FINAL
FEASIBILITY REPORT
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Caño Martín Peña Ecosystem Restoration Project

FEBRUARY 2016

US Army Corps of Engineers.

U.S. ARMY CORPS OF ENGINEERS
JACKSONVILLE DISTRICT

PROYECTO ENLACE DEL CAÑO MARTÍN PEÑA

CORPORACIÓN DEL PROYECTO
ENLACE DEL CAÑO MARTÍN PEÑA

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Acronyms and Abbreviations

ac	acres
AAHU	Average Annual Habitat Unit
ACGIH	American Conference on Governmental Industrial Hygienists
ACI	American Concrete Institute
ACM	Articulated concrete mat
ADCP	Acoustic Doppler Current Profilers
adICPR	advanced Interconnected Pond Routing
ADS	Autoridad de Desperdicios Sólidos
ALOHA	Areal Locations of Hazardous Atmospheres
AMC	Antecedent Moisture Condition
ASTM	American Society for Testing Materials
ATSDR	Agency for Toxic Substances and Disease Registry
ATR	Agency Technical Review
B2EHP	Bis (2-ethylhexyl) phthalate
BA	Biological Assessment
BACT	Best Available Control Technology
BDL	Below Detection Limit
BI	Benthic Index
BMP	Best Management Practice
C&D	Construction and demolition debris
°C	degrees Celsius
CAA	Clean Air Act
CAD	Contained Aquatic Disposal
CBIA	Coastal Barrier Improvement Act
CBRA	Coastal Barrier Resources Act
CBRS	Coastal Barrier Resources System
CCMP	Comprehensive Conservation & Management Plan for the San Juan Bay Estuary
CDLUP	Comprehensive Development and Land Use Plan
CDRC	Ciudad Deportiva Roberto Clemente
CE/ICA	Cost Effectiveness/Incremental Cost Analysis
CEM	Conceptual Ecological Model
CEQ	President's Council on Environmental Quality
CERCLA	Federal Comprehensive Environmental Response, Compensation and Liability Act

CERCLIS	Federal Comprehensive Environmental Response, Compensation and Liability Information System
CFMC	Caribbean Fisheries Management Council
CFR	*Code of Federal Regulations*
CFU	Fecal coliform bacteria units
CH3D-WES	Curvilinear Hydrodynamics in 3 Dimensions, WES version
CHDO	Community Housing Development Organization
CM	Construction Management
cm	centimeters
CMP	Caño Martín Peña
CMP-CLT	Caño Martín Peña Community Land Trust
CMP-ERP	Caño Martín Peña Ecosystem Restoration Project
CMP-MTZ	Caño Martín Peña Maritime Terrestrial Zone
CO	Carbon monoxide
CO_2	Carbon dioxide
COC	Contaminants of Concern
CORRACT	Federal Corrective Actions List
CPI	Consumer Price Index
CRIM	Municipal Tax Revenue Collection Center
CSD	Combined Sewer Discharge
CSO	Combined Sewer Overflow
CSRA	Cost Schedule Risk Analysis
CSS	Combined Sewer System
CVM	Contingent Valuation Method
CWA	Clean Water Act
cy	cubic yards
CZMP	Coastal Zone Management Program
dB	decibel
dB(A)	A-weighted decibel
dbh	diameter at breast height
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
DMMP	Dredged Material Management Plan
DNER	Puerto Rico Department of Natural and Environmental Resources
DO	Dissolved oxygen

DSS	Decent, Safe and Sanitary housing
DTPW	Puerto Rico Department of Transportation and Public Works
EA	Environmental Assessment
EC	Engineering Circular
ECC	ENLACE's Community Committee
ECO-PCX	Ecosystem Restoration Planning Center of Expertise
EDR	Environmental Data Resource, Inc.
EFH	Essential Fish Habitat
EGM	USACE Economic Guidance Memorandum
EIS	Environmental Impact Statement
EMF	Electromagnetic field
ENLACE	Corporación del Proyecto ENLACE del Caño Martín Peña
ENLACE Project	Caño Martín Peña ENLACE Project
EO	Executive Order
EPG	Emergency Power Generator
EQ	Environmental Quality Account
ER	USACE Engineering Regulation
ER	Engineering Report
ERAMPT	Ecosystem Restoration Adaptive Management Planning Team
ERDC	USACE's Engineer Research and Development Center
ERL	Effects Range–Low
ERM	Effective Range–Median
ERNS	Federal Emergency Response Notification System
ERP	Ecosystem Restoration Project
ERPG	Emergency Response Planning Guidelines
ESA	Endangered Species Act
ESI	Environmental Sensitivity Index
EUA	Ecological Uplift Assessment
°F	degrees Fahrenheit
FDA	Food and Drug Administration
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FMC	Fishery Management Council

FMP	Reef Fish Fishery Management Plan
FONSI	Finding of Non-Significant Impact
fps	feet per second
FR	Feasibility Report
FR	*Federal Register*
FRM	Flood Risk Management
FRP	Federal Recreation Plan
ft	feet
ft/s	feet per second
ft/y	feet per year
ft^2	square feet
ft^3	cubic feet
FWCA	Fish and Wildlife Coordination Act
FWPRA	Federal Water Project Recreation Act
FY	Fiscal year
g	grams
G-8	Group of the Eight Communities bordering the Caño Martín Peña
GHG	Greenhouse gas
GIS	Geographic Information System
GPS	Global Positioning System
H	Hybrid
H&H	Hydrology and Hydraulics
H_2S	Hydrogen sulfide
ha	hectare
HAP	Hazardous Air Pollutant
HAPC	Habitat Areas of Particular Concern
HDPE	High-density polyethylene
HEC	Hydraulic Engineering Circular
Hg	Mercury
HHW	Household Hazardous Waste
HIA	Health Impact Assessment
HTRW	Hazardous, Toxic, and Radioactive Waste
HU	Habitat Unit
HW	Household Waste
IA	Initial Assessment
IBC	International Building Code

IDC	Interest During Construction
IEPR	Independent External Peer Review
in	inches
in/yr	inches per year
INCICO	Instituto de Ciencias para la Conservación de Puerto Rico
IPCC	Intergovernmental Panel on Climate Change
IPRC	Institute of Puerto Rican Culture
IWR	USACE Institute for Water Resources
kg	kilograms
JD	Jurisdictional Determination
km^2	square kilometers
kV	kilovolt
L_{10}	Noise value exceeded 10% of the time
LBC	Level Bottom Capping
LC	Los Corozos
LEERD	Lands, Easements, Rights-of-Way, Relocations, and Disposal Area
L_{eq}	Equivalent (or average) noise level
LI	liquidity index
LL	liquid limit
LLC	Los Corozos Lagoon
LMM	Luis Muñoz Marín
LSJ1	Water Quality Station San José Lagoon 1
LSJ2	Water Quality Station San José Lagoon 2
LUST	State Leaking Underground Storage Tank
M	Million
m/s	meters per second
m^2	square meters
m^3/d	cubic meters per day
m^3/s	cubic meters per second
MCACES	Micro-Computer Aided Cost Engineering System
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mg/mg^3	milligrams per cubic milligrams
MGD	million gallons per day
MHHW	mean higher high water
MHW	mean high water

mi	miles
mi^2	square miles
mL	milliliters
MLLW	mean lower low water
MLW	mean low water
mm/yr	millimeters per year
MOA	Memorandum of Agreement
MP	Monitoring Plan
mph	miles per hour
MPRSA	Marine Protection, Research, and Sanctuaries Act
MRF	Material Recovery Facility
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
msl	mean sea level
MTL	Mean Tide Level
MTZ	Maritime Terrestrial Zone
MTZ-CMP	Public Domain lands within the Caño Martín Peña Maritime Terrestrial Zone
NAAQS	National Ambient Air Quality Standards
NAD 83	North American Datum 1983
NCDC	National Climatic Data Center
NED	National Economic Development
NEP	USEPA's National Estuary Program
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
NGVD 29	National Geodetic Vertical Datum 1929
NH_3	Ammonia
NMFS	National Marine Fisheries Service
NO_2	Nitrogen dioxide
NOA	Notice of Availability
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NO_x	Nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NPL	National Priority List
NRC	Natural Research Council
NRCS	Natural Resource Conservation Service
NRHP	National Register of Historic Places

NTP	Notice to Proceed
NTU	Nephelometric Turbidity Unit
NWI	National Wetland Inventory
O&M	Operation and Maintenance
O_3	Ozone
ODMDS	San Juan Bay Ocean Dredged Material Disposal Site
OGPe	Puerto Rico Permit Management Office (for its Spanish acronym)
OMRR&R	Operation and Maintenance, Repair, Replacement and Rehabilitation
OPA	Otherwise Protected Areas
OSC	On-Scene Coordination
OSE	Other Social Effects Account
OSHA	Occupational Health and Safety Administration
P&G	U.S. Water Resources Council Principles and Guidelines
PAH	Polycyclic aromatic hydrocarbons
Pb	Lead
PCBs	Polychlorinated biphenyls
PDI	Comprehensive Development Plan for the Caño Martín Peña Special District (Plan de Desarrollo Integral y Uso de Terrenos para el Distrito de Especial del Caño Martín Peña)
PDR	Project Design Report
PDT	Project Delivery Team
PED	Preconstruction Engineering and Design
PEL	Probable Effect Level
PI	plasticity index
PL	Public Law
PL	plastic limit
PM	Particulate Matter
PMP	Project Management Plan
PM_{10}	Particulate matter with an aerodynamic diameter less than or equal to a nominal 10 microns
$PM_{2.5}$	Particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 microns
PPA	Project Partnership Agreement
ppm	parts per million
ppt	parts per thousand
PR (P.R.)	Commonwealth of Puerto Rico
PRASA	Puerto Rico Aqueduct and Sewer Authority

PRCCC	Puerto Rico Climate Change Council
PRCZMP	Puerto Rico Coastal Zone Management Program
PREPA	Puerto Rico Electric Power Authority
PREQB	Puerto Rico Environmental Quality Board
PRGAP	Puerto Rico Gap Analysis Project
PRHTA	Puerto Rico Highway and Transportation Authority
Project Channel	2.2 miles of the Eastern CMP associated with the CMP-ERP
PRPB	Puerto Rico Planning Board
PR SCORP	Puerto Rico State Comprehensive Outdoor Recreation Plan
PRWQSR	Puerto Rico Water Quality Standards Regulation
psu	Practical salinity unit
PUD	Permanent Upland Disposal
RCRA	Federal Resource Conservation and Recovery Act
RCRA-G	RCRA Generators List
RCRA-TSD	RCRA Treatment, Storage, or Disposal List
REC	Recognized Environmental Conditions
RED	Regional Economic Development
REP	Real Estate Plan
RfC	Reference Concentration (for Chronic Inhalation Exposure)
ROD	Record of Decision
ROW	Right-of-Way
SAV	Submerged Aquatic Vegetation
SCS	Soil Conservation Service
SGC	Subaqueous geotextile confinement
SHPO	State Historic Preservation Office(r)
SHWS	State Hazardous Waste Site
SIP	State Implementation Plan
SJ	San José
SJ1	Artificial Pit San José 1
SJ2	Artificial Pit San José 2
SJ3/4/5	Artificial Pit San José 3/4/5
SJB	San Juan Bay
SJBE	San Juan Bay Estuary
SJBEP	San Juan Bay Estuary Program
SJHP	San Juan Harbor Project
SJL	San José Lagoon

SJMA	San Juan Metropolitan Area
SLR	Sea Level Rise
SO_2	Sulfur dioxides
SO_x	Sulfur oxides
SQG	Sediment quality guidelines
SQUIRT	Screening Quick Reference Tables
STAC	Scientific and Technical Advisory Committee
SV	Screening Value
SWMA	Puerto Rico Solid Waste Management Authority
T&E	Threatened and Endangered Species
TC	Technical Committee to the Project
TCLP	Toxicity characteristic leaching procedure
TCM	Travel Cost Method
TEL	Threshold Effect Level
TKN	Total Kjeldahl Nitrogen
TLV	Threshold Limit Value
TM	Thermal Stability Analysis
TN	Total nitrogen
TOC	Total Organic Carbon
tpy	tons per year
TSCA	Toxic Substances Control Act
TSD	RCRA Treatment, Storage, or Disposal List
TSS	Total Suspended Solids
UDV	Unit Day Value
µg/g	micrograms per gram
µg/L	micrograms per liter
URA	Uniform Relocation Act of Assistance and Real Property Acquisition Policies Act as amended, P.L.91-646; 42 U.S.C. 4601 et seq.
U.S.	Unites States of America
USACE	U.S. Army Corps of Engineers
U.S.C.	United States Code
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

UST	Underground storage tank
UWFP	Urban Waters Federal Partnership
VCS	State Voluntary Cleanup Site
VES	Visual Encounter Survey
VOC	Volatile Organic Compounds
WES	Waterways Experiment Station
WRDA	Water Resources Development Act
WQC	Water Quality Certification
yr	year
Zn	zinc

FINAL

Feasibility Report & Environmental Impact Statement for the

Caño Martín Peña Ecosystem Restoration Project

FEBRUARY 2016

US Army Corps of Engineers.

PROYECTO ENLACE DEL CAÑO MARTÍN PEÑA

Volume I

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SAN JUAN, PUERTO RICO

MAIN REPORT

February 2016

Prepared by:
Corporación del Proyecto ENLACE
del Caño Martín Peña

For review by:
U.S. Army Corps of Engineers

FINAL
FEASIBILITY REPORT
CAÑO MARTÍN PEÑA ECOSYSTEM RESTORATION PROJECT
SAN JUAN, PUERTO RICO

Responsible Agencies: The lead agency is the U.S. Army Corps of Engineers, Jacksonville District. The *Corporación del Proyecto ENLACE del Caño Martín Peña* is the non-Federal cost-sharing partner for the project. Operations, Maintenance, Repair, Rehabilitation, and Replacement will be the responsibility of the Puerto Rico Department of Natural and Environmental Resources (DNER).

Abstract: This Final Feasibility Report and Environmental Impact Statement document the study for the Caño Martín Peña Ecosystem Restoration Project, in accordance with the requirements of Section 5127 of the Water Resources Development Act of 2007. The Project is essential to achieve the rehabilitation of the San Juan Bay Estuary System, which is the only tropical estuary within the Environmental Protection Agency's National Estuary Program. It addresses the need to restore the natural hydraulic connection between the San José Lagoon and the San Juan Bay, which has been eliminated through years of backfilling, sedimentation, and other factors. The proposed project, a key component of the Comprehensive and Conservation Management Plan for the San Juan Bay Estuary, is necessary to restore fish habitat, species diversity, and overall health of the system. The restored conveyance of tidal flow through the Caño Martín Peña will decrease water residence time within the San José Lagoon, returning salinity and dissolved oxygen to more natural levels and restoring benthic habitat in several of the San Juan Bay Estuary water bodies. In addition to restoring connectivity in the estuary, mangrove habitat for aquatic invertebrates and other native species will be restored, providing important nursery grounds for commercial fish species such as snapper and grouper. The Caño Martín Peña Ecosystem Restoration Project is also critical for the revitalization of eight impoverished communities settled along the Martín Peña tidal channel, and restoration of this system will significantly improve human health and safety in the area by reducing residents' frequent contact with highly polluted floodwaters. Recreational navigation will also be re-established in the area, allowing for increased public and commercial use of the entire estuary.

This Final Feasibility Report and Environmental Impact Statement describe public and agency involvement in Project development, explains the plan formulation, evaluation, and selection process, and documents the National Ecosystem Restoration Plan features, including costs and environmental benefits.

THE OFFICIAL CLOSING DATE FOR THE RECEIPT OF COMMENT IS 30 DAYS FROM THE DATE ON WHICH THE NOTICE OF AVAILABILITY OF THIS EIS APPEARS IN THE *FEDERAL REGISTER*.

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FINAL
FEASIBILITY REPORT
CAÑO MARTÍN PEÑA ECOSYSTEM RESTORATION PROJECT
SAN JUAN, PUERTO RICO

EXECUTIVE SUMMARY

The non-Federal sponsors, the *Corporación del Proyecto ENLACE del Caño Martín Peña* (ENLACE) and the Commonwealth of Puerto Rico (the Commonwealth), acting through the Department of Natural and Environmental Resources (DNER), have completed a Final Feasibility Study and Environmental Impact Statement (FR/EIS) for the Caño Martín Peña Ecosystem Restoration Project (CMP-ERP). In accordance with Section 5127 of the Water Resources Development Act of 2007 and the subsequent implementation guidance, ENLACE and the Commonwealth submit this FR/EIS to the U.S. Army Corps of Engineers (USACE) for review and approval of the Assistant Secretary of the Army (Civil Works). This main report describes the purpose and need, location, National Ecosystem Restoration (NER) and Recommended Plan, and other alternatives considered. It also includes the data that were collected and generated, analyses, and evaluations made with regard to the alternatives that were formulated leading to the selection of the NER and Recommended Plan for implementation. A Final Environmental Impact Statement (EIS) has also been prepared for the proposed project. It has been prepared to satisfy documentation requirements of the National Environmental Policy Act of 1969, as amended (NEPA), as well as the Commonwealth of Puerto Rico Environmental Policy Act of 2004.

Purpose and Need for the Study

The CMP-ERP is an urban ecosystem restoration project to restore the Caño Martín Peña (CMP) and surrounding areas of the San Juan Bay Estuary (SJBE). Restoration of the CMP would re-establish the tidal connection between the San José Lagoon and the San Juan Bay, which would improve dissolved oxygen levels and reduce salinity stratification, increase biodiversity by restoring fish habitat and benthic conditions, and improve the functional value of mangrove habitat within the estuary.

The CMP is a tidal channel 3.75 miles long in metropolitan San Juan, Puerto Rico. It is an integral part of the SJBE, the only tropical estuary included in the U.S. Environmental Protection Agency (USEPA) National Estuary Program (NEP). The SJBE's watershed covers 97 square miles. It is heavily urbanized, with a population density of over 5,000 people per square-mile. The SJBE includes over 33 percent of the mangrove forests on the island with over 124 species of fish and 160 species of birds. The eastern half of the CMP, historically between 200 and 400 feet wide and navigable, currently ranges in depth from 3.94 feet to 0 foot towards San José Lagoon. Due to years of encroachment and fill of the mangrove swamps along the CMP, the channel no longer serves as a

functional connection between San Juan Bay and San José Lagoon. Sedimentation rates within the CMP are nearly two orders of magnitude higher than in other parts of the SJBE. Open waters in areas closer to the San José Lagoon have been lost, as the area has started transitioning into a wetland. A combination of sediment and solid waste is found in the CMP, of which the solid waste accounts for approximately 10 percent of its composition. In some sites, the solid waste extends to depths 10 feet below the sediment surface.

The conditions within the Eastern CMP have led to degradation within the entire estuary. Connectivity of the ecosystem has been severed and the biodiversity within the lagoons has been compromised, as more individuals of a reduced number of species are found when compared with other lagoons throughout the SJBE. The reduction in biodiversity in turn decreases the ability of fish and invertebrates to respond to natural changes, disease and other factors, resulting in a depletion of fish stock and losses of economic and recreational resources.

Water residence time in the San José Lagoon is of 16.9 days, much higher than a normal residence time, estimated to be about 3 days. The lack of tidal flushing causes strong salinity stratification and in turn leads to low oxygen or no oxygen levels in the 702 acres of lagoons with depth below 4 to 6 feet, severely affecting benthic habitats. Mangrove habitat, extremely important for native aquatic invertebrates, has been severely impacted, reducing habitat where important commercial fish species spend their juvenile life stages.

Ecological degradation within the estuary has also begun to affect socio-economic conditions of local human population surrounding the CMP. Inability to improve local drainage infrastructure due to the lack of conveyance capacity in the CMP leads to substantial flooding with the surrounding neighborhoods. Fecal coliform levels within these floodwaters are alarmingly high, and subsequent human contact with the waters of the CMP has been associated with higher rates of asthma and gastrointestinal disease. Recreational navigation within the estuary has also been severed, restricting public and commercial waterborne traffic within the capital city.

Initial Array of Alternatives

The plan formulation process built directly upon previous planning and design efforts. Structural management measures for the channel dredging, erosion control, dredged material disposal, mangrove planting and construction, recreation, as well as non-structural measures were identified and screened. An Initial Array of Alternatives consisting of rectangular channel cross sections ranging between 75- and 200-foot widths with 10-foot depths was then developed and evaluated. Screening criteria such as completeness, acceptability, cost effectiveness, and secondary effects on adjacent communities, were then used to eliminate unfavorable plans and develop a final array of alternatives.

Final Array of Alternatives, Plan Comparison, and Selection

Final Array: The final array of alternatives consisted of four alternative plans:

No Action Alternative Plan: Involves no further Federal actions.

Alternative Plan 1: Consists of a 75-foot-wide by 10-foot-deep channel; articulated concrete mats along the entire channel bottom for erosion control; an elongated weir under the Martín Peña, Tren Urbano, and Luis Muñoz Rivera bridges involving a 115-foot-wide by 6.5-foot-deep by 800-foot-long channel with riprap on side slopes and articulated concrete mats at the channel bottom; clearing and grubbing of approximately 91,909 cubic yards (cy) of vegetation and mixed material; dredging approximately 680,000 cy of mixed materials along 2.2 miles of the Eastern CMP; construction of a vertical concrete-capped steel sheet pile with hydraulic connections with the surrounding lands; and, restoration of 20.42 acres of open water and 39.62 acres of wetland.

