlands and impacts to jurisdictional waters. Full environmental assessment and impact analysis is required. This could result in high environmental mitigation costs. · Costs for acquisition of real estate interests may be high. · Additional exploration for potential cultural and historic resources needs to be completed. Significant cultural resource mitigation may be required.	· Yes, while costs may be high, this measure has the potential for economic justification this and will meet the planning objectives to reduce flood impacts in the basin.
Detention Basins	· Help reduce water surface elevations and flood damages by temporarily detaining waters upstream of areas traditionally	· Areas must exist that have the potential to store enough water temporarily to sufficiently reduce water surface elevations and flood damages downstream.	· Yes, this measure will meet the planning objectives to reduce flood impacts in the basin as areas with the potential

Measure	Outcome	Challenges	Retained for Further Study?
	sustaining flood damages.		for significant storage have been located.
Barriers (aka ringwalls)	· Reduce flood damages to properties. · Minimize environmental impacts.	· Constructing barriers on a significant portion of floodplain properties would be prohibitively expensive. · Public acceptability of a mandatory large-scale plan is typically difficult.	· Retained for further study as this would meet the planning objectives to reduce flood impacts in the basin.
Floodproofing of flood prone residences, businesses and public facilities subject to frequent flooding	· Reduce flood damages to properties. · Minimize environmental impacts.	· Floodproofing a significant portion of floodplain properties would be prohibitively expensive. · Public acceptability of a mandatory large-scale plan is typically difficult.	· Retained for further study as this would meet the planning objectives to reduce flood impacts in the basin. As per ER 1105-2-100, a nonstructural flood risk management plan must be examined to compare against structural flood risk management plans.
Permanent evacuation of residences and businesses (buyouts)	· Reduce flood damages to properties. · Minimize environmental impacts and possibly create additional open space and floodplain area.	· Acquisition and relocation of a significant portion of floodplain properties would be prohibitively expensive. · Public acceptability of a mandatory plan is unlikely.	· Retained for further study as this would meet the planning objectives to reduce flood impacts in the basin. As per ER 1105-2-100, a nonstructural flood risk management plan must be examined to compare against structural flood risk management plans.
Flood Warning System	· Allow residents to evacuate low-lying areas in advance of flood.	· Rapid overbanking leads to insufficient forecast and warning time to implement an effective evacuation for flash flooding within the basin.	· Not considered for further study as this measure would not provide any significant

Measure	Outcome	Challenges	Retained for Further Study?
			flood risk management benefits in this basin.
Clearing and Snagging	· Reduce water surface elevations. · Minimize environmental impacts and allow stream channel to maintain carrying capacity.	· Minor snagging and clearing would not have a measurable impact on flood stages.	· Not considered for further study as this measure would not meet the planning objectives to reduce flood impacts in the basin.

In addition to the more general measures above, measures involving the Middlesex Reservoir were analyzed but screened out.

Modification of Middlesex Reservoir
Several analyses were performed for the Middlesex Reservoir, a combination with several new outlet pipes/gate, operation before and during the storm event, and spillway modification.

All the analyzed plans resulted with a low performance in flood risk reduction in the Robinson's Branch. This is due to several reasons:

(1) Rahway River Flood - Backwater from the Rahway River prevents a reduction in flood for most of the Robinson's Branch.
(2) Lack of storage capacity - The storage capacity is approximately 200 ac-ft.

There are other disadvantages with the plan:

(1) Additional storage will delay the peak flow in Robinson's Branch making it more coincidental with the Rahway River peak flow. This might result in higher WSE at the confluence with the Rahway River.
(2) Complex operation of gates.
(3) Possible induced flooding upstream or downstream due to uncertainty in the storm event prediction and the associated operation of the dam.
(4) High cost associated with the dam modification and possible replacement.

Due to the low performance and significant disadvantages there was no further analysis on the Middlesex Reservoir. Similar results were concluded during the 1980's Robinson's Branch analysis.

4.7.1 Refined Measures

Measures that survived initial screening for the three project areas can be seen in Figures 18-20 below. For South Mountain and Orange Reservoir, detention is the only measure considered. This would provide flood risk management downstream to the municipalities of Cranford, Millburn and Springfield and would be accomplished by construction of a dam in the South Mounain area or by outlet modifications to the Orange Reservoir Dam and/or removal of sedimentation in the reservoir. In addition to benefitting from detention upstream, flood risk management in the Township of Cranford could be provided by channel modifications, levees/floodwalls and/or detention. Channel modification and levees/floodwalls could be constructed along the Rahway River within Cranford. Detention in Cranford would be provided by modification to the Lenape Park Dam and embankments. Flood risk management in the Robinson's Branch area in the city could be accomplished by levees/floodwalls, channel modifications and a variety of nonstructural measures. Section 4.8 lists the final array of alternatives and provides descriptions.

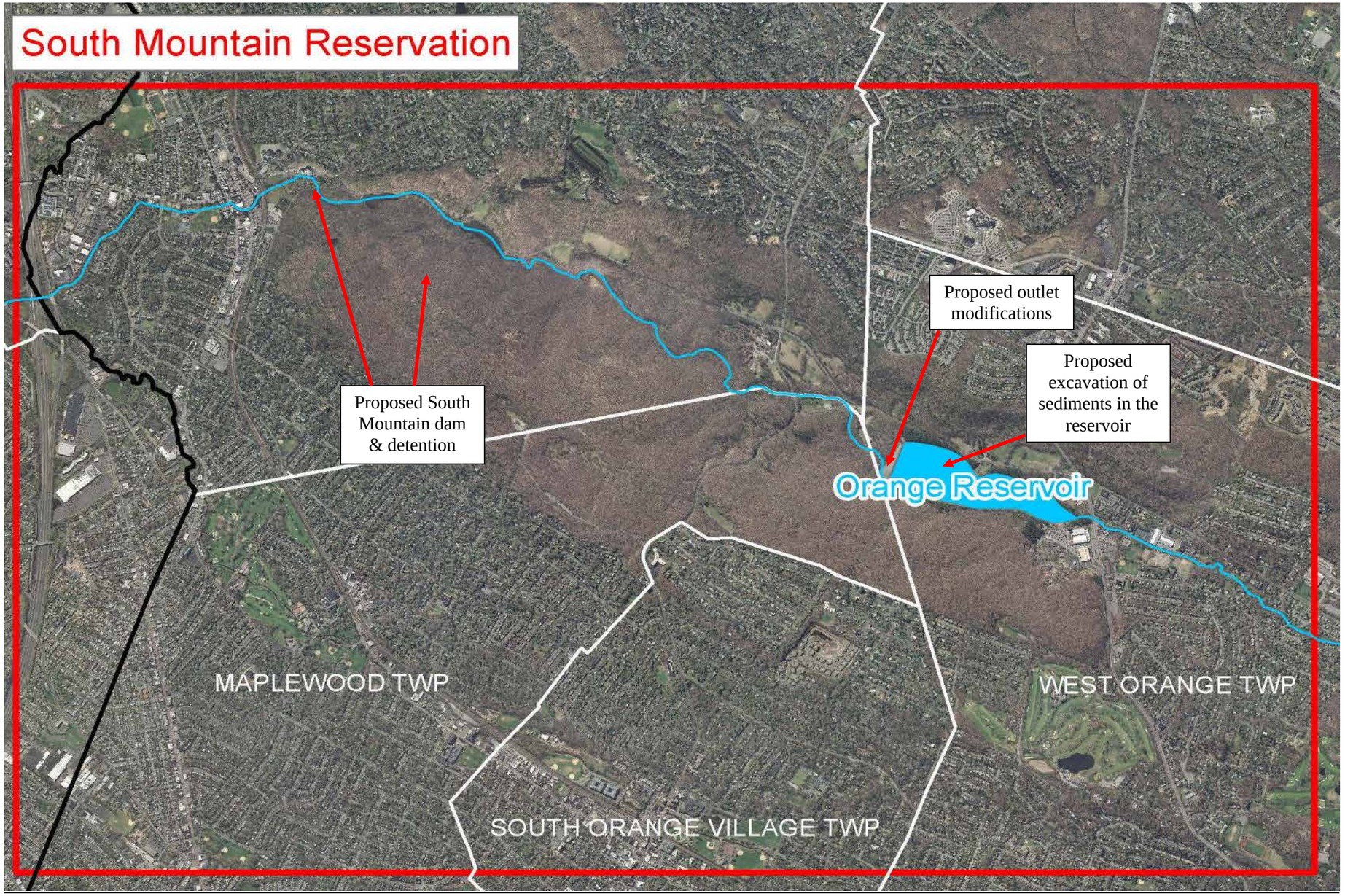

Figure 18. South Mountain Reservation and Orange Reservoir Measures

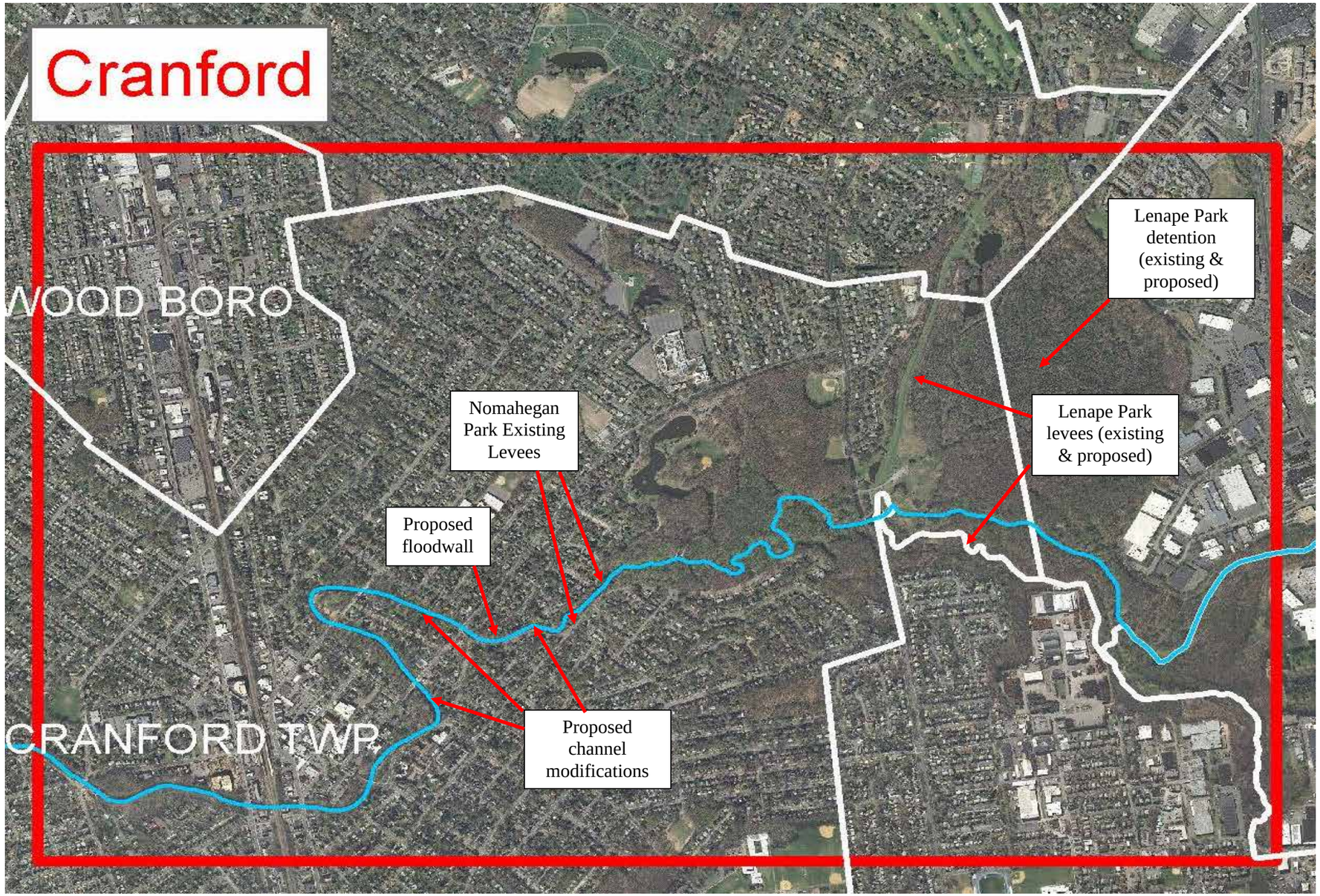

Figure 19. Township of Cranford Measures

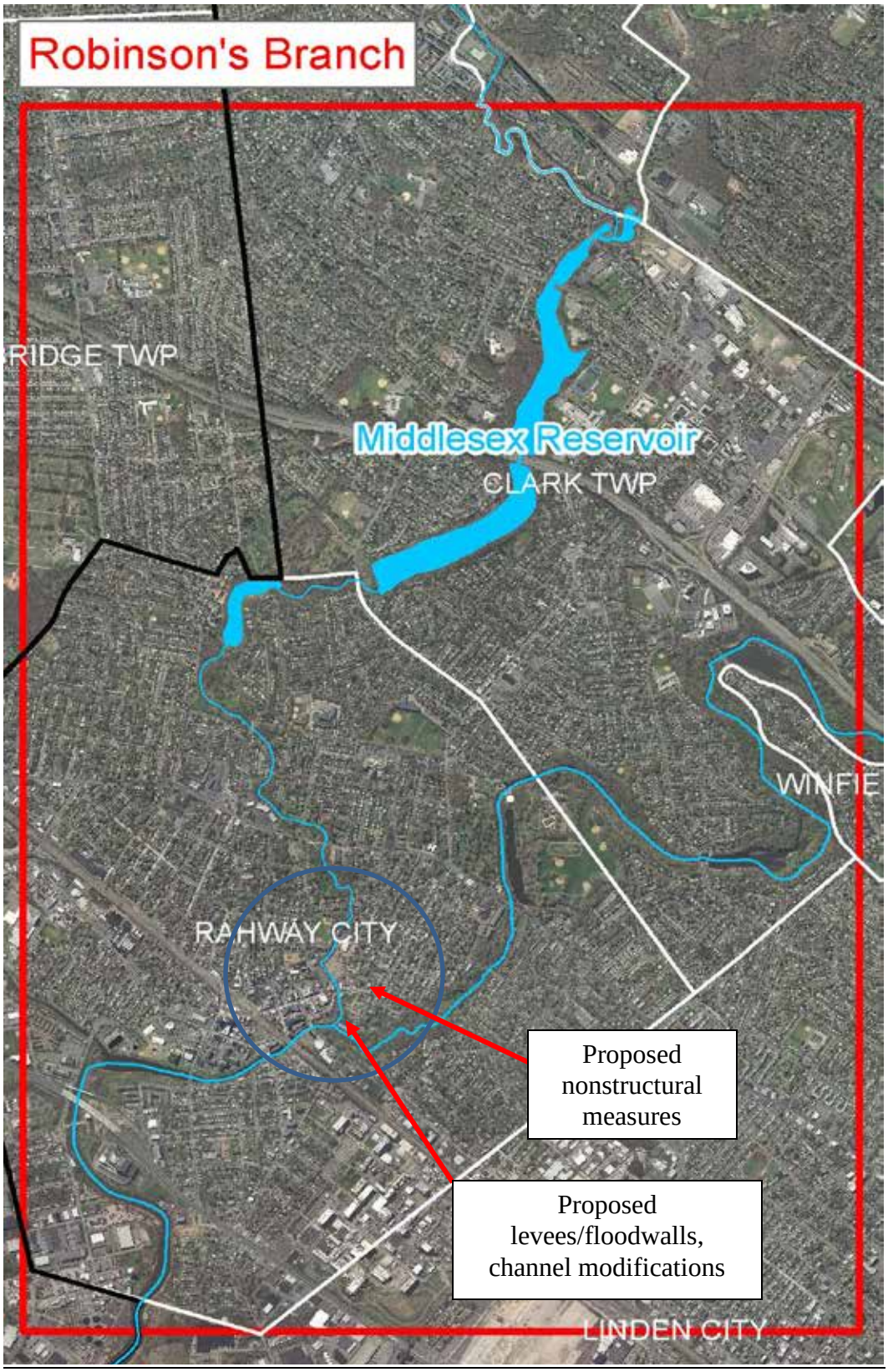

Figure 20. Robinson's Branch Measures

4.8 Final Array of Alternative Plans

An alternative plan is a set of one or more management measures functioning together to address one or more planning objectives. Those measures that were not screened out for further consideration were developed into the final array of numbered alternative plans. Below is the list of the alternatives:

- No Action: Without Project Condition
- Cranford/Upstream Alternative 1: Lenape Park Detention Basin & Channel Modifications
- Cranford/Upstream Alternative 2: Lenape Park Detention Basin and Nomahegan Park Levees Modifications and Channel Modifications
- Cranford/Upstream Alternative 3: Channel Modifications and Deepening Orange Reservoir
- Cranford/Upstream Alternative 4: Channel Modifications and Orange Reservoir Outlet Modification
- Cranford/Upstream Alternative 4a: Small Channel Modification and Orange Reservoir Outlet Modification w/ Replacement
- Cranford/Upstream Alternative 5: South Mountain Detention Basin (relocation, road and bridge modifications) and Channel Modifications
- Cranford/Upstream Alternative 6: South Mountain Detention Basin (relocation, road and bridge modification)
- Cranford/Upstream Alternative 7a & 7b: Nonstructural 10% and 1% Plan
- Cranford/Upstream Alternative 8: Lenape Park Detention Basin and Orange Reservoir Outlet Modifications
- Cranford/Upstream Alternative 9: Lenape Park Detention Basin, Orange Reservoir Outlet Modifications and Small Channel Modifications
- Robinson's Branch Alternative 1: Levees/floodwalls and Channel Modifications
- Robinson's Branch Alternative 2a & 2b: Nonstructural 10% and 1% Plan

No Action Plan: This measure means no additional Federal actions would be taken to provide for flood risk management. It provides the baseline against which the project benefits are measured. No action would be implemented if project costs exceed project benefits, thus indicating that storm risk management measures are not in the Federal interest under current NED guidelines.

Township of Cranford

In addition to the No Action plan, the following alternative plans have been formulated to address fluvial flooding for the Township of Cranford. Some of the alternatives involve features upstream of Cranford, particularly upstream detention and dam modifications. Although the primary intent of these alternatives is to provide flood risk management to the Township of Cranford these plans provide ancillary benefits to municipalities upstream and downstream of Cranford, including Millburn, Springfield, Union, Clark and Rahway.

Alternative #1: Major channel modification at the Rahway River at the Township of Cranford, and modification to Lenape Park Detention Basin (Figure 21). This alternative is likely to have a 1% chance of annual exceedance flood (100-yr event) in the Township of Cranford.

The Lenape dam modifications will include:

- Replacing the existing Lenape Dam spillway structure and raising by 6 ft.
- Widening the spillway by 100 ft.
- Widening the opening to 40 ft. and lowering by 0.5 ft.
- Modifying 10,000 ft. dam embankments by raising 6 ft.
- Widening the auxiliary spillway to 400 ft.
- Adding 6 ft. of floodwalls to the existing embankments in the northern area of Lenape Park near Fadem Rd. at Springfield Township.

This plan also includes approximately 15,500 ft. of channel work throughout the extent of the Rahway River in the Township of Cranford, from Kenilworth Blvd., just downstream of Lenape Dam, to a point approximately 1,500 ft. downstream of the Lincoln Avenue Bridge. Approximately 1,400 ft. of the channel work is expected in Nomahegan Park. The downstream slope is approximately 2.6 ft./mile with a maximum deepening of about 3.7 ft. near Hansel Dam. The new trapezoidal channel will consist of a combination of a natural channel bed or riprap material and a 60 ft. bottom width. The side slopes ranges from one vertical on two horizontal (1:2), to one vertical on two and a half horizontal (1:2.5). There will be approximately 2,000 ft. of new and removed/replaced retaining walls. Also, the Union Ave. and North Ave. Bridges will be removed and replaced.

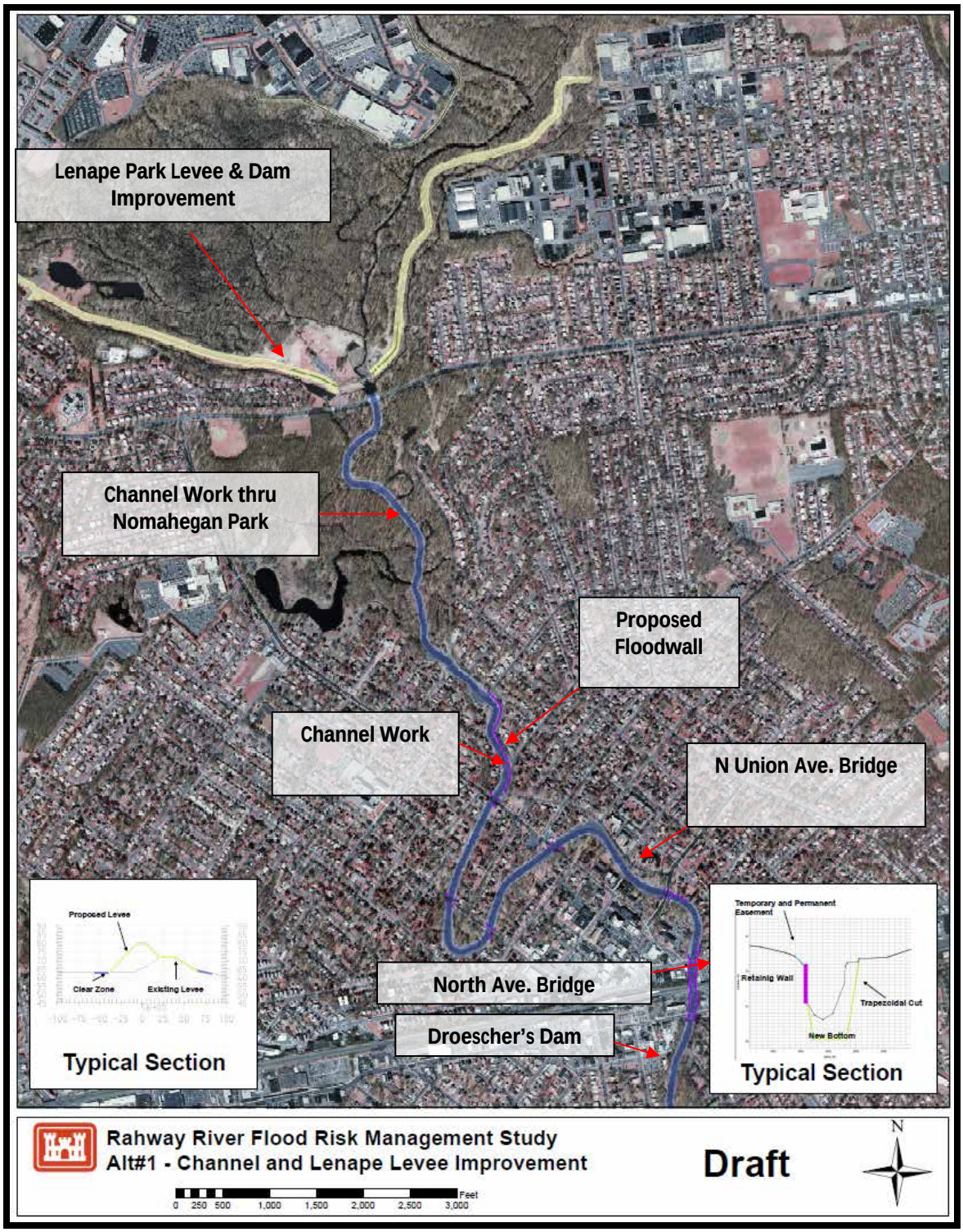

Figure 21. Alternative #1 - Lenape Park Detention Basin & Channel Improvements

Alternative #2 Limited channel modification at the Rahway River at Township of Cranford, and modification to the Nomahegan levees and Lenape Park Detention Basin (Figure 22). This alternative is likely to have a 1% chance of annual exceedance flood (100-yr event) in the Township of Cranford.

The Lenape dam modifications will include:

- Replacing the existing Lenape Dam spillway structure and raising by 6 ft.
- Widening the spillway by 100 ft.
- Widening the orifice to 40 ft. and lowering by 0.5 ft.
- Modifying 10,000 ft. dam embankments by raising 6 ft.
- Widening the auxiliary spillway to 400 ft.
- Adding 6 ft. of floodwalls to the existing embankments in the northern area of Lenape Park near Fadem Rd. at Springfield Township.

The levee system to be modified is located in the Nomahegan Park area. The proposed levees will be approximately 6 ft. higher than the existing levees.

Because of environmental considerations and the negative impact of a channel through Nomahegan Park, this plan includes reducing channel work to approximately 9,700 ft. throughout the extent of the Rahway River in the Township of Cranford. The channel work extends from about 200 ft. upstream of Springfield Ave. Bridge to a point approximately 1,000 ft. downstream of the Lincoln Ave. Bridge. The downstream slope is approximately 2.7 ft./mile with a maximum deepening of about 4 ft. near Hansel Dam. The trapezoidal channel will consist of a natural channel bed or riprap material and a 70 ft. bottom width. The side slopes ranges from one vertical on two horizontal (1 on 2), to one vertical on two and a half horizontal (1 on 2.5). There will be approximately 3,400 ft. of new and removed/replaced retaining walls. Also, the Union Ave. and North Ave. Bridges will be removed and replaced.

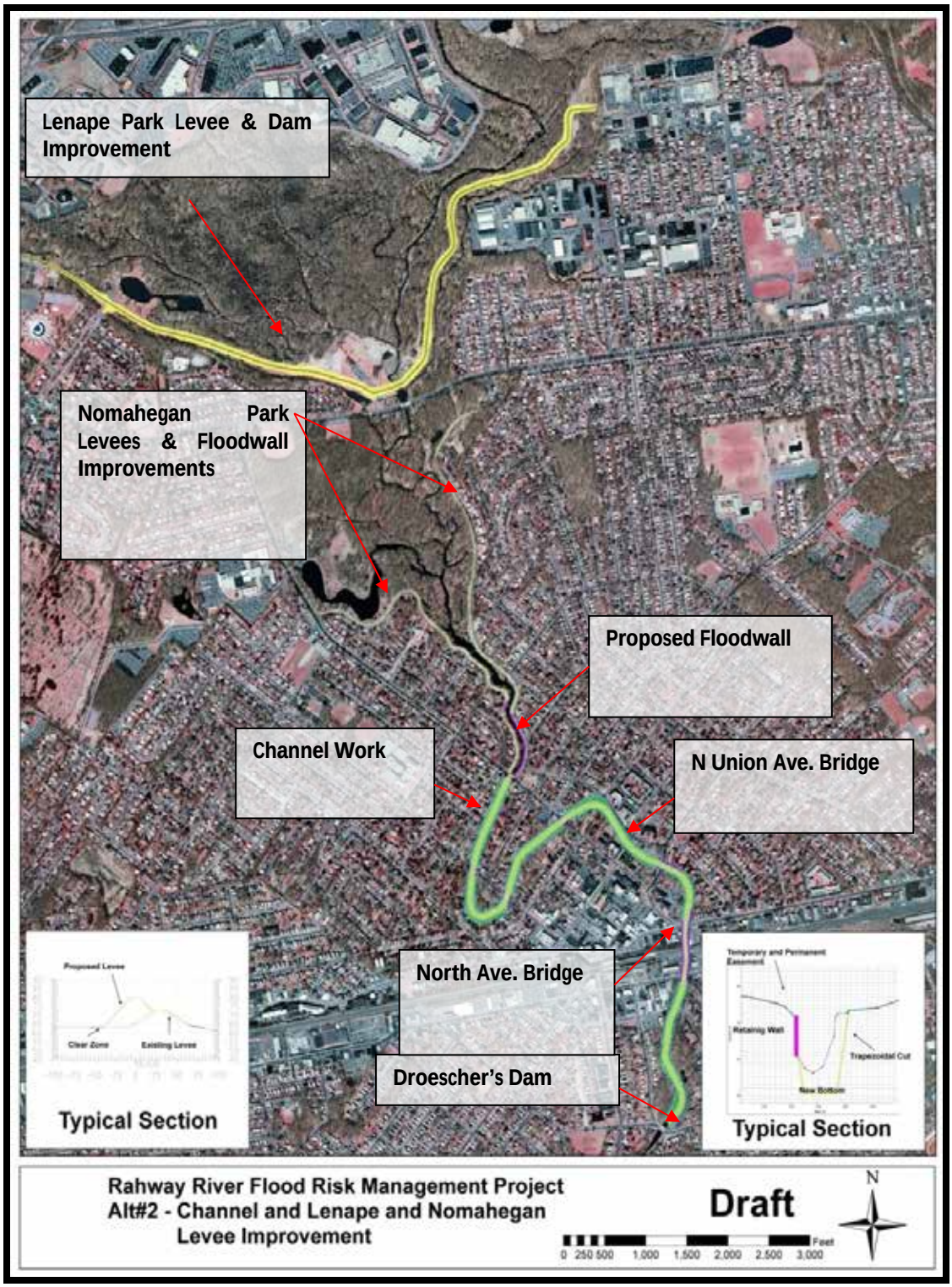

Figure 22. Alternative #2 - Lenape Park Detention Basin and Nomahegan Park Levee Modifications and Channel Improvement

Alternative #3: Major channel modification at the Rahway River at the Township of Cranford and dredging Orange Reservoir to increase storage capacity (Figures 23 and 24). This alternative is likely to have between a 2% to a 1% chance of annual exceedance flood (50yr to a100-yr event) in the Township of Cranford.