Alternative Plan 2: Consists of a 100-foot-wide by 10-foot-deep natural bottom channel; an elongated weir under the Martín Peña, Tren Urbano, and Luis Muñoz Rivera bridges involving a 115-foot-wide by 6.5-foot-deep by 800-foot-long channel with riprap on side slopes and articulated concrete mats at the channel bottom to reduce water velocity and erosion, and to control scour; clearing and grubbing of approximately 91,909 cy of vegetation and mixed material; dredging approximately 762,000 cy of mixed materials along 2.2 miles of the Eastern CMP; and construction of a vertical concrete-capped steel sheet pile with hydraulic connections with the surrounding lands; restoration of 25.57 acres of open water and 34.48 acres of wetland.

Alternative Plan 3: Consists of a 125-foot-wide by 10-foot-deep natural bottom channel; an elongated weir under the Martín Peña, Tren Urbano, and Luis Muñoz Rivera bridges involving a 115-foot-wide by 6.5-foot-deep by 800-foot-long channel with riprap on side slopes and articulated concrete mats at the channel bottom to reduce water velocity and erosion, and to control scour; clearing and grubbing of approximately 91,909 cy of vegetation and mixed material; dredging approximately 872,000 cy of mixed materials along 2.2 miles of the Eastern CMP; and construction of a vertical concrete-capped steel sheet pile with hydraulic connections with the surrounding lands; restoration of 30.97 acres of open water and 29.08 acres of wetland.

For Alternative Plans 1, 2, and 3, total construction time would be approximately 27 months; maintenance dredging would be required; and dredged material disposal would be divided between upland landfill for solid waste and disposal in the San José Lagoon pits for dredged sediment.

Evaluation and Comparison: Performance measures for Benthic Habitat, Fish Habitat, and Mangrove Habitat were developed to measure alternative output, and ecosystem restoration measure benefits were calculated for each alternative. A cost effectiveness and incremental cost analysis (CE/ICA) was conducted based on a project life of 50 years and a Federal Discount Rate of

3.5 percent and a base year of 2019. Each alternative was considered to be independent and not combinable with the other alternative. Due to weir restrictions to prevent erosion at bridges and other structures for all three action alternatives, average annual habitat units (AAHUs) would be nearly identical among alternatives, totaling 6,133 AAHUs per alternative. As a result, Alternative 2, with an average annual equivalent cost of $8,700,000, was determined to be cost effective and best buy when compared to Alternatives 1 and 3.

Additional considered criteria included project objectives and constraints, a comparison of the Four Accounts, and criteria contained in the "Principles and Guidelines" (P&G) for water resources planning adopted by the Water Resources Council.

Selection: Alternative 2, the 100-foot-wide channel, was identified as the NER and Recommended Plan and is both cost effective and a best buy. In accordance with the P&G criteria, Alternative 2 provides a complete solution to the problems identified for the study. It is also the most effective plan and meets the project objectives. The NER and Recommended Plan is acceptable and has been determined to be in the national and public interest and can be constructed while protecting the human environment from unacceptable impacts.

National Ecosystem Restoration Plan Elements

Channel

Alternative Plan 2 consists of dredging approximately 2.2 miles of the eastern half of the CMP to a width of 100 feet and a depth of 10 feet, with slight variations in channel width and depth at the four bridges to the west, the Barbosa Bridge to the east, and at the terminus of the CMP with the San José Lagoon. The walls of the Project Channel would be constructed with vertical concrete-capped steel sheet piles with hydrologic connections to the surrounding lands. The sill depth of the window would be set at mean low water so that tidal exchanges are facilitated to the mangrove beds. Rip rap would be placed at the four bridges. At the terminus of the Project Channel with the San José Lagoon, an extended channel would be dredged east into the San José Lagoon (over a distance of approximately 4,300 feet) as a hydraulic transition from the CMP. This extended channel would transition from the 10-foot-deep Project Channel to the 6-foot-deep areas of San José Lagoon. The extended channel would maintain the Project Channel's 100-foot width but replace its steel sheet pile walls with a trapezoidal configuration with 5-foot to 1-foot earthen side slopes. A temporary coffer dam would be constructed to parallel the shoreline at low-lying areas such as the bend at Barrio Obrero Marina to protect the area(s) until the dredging and permanent sheet pile construction was completed.

Disposal

Materials within the Caño Martín Peña include various types of solid waste, debris, and other materials. Such materials will require further testing prior to and/or during project construction, as appropriate, in accordance with an agreed sampling plan. If the testing determines that any

materials contain hazardous substances at levels that are not suitable for unregulated disposal, they will be managed in accordance with the applicable laws and regulations of the relevant regulatory agencies.

Clearing and grubbing activities would remove on average 12 inches from the project area within the CMP channel, and would result in the removal of approximately 91,909 cy of vegetation and mixed material, and 642 cy of asphalt paving. This material would be transported by truck to the Humacao landfill site for disposal.

A barge-mounted mechanical clamshell dredge would be used to widen and deepen the CMP channel, and would place dredged material into dump scows. Approximately 76,200 cy of solid waste would be screened from the 762,000 cy of dredged material and transported from the CDRC staging area to the Humacao landfill site, which is located approximately 32 miles from the CMP-ERP site.

After screening and removal of solid waste debris, the remaining sediment and smaller pieces of solid waste would be encapsulated within geotextile fabric bags, and transported by shallow-draft barges to the San José Lagoon artificial subaqueous pits. Sediments would be placed utilizing contained aquatic disposal (CAD) in the SJ1 and SJ2 pits. Prior to disposal operations, both of these sites would be modified to increase capacity to accommodate the majority of dredged sediments and the required 2-foot sand cap. Enlarging SJ1 and SJ2 is the cost-effective approach versus disposing of dredged sediment across all five San José Lagoon artificial subaqueous pits because the surficial area in the latter approach would require significant more area for a sand cap. Approximately 506,381 cy of material would be removed from SJ1 and SJ2 and deposited within the SJ 3/4/5 artificial subaqueous pits. During the CMP-ERP disposal operations, approximately 648,000 cy of in situ sediments would be placed in the SJ1 and SJ2; however, additional water quality and sediment testing, such as bioassays, would be conducted prior to placement to ensure their suitability for disposal. Approximately 37,800 cy of in-situ sediments would be used to complete the sheet pile construction and mangrove bed restoration.

The SJ1 and SJ2 CAD sites would be capped with a 2-foot layer of sand. Material for the sand cap would be quarried from upland quarry sites and transported by trucks to the construction staging area for transfer to dump scows for placement. Silt curtains would also be employed around the pits in the San José Lagoon. In critical areas, the curtains may double ring the active area for additional precautions. The curtains would be constructed to the full depth of the water where they are placed.

For activities related to the installation of the weir in the western end of the Project Channel, a 2-acre upland staging area (Las Piedritas) east of the Martín Peña bridge would be used to temporarily stockpile and transfer the collected sediment and solid waste excavated during the dredging process. Equipment and materials would be staged on floating barges. After the construction of the weir, and once the dredging from the eastern portion of the Project Channel

opened the CMP, the temporary turbidity containment coffer dam would be removed. Solid waste and dredged sediment would be placed into trucks and hauled for disposal at the Humacao upland landfill.

Erosion Control

A weir would be constructed at the western end of the Project Channel to mitigate water flows into the adjacent Western CMP waterway. The weir would be constructed with an articulated concrete bottom, while the remainder of the Project Channel would be earthen bottom.

Non-Structural Measures

Non-structural measures related to structure acquisitions and relocations within the public domain boundary (and confines of the Federal project), as well as activities outside of the project that would be conducted by the non-Federal sponsors, included structure acquisition and relocation, increased enforcement of illegal dumping, and community education. There are 393 residential structures that would be acquired and 394 relocations that would occur as part of the proposed project, of which 96 structure acquisitions and 62 relocations have already been completed and/or are in-process of being completed. No non-structural measures were identified to restore circulation to San José Lagoon.

Mangrove Restoration

Approximately 34.48 acres of mangrove wetlands would be restored by grading lands adjacent to the CMP and planting four native species of mangrove.

Secondary Project Components

Secondary project components are as follows: Recreation Plan, Project Monitoring and Adaptive Management Plan, Nuisance and Exotic Vegetation Control, and Draft Project Operating Manual. The proposed Federal recreation plan includes numerous water access areas that would replace lost functions within the project area.

The total estimated project first cost is $214,156,000, estimated at October 2015 price levels. The cost share for the ecosystem restoration features of the project will be 65 percent Federal and 35 percent non-Federal. Recreational features would be cost shared at 50 percent Federal and 50 percent non-Federal. The non-Federal sponsor must provide all Lands, Easements, Right-of-Way, Relocations, and Disposal Areas required for the project, for which ENLACE would be 100 percent responsible. Operations, Maintenance, Repair, Rehabilitation, and Replacement of the project would be a 100 percent DNER responsibility. Thus, the Federal estimated cost share is $137,508,500 and the non-Federal cost share is $76,647,500.

Environmental Operating Principles

The proposed project is consistent with the USACE "Environmental Operating Principles" and is intended to achieve a sustainable, healthy CMP and SJBE ecosystem as well as the surrounding communities. Planning for the CMP-ERP was based on over a decade of intense work to engage the public and stakeholders in developing management plans, creating a platform for a successful, collaborative planning effort. The planning process fully considered the relationship of a restored ecosystem to the socioeconomic wellbeing of the surrounding neighborhoods. It has been open and transparent, and has fully leveraged the scientific, economic, and social knowledge of the project's stakeholders, and government agencies.

Areas of Controversy and Unresolved Issues

Throughout the informal public participation process carried out by the Sponsor, several issues have been raised and are addressed in the FR/EIS. The most important areas of concern are related to water quality, dredging, and disposal of dredged material, including potentially contaminated sediments. Alternatives presented in the FR/EIS were discussed and analyzed with stakeholders. The public has also raised concerns regarding temporary impacts during construction such as noise, odors, vibrations and structure stability, and vectors. The EIS discusses recommendations to reduce these impacts.

Public concerns also include the acquisition of structures and relocation of families living along the CMP and the possibility of gentrification once the project is completed. The Sponsor has worked closely with the organized communities along the CMP to ensure participation in the decision making process, leading to the design of strategies to address such concerns incorporated within the Comprehensive Development and Land Use Plan for the District and in Puerto Rico Law 489 of September 24, 2004, as amended. Strategies include the relocation plan, the creation of a citizens' relocation committee to comply with applicable policies, as well as the creation of the Fideicomiso de la Tierra del Caño Martín Peña, a community land trust.

Agency Technical Review

An Agency Technical Review (ATR) has been performed on the Draft FR/EIS. The ATR was conducted by a multidisciplinary team consisting of technical staff from USACE Districts across the nation, and was completed in accordance with recent USACE policy regarding coordination with the National Ecosystem Center of Expertise and the National Cost Engineering Directorate of Expertise.

Independent External Peer Review

An Independent External Peer Review (IEPR) has been performed on the Draft Feasibility Report and Environmental Impact Statement (EIS). The Sponsor contracted a multi-disciplinary panel of experts from the public to perform the IEPR. The Review was conducted in accordance with USACE policy regarding coordination with the National Ecosystem Planning Center of Expertise.

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Acronyms and Abbreviations

AAHU	Average Annual Habitat Units
ACM	Articulated Concrete Mat
ATR	Agency Technical Review
B2EHP	Bis (2-ethylhexyl) phthalate
BI	Benthic Index
BMPs	Best Management Practices
C&D	Construction and Demolition
CAD	Contained Aquatic Disposal
Cantera Company	*Compañía para el Desarrollo Integral de la Península de Cantera*
Commonwealth	The Commonwealth of Puerto Rico
CCMP	Comprehensive Conservation & Management Plan for the San Juan Bay Estuary
CDLUP	Comprehensive Development Land Use Plan
CDRC	Ciudad Deportiva Roberto Clemente
CE/ICA	Cost Effectiveness/Incremental Cost Analysis
CEM	Conceptual Ecological Model
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CH3D-WES	Curvilinear Hydrodynamics in 3-Dimensions-Waterways Experiment Station model
CHDO	Community Housing Development Organization
CMP	Caño Martín Peña
CMP-ERP	Caño Martín Peña Ecosystem Restoration Project
CSRA	Cost Schedule Risk Analysis
cy	cubic yard
dB	decibels
DDT	dichloro-diphenyl-trichloroethane
District	CMP Special Planning District
District's Plan	CMP Special Planning District's Land Use and Comprehensive Development Plan
DNER	Puerto Rico Department of Natural and Environmental Resources
DO	dissolved oxygen
DTPW	Puerto Rico Department of Transportation and Public Works
EC	Engineering Circular
ECO-PCX	USACE Ecosystem Restoration Planning Center of Expertise
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
ENLACE	Corporación del Proyecto ENLACE del Caño Martín Peña

ENLACE Project	Caño Martín Peña ENLACE Project
EQ	Environmental Quality Account
ER	Engineering Regulation
ERDC	USACE Engineer Research and Development Center
ERP	Ecosystem Restoration Project
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FMP	Reef Fish Fishery Management Plan
FR	Feasibility Report
FRM	Flood Risk Management
ft^2	square feet
ft/s	feet per second
ft/y	feet per year
IWR	USACE Institute for Water Resources
G-8	Grupo de las Ocho Comunidades Aledañas al Caño Martín Peña (Group of the Eight Communities bordering the Caño Martín Peña)
g	grams
GHG	Greenhouse Gas
GIS	Geographic Information System
H_2S	hydrogen sulfide
HW	Household Waste
HHW	Household Hazardous Waste
HTRW	Hazardous, Toxic, Radioactive Waste
HU	Habitat Unit
IDC	Interest During Construction
IEPR	Independent External Peer Review
in	inches
IPRC	Institute for Puerto Rican Culture
Juan Méndez	Quebrada Juan Méndez
LERRDs	Lands, Easements, Right-of-Way, Relocations, and Disposal Areas
Kg	kilograms
m	meters
MCACES	Micro-Computer Aided Cost Estimating System
mg/Kg	milligrams per kilogram
mg/L	milligrams per liter
mi^2	square mile
mL	milliliter
MLLW	mean low low water
mm/yr	millimeters per year

MOA	Memorandum of Agreement
mph	miles per hour
MSL	mean sea level
MTZ-CMP	Public Domain lands within the Caño Martín Peña Maritime Terrestrial Zone
NED	National Economic Development Account
NEP	USEPA's National Estuary Program
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
NGVD 29	National Geodetic Vertical Datum 1929
NH_3	Ammonia
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NRC	Natural Research Council
NTU	Nephelometric Turbidity Unit
O&M	Operations and Maintenance
ODMDS	Ocean Dredged Material Disposal Site
OMRR&R	Operations, Maintenance, Repair, Rehabilitation, and Replacement
OSE	Other Social Effects Account
P&G	United States Water Resources Council Principles and Guidelines
PAH	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PDT	Project Delivery Team
PED	Preconstruction engineering and design
PL	Public Law
PMP	Project Management Plan
PPA	Project Partnership Agreement
ppm	parts per million
PR	Puerto Rico
PRASA	Puerto Rico Aqueduct and Sewer Authority
PREQB	Puerto Rico Environmental Quality Board
PRHTA	Puerto Rico Highway and Transportation Authority
Project Channel	2.2 miles of the Eastern CMP associated with the CMP-ERP
PRPB	Puerto Rico Planning Board
PRWQSR	Puerto Rico Water Quality Standards Regulation
PUD	Permanent Upland Disposal
RCRA	Resource Conservation and Recovery Act
REC	Recognized Environmental Condition
RED	Regional Economic Develop Account

ROD	Record of Decision
ROW	Right-of-Way
SHPO	State Historic Preservation Office
SJBE	San Juan Bay Estuary
SJBEP	San Juan Bay Estuary Program
SJHP	San Juan Bay Harbor Project
SJL	San Juan Lagoon
T&E	Threatened and Endangered Species
TC	Technical Committee to the Project
TN	Total Nitrogen
µg/g	micrograms per gram
URA	Uniform Relocation Act of Assistance and Real Property Acquisition Policies Act as amended, P.L.91-646; 42 U.S.C. 4601 et seq.
USACE	United States Army Corp of Engineers
U.S.C.	United States Code
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USWRC	United States Water Resources Council
UWFP	Urban Waters Federal Partnership
WQC	Water Quality Certification
WRDA	Water Resources Development Act

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1.0 INTRODUCTION

The Caño Martín Peña (CMP) is a considerably degraded tidal channel in the heart of heavily urbanized San Juan, Puerto Rico. Due to years of infill in the surrounding communities, the CMP no longer serves as a functional connection between San Juan Bay and San José Lagoon. The resulting loss of tidal circulation has led to decreased functional value of the region's fish, wildlife, and mangrove habitat, degraded water and sediment quality, and extensive human health impacts in the surrounding communities. This Feasibility Report documents the feasibility study process used to develop, evaluate, compare, and recommend a National Ecosystem Restoration (NER) Plan to improve the CMP for the benefit of the natural and human communities.

1.1 STUDY AUTHORITY

The Puerto Rico Department of Natural and Environmental Resources (DNER), custodian authority of the Maritime-Terrestrial Zone of the Caño Martín Peña (MTZ-CMP) and the USACE have performed preliminary technical analyses concerning the dredging of the CMP under a Support for Others Memorandum of Agreement (MOA) dated March 3, 1996, and amended on May 24, 1999. This work concluded with the report "Dredging of Caño Martín Peña, Project Design Report and Environmental Impact Statement (EIS)" (USACE, March 2001).

After the Caño Martín Peña Ecosystem Restoration Project (CMP-ERP) was assigned to the Puerto Rico Highway and Transportation Authority (PRHTA), the USACE prepared the "Reconnaissance Report Section 905(b) Water Resources Development Act of 1986 (WRDA 86) Analysis, Caño Martín Peña, Puerto Rico Ecosystem Restoration." This report was prepared under a Congressional Resolution by the Committee on Transportation and Infrastructure of the U.S. House of Representatives, Docket 2702, dated September 25, 2002, which reads as follows:

> *Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That the Secretary of the Army is requested to review the report of the Chief of Engineers on the Puerto Nuevo River, Puerto Rico, and other pertinent reports to include the dredging of Caño Martín Peña Project Design Report and Environmental Impact Statement, dated March 2001, to determine whether modifications to the recommendations contained therein are advisable at the present time in the interest of environmental restoration and protection and related purposes at the Martín Peña Canal, San Juan, Puerto Rico.*

The purpose of the reconnaissance study was to determine whether there was a Federal interest in the USACE participating in a cost shared feasibility phase study for ecosystem restoration and other related purposes along the CMP in San Juan, Puerto Rico. This Reconnaissance Report, which was completed in 2004, presented the results of studies for the CMP ecosystem restoration and concluded that there was a strong Federal interest in continuing the study into the feasibility phase. This conclusion was based on the likelihood that a Federal ecosystem restoration project would be environmentally and economically justified and implementable.

The 110th Congress enacted Public Law (PL) 110–114, known as the "Water Resources Development Act of 2007," or WRDA 2007, on November 8, 2007. Section 5127 directed that:

> *The Secretary shall review a report prepared by the non-Federal interest concerning flood protection and environmental restoration for Caño Martín Peña, San Juan, Puerto Rico, and, if the Secretary determines that the report meets the evaluation and design standards of the Corps of Engineers and that the project is feasible, the Secretary may carry out the project at a total cost of 150,000,000.*

On October 27, 2008, the Director of Civil Works issued an implementation guidance memorandum for Section 5127 of the WRDA 2007, which established that the feasibility study "will follow the requirements set forth in Appendix H of Engineering Regulation (ER) 1105-2-100 for projects authorized without a report and be submitted for approval by the Assistant Secretary of the Army (Civil Works)."

As indicated above, the proposed CMP-ERP was authorized as multi-purpose Ecosystem Restoration and Flood Risk Management project. Prior to embarking on the Feasibility Report, an appraisal of potential Flood Risk Management (FRM) benefits was conducted for the proposed project. Initial analysis indicated that the FRM National Economic Development (NED) benefits would not be equivalent to those that would be generated from a NER analysis. As a result, it was concluded that the project would be more aptly formulated as a single-purpose, Ecosystem Restoration project with incidental FRM benefits. A qualitative analysis has been conducted for FRM and those benefits are identified within the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G) Four Accounts description and NER Plan sections of this Report. Federal recreation features have also been included in the CMP-ERP consistent with ER 1105-2-100.

1.2 NON-FEDERAL SPONSORS

The *Corporación del Proyecto ENLACE del Caño Martín Peña* (ENLACE) is a public agency created under the Commonwealth of Puerto Rico (the Commonwealth) Law 489-2004 of September 24, 2004, for the implementation of the Comprehensive Development of the Caño Martín Peña Special Planning District, as amended (PR Law 489-2004). ENLACE is the non-Federal sponsor for the feasibility study effort of the CMP-ERP. As such, it initiated the feasibility phase of the study in September 2010. In June 2012, ENLACE and the Department of the Army executed a contributed funds agreement for the revision of the Feasibility Report and Environmental Impact Statement for the CMP-ERP. ENLACE performed the planning and technical analyses for the feasibility report according to USACE regulations using a combination of in-house and contracted staff resources. The USACE Jacksonville District provided oversight and technical review of the process to ensure the Final Feasibility Report complied with ER 1105-2-100. Operations, Maintenance, Repair, Rehabilitation, and Replacement will be the responsibility of the DNER, who will also be a Local Sponsor.