This plan includes approximately 15,500 ft. of channel work throughout the extent of the Rahway River in the Township of Cranford, from Kenilworth Blvd, just downstream of Lenape Dam, to a point approximately 1,500 ft. downstream of the Lincoln Avenue Bridge. Approximately 1,400 ft. of the channel work is expected in Nomahegan Park. The downstream slope is approximately 2.6 ft./mile with a maximum deepening of about 3.7 ft. near Hansel Dam. The new trapezoidal channel will consist of a combination of natural channel bed or riprap material and a 60 ft. bottom width with side slopes ranging from one vertical on two horizontal (1:2), to one vertical on two and a half horizontal (1:2.5). There will be approximately 2,000 ft. of new and removed/replaced retaining walls. Also, the Union Ave. and North Ave. Bridges will be removed and replaced.

In addition, this plan includes the use and operation of Orange Reservoir for flood water storage. This requires the dredging approximately 375,000 cyd. of sediment in the reservoir, to return to its original maximum capacity, and installing additional outlet pipes in the dam structure. The additional pipes will help lower the reservoir prior to a storm to maximize the effective use of the new storage capacity of the reservoir.

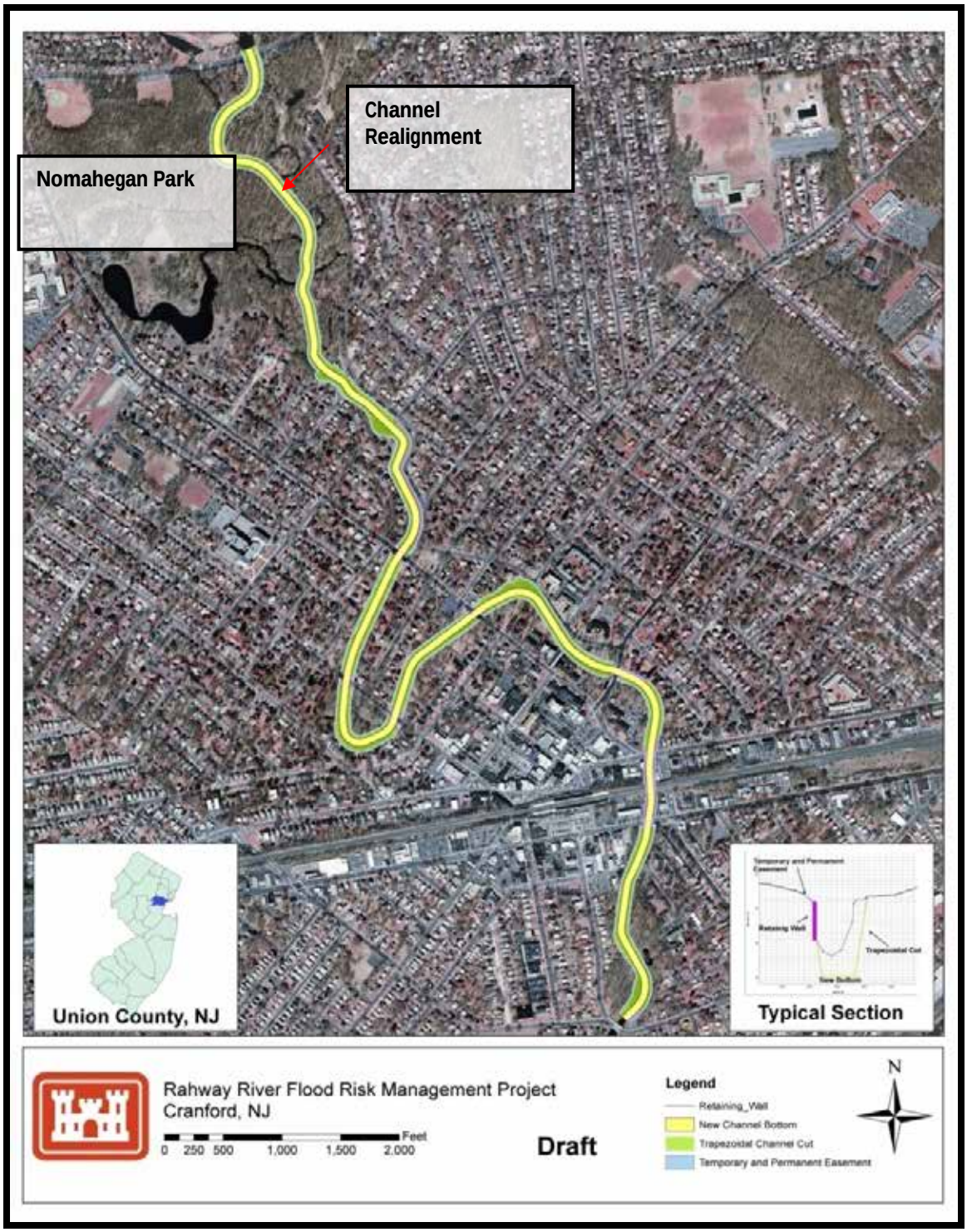

Figure 23. Alternative #3 - Channel Improvements

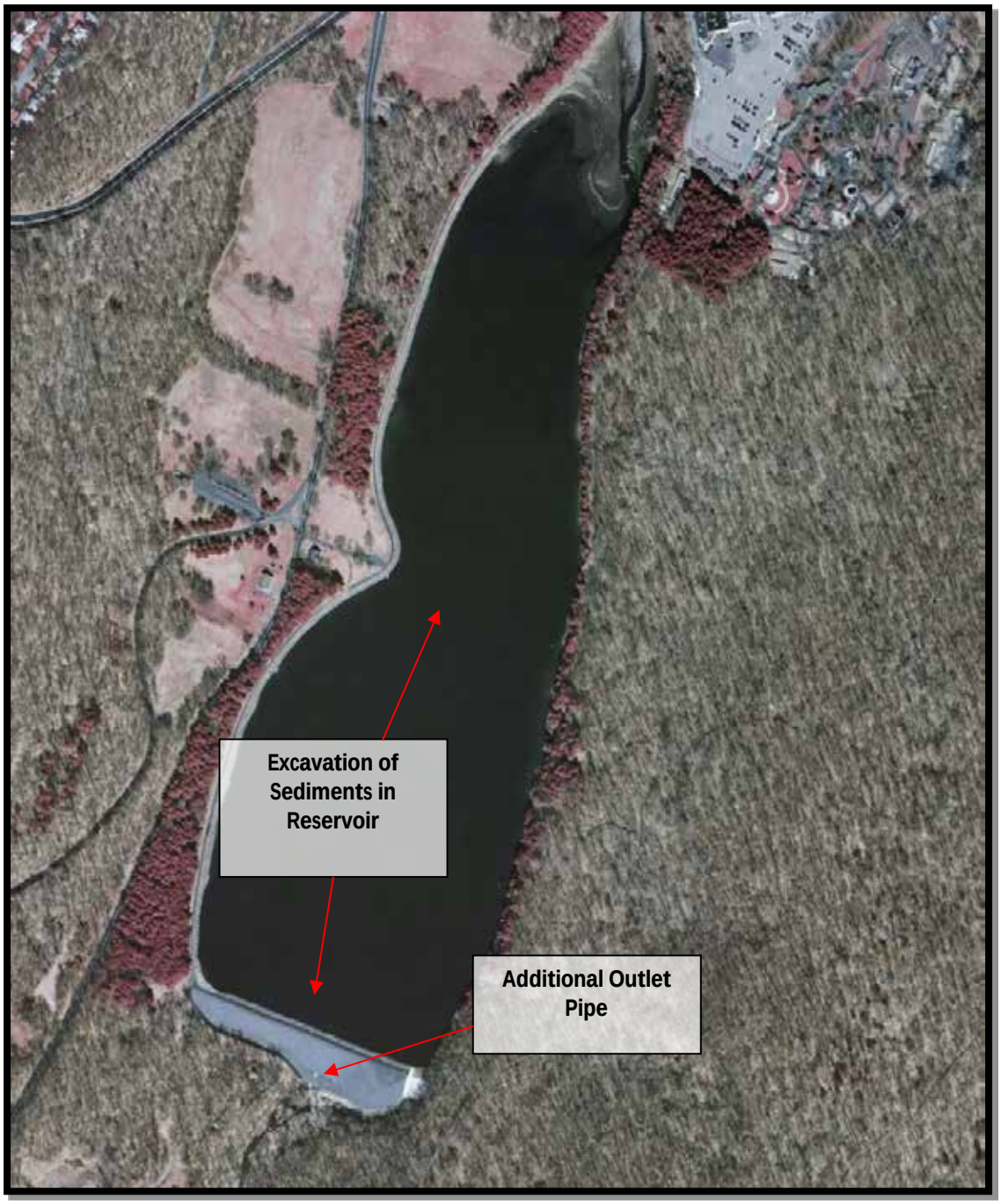

Figure 24. Alternative #3 - Deepening of Orange Reservoir

Alternative #4: Orange Reservoir and channel modification in the Township of Cranford (Figures 25 and 26). This alternative is likely to have between a 2% to a 1% chance of annual exceedance flood (50-yr to a 100-yr event) in the Township of Cranford.

The plan requires modification to Orange Dam that includes two additional 36 in. diameter outlet pipes at the dam and operation two days prior to a storm event. The required drawdown is approximately 15 ft., from a maximum depth of about 30 ft. to a depth of about 15 ft. This plan requires little to no dredging in the reservoir.

This plan also includes approximately 15,500 ft. channel work throughout the extent of the Rahway River in the Township of Cranford, from Kenilworth Blvd, just downstream of Lenape Dam, to a point approximately 1,500 ft. downstream of the Lincoln Avenue Bridge. Approximately 1,400 ft. of the channel work is expected in Nomahegan Park. The downstream slope is approximately 2.6 ft./mile with a maximum deepening of about 3.7 ft. near Hansel Dam. The new trapezoidal channel will consist of a combination of natural channel bed or riprap material and a 60 ft. bottom width with side slopes ranging from one vertical on two horizontal (1:2), to one vertical on two and a half horizontal (1:2.5). There will be approximately 2,000 ft. of replaced retaining walls. Also, the N. Union Ave. and North Ave. Bridges will be removed and replaced.

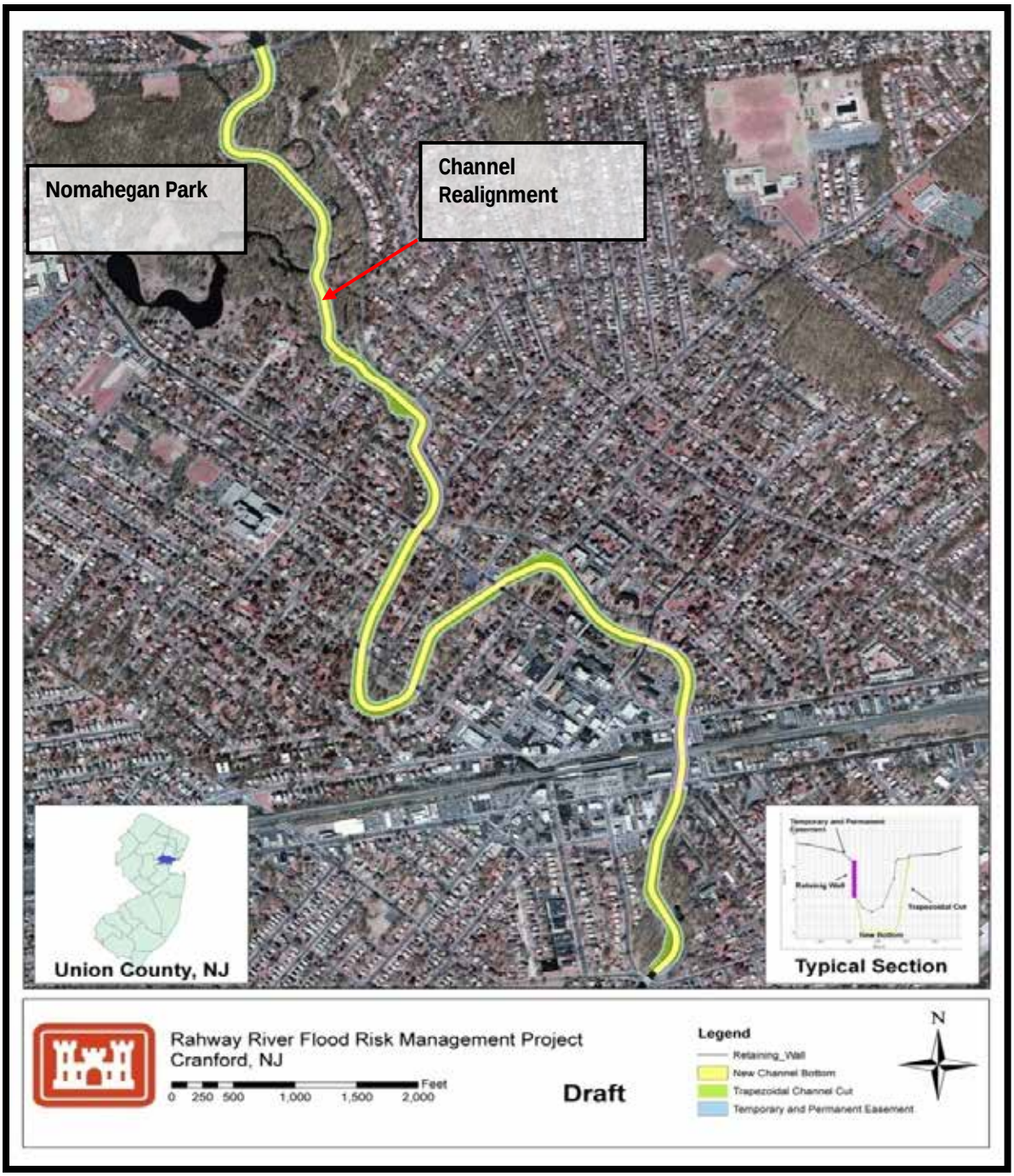

Figure 25. Alternative #4 - Channel Improvements

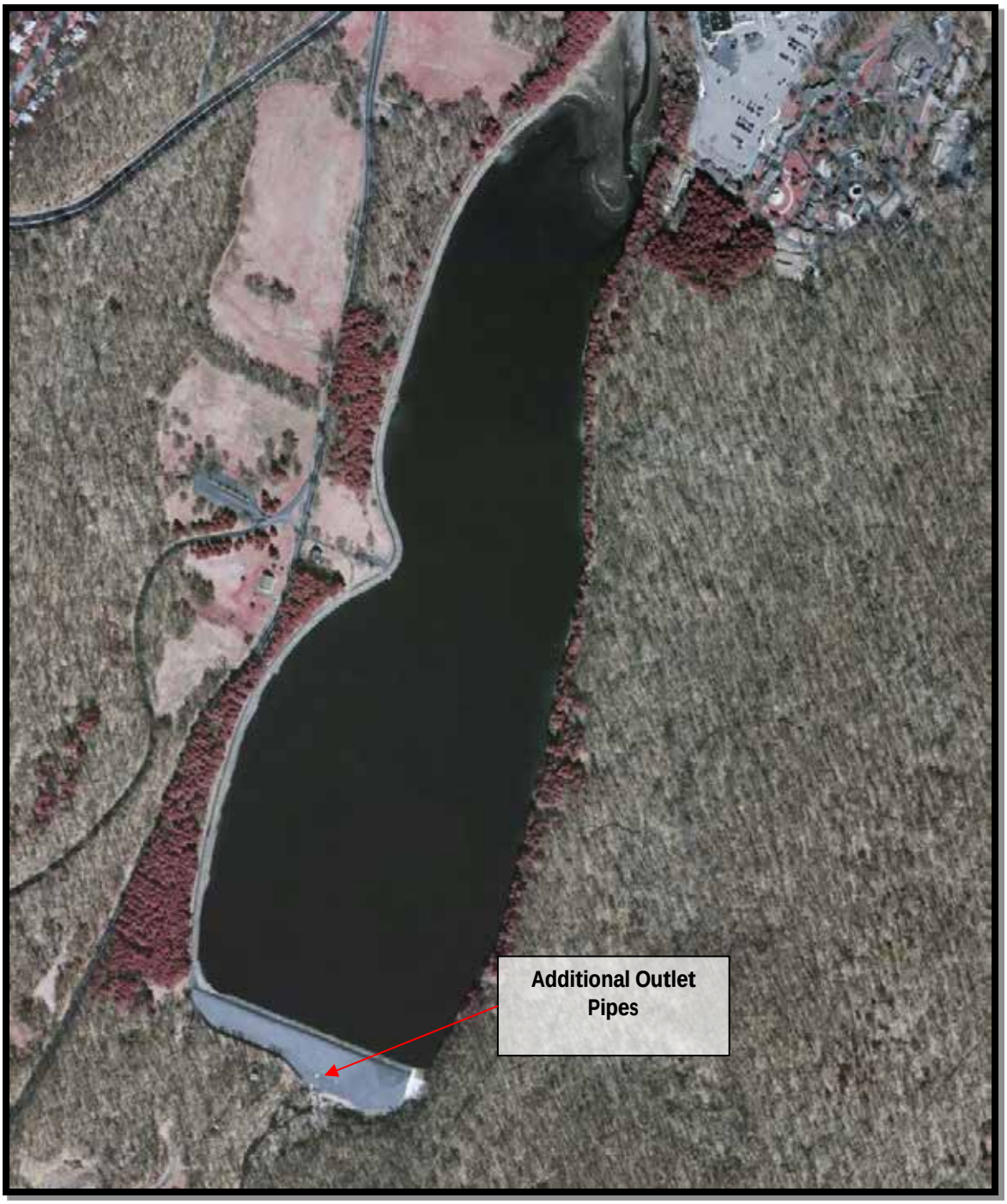

Figure 26. Alternative #4 – Modification of Orange Reservoir Outlet

Alternative #4A: Replacement in-kind of Orange Dam and outlet modification. Also, limited channel modification in the ownship of Cranford (Figures 27 and 28). This alternative is likely to have a 4%-2% chance of annual exceedance flood (25-yr event ~ 50-yr event) in the Township of Cranford.

The plan requires the replacement in-kind of Orange Dam and includes two additional 36 in. diameter outlet pipes at the dam and operation two days prior to a storm event. The required drawdown is approximately 15 ft., from a maximum depth of about 30 ft. to a depth of about 15 ft. This plan requires little to no dredging in the reservoir.

The plan also requires approximately 8,930 ft of channel modification. The proposed channel modification starts in the vicinity of the footbridge by Nomahegan Park and ends approximately 650 ft. downstream of South Ave. E. The slope is approximately 2.6 ft./mile with a maximum deepening of about 1.9 ft. in the vicinity Hansel Dam. The new trapezoidal channel will consist of a natural channel bed with a 35 to 45 ft. bottom width and side slopes of one vertical on two and a half horizontal (1:2.5). There is some riprap material in a small segment of the river near the Eastman Ave. Bridge at McConnell Park. No dam or bridge removal along the Rahway River in the vicinity of Cranford is expected in this alternative.

Figure 27. Alternative #4a – Channel Improvements

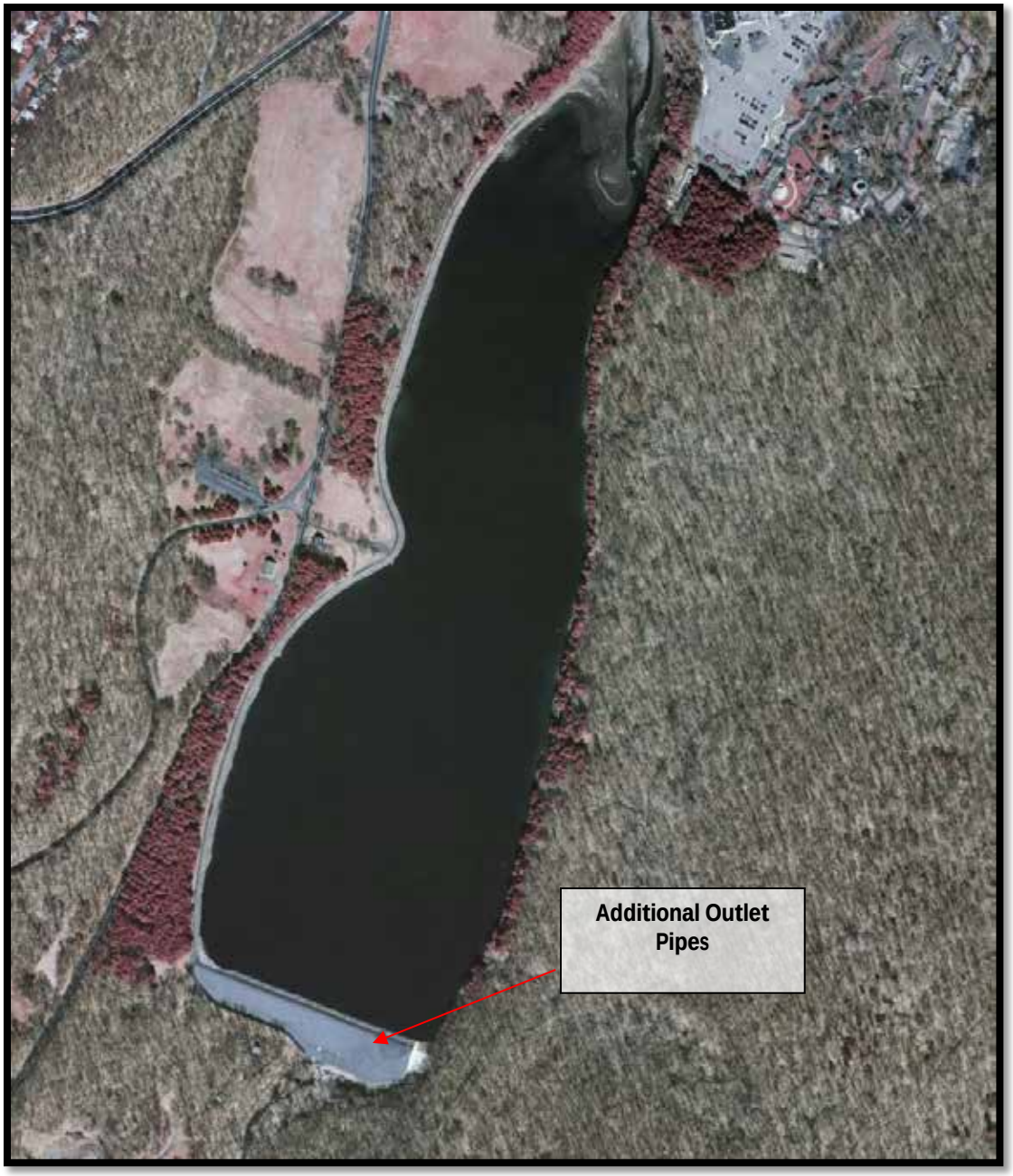

Figure 28. Alternative #4a – Modification of Orange Reservoir Outlet

<u>Alternative #5</u>: Major channel modification at the Rahway River at the Township of Cranford and the construction of South Mountain Regional Detention Basin (Figures 29 and 30). The alternative is likely to have a 1% chance of annual exceedance (100-yr event) in the Township of Cranford.

This plan includes approximately 15,500 ft. channel work throughout the extent of the Rahway River in the Township of Cranford, from Kenilworth Blvd., just downstream of Lenape Dam, to a point approximately 1,500 ft. downstream of the Lincoln Avenue Bridge. Approximately 1,400 ft. of channel work is expected in Nomahegan Park. The downstream slope is approximately 2.6 ft./mile with a maximum deepening of about 3.7 ft. near Hansel Dam. The trapezoidal channel will consist of a combination of natural bed channel or riprap material, a 60 ft. bottom width with side slopes ranging from one vertical on two horizontal (1:2), to one vertical on two and a half horizontal (1:2.5). There will be approximately 2,000 ft. of new and removed/replaced retaining walls. Also, the Union Ave. and North Ave. Bridges will be removed and replaced.

In addition, this plan includes a new dry detention structure in South Mountain Reservation just upstream of Campbell's Pond. The structure will be approximately 810 ft. long by 75 ft. high. The area flooded during a storm event of 0.2% chance of exceedance (500-yr event) is approximately 85 acres and the dam structure will have a footprint of approximately 6.6 acres. The dry detention structure will provide approximately 2,500 acre-ft. of flood water storage. This alternative requires the relocation of approximately 3,000 ft. of Brookside Drive and a steel truss maintenance bridge across the spillway of the dam.

Figure 29. Alternative #5 - Channel Improvements

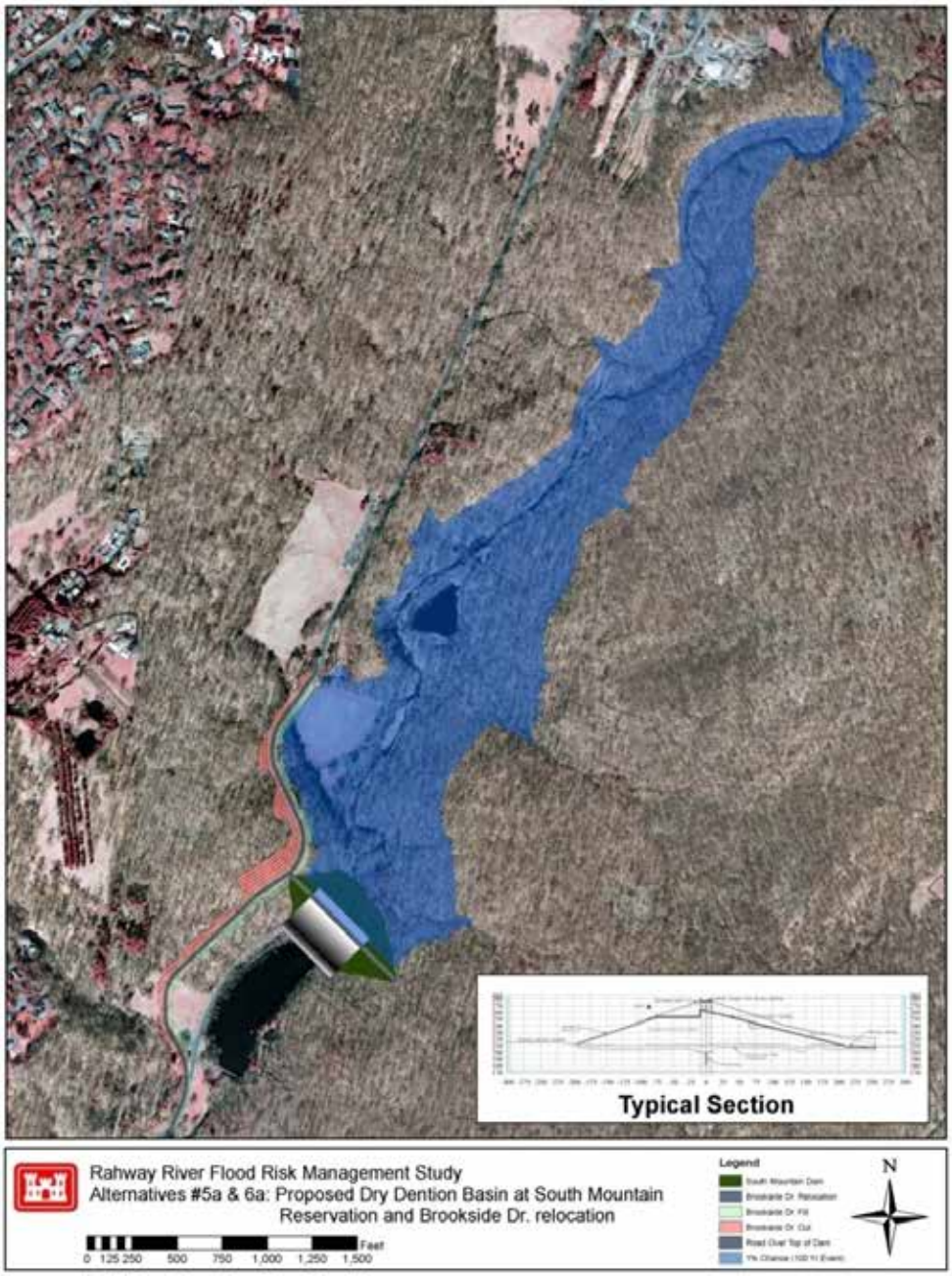

Figure 30. Alternative #5 - South Mountain Detention Basin (relocation, road and bridge modifications)

<u>Alternative #6</u>: South Mountain Regional Detention Basin (Figures 31 and 32). This alternative is likely to have a 4% chance of annual exceedance flood (25-yr event) in the Township of Cranford.

This plan includes a new dry detention structure in South Mountain Reservation just upstream of Campbell's Pond. The structure will be approximately 810 ft. long by 75 ft. high. The area flooded during a storm event of 0.2% chance of exceedance (500-yr event) is approximately 85 acres and the dam structure will have a footprint of approximately 6.6 acres. The dry detention structure will provide approximately 2,500 acre-ft. of flood water storage. In addition this alternative requires the relocation of approximately 3,000 ft. of Brookside Drive and a steel truss maintenance bridge across the spillway of the dam.

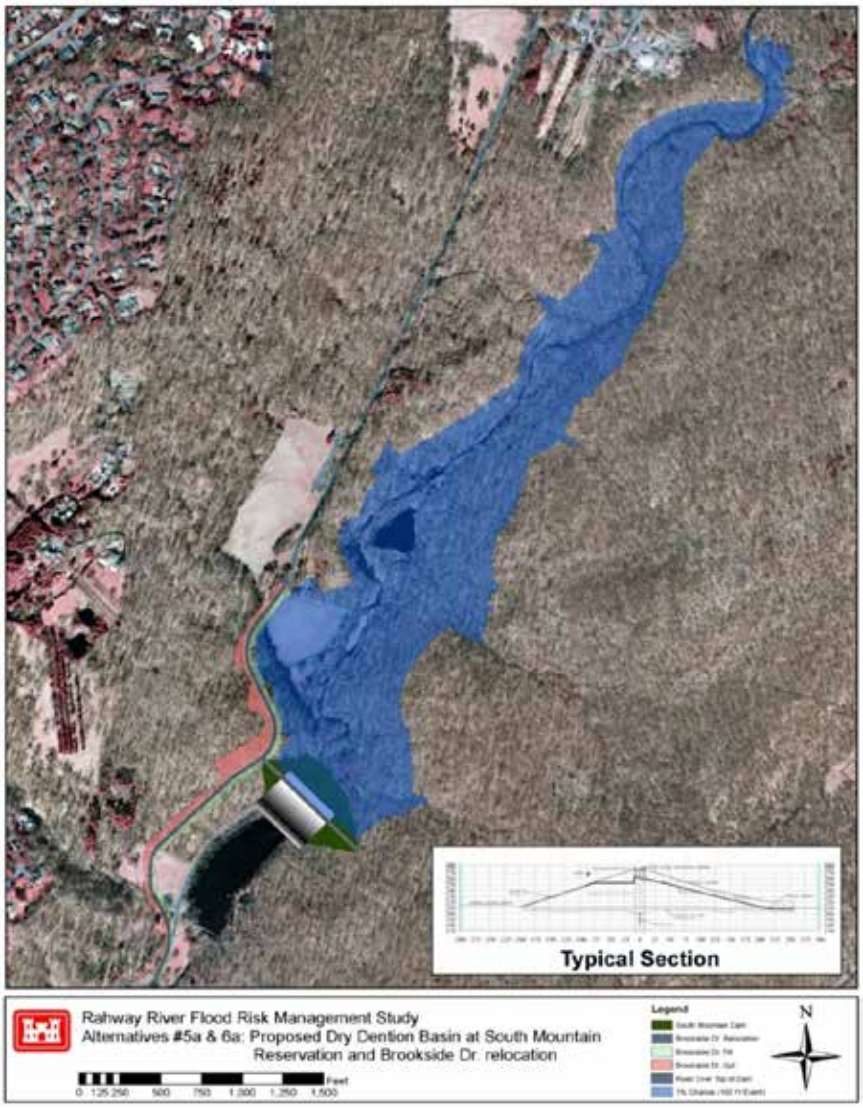

Figure 31. Alternative #6 - South Mountain Detention Basin (relocation, road and bridge modification)

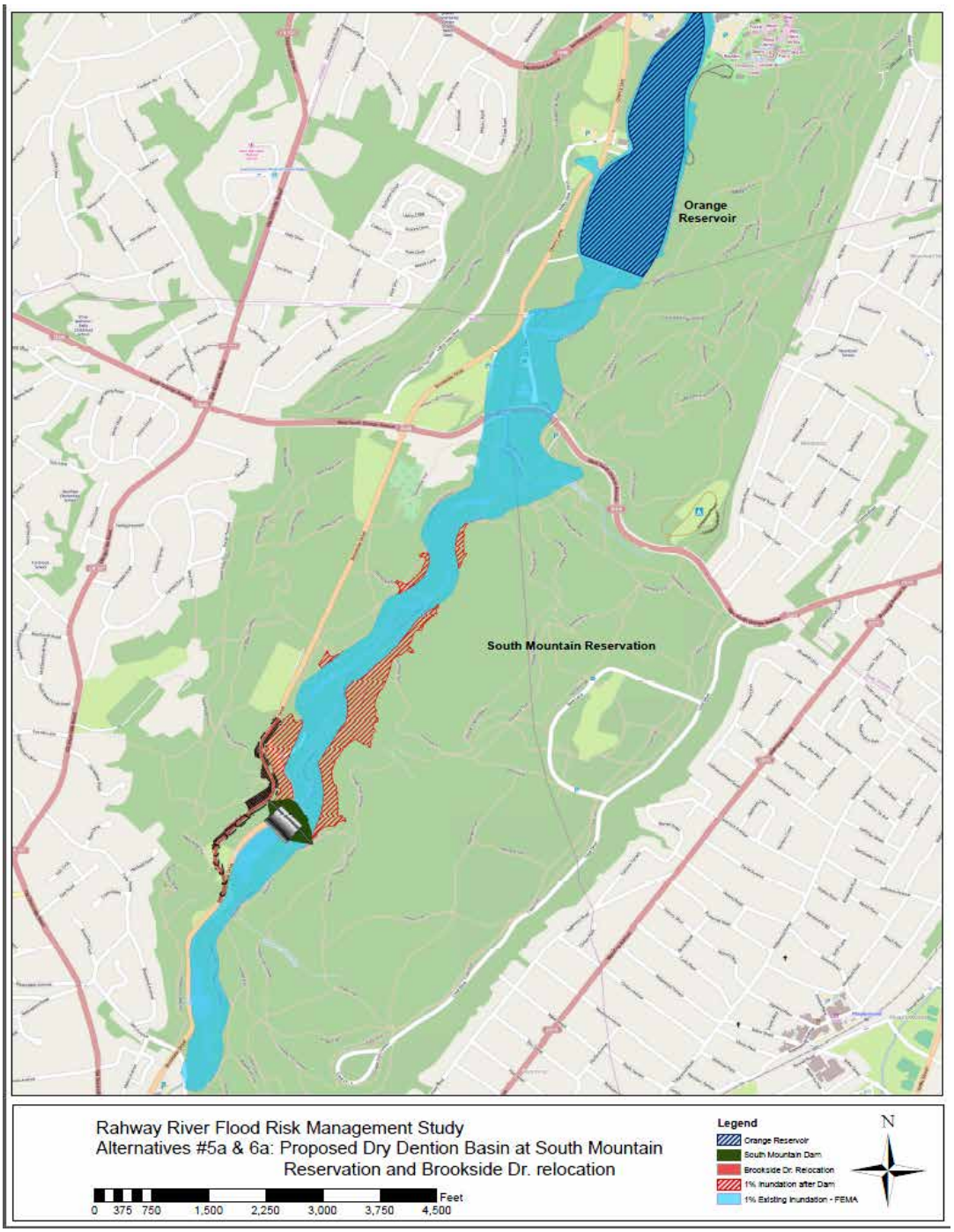

Figure 32. Alternative #6 - South Mountain Detention Basin (relocation, road and bridge modification)

Alternative #7a & 7b: Nonstructural Plans with a 1% (7b) and 10% (7a) chance of annual exceedance along the Rahway River at Cranford.

Nonstructural Flood Proofing measures considered in this project were:

Dry Flood Proofing. Dry flood proofing measures allow flood waters to reach the structure but diminish the flood threat by preventing the water from getting inside the structure walls. Dry flood proofing measures considered in this screening make the portion of a building that is below the flood level watertight through attaching watertight closures to the structure in doorway and window openings.
Wet Flood Proofing. Wet flood proofing measures allow flood water to get inside lower, non-living space areas of the structure via vents and openings in order to reduce the effects of hydrostatic pressure and, in turn, reduce flood-related damages to the structure's foundation.
Elevation (aka. Raise). Elevation involves raising the lowest finished floor of a building to a height that is above the flood level. In some cases, the structure is lifted in place and foundation walls are extended up to the new level of the lowest floor.
Barriers (aka. Ringwall). Barriers usually surround the building(s) and are sometimes used where nonstructural measures are not feasible (barriers are a structural solution).
Buyouts. It involves the purchase and elimination of flood damaged structures, allowing owners to move to places away from flood risk.

Nonstructural measures are being finalized for approximating 700 structures contained in the 1% annual exceedance (100-yr event) and approximating 100 structures contained in the 10% annual exceedance (10-yr event) flood inundation areas for the Rahway River in Cranford. All structures will be treated to an elevation of one foot above the 1% annual exceedance event. Different nonstructural measures were applied to individual structures based on the the appropriateness of that meaure with respect to the main floor elevation of each structure. Completed Nonstructural Plans for the 10% and 1% annual exceedance events are summarized in Table 20.

Table 20. Rahway River at Cranford Nonstructural Plan for the 10% and 1% annual exceedance events

Nonstructural Flood Proofing Measure	10% (10-yr) Annual Exceedance			1% (100-yr) Annual Exceedance		
	Residential	Non-Residential	Sub Total	Residential	Non-Residential	Sub Total
Dry Flood proofing	0	0	0	7	4	11
Wet Flood proofing	1	0	1	326	0	326
Barriers	1	0	1	32	5	37
Raise	62	0	62	310	1	311
Buyout	2	0	2	36	5	41
Total of Structures	66	0	66	711	15	726

<u>Alternative #8</u>: Replacement and modification of Lenape and Orange Dams Figures 33 and 34). The Lenape dam modifications will include:

- Replacing the existing Lenape Dam spillway structure and raising by 6 ft.
- Widening the spillway by 100 ft.
- Widening the orifice to 40 ft. and lowering by 0.5 ft.
- Removing approximately 10,000 ft. existing earthen dam embankments and replacing with a 6 ft. higher embankment. Also widening the top of the embankments to 25 ft.
- Widening the auxiliary spillway to 400 ft.
- Adding 6 ft. of floodwalls to the existing embankments in the northern area of Lenape Park near Fadem Rd. at Springfield Township.

The plan requires the replacement in-kind of Orange Dam and includes two additional 36 in. diameter outlet pipes and operation two days prior to a storm event. The required drawdown is approximately 15 ft., from a maximum depth of about 30 ft. to a depth of about 15 ft. This plan requires little to no dredging in the reservoir.

Figure 33. Alternative #8 - Modification to Lenape Park Dam

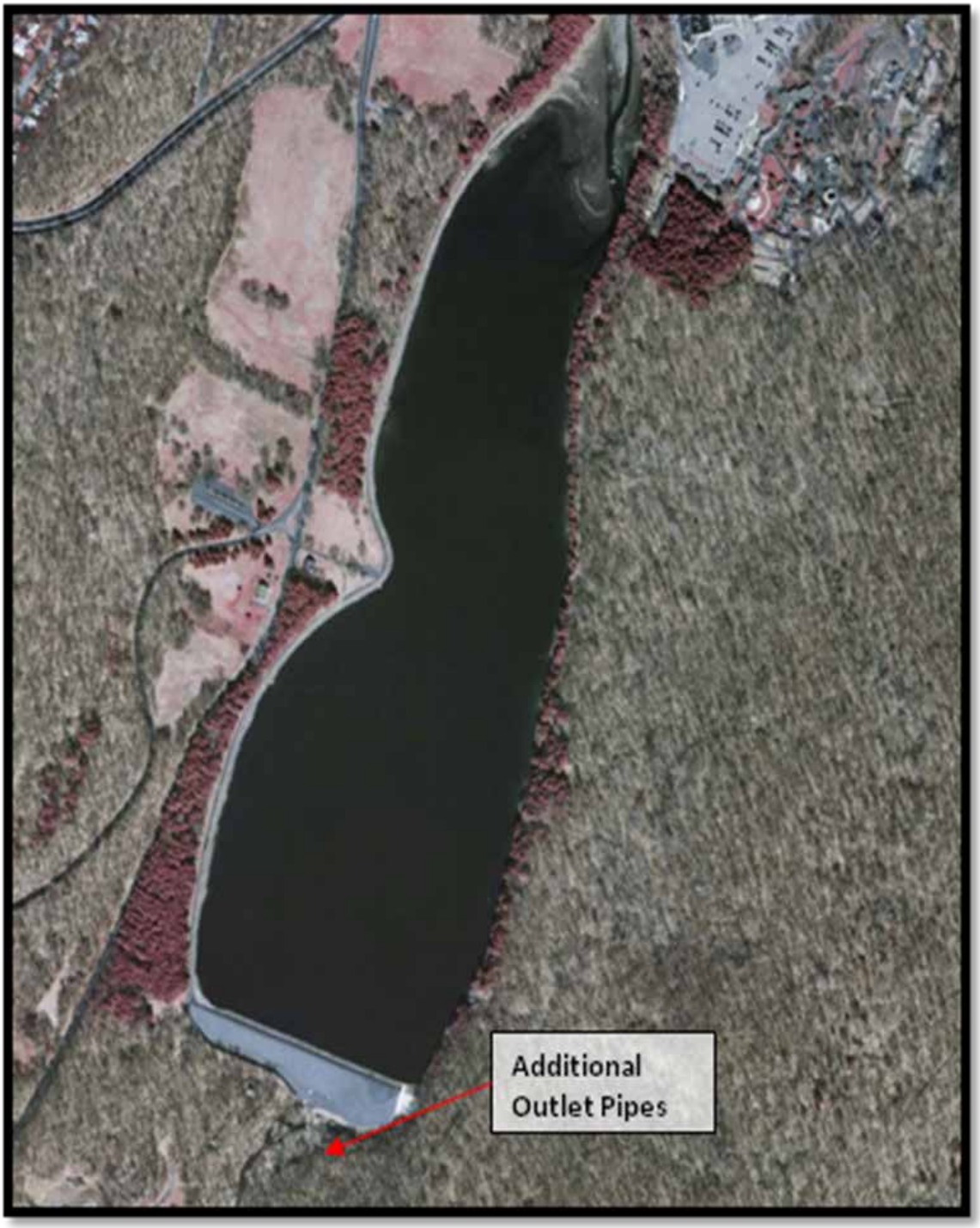

Figure 34. Alternative #8 – Modification of Orange Reservoir Outlet

Alternative #9: Replacement and modification of Lenape and Orange Dams (Figures 35 and 36). Also, limited channel modification.

The Lenape dam modifications will include:

Replacing the existing Lenape Dam spillway structure and raising by 6 ft.
Widening the spillway by 100 ft.
Widening the orifice to 40 ft. and lowering by 0.5 ft.
Removing approximately 10,000 ft. existing earthen dam embankments and replacing with a 6 ft. higher embankment. Also widening the top of the embankments to 25 ft.
Widening the auxiliary spillway to 400 ft.
Adding 6 ft. of floodwalls to the existing embankments in the northern area of Lenape Park near Fadem Rd. at Springfield Township.

There will be approximately 8,930 ft. channel work throughout the extent of the Rahway River in the Township of Cranford, from the footbridge at Nomahegan Park to a point approximately 650ft. downstream of the South Ave. Bridge.

The general slope of the channel cut will be approximately 2.6 ft./mile with a maximum deepening of about 1.9 ft. in the vicinity of Hansel Dam. The new trapezoidal channel will consist of a natural bed channel with a 35 to 45 ft. bottom width and side slopes of one vertical on two and a half horizontal (1:2.5). There is some riprap material in a small segment of the river near the Eastman Ave. Bridge at McConnell Park. No dam or bridge removal along the Rahway River in the vicinity of Cranford is expected in this alternative.

The plan requires the replacement in-kind of Orange Dam and includes two additional 36 in. diameter outlet pipes and operation two days prior to a storm event. The required drawdown is approximately 15 ft., from a maximum depth of about 30 ft. to a depth of about 15 ft. This plan requires little to no dredging in the reservoir.

Figure 35. Alternative #9 - Lenape Park Dam and Channel Modification

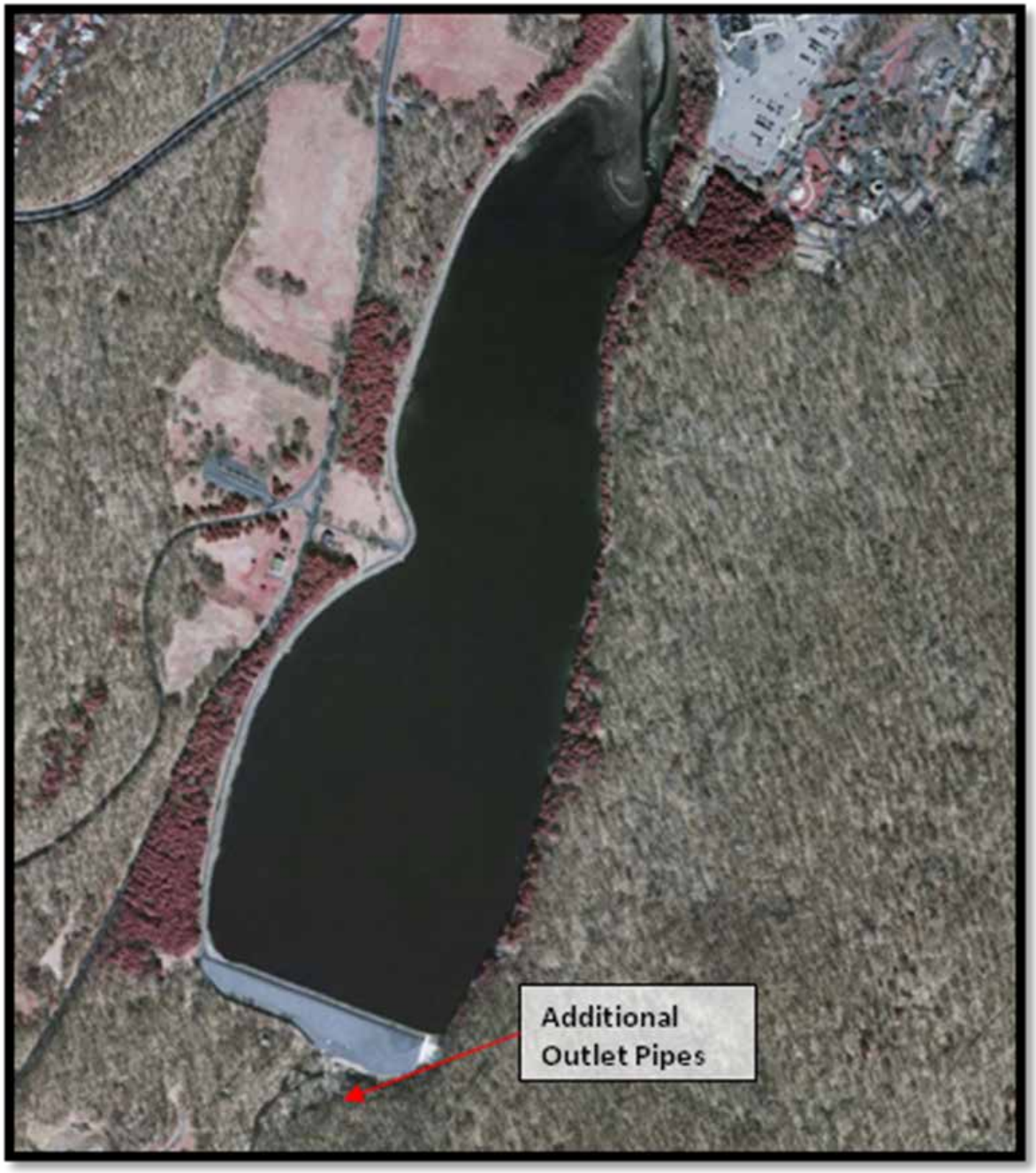

Figure 36. Alternative #9 – Orange Reservoir Modification

4.8.1 Plan Comparisons

Table 21 below compares the features and design events for the Cranford alternatives.

Table 21. Rahway Flood River Risk Management Study Alternatives

Alternative	Reservoir/Dam	Embankments/ Levees	Channel & Bridge Modification	Annual Exceedance Probability (Level of Performance)	
				*Cranford	Other
1	Raise Lenape 6ft.	Raise: Lenape 6ft.	60ft. wide - 15,500ft. long	1%	None upstream, some downstream
2	Raise Lenape 6ft.	Raise: Lenape and Nomahegan 6ft.	70ft. wide - 9,700ft. long	1%	None upstream, some downstream
3	Dredging Orange and Operation	N/A	60ft. wide - 15,500ft. long	Between 2% - 1%	Some upstream, none downstream
4	Orange Operation: Drawdown	N/A	60ft. wide - 15,500ft. long	Between 2% - 1%	Some upstream, none downstream
4a	Orange	N/A	35ft.-45ft. wide – 8,390ft. long	Between 4% - 2%	XXX
5	South Mountain & Road Relocation	N/A	60ft. wide - 15,500ft. long	1%	Good upstream, some downstream
6	South Mountain & Road Relocation	N/A	N/A	4%	Good upstream & downstream
7	Nonstructural	N/A	N/A	1% and 10%	None upstream and downstream

8	Orange Operation: Drawdown and raise Lenape 6ft.	Raise: Lenape 6ft.	N/A	4%	Some upstream, none downstream
9	Orange Operation, channel and raise Lenape 6ft.	Raise: Lenape 6ft.	35-45ft. wide - 9,700ft.	2%	Some upstream & downstream

* Likely to contain the annual exceedance.

Table 22 below compares water surface elevation reductions for alternatives 4, 8 and 9. Alternatives 4, 8 and 9 include the common element of modifying the Orange Reservoir Dam. This table compares downstream flood risk management effects due to this common element among these alternatives.

Table 22. Water surface elevation reduction comparison for alternatives 4, 8 and 9

Town	Location	Reduction in Flood (ft)								
		25YR			50 YR			100 YR		
		Al	Al	Al	Al	Al	Al	Al	Al	Al
Springfield/ Millburn	Downstream of I-78	1.6	1.6	1.6	1.2	1.2	1.2	0.5	0.5	0.5
Springfield	Just downstream of Morris Ave. Bridge	1.0	1.0	1.0	0.6	0.6	0.6	0.9	0.9	0.9
Springfield	Upstream of Route 22	0.7	0.7	0.7	0.4	0.4	0.4	0.3	0.3	0.4
Cranford	Lenape Park	0.9	-0.7	-0.7	0.7	-2.8	-2.8	0.4	-3.9	-3.9
Cranford	Kenilworth Area	4.6	1.5	2.2	2.8	1.4	2.2	2.0	1.3	1.4
Cranford	Nomahegan Park	4.2	1.2	2.2	3.8	2.1	3.1	3.1	1.1	1.9
Cranford	Below Nomahegan Park - Footbridge	4.6	1.3	2.5	4.1	2.2	3.5	3.3	1.1	2.1
Cranford (Town)	Springfield Ave. Bend	3.6	1.1	1.7	3.4	2.4	3.0	3.1	1.3	1.9
Cranford (Town)	Hansel Dam Park - Casino Brook Area	3.0	1.0	0.9	3.2	2.6	2.6	2.8	1.2	1.5

Cranford (Town)	From Union Ave. to North Ave. Bridge	2.2	1.5	1.3	2.2	2.6	2.6	1.7	1.3	1.6
Cranford	Downstream of RR Bridge and South Ave. Bridge	1.5	0.6	0.5	1.1	1.4	1.3	1.4	1.8	1.8
Cranford	Just downstream of Lincoln Ave. Bridge	0.2	1.0	0.8	0.1	1.8	1.6	0.8	1.3	1.4

City of Rahway

In addition to the No Action plan the following three alternative plans have been formulated to address fluvial flooding for the Robinson's Branch area of the City of Rahway.

Alternative #1: 1985 GRR Plan- Levees, Floodwalls, & Channel Modification (Figure 37)
This plan includes approximately 8,300 ft of channel work throughout the Robinson's Branch and Rahway River. In Robinson's Branch, the channel starts about 600 ft downstream of Maple Ave. Bridge and ends in the confluence with Rahway River. In the Rahway River, the channel starts about 75 ft upstream of W Grand Ave. Bridge and ends in the confluence with Rahway River. There is also channel work in the Rahway River downstream of the confluence to approximately 550 ft downstream of the Monroe Ave. Bridge. All channel cuts mainly consist of 35 ft wide trapezoidal channel with natural bed and one vertical on two and a half horizontal (1 on 2.5) side slopes. There are also a few sections with rectangular cuts of 60 ft wide and 20 ft wide pilot channels in Robinson's Branch. Riprap protection is proposed at the upstream end of the channel modification in Robinson's Branch and between the Elizabeth Avenue and Rail Road Bridges in the Rahway River.

There are also approximately 1,350 ft of levees and 4,000 ft of floodwalls included in this plan. These levees and floodwalls were divided into three systems. System 1 extends from high ground near W Milton Ave. to St. Georges Ave. (approx. 1,300 ft of levee/floodwall), System 2 extends from Hamilton St. to Irving St. (approx. 150 ft of floodwall) and System 3 extends from New Church St. to high ground near Whittier St. in the Rahway River (approx. 3,900 ft of levee/floodwall).

Other features included in this plan are four road closure gates located at Central Ave, Hamilton St, Irving St and West Grand Ave, and two ponding areas located near Hamilton St and near Allen St.

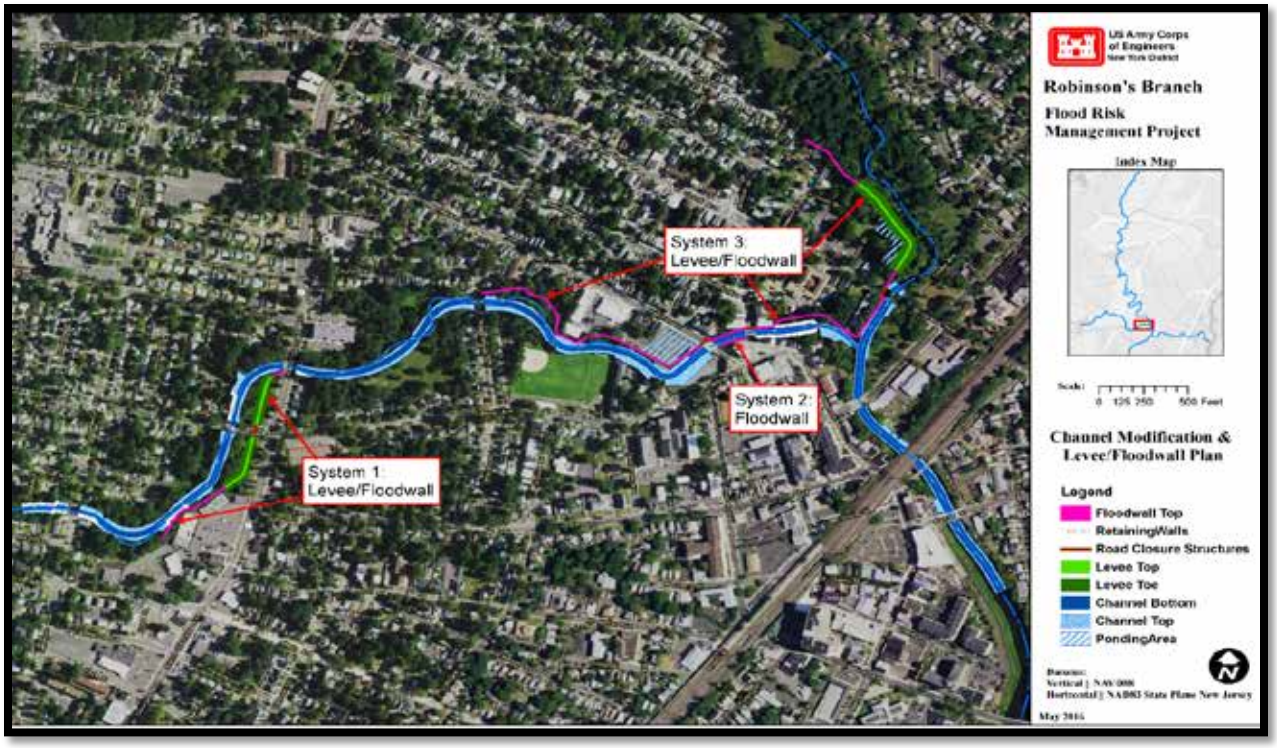

Figure 37. Alternative #1 - Combination of Levees/Floodwalls and Channel Modifications

<u>Alternative #2a & 2b</u>: Nonstructural Plans with a 1% (2b) and 10% (2a) chance of annual exceedance along the Robinson's Branch and Rahway River at Clark

Nonstructural Flood Proofing measures considered in this project were:
Dry Flood Proofing. Dry flood proofing measures allow flood waters to reach the structure but diminish the flood threat by preventing the water from getting inside the structure walls. Dry flood proofing measures considered in this screening make the portion of a building that is below the flood level watertight through attaching watertight closures to the structure in doorway and window openings.
Wet Flood Proofing. Wet flood proofing measures allow flood water to get inside lower, non-living space areas of the structure via vents and openings in order to reduce the effects of hydrostatic pressure and, in turn, reduce flood-related damages to the structure's foundation.
Elevation (aka. Raise). Elevation involves raising the lowest finished floor of a building to a height that is above the flood level. In some cases, the structure is lifted in place and foundation walls are extended up to the new level of the lowest floor.
Barriers (aka. Ringwall). Barriers such as ringwalls, levees, or berms generally surround the building but are not attached. It is used where elevation of the structure is not practical or feasible.
Buyouts. It involves the purchase and elimination of flood damaged structures, allowing owners to move to places away from flood risk.