1.3 PROJECT AREA

The CMP is a tidal channel 3.75 miles long in metropolitan San Juan, Puerto Rico. It is part of the San Juan Bay Estuary (SJBE), the only tropical estuary included in the U.S. Environmental Protection Agency (USEPA) National Estuary Program (NEP). The SJBE has been defined as the "Study Area" due to the expected direct, indirect and cumulative benefits that the CMP-ERP will have in the SJBE (Figure 1). The "Project Area," which mostly lays out the construction footprint, has been defined as the Project Channel, where dredging would take place, and the adjacent delimitation of the public domain lands within the Caño Martín Peña Maritime Terrestrial Zone (MTZ-CMP), where relocations are scheduled to occur. Also included in the Project Area is the 2-acre dredged material staging area adjacent to the Martín Peña bridge (known as Las Piedritas Stadium), the 6-acre dredged material staging area within the 35-acre Ciudad Deportiva Roberto Clemente (CDRC) site, the boating routes from the eastern limit of the CMP to the CDRC, and the five pits in San José Lagoon (Figure 2).

Eight communities are adjacent to the Eastern CMP including Barrio Obrero Oeste y San Ciprian, Barrio Obrero Marina, Buena Vista Santurce, Parada 27, Las Monjas, Buena Vista Hato Rey, Israel-Bitumul, and Peninsula de Cantera (Figure 3). In addition, there are three major utilities that are located within the project area: a 115-kV Power Line, the Borinquen Water Transmission Line, and the Rexach Sewer Line (Figure 4). Another major utility, the San José Sewer Line, is adjacent to the CMP-ERP Project Area but outside the Federal project.

The SJBE, along the northern coast of Puerto Rico, is the largest system of its kind on the island. Located within the largest urbanized and most densely populated region in Puerto Rico, the SJBE's watershed includes the municipalities of Toa Baja, Cataño, Bayamón, San Juan, Guaynabo, Carolina, Loíza, and Trujillo Alto. The system is characterized by a network of lagoons, channels, man-made canals, permanently and seasonally flooded woody and herbaceous wetlands, and the San Juan Bay, which is home to Puerto Rico's busiest port.

Figure 1. The San Juan Bay Estuary Study Area.

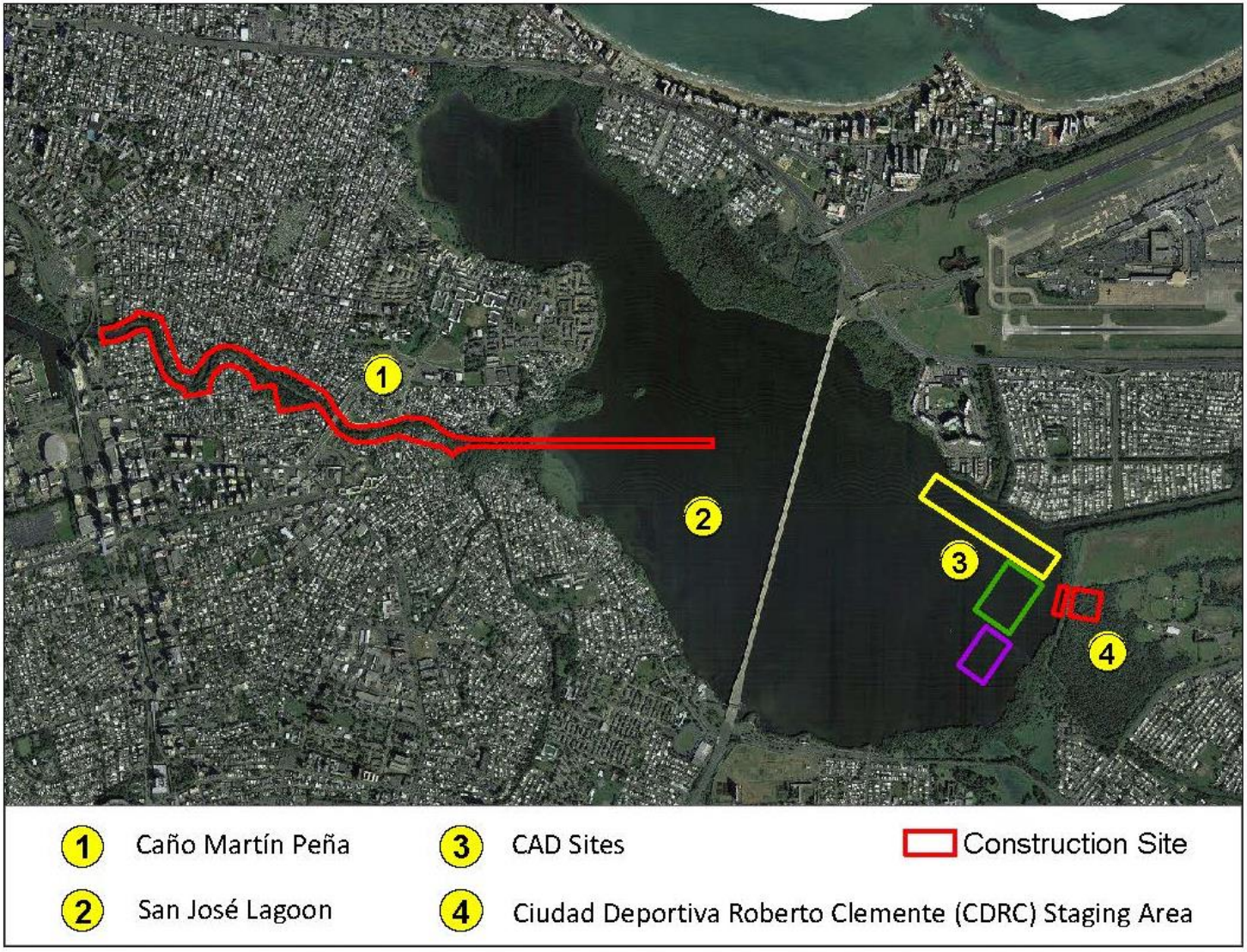
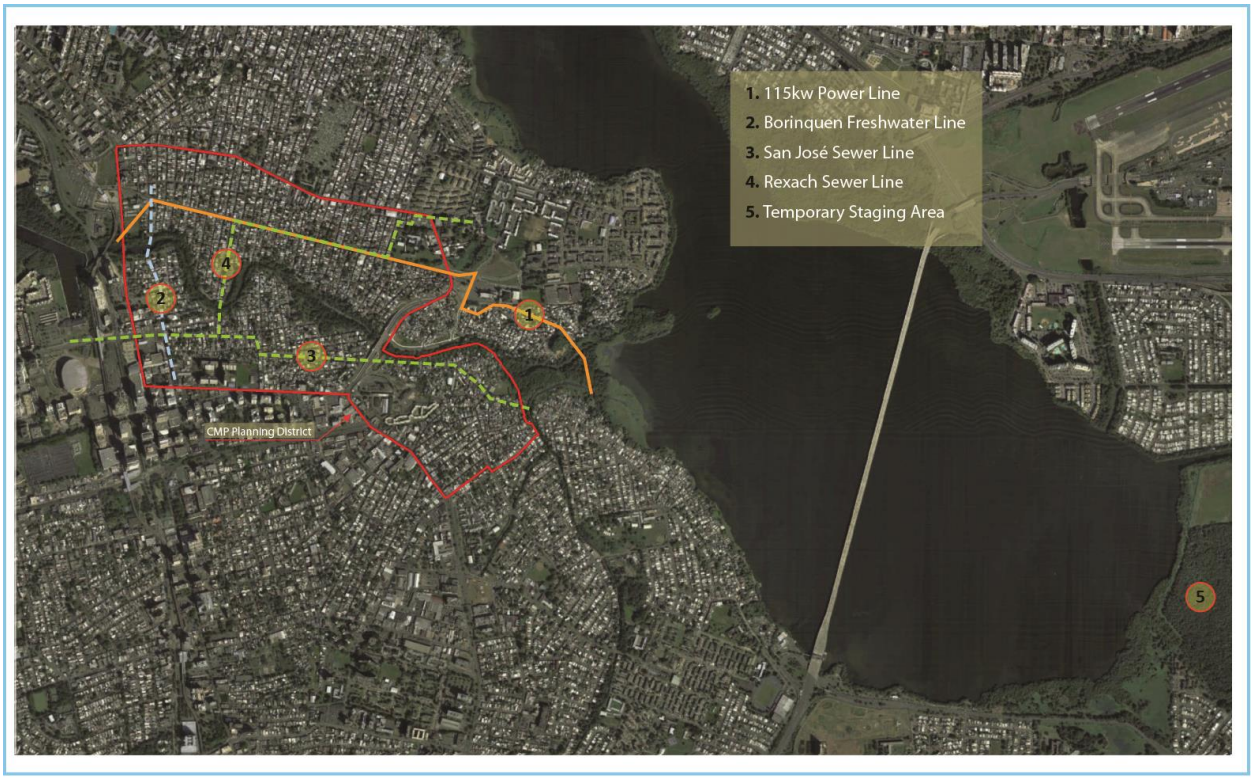


Figure 2. The Caño Martín Peña Ecosystem Restoration Project Area

Figure 3. Communities Adjacent to the Caño Martín Peña

The SJBE includes the San Juan Bay, the Condado, San José, Los Corozos, La Torrecilla, and Piñones lagoons, the interconnecting CMP, San Antonio Channel, and Suárez Canal, as well as the Piñones mangrove forest and Las Chucharillas Swamp. Fresh water flows into the system from the creeks and rivers flowing mostly north from its watershed, covering approximately 97 square miles (see Figure 1). These include the Río Piedras (Puerto Nuevo) River, Juan Méndez, San Antón, and Blasina creeks, and the Malaria Canal. During medium to extreme flood events, fresh water is also received from the Río Grande de Loíza River located east of the Piñones State Forest. Several flood control pump stations as well as storm water sewers discharge fresh water into the system. Ocean water enters the SJBE through three openings or outlets: Boca del Morro at the San Juan Bay, El Boquerón at the Condado Lagoon, and Boca de Cangrejos at La Torrecilla Lagoon. The Puerto Nuevo River, whose drainage area is of about 25 square miles, flows into the western end of the CMP, close to the San Juan Bay. The western half of the CMP was dredged during the 1980s as part of a waterway transportation project. This portion of the CMP is navigable and has a channel width and depth of 200 feet and 10 feet, respectively. The total drainage area of the CMP is about 4 square miles (2,500 acres).



Source: ENLACE & Puerto Rico Planning Board

Figure 4. Major Utilities Within and Adjacent to the Project Area

1.4 PURPOSE AND SCOPE FOR THE PROJECT

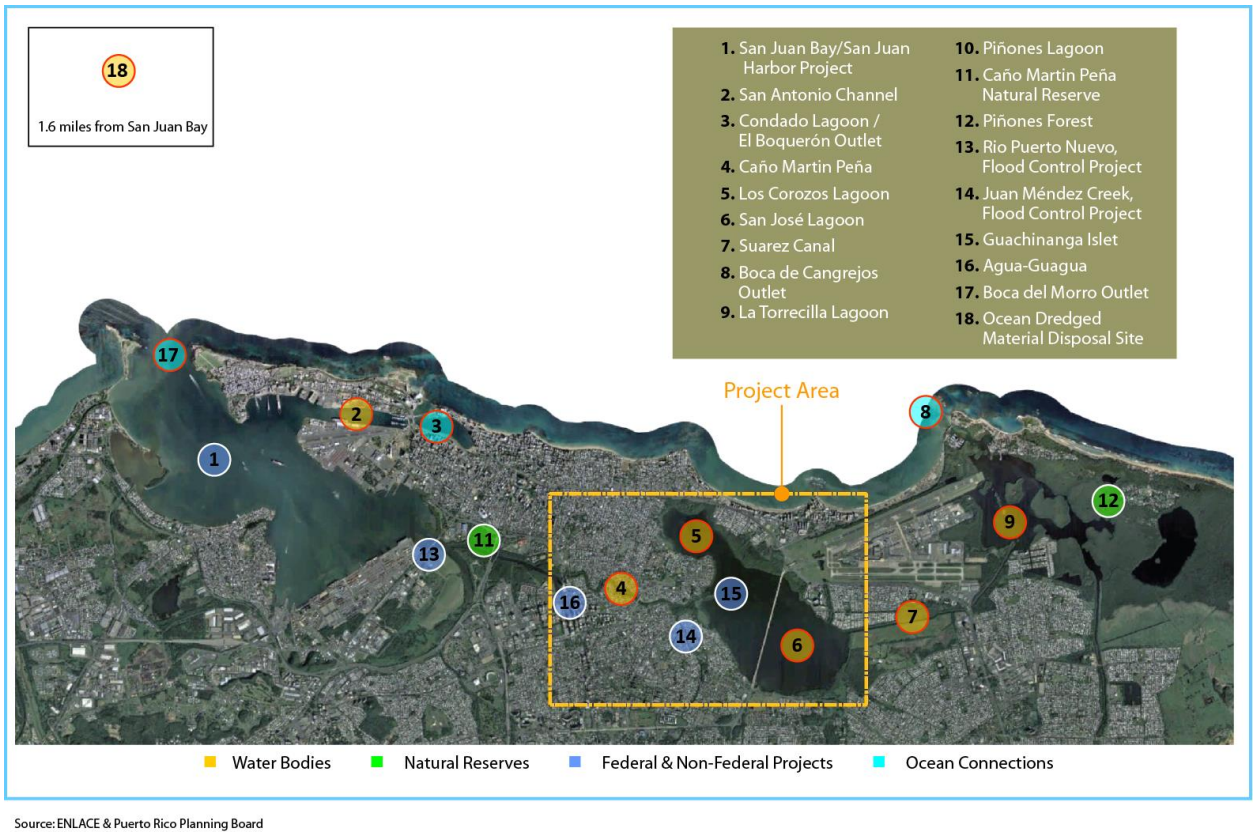
The project has been formulated and evaluated as a single-purpose ecosystem restoration project for the purpose of environmental restoration for the Caño Martín Peña, San Juan, Puerto Rico. The national significance of the resource (e.g., public, institutional, and technical significances) is further discussed in Section 6.1.1 (*Significance of Ecosystem Restoration Benefits*) of this report. The Feasibility Report directly builds on the following previous technical and planning efforts by incorporating those previous technical and plan formulation considerations into the current feasibility study:

- San Juan Bay Estuary Program (SJBEP) Comprehensive Conservation and Management Plan (CCMP) (2000);
- USACE Dredging of Caño Martín Peña, Project Design Report and Environmental Impact Statement, Jacksonville District (2001);
- USACE Reconnaissance Report Section 905(b) Analysis, Caño Martín Peña, Puerto Rico Ecosystem Restoration (2004);
- PRHTA Comprehensive Development and Land Use Plan for the Caño Martín Peña Special Planning District (2006); and,

- Puerto Rico Planning Board (PRPB) Comprehensive Development Plan for the Cantera Peninsula (1995).

1.5 RELATIONSHIP TO OTHER USACE, FEDERAL, AND NON-FEDERAL PROJECTS

There are several related Federal and non-Federal projects and other efforts in the Study Area that have been or are being implemented. Their locations are shown in Figure 5.



Source: ENLACE & Puerto Rico Planning Board

Figure 5. Existing Projects Related to the Caño Martín Peña Ecosystem Restoration Project

1.5.1 San Juan Harbor Project

San Juan Harbor, which is part of the SJBE system, has the Commonwealth's main port, handling over 15 million tons (or 80 percent) of waterborne commerce moving through the harbor annually.

The San Juan Harbor Project (SJHP), west of the CMP, is a completed Federal Deep-Draft Navigation Project with congressional authorizations dating back to 1917, the most recent included in the Water Resources Development Act (WRDA) of 1996, to deepen the navigation channels. The current project consists of a Bar Channel with depths from 56 to 49 feet, a 40-foot-deep Anegado entrance channel, a 40-foot-deep Army Terminal Channel, a 39-foot-deep Puerto Nuevo Channel, a

34-foot-deep Sabana Approach, a 36-foot-deep Graving Dock Channel, a 30-foot-deep Graving Dock Turning Basin, a 36-foot-deep San Antonio Channel, a 30-foot-deep extension to the San Antonio Channel, two 30-foot-deep Cruise Ship Basins, a 36-foot-deep Anchorage Area E, and a 30-foot-deep Anchorage Area F. Maintenance dredging works for the navigational channels is performed on a regular basis. The basic channel structure of the SJHP is complete; however, there may be requirements in the future for basin or wharf improvements or modifications.

Dock and storage facilities in the San Juan Bay (SJB) led to the elimination of almost all of the mangrove basin forests that existed in this waterbody, such as those associated with the outlets of the CMP, the Puerto Nuevo River, and the San Fernando Channel, and especially those that used to fringe the San Antonio Channel, including most of what is today the Isla Grande Península. Dredging works have caused the temporary resuspension of sediments and concomitant impacts to the Bay's water quality, including the mechanical destruction of benthic communities. The USACE has proposed to mitigate the latest impacts to submerged aquatic vegetation by filling two artificial dredged pits in the Condado Lagoon in order to promote its restoration with seagrasses (USACE, 2014; Tetra Tech, 2011). The study to conduct the San Juan Harbor Mitigation Project, San Juan, Puerto Rico, has already begun.

Overall, beneficial effects resulting from the CMP-ERP are anticipated within San Juan Harbor. The CMP-ERP would help offset some of the SJHP short- and long-term impacts of the ports operations and maintenance by restoring mangrove forests and open waters along the Eastern CMP, and improving overall water quality and benthic habitat conditions within the SJBE.

1.5.2 Agua-Guagua Project (AcuaExpreso)

In 1982, the Puerto Rico Department of Transportation and Public Works (DTPW) requested the USACE to conduct engineering and design studies for a waterway along the western half of the CMP, from the San Juan Bay to the Hato Rey Financial District, as part of the mass transportation Agua-Guagua Project. A Final Report was completed in August 1983. The Urban Mass Transit Administration provided funding for this project.

The USACE began construction in 1984 and completed it in 1988 at a cost of $20 million. Work consisted of dredging the Western CMP to 200 feet wide and 10 feet deep, ocean disposal of over 1.3 million cubic yards (cy) of material dredged from the channel, and construction of 13,000 feet of concrete retaining bulkhead. Docking facilities were designed and built by the Commonwealth. The completed mass transportation waterway project was inaugurated in March 1991. The Agua Guagua (now AcuaExpreso) Project created substantial environmental and recreational benefits along the western half of CMP in addition to its use by the public as a transportation system. The Enrique Martí Coll Linear Park was built above the bulkheads along the northern shore of the CMP, connecting the Hato Rey Financial District to the Parque Central. A pedestrian bridge to cross over to the southern shore, next to the AcuaExpreso docking facilities in Hato Rey, was also built. The

infrastructure associated with this project was considered in the CMP-ERP FR/EIS as increased tidal flows through the entirety of the CMP may affect it.

In section III.A.5 of the 1983 EIS, it is stated that the Western CMP had been plagued by water quality problems, mostly due to the construction of structures over the water, untreated waste-water discharges, and garbage and debris disposal. Elevated levels of contaminants were also found from water samples taken in this area. Even though contaminants were found in the Western CMP, the report states that dredged material would be preferably disposed at the ocean (given that requirements of Section 103 of the CWA were met), while non-dredging waste would be disposed in the municipal dump. Upon completion of appropriate testing, dredged sediments were in fact disposed of in the ocean, while solid waste was disposed of in a landfill.

1.5.3 Juan Méndez Creek Flood Control Project

Juan Méndez Creek, whose outlet originally discharged into the eastern end of the CMP, is a small drainage system that lies within one of the most densely developed residential sectors of San Juan. Prior to constructing the flood control project, encroachment on the creek by informal settlements and fill deposition, as well as a lack of maintenance of the upstream channel led to the formation of a shoal at the mouth. This shoal impeded drainage and became colonized by mangroves. It became a major cause of upstream flooding and associated health hazards to the occupants of 290 residential and commercial structures near the creek's outlet. It extended about 1,640 feet up-stream from the outlet at San José Lagoon, with an average depth of about 3 feet in this area.

The project for the clearing of the Juan Méndez Creek outlet was conducted under the authority of Section 208 of the Flood Control Act of 1954, as amended. The Municipality of San Juan was the non-Federal sponsor for the project. During the 3 years prior to construction of the project, the Municipality of San Juan invested $2.5 million to relocate 35 families that were living in areas required for construction and maintenance.

The project consisted of removing the existing shoal to restore the natural channel cross section. Excavation work was performed by a long arm backhoe working from the southeast channel bank. Channel cleaning activities generated about 15,700 cy of dredged material that was hauled by truck to a sanitary landfill. Also, the creek's outlet was rerouted through the excavation of a trapezoidal channel with an average top width of 89 feet and a depth of 3.3 feet. It runs now south and parallel to the CMP for about 1,214 feet into the San José Lagoon (USACE 2004). Sediment inputs from this creek have the potential to affect the eastern outlet of the CMP into the San José Lagoon.

1.5.4 Puerto Nuevo River Flood Control Project

The Puerto Nuevo River Flood Control Project, currently under construction and estimated to be completed in the next 10-15 years, is located on the north coast of Puerto Rico within the San Juan Metropolitan Area and the SJBE. The Puerto Nuevo River (Río Piedras) used to flow into the San

Juan Bay, and now flows into the western end of the CMP. Project construction was authorized under Section 202 of WRDA 1986 (PL 99-662). Improvements to the CMP were not included as part of this authorization. The improvement plan protects against the 100-year flood (the flood with a 1 percent likelihood of occurring in any year) through the construction of 1.7 miles of earth lined channel, 9.5 miles of concrete lined channels (5.1 of which are high velocity), and two debris basins in the Puerto Nuevo River and its tributaries. The plan also requires the construction of five new bridges, the replacement of 17 bridges, and the modification of eight existing bridges.