Nonstructural measures were evaluated for approximately 430 structures contained in the 1% annual exceedance (100-yr event) flood inundation area and approximately 90 structures contained in the 10% annual exceedance (10-yr event) flood inundation area for the Robinson's Branch and Rahway River at Clark. All structures will be treated to an elevation of one foot above the 1% annual exceedance event. Different nonstructural measures were applied to individual structures based on the the appropriateness of that meaure with respect to the main floor elevation of each structure. Completed Nonstructural Plans for the 10% and 1% annual exceedance events are summarized in Table 23 and shown in Figures 38 and 39.

Table 23. Rahway River at Robinson's Branch Nonstructural Plan for the 10% and 1% annual exceedance events

Nonstructural Flood Proofing Measure	10% (10-yr) Annual Exceedance			1% (100-yr) Annual Exceedance		
	Residential	Non-Residential	Sub Total	Residential	Non-Residential	Sub Total
Dry Flood proofing	0	0	0	11	7	18
Wet Flood proofing	1	1	2	2	3	5
Barriers	2	4	6	3	10	13
Raise	13	0	13	188	0	188
Buyout	0	0	0	0	0	0
Total of Structures	16	5	21	204	20	224

Figure 38. Alternative #2a - Nonstructural Plan with a 10% (2a) chance of annual exceedance along the Robinson's Branch and Rahway River at Clark

Figure 39. Alternative #2b - Nonstructural Plan with a 1% (2b) chance of annual exceedance along the Robinson's Branch and Rahway River at Clark

4.9 Costs for Alternatives

The costs for each alternative were estimated in order to compare alternatives and calculate the Benefit/Cost Ratio for evaluation purposes. Costs include planning, engineering and design, construction management, interest during construction and operation and maintenance. The construction cost estimates were developed in MCACES, Second Generation (MII) and based on current estimated quantities provided by hydraulics & hydrology, civil, and structural engineering disciplines and environmental and real estate mitigation costs. The cost estimates were developed from these quantities using cost resources such as RSMeans, historical data from similar construction features, and MII Cost Libraries. Contingency percentages were estimated for the alternatives using the Abbreviated Cost Schedule Risk Analysis (ARA), the template of which was provided by the Cost Mandatory Center of Expertise (MCX), located in the Walla Walla District of USACE. These contingencies were applied to the construction cost estimates to develop the Total Project First Cost. The construction schedule was developed based on the assumption that multiple crews would work simultaneously.

Planning, Engineering and Design

The costs were developed for all activities associated with the planning, engineering and design effort. The cost for this account includes the preparation of Design Documentation Reports and plans and specifications for each construction contract and engineering and planning support, including environmental compliance and monitoring, during construction through project completion. It includes all the in-house labor based upon work-hour requirements, material and facility costs, travel and overhead.

Construction Management
The costs were developed for all construction management activities from pre-award requirements through final contract closeout. These costs include the in-house labor based upon work-hour requirements, materials, facility costs, support contracts, travel and overhead. Costs were developed based on the input from the construction division in accordance with the Civil Works Breakdown Structure (CWBS) and include but are not limited to anticipated items such as the salaries of the resident engineer and staff, survey men, inspectors, draftsmen, clerical, and custodial personnel; operation, maintenance and fixed charges for transportation and for other field equipment; field supplies; construction management, general construction supervision; project office administration, distributive cost of area office and general overhead charged to the project. The work items and activities would include, but not be limited to: the salaries of all supervisory, engineering (including resident geologist and geological staff), office and safety field personnel; all on site expenses.

Interest During Construction
Interest During Construction (IDC) is the cost of construction money invested before the beginning of the period of economic analysis and before the accumulation of benefits by the project. IDC costs have been added to the project cost to determine investment costs. Average annual costs were determined based on investment costs which include IDC. The pre-base year costs were estimated using the Federal interest rate of 3.125% (FY16).

Operation, Maintenance, Repair, Rehabilitation, and Replacement
The Operation, Maintenance, Repair, Rehabilitation, and Replacement (OMRR&R) costs were estimated to represent the anticipated annual costs necessary to maintain the project at full operating efficiency throughout the project life. Following completion of the project, operation and maintenance of project facilities would be performed by the local cooperating agency in accordance with federal regulations and operations manual.

Estimated Average Annual Costs
Average annualized costs are based on an economic project life of 50 years and an interest rate of 3.125%. The annual charges include the annualized investment costs along with annual operation and maintenance costs.

4.10 Economic Evaluation and Comparison

The alternatives were evaluated using the HEC-FDA model. Model output of damages was used to calculate the reduction in damages achieved by an alternative. A 50-year period (2023-2073) was analyzed and the FY16 discount rate of 3.125% was used to calculate present value (PV) of the damages. Below are the alternatives simulated in the HEC-FDA model.

- No Action
- Cranford/Upstream Alternative 1: Lenape Park Detention Basin & Channel Modifications
- Cranford/Upstream Alternative 2: Lenape Park Detention Basin and Nomahegan Park Levees Modifications and Channel Modifications
- Cranford/Upstream Alternative 3: Channel Modifications and Deepening Orange Reservoir
- Cranford/Upstream Alternative 4: Channel Modifications and Orange Reservoir Outlet Modification
- Cranford/Upstream Alternative 4a: Small Channel Modification and Orange Reservoir Outlet Modification w/ Replacement
- Cranford/Upstream Alternative 5: South Mountain Detention Basin (relocation, road and bridge modifications) and Channel Modifications
- Cranford/Upstream Alternative 6: South Mountain Detention Basin (relocation, road and bridge modification)
- Cranford/Upstream Alternative 7a & 7b: Nonstructural 10% and 1% Plan
- Cranford/Upstream Alternative 8: Lenape Park Detention Basin and Orange Reservoir Outlet Modifications
- Cranford/Upstream Alternative 9: Lenape Park Detention Basin, Orange Reservoir Outlet Modifications and Small Channel Modifications
- Robinson’s Branch Alternative 1: Levees/floodwalls and Channel Modifications
- Robinson’s Branch Alternative 2a & 2b: Nonstructural 10% and 1% Plan

Evaluation and Comparison of Array of Alternative Plans

Evaluation and comparison of alternatives in the Cranford, upstream detention areas and the Robinson’s Branch has been completed. Table 24 below displays the results of the benefit-cost analysis.

Table 24. Benefit-Cost Analysis

Alternative	Flood Damages		Annual Benefits	First Cost	Annual Cost	Net Benefits	BCR
	Without-Project	With-Project					
Cranford UpstreamAlternative 1: Lenape Park Detention Basin & Channel Modifications	$9,773,600	$7,499,200	$2,274,400	$91,123,800	$4,096,300	-$1,821,900	0.6
Cranford Upstream Alternative 2: Lenape Park Detention Basin and Nomahegan Park Levees Modifications and Channel Modifications	$9,773,600	$7,423,900	$2,349,700	$90,816,400	$4,074,200	-$1,724,500	0.6
Cranford Upstream Alternative 3: Channel Modifications and Deepening Orange Reservoir	$9,773,600	$4,937,100	$4,836,500	$230,303,600	$10,710,000	-$5,873,500	0.5
Cranford Upstream Alternative 4: Channel Modifications and Orange Reservoir Outlet Modification w/Replacement	$9,773,600	$5,290,900	$4,482,700	$134,726,100	$6,050,600	-$1,567,900	0.7
Cranford Upstream Alternative 4a: Small Channel Modification and Orange Reservoir Outlet Modification w/ Replacement	$9,773,600	$6,070,300	$3,703,300	$69,570,000	$3,177,200	$526,100	1.2
Cranford/Upstream Alternative 5: South Mountain Detention Basin (relocation, road and bridge modifications) and Channel Modifications	$9,773,600	$3,054,700	$6,718,900	$174,019,300	$8,047,600	-$1,328,700	0.8
Cranford/Upstream Alternative 6: South Mountain Detention Basin (relocation, road and bridge modification)	$9,773,600	$4,172,600	$5,601,000	$118,576,200	$5,285,900	$315,100	1.1
Cranford/Upstream Alternative 7a : Nonstructural 10-yr Floodplain	$9,773,600	$8,783,300	$990,300	$19,447,800	$935,300	$55,000	1.1
Cranford/Upstream Alternative 7b: Nonstructural 100-yr Floodplain	$9,773,600	$7,495,800	$2,277,800	$186,935,700	$7,802,700	-$5,524,900	0.3
Cranford/Upstream Alternative 8: Lenape Park Detention Basin and Orange Reservoir Outlet Modification w/Replacement	$9,773,600	$5,755,600	$4,018,000	$113,212,500	$5,061,300	-$1,043,300	0.8
Cranford/Upstream Alternative 9: Lenape Park Detention Basin, Orange Reservoir Outlet Modifications w/Replacement and Channel Modifications	$9,773,600	$5,508,700	$4,264,900	$128,949,300	$5,741,600	-$1,476,700	0.7
Robinson’s Branch Alternative 1: Levees/floodwalls and Channel Modifications	$2,695,800	$1,499,600	$1,196,200	$54,870,400	$2,368,000	-$1,171,800	0.5
Robinson’s Branch Alternative 2a: Nonstructural 10-yr Floodplain	$2,695,800	$1,339,900	$1,355,900	$10,018,400	$402,800	$953,100	3.4
Robinson’s Branch Alternative 2b: Nonstructural 100-yr Floodplain	$2,695,800	$633,200	$2,062,600	$39,452,200	$1,646,800	$415,800	1.3

Cranford Upstream: Alternatives 1, 2, 3, 4, 5a, 7b, project costs at FY 2014 price level, 3.125% discount rate, benefits at FY16 price levels, 3.125% discount rate
Cranford: Upstream Alternatives 4a, 6, 7a, 8, 9, project cost and benefits at FY 2016 price level, 3.125% discount rate
Robinson’s Branch: Alternatives 1, 2a, 2b, project costs and benefits at FY 2016 price level, 3.125% discount rate
Annual Cost includes First Cost, IDC, and O&M

Table 23 illustrates that Alternative 4a (Channel Modifications and New Outlet at Orange Reservoir) is the alternative that maximizes net benefits for the Township of Cranford and upstream areas and that Alternative 2a (Nonstructural - 10% annual chance exceedance floodplain) is the alternative that maximizes net benefits for the Robinson's Branch.

It is important to state that Alternatives 5 and 6 were developed to include relocation of Brookside Drive (owned by Essex County) as they originally did not include this necessary plan feature. USACE met and coordinated with Essex County and thus determined that the county required the relocation of Brookside Drive as elimination of Brookside Drive would cause longer alternate traffic routes unacceptable to the county. Costs for those alternatives involving modification of the Lenape Park and Orange Reservoir dams include full replacement costs in order to assure that those structures meet USACE dam safety regulations. These costs are included as this study does not include geotechnical borings and dam break analysis of the structures. In addition, costs for those alternatives involving modification of the Lenape Park and Orange Reservoir dams include the creation of a 50 ft no-vegetation buffer from any portion of a dam in order to assure that those structures meet USACE dam safety regulations. Temporary full drawdown of Orange Reservoir would be required during construction.

Price levels vary among alternatives due to formulation and analysis of alternatives at different times within the study. Additionally, some alternatives were not updated due to being not economically justified. Price levels of all alternatives will be updated to the latest common year upon submission of the Final Integrated Report/Environmental Impact Statement with Appendices.

Identifying a Tentatively Selected Plan

The alternative that maximized net benefits for each independent reach was selected as an element of the Tentatively Selected Plan (TSP). Alternative 4a (Channel Work and New Outlet at Orange Reservoir) for Cranford and the upstream detention areas was combined with Alternative 2a (Nonstructural - 10% annual chance exceedance floodplain) for the Robinson's Branch to form the TSP. This method is predicated upon the fact that the Cranford and upstream detention areas are geographically and hydrologically separate from the Robinson's Branch. Cranford/Upstream Alternative 4a and Robinson's Branch Alternative 2a are separate incrementally justified elements of the TSP and together maximize net benefits

Alternative 4a would provide flood risk management for Cranford and the upstream municipalities with modification to the Orange Reservoir dam providing flood risk management to Millburn and Springfield and the combination of Orange Reservoir dam modifications channel work providing flood risk management to Cranford. The nonstructural plan along the Robinson's Branch provides flood risk management provides flood risk management to those structures along the Robinson's Branch that are treated.

As the TSP is optimized later in the study phase any limited downstream effects along the Robinson's Branch from the Cranford and upstream detention elements will be taken into account. This would not change plan selection in either the Cranford and upstream areas

or the Robinson's Branch. Nonstructural elements will be examined to account for residual risk at Cranford. The viability of the TSP is based upon participation by local stakeholders.

Initial construction of the outlet modifications to Orange Reservoir and the channel modifications in the Township of Cranford are estimated to take from the middle of March 2020 until July 2023. Initial construction of the nonstructural measures along the Robinson's Branch are estimated to take place from March 2020 to December 2020. The period of analysis (2023-2073) is assumed for the economics evaluation in this study.

Chapter 5.0 Tentatively Selected Plan*

5.1 Proposed Action/Plan Components

The Tentatively Selected Plan (TSP), which is also the National Economic Development (NED) Plan, consists of modification of the outlet structures of Orange Reservoir Dam, channel modifications in Cranford and nonstructural measures along the Robinson's Branch in the City of Rahway. The TSP plan is illustrated in Figures 39, 40 and 41. Additional detail on the TSP is included in the appendices.

Further evaluation and optimization of the tentatively selected plan will occur after public and agency review of the Draft Integrated Feasibility Report/Environmental Impact Statement (DIFR/EIS) and the appendices as the study progresses. This will include refinements to the plan and design.

TENTATIVELY SELECTED PLAN FEATURES*

Township of Cranford/Upstream

The TSP consists of project elements in three different areas, the first of which consists of outlet modification to the Orange Reservoir Dam. This provides flood risk management to communities downstream of the dam by allowing water levels in Orange Reservoir to be efficiently drawn down prior to a storm event, creating storage for flood waters in the reservoir. These municipalities consist of Cranford, Millburn, Springfield and Union. The second TSP element consists of channel modification in the Township of Cranford, allowing flood waters to more effectively pass through the damage area. The modifications to the Orange Reservoir Dam and the channel in Cranford collectively provide flood risk management to Cranford. The flow detention capacity of the Orange Reservoir will mitigate the increase in downstream flow caused by deepening and widening the channel in Cranford.

The plan includes two additional 36 in. diameter outlet pipes at the Orange Reservoir dam and operation two days prior to a storm event. Prior to storm events, the reservoir will be drawndown from a depth of approximately 30 ft to a depth of 15 ft. It will take two days to complete this drawdown. The refilling of the reservoir will be dependent on the level of storm experienced and will range from 30 hours to one week. In the event the storm does not occur, the reservoir would take approximately two weeks to refill. This plan requires little to no dredging in the reservoir. Table 25 states drawdown and refilling times of the Orange Reservoir.

Table 25. Orange Reservoir Drawdown

*Events	Time
Drawdown	2 days
Re-fill - (25 yr event)	30 hrs
Re-fill - (1 yr event)	One week
Maximum re-fill	Two weeks

*Drawdown and refill depth = 15ft.

The channel element of the TSP approximately 8,930 ft of channel modification. The proposed channel modification starts in the vicinity of the footbridge by Nomahegan Park and ends approximately 650 ft. downstream of South Ave. E. The slope is approximately 2.6 ft./mile with a maximum deepening of about 1.9 ft. in the vicinity Hansel Dam. The new trapezoidal channel will consist of a natural channel bed with a 35 to 45 ft. bottom width and side slopes of one vertical on two and a half horizontal (1:2.5). There is some riprap material in a small segment of the river near the Eastman Ave. Bridge at McConnell Park. No dam or bridge removal along the Rahway River in the vicinity of Cranford is expected in this alternative.

The Orange Rersevoir modifications and channel modifications are designed to provide flood risk management for the the 4% annual chance exceedance flood in the Township of Cranford.

City of Rahway/Robinson's Branch

The third element of the TSP consists of nonstructural measures for structures within the 10% annual chance exceedance (10-yr event) floodplain in the Robinson's Branch area. Measures examined include dry and wet floodproofing, ring walls, elevation and buyouts. Note that all structures will be treated to an elevation of one foot above the formulated 1% annual chance exceedance event within the 10% annual chance exceedance floodplain.

Table 26 contains details pertaining to the treatment of individual structural in the Robinson's Branch area.

Table 26. Robinson's Branch Nonstructural Treatments

Nonstructural Flood Proofing Measure	**10% (10-yr) Annual Exceedance**		
	Residential	Non-Residential	Sub Total
Dry Flood proofing	0	0	0
Wet Flood proofing	1	1	2
Ringwalls/Levees*	2	4	6
Raise	13	0	13
Buyout	0	0	0
Total of Structures	16	5	21

*Note: Ringwalls/Levees to provide flood risk management to individual structures or small clusters of structures (e.g. apartment complex) are a structural measure but at the time of formulation and analysis were included as part of the nonstructural plans in this study.

The above dimensions and requirements will be refined by further project evaluation, agency reviews, and optimization as the study progresses. Figure 38 below illustrates the project areas where the TSP elemements are located. Figures 41, 42 and 43 illustrate the different elements of the TSP and are additionally shown as inserts in Figure 40 for clarity in viewing the TSP as one alternative plan.

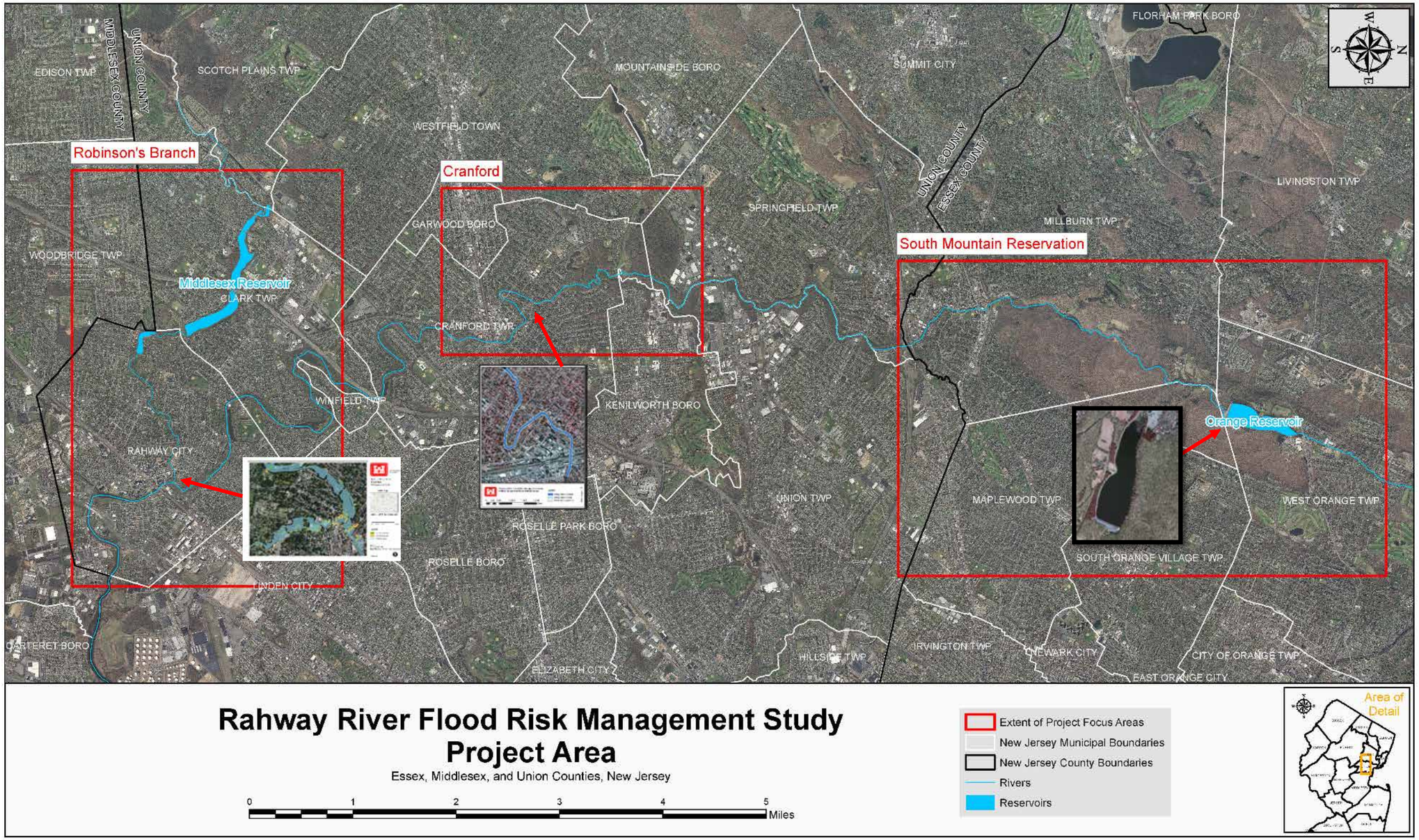

Figure 40. Rahway River Basin Project Areas

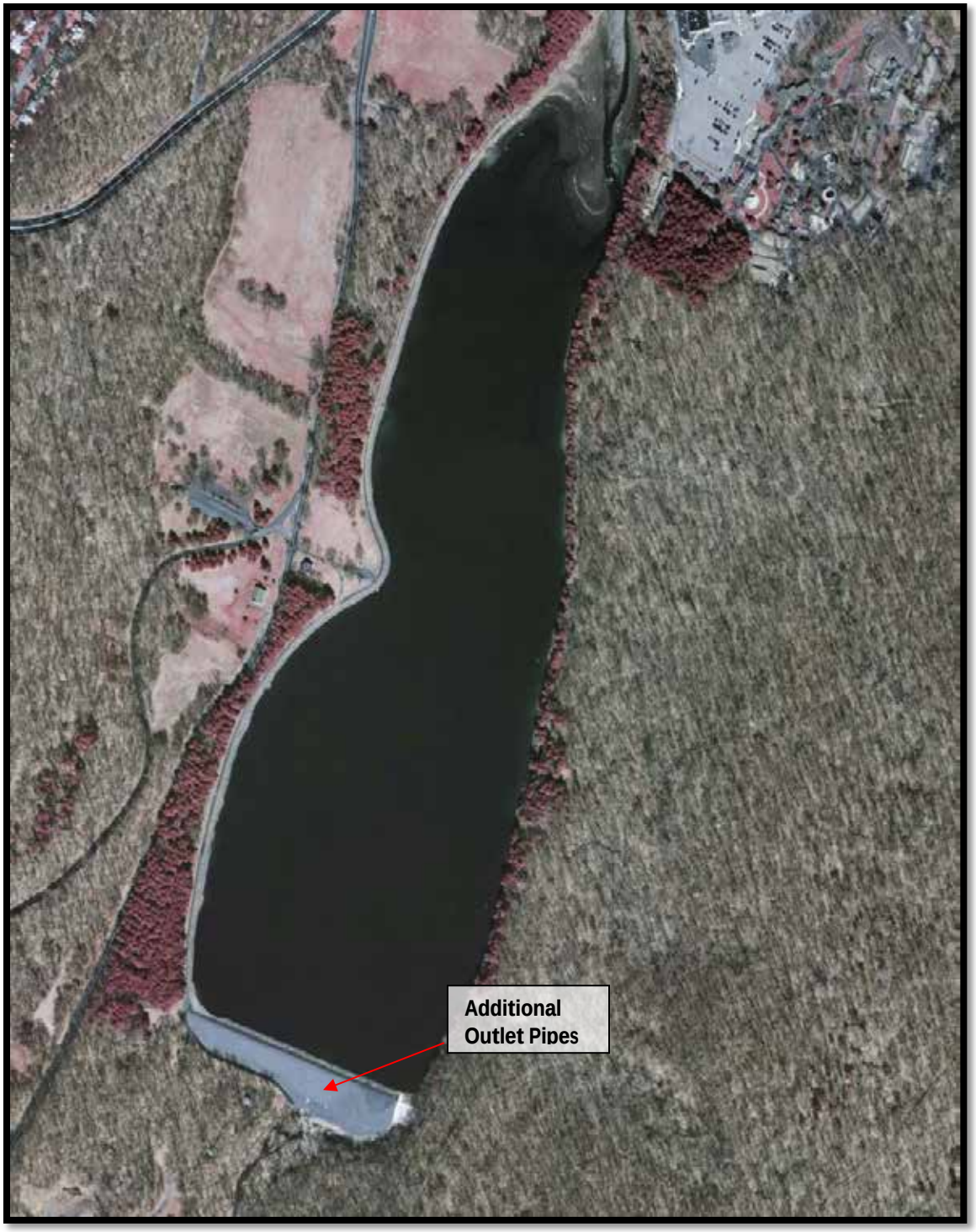

Figure 41. Alternative #4a – Modifying Orange Reservoir Outlet

Figure 42. Alternative #4a – Channel Improvements

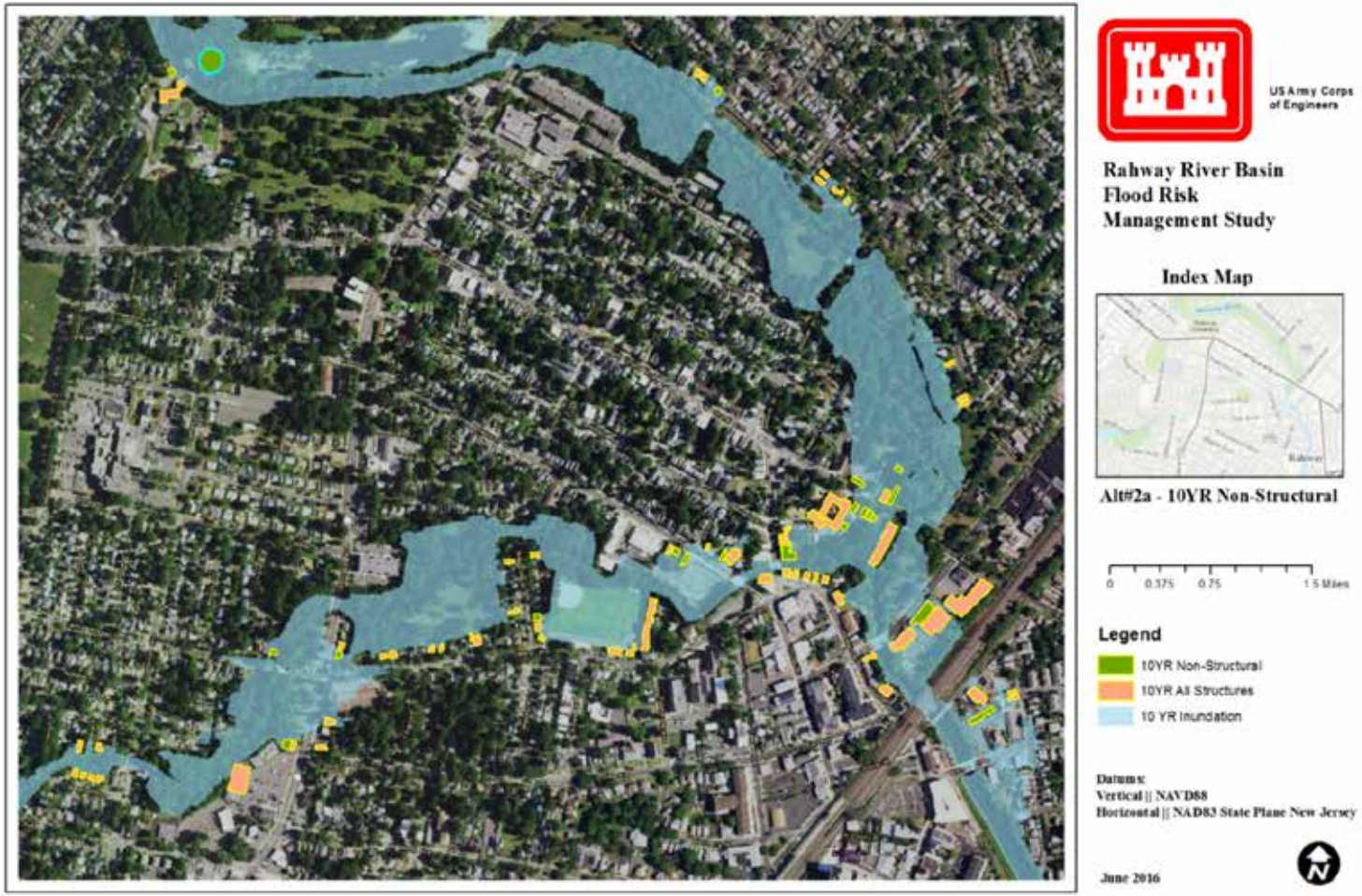

Figure 43. Alternative #2a - Nonstructural Plan with a 10% (2a) chance of annual exceedance along the Robinson's Branch and Rahway River at Clark

Construction Method: Initial construction of the outlet modifications to Orange Reservoir and the channel modifications in the Township of Cranford are estimated to take from the middle of March 2020 until July 2023. Initial construction of the nonstructural measures along the Robinson's Branch are estimated to take place from March 2020 to December 2020. Construction years are assumed for the economics evaluation in this study, but are subject to future project approval and funding requirements.