Concerns have been expressed over whether these improvements might have detrimental effects on the CMP-ERP. It is understood that the USACE modeled 10 scenarios resulting in hydrologic and water quality changes as part of the Hydrodynamic and Water Quality Model Study conducted for the SJBE Program in 2000. At least one of the scenarios, with a similar configuration as the NER and Recommended Plan for CMP-ERP, did not point to problems or issues such as backflow into the Lagoon, or significant increases in flood levels to those communities fringing the Eastern CMP. The model showed that levels in the San José Lagoon increased due to tidal influence. The models enlisted above and any other modeling conducted as part of the Puerto Nuevo Flood Control Project should be further reviewed to determine whether there are any problems or issues such as backflow into the San José Lagoon, or a significant increase in flood levels resulting from the Puerto Nuevo Flood Control Project that would affect those communities fringing the Eastern CMP once it is dredged. Dependent upon the results of the review, further modeling may be warranted. In addition and as stated in Section 6.4.1 of the FR, additional technical investigations and studies, including Hydraulic and Hydrologic (H&H) modeling and/or analyses, will be conducted for the CMP-ERP during PED.

The 1984 Survey Report associated with this project effort states that elevated levels of contaminants were found in the waters of the project site. Solid waste and sediments were also found at the site; however, these were not deemed hazardous and were disposed at the ocean in the EPA-approved ocean disposal site in San Juan, pursuant to Section 103 of the Clean Water Act (CWA).

1.5.5 San Juan Bay Estuary Comprehensive Conservation and Management Plan

In 1992, and in recognition of the continued threats facing the SJBE system, the Governor of Puerto Rico nominated it for the USEPA's NEP. The NEP is a place-based program established under Section 320 of the 1987 Clean Water Act Amendments that works to protect and restore the water quality and ecological integrity of 28 estuaries across the United States. The USEPA approved the nomination, and Federal funds were made available in 1993 to develop a Comprehensive Conservation and Management Plan (SJBEP 2000). With its inclusion in the NEP, the SJBE was designated as an "estuary of national significance" (SJBEP 2000).

On August 2000, the SJBE Program completed a CCMP for the SJBE that identified problems and recommended solutions to guide future management of the SJBE resources. The SJBE's CCMP is a long-term plan that contains 49 specific actions designed to address: (1) water and sediment quality; (2) habitat, fish, and wildlife; (3) aquatic debris; and (4) public education and involvement solutions to the estuary's priority problems. Six actions related to water and sediment quality improvements were identified as high priority or "urgent", as they "deserve immediate attention and should be initiated as soon as possible or within 0 to 5 years after CCMP approval" (SJBEP 2000). Three of these priority actions are directly related to the CMP-ERP:

- **Action WS-2**: Relocate families living adjacent to the CMP.
- **Action WS-5**: Improve flow in the Martín Peña Channel.
- **Action WS-6**: Fill artificial depressions at the Suárez Canal and at the San José, and La Torrecilla lagoons.

1.5.6 Cantera Peninsula Project

The Cantera Peninsula is one of the eight communities adjacent to the CMP. The portion of the CMP south of the Cantera Peninsula and north of the Israel–Bitumul neighborhood is the most affected by accumulation of trash and debris, and encroachment. In partnership with others, the *Compañía para el Desarrollo Integral de la Península de Cantera* (Cantera Company) has developed several housing projects to allow for relocation alternatives within the community. Both the PRHTA and the Cantera Company have relocated over 200 families, over 100 of which lived adjacent to the CMP. Moreover, a vacuum sanitary sewer and other vital infrastructure have been built. The Cantera Company already completed the first segment of the Paseo del Caño, the street proposed to be developed along the MTZ-CMP as a public space that separates the eight communities from the CMP and its mangroves and prevents future encroachment. The Paseo del Caño is envisioned to be built on both the northern and southern boundaries of the CMP.

The future without-project condition and CMP-ERP design assume that the relevant aspects of Cantera Peninsula project are fully implemented. If the remaining features are not constructed, there should be little to no impact on the physical features of the CMP-ERP and no diminution of benefits.

1.5.7 Guachinanga Islet

Located north of the CMP eastern end, the Guachinanga Islet is a small haystack hill that used to be surrounded by San José Lagoon waters, but debris and sedimentation closed the small channel that separated it from the Cantera Peninsula. Partly due to its isolation, the Guachinanga Islet is a nesting paradise for coastal birds and is home to a very unique biodiversity in the midst of the San Juan Metropolitan Area. The Cantera Company has organized several cleanup activities in the Guachinanga Islet and is currently working together with the SJBE Program in the restoration of the

small channel that separated it from the Cantera Peninsula. The Guachinanga channel restoration is not expected to impact or influence the CMP-ERP, but rather the latter is expected to have a net positive effect on the Guachinanga project goals.

1.5.8 Villas El Paraíso

The Israel-Bitumul community organized the first Community Housing Development Organization (CHDO) in Puerto Rico under U.S. Department of Housing and Urban Development regulations. As such, this CHDO developed the Villas El Paraíso project located in the community. With the support of the Municipality of San Juan, 108 families were relocated from the MTZ-CMP to Villas El Paraíso. The second phase of this project, which will provide housing for 120 families, is currently on the predevelopment stages. The CMP-ERP will benefit from completion of the second phase, as a relocation alternative for families living within the MTZ-CMP who which to remain in their communities.

1.5.9 Project Design Report for the Dredging of Caño Martín Peña (USACE 2001)

In 2001, the Planning Division of the USACE (Jacksonville District), under the Support for Others Program, prepared the *Project Design Report and Environmental Impact Statement for the Dredging of Caño Martín Peña* at the request of the DNER (USACE 2001). According to this report, various alternatives were evaluated on the basis of their construction method and cost, environmental impacts, real estate requirements, etc. All alternative plans proposed dredging the Project Channel following its current alignment, beginning at the San José Lagoon and extending for about 11,600 feet to end west of the Luis Muñoz Rivera Avenue Bridge.

USACE's 2001 Design Report also evaluated three alternatives for the disposal of CMP's dredged material, a recommendation of in-bay disposal within the largest artificial pits located at Los Corozos and San José Lagoons. In 2002, the USACE further evaluated the in-bay disposal alternative through the *Design of Contained Aquatic Disposal (CAD) Pits for Martín Peña Canal, San Juan, Puerto Rico* study developed by the U.S. Army Engineer Research and Development Center (ERDC).

1.5.10 Caño Martín Peña Comprehensive Development Plan

In 2001, the DTPW assumed the inter-agency leadership of the CMP dredging and established what became the Caño Martín Peña ENLACE Project (ENLACE Project) under the Puerto Rico Highway and Transportation Authority (PRHTA). On May 17, 2002, the PRPB designated the CMP Special Planning District (District) and delegated the elaboration of the District's Land Use and Comprehensive Development Plan (District's Plan) to the PRHTA. The District includes the following seven communities: (1) Barrio Obrero (West and San Ciprián); (2) Barrio Obrero-Marina; (3) Buena Vista-Santurce; (4) Parada 27, (5) Las Monjas; (6) Buena Vista-Hato Rey; and (7) Israel-Bitumul (see Figure 3).

As part of the planning process, the ENLACE Project held over 700 community participation activities between 2002 and 2004, including round table discussions, public assemblies, workshops, presentations, and educational activities at local schools. The CMP's dredging, channelization, and ecosystem restoration is only one of the principal elements of the District Plan strategies, which also integrate the design and implementation of a number of environmental, infrastructure, housing development, family relocation, urban revitalization, land tenure, and socioeconomic development strategies before, during, and after the channel's dredging and restoration phase.

The District's Plan focuses its vision, goals, and policies on four principal areas: (1) environment; (2) socioeconomic development; (3) institutional capacities; and (4) mobility, transportation, and tourism development. It included the following relevant critical components:

- The CMP-ERP with a recommended channel configuration alternative of a 150-foot width and a depth of 10 feet following the existing channel alignment, as a reference for the future establishment of the MTZ-CMP and for the relocation and infrastructure strategies.
- A mangrove conservation area within the MTZ-CMP along the proposed channel.
- Recreational access areas, proposed as formal interaction public spaces between the CMP and its users located within the conservation area. They are critical to avoid disturbance to the mangroves and as recreational components that will also provide the District with economic development opportunities.
- The Paseo del Caño, a proposed street along the MTZ-CMP as a public space that separates the eight communities from the CMP and its mangroves and prevents future encroachment. It also provides a bicycle lane and pedestrian amenities, as well as access to the recreational access areas.
- A relocation plan as required under the Uniform Relocation Act of Assistance and Real Property Acquisition Policies Act as amended, P.L.91-646; 42 U.S.C 4601 et seq. (URA).
- Construction of new housing units and rehabilitation of existing ones, primarily to provide relocation alternatives within the District.
- Construction of critical infrastructure and relocation of several infrastructure facilities, including 66-inch-diameter San José and Rexach sewer trunks, the 36-inch-diameter Borinquen water distribution line, and the 115-kV power transmission line.
- New streets to provide for public space that can be used to locate critical infrastructure, as needed to address the lack of sewer systems.

ENLACE is implementing the following CMP-ERP related initiatives.

- Acquisition of 96 structures to date within the MTZ-CMP, which includes the relocation of 62 eligible occupants, and demolition of structures. All acquisition and relocation efforts have been made in compliance with the URA, as required under PR Law PR 2004-489. Together with the efforts of the Cantera Company, the Israel-Bitumul CHDO, and the PRHTA, approximately 500 households have been relocated from the MTZ-CMP and adjacent areas and the remaining 297 structures located within the MTZ-CMP still need to

be acquired. No more than 5 percent of the total remaining relocations are expected to be mandatory, with the remaining relocations to be voluntary. Real estate acquisition in other areas of the District, and housing rehabilitation to serve as relocation opportunities within the District.

- One-on-one orientation to families living within the MTZ-CMP in the District.
- Design of improvements to the San José Trunk in the segment within the Israel-Bitumul communities. The project will be built by the Puerto Rico Aqueduct and Sewer Authority (PRASA).
- Development of the FR/EIS for the CMP-ERP.
- Design of the Israel-Bitumul segment of the Paseo del Caño, the street along the MTZ-CMP designed, in part, to prevent future encroachment of the CMP.
- Environmental awareness activities targeting mainly school children.
- A microbusiness incubator that provides support to recycling and ecotourism community owned businesses.

The following relevant initiatives are or have been implemented by other Commonwealth government agencies, most under the coordination of ENLACE.

- Relocation of the Barbosa Bridge over the CMP, elevating it to allow access for the barges, as part of the future CMP dredging (PRHTA).
- Two surface debris clean-up activities in areas adjacent to the CMP, which resulted in the removal of over 885 tons of debris and the recuperation of over 1,500 pounds of recyclable material.
- Construction of the Barrio Obrero Marina vacuum sewer system, north of the CMP. Evaluation of alternatives for the relocation of the San José and Rexach 66-inch-diameter sewer trunks and the Borinquen 36-inch-diameter potable water distribution line (PRASA).
- Conceptual design for a sewer system in northern Israel-Bitumul (PRASA).
- Delineation of the public domain lands associated to the MTZ-CMP within the District (DNER).

The activities and projects being implemented by ENLACE are vital to the success of the CMP-ERP. An immense public outreach campaign for such a project is necessary to inform and educate the public of the importance of a healthy ecosystem in the area, discouraging future secondary effects that could occur. Utility and other infrastructure improvements that have been conducted are also vital, and debris removal, sewer construction and other activities guarantee the effectiveness of the CMP-ERP. Additionally, the *Fideicomiso de la Tierra del Caño Martín Peña*, a community land trust, was created under PR Law 489-2004 to prevent gentrification as a result of the CMP-ERP.

1.5.11 Urban Waters Federal Partnership

On May 2013, USEPA designated the CMP as one of 18 sites nationwide that participate in the Urban Waters Federal Partnership (UWFP). This initiative seeks to revitalize urban waters and the communities that surround them, transforming overlooked assets into treasured centerpieces and drivers of urban revival. The USACE is one of 13 federal agencies that are part of the partnership, together with ENLACE and other local agencies and organizations. The CMP-ERP is key to the objectives of the UWFP around the CMP.

2.0 EXISTING CONDITIONS

2.1 HISTORIC CONDITIONS

2.1.1 Caño Martín Peña

For centuries, the SJBE has been affected by dredging, channelization, the mining and placement of fill material, and sedimentation (SJBEP 2000). The first known intervention in the CMP consisted of a "paso," or causeway. "Pasos" were typically made by piling rocks or stones at the bottom of a shallow waterbody, hardening the soft sediments found at the bottom, reducing its depth to facilitate its crossing, and while still allowing flow. In the area, various bridges have been built up to this date, including the historic Martín Peña Bridge at Ponce de León Avenue.

The construction of the tram and the train bridges over the CMP during the 1890s signaled the beginning of profound changes in the surrounding natural landscape of the SJBE. Many areas previously occupied by fresh water wetlands and marshes adjacent to the San José and Los Corozos lagoons, the Suárez Canal, and those lands south of La Torrecilla and the Piñones lagoons were converted to agricultural use. In Puerto Rico, mangroves were overexploited during the 1900s for firewood and charcoal. In 1918, Governor Arthur C. Yager proclaimed mangrove swamps as Insular Forests, and recognized that charcoal was an article of prime necessity. In 1927, the Puerto Rico Senate resolved that mangroves could be sold to raise funds for the completion of the Capitol Building, and they were erroneously associated with the propagation of the malaria mosquito. The sale was conditioned to the declaration of a public health problem by the Health Commissioner, and to the drainage and fill of the mangrove lands (Legislatura de Puerto Rico 1927).

In the late 1910s and early 1920s, the wetlands adjacent to the San Juan Bay and along CMP were used as disposal sites for the material that was dredged from the SJHP affecting or eliminating more than 80 percent of the original mangrove acreage found in this area of the SJBE. Most of the filled area adjacent to the San Juan Bay was then developed for the construction of port and storage facilities.

The western section of the CMP was dredged and straightened, further eliminating mangroves and replacing these with open-water areas. These works created two mangrove "islands" between the segments of the original and dredged channel (Sepúlveda 2003). Mangroves were basically confined to these islands, and to a fringe in the southern shores of this segment of the CMP, lands that at that time were under the U.S. military control.

During the 1920s, the government built 260 houses in Barrio Obrero, a workers neighborhood, thus starting encroachment towards the mangrove forests at the northeastern area of the CMP, delimited by what today is the Rexach Avenue (Sepúlveda 2003). The downfall of the sugar cane industry and Hurricanes San Felipe and San Ciprián, two of the worst in Puerto Rico's recent

history, destroyed agricultural production and left thousands of people homeless. Migrants fled rural communities for San Juan, and there, lacking the resources for anything else, informally settled the wetlands around the CMP. Residents made the swamps habitable first by building their homes on stilts, and afterwards, by depositing solid waste such as vegetative material, garbage, and debris into the swamp until it became firm enough to support the makeshift homes they built from salvaged wood and corrugated tin. By the end of the 1930s, the limestone hills or "mogotes" found at both shorelines of the CMP and east of the Barbosa Avenue Bridge began to be mined for the production of construction aggregates and as a source of material to fill the adjoining mangroves. By 1948, informal settlements replaced the mangrove swamps along the north shore of the CMP and on the eastern half of its southern shore. An aerial photograph of 1936 shows a 200- to 400-foot-wide natural channel in the 2.2 miles of the Eastern CMP (Project Channel), as well as the first settlements in the area (USACE 2004; Figure 6).

Most, if not all of the housing on former mangrove forests was built without basic utilities such as a sanitary sewer system, resulting in discharges of untreated sewage directly into the CMP, or indirectly, as in the case of older dwellings built on uplands, through the combined storm and sewer system that serviced the Santurce-Cangrejos area north of the CMP. These communities lacked proper access to other public services, such as garbage collection. Residents disposed of their refuse in the channel or used it as fill material to extend their properties (SJBEP 2000). Eventually, the Municipality of San Juan contributed to the process with fill material, and built a storm sewer system in the communities adjacent to the Project Channel.

In 2004, the eastern segment of the CMP was described as follows:

> "A 1962 aerial photograph of the eastern half of the CMP shows a reduced canal width, no more than 200 feet, with dense urban development all the way to the edge of both banks. A 2000 aerial photograph shows, in the remaining 2.2 miles of unimproved eastern segment of the channel a minimum canal width near the bridges, a very dense urban development all the way, and a completely filled up canal, which is impeding water flow between the San José Lagoon and the San Juan Bay.
>
> "Today, the canal's ability to convey flows has been almost completely blocked as a result of siltation, trash and debris accumulation, and structure encroachments along the eastern segment. Recent subsurface investigations in the canal and both banks along the eastern half of Caño Martín Peña found trash and debris down to 9 feet below the surface. As a result of the progressive clogging, there is very little tidal exchange between the San José Lagoon and the San Juan Bay and the water quality is very poor" (USACE 2004).

Figure 6. Historic and Existing Conditions within the Caño Martín Peña

The unsanitary and unsafe conditions suffered by the 26,000 inhabitants of the eight communities living near the Eastern CMP have prompted a concerted effort with the community to restore its ecological functions and values, starting in the early 1990s. After Hurricane Hugo, the Cantera Peninsula neighborhood organized itself, promoted the creation of the Cantera Peninsula Special Planning District and started implementing its Land Use Plan. The Israel-Bitumul neighborhood to the south organized the first community housing development organization that allowed them to receive funds from the US Department of Housing and Urban Development. In 2001, the eight communities adjacent to the CMP created the G-8, Inc., a grassroots nonprofit, while the ENLACE Project flourished as an alternative that brings together the community, the private sector and the government around the CMP-ERP, among other environmental justice and comprehensive development initiatives. The CMP Land Trust was created as an innovative land titling initiative, intimately related to the new regularization approach. Also under PR Law 489-2004, the DNER established the limits of the public domain lands associated to the MTZ-CMP within the District.

These initiatives have resulted in the relocation of 500 families that lived along the CMP shoreline, the construction of new sewer systems for the Barrio Obrero Marina and the Cantera Peninsula neighborhoods, the creation of recycling microbusinesses, an environmental awareness program, and several debris clean-up activities, among others. In 2007, a new bridge at Barbosa Avenue was built with much higher clearance over the CMP than the previous one to allow the navigation of barges and other machinery that will be used in the CMP-ERP. Actions continue today that are geared towards a fully restored and functioning CMP.

2.2 EXISTING CONDITIONS

The eastern segment of the CMP found within the Project Area has an approximate length of 2.2 miles, up to its outlet to the San José Lagoon. The widest open-water section of the CMP in the Project Area is approximately 131.2 feet wide just east of the Martín Peña Bridge. Its depth ranges from approximately 3.94 feet about 328 feet west of the Barbosa Avenue Bridge, to essentially 0 feet east of that bridge. Wherein that area, mangroves and other wetland vegetation, including aquatic weeds, have grown over sediments and solid waste used as fill material over the past decades (Webb, R. and F. Gómez-Gómez 1998), obstructing most water exchange between the channel and the San José Lagoon. Maximum elevations along the CMP's northern watershed are approximately 98 feet (30 meters) above mean sea level (MSL), and street slopes are approximately 4 percent. Elevations along the communities located south of the CMP are gentler, with maximum elevations of approximately 32 feet (10 meters) above MSL and street slopes averaging 1 percent. The San José Lagoon is divided, hydrologically, into two sections: Los Corozos Lagoon to the northwest and the San José Lagoon to the southeast. These have a combined surface area that ranges from approximately 1,129 acres (SJBEP 2000) to approximately 1,242 acres (Appendix A – NER Benefits Appendix). There is no direct connection between these lagoons and the ocean. The natural average depth of the San José and Los Corozos lagoons was 6 feet; it did not exceed 8.2 feet

(Ellis 1976); however, the lagoons were dredged for sand and fill mining, between the late-1950s and 1960s, altering about 17 percent of their combined bottom surface, and as a result, several depressions or dredge pits are found today.

The dredge pit at Los Corozos Lagoon is known to have an approximate depth of 17.5 feet. Two dredged areas can be distinguished in the San José Lagoon. The first depression extends from the outlet of the Suárez Canal, towards the northwest and parallel to the lagoon's shores, until halfway to the Teodoro Moscoso Bridge. This area consists of three dredge pits, with depths varying from approximately 15 to 28.4 feet, and named San José pits 3, 4, and 5. The second depression is found south of the Suárez Canal outlet, extending along the southeastern shore of the lagoon, next to the Quebrada San Antón creek's outlet. It consists of two dredge pits that approximately 28.4 to 32 feet deep. They are named San José pits 1 and 2.

The western segment of the Suárez Canal has an approximate length of 1.39 miles. Most of the canal has an average width of approximately 90 feet. The canal has a section, approximately 541 feet wide by 2,346 feet long, that was deepened and widened towards its northern bank during the 1960s for the development of a never completed yacht basin. The deepest site within this area of the Suárez Canal has an approximate depth of 30 feet (SJBEP 2000).

2.2.1 Abiotic Characteristics

Existing conditions are described for abiotic characteristics, biotic characteristics, and socio-economic conditions.

2.2.1.1 Climate

The National Weather Service's Luis Muñoz Marín International Airport automated weather station, collects data on rainfall and temperature that is representative to the Project Area's climatic conditions. It is located at an approximate elevation of 9 feet above MSL, at approximately 0.53 mile northeast of the San José Lagoon. Table 1 displays the average monthly conditions in the Project Area, including temperature, rainfall, humidity, and winds. Additional information on the Study Area climate can be found in Section 3.1 of the EIS and Section 4.1 in the Engineering Appendix.

Table 1. Study Area Climate

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average High Temp (°F)	83.2	83.7	84.9	86.2	87.5	88.9	88.7	89.2	89.2	88.4	85.9	83.9
Average Low Temp (°F)	72.0	72.0	72.9	74.4	76.3	77.7	78.1	78.2	77.8	76.9	72.2	73.4
Average Rainfall (in)	3.76	2.39	1.95	4.68	5.90	4.41	5.07	5.46	5.77	5.59	6.35	5.02
Average Humidity (%)	75	71.5	69	69	72	71	73	73.5	73	73.5	74.5	74.5
Average Wind Direction	E	ENE	ENE	ENE	ENE	ESE	E	E	E	ESE	E	ENE
Average Wind Speed (mph)	8.3	8.7	9.1	8.8	8.3	8.9	9.6	8.7	7.5	6.6	7.4	8

2.2.1.2 Geology

Puerto Rico's geology can be divided into two, broad formations belonging to rocks of volcanic or sedimentary origin. Those of sedimentary origin consist mostly of limestone, and are normally found underlying the northern coastal plains. The coastal plain of the San Juan Metropolitan Area shows a surficial geology dominated by lagoon and estuary environments, covered by fluvial and eolian deposits that have dictated the geomorphologic evolution of this region. The estuary areas are characterized by low-lying flat land that has evolved to its present conditions by erosion, deposition, compaction, and subsidence, all of which are still active. In the CMP, east of the José Celso Barbosa Bridge, limestone can be found at depths as shallow as 10.5 feet (Atkins 2011d). Additional information on the Study Area's geology can be found in Section 3.2 of the EIS.

2.2.1.3 Soils

Today, most of the soils of the Project Area have been severely altered, mainly composed of artificial fill consisting of sand, limestone and volcanic rock. In those areas once occupied by wetlands or open water where substandard housing has been established, such as the eastern section of the CMP, the western shores of Los Corozos Lagoon, and the southwestern shores of the San José Lagoon, the superior soil layers are composed of a combination of sediment and solid waste.

The sediments that characterize the first 10 feet of depth of the Project Channel are generally soft to very soft black organic mud, clays and silts with some lenses of sandy material. The sediments that characterize the first 40 feet on the channel banks show a large range of geotechnical conditions from soft to very soft black organic mud, clays, silts with some lenses of sandy material, consistent with the channel, then become stiff sandy clays and stiff silty clays, sandy gravels and clayey gravels. Silica sands and alluvium appear to be most unconsolidated deposits in this region of the CMP. Gravels, cobbles and boulders may be present east of the José Celso Barbosa Avenue Bridge

(Atkins 2011d). Most areas now covered by artificial fill are under laid by swamp deposits. Additional information on the Study Area's soils can be found in Section 3.3 of the EIS.

2.2.1.4 Solid Waste

Solid waste is any discarded material, abandoned, inherently waste-like, and not excluded by law such as domestic sewage. All waste classified as solid waste are regulated by the Resource Conservation and Recovery Act (RCRA) and in Puerto Rico is also regulated by the Puerto Rico Solid Waste Management Regulation. RCRA excluded waste are regulated by different laws. An example is domestic waste that is regulated under the Clean Water Act.

Materials within the Caño Martín Peña include various types of solid waste, debris, and other materials, which will require further testing prior to and/or during project construction, as appropriate, in accordance with an agreed sampling plan to determine whether any materials contain hazardous substances at levels that are not suitable for unregulated disposal.

These findings are supported by several previous studies and investigations, including:

- a 1997 Preliminary Site Characterization of the CMP that was prepared by Roy F. Weston, Inc. for the USACE;
- an Environmental Site Assessment report prepared by ECG, Inc. for the USACE in 1998,
- a Draft Phase 1 Environmental Site Assessment prepared by CMA Architects and Engineers, LLP. for the Puerto Rico Highway and Transportation Authority in 2002; and
- a 2011 Initial Assessment prepared by PBS&J for the CMP-ERP feasibility study.

Household waste is any material, garbage, trash, sanitary waste derived from single and multiple-family residences, hotels and motels, bunkhouses, ranger stations, crew quarters, campgrounds, picnic grounds, and day-use recreation areas. Bulky wastes such as household appliances, furniture, large auto parts, trees, branches and stumps are all considered household waste.

Construction and Demolition (C&D) materials consist of the debris generated during the construction, renovation, and demolition of buildings, roads, and bridges. C&D debris often contain larger, heavy materials, such as concrete, asphalt, wood, metals, glass, and salvaged building components. Disposal of C&D debris is only regulated to the extent that solid waste landfills must follow a few basic standards outlined at 40 CFR parts 257.

Hazardous Radioactive Toxic Waste (HTRW) is a solid waste with a listed hazardous substance, is listed as a hazardous waste, or presents characteristics of ignitability, corrosivity, reactivity, or toxicity and is not considered a household waste. Some wastes are excluded by law from being a hazardous waste. Household waste including Household Hazardous Wastes (HHW) are excluded from being classified as hazardous waste under 40 CFR 261.4(b)(1). HHW are leftover household products that may contain corrosive, toxic, ignitable, or reactive ingredients. Examples are paints,

cleaners, fluorescent light bulbs, oils, batteries, automotive products, and pesticides. Segregation of HHW from the municipal waste is encouraged but not required by law. HHW are classified as household waste independent of the chemical composition.

Dredged material, as defined by 40 CFR 323.2(d), is any material dredged from Waters of the U.S. and sediments proposed for management under Sections 404 of the Federal Water Pollution Control Act (33 United States Code [U.S.C.]1344) and 103 of the Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972 (33 U.S.C. 1413), and the dredged material would only qualify as HTRW if they are within the boundaries of a site designated by the USEPA, or a state, for a response action under CERCLA, or if they are a part of a National Priority List (NPL). Dredged material under Waters of the United States are also excluded from being classified as hazardous waste under 40 CFR 261.4(g). It is recognized that there may be disagreement as to the extent of the characterization of Waters of the United States as it applies to the CMP-ERP Project Channel at the time of this report development.

2.2.1.5 Hydrology

2.2.1.5.1 General characteristics

The SJBE receives direct fresh water inputs from several small streams, storm water pump stations, storm water runoff, drainage canals, and untreated sanitary sewage outfalls. Upland steep topography and the nearly complete urbanization of most of the SJBE drainage basin result in extremely flashy rainfall-runoff events (Webb and Gómez-Gómez 1998).

Tides in the Study Area are mixed semidiurnal with two highs and two lows of unequal height every day. The tidal range between the mean elevation of the lower of the two waters and the mean of the higher of the two high waters is 19.2 inches. The magnitude of daily tidal oscillations varies within the SJBE and is controlled primarily by the hydraulic characteristics of the channels and surface areas of each water body. Tidal oscillations in the San José Lagoon, for example, are limited to about 1.97 inches (Webb and Gómez-Gómez 1998).

Webb and Gómez-Gómez (1998) reported that it is common for river and storm-water discharges to dominate tidal flow patterns in the SJBE, especially in regions such as the CMP that have restricted connections to the open sea. Salt water reaches the Project Channel through its western section, which connects to the ocean by means of the San Juan Bay's Boca del Morro outlet. Ocean waters have access to the San José and Los Corozos lagoons, and the Suárez Canal, through the Boca de Cangrejos outlet by means of La Torrecilla Lagoon. There is a constricted section at the middle of the Suárez Canal, which is limited by the pilings of the Ramón Baldorioty de Castro Expressway (Road PR-26) Bridge. It takes, on average, about 16.9 days for the San José lagoon to renew its waters (Atkins 2011a).

The San José Lagoon receives fresh water discharges from the Juan Méndez Creek, in its southwestern end, and from the San Antón Creek, in its southeastern shore. Several small drainage canals, both unpaved and paved, discharge into the southern shores of the lagoon. A relatively large unpaved drainage canal coming from the Luis Muñoz Marín International Airport, flows into the northeastern corner of the lagoon. The estimated in-fill rate within the CMP's outlet at San José Lagoon is 6.7 feet per year (ft/yr). Discharges in the lower reaches of the Juan Méndez Creek are the primary contributor of sediments deposited within the channel's outlet. The sedimentation rate for the entire CMP was estimated to be 1.5 in per year, with illegal filling and dumping, as well as combined sewer discharges, identified as the primary sources for sedimentation in the entire CMP. Sedimentation rates within the CMP, are thus more than 50 times higher than in other parts of the SJBE (SJBEP 2000).

Main fresh water inputs to Los Corozos Lagoon come from two storm water pump stations that discharge into its northern shores. One, operated by the Municipality of Carolina, services the Villamar residential community. The second one, managed by the DNER, services a larger area, and receives combined sewer overflows from a section of the Ramón Baldorioty de Castro Expressway and neighboring sectors.

Groundwater discharges from the upper aquifer to the SJBE are limited to a segment of about 8.7 miles from the San Juan Bay to the San José Lagoon, and estimated at 43,162 cy/day (Webb and Gómez-Gómez 1998). Additional information on the Study Area hydrology can be found in Section 3.4 of the EIS and Sections 4.2 and 4.3 of the Engineering Appendix.

2.2.1.5.2 Domestic sewage discharges

Much of the developed lands adjoining the CMP do not have the necessary infrastructure to properly collect and convey sewage effluent to treatment facilities. In several communities in and around the Project Area, a sanitary sewer system is nonexistent. A 2002 study effort on potable water and sanitary sewer installations concluded that 1) the existing transmission and distribution potable water system, as well as the sanitary sewer system, had deteriorated; 2) both systems were neither adequate nor reliable; and 3) both systems were not in compliance with standards of the agencies having jurisdiction (ENLACE 2002).

Because the sanitary sewer system was combined with the storm water system, the hydraulic capacity of both was reduced. Storm events can overwhelm the sewer lines with limited capacities, resulting in the overflow of the combined effluent into the community and the CMP. Some sanitary sewer mains outfall untreated sewage effluent directly into the existing CMP channel. For example, the combined sewer/storm water trunk serving areas of Hato Rey and Río Piedras continues to discharge raw sewage adjacent to the Mercantil Plaza Building next to the Martín Peña Bridge. The eastern segment of the CMP is the Project Area's section that receives the most direct discharges of untreated sewage coming from the adjoining communities that lack a proper sanitary sewer

system, as well as overflow of combined sewers serving other urban areas during heavy rainfall. The Rexach storm water pump station, managed by the Municipality of San Juan, discharges west of the José Celso Barbosa Avenue Bridge.

The adjoining communities have ongoing and proposed projects to construct new sanitary sewers to collect and convey effluent to treatment facilities, and new storm sewers that will collect and treat storm water prior to its discharge it into the channel. As part of the Comprehensive Development Plan, relocations (e.g., the Rexach Sewer Line and the Borinquen Water Transmission Line) and the construction of these improvements (e.g. San José Sewer Line) would precede completion of the CMP and precede dredging operations. For example, the PRASA is working on a project to separate the combined sewer/storm water trunk serving the areas of Hato Rey and Río Piedras into sanitary and storm water sewers. In addition, the San José Sewer Line would be reinforced in-place and, with the planned repairs and improvements, would help mitigate sewage discharges that currently affect the Israel-Bitumul community. Another example of a sanitary sewer system project nearby the Project Area is the construction of the Barrio Obrero Marina vacuum sewer system, which is located to the north of the CMP in the adjacent Barrio Obrero Marina community. Relocations of the Rexach Sewer Line and the Borinquen Water Transmission Line are requisite for the construction of the CMP-ERP, and thus are considered an element of the CMP-ERP.

ENLACE continues to work with numerous government agencies, such as the USEPA and PRASA, and the Municipality of San Juan to facilitate the removal, reduction, and/or remediation of sewage discharges into the project and study areas. The elimination of sewage discharges into other parts of the SJBE would be part of a greater island-wide effort that PRASA is undertaking.

2.2.1.5.3 Flooding

Historically, low-lying areas along the CMP have been subject to frequent flooding from several sources. Sources of flooding include urban runoff from rain events over the CMP basin. Existing storm sewer inlets along Borinquen, A, and Rexach avenues are frequently clogged with sediment or garbage, and runoff that fails to enter these inlets continues south along the streets until it reaches CMP. Flood waters flow along the Juan Méndez Creek on the southeastern end of the CMP and a much attenuated storm surge through the San Juan Bay to the west of the CMP and/or the Suárez Canal into San José Lagoon to the east of the CMP.

Due to the CMP's lack of conveyance to manage storm water discharges, the communities bordering the CMP continually suffer flooding events. This situation becomes critical because of the significant amount of untreated sewage water that is also discharged to the CMP, causing the flood waters to be contaminated with extremely high bacterial concentrations, far exceeding established water quality standards.

According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) panel number 720000-0051D and 0054D, a significant portion of the CMP banks are located

within a flood prone area with 100-year base flood elevation of 6.56 feet above MSL. The 100-year floodplain extends up to 350 meters (1,148 feet) south and up to 550 meters (1,804 feet) north from the channel. These base flood levels are influenced by the storm surges at San José Lagoon and San Juan Bay.

An examination of the bathymetries conducted in San José lagoon during the past decade demonstrates that it has been losing depth. Its ability to convey storm water has decreased, and neighboring areas such as the Vistamar and Los Angeles communities in the Municipality of Carolina have experienced an increase in flooding. One of the main drainage channels of the Luis Muñoz Marín International Airport flows into the northeastern San José Lagoon.

Additional information regarding flooding in the Study Area can be found in Section 3.4.1 of the EIS and 4.2.6 of the Engineering Appendix.

2.2.1.6 Navigation

The CMP has been used since prehistoric times to provide an inland route to navigate the north coast of the island and for fishing and collection of crustaceans, wood, and other products. Historically, the CMP had an average width of at least 200 feet and a depth between 6 and 8 feet, and provided tidal exchange between San Juan Bay and San José Lagoon. Modifications of the channel and its wetlands that led to significant reduction of its section, significant loss of open waters and to a transition to a wetland ecosystem in areas closer to San José Lagoon, preclude navigation for all types of watercraft through the Eastern CMP. The western half of the CMP is navigable, and is used intermittently as a mass transportation waterway.

2.2.1.7 Air Quality

Hydrogen sulfide is a gas with a characteristic rotten egg smell. The gas is commonly found in volcano explosions, mangrove wetlands and other natural habitats. It is heavier than normal air so it remains within the atmosphere for longer periods of time and affects smaller stature populations such as children with more ease. The gas can remain in the atmosphere for about 18 hours (USEPA 2003). Recent air samples by the USEPA (2011) in areas near or on the CMP revealed concentrations of hydrogen sulfide between 0.002 parts per million (ppm) and 0.062 ppm. The reference concentration for chronic inhalation of the hydrogen sulfide, which is also the reference value used for chronic exposure among children, is 0.001 ppm (USEPA 2003). Chronic exposure is defined as contact with a substance over a long period of time (over a year). All of the samples in referenced places exceeded the minimum reference levels acceptable for inhalation of hydrogen sulfide in a chronic exposure situation. Chronic exposure potential effects include is difficulty breathing, particularly in vulnerable populations as asthmatics, other negative effects to the respiratory system, lethargy, lack of coordination, headaches, loss of short term memory and motor dysfunction due to an affected nervous system (ATSDR 2006). Additional information on air quality in the Study Area can be found in Section 3.6 of the EIS.

2.2.1.8 Water and Sediment Quality

The water quality of the SJBE has been significantly altered from its natural state not only by land-use activities, but also by the modification of its hydraulic properties through the dredging and filling of many of its water bodies. Water quality within both the Caño Martín Peña and San José Lagoon has been previously documented as being degraded (Kennedy et al. 1996, Webb and Gomez-Gomez 1998, San Juan Bay Estuary Program 2000, Puerto Rico Environmental Quality Board 2008) and data suggest that the Caño Martín Peña is a source of turbidity and bacteria to the waters of San José Lagoon; however, the Caño Martín Peña does not appear to be a source of nutrients for the San José Lagoon (Atkins 2011a).

Impacts to the water quality of the Caño Martín Peña and San José Lagoon include inflows from combined storm sewer overflows, inflows from areas lacking sanitary sewers, untreated industrial discharges, surface runoff and subsurface seepage over areas with household waste, and from direct dumping of household waste. While water quality concerns remain within both the Caño Martín Peña and San José Lagoon, there is ample evidence of substantial improvements in water quality within San José Lagoon in recent decades, due mostly to improvements in the collection and treatment of wastewater loads in the San Juan Bay region (Webb and Gomez-Gomez 1996 and 1998; Webb et al. 1998). In western San José Lagoon, in the part of the Lagoon closest to the Caño Martín Peña, phosphorus concentrations have decreased more than 50 percent since the late 1970s to early 1980s, and water clarity (as measured by Secchi disk depth) has doubled since the early 1980s (Atkins 2011a).

The recent trends of improved water quality in much of the San Juan Bay Estuary have been achieved only after the investment of substantial time and resources. Since the late 1980s alone, the USEPA has awarded in excess of $650 million to the Commonwealth via the Clean Water State Revolving Fund program (Caribbean Business Journal 2012). As a result of these and other coordinated actions, there is an obvious trend of improving water quality in the San José Lagoon, as outlined in the report "Technical Memorandum for Task 2.6 – Water and Sediment Quality Studies" (Atkins 2010b). Similar findings of improving water quality in the greater San Juan Bay estuary system have been previously reported by Webb and Gomez-Gomez (1996 and 1998) and by Webb et al. (1998). Webb and Gomez-Gomez (1998) concluded that "these records document the improved water quality that has resulted from implementing pollution control measures established in the 1970s."

The ongoing and reduced ecological integrity of the San José Lagoon, despite substantial reductions in pollutant loads, appears to be mostly due to salinity stratification and the development of hypoxic conditions (low levels of dissolved oxygen) in waters deeper than 4 to 6 feet (Atkins 2011b). Model results lead to the conclusion that restoration of the tidal exchange capacity of the Caño Martín Peña would increase salinity in the surface waters of the San José Lagoon, which would decrease salinity stratification and thus reduce the spatial extent and severity of hypoxic conditions

(Atkins 2011b). Although acceptable levels of dissolved oxygen exist in those portions of the San José Lagoon that are shallower than approximately 4 feet, hypoxic to anoxic conditions are encountered throughout approximately 700 acres of the Lagoon where the water depths are greater than 4 feet. One of the most severe water quality problem in the Caño Martín Peña is levels of dissolved oxygen. Also, Webb and Gomez-Gomez (1998) found ammonia concentrations up to 2.3 milligrams per liter (mg/L) (as nitrogen) and orthophosphate concentrations of 0.22 mg/L (as phosphorus) as well as anoxic conditions within the Caño Martín Peña water column. Also in the Caño Martín Peña, recent studies have documented from 2,000,000 to 6,000,000 fecal coliform bacteria colonies per 100 milliliters (ml) well above guidance criteria of 200 colonies per 100 ml (SJBEP 2012). Additionally, levels as high as 1,200,000 for Enterococci bacteria colonies per 100 ml, where the guidance criteria of 35 colonies per 100 ml (SJBEP 2012).

Detected levels of lead and mercury and lesser concentrations of polycyclic aromatic hydrocarbons (PAH), oil and grease, and residual pesticides were noted in CMP sediments (Webb and Gómez-Gómez 1998). Substantial quantities of Polychlorinated biphenyls (PCBs), PAHs, pesticides, Bis (2-ethylhexyl) phthalate (B2EHP), lead, and mercury were measured within the sediments of the CMP. Sediment cores from six sites in the SJBE and CMP (Webb and Gómez-Gómez 1998) representing time periods of 1925–1949, 1950–1974, 1975–1995, show increases in concentrations of:

- Lead from 30 to 745 micrograms per gram (µg/g)
- Mercury from 0.16 to 4.7 (µg/g)
- PCBs from 12 to 450 micrograms per kilogram (µg/kg)

In contrast to increasing trends for lead, mercury and PCBs, DDT and its derivatives decreased over time, from 46 µg/kg in sediments during the years 1950 to 1974 to 14.6 µg/kg in sediments dated to the years 1975 to 1990.

In 2002 and 2011, elutriate testing of the Eastern CMP sediments and sediment pore water confirmed the presence of heavy metals such as lead and mercury, PAHs, PCBs, oil and grease and residual pesticides (Atkins 2013). Table 2 documents average sediment chemical characteristics from the CMP (and Lagoon Pit sites for comparison), representing time periods from 2002 and 2011. Both the sediments and the sediment pore water of the CMP are characterized by elevated levels of various contaminants. Levels in excess of sediment quality guidelines, as defined in the National Oceanic and Atmospheric Administration (NOAA) Screening Quick Reference Tables, were found for anthracene, antimony, arsenic, copper, dieldrin, lead, mercury, selenium, silver and zinc, along with others (Buchanan 2008). The pore water within the sediments of the Eastern CMP also exceeded criteria for multiple parameters. Problematic results were found for chromium, copper, lead, mercury, nickel, and zinc. Complicating this issue, the surface waters of the CMP and the San José Lagoon already exceed relevant criteria for copper and mercury.

The effects of these contaminants on the health of exposed organisms could be of concern depending on the type and concentration of the pollutants and the degree of exposure; however, these contaminants are now less abundant in surface waters and surface sediments than in the past. Additional information on sediment quality in the Study Area can be found in Section 3.5 of the EIS.