Real Estate Requirements. USACE projects require the non-Federal sponsor provide lands, easements, rights-of-way and relocations, and disposal/borrow areas (LERRDs) for a project. Currently, the TSP will require the non-Federal sponsor to acquire temporary and permanent easements for construction. Details are provided in the Appendix E (Real Estate Plan).

5.2 TSP Refined Cost Estimate

The costs presented at the TSP were developed using the Micro-Computer Aided Cost Estimating System (MCACES), Second Generation (MII) program. The MII cost estimate used RSMeans, MII Cost Libraries, and vendor quotations. The project contingencies were developed through the Abbreviated Risk Analysis (ARA) tool provided by the USACE Mandatory Center of Expertise. The summary of the results of this risk analysis, and more detail on the cost estimate, can be viewed in Appendix D (Cost Engineering).

The project cost estimate is broken out by cost component in Table 27. This includes planning, engineering and design, construction management, interest during construction and operation and maintenance (contingencies are included). The TSP Total Project Cost for Cranford/Upstream Alternative 4a and Robinson's Branch Alternative 2a are $78,157,000 and $10,997,000 respectively.

Table 27. TSP Refined Cost Estimate[6]
(FY16 Price Level, FY 16 3.125 % discount rate)

Account/Cost Component	Cranford/ Upstream Alternative 4a	Robinson's Branch Alternative 2a
Total Project Cost		
01 – Lands and Damages	$2,947,000	$526,000
03 – Reservoirs	$55,362,000	$0
06 – Fish & Wildlife Facilities	$6,206,000	$0
09 – Channels & Canals	$2,428,000	$0
18 – Cultural Resource Preservation	$1,768,000	$1,661,000
19 – Buildings, Grounds & Utilities	$0	$7,811,000

[6] Initial construction is cost shared 65% Federal and 35% non-Federal and continuing construction is cost shared 50% Federal and 50% non-Federal. See Section 9.2 for cost apportionment.

30 – Planning, Engineering & Design	$5,694,000	$517,000
31 – Construction Management	$3,752,000	$482,000
Estimated Total Project Cost	**$78,157,000**	**$10,997,000**

*Note: These costs will be revised by further project evaluation, agency reviews, and optimization as the study progresses.

Operation, maintenance, repair, rehabilitation, and repair (OMRR&R) requirements are considered in the economic analysis for the project. The non-Federal sponsor is responsible for 100% of requirements. This would consist of periodic project surveillance and maintenance. The OMRR&R cost is estimated at $258,000/year.

5.3 Refined Annual Cost and Benefit of the TSP

Table 28 states the cost and benefit for the TSP. The BCR for the TSP is calculated to be 1.4.

Table 28. Refined TSP, Annual Benefit and Cost Summary*
(FY16 Price Level, FY 16 3.125 % discount rate)

	Cranford Upstream Alternative 4a	Robinson's Branch Alternative 2a	Combined TSP
First Cost	$69,570,000	$10,018,400	$79,588,400
Interest During Construction	$3,790,400	$103,500	$3,893,900
Total Investment Cost	$73,360,400	$10,121,900	$83,482,300
Annual Investment Cost	$2,919,200	$402,800	$3,322,000
Annual O&M	$258,000	$0	$258,000
Annual Cost	$3,177,200	$402,800	$3,580,000
Annual Without Project Damages	$9,773,600	$2,695,800	$12,469,400
Annual With Project Damages	$6,070,300	$1,339,900	$7,410,200
Annual Benefits	$3,703,300	$1,355,900	$5,059,200
Net Benefits	$526,100	$953,100	$1,479,200
Benefit Cost Ratio	1.2	3.4	1.4

*Note: The Benefit-Cost Ratio will be revised by further project evaluation, agency reviews, and optimization as the study progresses.

5.4 Risk and Uncertainty Analysis

Risk and uncertainty has been explicitly factored into the economic analysis of this project. A statistical risk based damage model, Hydrologic Engineering Center-Flood Damage Analysis (HEC-FDA), was used in this study to formulate and evaluate the project in a life-cycle approach. HEC-FDA integrates the engineering and economic analyses and incorporates uncertainty in both physical parameters and storms, which enables

quantification of risk with respect to project evolution and economic costs and benefits of project implementation. For more information please refer to Section 4.2.5 of Appendix B – Economics. For information on risk and uncertainty with respect to hydrology and hydraulics please refer to Section 12 of Appendix C1 – Hydrology and Section 5.0 of Appendix C2 – Hydraulics.

5.5 Economic, Environmental, and Other Social Effects

In reducing damages from future events, the TSP contributes to National Economic Development. National Environmental Restoration considerations are addressed in Chapter 6 (Environmental Effects) of this report. As for Other Social Effects (OSE), the project would maintain the viability of routes of transportation, including emergency and other vital services. Maintaining their integrity will increase the efficiency of emergency response teams in the area. The Cranford First Aid Squad ambulance facility located at 6 Centennial Avenue in Cranford has suffered prior flood damage, notable and most recently from Tropical Storm Irene, from which it was forced to renovate the facility. Figure 44 illustrates the critical infrastructure overlaid on an aerial view of the with-project and without-project 4% annual chance of exceedance floodplain for the Cranford area. Critical infrastructure in the Robinson's Branch would not be significantly affected as the TSP element in that location is nonstructural and would not alter the floodplain.

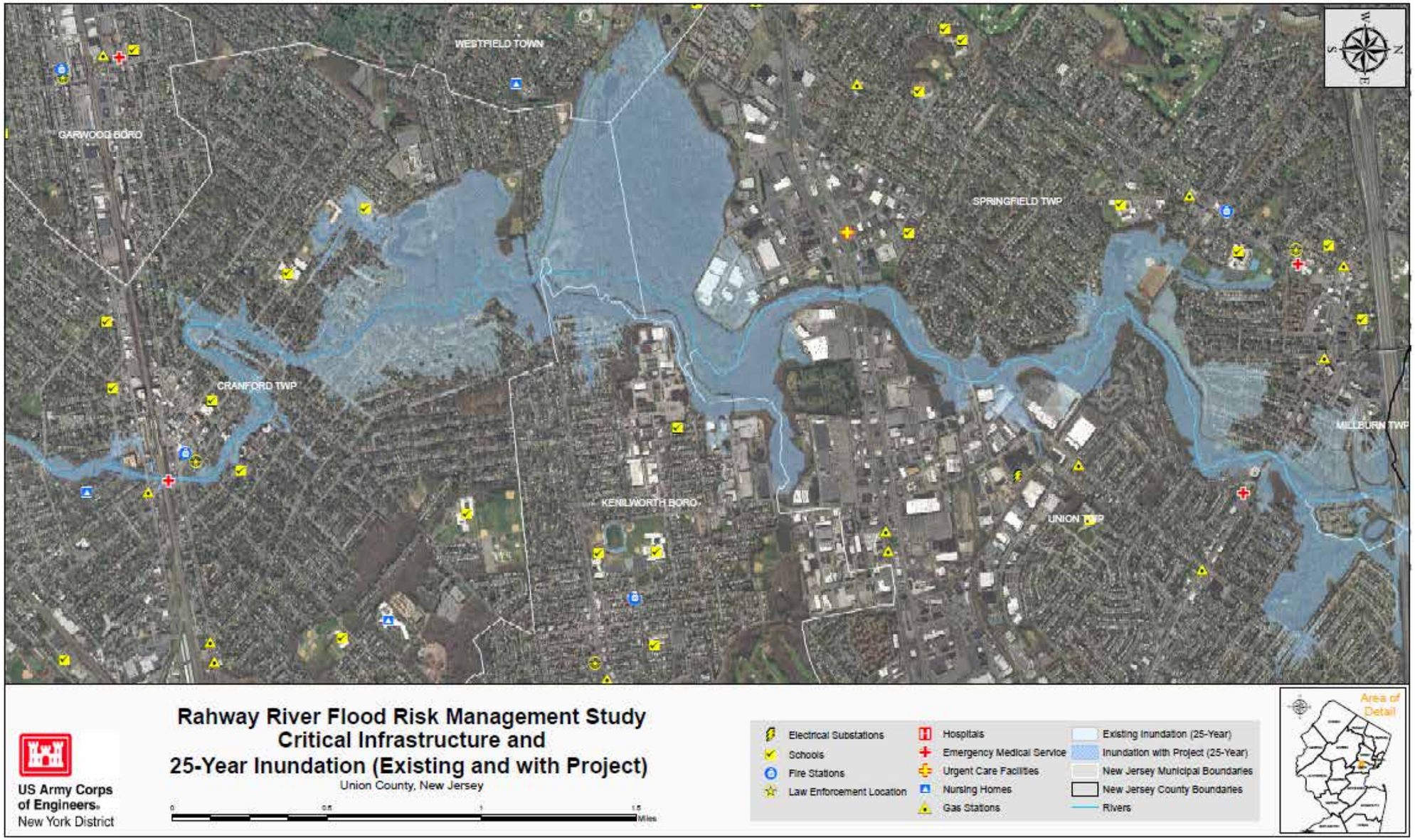

Figure 44. Critical Infrastructure with the 4% (25 year) annual chance of exceedance floodplain (with-project & without-project) in the Cranford Area

Chapter 6.0 Environmental Effects of the TSP*

This chapter discusses the potential positive and adverse environmental effects and consequences resulting from implementation of the Tentatively Selected Plan (TSP). The effects of the TSP are directly compared against the baseline Future Without Project /No Action alternative conditions as described in Section 4.4.2.

As discussed in Section 4.5, modification of the Orange Reservoir dam assumes full cost to replace the dam to bring it into compliance with USACE Dam Safety Standards. Included in the assumption is the complete drawdown of the Orange Reservoir in order to construct the dam replacement even though a coffer dam and partial lowering of the reservoir may ultimately be the primary construction method. For the purposes of the environmental effects analysis, the maximum impact scenario of a complete dam replacement with the full drawdown of the reservoir is considered.

In addition to discussing potential beneficial and adverse environmental effects, this chapter outlines potential mitigation measures for adverse impacts and potential adaptive management methods that may be implemented to ensure success of the mitigation. In accordance with the Council of Environmental Quality NEPA regulations, mitigation includes: (a) Avoiding the impact by not taking a certain action or parts of an action; (b) Minimizing the impact by limiting the degree or magnitude of the action and its implementation;(c) Rectifying the impact by repairing, rehabilitating, or restoring the effected environment;(d) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; (e) Compensating for the impact by replacing or providing substitute resources or environments.

6.1 Land Use

The proposed action will have a short term minor impact on residential and commercial land use around temporary workspaces during and immediately after construction. Permanent easement will be acquired from property owners adjacent to the Rahway River to enable maintenance activities but will not constitute a change in land use. In the long term, the proposed action will be compatible with surrounding land uses. Uses of the Orange Reservoir and the Rahway River and Robinson's Branch will not change, nor will the opens space character of the parks. Increased turbidity may affect fishing and recreational use of the Rahway River from the direct disturbance, though this potential impact will be minor and temporary. Portions of the existing channel will be modified but there will be no direct long term conversion of adjacent land uses.

Implementation of the proposed action will likely produce long term benefits by reducing flood risk and future damage to residential, manufacturing/industrial, commercial/office, transportation/utilities and open space land uses located within the project area.

<u>Mitigation</u>

Temporary workspaces along the top of the channel within the channel modification footprint in the Township of Cranford will generally be limited to a 15 ft clearance from the channel bank edge along portions of the project area. In addition, channel construction

and its impacts will not be concentrated in any one location for extended periods of time, as construction will be moved from area to area as it progresses. Disturbed areas will be restored and their use returned to pre-construction conditions.

6.2 Topography, Geology and Soils

6.2.1 Topograhy and Geology

Township of Cranford/Upstream

There will be no impacts to topography or geology as a result of the replacement of the Orange Reservoir dam. The channel modifications to the Rahway River in the Township of Cranford will constitute a change in the topography as it will change the river gradient. However, the modification is required to achieve the level of flood risk management.

City of Rahway/Robinson's Branch

For the nonstructural measures proposed within the Robinson's Branch portion of the project area grading may be required around the foundation and potentially the lot. The topographical changes are expected to be negligible.

6.2.2 Soils

Township of Cranford/Upstream

The full drawdown of Orange Reservoir to replace the dam will expose the reservoir bed, making it susceptible to erosion during storm events. In order to minimize erosion potential, the reservoir bed and side slopes will be seeded with grass. To minimize the release of sediment as well as to prevent erosion downstream of the dam the preconstruction drawdown will be performed slowly and will not exceed the current discharge velocities. Therefore, significant sediment and erosion to the portion of the Rahway River below the dam is not expected.

Construction site and staging preparation will require clearing and regrading of the Orange Reservoir dam replacement site, establishing the 50 ft vegetation free zone, The channel modifications to the Rahway River in the Township of Cranford will involve excavation and fill of channel bottom or substrate, with construction generally being restricted to the existing channel banks. The specific channel modifications to be implemented are limited in scope (e.g., channel depth and width, and volume of material). Rip-rap will be placed long approximately 800 ft of the Rahway River near McConnell Park to prevent scouring and erosion of soils. Staging areas also will sustain short-term minor impacts during construction activities.

City of Rahway/Robinson's Branch

No significant impacts to soils as a result of implementation of the nonstructural measures in the Robinson's Branch portion of the project area is expected.

<u>Prime Farmland</u>

The proposed action occurs in an urbanized setting that does not include any additional land uses related to agriculture or silviculture. Therefore, significant adverse impacts to Prime Farmland soils will not occur.

Mitigation Measures

An Erosion and Sediment Control Plan will be developed and submitted to the Somerset-Union Conservation District for approval prior to construction. Best management practices including, but not limited to, silt fence, turbidity curtains and temporary seeding, such as the stabilization of the bottom of the Orange Reservoir, will be implemented to reduce soil erosion within the project footprint. Cofferdams will be installed to construct the channel modifications in the Township of Cranford.

Long term erosion mitigation measures include installing rip rap to approximately 800 linear ft of the Rahway Riverbank along McConnel Park. In addition, native herbaceous vegetation will be used to stabilize the modified channel banks and native shrub and tree species will be planted along the top of bank.

Elements of the proposed action are designed to protect existing soils and surficial material (especially erodible soils exposed along the streambanks) by reinforcing the streambed and channel slopes with riprap, retaining walls, and vegetation. Following completion of modifications and structures, temporary work locations will be restored to pre-construction conditions.

6.3 Water Resources

6.3.1 Surface Water

Township of Cranford/Upstream

The drawdown of the Orange Reservoir to complete the dam replacement will require a Lowering Permit from the New Jersey Division of Fish and Wildlife. Per likely permit requirements, the drawdown will occur in the fall timeframe when reservoir waters are less likely to have low dissolved oxygen levels that could effect downstream water resources. The lowering will be performed at a slow rate to prevent over-bank flow of the primary downstream channel to minimize the release and transport of silt, detritus and debris downstream. The full drawdown would take approximately one month. Assuming a full drawdown, the reservoir would be drained for approximately 1.5 years. The construction contractor will be required to maintain flow of the Rahway River through the reservoir during construction. The reservoir would refill naturally once construction is completed.

Prior to storm events, the reservoir will be drawndown from a depth of approximately 30 ft to a depth of 15 ft. It will take two days to complete this drawdown. The refilling of the reservoir will be dependent on the level of storm experienced and will range from 30 hours to one week. In the event the storm does not occur, the reservoir would take approximately two weeks to refill.

The proposed channel modifications in the Township of Cranford, as described in Section 5.1, will alter the hydrology of the Rahway River in order to manage flood risk within the project area. However, the majority of the work involves modifications to the channel bottom. Specifically, excavation will be performed to increase the depth of the river by one to two feet and to increase the channel bottom width to 35-45 ft. There will be some work along the riverbanks to create a bank slope of 1V:2.5H. However, the average top width of the Rahway River within the footprint of the channel modifications is 70 ft. Therefore, with

the exception of a few locations where the top of channel is less than 70 ft wide, the top of bank width will remain the same. Normal baseflow velocities and depths will be similar to pre-project conditions. During optimization, the District will evaluate replacing the substrate excavated during construction in order to restore the substrate to pre-project conditions.

In order to minimize sedimentation to the river during construction, cofferdams will be installed so that work can be conducted in dry conditions. Construction of the channel modifications will predominantly occur from top of the riverbank except for locations where the workspace is constrained by structures. In that case, work will be conducted from within the river channel.

City of Rahway/Robinson's Branch
The implementation of nonstructural measures within the Robinson's Branch portion of the project area will have no impacts to the surface waters associated with Robinson's Branch.

Mitigation
Discussions of water resources mitigation, monitoring and adaptive management are described in Section 6.3.2 below.

6.3.2 Water Quality and Aquatic Habitat

Township of Cranford/Upstream
The physical drawdown of the Orange Reservoir will cause a loss of lacustrine and littoral habitat. Given that construction could take 1.5 years, this impact is considered a longer term temporary impact. The littoral zone is composed of a vertical stone shoreline and rip rap and has little to no vegetation. Therefore, the loss of reservoir and littoral zone for the duration of the construction is not expected to be significant.

The aquatic habitat immediately downstream of the reservoir will likely be impacted during drawdown through the deposition of sedimentation and the creation of turbid conditions. In order to minimize these impacts, the drawdown will occur slowly and at the same discharge rate as current conditions.

As stated in section 6.2.2 above, the reservoir bottom and side slopes will be stabilized with grass seed and the construction contractor will be required to maintain flow of the Rahway River through the reservoir. The current construction method assumes a channel will be excavated along the reservoir floor to contain baseflows of the river during construction. The excavated material is planned to be stockpiled within the reservoir and will be seeded.

Given that the Orange Reservoir is, approximately, 0.69 miles long, the portion of the Rahway River that flows through it will be subject to sun exposure which will likely cause thermal impacts. Reservoirs are commonly known to accumulate sediments high in nutrients which, in combination with heat, can create eutrophic conditions. The Orange Reservoir exhibited signs of eutrophication during a site visit in August 2016.

Consequently, the probability is high that the sediments within the reservoir contain elevated levels of nutrients typically associated with urban land use. Grass buffers applied between waterways and agricultural sites, where there is typically a concentration of nutrients and pathogens, have demonstrated the ability to successfully retain such contaminants. The stabilization of the reservoir floor and slopes with grass will perform the same function. Additionally, the grass along the constructed channel will be allowed to grow to provide some shade to reduce thermal impacts, thus minimizing the potential of eutrophication of the river during construction.

Any thermal increases experienced by the Rahway River within the reservoir during construction will likely effect the portion of the Rahway River immediately below the reservoir. However, thermal impacts further downstream of the reservoir are expected to be offset by the dense forest canopy through which the river flows for much its extent in the South Mountain Reservation. As a result, the impacts are expected to be negligible.

The new pipes that comprise the outlet will be larger than the current pipes to allow for a faster drawdown prior to storm events. The outlets will be positioned in the reservoir to minimize sedimentation and turbidity during pre-storm drawdown as well as to avoid discharging warm water that could adversely impact the water quality and aquatic habitat of the river downstream of the dam. The discharge velocity of the outlets during normal flows are anticipated to be similar to pre-project velocities. The pre-storm drawdown velocities will be higher than current discharge rates. However, as this section of river is composed of large rock, erosion and scour to the downstream river channel is not expected.

Construction of the channel modifications in the Township of Cranford will create short term, minor water quality impacts primarily resulting from the installation of cofferdams. These effects will predominantly be concentrated within the project area with effects dissipating further downstream. The channel modifications are located within a segment of the Rahway River listed in the 303(d) list for arsenic and phosphorus. Construction activities may re-suspend particles containing these pollutants. The implementation of erosion and sediment BMPs will minimize transport pollutant-laden sediment downstream. Additionally, the length of this 303(d) listed segment extends downstream to the Robinson's Branch, therefore, any sediment transported downstream is already within an impacted river segment.

The proposed action will not effect the use of the river as a water source for the City of Rahway given that treatment already occurs and the treatment plant is approximately 3 miles downstream from the terminus of the channel modifications.

Excavation to deepen and widen the bottom of the channel will remove the existing cobble/gravel substrate. Because excavation to deepen the channel ranges from one to two feet, there is a possibility that the excavation process exposes finer sediment, which would result in a temporary conversion of dominant substrate type. Restoring the existing substrate as part of construction will minimize this potential impact. Pool and riffle complexes, to the extent that they occur within the channel improvement footprint, will be removed as a result of excavation and grading activities. Through mitigation and the natural

morphological processes, the pool and riffle complexes will reform. The approximately 800 linear ft of riprap applied along the river bank near McConnell Park will increase the amount of hard structure along the riverbank in the project area.

Removal of mature vegetation reduces available forage, shelter and nesting sources for fish, aquatic macroinvertebrates and wildlife resources inhabiting the project area. Additionally, the loss of tree canopy over the river may cause an initial increase of water temperatures and more extreme diurnal fluctuations. However, the tree canopy along this segment of river currently does not completely shade the river, thus, impact will not be significant. Temperature increases and diurnal fluctuations will decrease as the vegetation along the top of bank matures and coverage of the tree canopy re-establishes over portions of the river.

Overall, the significance of long term adverse impacts to water quality and aquatic habitat from implementation of the proposed action is somewhat lessened due to the amount of previous disturbance that the project area has experienced. Based on site investigations and review of aerial photography, approximately 40% of the left bank and 17% of the right bank within the footprint of the channel modifications have been directly modified through the installation of other flood risk management measures, development of transportation infrastructure (e.g. bridges, roads), rip rap and a combination of aesthetic and structural retaining walls. General field observations of this segment of the Rahway River noted high levels of sediment deposition overlaying and embedded within the cobble/gravel substrate. Few pool and riffle complexes were observed. Velocities were near stagnant and were associated more with backwater flow from the Hansel Dam.

City of Rahway/Robinson's Branch

It is our conclusion that implementation of nonstructural measures in the Robinson's Branch portion of the project area will not have significant impacts on water quality or aquatic habitat.

<u>Mitigation</u>

During construction of the dam replacement and channel modifications, standard erosion and sediment control management Best Management Practices (BMPs) to protect water quality and wetlands during in-stream work will be implemented to reduce the potential adverse and significant impacts.

A summary of mitigation measures to be implemented specifically to minimize adverse impacts to the Rahway River resulting from the Orange Reservoir dam replacement and outlet modification is as follows:

- Performing a slow drawdown of the reservoir prior to construction to minimize erosion and sedimentation downstream of the reservoir;
- Stabilizing the Orange Reservoir shoreline and bed with grass seed;
- Excavating a channel within the reservoir to maintain flow of the Rahway River through the reservoir; and
- Allowing vegetation to grow along the channel to provide shade in order to minimize thermal impacts and eutrophication.

The minimum long term mitigation goal will be to maintain water quality standards and habitat similar to pre-project conditions with a larger goal of enhancing aquatic habitat.

Measures that will be evaluated during optimization to mitigate adverse impacts related to the channel modifications include:

- Constructing from one side of bank with preference to preserving vegetation on the western bank to optimize thermal impact reduction.
- Constructing the channel in a manner that contains baseflows, accentuates meanders within the channel, creates pool and riffle complexes and maintains velocities to sustain maintain transport. This may be achieved either through the excavation of a low flow channel or contouring the bottom of channel to direct flows in a certain direction within the channel.
- Restoring the existing substrate by stockpiling the gravel/cobble substrate excavated from the channel during construction and re-installing it once grading is completed.
- Applying the proposed riprap along Eastman Avenue in a manner that provides foraging and resting habitat for fish and aquatic macroinvertebrates.
- Riparian zone re-establishment. Native herbaceous material will be applied to the riverbanks in order to maintain the hydraulic efficiency of the channel during storm events. Native shrubs and trees will be planted on the top of bank.

Monitoring and Adaptive Management

New Jersey Freshwater Protection Act Wetlands Rules require a minimum monitoring period of five years to determine mitigation success while Federal Wetland Protection Act Mitigation Rules do not specify a timeframe. Therefore, the minimum monitoring period will be five years. The New Jersey High Gradient Macroinvertebrate Index and Northern New Jersey Fish Index of Biological Integrity along with the companion EPA RBP stream habitat assessment method will be utilized to determine mitigation success.

Surveys utilizing these methods will be conducted prior to construction to form baseline conditions. Surveys will then occur minimally one time per year as recommended in each of the methods respective guidance documents. A report discussing the results of the surveys and whether adaptive management measures may be required will be prepared annually. The report will be submitted to the New Jersey Department of Protection, Division of Land Use and will be made available to the public for review.

Adaptive management that could potentially be considered include additional morphological changes to enhance aquatic habitat, and repairing or relocating in-stream habitat features. Any proposed adaptive management measures will be coordinated with NJDEP prior to implementation.

6.3.3 Wetlands

Township of Cranford/Upstream

In the absence of formal wetland delineations, it is assumed that approximately 0.13 acres of palustrine forested wetland will likely be permanently impacted through the creation of

the 50 ft vegetation free zone at the base of Orange Reservoir. Formal wetland delineation surveys will be conducted in the Preconstruction Engineering and Design (PED) Phase of the project to determine actual impacts.

City of Rahway/Robinson's Branch

It is our conclusion that the implementation of the channel modification in the Township of Cranford and nonstructural measures within the Robinson's Branch portion of the project area will have no significant impacts to wetlands.

Mitigation

Permanent adverse impacts to wetlands will be compensated through either the enhancement of existing wetlands, the restoration or creation of wetlands or through the purchase of wetland mitigation credits. Federal Mitigation Rules typically require wetland compensation to be consistent with a minimum of 1:1 ratio based on functional value. The NJDEP Freshwater Wetlands Protection Act Rules require a mitigation ratio of 3:1 for wetland enhancement and a 2:1 ratio for wetland restoration or creation. The purchase of wetland mitigation credits is based on a 1:1 mitigation ratio and must be must be obtained from a wetland mitigation bank that has been approved by the NJDEP to operate within the Watershed Management Area in which the impact is located.

Given the small impact the proposed action has on wetlands, the District has determined that it is more efficient to follow the NJDEP mitigation requirements rather than utilize a functional assessment model to determine the appropriate mitigation amount. A full assessment of the type of mitigation to be performed will be conducted during the PED phase of the project. Should the mitigation alternative selected involve wetland enhancement, restoration, or creation, the specific location to conduct the mitigation will be evaluated during PED phase. Potential wetland enhancement opportunities were identified within the South Mountain Reservation, Lenape Park and Nomahegan Park during cursory field investigations. These areas will likely be further investigated to serve as mitigation sites in the PED phase if the wetland mitigation credits cannot be purchased.