Channel and lagoon sediment results from the 2011 monitoring event were compared to the toxicity characteristic values of hazardous waste under 40 CFR 261.24, the Universal Treatment Standards (Land Disposal Restrictions for hazardous waste) under 40 CFR 268.48, and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Regional Screening Levels for groundwater protection. This evaluation of existing analytical data provided a scientific basis for estimating approximate locations and concentrations of affected sediment areas within the CMP-ERP project area and disposal locations. Approximate toxicity characteristic leaching procedure (TCLP) values were calculated from the 2011 data using the approved method described in EPA Method 1311. When a waste is 100 percent solid as defined under the TCLP method, then the results of the total constituent analysis may be divided by twenty to convert the total results into a maximum leachable concentration. Dry weight samples were not reviewed during this initial screening, and since the Method 1311 calculation is performed on wet samples in this TM analysis, the determined TCLP values serve only as a rough estimate. Screening of the total metals concentrations via EPA Method 1311 suggested that lead may be the only total metal present in the canal sediments with a hazardous concentration.

Furthermore, hazardous debris, including household hazardous waste items and universal wastes that are extracted from the CMP-ERP during dredging activities, may not meet the exclusion criteria described above. Materials containing hazardous substances at levels that are not suitable for unregulated disposal will be managed in accordance with the applicable laws and regulations of the relevant regulatory agencies. More detail on the approach to handling of such contaminated material is included in Sections 6.2.2 and 7.2

2.2.1.9 Noise

The Study Area is found within a densely populated area that includes residential, recreational, commercial, and industrial elements. A heavy rail train and two 4-lane avenues divide the CMP in half. Two expressways cross over the western half of the CMP and the José Celso Barbosa Avenue over the eastern half. Vehicular traffic, commerce and industry all contribute to the background noise in the area. Additionally, aircraft approaching the Luis Muñoz Marín International Airport also represent an important source of noise. A noise study conducted within the District and the Cantera Peninsula in 2003 concluded that main sources of noise pollution came from these sources. The study estimated noise levels were of 60 decibels (dB) during daytime and 50 dB during nighttime. Speed and distance from source was the main influencing factor on the receiver. Additional information on the existing noise conditions can be found in section 3.7 of the EIS.

Table 2. Study Area Sediment Quality

	Sediment average concentrations (mg/kg)			Elutriate average concentrations (mg/L)*		PREQB Water Quality Standards (2010)	Dilution needed to meet PREQB (2010) criteria
Contaminant[1]	**CMP 2002[2]**	**CMP 2011**	**Lagoon Pits 2011**	**CMP 2002[2]**	**CMP 2011**		
TOC	9,300.000	35.800	7.108	4.50000	11.5980	NA	NA
Ammonia (NH_3) [3]	-	73.180	24.950	-	**9.79200**	5.00000	**2.0**
Antimony-Total	1.170	BDL	BDL	0.01200	0.00435	0.64000	NA
Aroclor 1260	-	0.020	ND	-	ND	NA	NA
Arsenic - Total	12.400	6.591	7.324	0.03100	BDL	0.03600	NA
Berylium	-	BDL	BDL	-	0.0002	NA	NA
Cadmium - Total	9.590	0.723	BDL	-	BDL	0.88500	NA
Chromium (Cr)	47.500	23.985	33.304	< 0.0010	0.00450	0.05035	NA
Chromium (Cr +3)	-	23.985	33.304	< 0.0010	BDL	NA	NA
Chromium (Cr +6)	-	BDL	BDL	-	BDL	0.05035	NA
Copper - Total	181.000	45.730	14.550	< 0.001	**0.06814**	0.00373	**18.3**
Cyanide - Total	-	0.452	BDL	-	**0.00188**	0.00100	**1.9**
Lead	281.000	67.960	3.074	0.00400	**0.01226**	0.00852	**1.4**
Mercury	2.440	0.550	0.120	< 0.00010	**0.00020**	0.00005	**3.9**
Nickel - Total	32.300	7.752	2.426	0.00500	**0.00930**	0.00828	**1.1**
Selenium	1.000	1.576	BDL	**0.10100**	BDL	0.07114	**1.4**
Silver - Total	3.400	1.481	0.866	< 0.002	BDL	0.00224	NA
TPH-DRO	-	456.000	ND	-	ND	NA	NA
TPH-GRO	-	0.000	0.025	-	0.21900	NA	NA
TPH-ORO	-	2,857.000	ND	-	ND	NA	NA
Zinc - Total	1,050.000	230.000	14.000	0.00000	0.00000	0.08562	NA
Thalium [4]	0.300	0.900	0.800	< 0.002	BDL	0.00047	NA
Sulfide [4]	696.000	573.000	-	< 1	-	0.00200	NA
Di-n-butyl phthalate	-	0.554	15.666	-	ND	4.50000	NA
Di(2-ethylhexyl) phthalate	-	ND	-	-	**0.03000**	0.02200	**1.4**
Total Solids (%)	-	52.000	62.000	-	-	NA	NA

BDL Below Detection Limit; ND Not Detected; - Data not available

[1] List of contaminants contains only those detected in the sediment composite and elutriate of 2011 sampling effort.

[2] Design of Contained Aquatic Disposal Pits for Martín Peña Canal, December 2002 report, Appendix B-Elutriate Testing.

[3] No ammonia criteria for the Class SB waters of CMP and San José Lagoon. However, ammonia is a component of Total Nitrogen (TN) and existing criteria for TN of 5 mg/l would apply

[4] Potential for lab minimum detection limit to be problematic

* **Bold Red** values indicate exceedance in the allowed maximum concentration established by the Puerto Rico Water Quality Standards Regulation (PRWQSR).

2.2.1.10 Hazardous, Toxic, and Radioactive Waste

Materials within the Caño Martín Peña include various types of solid waste, debris, and other materials. Such materials will require further testing prior to and/or during project construction, as appropriate, in accordance with an agreed sampling plan. If the testing determines that any materials contain hazardous substances at levels that are not suitable for unregulated disposal, they will be managed in accordance with the applicable laws and regulations of the relevant regulatory agencies. More detail on the approach to handling such contaminated materials is included in Sections 6.2.2 and 7.2, as well as Section 3.8 in the EIS.

2.2.2 Biotic Characteristics

2.2.2.1 Freshwater Aquatic, Wetland, and Terrestrial Plant Communities

The Project Channel, even though severely degraded, still harbors one of the most valuable ecological areas in Puerto Rico. Four major habitat types were identified within the CMP: swamps (forested wetlands/mangroves); marshes (emergent wetlands); open water; and transitional secondary forests (Figure 7). Based on the Cowardin classification (1979), the forested wetlands could be classified as estuarine and palustrine, and the emergent wetlands as palustrine (Figure 8). Additional information on freshwater aquatic, wetland, and terrestrial plant communities can be found in Section 3.9 of the EIS.

2.2.2.1.1 Estuarine Open Water

Open-water areas in the Project Area consist of the CMP, San José lagoon, and the San Juan Bay. Floating vegetation was present within some of the open-water areas, specifically in the areas where the CMP channel is clogged. The dominant species within these areas are *Eichhornia crassipes* (water hyacinth), *Lemna aequinoctialis* (duckweed), and *Pistia stratiotes* (water lettuce). The Cowardin classification (1979) for these areas is estuarine, sub tidal, unconsolidated bottom, and sub tidal (E1UBL). Within the Eastern CMP Project Area, there are 7.40 acres of estuarine open water.

2.2.2.1.2 Estuarine Forested Wetland

Estuarine forested wetlands within the Project Area are tidally influenced. These wetlands consist of a mangrove forest fringe along most areas of the CMP bank and a large area on the eastern end of the CMP, near the connection with the San José Lagoon. Mangroves also populate the banks of the western half of the CMP, in an area that was declared a natural reserve by the PRPB. The dominant species within the estuarine, forested wetlands are *Avicennia germinans* (black mangroves), *Laguncularia racemosa* (white mangroves) and *Rhizophora mangle* (red mangroves). Other abundant species include *Terminalia catappa* (tropical almond), *Cocos nucifera* (coconut palm) and *Thespesia populnea* (seaside mahoe). The Cowardin classification (1979) for these areas is estuarine, intertidal, forested, broad-leaved evergreen, and irregularly exposed (E2FO3M). Within the Eastern CMP Project Area, there are 15.53 acres of estuarine forested wetlands.

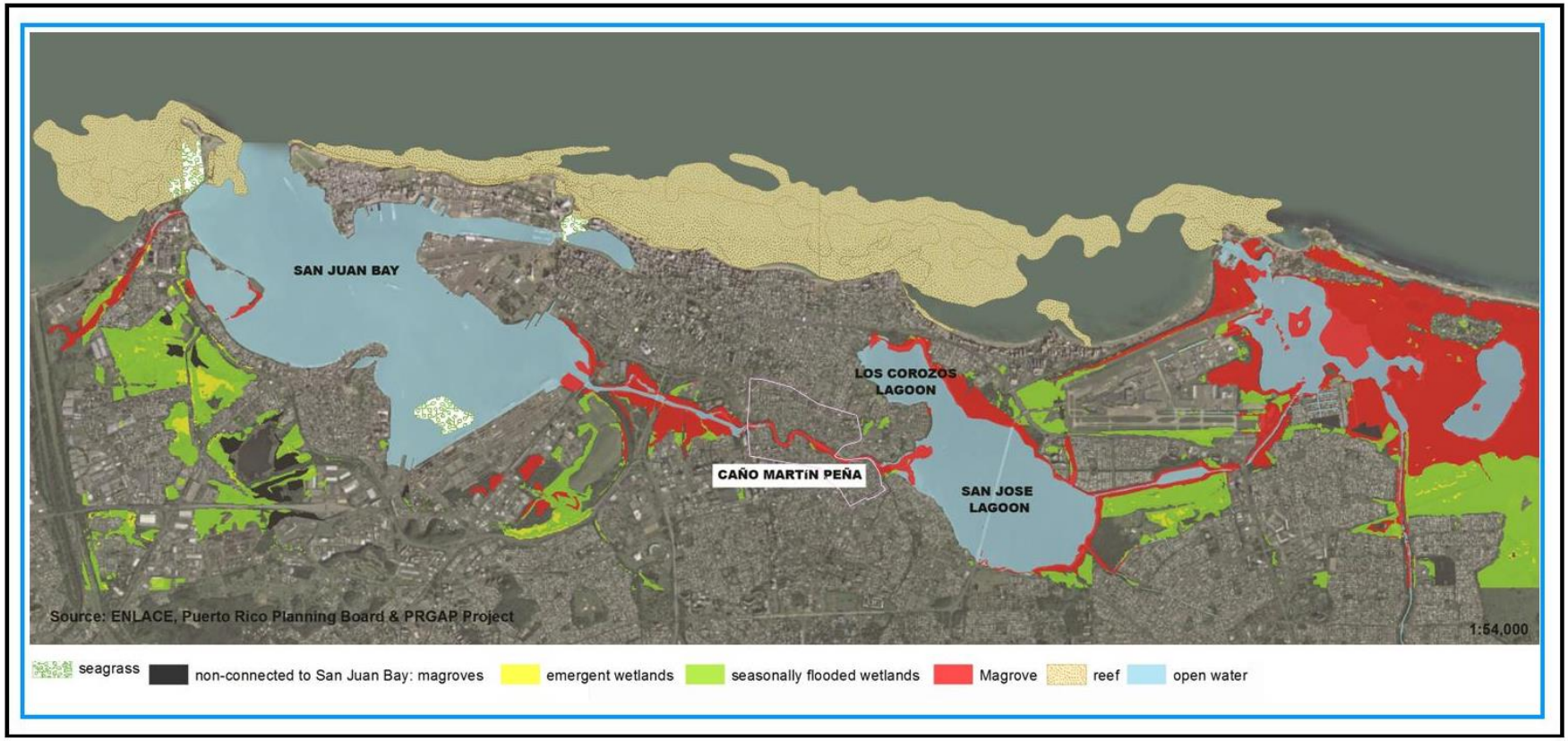
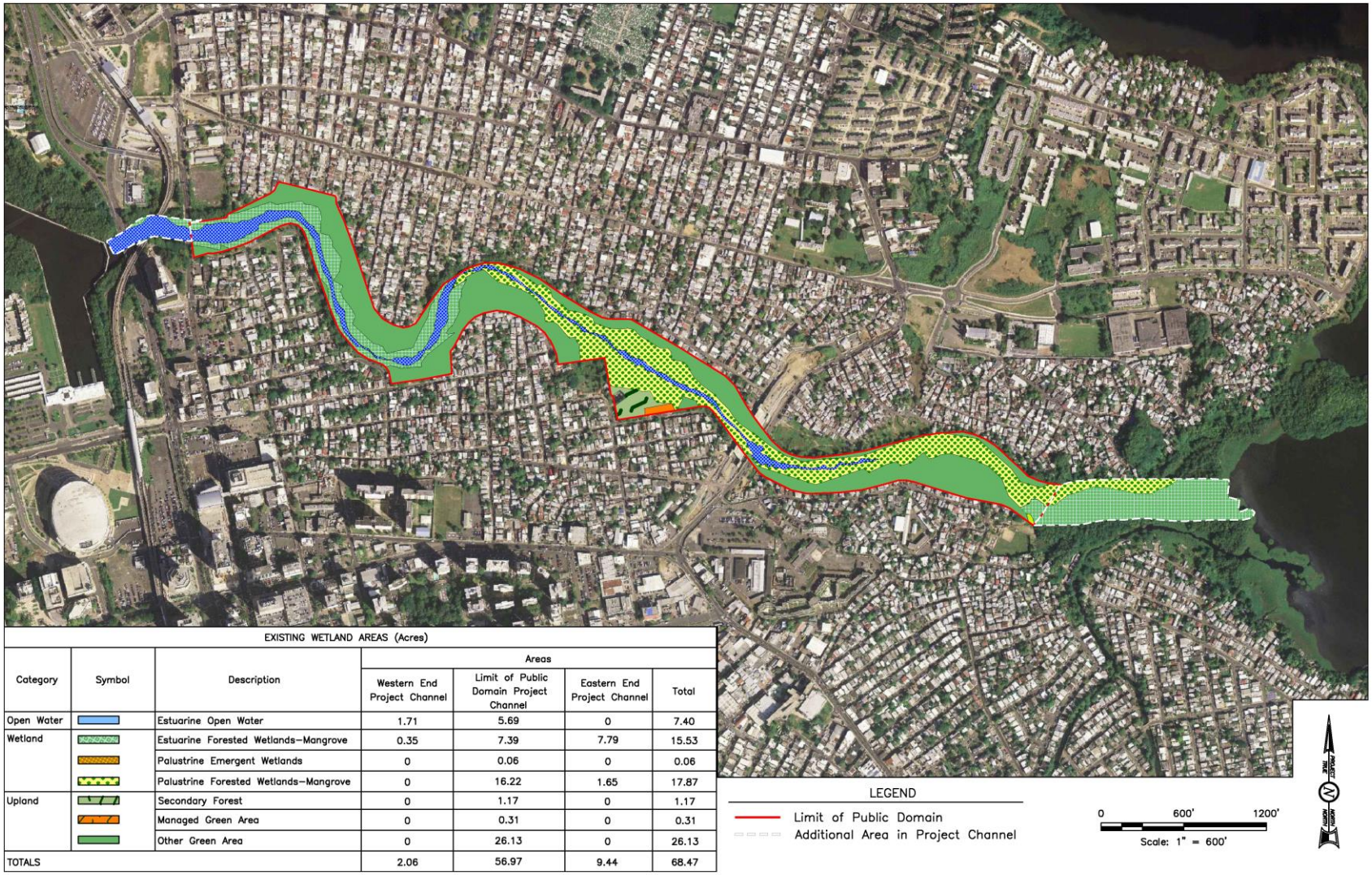


Figure 7. Freshwater Aquatic, Wetland, and Terrestrial Plant Communities in the CMP-ERP Study Area



EXISTING WETLAND AREAS (Acres)

Category	Symbol	Description	Areas			
			Western End Project Channel	Limit of Public Domain Project Channel	Eastern End Project Channel	Total
Open Water		Estuarine Open Water	1.71	5.69	0	7.40
Wetland		Estuarine Forested Wetlands–Mangrove	0.35	7.39	7.79	15.53
		Palustrine Emergent Wetlands	0	0.06	0	0.06
		Palustrine Forested Wetlands–Mangrove	0	16.22	1.65	17.87
Upland		Secondary Forest	0	1.17	0	1.17
		Managed Green Area	0	0.31	0	0.31
		Other Green Area	0	26.13	0	26.13
TOTALS			2.06	56.97	9.44	68.47

Figure 8. Existing Condition Wetland Analysis

2.2.2.1.3 Palustrine Forested/ Emergent Wetlands

Palustrine forested/emergent wetlands are tidally influenced and share the same vegetation composition as the estuarine forested wetlands, with some differences in their structure. While estuarine forested wetlands were dominated by *Avicennia germinans* (black mangrove), the palustrine forested/emergent wetlands had a relatively low abundance of this species. In addition, the abundance of emergent vegetation, mostly *Acrostichum aureum* (golden leatherfern), is substantial. The Cowardin classification (1979) for these areas is palustrine, forested, broad-leaved evergreen/emergent, persistent, seasonally flooded (PFO3/EM1C). The seasonal wetlands can be described as having surface water present for extended periods, especially early in the growing season, but absent by the end of the growing season in most years. The water table after flooding ceases is variable, extending from surface saturated to a water table well below the ground surface. Within the Eastern CMP Project Area, there are 17.87 acres of palustrine forested/emergent wetlands.

2.2.2.1.4 Palustrine Emergent Wetlands

Palustrine emergent wetlands are mostly dominated by *Colocasia esculenta* (malanga), *Brachiaria purpurascens* (para grass), *Commelina diffusa* (climbing dayflower), *Paspalum fasciculatum* (mexican crowngrass), and various *Ipomoea* spp. These areas are located mostly between the mangroves and the houses on the north bank of the CMP, specifically in its easternmost portion. The Cowardin classification (1979) for these areas is palustrine, emergent, persistent, seasonally flooded (PEM1C). Within the Eastern CMP Project Area, there are 0.06 acre of Palustrine emergent wetlands.

2.2.2.2 Invasive Species

As part of the habitat characterization study conducted in 2011, one hundred fifty-two species of vascular plants were identified among 61 plant families. Of the plant species, sixty-eight (44.74%) are introduced to Puerto Rico and 84 (55.26%) are native to the island. Invasives such as water hyacinth and duck weed can be found in parts of the SJBE, particularly in the CMP towards the San José Lagoon. Additional information on invasive species can be found in Sections 3.10.1.1 and 3.10.2.1 of the EIS.

2.2.2.3 Benthic Habitat

Benthic habitats are those that support plants and animals on or in the bottom of water bodies, also known as the benthos. Twenty-one distinct benthic habitat types are found in Puerto Rico, including: unconsolidated sediments, submerged vegetation, mangrove forests, coral reef and hard bottom (NOAA 2001). Differences in these habitats are dictated by the chemical and physical characteristics of the substrate and of the water column above.

The existing high sedimentation rates, presence of contaminants within the sediments, low dissolved oxygen levels, and salinity stratification within the CMP and/or the San José lagoon do not provide a healthy ecosystem for benthic organisms (e.g., infauna, meiofauna, epifauna) or organisms relying upon the estuarine water column (e.g., fish and invertebrates; Kennedy et al. 1996, Otero 2002, SJBEP 2000, Puerto Rico Environmental Quality Board [PREQB] 2008). Benthic habitats in and around the Project Channel area are highly degraded due to the contaminant loads and reduced tidal flushing present, which result in limited light penetration, poor water quality, and anoxic, highly organic sediments.

Soft bottoms in these shallow areas, the mangrove roots that line the lagoons, seawalls, rip-rap and other surfaces at these depths are covered with a thriving community dominated by mussels. Rivera (2005) estimated 66.7 acres of this mussel reef within the San José lagoon, which he hypothesized, is a "large source of food for the Lagoon" and provides a water filtering function "which must help maintain the water quality."

Species abundance and diversity (important indicators of healthy habitats) of the encrusting community of red mangrove prop roots is higher in the La Torrecilla Lagoon (closest to the Atlantic Ocean), becomes less diverse and less abundant within the San José Lagoon (farthest from the flushing source), and is non-existent or limited (severely limited flushing) within the CMP. This could be related to dissolved oxygen and salinity concentrations.

This macrofauna follows a general pattern of reduced diversity and abundance along a gradient from Torrecilla Lagoon to Suárez Canal, to the San José Lagoon to the CMP. In general, sponges, crabs, worms and mussels become less abundant to absent along a gradient from the eastern end of Suárez Canal, along San José Lagoon and into the CMP.

In summary, the results of the benthic habitat survey in the shallow portions of San José Lagoon indicate that diverse and healthy biological communities are restricted to the shallowest (less than 4 feet) regions, where salinity stratification does not occur, and where sufficient levels of dissolved oxygen exist. These are the conditions that support a healthy benthic habitat, that type that would support sustenance and recreational fishery in the Lagoons; however, at the minimal dissolved oxygen conditions found in 702 acres of waters deeper than 4 feet in San José lagoon, the presence of hydrogen sulfide in the sediments is a strong indicator that the water layer above the sediments is also hydrogen sulfide laden. Therefore, these areas of the bottom of the lagoons cannot sustain a benthic habitat. Additional information on benthic habitat can be found in Section 3.9.2 of the EIS.

2.2.2.4 Fish and Wildlife Resources

Some of the 124 species that have been documented in the SJBE system have been locally identified as important target species for recreational, charter, and commercial fisheries. The important target species of common snook (*Centropomus undecimalis*) and tarpon (*Megalops atlanticus*) are caught within San José Lagoon itself (Yoshiura and Lilyestrom 1999). The commercially important

offshore fishery for mutton snapper (*L. analis*) is dependent, in part, on the maintenance of a healthy inshore, lower-salinity mangrove habitat for post-larval and juvenile phases (Faunce et al. 2007). Out of the 124 species of fish documented within the SJBE system, fifteen of these are also found within the 84 managed species included in the Caribbean Fishery Management Council's Fisheries Management Program (FMP) (Yoshiura and Lilyestrom 1999).

Due to the current clogging of the Eastern CMP, there is essentially no tidal exchange between San Juan Bay and the San José Lagoon. As a result, fish within San Juan Bay cannot directly access the mangroves, seagrass meadows, and open-water habitats of San José Lagoon, Los Corozos Lagoon, the Suarez Canal, La Torrecilla Lagoon, and Piñones Lagoon, just as fish within those waterbodies cannot directly access the habitats afforded by San Juan Bay. Additional information on fish and wildlife resources can be found in Section 3.10 of the EIS.

2.2.2.5 Study Area Threatened and Endangered Species

There were no Commonwealth or federally listed terrestrial flora species found during the survey in the Project Channel within the Project Area. The Flora Gentry Transect Survey results were as follows: Within 616 flora individuals and 15 species identified among 11 families, thirteen are tree species and 2 are palm trees.

There are four federally listed plant species in the Study area: 2 threatened, *Schoepfia arenaria* and *Stahlia monosperma*; and 2 endangered, *Banara vanderbiltii* and beautiful goetza (*Goetzea elegans*).

There are 19 federally listed species of fauna in the Study Area:

Reptiles: Four federally listed reptiles have been documented in the Study Area, but none within the Project Area: 1 threatened, Green sea turtle (*Chelonia mydas*); and 3 endangered, Leatherback sea turtle (*Dermochelys coriacea)*, Hawksbill sea turtle (*Eretmochelys imbricata)* and the Puerto Rican boa *(Epicrates inornatus).* Indeed, of the four species of sea turtles known to inhabit Puerto Rican waters, three have been reported in the nearshore waters at the Study Area. Juvenile green and hawksbill turtles may be found off the northern shore of Puerto Rico, associated with rafts of *Sargassum.*

Mammals: One federally endangered marine mammal has been documented in the Study Area. The Antillean manatee (*Trichechus m. manatus*), could be found west of the Project Area, at the juncture between the western half of the CMP and the Puerto Nuevo River Channel.

Birds: Three listed species of bird are found in the Study Area. The federally threatened yellow-shouldered black bird (*Agelaius xanthomus*) has been documented in the Study Area mangroves; the closest to the Project Area has been at the western half of the CMP. Federally threatened species such as the roseate tern (*Sterna d. dougallii*) and the red knot

(*Calidris canutus)* were also sighted with other shorebirds on the mudflats that once existed in the western end of the CMP, at its outlet to the SJB.

Corals: Seven threatened coral species inhabit the nearshore marine waters in the Study Area. All identified in marine waters, north of the SBJE. Two belong to the *Acropora* genus: elkhorn coral (*A. palmata)* and the staghorn coral (*A. cervicornis)*; three to the *Orbicella* genus: Lobed star coral *(O. anularis),* Mountainous star coral (*O. faveolata)* and Knobby star coral (*O. franksi*), along with the rough cactus coral (*Mycetophyllia ferox) and the* Pillar coral *(Dendrogyra cylindrus*).

Critical habitat for *A. palmata* and *A. cervicornis* has been designated and include nearshore reefs within the Study Area, north of the SJBE, as well as other coastal areas around the Island with suitable requirements for these to thrive (e.g. heavy surf, clear-low nutrient ocean-water salinity conditions). As a result, none of these species are found in the CMP or the San José Lagoon.

The Puerto Rico Regulation 6766 for the Threatened and Endangered Species of the Common-wealth of Puerto Rico (created under the Puerto Rico Wildlife Law, Law No. 241 of August 15, 1999) also identifies other 19 species of special concern in the Study Area, in addition to those that have been federally listed: two species of seahorses *Hippocampus erectus (*lined seahorse) and *Hippocamus reidi (*longsnout seahorse); 12 species of birds: one species is listed as endangered, Masked duck (*Nomonix dominica*); 3 are listed as threatened, Ruddy duck (*Oxyura jamaicensis*), White-cheeked pintail (*Anas bahamensis*) and Caribbean coot (*Fulica caribaea*); 3 are listed as critically endangered, West Indian whistling duck (*Dendrocygna arborea*); the Snowy plover (*Charadrius alexandrinus)*, and the Peregrine falcon (*Falco peregrinus*); 1 is listed as low risk, the Puerto Rican vireo (*Vireo latimeri*); and 4 species are listed as data deficient due to lack of data on its population status: Grasshopper sparrow (*Ammondramus savanarum*), Black cowled oriole (*Icterus dominicensis*), Least tern (*Sterna a. antillarum*) and White-crowned pigeon (*Patagioenas leucocephala*).

Other data deficient species is the reptile, Puerto Rican slider (*Trachemys s. stejnegeri*) that can be found in the Study and Project areas. Likewise, two species of crustaceans are listed as data deficient, the Fiddler crab (*Uca sp.)* and the Mangrove tree crab (*Aratus pisonii*). Three other species of crab are listed as low risk: the Mangrove root crab (*Goniopsis cruentata*), the Common land crab (*Cardisoma guanhumi*) and the Swamp ghost crab (*Ucides cordatus*).

2.2.2.6 Essential Fish Habitat

Four types of Essential Fish Habitat (EFH) have been identified within the Study Area: mangrove wetland EFH (2,240 acres), sea grass EFH (11 acres), reef and hard bottom community EFH (3,564 acres), and estuarine water column EFH (5,759 acres). Of these four, only two exist within the Project Area: mangrove wetland EFH and estuarine water column EFH. The existing mangrove habitat within the Project Channel and along the shoreline of the San José lagoon is degraded as a

consequence of extensive human encroachment, the massive amount of fill material, scrap and trash deposited within the mangroves, the severely degraded water quality from wastewater discharges, and the limited tidal flushing. Likewise, the estuarine water column is impaired by the existing high sedimentation rates, presence of contaminants within the sediments, low dissolved oxygen levels, and salinity fluctuations. Additional information on essential fish habitat can be found in Section 3.9 of the EIS.

2.2.3 Socioeconomic Conditions

Historically, neighborhoods along the CMP have a disproportionate adverse economic and environmental burden compared with the surrounding area of the municipality of San Juan and with Puerto Rico. The precarious economic situation of these disadvantaged communities has exacerbated the degradation of the surrounding environment. These circumstances have continued for decades, subjecting residents to conditions that adversely affect their health, safety and their quality of life. Despite these challenges, the CMP communities have a strong sense of belonging and social cohesiveness. Additional information on socioeconomic conditions can be found in Section 3.13 of the EIS.

2.2.3.1 Infrastructure

The present infrastructure along the Project Channel consist of three main avenues with bridge crossings, a pedestrian bridge, limited paved local access streets, water lines on bridge crossings, very limited storm and sanitary sewers, one trunk sewers and one water transmission line with cannel under-crossings, storm water system pumps, telephone and power supply network, limited cable TV, and limited recreation facilities. Recent additions to the existing infrastructure in the surrounding areas, including: the relocation of the José Celso Barbosa Avenue Bridge that makes feasible the access of dredging barges to a significant portion of the Project Area, Tren Urbano Sagrado Corazón station and its bridge crossing over the CMP, new vacuum sewer systems serving Barrio Obrero Marina and the Cantera Peninsula, new housing in the Cantera Peninsula and Israel-Bitumul, the José Miguel Agrelot Puerto Rico Arena, new recreational parks, community gardens, and associated facilities. The PRASA also deviated the continuous raw sewage discharge adjacent to the Mercantil Plaza Building next to the Martín Peña Bridge, related to a combined sewer trunk serving areas of Hato Rey and Río Piedras. PRASA is working on a project to separate this trunk into sanitary and storm water sewers, but in the meantime, overflow continues to occur. There are many ongoing studies and other efforts for improving and/or providing new storm and sanitary sewers to areas with deficient or non-existent sewers.

A segment of the San José Trunk Sewer runs from east to west adjacent to the Project Area. It is one of the principal San Juan area trunk sewers. This trunk sewer conveys wastewater from Trujillo Alto, Santurce, Barrio Obrero, Isla Verde, and Hato Rey to the Puerto Nuevo Wastewater Treatment

Plant. While improvements to the San José Trunk Sewer are not a part of the CMP-ERP, it is located within the Study Area.

The Rexach Trunk Sewer is one of the main San Juan area trunk sewers, is located within the Project Area, and conveys wastewater from areas that include Isla Verde, Santurce, and Barrio Obrero to the San José Trunk Sewer. The Rexach Trunk Sewer flows from north to south along Street 13 of the Barrio Obrero-Marina community, crosses the CMP, and continues along the Luna Street of the Parada 27 community until it connects to the San José Trunk Sewer. The Rexach Trunk Sewer has a diameter of 48 inches when it crosses the CMP and is encased in concrete. The crown of the trunk sewer in the CMP is at an elevation of 7.5 feet below MSL. The design and relocation of the Rexach Trunk Sewer is ongoing and will be completed prior to the dredge of the CMP.

The Borinquen Water Transmission Line is a 36-inch diameter pipe that travels from south to north along the Uruguay and Gardel Streets of the Parada 27 community, crosses the CMP, and continues on Argentina Street of the Barrio Obrero-Marina community. This transmission line has only 3 feet of cover where it crosses the CMP. Additional information on infrastructure in the Project Area can be found in Section 3.12 of the EIS and Sections 5.14 in the Engineering Appendix. The design and relocation of the Borinquen Water Transmission Line is ongoing and will be completed prior to the dredge of the CMP.

A 115-kV overhead transmission line ran from a substation near the Tren Urbano guiderail on the western end of the CMP-ERP, east via Rexach Avenue, and then south to the channel and San José Lagoon. The 115-kV overhead transmission line has been relocated as a component of the CMP-ERP.

2.2.3.2 Recreation

Recreation in the Project Channel is impaired and unsafe compared to the CMP channel to the west of the bridges (the Western CMP). There are no areas where residents may access the canal for fishing, bird watching, or other recreation activities except at the three bridges which cross the canal. Navigation is impaired in the Project Channel as water depths are shallow and the easternmost section is completely filled in with sediment and solid waste. There is an existing basketball and volleyball court within the Public Domain Limit. The Las Piedritas staging area (outside of the MTZ) is occasionally used for recreation activities. Additional information on recreation resources can be found in Section 3.16 in the EIS.

2.2.3.3 Cultural Resources

At present, no previously recorded sub-aquatic prehistoric cultural resources have been identified in the area, and there is no historic evidence of smaller marine vessels encountered in the CMP; however, the investigations conducted in the area have been limited due to restricted access and solid waste in the Project Channel. Based on initial consultations with the State Historic

Preservation Office (SHPO), the possibility of encountering submerged cultural remains within the CMP and Project Area still exists, and is considered to be high. It concluded that the accumulation of household and construction debris deposited within the Eastern CMP since early in the twentieth century could be considered an archeological site. There is also a probability of encountering cultural remains from the old bridges constructed in the area, as well as the remains of fishing corrals from the early twentieth century.

The Martín Peña Bridge is a historic structure because of its architectural value, and its location is an historic site, as several bridges that constituted the main crossing between Hato Rey and Santurce towards Old San Juan have been built in the area since the 1500s. This location is also the site of one of the key battles that led to the defeat of the British invasion of San Juan in 1797, led by Admiral Ralph Abercrombie. Community efforts to preserve the bridge led to Law 110 for the Declaration of the CMP Bridge as a Historic Monument, which was signed on August 15, 2007. The bridge is also listed in the National Register of Historic Places. Additional information on cultural resources can be found in Section 3.15 of the EIS.

2.2.3.4 Socioeconomics and Environmental Justice

The Eastern CMP is mostly lined by a very narrow fringe of mangrove-dominated forest, which is completely encroached by high-density urban development, consisting in many instances of substandard residential units. From west to east, those communities found along this entire section of the CMP include, in its northern bank, Barrio Obrero Marina, Barrio Obrero Oeste and San Ciprián, and Cantera Peninsula. Parada 27, Las Monjas, Buena Vista Hato Rey, and Israel-Bitumul are found in the southern bank (Figure 3). The following information summarizes the socio-economic characteristics of these communities:

- Approximately 23,420 inhabitants (Census 2010), representing about 6 percent of San Juan's population.
- Population density (8,775 people/km^2) is very high — more than twice that of San Juan's (3,417) and significantly higher than Puerto Rico's (419). Communities with the highest population density are Barrio Obrero Oeste (11,244) and Buena Vista-Santurce (10,264).
- Median household income for the communities adjacent to Eastern CMP is $12,268, considerably lower than Puerto Rico's ($18,791).
- Most households (59%) fall below the poverty level, being Cantera Península the community with the highest proportion of the population below poverty level (72%). These values are greater that the percentage for the Municipality of San Juan (37%).
- Only 6 percent of the residents of these communities have obtained a college degree, a proportion lower than Puerto Rico's (20%). The community with the largest proportion of residents with a college degree is Parada 27/Las Monjas with 10 percent, followed by Buena Vista Santurce with 8 percent.

- Housing occupancy rate in the communities adjacent to the Eastern CMP is 84.8%, slightly larger than Puerto Rico's (84.2%). Nonetheless, in Barrio Obrero Oeste, Buena Vista Santurce, and Buena Vista Hato Rey the occupancy rate is a little lower than Puerto Rico's.

Additional information on socioeconomics can be found in Section 3.13 of the EIS.

2.2.3.5 Human Health and Safety

2.2.3.5.1 Exposure to Contaminated Waters

The CMP's environmental degradation has impacted the adjacent communities' public health. As the Project Channel has significantly decreased its capacity to convey water, a regular rain event will cause flooding in nearby residences. In addition to the frequent floods due to the CMPs decreased capacity, the communities bordering the CMP have significant infrastructure problems such as poor quality housing, lack of a sanitary sewer system, decreased or inefficient trash collection services due to poor access, among others (PRHTA 2004). Sanitary discharges flow directly into the already compromised CMP with about 40 percent of the structures neighboring the CMP completely lacking a sanitary sewer (PRHTA 2004).

Recent surface water samples by the USEPA and the SJBE Program have revealed fecal coliform counts ranging from 2,100 colonies per 100 ml of water to 2,000,000 colonies per 100 ml of water. These concentrations indicate that CMP waters have from 10 to 10,000 times the permitted standard for indirect contact with water according to the PREQB. The maximum standard permitted by the PREQB for indirect contact is 200 fecal coliforms (PREQB 2010). Fecal coliforms in the water may signify the potential presence and risk of contracting diseases transmitted through warm bodied animal waste. Levels of *Enterococci* bacteria have been reported at 11,000 colonies per 100 ml of water and up to 1,200,000 colonies per 100 ml of water. The maximum permitted standard for *Enterococci* bacteria for indirect water contact is 35 colonies per 100 ml of water. Colony levels surpass the permitted standard over 35,000 times. These findings reveal the presence of microbes indicative of human contagious diseases. *Enterococci* are more precise indicators of pollution of human waste origin. The levels of *Enterococci* bacteria are the most worrisome pollution parameter with regard to its public health risks. Finding these significant levels of colonies confirms the presence of direct human waste pollution. Residents have already expressed concern about exposure to contaminated waters and the polluted waters potential mixing with the potable water lines at each flood event, (PRHTA 2004). The community census carried out by the ENLACE Project in 2002, which interviewed all community households, revealed that nearly 40 percent of residents that answered replied that their residence or nearby areas flooded between 1 and 20 times during the previous year (PRHTA 2003).

In 2011, the Ponce School of Medicine and Health Sciences carried out an investigation to measure the level of gastrointestinal symptoms within the populations of CMP-adjacent communities and establish if there was a correlation between documented symptoms and flood events in the past

three months. The conclusion, with a statistically significant population sample, showed that residents within the CMP adjacent communities had a higher prevalence of gastroenteritis symptoms (31 percent in the CMP communities, as opposed to 22 percent within the rest of the island population) and that residents exposed to flood waters (whether it entered their home or just reached the street) were twice as likely to develop gastrointestinal symptoms than residents not exposed to flood waters. Stagnant waters, such as the ones in the CMP, with such high bacteria levels may indicate the presence of other bacteria. Other risks to which community residents are exposed include the Hepatitis A virus, the bacteria *Vibrio colerae*, and shigella, a close relative of salmonella.

There is very limited human consumption of fish from the CMP and from the flood waters, as well as consumption of fish and crustaceans in the San José lagoon. Also, there is consumption of crops exposed to flood waters.

2.2.3.5.2 Exposure to Environmental Degradation

In addition to the decreased conveyance capacity offered by the CMP, the CMPs environmental degradation is exemplified by the clogging up of the waterway due to waste from the surrounding areas and area contractors that dispose of construction debris within the CMP. As such, the environmental degradation of the Project Channel is exacerbated by the amount of trash deposited within the area including paper, plastics, tires, junk cars, domestic appliances, construction debris among others (PRHTA 2004). Inadequate trash disposal promotes environments that increase proliferation of rats, insects, flies and other animals that transmit disease. Among the many diseases that could be transmitted are Leptospirosis and dengue fever. Concentration of trash in particular areas also becomes a source of dust and leaching from the trash becomes another potential source of pollution for adjacent waters.

Children under five years old living within the CMP adjacent communities have double the prevalence of asthma than that reported for the island of Puerto Rico (44.5 percent for CMP children over 21.5 percent for Puerto Rico), and there is a clear trend of a higher number of cases as distance from the residence to the CMP decreases (Departamento de Bioestadística y Epidemiología 2012). Additional information on health and safety conditions can be found in Section 3.14 of the EIS.

2.2.3.6 Aesthetics

Only the western half of the CMP is used extensively for bird watching, cycling, and other recreational activities and has high aesthetical value. The eastern half of the CMP is not well defined and views into the CMP are obstructed due to encroachment. Limited access to the eastern half of the CMP has fostered its use for illegal dumping, which coupled with decades of filling with various vegetative material and solid waste, has negatively affected the view to the CMP. Additional information on aesthetics can be found in Section 3.17 of the EIS.

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3.0 FUTURE WITHOUT-PROJECT CONDITIONS

3.1 "WITH AND WITHOUT" COMPARISONS

The U.S. Water Resources Council's Principles and Guidelines provide the instructions and rules for federal water resources planning (USWRC 1983). One Principles and Guidelines requirement is to evaluate the effects of alternative plans based on a comparison of the most likely future conditions with and without those plans in place. In order to make this kind of comparison, descriptions must be developed for two different future conditions: the future without-project condition and the future with-project condition.

The future without-project condition describes what is assumed to be in place if a study's alternative plans are not implemented. The without-project condition is the same as the alternative of "no action."

Future with-project conditions describe what is expected to occur as a result of implementing each alternative plan being considered in a study. With-project conditions are developed for each alternative plan; therefore, there are as many with-project conditions as there are alternative plans. The differences between the without-project condition and the with-project condition are the effects or impacts of the plan.

3.2 "WITH AND WITHOUT" VERSUS "BEFORE AND AFTER" COMPARISONS

Many people typically think about the effects of alternative plans in terms of "before and after"; that is, they compare the condition that exists now or before it is changed by a plan, to the condition they expect will exist in the future after it has been changed by a plan. For example, if a proposed channel dredging project were to disturb four acres of an existing ten-acre wildlife habitat, then using a before-and-after comparison, the project could be said to result in a loss of four acres of that habitat.

Another way to think about effects is to compare expected future conditions if no alternative plan is implemented (the without-project condition), to expected future conditions if a particular plan is implemented (the with-project condition). Returning to the example, assume that the ten-acre wildlife habitat is already included in a residential development plan that would convert three of its acres to residential sites. Now suppose the proposed dredged channel would cover four acres of the ten-acre site, including the same three acres that would be converted to residential sites. Using a with and without comparison, the channel would be said to result in a loss of only one acre since three of the four acres would be affected even if the channel were never constructed. With-and-without comparisons recognize that the future is often different from the existing condition; and unlike before-and-after comparisons, account for future changes in the comparison.

3.3 PLANNING HORIZON

The period of analysis for the study is of 50 years, from calendar year 2020 through calendar year 2070. Although most project objectives will be reached within the first 3 to 15 years, construction costs and maintenance costs presented in this report are based on a project life of 50 years.

3.4 FORECASTED WITHOUT-PROJECT CONDITIONS

Federal improvements to the CMP would not be conducted. Under the future without-project condition, the non-Federal sponsor, ENLACE, and its partners would still conduct planned improvements to the area surrounding the CMP. These efforts would include:

- the Cantera Peninsula Project (Section 1.5.6 of this report);
- the partial construction of the Paseo del Caño with important limitations regarding storm sewer management (ENLACE CMP Project; Section 1.5.10 of this report);
- improvements to the San José Trunk Sewer Line;
- relocation of all residents that would be affected by construction of the Paseo del Caño (outside of the CMP Public Domain limit);
- housing acquisition and rehabilitation in eight CMP neighborhoods outside of the MTZ-CMP to improve the stock of standard housing units; and
- sewer system upgrades in the eight CMP neighborhoods to eliminate discharge of untreated sewage into the CMP.

Although these efforts could improve socioeconomic conditions for the residents in the area, these efforts would not provide any ecological restoration of the CMP. The actions listed above would not serve to alleviate the current problems that are occurring in the estuary such as fragmentation, poor dissolved oxygen levels, increased sedimentation, etc. In fact, many future projects by the non-Federal sponsor, ENLACE, to further improve socio-economic conditions are contingent on restoring tidal flow and environmental conditions within the CMP.