Monitoring and Adaptive Management

The New Jersey Freshwater Wetlands Protection Act Rules require a minimum monitoring period of five years for any wetland enhancement, restoration or creation, and establish specific criteria for determining success. The success criteria at the end of the five year monitoring period for which mitigation success is determined includes: 1) 85 percent survival and 85 percent area coverage of the mitigation plantings or target hydrophytes which are species native to the area and similar to ones identified in the mitigation planting plan; 2) Any trees planted are at least five feet in height; 3) The site contains hydric soils or there is evidence of oxidatative reduction (redox) occurring in the soil; 4) Evidence that the site is meeting the hydrologic regime as specified in the mitigation proposal; 5) The site is less than 10 percent occupied by invasive or noxious species; and 6) The site delineates as a wetland using the 1989 Federal Manual for Identifying and Delineated Jurisdictional Wetlands.

The District will perform all monitoring in accordance with the NJDEP FWPAR requirements should it select wetland enhancement, creation, or restoration as the mitigation alternative. Surveys will then occur twice a year as outlined in the mitigation requirements. A monitoring report that discusses the results of the surveys and whether adaptive management measures may be required will be submitted annually to the New Jersey Department of Protection, Division of Land Use Regulation (NJDEP LUR) and will be made available to the public for review.

An adaptive management plan specific to the needs of the wetland mitigation site will be developed during the monitoring period. However, common adaptive management measures implemented to ensure wetland mitigation success include invasive plant species management, implementation and maintenance of anti-herbivory measures, additional topographical changes to promote hydrology necessary to sustain the wetlands and replanting any vegetation to meet the 85 percent coverage criteria. All proposed adaptive management measures will be coordinated with NJDEP prior to implementation.

6.4 Vegetation

6.4.1 Uplands and Riparian Corridor

Township of Cranford/Upstream

Approximately 1.09 acres of upland forest immediately adjacent to the toe of the Orange Reservoir dam will be cleared as part of the dam replacement to create the 50 ft vegetation free zone as required by ETL 1110-2-583 *Guidelines for Landscape Planting and Vegetation Management at Levees, Embankment Dams and Appurtenant Structures*.

The construction of channel modifications in the Township of Cranford will likely result in the clearing of approximately 15 acres of riparian vegetation. The total amount of vegetation cleared will depend upon whether construction can be performed from one side of the bank. The USACE will evaluate the potential of constructing from one side of the bank during the PED Phase of the project.

Upon completion of the channel modifications, a combination of herbaceous, shrub and tree species will be replanted along the riverbanks and top of bank. To maintain the hydraulic efficiency of the improved channel, herbaceous vegetation will be planted on the riverbank. Trees and shrubs will be planted at the top of the bank.

The removal of vegetation from the river channel will have long term adverse impacts on land cover. The riparian vegetation, especially mature trees, which provide shade and privacy screening for abutting residential yards, will impact the character and use of some residential and commercial properties. Although vegetation will be replanted and replaced, it may take decades for new trees to reach the height and character of trees found in existing riparian habitat. Shrubs and other low growing vegetation will take considerably less time to reach preconstruction conditions. Larger planting stock will be used in order to reduce the amount of time it takes for the tree to reach maturity.

City of Rahway/Robinson's Branch

Within the Robinson's Branch project area, clearing of vegetation will be limited to what is necessary to construct the nonstructural flood risk management measures. Therefore, any vegetation immediately adjacent to the structure receiving nonstructural treatments may need to be removed.

Mitigation

Compensation for the upland forest vegetation removed as a result of the Orange Reservoir dam replacement and compliance with the ETL 1110-2-583 *Guidelines for Landscape Planting and Vegetation Management at Levees, Embankment Dams and Appurtenant Structures* will be performed in kind at a 1:1 ratio. The specific mitigation location will be determined during the PED Phase of the project. However, Essex County currently has installed 42 forest reestablishment cells within the Reservation to address damage to forest understory caused by deer browsing (Desisto and Kadosh, March 2016). The District will coordinate with Essex County to determine if additional areas within the Reservation could be candidates for similar reforestation efforts.

The District will evaluate the ability to minimize impacts to riparian vegetation by constructing the channel modifications in Cranford from one side of the bank during the PED phase. In compliance with USACE policy against the introduction and establishment of invasive plant species, vegetation removed during construction will be disposed of in a manner that will prevent the spread of any invasive plant species removed. Native herbaceous, shrub and tree species will be used to revegetate the riverbanks and top of bank. The District will coordinate with the Cranford Tree Advisory Board and the Cranford Environmental Commission when assessing appropriate plant species for the replanting effort. Larger tree stock, as opposed to saplings, will be considered to reduce the amount of time it will take for the trees to reach maturity.

The New Jersey Flood Hazard Area Control Act (FHACA) Rules regulates compensation for impacts to riparian zone vegetation. Mitigation types under the Rule, which was revised in June 2016, include riparian creation, restoration or enhancement. As defined in the Rule, riparian creation involves the restoration of a regulated water by removing a structure such as a pipe or culvert. The mitigation ratio for riparian creation is 1:1. Restoration entails reestablishment of the riparian zone through the removal of an impervious surface from the top of bank, restoring the morphology of a straightened channel, or removing hard streambank stabilization structures such as retaining walls. The mitigation ratio for riparian restoration is 2:1. Enhancement is defined as improving the functional value of a degraded riparian zone through the removal of invasive plant species and replanting with native vegetation. The mitigation ratio for riparian zone enhancement is 3:1. Because the riparian zone width for the Rahway River is 50 ft, the rules allow for restoration and enhancement mitigation to occur within 100 ft of top of bank. Credits may also be purchased at a NJDEP approved mitigation bank operating in the same watershed management area as the impact.

A full assessment of the type of mitigation to be accomplished will be conducted during the PED Phase of the project. Should the mitigation alternative selected involve riparian zone enhancement, restoration or creation, the identification of appropriate mitigation sites

will be performed. The revised FHACA Rules allow mitigation to occur on Green Acres land subject to approval from the Green Acres Program. Preliminary coordination with Green Acres staff has indicated their support to perform mitigation on Green Acres lands as long as the mitigation is compatible with the use of the park. Therefore, locations that will likely be evaluated for mitigation will include Green Acres lands within the project area.

Monitoring and Adaptive Management

Monitoring of mitigated upland vegetation will be conducted for a minimum of five years to ensure mitigation success. Adaptive management measures may include invasive plant species management, installation of additional anti-herbivory measures and replanting where necessary.

NJDEP requires monitoring of riparian mitigation for a minimum period of five years. Success criteria outlined in the FHACA Rule is general in nature and only specifies that the goals and the percent coverage of planted vegetation detailed in the approved mitigation plan have been achieved. The District will perform all monitoring in accordance with the NJDEP FHACA Rules requirements should it select wetland enhancement, creation, or restoration as the mitigation alternative. Surveys will then occur twice a year as outlined in the mitigation requirements. A monitoring report that discusses the results of the surveys and whether adaptive management measures may be required will be submitted annually to the NJDEP LUR and will be made available to the public for review.

An adaptive management plan specific to the needs of the riparian mitigation site will be developed during the monitoring period. However, common adaptive management measures implemented to ensure riparian mitigation success include invasive plant species management, implementation and maintenance of anti-herbivory measures, and replanting any vegetation to meet the 85 percent success criteria. All proposed adaptive management measures will be coordinated with NJDEP prior to implementation.

6.4.2 Wetlands

The clearing associated with the 50 ft vegetation free zone will convert the existing vegetation from deciduous wetland forest to maintained lawn.

Mitigation

Mitigation for wetland vegetation is discussed in section 6.3.3 Wetlands above.

Monitoring and Adaptive Management

Monitoring and adaptive management of wetland vegetation is discussed in section 6.3.3 Wetlands above.

6.5 Aquatic Resources and Wildlife

6.5.1 Fish

Township of Cranford/Upstream

The drawdown of the Orange Reservoir to complete the dam replacement will likely have minor adverse impacts to native fish species. As required by the Lowering permit obtained

from the New Jersey Division of Fish and Wildlife, the timing of the drawdown will be restricted to occur between mid-September through October to minimize stress on fish. Prior to initiating the drawdown, a fish salvage that involves the collection and relocation of non-invasive fish species will be performed. Carp and goldfish are considered invasive species and under New Jersey law, are prohibited from being relocated. As per likely permit conditions, any carp and/or goldfish collected within the reservoir will be humanely euthanized. The drawdown will be completed gradually to prevent ponding that may strand any fish that may enter the reservoir after the fish salvage.

During construction, the flow of the river will be maintained through and downstream of the reservoir. Fish, to the extent that they inhabit the reservoir, are presumably entering the reservoir from the Rahway River upstream of the reservoir and are thus adapted to riverine habitat. Therefore, it is expected that fish will utilize the river within the reservoir. Subsequent to the dam replacement the reservoir will be refilled. Because the Orange Reservoir is used for fishing, the District will coordinate with the New Jersey Division of Fish and Wildlife to restock the reservoir with the appropriate fish species. Pre-storm drawdown will reduce the amount of available lacustrine habitat, but not to a significant level.

The construction of the channel modifications in the Township of Cranford is expected to have temporary adverse impacts to fishery resources. During construction, any juvenile or adult fish within the project area are expected to be mobile enough to leave the area. The turbidity caused by construction activities could hinder predation efficiency of sight feeding fish within river. In addition, the loss of aquatic macroinvertebrate species resulting from the channel modifications will eliminate a food source for fish until the aquatic macroinvertebrates recolonize the new channel.

The segment of the Rahway River immediately below Nomahegan Park is stocked with rainbow trout by the NJ Division of Fish and Wildlife. Pre-season stocking generally occurs late March through early April with in-season stocking taking place from mid- April to late May. As this segment is within the footprint of the channel modifications, it is presumed that stocking efforts will be suspended until construction completion. The District will coordinate with the NJ Division of Fish and Wildlife during construction to allow them to modify their stocking efforts, accordingly, in the Rahway River.

The majority of species caught from the most recent fish surveys conducted by the NJ BFBM were tolerant of degraded water quality and habitat. Subsequent to construction completion, the species most tolerant of impaired conditions, such as sunfish species, are expected to be the first to utilize the area. As the river system recovers, vegetation planted along the banks and top of bank establish and, it is expected that more species will utilize the channel.

City of Rahway/Robinson's Branch

The implementation of nonstructural measures in the Robinson's Branch portion of the project area will not significantly adversely impact fish species.

Mitigation

If a complete dam replacement is determined to be necessary, the District will develop plans to implement a fish ladder to provide fish passage to upstream areas. These plans would be coordinated with USFWS and NJDEP, as well as with other stakeholders during the PED phase of the project.

The use of erosion and sediment control best management practices will minimize sedimentation and turbidity that can negatively impact fish species and their habitat. In addition, an in-water work restriction from 1 May through 30 June, as per the NJDEP Freshwater Protection Act Rules, will be implemented during construction to protect any spawning fish species.

As discussed in the mitigation section for section 6.3.2, during optimization of the TSP, the District will evaluate restoring the substrate excavated during construction to facilitate recolonization of aquatic macroinvertebrates that could be used as food sources for fish, along with providing suitable spawning habitat. Additionally, the District will evaluate the ability to design the channel modifications in a manner that will maintain optimum depths and velocities during baseflow conditions and create pool and riffle complexes to enhance habitat supportive of various life cycles of fish species.

Monitoring and Adaptive Management

The District will monitor the recovery of fishery resources using the NJ FIBI as described in Section 6.3.2 Water Quality and Aquatic Habitat above. Adaptive management measures related to fish habitat are also described in Section 6.3.2.

6.5.2 Aquatic Macroinvertebrates

Township of Cranford/Upstream

The complete drawdown of the Orange Reservoir to replace the dam will likely cause direct mortality of any aquatic macroinvertebrates that inhabit the reservoir floor and littoral zone due to dry conditions. Additionally, macroinvertebrate communities inhabiting the Rahway River immediately below the Orange Reservoir will likely be adversely effected through the deposition of sediment discharged during the drawdown. Given the length of time the reservoir will be drained it is expected that the channel created to maintain flow of the Rahway River through the reservoir will be colonized by aquatic macroinvertebrates. In all likelihood, these species will be more adapted to riverine systems and may experience direct mortality when the reservoir is refilled due to the inability to survive in lacustrine habitats. The drawdown of the reservoir prior to storm events may negatively impact aquatic macroinvertebrates inhabiting the littoral zone, but this impact is not significant given the limited habitat.

Construction of the channel modifications in the Township of Cranford will cause the direct mortality of aquatic macroinvertebrates as a result of installation of the cofferdams, excavation of the channel and the installation of riprap along the riverbanks near McConnell Park. Temporary increases in turbidity and suspended sediments near and downstream of the construction activities could cause direct mortality or indirect decreased reproductive success in benthic species over the short-term.

Recolonization of disturbed river channels by aquatic invertebrates is site specific and is dependent on factors such as the proximity of a source of colonizers, the stability of the substrate and other physical conditions. Typical colonization methods include oviposition, drift or crawling and can occur within a few months after the initial disturbance. (Giller 1998).

Depending on the type of substrate exposed during project construction, recolonization by aquatic invertebrate species tolerant to disturbances and degraded conditions will occur. The re-establishment of the pre-project substrate and replanting the river banks and top of banks with native vegetation will assist in recruiting a more diverse macroinvertebrate community as the river system recovers.

City of Rahway/Robinson's Branch

Implementation of nonstructural measures within the Robinson's Branch portion of the project area will not have any significant adverse impacts on macroinvertebrate species.

Mitigation

The use of erosion and sediment control best management practices will minimize sedimentation and turbidity that can negatively affect macroinvertebrate species and their habitat. The mitigation measures described in section 6.3.2 above, will directly benefit aquatic macroinvertebrate species. The restoration of the existing substrate will provide these species with spawning habitat. The interstitial spaces between cobble and gravel provide refuge during flood events. Restoration of herbaceous and woody plant material along and on top of the riverbanks provide organic material that serves as a food source and cover/spawning habitat.

Monitoring and Adaptive Management

The District will monitor the recovery of aquatic macroinvertebrates using the High Gradient Macroinvertebrate Index as described in Section 6.3.2 Water Quality and Habitat above. Adaptive management measures related to macroinvertebrate habitat are also described in Section 6.3.2.

6.5.3 Birds

Township of Cranford/Upstream

The drawdown of the Orange Reservoir will eliminate lacustrine habitat for waterbird species such as geese and ducks. However, research has not indicated that the reservoir is considered an important area for birds, and few waterbird species were observed utilizing the reservoir during site visits. Therefore, the impact is not significant. In addition, the shoreline along the river is extremely limited so impacts to wading birds will be negligible. Once the dam replacement is completed, the reservoir will be refilled. The drawdown of the reservoir prior to storm events will reduce the wetted surface area within the reservoir, but the impact is not significant. Removal of the 1.09 acres of mature forest immediately below the Orange Reservoir will not have significant impacts to bird species as it is expected they will utilize other portions of the South Mountain Reservation.

The construction of the channel modifications in the Township of Cranford that may create short-term minor adverse impacts to migratory bird species are expected from the clearing of vegetation, as well as noise resulting from construction activities. However, since bird species are highly mobile, they are expected to move away from the project area during construction. Furthermore, outside the breeding season these species do not permanently remain in any one location. Implementation of seasonal tree clearing restrictions will benefit both ground and tree-dwelling migratory birds during the breeding season. Therefore, adverse impacts to migratory bird species are expected to be short term and minor, and largely limited to the period of construction. Following construction, bird species are expected to resume their normal habits consistent with post-construction habitat availability in and within the vicinity of the project area. As the channel modifications are located in a relatively urbanized section of the river, long term permanent or significant adverse impacts are not anticipated.

City of Rahway/Robinson's Branch

Implementation of the nonstructural measures in the Robinson's Branch portion of the project area may have temporary impacts to birds during construction due to noise and movement of equipment during construction. The expectation that birds will leave the area but will return upon cessation of construction. No permanent, long term or significant impacts to birds will occur.

Mitigation

In order to comply with the Migratory Bird Treaty Act, a clearing restriction of shrubs and trees from 15 March through 31 July will be implemented to avoid adverse impacts to any potential nesting birds that are protected under this act. Foraging, shelter and nesting habitat will be restored through re-establishment of native herbaceous, shrub and tree species after construction. Re-establishing existing substrate to facilitate the recolonization of aquatic macroinvertebrates within the channel will increase the available food sources for insectivorous bird species.

Monitoring and Adaptive Management

The majority of vegetation removed is located within the riparian zone, and will be subject to monitoring for a period of five years to ensure that the plantings survive. Refer to section 6.4.1 Uplands and Riparian Corridor for the discussion of monitoring and adaptive management measures requirements. No specific monitoring plan will be developed for birds. However, bird species observed during mitigation monitoring investigations may be documented.

6.5.4 Mammals

Township of Cranford/Upstream

The complete drawdown of the reservoir is expected to have negligible impacts to wildlife. Fencing around the reservoir along with Northfield Avenue and the South Mountain Recreational Center on the northern boundary generally serves as a barrier to wildlife access. There is a possibility that smaller animals such as raccoons and opossums could gain entry into the empty reservoir and not be able to find their way out.

Long term impacts from the conversion of the 1.09 acres of forest to maintained lawn downstream of the dam will not be significant given the amount of available forest within the South Mountain Reservation. Mammals are expected to move to other undisturbed sections of the park.

Construction activities associated with the channel modifications in the Township of Cranford will result in the temporary disturbance of habitat (e.g., vegetation and tree removal) and possible mortality of less mobile, burrowing, and/or denning species of mammals. Construction activities may also cause the temporary and permanent displacement of more mobile species due to increased human activity and habitat alterations. Tree-cutting restrictions implemented to protect migratory bird species will provide some protection for tree-dwelling mammal species.

Following construction, mammals are expected to resume their normal habits consistent with post-construction habitat availability in and within the vicinity of the project area. The channel improvement footprint occurs in a relatively urban environment. Long-term impacts on local mammal populations will be minor, resulting from permanent loss of habitat in areas where the stream channel is expanded into adjacent riparian habitat.

City of Rahway/Robinson's Branch
Implementation of nonstructural measures within the Robinson's Branch portion of the project area will not have significant temporary or permanent long term adverse impacts to mammals.

Mitigation
The re-establishment of upland, riparian and wetland vegetation as described in sections 6.3.3 Wetlands and 6.4.1 Uplands and Riparian Corridor will provide foraging and cover habitat supportive of wildlife.

Monitoring
No specific monitoring plan will be developed for mammals. However, species observed during mitigation monitoring investigations may be documented.

6.5.5 Reptiles and Amphibians

Township of Cranford/Upstream
The use of the Orange Reservoir by reptilian and amphibian species is not well documented. However, the lack of habitat and frequent human activity around the reservoir likely limits the presence of these species. Nevertheless, as per the Lowering permit, the drawdown of the reservoir will be completed by November 1 in order to protect any turtles and frogs inhabiting the area. Therefore, the drawdown of the Orange Reservoir to replace the dam is not expected to have significant adverse impacts to these species. Similarly, the drawdown associated with lowering water levels prior to storm events will not have significant adverse impacts.

Construction activities to replace the dam and to clear the 1.09 acres of forest may cause mortality of individuals or less mobile species that reside in the forest. More mobile species

will be temporarily displaced from the area and are expected to relocate to other, undisturbed locations through the South Mountain Reservation. The conversion of the forest to maintained lawn will likely eliminate preferred habitat to any reptile and amphibian species within the project area. However, given the amount of suitable habitat available within the vicinity of the dam, this impact is negligible.

Short-term and long-term minor adverse impacts on amphibians and reptiles are expected to occur as a result of implementing the channel modifications in the Township of Cranford. In the short-term, construction activities may cause mortality of individuals of less mobile species of reptiles and amphibians that reside in or pass through upland, riparian, or aquatic habitats within the project area. More mobile species will be temporarily displaced from work areas, escaping to nearby undisturbed areas. Construction activities may deter some species from utilizing the project area. Following construction, reptile and amphibian species are expected to resume their normal habits consistent with post-construction habitat availability in and within the vicinity of the project area.

Long-term impacts include effects on movement patterns of some amphibians and reptiles, and loss or modification of habitat. Installation of riprap along the river banks near McConnell Park will likely restrict or preclude movement of herpetofauna between the land and the river. The riprap will reduce the amount of natural banks. However, the impacts associated with installation of the riprap will be minor as these features are already present along much of Rahway River.

City of Rahway/Robinson's Branch

Implementation of nonstructural measures within the Robinson's Branch portion of the project area will not have significant adverse temporary or permanent impacts on amphibian or reptile species.

Mitigation

The re-establishment of upland, riparian and wetland vegetation as described in Sections 6.3 and 6.4.1 will provide foraging and cover habitat supportive of wildlife. Re-establishing existing substrate to facilitate the recolonization of aquatic macroinvertebrates within the channel will increase the available food sources for these species.

Monitoring and Adaptive Management

No specific monitoring plan will be developed for reptile and amphibian species. However, species observed during mitigation field surveys may be documented.

6.6 Threatened and Endangered Species

6.6.1 Federal, Threatened and Special Concern Species

Township of Cranford/Upstream

The clearing activities associated with the Orange Reservoir dam and the channel modifications in the Township of Cranford could potentially remove Indiana bat and northern long-eared bat summer roosting habitat. To minimize adverse impacts to these species during construction, a tree clearing restriction from 1 April through 30 September will be implemented. Permanent adverse impacts to these species are not expected. The

1.09 acres of mature upland forest and 0.13 acres of forested wetland that will be removed to create the vegetation free zone at the base of the Orange Reservoir dam is small in comparison to the surrounding acreage of forest that could be utilized by these species. The proposed channel improvements in the Township of Cranford are within close proximity to the Lenape and Nomahegan Parks. Given the relative lack of disturbance to the riparian zone and Rahway River in these parks, it is likely that bats would inhabit these locations over the channel modification footprint.

Regarding the bald eagle, open waterbodies such as lakes and reservoirs often serve as foraging habitat. Although there is a lack of existing information documenting the use of the Orange Reservoir for foraging by bald eagles, there has been confirmed foraging activity at a reservoir in the Township of Livingston, which is approximately five miles west of the Orange Reservoir. Therefore, it is likely that bald eagles may utilize the Orange Reservoir and that the drawdown of the Orange Reservoir during construction will cause a loss of foraging habitat. The level of impact, however, is negligible as the reservoir in the Township of Livingston as well as two other reservoirs in the neighboring Township of Millburn can be used as alternative foraging location.

The limited riparian habitat within proposed channel improvement in the Township of Cranford reduces the significance of impact to the bald eagle. It is expected that that bald eagles would utilize Lenape and Nomahegan Parks which contain more suitable foraging habitat. Therefore, the adverse impacts resulting from the channel improvements in the Township of Cranford to bald eagle are negligible.

City of Rahway/Robinson's Branch

The implementation of nonstructural measures in the Robinson's Branch portion of the project area will not have any short term or long term significant adverse impacts to federally endangered and threatened bat species or bald eagle. Any woody vegetation that needs to be cleared to implement the nonstructural measures will occur outside of 15 March through 30 July to protect bald eagle and 1 April through 30 Septebmer to protect endangered and threatened bat species.

<u>Mitigation</u>

As mentioned previously, a tree clearing restriction extending from 1 April through 30 September will be implemented during construction to protect the Indiana bat and northern long-eared bat. Alternatively, if clearing must occur within this timeframe, a presence/absence survey will be conducted prior to construction with results coordinated with USFWS. A preference to tree species that provide roosting habitat for Indiana bat and northern long-eared bat will be given during development of mitigation plans.

Adherence to the 15 March through 31 July tree and shrub clearing restriction will protect any bald eagles within project area. In addition, the District will continue to coordinate with the USFWS to determine if recommendations for avoiding disturbance at foraging areas and communal roost sites as outlined in the National Bald Eagle Management Guidelines will be required during construction.

The re-establishment of native vegetation within the project area and mitigation sites will restore potential adverse affects to bald eagle habitat.

Monitoring
No specific monitoring will be conducted for Indiana bat and/or northern long-eared bat unless required by the USFWS.

6.6.2 State Endangered, Threatened and Special Concern Species

As state endangered, threatened and special concern species known to occur in the project area are bird species, the impacts associated with the project area are similar to what was discussed in section 6.5.3 Birds.

Mitigation
Compliance with the Migratory Bird Treaty Act, shrub and tree clearing from 15 March through 31 July will minimize adverse impacts to state endangered, threatened and special concern species. Foraging, shelter and nesting habitat will be restored through re-establishment of native herbaceous, shrub and tree species after construction. Re-establishing existing substrate to facilitate the recolonization of aquatic macroinvertebrates within the channel will increase the available food sources for insectivorous bird species.

Monitoring
No specific monitoring plan will be developed for state endangered, threatened or special concern species. However, bird species observed during mitigation field surveys may be documented.

6.7 Socioeconomics

The proposed action is not expected to adversely impact the socioeconomic environment of the area. During construction of the channel modifications, some of the residents within the project area may be unable to fully utilize their property. Additionally, they may be required to move or dissemble structures such as sheds and above ground swimming pools to accommodate construction. Permanent easements will be required for maintenance, inspection and operational requirements. However, property owners will be compensated for the easement at its market value for the potential adverse effect on property values.

Long term benefits achieved by the project include flood risk management benefits such as reduced damage to property, flood risk management for business and residential structures, improved public health and safety, reduced traffic delays and emergency access for the fire department, medical personnel and police protection.

6.8 Environmental Justice

As discussed in Section 3.6.3, Environmental Justice considerations are applicable to the Cities of Orange and Rahway, and the Township of West Orange.

The City of Orange owns the Orange Reservoir but is outside of the project area and will not receive any FRM benefits. Under a 20- year lease agreement, Essex County manages the reservoir as part of the South Mountain Reservation and South Mountain Recreational

Complex. Because the city is outside of the project area, city residents will not be impacted by noise or air emissions related to construction activities. Once the project is completed, operation and maintenance of the Orange Reservoir as a flood risk management feature will be performed by either the County or municipalities receiving flood risk management benefits. The District has maintained coordination with representatives from the City of Orange throughout the study in order to understand and address any concerns they may have regarding the use of the reservoir. Based on coordination efforts to date, no significant issues that would require additional remedial actions have been identified. Therefore, no significant or disproportionate adverse impacts to the City of Orange is expected. The District will continue coordination with the City throughout the study process.

The Township of West Orange is located within the extreme northern portion of the project area. South Mountain Reservation and the Orange Reservoir are physically located within West Orange Township. However, Essex County owns the South Mountain Reservation and is leasing the Orange Reservoir from the City of Orange. Residences closest to the dam who may be affected by construction activities are approximately 0.25 miles away on the other side of a hill. In addition, the township may receive some flood risk management benefits through the reduction of flooding to Northfield Avenue. Therefore, significant and disproportionate adverse impacts to residents of West Orange are not expected.

Although the flood risk management measures will not provide flood risk management to the entire community, it will provide flood risk management to the most floodprone structures. Therefore, no significant adverse impacts to environmental justice communities is expected.

6.9 Hazardous Toxic and Radioactive Waste

Township of Cranford/Upstream

The section of the Rahway River as it flows through Cranford has no Known Contaminated Sites within the Alternative 4a footprint. There is one site adjacent to the 4a footprint but is outside it. This particular site is a leaking underground oil tank currently under NJDEP monitoring for remediation by the responsible party and should not be an issue for the local sponsor if/when construction takes place on 4a. The predominant HTRW issue is leaking underground storage tanks, home heating oil or motor fuels of those sites in Cranford.

City of Rahway/Robinson's Branch

Along the Robinsons Branch as it flows through Rahway there are no Known Contaminated sites within the water way. There are sites located adjacent to the stream bank. These sites are currently on the NJDEP Known Contaminated Sites list and undergoing remediation by the responsible party. The northern bank of the Robinsons Branch does cross through the designated Brownfields zone located within the City of Rahway. Currently the site is under remediation.

6.10 Cultural Resources

The District has certain responsibilities regarding the identification and protection of cultural resources. The Federal statutes and regulations authorizing the District to undertake these responsibilities include Section 106 of the National Historic Preservation

Act, as amended, and the Advisory Council on Historic Preservation Guidelines for the Protection of Cultural and Historic Properties (36 CFR Part 800). The Area of Potential Effect (APE) consists of areas that will be directly effected by the proposed undertaking as well as those areas that are effected visually. The District is required to identify historic properties within the APE and determine if the proposed project will have an effect on those properties.

Township of Cranford/Upstream

The APE for the Township of Cranford and Orange Reservoir measures of the project includes the vertical and horizontal limits of channel modification, and the staging areas and mitigation areas associated with the channel modification.

The APE for Cranford overlaps with four NRHP-eligible historic districts. These are the North Cranford Historic District, the Rahway River Parkway Historic District, the Union County Park System Historic District, and the Central New Jersey Main Line Corridor Historic District. In addition to these, a number of historic resources are located within the APE in Cranford (Table 29). Most of the resources within the APE are eligible for the NRHP as contributing elements to a historic district.

Alterations to the River within historic districts and parks as well as alterations to the grounds or other features associated with NRHP-eligible historic properties has the potential to result in adverse effects. Additional architectural survey is required to update the boundaries of the North Cranford Historic District and to formally assess the NRHP eligibility of many of the contributing structures and elements of the historic district. The APE has been determined sensitive for prehistoric and historic archaeological sites. To conclude identification of resources, archaeological and architectural surveys will be carried out for the APE, this will inform the determination of adverse effects. A preliminary draft Programmatic Agreement to address the process for additional investigations and resolution of adverse effects can be found in Appendix B.

The APE for the replacement of the Orange Reservoir Dam includes the Dam, the Reservoir, and any construction or staging areas utilized as part of the undertaking. The Orange Reservoir and Dam have the potential to be determined eligible for the NRHP however a formal architectural survey is required to make that determination. Besides the dam and reservoir, there are no NRHP-eligible or listed properties or archaeological sites within the APE. However, some portions of the APE are archaeologically sensitive, and furthermore, it is likely that staging for construction will expand to overlap with the South Mountain Reservation Historic District. The proposed replacement of the Dam and its associated features has the potential to result in adverse effects and additional survey will be necessary as the plan is developed (see PA in Appendix B).

Table 29. Historic Properties within the APE for the Proposed Channel Modifications in Cranford

Resource	NRHP Status	Approximate Date of Construction
Girl Scout Park	Eligible as a contributing element to the North Cranford Historic District (NCHD)	Unknown
Hanson Park/Hanson House	Eligible as contributing element to the NCHD	1990
McConnell Park	Eligible as contributing element to the NCHD	1919
Hampton Park	Eligible as contributing element to the NCHD and the RRPHD	1969
Memorial Park	Eligible as a contributing element to the NCHD and the RRPHD	Unknown
Sperry Park	Eligible as contributing element to the NCHD, Rahway River Parkway Historic District (RRPHD), and Union County Park System HD	1926
Cranford Section of Rahway River Parkway HD	Eligible as contributing element to the Rahway River Parkway HD	Unknown
12 Hampton Road (House and Garage)	Eligible as contributing to NCHD	Ca. 1920
20 Hampton Road	Eligible as contributing element to the North Cranford Historic District	Ca. 1920
8 Hampton Street	Eligible as contributing element to NCHD	Ca. 1930
16 Hampton Street	Eligible	Unknown
18 Hampton Street	Eligible as contributing element to NCHD	Ca. 1930
204 Hampton Street (Garage)	Eligible as contributing element to the NCHD and Rahway River Parkway HD	1920
208 Hampton Street	Eligible as contributing element to NCHD	1914
Culvert crossing Rahway River at Hampton Street	Eligible as contributing element to the NCHD and the RRPHD	1980
Eastman Street Bridge at Hampton Street	Eligible as contributing element to the NCHD, RRPHD, and Union county Park System HD	2004
2 Central Ave and Garage	Eligible as contributing elements to the NCHD	1925
5 Central Ave	Eligible as contributing to the NCHD	1930
7 Central Ave	Eligible as contributing to the NCHD	Unknown
22 Central Ave	Eligible as contributing to the NCHD	Unknown
10 Central Ave and Garage	Eligible as contributing elements to the NCHD	1926
8 Central Ave and Garage	Eligible as contributing elements to the NCHD	1920
6 Central Ave and Garage	Eligible as contributing element to the NCHD	Unknown
126 Eastman Ave	Eligible as contributing elements to the NCHD	1925

Resource	NRHP Status	Approximate Date of Construction
122 Eastman Ave	Eligible as contributing elements to the NCHD	1923
Bridge on Eastman Avenue at Holly Street (NJDOT #2003025)	Eligible as a contributing element to the RRPHD, NCHD, and Union County Park System HD	1970
9 Holly Street and Garage	Eligible as contributing element to the NCHD	1920
11 Holly Street and Shed	Eligible as a contributing element to the NCHD but the shed is not	Unknown
102 Orchard Street	Eligible as contributing element to the NCHD	1914
104 Orchard Street and Garage	Eligible as contributing element to the NCHD	1900
106 Orchard Street and Garage	Eligible as contributing element to the NCHD	1900
114 Orchard Street and Garage	Eligible as a contributing element to the NCHD, not the garage	1914
Cranford Canoe Club	Eligible as contributing element to the NCHD	Various
Bridge on Springfield Avenue at Orange Street	Eligible as contributing element to the RRPHD and the Union County Park System HD	2010
107 Riverside Drive	Eligible as contributing element to the NCHD	1900
107 Riverside Drive Culvert and Walls	Eligible as contributing element to the NCHD	Unknown
Bridge on Union Avenue crossing the Rahway River at Sperry Park	Eligible as contributing element to the NCHD, RRPHD, and Union County Park System HD	1916
12 Forest Street	Eligible as contributing element to the NCHD	1915
18 Forest Street and Garage	Eligible as contributing element to the NCHD, garage not eligible	1930
22 Forest Street and Garage	Eligible as contributing element to the NCHD, garage not eligible	1930
26 Forest Street	House is eligible as a contributing element to the NCHD, garage is undetermined	Unknown
Bridge at North Avenue and Centennial Avenue	Eligible as a contributing element to the RRPHD, and the Union County Park System HD	1965
Central Railroad of NJ Bridge at Centennial Avenue and crossing the Rahway River	Eligible as a contributing element to the CNJ Main Line Corridor HD	1929
Central RR Storage building	Eligible as a contributing element to the CNJ Main Line Corridor HD	Unknown
Bridge at South Avenue and Centennial Ave	Eligible as a contributing element to the RRPHD and the Union County Park System HD	1983
Entry gates, walls, urns, seating area for Lincoln Park	Eligible as contributing elements to NRE Lincoln Park which is a contributing element to the RRPHD and the Union County Park System HD	1917

City of Rahway/Robinson's Branch

The APE for the Robinson's Branch section consists of nonstructural flood-proofing for approximately 21 structures as well as the areas surrounding the structures where excavation and staging are planned and areas where ring walls are planned. Six NRHP-eligible historic districts exist within the APE. The majority of the study area lies within historic district boundaries and many of the structures identified for nonstructural flood-proofing measures either have been determined eligible or are potentially eligible for the NRHP. An architectural survey will be required to determine the NRHP eligibility of each structure selected for nonstructural flood-proofing measures. Archaeological survey may also be required for staging and construction areas. A Programmatic Agreement outlining the process for additional investigations and the resolution of adverse effects is included in Appendix B.

6.11 Recreation

The complete drawdown of the Orange Reservoir associated with the dam replacement for approximately 1.5 years will have minor to significant adverse impacts on recreational features of the reservoir. The southern portion of the walking path near and on the dam will be closed to the public during construction. Although it is anticipated that the remainder of the path will remain open, the flow of pedestrian traffic will be disrupted due to park patrons having to turn around and backtrack rather than continuing on to complete the loop. Additionally, park patrons may be disturbed by the construction noise. Further, the sediments on the floor of the reservoir may initially emit a foul odor as they are drying out from the drawdown. All of these factors may cause area residents to find an alternative location for exercise until construction is completed. The full extent of the walking path will be reopened after construction.

Water dependent recreational activities such as the paddle boats and the annual fishing derby will be discontinued until the project is completed and the reservoir refilled. The drawdown will require the removal of the dock and the paddle boats until project completion, at which point they will be reinstalled.

Minor adverse impacts to water dependent recreation at the reservoir due to the operation of the reservoir as a flood risk management feature is anticipated. The pre-storm drawdown will require the reservoir to be drawndown approximately 15 ft lower than normal water surface elevations. The paddle boat dock may either need to be removed or modified to extend such a distance. Fishing will also be impacted during pre-storm drawdown and the span of time it takes for the reservoir to refill due to the lower water surface elevation. No adverse impacts to the walking trail during any operation and maintenance activities of the reservoir are expected.

Parks located within the footprint of the channel modifications in the Township of Cranford include Hampton Park, McConnell Park, Hanson Park, Sperry Park, Cranes Park and Rahway River Park. One or more of the parks may be partially or fully closed to the public during construction either due to being used as a staging area or because of the construction of the channel modifications.

Upon completion of the project, recreational uses and activities of the effected parks will resume without additional or permanent significant impacts.

A longer term adverse impact to the parks that will likely occur is the removal of mature trees that could effect the parks aesthetic character. Minimally, native herbaceous, shrub and tree species will be replanted within the parks after construction. To avoid this impact, the District will consider constructing the channel modifications from the bank opposite of the parks. A long-term positive impact resulting from the proposed action includes a reduction in flooding of the parks adjacent to the Rahway River.

Water dependent activities will also be temporarily adversely impacted during construction of the proposed action. The main canoe route from the Canoe Club is within the channel improvement footprint. As a result, canoe/kayaking will need to stop during construction for safety reasons. Fishing will be affected by the closure of the fishing access area on Lincoln Avenue and by the suspension of rainbow trout stocking efforts near the Nomahegan Park footbridge during construction. Depending on the timing of the annual Cranford rubber duck race, it may also need to be rescheduled during construction activities. All activities are expected to resume once construction is completed.

Implementation of the nonstructural flood risk management measures will not have any temporary or long term or significant adverse impacts on recreation within the Robinson's Branch portion of the project area.

Mitigation

Specific mitigation measures that may be implemented to reduce the limited short-term effects of construction activities on recreation include:

- Planting native herbaceous, shrubs and trees within the parks after construction;
- Constructing the channel modifications in a manner that maintains water depths to support canoeing/kayaking;
- Erecting temporary fences and other physical barriers to control movement through construction areas and maintain a safe distance for pedestrians; and
- Installing signage that informs residents and others using effected recreational spaces of the proposed action's purpose and closure duration.

6.11.1 Green Acres Program

Township of Cranford

Under the Green Acres program, lands obtained or developed with Green Acres funding and lands held by a local government for recreation and conservation purposes must permanently remain in use for recreation and conservation purposes. In general, lands subject to the rules of the program cannot be disposed of or diverted unless it can be demonstrated to the State that the modification will protect or enhance the use of the area. By definition in the Green Acres Rules, land that is used for purposes other than recreation and conservation is considered a "diversion" while a "disposal" is the selling, donating, or some other form of permanent transfer of possession of parkland.

Flood risk management measures such as levees, floodwalls and channel modifications are typically considered as diversions. However, flood risk management projects that provide regional benefits and also create or enhance a permanent water body suitable for water dependent public recreation are exempt from the diversion designation. As part of this exemption, the flood risk management project cannot have significant adverse impact on natural resources or recreational value of the affected parkland.

The Orange Reservoir is not located within Green Acres encumbered lands. Therefore, there will be no significant adverse impacts.

Green Acres encumbered lands that are located within channel modification footprint in the Township of Cranford include Hampton Park, McConnell Park, Hanson Park, Sperry Park, Cranes Park and Rahway River Park. The proposed action will likely have temporary adverse impacts to the parks during construction.

The channel modifications are a component of the regional flood risk management project and will ultimately provide flood risk management to the parks during flood events. The channel modifications primarily involve deepening and widening the bottom of the existing channel. Modifications to the top of bank will be limited, thus minimizing adverse impacts to park lands. Riprap will be required along the riverbank at McConnell Park, but will be restricted to the bank toe. In addition, there are opportunities to enhance the parks through the planting of native vegetation after construction. Therefore, the channel improvements will not have significant long term adverse impacts to Green Acres properties.

Robinson's Branch

The nonstructural measures within the Robinson's Branch portion of the project area will have any temporary or long term significant impacts to Green Acres lands.

Mitigation

As stated previously, the District will evaluate the feasibility of constructing the channel modifications from one side of the riverbank. Because Hanson Park has a walking trail and identified specimen trees along the riverbank, every effort will be made to avoid significant impacts to this park.

In the event construction of the channel modifications need to be made from the parks, native herbaceous, shrub and tree species will be planted. A meeting with representatives from the Green Acres Program in August 2016 indicated that the project, as proposed, may not be considered a diversion that would require land compensation. The District will continue to coordination with Green Acres staff to ensure that additional mitigation will not be necessary.

Monitoring and Adaptive Management

The monitoring and adaptive management of vegetation planted on Green Acres properties is discussed in section 6.4.1 Vegetation.

6.12 Aesthetics and Scenic Resources

Cranford Township

The complete drawdown of the Orange Reservoir to replace the dam will have minor adverse longer-term temporary impacts to the aesthetic and scenic quality of the reservoir viewshed. The most adverse impact will occur will be during immediate period after the drawdown when the soil and sediments of the reservoir bed and side slopes are exposed. The seeding of the reservoir and side slopes will reduce the visual impacts somewhat, but will not fully compensate for the loss of water views. The drawdown of the reservoir prior to storm events will have marginal adverse aesthetic impacts, but will be temporary in nature.

The construction of the channel modifications in the Township of Cranford will have short-term and long-term minor adverse impacts to aesthetic and scenic resources. In the short-term, the presence of construction equipment and active construction activities throughout the project area will result in minor temporary impacts to each construction site's immediate aesthetics and scenic resources. In the long term, channel modifications will require the removal of mature trees and vegetation along and close to the riverbanks. The greatest visual impacts will be sustained by the residential and commercial landowners located closest to the proposed river channel modifications. In addition, the new channel may have an "engineered" appearance initially after construction. However, this will dissipate as the vegetation matures and pool and riffle complexes begin to reform, and the project area assumes a more natural look.

Robinson's Branch

The implementation of nonstructural measures within the Robinson's Branch portion of the project area is not expected to result in significant adverse impacts on the area's aesthetics and scenic resources.

Mitigation

Mitigation measures that will be implemented to minimize impacts to aesthetics include:

- Seeding the side slopes and bottom of the Orange Reservoir during the dam replacement construction
- Replanting disturbed areas with native vegetation. The District will use of larger tree stock in lieu of saplings since larger tree stock will reduce the amount of time it will take for the replacement trees to reach maturity.

6.13 Transportation

Cranford Township

Traffic along Cherry Lane will likely increase as a result of construction equipment and materials being transported to the site, as well as workers commuting to the project area. Minor delays may be experienced if traffic needs to be temporarily halted to allow construction vehicles to enter/exit the dam replacement staging area. This impact is minor and temporary, and will end once construction is completed.

During construction of the channel modifications in the Township of Township of Cranford, roads that are close to the river may experience minor delays in operations, or temporary closures to allow construction equipment access and movement. Residential neighborhoods could experience short duration encroachment on pedestrian walkways and on-street parking. The impacts on transportation will not be concentrated in any one location for extended periods of time and will relocate to other areas within the channel improvement footprint as construction progresses. These are short term adverse effects and will end once construction is completed.

Long term positive impacts resulting from implementation of the proposed action includes a reduction in road closures due to flooding and clean-up of any debris deposited on roads during flood events.

Robinson's Branch
The implementation of the nonstructural flood risk management measures in the Robinson's Branch portion of the project area will not have any short term or long term significant impacts on transportation.

Mitigation
In order to minimize impacts to traffic during construction, traffic control and operations strategies that may be implemented during construction may include:

- Preparing a Construction Traffic Management Plan;
- Routing and scheduling construction vehicles to minimize conflicts with other traffic;
- Strategically locating localized staging areas to minimize traffic impacts; and
- Establishing detours and alternate routes when it is important to close the work area to perform certain construction tasks or when diverting traffic will substantially reduce traffic volumes.

A comprehensive traffic management plan will be developed by the contractor in the Construction phase and will be coordinated with the appropriate municipal and/or county officials.

6.14 Air Quality

Emissions from Federal Actions, such as the proposed action, are regulated under 40 CFR §93 Subpart B General Conformity (GC). Emissions from the proposed action are associated with non-road construction equipment working on the site and on-road trucks moving on public roads to and from the project site. Emissions from these two source categories are primarily generated from their diesel engines with emissions that include NOx, VOCs SO2 and PM2.5. Fugitive dust on worksite can potentially be generated due to trucks and equipment moving on unpaved surfaces but can be significantly reduced through the use of best management practices relating to site work dust mitigation. Fugitive dust is made up of PM and can contain PM2.5.

The implementation of the project is in the preplanning stages and a detailed construction schedule and a final list of equipment is not available at this time. However, a preliminary

emissions analysis has been conducted using the initial construction equipment list generated for the preliminary cost estimate.

Based on the preliminary emissions analysis, the TSP emissions are below the de minimus levels for NOx (100 tons in any year), VOC (50 tons in any year), PM 2.5 (100 tons in any year) and SO2 (100 tons in any year). Therefore, the TSP is considered de Minimis under the GC Rule and will only have a temporary impact around the construction activities with no significant impacts. A Record of Non-Applicability has been prepared and is contained in Appendix A. Temporary localized emission increases from the equipment working onsite may occur during construction, however, the localized increases from the equipment will last only during the projects construction period

There will be no permanent sources of air emissions associated with the flood risk management measures.

Mitigation

Because the impact on air quality will be less than significant, no mitigation measures will be required outside of existing air quality regulations. NJDEP outlines requirements applicable to construction, such as controlling fugitive dust and open burning. All persons responsible for any operation, process, handling, transportation, or storage facility that could result in fugitive dust will take reasonable precautions to prevent such dust from becoming airborne. Reasonable precautions and best management practices (BMPs) might include using water to control dust from the dam reconstruction and land clearing associated with the dam reconstruction and channel modifications. In addition, construction will be performed in full compliance with current New Jersey Air Pollution Control requirements (N.J.A.C. 7:27-1-34), with compliant practices and/or products. These requirements include the following:

- Control and Open Prohibition of Burning (N.J.A.C. 7:27-2.3B)
- Control and Prohibition of Air Pollution from Diesel-powered Motor Vehicles (N.J.A.C. 7:27-14.15)

This listing is not all-inclusive; the USACE and contractors will use BMPs during construction and comply with all applicable air pollution control regulations.

6.14.1 Green House Gases and Climate Change

There will be no ongoing sources of Green House Gas emissions resulting from the proposed action once construction is completed. All construction activities combined will generate approximately 2,911.36 tons of CO2, which is below the CEQ threshold of 25,000 metric tons. Therefore, these effects are negligible.

Approximately 1.22 acres of mature deciduous upland and wetland trees will be removed in the Orange Reservoir portion of the project area and approximately 15 acres of mature deciduous trees could be removed in the Cranford portion of the project area. The acreage of mature vegetation removed within the Cranford portion of the project area may

potentially be reduced based on the determination on whether construction can take place from one river bank.

Through mitigation, the vegetation, including trees will be replaced. It is anticipated that minor, short term impacts to carbon sequestration and temperature reduction will occur until the trees achieve a larger size. In the long-term replanting even with younger trees may introduce a variety of ages and species that would maximize carbon reduction over time.

6.15 Noise

The implementation of the proposed action will result in an increase in short-term minor adverse impacts related to noise. Specifically, an increase in noise due to heavy equipment use during construction associated with the Orange Reservoir dam replacement, channel modifications to the Rahway River and the potential implementation of nonstructural measures within the Robinson's Branch portion of the project area. The proposed action will produce no permanent sources of noise and there will be no long-term changes in the noise environment.

The specific impact of construction activities on the nearby receptors will vary depending on the type, number, and loudness of equipment in use. Excavators and other heavy equipment, truck removal of excavated material, and the delivery of riprap and concrete to workspaces will be the primary sources of noise. Individual pieces of heavy equipment typically generate noise levels of 80–90 dBA at a distance of 50 ft (15 m). With multiple items of equipment operating concurrently, noise levels can be relatively high during daytime periods at locations within several hundred feet of active construction sites. The zone of relatively high noise levels typically extends to distances of 400–800 ft (122–244 m) from the site of major equipment operations. Locations more than 800 ft (244 m) from construction sites seldom experience substantial levels (greater than 62 dBA) of noise.

Property owners within the footprint and vicinity of the channel modifications in the Township of Township of Cranford and where nonstructural measures will be implemented in the City of Rahway will experience appreciable amounts of noise from heavy equipment during construction. However, given the temporary nature of proposed construction activities and the limited amount of noise that heavy equipment would generate, this impact will be minor. In addition, limited truck and worker traffic may be audible at locations along haul roads and roadways approaching the construction area. These impacts also will be negligible. Channel construction and associated noise will not be concentrated in any one location for extended periods of time. Impacts to the noise environment will move from one area to another as construction progresses.

There will be no permanent or ongoing sources of noise from the proposed action. Noise will end with the construction phase; therefore, there will be no long-term or significant impacts on the noise environment.

Mitigation

Because the impact to the noise environment will be less than significant, no mitigation measures will be required. In accordance with the Township of Cranford's noise ordinance, construction activities are limited to occur between the hours of 7:00 a.m. through 6:00 p.m. from Monday through Friday and 9:00 a.m through 6 p.m. on the weekend and holidays.

6.16 Summary of Mitigation

The various mitigation measures being considered to avoid, minimize, reduce or compensate for the adverse environmental impacts expected from implementation of the proposed action are summarized in Table 30.

Table 30. Summary of Mitigation Measures

Land Use · Most of the construction activity will occur within the existing channel which will help minimize impacts to adjacent land uses. Temporary workspaces along the top of channel will generally be limited to a 15ft clearance from the channel bank. · Disturbed areas will be restored and their use returned to pre-construction land uses.
Soils · Implementation of Erosion and Sediment Control Best Management Practices (BMPs) during construction, including the installation of cofferdams to construct the channel modifications in the Township of Cranford. · Stabilization of the bottom and side slopes of Orange Reservoir while it is drawn down during dam replacement. · Installation of approximately 800 linear ft of riprap along the east (left) bank of the Rahway River along McConnell Park.
Water Resources · Implementation of Erosion and Sediment Control Best Management Practices (BMPs) during construction, including the installation of cofferdams to construct the channel modificaitons in the Township of Cranford. · Mitigation measures specific to the Orange Reservoir pre-construction drawdown: o Performing a slow drawdown of the reservoir prior to construction to minimize erosion and sedimentation downstream of the reservoir; o Stabilizing the Orange Reservoir shoreline and bed with grass seed; o Excavating a channel within the reservoir to maintain flow of the Rahway River through the reservoir; and o Allowing vegetation to grow along the channel to provide shade in order to minimize thermal impacts and eutrophication. · Mitigation measures to be evaluated during optimization for the channel modification in Township of Cranford: o Constructing from one side of bank with preference to preserving vegetation on the western bank to optimize thermal impact reduction. o Constructing the channel in a manner that contains baseflows, maintains velocities to sustain maintain transport. o Restoring the existing substrate by stockpiling the gravel/cobble substrate excavated from the channel during construction and re-installing it once grading is completed.

o Riparian zone re-establishment with native herbaceous, shrub and tree species
Wetlands Compensation of 0.13 acres of wetland mitigation will be assessed during the PED phase and will include evaluation of: · Purchase of wetland mitigation credits at a 1:1 mitigation ratio from a NJDEP approved wetland mitigation bank; · Wetland restoration/creation at 2:1 mitigation ratio; or · Wetland enhancement at 3:1 mitigation ratio.
Vegetation · Compensation of 1.09 acres of upland vegetation through either 1:1 creation/restoration or forest enhancement of areas that have been damaged through herbivory. · Compensation of approximately 15.35 acres of riparian zone removal through on-site replanting and potential off –site riparian zone enhancement, restoration or creation. · Use of more mature tree stock to reduce maturation time.
Aquatic Resources and Wildlife · Tree and shrub clearing restriction from15 March through 30 July to comply with the Migratory Bird Treaty Act · Re-establishment of native herbaceous, shrub and tree species in disturbed areas and in mitigation sites. · Mitigation measures specific to the pre-construction drawdown of the Orange Reservoir Dam: o Conducting a fish salvage will occur prior to drawdown o The drawdown of the Orange Reservoir Dam drawdown for full replacement will occur from mid-September to October to minimize adverse impacts to fish o Completion of drawdown by November 1 to minimize impacts to amphibian and reptile species. · Mitigation specific to the channel modification in the Township of Cranford: o Restoration of existing substrate. o Creation of pools and riffle complexes o Applying the proposed riprap along Eastman Avenue in a manner that provides foraging and resting habitat for fish and aquatic macroinvertebrates.
Federal and State Endangered, Threatened and Special Concern Species · Implementation of a tree clearing restriction from 1 April through 30 September to protect roosting bat species. · Including tree species used by bats for summer roosting in mitigation plans.
Cultural Resources · The project is expected to have an adverse impact on historic properties, however, additional investigation is required to determine what properties will be impacted. A Programmatic Agreement has been developed for the project that outlines the steps that will be taken to determine adverse effects and the appropriate mitigation measures in consultation with interested parties (see Appendix A). Some mitigation measures to be considered include HABS/HAER documentation of historic structures, archaeological data collection, replacing

or providing substitute resources, monitoring during construction, and enhancement of historic districts through signage and public outreach.
Recreation · Planting native herbaceous, shrubs and trees within the parks after construction. · Erecting temporary fences and other physical barriers to control movement through construction areas andmaiantin a safe distance for pedestrians · Installing signage that informs residents and others using the effected recreational spaces of the proposed actions purpose and closure duration. · Constructing the channel modifications in a manner that maintains water depths to support canoeing/kayaking.
Aesthetics and Scenic Resources · Stabilization of the side slopes and bottom of the Orange Reservoir with grass during construction. · Replanting disturbed areas with native herbaceous, shrub and tree material after construction.
Transportation · Preparation of a Construction Traffic Management Plan. · Routing and scheduling construction vehicles to minimize conflicts with other traffic · Strategically locating localized staging areas to minimize traffic impacts; and · Establishing detours and alternate routes when it is important to close the work area to perform certain construction tasks or when diverting traffic will substantially reduce traffic volumes.
Air Quality · Because the air emissions are below de minimis levels for NOx, VOC, PM2.5 and SO2, no specific mitigation is required. Construction will be performed in compliance with current New Jersey Air Pollution Control requirements (N.J.A.C. 7:27-1-34).
Noise · Construction will occur within the timeframes allowed as per local noise ordinances.

Chapter 7.0 Cumulative Effects*

The Council of Environmental Quality (CEQ) defines cumulative effects as the impact on the environment, which results from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions regardless of what agency or individual takes the action.

The cumulative impact analysis encompasses the Rahway River Basin. As stated in previous sections of the report, the Rahway River has experienced numerous modifications. In addition to the cumulative impacts associated with those disturbances, the cumulative impacts analysis evaluates the impacts associated with past, present and foreseeable future actions listed in Tables 5-7 in Chapter 1 of this report.

7.1 Land Use

The replacement of the Orange Reservoir dam and use of it as a flood risk management feature will not have any adverse cumulative adverse impacts on land use. The majority of the channel improvements proposed in the Township of Cranford fit within the existing footprint of the existing river and will therefore have negligible adverse cumulative effects on land use and/or zoning. The implementation of nonstructural measures in the Robinson's Branch portion of the project area will not have any cumulative impacts on land use. Cumulative positive benefits include reduction of flooding that reduces land use capabilities.

7.2 Topography, Geology and Soils

The proposed action will not have any significant adverse cumulative impacts on topography, geology or soils. The deepening and widening of the Rahway River in the Township of Cranford, in conjunction with other changes in topography, represents a long-term cumulative impact. However, the channel modification is another element aimed at providing comprehensive flood risk management within the Rahway River Basin. As it relates to soils, the proposed action will result in short and long term minor adverse impacts, primarily associated with sedimentation, dust and waste generated by clearing vegetation, grading activities related to the dam replacement and channel improvements. However, these impacts are expected to have negligible cumulative effects overall.

7.3 Water Resources

Implementation of the TSP will have negligible to minor cumulative impacts. The replacement of the Orange Reservoir dam and outlet will predominantly have temporary impacts. The impacts will be minimized through the gradual drawdown of the reservoir and timing the drawdown to occur in the fall when water quality parameters such as dissolved oxygen are at optimum levels. The drawdown prior to storm events will have negligible cumulative impacts.

The channel modifications in the Township of Cranford will likely have minor adverse cumulative impacts. Both the riparian and aquatic habitat within the channel improvement footprint have been subject to various and multiple past disturbances. The channel modifications represent an additional disturbance that could potentially setback the rivers

recovery from the past disturbances. The implementation of cofferdams and other erosion and sedimentation best management practices during construction, in-stream mitigation features, and re-establishment of native riparian vegetation aim to minimize this potential.

In general, the flood risk management measures, stormwater management, habitat mitigation and ecosystem restoration actions, when combined with each other, could result in minor improvements in water quality and aquatic habitat. Flood risk management measures contribute to water quality and aquatic habitat improvements by reducing the amount of manmade debris and pollutants introduced into waterways during flood events. Stormwater management measures reduce the amount of urban runoff that typically has high levels of nutrients and other pollutants that contribute to water quality and habitat degradation, entering waterways.

The conversion of the 0.13 acres of wetland forest to maintained lawn associated with the 50 ft vegetation free zone at the Orange Reservoir dam will contribute to cumulative losses of wetland values and functions within the watershed. However, this impact will be minimized through mitigation. Depending on the mitigation type (creation/restoration or enhancement) selected, there could be an increase in the amount of wetlands within the watershed. Therefore, the cumulative impact is considered negligible.

7.4 Vegetation

In general, the proposed action is expected to have negligible cumulative impacts on vegetation. The conversion of the 1.09 acres of upland forest and 0.13 acres of wetland forest in around Orange Reservoir will have negligible cumulative impacts due to the amount of intact forest surrounding the reservoir. In addition, the District will compensate for the loss through replanting native upland vegetation elsewhere within South Mountain Reservation.

Riparian vegetation removed as a result of the construction of the channel modifications will be compensated in accordance with the requirements of the Flood Hazard Area Control Act permit. Large trees will be evaluated for use in the compensation rather than saplings to decrease the temporal and cumulative impact. Monitoring and adaptive management taken to ensure success of mitigation will reduce cumulative impacts.

In addition to the proposed action, any current or future actions taken by others that require a Flood Hazard permit and disturb riparian vegetation is subject to the riparian mitigation requirements. Depending on the type of mitigation selected, this could lead to an increase in higher value riparian habitat for fish and wildlife, which will minimize cumulative impacts.

7.5 Fish and Wildlife

The TSP is expected to have minor cumulative impacts to fish and wildlife resources. Mitigation associated with aquatic, riparian, wetland and upland habitat discussed in previous sections of the report will minimize cumulative impacts. In addition, actions taken by others that effect aquatic, wetland and riparian habitat are subject to permit mitigation

requirements. Any mitigation actions taken by others in conjunction with any ecosystem restoration projects could improve fish and wildlife habitat throughout the watershed.

The proposed action is not expected to have significant adverse cumulative impacts to state and/or Federal endangered, threatened and special concern species that may occur in the project area. As part of the mitigation associated with riparian, wetland and upland habitat, emphasis will be placed on utilizing tree species preferred by Indiana bat and northern long-eared bat as well as state endangered, threatened or special concern bird species.

7.6 Socioeconomics and Environmental Justice

In general, the objective of the proposed action and other flood risk management measures implemented within the Rahway Watershed is to provide a long term risk reduction to loss of life and property/infrastructure damages resulting from flood events.

The proposed action will have no adverse cumulative impacts on the existing demographics, economy, housing and Environmental Justice communities in the geographical region analyzed for cumulative impacts. Increasing storm and flood risk management will reduce damage to property and infrastructure within the study area; thus implementation of the TSP is expected to benefit the local economy and housing in the long term.

All of the actions considered could produce positive cumulative socioeconomic impacts within the watershed by reducing flooding, which is disruptive to socioeconomic conditions.

7.7 Hazardous, Toxic and Radioactive Waste

The proposed action will have negligible cumulative effects on issues involving HTRW. The implementation of erosion and sediment control best management practices during the dam replacement and constructing the proposed channel modifications in the Township of Cranford will minimize potential adverse cumulative impacts related to HTRW.

7.8 Cultural Resources

The cumulative effect of channelization of the Rahway River through historic districts, historic parks and the backyards of historic properties is the potential adverse effect to the historic districts. The proposed modification or full replacement of the Orange Reservoir Dam would result in an adverse effect should the Dam and Reservoir be determined eligible for the NRHP. Elevation or other flood-proofing measures carried out in the City of Rahway for the Robinson's Branch section would potentially adversely affect not just the structures, but cumulatively impact the historic resources that collectively make up a historic district. As part of the on-going consultation, mitigation efforts will look to reduce these effects.

7.9 Recreation

The TSP will result in short term park closures and other construction related disruptions to recreation, but these impacts will have negligible cumulative impacts. The proposed action is expected to benefit recreational resources and activities in the project area by

managing risk from repetitive flooding, especially to parks adjacent to the Rahway River. Measures to minimize adverse cumulative impacts to recreation include replanting disturbed areas with native herbaceous, shrub and tree material and constructing the channel modifications in the Township of Cranfordin a manner to maintain water depths for canoeing/kayaking.

7.10 Aesthetics and Scenic Resources

The visual resources in the project area may result in minor adverse cumulative affects due to the removal of trees and other vegetation, as well as the utilization of riprap in some segments of the Rahway River in the Township of Cranford. However, the restoration of upland and riparian vegetation to include trees and shrubs, will reduce the cumulative effects to a negligible level. The implementation of nonstructural measures, per the property owners' request, is expected to result in no significant cumulative impacts of the areas aesthetics and scenic resources.

7.11 Transportation

Neither the Township of Cranford TSP nor the Robinson's Branch TSP will have any adverse cumulative impacts on transportation. Positive cumulative impacts resulting from the combination of the proposed action and with past, actively occurring or future flood risk management actions will be the reduction in road closures and damage to transportation infrastructure due to flooding within the Rahway River watershed.

7.12 Air Quality

The proposed action will not have any adverse cumulative impacts on air quality. Air emissions related to land-based construction activities are a short-term and local impact accounted for in New Jersey's State Implementation Plan (SIP). There are no operable parts of the completed project that will result in emissions.

There will be no ongoing sources of GHG emissions resulting from the TSP once the project is completed. All construction activities combined will generate 2199.36 tons of CO2, which will be below the CEQ threshold. These effects will be negligible.

Most vegetation will be replaced through onsite and offsite mitigation. It is anticipated that minor short term impacts to carbon sequestration and temperature reduction will occur until the trees achieve a larger size. In the long term replanting with younger trees may introduce a variety of ages and species that would maximize carbon reduction over time.

7.13 Noise

The proposed action will introduce short-term increases in the noise environment from construction. These changes will have a negligible cumulative effect. There will be adverse cumulative impacts on the existing environment once construction is completed.

Chapter 8.0 Coordination & Compliance with Environmental Requirements

A NEPA Scoping meeting was held on June 15, 2015 in order to inform regulatory agencies and the public of the feasibility study process and to solicit feedback. The focus of comments received during the 30-day public scoping period centered on questions regarding the details of the preliminary flood risk management alternatives, and concerns with adverse impacts flood risk management alternatives would have on fish and wildlife resources, parks and water dependent recreational activities. The Response to Comment Document and NEPA Scoping presentation materials can be found at: http://www.nan.usace.army.mil/Missions/Civil-Works/Projects-in-New-Jersey/Rahway-River/

Several meetings to discuss the preliminary flood risk management alternatives have been held with staff from the New Jersey Department of Environmental Protection Bureau of Flood Control and Dam Safety, the Division of Land Use Regulation and the Green Acres Program. Additional coordination with these offices within NJDEP will be scheduled when there is more detailed technical information is available for agency review.

The USFWS submitted a Planning Aid Report to the District on February 20, 2015 outlining concerns and recommendations related to the preliminary alternatives. In addition, the District coordinated with the USFWS throughout the alternative formulation process to determine Endangered Species Act compliance requirements associated with the potential impacts of the preliminary alternatives. A draft Fish and Wildlife Coordination Act report that focuses on the TSP is currently scheduled to be submitted to the District in late 2016. The USFWS PAL and correspondence between the District and the USFWS is located in Appendix A.

The District carried out consultation with the New Jersey State Historic Preservation Office (NJSHPO), the Union County Department of Parks and Community Renewal, and the North Cranford Historic Preservation Advisory Board in 2013 upon completion of the Phase IA and Reconnaissance-level cultural resources surveys for the Cranford and Robinsons Branch portions of the project. In 2016 the District consulted again with the NJSHPO upon completion of the Orange Reservoir survey report. The District met with the NJSHPO in May of 2016 to discuss the NED plan and the need for development of a Programmatic Agreement (PA) to ensure that additional investigations are carried out when the project is authorized and additional funds become available. A meeting was held in June of 2016 with the Cranford Preservation Advisory Board to discuss the NED plan and to receive the Board's input as well as hear any concerns or recommendations relating to the project.

Two PAs have been prepared which detail the steps that will be taken to determine and address adverse effects to significant historic resources. A separate agreement was prepared for the Cranford/Orange Reservoir portion and the Robinsons Branch portion of

the project to allow for independent coordination as these project elements move forward toward construction (see Appendix A).

The Advisory Council on Historic Preservation, the Delaware Nation, Delaware Tribe of Indians, and the Shawnee and Eastern Shawnee Tribes of Oklahoma have been invited to review and participate in the PA. Additional public involvement will be conducted as part of the public review of the EIS and the PA under NEPA and will serve as the District's Section 106 public coordination. The final PA will incorporate comments on the draft document, as appropriate.

Table 31. Compliance Status of Federal Laws and Executive Orders

Legislative Title U.S. Code/Other		Compliance
Clean Air Act	42 U.S.C. §§ 7401-7671g	An air quality analysis was completed for the project. Based upon the completed analysis, the emissions from the project are considered to have an insignificant impact on the regional air quality, and according to 40 CFR 93.153 (f) and (g) the proposed project is presumed to conform to the SIP. A preliminary draft Record of Non-Applicability is located in Appendix A (Environmental Documentation).
Clean Water Act	33 U.S.C. §§ 1251 et seq.	A 404(b) Evaluation is located in Appendix A (Environmental Documentation). In addition, the District will submit a Freshwater Wetlands Individual Permit and water quality certification application to NJDEP to fulfill the requirements of Section 404 of this act prior to initiating construction.
Endangered Species Act of 1973	16 U.S.C. §§ 1531 et seq.	Based on initial coordination with the U.S. Fish and Wildlife Service, the project may contain habitat supportive of Indiana bat and northern long-eared bat. Protection of these species typically involves implementing a tree clearing restriction from 15 April – 30 September. The District will continue coordination with the USFWS throughout the life of the project.
Fish and Wildlife Coordination Act	16 U.S.C. § 661 et seq.	The Corps is in continued coordination with the U.S. Fish and Wildlife Service. The USFWS is in the process of preparing a Fish and Wildlife Coordination Act Report. The Planning Aid Letter is located in Appendix A (Environmental Documentation).
National Environmental Policy Act of 1969	42 U.S.C. §§ 4321-4347	The circulation of the EIS fulfills requirements of this act.
National Historic Preservation Act of 1966	16 U.S.C. §§ 470 et seq.	The District has continued to coordinate with the State Historic Preservation Office to fulfill requirements of this act. Correspondence indicating SHPO's non objection to the project is located in Appendix A (Environmental Documentation).
Executive Order 11990, Protection of Wetlands	May 24, 1977	Circulation of this report for public and agency review fulfills the requirements of this order.

Executive Order 11988 Floodplain Management	May 24, 1977	The proposed action is within the floodplain. However the project is designed to reduce damages to existing infrastructure located landward of the proposed project. The circulation of the Draft integrated Feasibility Report/EIS for public review satisfies the public coordination requirement under this EO.
Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks	April 21, 1997	Implementation of this project will reduce environmental health risks. Circulation of this report for public and agency review fulfills the requirements of this order.
Executive Order 13112 Invasive Species	February 3, 1999	BMPs to prevent spread, proper disposal of invasives during construction, replanting with native vegetation monitoring and adaptive management such as invasive species management until mitigation is determined to be successful.

Table 32. Compliance Status with State Laws

Legislative Title and code/date		Compliance
NJDEP Rules and Regulations – Flood Hazard Area	N.J.A.C. 7:13 (N.J.S.A 58:16A)	The District is in continued coordination with the NJDEP. Permits will be obtained during construction phase.
NJDEP Rules and Regulations – Freshwater Wetlands Permit	N.J.A.C. 7:7A (N.J.S.A. 13:9B)	The District is in continued coordination with the NJDEP. Although permits will be obtained during construction phase, a conditional water quality certification or equivalent will be included in Appendix A (Environmental Documentation) in the Final Report.
New Jersey Erosion and Sediment Control Act	N.J.A.C. 2:90-1.1 (N.J.S.A. 4:24-39)	An erosion and sediment control plan will be developed during the construction phase and will be submitted to the Union-Somerset Soil Conservation District for approval.
New Jersey Pollution Disharge Elimination System Permit	N.J.A.C. 7:14A (N.J.S.A. 58:10A-58:12A-1)	The SPDES permit will be applied for by the construction contractor once the E&S Plan is approved by the Union-Somerset Soil Conservation District.
Water Lowering Permit	N.J.A.C. 7:25-6:25 N.J.S.A. 23:5-29	A Water Lowering Permit will be obtained from the New Jersey Division of Fish and Wildlife during the construction phase.

Irreversible and Irretrievable commitment of Resources

There are several resources, both natural and built, that would be expended during the construction and operation of the proposed project. These resources include the land area used for the channel modifications within the Township of Cranford and implementation

of nonstructural measures in the Robinson's Branch portion of the project area. Materials used for construction; energy in the form of gas and electricity consumed during construction and routine maintenance activities; and the human effort (time and labor) required to develop construct and maintain various project components. These resources are considered irretrievably committed because their reuse for some purpose other than the project would be highly unlikely. This commitment of resources and material has been weighed against the public purpose and need for the proposed action and would provide various social, environmental and economic benefits.

Chapter 9.0 Plan Implementation

The implementation process would carry a plan that is recommended through the pre-construction engineering and design (PED) phase of a project, including development of plans and specifications, and construction. Funding by the Federal Government to support these activities would have to meet traditional civil works budgeting criteria.

9.1 Consistency with Laws and Policy

This draft feasibility report has been prepared in accordance with relevant laws and USACE policy. Specifically, this section of the report addresses:

- the specific requirements necessary to demonstrate that the project is technically feasible, economically justified and environmentally complaint;
- and the costs and cost-sharing to support a Project Partnership Agreement (PPA).

Economics Justification and Environmental Compliance. The prior sections of this draft report demonstrate that the TSP is technically feasible. It also identifies the TSP at this point in the study to have benefits greater than costs. The draft Environmental Impact Statement has been prepared to meet the requirements of NEPA and demonstrate that the TSP is compliant with environmental laws, regulations, and policies and has effectively addressed any environmental concerns of resource and regulatory agencies.

9.2 Cost Sharing and Non-Federal Sponsor Responsibilities

The non-Federal costs include the value of lands, easements, rights-of-way, relocations, and dredged or excavated material disposal areas (LERRD), estimated to be $3,473,000.

In accordance with the cost share provisions in Section 103 of the Water Resources Development Act (WRDA) of 1986, as amended (33 U.S.C. 2213), project design and implementation are cost shared 65% Federal and 35% non-Federal. The estimated Total Project Cost is $89,154,000, cost-shared $57,950,100 Federal and $31,203,900 non-Federal.

Table 33. Cost Apportionment Table

	Federal	Non-Federal	Total
Initial Project Cost	$57,950,100	$31,203,900	$89,154,000
Real Estate Credit		$3,473,000	$3,473,000
Cash Contribution		$27,730,900	$27,730,900
Total	$57,950,100	$31,203,900	$89,154,000

Operation, maintenance, repair, rehabilitation, and repair (OMRR&R) requirements are considered in the economic analysis for the project. The non-Federal sponsor is responsible for 100% of annual OMRR&R requirements, estimated at $258,000/year. The

Federal government is responsible for preparing and providing an OMRR&R manual to the sponsor.

9.3 Design and Construction Considerations

In order for preconstruction, engineering and design (PED) and construction to be initiated, USACE must sign a Project Partnership Agreement (PPA) with a non-Federal sponsor to cost share PED and construction. This project would require congressional authorization for PED and implementation. PED and construction are cost shared 65% Federal and 35% non-Federal. Implementation would then occur, provided that sufficient funds are appropriated to design and construct the project.

Draft Schedule. The draft schedule for plan implementation was developed for planning and cost estimating purpose. See Appendix D (Cost Engineering) for the proposed construction schedule.

Table 34. Draft TSP Implementation Schedule

Rahway River Basin, New Jersey Flood Risk Management Project	
Implementation Schedule	**Date**
Submission of Chief's Report	
Chief Signs Report	March-2018
Project Partnership Agreement (PPA)	
PPA Execution	April-2018
Pre-Construction Engineering & Design	
Prepare Plans & Specifications &RFP	May-2018
Contract Award	February-2020
Construction	
Construction complete	July-2023

Initial construction of the outlet modifications to Orange Reservoir and the channel modifications in the Township of Cranford is estimated from March 2020 until July 2023. Initial construction of the nonstructural measures along the Robinson's Branch are estimated to take place from March 2020 to December 2020. Construction years are assumed for the economics evaluation in this study, but are subject to future project approval and funding requirements.

9.4 Real Estate Requirements

USACE projects require the non-Federal sponsor provide lands, easements, rights-of-way and relocations, and disposal/borrow areas (LERRDs) for a project. Currently, the TSP will require the non-Federal sponsor to acquire temporary and permanent easements for construction. The non-Federal costs include the value of lands, easements, rights-of-way, relocations, and dredged or excavated material disposal areas (LERRD), estimated to be $3,473,000. Details are provided in the Appendix E (Real Estate Plan).

9.5 Views of Non-Federal Sponsors and Other Agencies

The non-Federal sponsor has indicated their support for releasing this report for public and agency input. The non-Federal sponsor's support for the TSP will be confirmed through a Letter of Support following Public and Agency reviews.

Chapter 10.0 Local Cooperation Requirements

The non-Federal Sponsor would need to provide their support of the recommendations presented in this report and agree that they intend to execute a Project Partnership Agreement (PPA) for the Recommended Plan before the Draft Integrated Feasibility Report and Environmental Impact Statement can move forward to the Civil Works Review Board Milestone. A coordinated PPA package would be prepared subsequent to the approval of the Feasibility Report, which would reflect the recommendations of the report.

Federal implementation of the recommended project would be subject to the non-Federal sponsor agreeing to comply with applicable Federal laws and policies, including but not limited to:

a. Provide a minimum of 35 percent of initial project costs assigned to flood risk management:

(1) Provide, during design, 35 percent of design costs allocated to flood risk management in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;

(2) Provide all lands, easements, rights-of-way, and perform or assure performance of all relocations, including utility relocations, as determined by the Federal government to be necessary for the initial construction or operation and maintenance of the project;

(3) Provide, during construction, any additional amounts necessary to make its total contribution equal to 35 percent of initial project costs assigned to coastal and storm damage reduction plus 100 percent of initial project costs assigned to protecting undeveloped private lands and other private shores which do not provide public benefits;

b. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the outputs produced by the project, hinder operation and maintenance of the project, or interfere with the project's proper function;

c. Participate in and comply with applicable Federal floodplain management and flood insurance programs; comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12); and publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with protection levels provided by the flood risk management features;

d. Operate, maintain, repair, replace, and rehabilitate the completed project, or function portion of the project, at no cost to the Federal government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal government;

e. For so long as the project remains authorized, ensure continued conditions of public ownership and use of the shore upon which the amount of Federal participation is based;

f. Provide and maintain necessary access roads, parking areas, and other public use facilities, open and available to all on equal terms;

g. At least twice annually and after storm events, perform surveillance of the project area to inspect for condition and damages and provide the results of such surveillance to the Federal government;

h. Give the Federal government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;

i. Hold and save the United States free from all damages arising from the initial construction, operation, maintenance, repair, replacement, and rehabilitation of the project, except for damages due to the fault or negligence of the United States or its contractors;

j. Keep, and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, and other evidence are required, to the extent and in such detail as will properly reflect total cost of the project, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and local governments at 32 CFR, Section 33.20;

k. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal government determines to be necessary for the initial construction, operation and maintenance of the project;

l. Assume, as between the Federal government and the non-Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands,

easements, or rights-of-way required for the initial construction, or operation and maintenance of the project;

m. Agree, as between the Federal government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and, to the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project in a manner that will not cause liability to arise under CERCLA;

n. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, (42 U.S.C. 1962d-5b) and Section 101(e) of the WRDA 86, Public Law 99-662, as amended, (33 U.S.C. 2211(e)) which provide that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element;

o. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended, (42 U.S.C. 4601-4655) and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way necessary for construction, operation, and maintenance of the project including those necessary for relocations, the borrowing of material, or the disposal of dredged or excavated material; and inform all effected persons of applicable benefits, policies, and procedures in connection with said act;

p. Comply with all applicable Federal and State laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (revising, codifying and enacting without substantive change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c)); and

q. Not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefore, to meet any of the non-Federal sponsor's obligations for the project unless the Federal agency providing the funds verifies in writing that such funds are authorized to be used to carry out the project.

Chapter 11.0 Recommendations (DRAFT)

In making the following recommendations, I have given consideration to all significant aspects in the overall public interest, including environmental, social and economic effects, engineering feasibility and compatibility of the project with the policies, desires and capabilities of the State of New York and other non-Federal interests.

I recommend that the selected plan for flood risk management in the Rahway River Basin, New Jersey, as fully detailed in this Integrated Feasibility Report and Environmental Impact Statement, be authorized for construction as a Federal project, subject to such modifications as may be prescribed by the Chief of Engineers.

The recommendations contained herein reflect the information available at this time and current departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of highest review levels within the Executive Branch. Consequently, the recommendations may be modified (by the Chief of Engineers) before they are transmitted to the Congress as proposals for authorization and implementing funding. However, prior to transmittal to Congress, the partner, the State, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

David A. Caldwell
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Chapter 12.0 References

Amy S. Greene Environmental Consultants, Inc. March 11, 2014. Environmental Resource Inventory Report for Millburn Township, Essex County, New Jersey.
_____. June 2007. Environmental Resource Inventory for County of Essex. Prepared for Essex County Environmental Commission, Essex County Department of Parks, Recreation and Cultural Affairs.

Cranford Environmental Commission. 15 July 2015. Email regarding Rahway River Flood Risk Study Comments.

Desisto, Danielle and Matthew Kadosh. March 31, 2016. News Article "Hunters double their deer kills in reservation bording Millburn". North Jersey.com. Available at: http://www.northjersey.com/news/hunters-double-their-kills-1.1535628

East Coast Greenway. 2016. Available at: http://www.greenway.org/ Accessed 13 July 2016.
Fishing-Crew. 2016. Available at: https://www.fishing-crew.com/fishing-reports/new-jersey/orange-reservoir-nj . Accessed 4 August 2016.

Friends of Lenape Park and Union County Department of Parks & Facilities (Union County DPF). May 2007. Birds of Lenape Park, Union County, New Jersey.

Intergovernmental Panel for Climate Change (IPCC). 2007. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA (IPCC, 2007).

Kraft, Herbert C. Archaeological and Historical Survey of the Proposed Rahway River Flood Control Project, Townships of Cranford and Millburn, NJ. Archaeological Research Center, Seton Hall University Museum, South Orange, NJ.

Millburn Environmental Commission, Millburn Township. Natural Resources Inventory Report. December 2005.

Natural Resources Conservation Service, United States Department of Agriculture (NRCS) . Web Soil Survey. Available online at http://websoilsurvey.nrcs.usda.gov. Accessed June 1 2016.
_____. February 2007. New Jersey Hydric Soil List. Available online at: http://soils.usda.gov/use/hydric/. Accessed June 1 2016.
_____. Soil Survey of Essex County, New Jersey. 2007.
_____. October 2006. Dunellen Series Description.
_____. July 2011. Boonton Series Description.

_____. New Jersey Important Farmlands Inventory. Website accessed 12 July 2016. Available at: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/nj/soils/?cid=nrcs141p2_018875

New Jersey Administrative Code (N.J.A.C.) 7:9B Surface Water Quality Standards. June 16, 2008 (40 N.J.R. 3630(b))

New Jersey Department of Environmental Protection. January 2006. Fish IBI Report, 2004 Sampling.

New Jersey Division of Fish & Wildlife (NJDFW). 2016a. 2016 Spring Trout Stocking Schedule Week 2, April 18-22 Available at: http://www.njfishandwildlife.com/wk2trt16.htm Accessed 12 July 2016.
_____. 2016b.Fishing Access Locations on Trout Waters, County Listing. Available at: http://www.njfishandwildlife.com/accesscnty.htm#Union Accessed 13 July 2016.

Nolte, Kelly, Donald A. Smith, Mark A. Steinback, and Michael Cinquino. 2013a. Phase IA Cultural Resources Investigation for the Rahway River Flood Risk Management and Ecosystem Restoration Project, Townships of Cranford, Springfield, and Borough of Kenilworth, Union County, New Jersey. Panamerican Consultants, Inc. Buffalo, NY. Prepared for U.S. Army Corps of Engineers, New York District, New York.

Nolte, Kelly, Donald A. Smith, Mark A. Steinback, and Michael Cinquino. 2013b. Reconnaissance-Level Cultural Resources Investigation for the Rahway River Flood Risk Management and Ecosystem Restoration Project, Robinson's Branch Section, Township of Clark and City of Rahway, Union County, and Township of Woodbridge, Middlesex County, New Jersey. Panamerican Consultants, Inc. Buffalo, NY. Prepared for U.S. Army Corps of Engineers, New York District, New York.

Miller, Thomas. New Jersey Department of Environmental Protection (NJDEP), Bureau of Water Monitoring, and Standards. December 2012. Ambient Biomonitoring Network, Raritan Water Region,Watershed Management Areas 7, 8, 9 and 10, Round 4 Benthic Macroinvertebrate Data Volumes 1 and 2.

Rutgers Cooperative Research & Extension. July 20, 2005.Characterization and Assessment of the Regional Stormwater Management Planning Area for the Robinson's Branch Watershed.

Scarpa, Carissa. 2016 Phase I Cultural Resources Investigation of the Orange Reservoir and Dam, West Orange, Essex County, New Jersey for the Rahway River Flood Risk Management and Ecosystem Restoration Project. New York District, U.S. Army Corps of Engineers.

Smith, Larissa and Kathleen E. Clark. New Jersey Department of Environmnetal Protection, Division of Fish and Wildlife, Endangered and Nongame Species Program. 2015. New Jersey Bald Eagle Project, 2015.

Township of Cranford. December 2003. Natural Resources Inventory, Township of Cranford, Union County, New Jersey.

Union County. 2005. BioBlitz in Lenape Park.

U.S. Fish and Wildlife Service. August 27, 2015. New Jersey Municipalities with Hibernation or Maternity Occurrence of Indiana bat or Northern Long-eared bat.
_____. Indiana Bat (Myotis sodalis) Draft Recovery Plan: First Revision. April 2007. U.S. Fish and Wildlife Service, Fort Snelling, MN.
_____. December 2015. Final Environmental Assessment, Final 4(d) Rule for the Northern Long-eared bat.
_____. 20 February 2015. Planning Aid Letter for the Rahway River Basin Flood Risk Management Feasibility Study, Essex, Middlesex and Union Counties, New Jersey.

United States Census Bureau. 2010a. 2010 Demographic Profile Data of Township of Cranford, New Jersey. Available at: http://factfinder.census.gov/home/saff/main.html
_____. 2014a. Selected Economic Characteristics, 2010-2014 American Community Survey 5-Year Estimates. Township of Cranford, Union County, New Jersey.
_____. 2010b. 2010 Demographic Profile Data of West Orange Township, New Jersey
_____. 2014b. Selected Economic Characteristics, 2010-2014 American Community Survey 5-Year Estimates, West Orange Township, Essex County, New Jersey.
_____. 2010c. 2010 Demographic Profile Data of Millburn Township, New Jersey.
_____. 2014c. Selected Economic Characteristics 2010-2014 American Community Survey 5-Year Estimates, Millburn Township, Essex County, New Jersey.
_____. 2010d. 2010 Demographic Profile Data of Springfield Township, New Jersey.
_____. 2014d. Selected Economic Characteristics 2010-2014 American Community Survey 5-Year Estimates, Springfield Township, Union County, New Jersey.
_____.2010e. 2010 Demographic Profile Data of City of Rahway, New Jersey.
_____.2014e.Selected Economic Characteristics 2010-2014 American Community Survey 5-Year Estimates, City of Rahway, Union County, New Jersey.

Union County Planning Board. March 1974. Lenape Park Stormwater Retarding Basin Feasibility Study, Union County, New Jersey.

United Water. June 2016 Available at: https://www.mysuezwater.com/sites/default/files/w_h16_rahway.pdf Accessed 17 July 2016.

Vile, John. September 2011. New Jersey Department, Bureau of Freshwater & Biological Monitoring. Fish IBI Report, 2010 Sampling, Round 3, Year 1 of 5, Volumes 1 and 2.
_____. March 2011. New Jersey Department, Bureau of Freshwater & Biological Monitoring. Fish IBI Report, 2009 Sampling, Round 2 Year 5 of 5, Volumes 1 and 2.

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