3.4.1 Future Abiotic Characteristics

San José lagoon is expected to continue to lose depth. The CMP would continue to fill in due to channel sedimentation and illegal dumping, leading to a further decrease in open-water area. Water quality in the CMP and the western San José lagoon would continue to degrade due to continued isolation from significant tidal influences. Estuarine open waters would continue to be persistently hypoxic or anoxic below 4 to 6 feet depth in San José lagoon, precluding the establishment of submerged aquatic vegetation and healthy benthic communities. Salinity stratification within the lagoon would likely continue to degrade with fish kills becoming more prevalent.

Flooding of residential and commercial structures in the Project Area would become more frequent with the continued loss of outlet capacity in the CMP. While certain contaminant concentrations

may decrease in the greater SJBE, bacterial counts would remain high in the CMP, and contaminants from untreated runoff will remain consistent with today's unhealthy levels. Air quality would continue to be a problem due to elevated levels of hydrogen sulfide (H_2S), particularly in areas adjacent to the waters of the Project Channel. Table 4 summarizes the future without-project abiotic conditions.

3.4.1.1 Sea Level Change

The effect of sea level change (SLC) on the CMP project provides information guided by the U.S. Army Corps of Engineers recommending that sea level change be calculated and reported as a low, intermediate, and high rate for consideration of project impacts. The following analysis is made consistent with Engineer Regulation (ER) 1100-2-8162 "Incorporating Sea-Level Change Considerations in Civil Works Programs," released in December 2013.

The "low" sea level change rate is defined as the historic rate of relative sea level change at the local tide station. NOAA has evaluated sea level change trends for each tide station (NOAA 2008) and provides the data for the mean sea level trend at the San Juan tide gauge, station 9755371. The mean sea level trend has been calculated by NOAA to be 0.00541 feet/year.

The "intermediate" sea level change rate is defined as the rate of local mean sea level change using the modified Natural Research Council (NRC) Curve I. The "high" sea level change rate is defined as the rate of local mean sea level change using the modified Natural Research Council (NRC) Curve III. Both the "intermediate" and "high" rates include a consideration for the future acceleration of sea level change that is not considered when evaluating the historical ("low") rate of relative sea level change.

Assuming a project life of 50 years, with construction beginning in 2018 and completing in 2020, sea level change was calculated. Using the updates to the NRC Equations and extending the calculation 50-years from a construction completion date of 2020, Table 3 provides the summary of all estimated sea level change rates. As further reference, the Puerto Rico Climate Change Council (PRCCC 2013) recommends planning for a rise of 0.5–1.0 meter (1.64–3.28 feet) by 2100.

Table 3
Summary of Sea Level Change Estimates
(U.S. Army Corps of Engineers 2013)

SLC Estimate		
(feet)	Method	Estimate
0.36	Tide Gauge Trend	Low
0.76	NRC Curve I	Intermediate
2.03	NRC Curve III	High

Table 4. Summary of Future Without-Project Abiotic Conditions

Resource	Future Without-Project Condition
Climate Change and Sea Level Change	The filled condition of the CMP translates to greater impacts of storm surge, more frequent and severe storms, and sea level change in the Project Area, i.e. more flooding and land loss, and erosion. Continued trends in increased greenhouse gas (GHG) emissions.
Geology	There would be continued accumulation of debris and sediments over the historic channel bottom and adverse impacts to the physical geological features that affect water conveyance and runoff in the Study Area, including reduced depth and width of channel. No significant adverse impacts to underlying geology are anticipated.
Soils	Soils would remain significantly altered by urbanization and human settlement. In areas converted for human habitation, soils include debris, rip rap, rubble, household waste, vegetation, discarded furniture, abandoned cars, and other waste. Debris would remain >10% of the soil.
Hydrology	Channel depth and width would continue to be reduced with continued debris and sediment accumulation from watershed. Continued disruption of historic hydrologic connection between San José Lagoon and San Juan Bay. Constricted CMP would continue to exacerbate flooding in the watershed due to flashy runoff and poor drainage, whose waters are likely to be contaminated. Poor water quality would continue to be manifested as health issues in the adjacent communities
Flooding	Inadequate drainage would continue to result in flooding. The risk of flooding in adjacent communities as a result of continued filling in and sedimentation within the CMP and sea level change would increase.
Navigation	Navigation and watercraft access would continue to be precluded through the Eastern CMP.
Coastal Processes	Lagoons in the Study Area have been dredged or mined. Average tidal range in San Juan Bay would remain consistent with existing condition, 19.2 inches compared with 2.0 inches in San José Lagoon because of reduced tidal influence. Estimated sedimentation rates among lagoons (ranging from 0.1 inches/yr to 0.2 inch/yr), would remain much lower than San José Lagoon (1.5 inches/yr) due to tidal exchange.
Air Quality	Hydrogen Sulfide would continue to be a problem in the area, likely worsening with continued filling of the Eastern CMP.
Water Quality	Negligible tidal exchange in the CMP would persist, and this condition would continue to cause salinity stratification and poor dissolved oxygen in depths from 4-6 feet, thus contributing to poor habitat for benthic and fish and wildlife communities. Water quality would continue to violate existing federal and local water quality standards, and would remain as a major health hazard. Plan to improve local drainage and sewer would be limited by lack of conveyance capacity in the CMP.
Sediment Quality	The sediments deposited in the SJBE system would continue to be upland sediments mixed with anthropogenic inputs.
Noise	No significant adverse impacts are anticipated since no new activities would occur.
Hazardous, Toxic, and Radioactive Waste	No additional evidence of HTRW sites in the CMP, and the potential for new HTRW in the Project Area would be minimal.

3.4.2 Future Biotic Characteristics

A functional CMP is critical to the health of the entire SJBE. If the project is not carried out, environmental conditions would continue to worsen within the entire estuary. Degraded mangrove habitats would decrease habitat for water birds and migratory fowl. Increased sedimentation would be expected to bury pneumatophores and roots, compromising the health of the mangrove and leading to decreased growth and survival. A lack of tidal flushing can result in future algal blooms in the surrounding areas becoming more intense due to increased nutrients and lack of light filtration. These factors may decrease germination and survival of mangrove seedlings, reducing canopy coverage and preventing colonization of new areas.

Estuarine open waters would continue to be persistently hypoxic and/or anoxic below 4 feet in depth throughout the Project Channel and the San José Lagoon, precluding the establishment of submerged aquatic vegetation or healthy benthic communities. Estuarine fish species dependent on healthy benthic communities and wetland habitats would remain absent from these water bodies due to low habitat suitability and insufficient tidal access, also reducing populations and impacting nesting success of water-dependent birds. The existing condition for benthic, fish, and mangrove habitat would persist into the future. Table 5 summarizes the future without-project biotic conditions.

3.4.3 Future Socioeconomic Conditions

The inhabitants of neighboring communities to the CMP would continue to suffer the social stresses associated with substandard living conditions, deteriorated air and water quality, frequent flooding events, and numerous public health hazards. The low education, employment, and home ownership rates would continue to be consistent with today's rates, and population density will remain unsustainably high. The subsistence fishermen that use fish and shellfish caught in San José a lagoon would continue to ingest the contaminants present in the seafood and may pass those contaminants to unsuspecting consumers when they sell their catch (Atkins 2011b).

In general, residents would continue to experience disproportionate adverse economic and environmental burden compared to surrounding areas of San Juan, the rest of Puerto Rico and the United States with respect to health, safety and quality of life. Table 6 summarizes the future without-project socioeconomic conditions.

Table 5. Summary of Future Without-Project Biotic Conditions

Resource	Future Without-Project Condition
Freshwater Aquatic, Wetland, Terrestrial Habitats	The approximately 33.46 acres of wetland areas within the Project Channel would remain primarily mangrove swamp of comparatively low functional value as a result of disturbed conditions due to human habitation of the area, and poor water quality due to flooding and untreated waste and storm water. The fish and mangrove habitat conditions would persist similar to the existing condition.
Invasive Species	The 152 invasive plant and animal species documented as occurring in Puerto Rico would persist, with some possible increase with disturbances. Invasive species often become established due to disturbance of native habitats and would continue to expand in the Project Area without management.
Benthic Habitat	Benthic Index (BI) for the San José Lagoon was 1.55, reflecting salinity stratification and poor DO in -4 to -6 feet of depth due to poor tidal exchange along CMP. This existing condition is expected to persist into the future
Fish and Wildlife Resources	Some fish and wildlife species would likely decline, in population and geographic distribution within the Study Area; overall species diversity would decline.
Threatened and Endangered Species (T&E)	T&E species population numbers losses are not anticipated to significantly change due to existing regulations and lack of quality, available habitat in the project area. There is no critical habitat for listed species in the Project Area and no T&E plant species have been found in the area of the proposed disposal sites.
Essential Fish Habitat	The Project Area includes mangrove wetland EFH and estuarine water column EFH. Mangrove habitat in the Project Channel and along the San José lagoon would remain functionally degraded due to extensive human encroachment, wastewater discharges, and severely limited tidal exchange along the CMP. Estuarine water column EFH in the CMP would remain impaired and functionally degraded by the existing high sedimentation rates, sediment toxins, low DO levels, and salinity fluctuations and stratification.

Table 6. Summary of Future Without-Project Socioeconomic Conditions

Resource	Future Without-Project Condition
Land Use and Infrastructure	Plans for improving sanitary sewer infrastructure, independent of the proposed project, would partially and perhaps temporarily improve health conditions in some areas. The feasibility of improved storm water infrastructure will be seriously impaired, due to the lack of water conveyance at the CMP. Thus, CMP and storm sewer related flooding is expected to continue, limiting land use opportunities.
Recreation	Recreation opportunities would remain very limited due to lack of transportation and recreation infrastructure. Charter (e.g. tarpon anglers who presently fish borrow pits) and recreational fishing, as well as other water related activities, would be precluded in the CMP due to little to no tidal flow through it. The 4 existing basketball/volleyball courts within the CMP Public Domain limit would be relocated to areas within the surrounding communities along the CMP.
Cultural Resources	The Martín Peña Bridge would remain as the only designated Historic Monument under Law 110. No additional resources eligible for the National Register of Historic Places are listed as occurring in the Project area.
Socioeconomics	Adverse economic impacts to charter and recreational fishing, tourism and land values in the communities and region would continue.
Environmental Justice	Historic neighborhoods along the CMP would continue to experience disproportionate adverse economic and environmental burden compared with the surrounding areas of the San Juan and the rest of Puerto Rico with respect to health, safety, and quality of life. Although local projects would alleviate some of these problems, the communities bordering the CMP would continue to experience the degraded environmental conditions and health hazards, and have limit economic development opportunities.
Human Health and Safety	Communities along the CMP would continue to experience adverse health impacts directly related to the ecological conditions of the CMP. Although some progress may be made through future sewer and infrastructure improvement projects, local asthma and disease rates are not expected to improve significantly.

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4.0 IDENTIFICATION OF PLANNING OBJECTIVES

4.1 PROJECT GOALS

The project goal is defined as environmental restoration of the Caño Martín Peña.

4.2 PROBLEMS AND OPPORTUNITIES

4.2.1 Problems

The health of the SJBE has been compromised by the lack of tidal interchange between the San Juan Bay and the San José Lagoon, resulting from habitat destruction and the near-complete blockage of the Caño Martín Peña. The fragmented estuary has functionally been divided in half, which can cause such severe ecological effects as crowding, increased competition, and loss of population density and species diversity. The habitat fragmentation leaves the ecosystem extremely susceptible to changes in climate or shifts in available resources, which can have devastating effects on the community and can alter the overall species composition of the estuary.

The SJBE, being in an area of relatively low tidal amplitude, now suffers from a lack of tidal flushing that has led to decreases in dissolved oxygen and adverse changes in salinity stratification. The poor water quality conditions cause disruptions to the normal levels of species evenness and richness, leading to poor benthic habitat. These conditions have also led to poor species distribution and populations density within the mangrove root community. Research within the estuary has indicated that the mangrove root habitat decreased in overall quality with closer proximity to the Caño Martín Peña. Specifically, the current conditions within the Caño Martín Peña have led to the following problems:

1. Aquatic habitat in the SJBE has been fragmented due to the near complete obstruction of the CMP, eliminating connectivity throughout the entire estuary.
2. Severe hypoxic/anoxic bottom water conditions and poor salinity stratification exist in the San José lagoon due to a lack of tidal flushing and resulting in decreased habitat for benthic species in the estuary.
3. Mangrove wetland habitat in the CMP, the San José lagoon, and the Suárez Canal has been adversely impacted due to the lack of tidal flow and the subsequent reduction in density of native species that use this habitat.

These problems are anticipated to remain under the future-without project condition.

4.2.2 Opportunities

Opportunities to provide ecological improvements within the Caño Martín Peña and also the surrounding SJBE have been recognized by numerous groups and agencies. Although the CMP and

associated SJBE have been severely impacted by the problems identified above, most of the damage that has occurred is reversible. Based on this fact, there are opportunities to:

1. Reconnect estuarine areas within the SJBE and restore fish habitat;
2. Improve conditions for benthic species within the SJBE, and;
3. Improve mangrove habitat within the historic CMP and surrounding SJBE areas.

4.3 OBJECTIVES AND CONSTRAINTS

4.3.1 Objectives

Planning objectives are statements that describe the desired results of the planning process by solving the problems and taking advantage of the opportunities identified. The planning objectives must be directly related to the problems and opportunities identified for the study and will be used for the formulation and evaluation of plans. Objectives must be clearly defined and provide information on the effect desired (quantified, if possible), the subject of the objective (what will be changed by accomplishing the objective), the location where the expected result will occur, the timing of the effect (when would the effect occur) and the duration of the effect.

The following objectives have been developed for the CMP-ERP. Unless otherwise noted, the objectives are intended to begin being met immediately upon construction of the project and deliver ecosystem restoration benefits throughout the life of the project.

1. Improve fish habitat in the SJBE system by increasing connectivity and tidal access to estuarine areas.
2. Restore benthic habitat in San José Lagoon by increasing dissolved oxygen in bottom waters and improving the salinity regime to levels that support native estuarine benthic species.
3. Increase the distribution and population density and diversity of native fish and aquatic invertebrates in the mangrove community by improving hydrologic conditions in the SJBE.

The timing and duration for the objectives would occur over the period of analysis, beginning with project implementation in year 2020 and continuing for 50 years.

4.3.2 Constraints

The following constraints were identified as a basis for development of a solution to the identified problems. The CMP-ERP must:

1. Comply with all Federal, state, and local laws, regulations and policies, including those for floodplain management, environmental protection, and historic preservation;

2. Avoid increasing sedimentation, algal growth, and other impacts to near-shore reefs adjacent to the Study Area;

3. Avoid induced flooding and other secondary effects such as noise, odors, release of H_2S, and damage to structures resulting from vibration within the communities adjacent to the CMP; and,

4. Avoid damage to existing sheet piles, bridges, and other structures in the Study Area.

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5.0 FORMULATION, EVALUATION, AND COMPARISON OF ALTERNATIVE PLANS

5.1 PLAN FORMULATION OVERVIEW

The Feasibility Report for the CMP-ERP followed the USACE 6-step planning process and was conducted by a Project Delivery Team (PDT) consisting of ENLACE, USACE, and consultant personnel. ENLACE also convened a Technical Committee (TC) (see Table 30) to assist in the development of the feasibility study as part of the public engagement process. The documents used by the PDT and the TC in its planning and feasibility study efforts included:

- San Juan Bay Estuary Program Comprehensive Conservation and Management Plan (2000)
- USACE Dredging of Caño Martín Peña, Project Design Report and Environmental Impact Statement, Jacksonville District (2001)
- USACE Reconnaissance Report Section 905(b) Analysis, Caño Martín Peña, Puerto Rico Ecosystem Restoration (2004)
- PRHTA Comprehensive Development and Land Use Plan for the Caño Martín Peña Special Planning District (2004)

Section 5 of the Feasibility Report documents the last four steps of the USACE Planning Process: Formulation, Evaluation, Comparison and Plan Selection.

5.2 PLAN FORMULATION

5.2.1 Plan Formulation Strategy

Management measures were initially created to address planning objectives for the proposed project. A management measure is a feature (a structural element that requires construction or assembly on-site) or an activity (a nonstructural action) that can stand alone or be combined with other management measures to form alternative plans. Most management measures were derived from a variety of sources including prior studies, the NEPA public scoping process, and the TC (see Table 30). Four categories of Management Measures were created:

- Channel Dredging
- Beneficial Use of Dredged Material
- Mangrove Planting Bed Construction
- Non-Structural Measures

Measures were then screened based on factors such as constructability, exposure to wind and wave actions, environmental impacts, conflict with planning objectives, elimination of subaqueous, benthic habitat within the estuarine system, capacity in landfills or other available sites in San Juan,

engineering/infrastructure considerations such as proximity next to flowing water or insufficient roadways, impacts to adjacent communities by noise or air pollution or by undiluted containment of solid waste, and potential for unacceptable erosion. In addition to the measures, dredged material disposal options and erosion control features were also evaluated, as these components were necessary for the channel dredging measures to function. Afterwards, different scales of the channel dredging measure were combined with other measures as well as the appropriate disposal options and erosion control features to create alternatives. The alternatives were then compiled into an Initial Array to proceed with plan evaluation, comparison, and selection.

5.2.2 Planning Assumptions

Due to the large amount of heterogeneous nature of the dredged material as well as the unique island location of the project, several assumptions were established to guide initial plan formulation. First, due to the large amount of sediment and solid waste that would be dredged, capacity was not available at existing disposal facilities within the San Juan area to dispose of both the sediment and solid waste together. This assumption was verified with local landfills. Second, solid waste would need to be removed or filtered from sediment to the maximum extent practicable before potential disposal at any aquatic site. Third, based on surveys, testing and historical data, solid waste at the site was assumed to be eligible for disposal at a municipal landfill. Coordination with the Humacao landfill in San Juan indicated that the solid waste would be acceptable for disposal.

For aquatic disposal measures formulated, sediment testing and concurrence from the USEPA would be necessary in accordance with Section 103 of Public Law 92-532 (the Marine Protection, Research, and Sanctuaries Act of 1972) for ocean disposal. For inland aquatic disposal, sediment testing and concurrence from the PREQB would be necessary in accordance with Section 404 of the Clean Water Act. Due to resource limitations for the non-Federal sponsors, Section 103 and/or Section 404 testing would not be conducted until the preconstruction engineering and design (PED) phase, at the latest, if aquatic disposal is included as part of any recommended alternative. Initial assessments of sediment and solid waste and coordination with regulatory agencies have been conducted.

Dewatering of the solid waste is not considered necessary for the disposal process in light of the planning assumption that the solid waste would air dry during transportation from the CMP to the landfill.

5.2.3 Alternatives Considered but Not Carried Forward for Further Evaluation

Two alternatives to enhance tidal influence and reduce residence time in the San José Lagoon were also considered that did not involve restoring the hydrologic connection between San Juan Bay and

San José Lagoon via the CMP. Both alternatives involved modifications to the cross section or configuration of specific areas within some of the water bodies found in the eastern half of the SJBE.

The first alternative involved increasing the water conveyance capacity of the Suarez Canal with ocean waters through La Torrecilla Lagoon by addressing the flow constriction at the Ramón Baldorioty De Castro's expressway (Road PR-26) caused by the bridge pilings. The action would be to dredge a section of the Suárez Canal found underneath the expressway, from 50 feet wide and 3 feet deep, to 100 feet wide and 9 feet deep. This modification was also one of the scenarios (Scenario 3) considered and evaluated as part of the Hydrodynamic and Water Quality Model Study for the SJBE performed by the USACE in 2000 (Bunch et al. 2000). The 2000 USACE study concluded that this modification "did little to improve overall water quality" in the SJBE, and thus, the San José Lagoon and the CMP, when compared to existing conditions. The study team for this feasibility study effort concurs with the USACE's original conclusion, and recognizes that this alternative would not meet the project purpose and objectives of the CMP-ERP.

The second alternative would require the construction of a new, man-made channel to provide for a direct connection between the San José Lagoon and the Atlantic Ocean, through the narrowest point north of the lagoon. The land mass that separates these two waterbodies, however, is densely urbanized, and includes sensitive sites or infrastructure such as a cemetery and the Ramón Baldorioty De Castro's expressway; the latest is the main access road that connects the municipality of San Juan with the northeastern region of the Island. Even if these constraints could be properly handled, the new channel would require very frequent dredging to counter sediment and sand deposition, especially at its outlet in the ocean. In addition, flow exiting the San José Lagoon would most probably affect nearby coral reef communities that are not accustomed to the high turbidity, rich nutrient waters that characterized this and other coastal lagoons in the Island. In light of these impacts, and considering that the alternative would not meet the project purpose and objectives of the CMP-ERP, it was not carried forward for further evaluation.

Other projects involving additional structural measures to improve tidal flow, such as placing a box culvert or pipeline between the western half of the CMP and the San José Lagoon along the channel's historic alignment, were also briefly considered. These alternatives were not carried forward for further evaluation because none would meet the project's purpose and objectives of the CMP-ERP. Each of these alternatives would result in additional man-made modifications to the SJBE without restoring its connectivity and the ecological health of the CMP, nor achieving improvements to water and habitat quality throughout the SJBE.

5.2.4 Management Measures

This section provides a brief description of the management measures that were developed and also describes the screening process that was conducted. For full descriptions of the measures, please refer to the Engineering Appendix.

5.2.4.1 Channel Dredging

In order to increase the connectivity and tidal access within the SJBE and also restore benthic habitat and the mangrove root community, a connection must be re-established between San Juan Bay and the San José Lagoon. The construction of a new channel outside of the historic alignment is not feasible due to the high density of housing in the area and topography (higher elevations), so dredging of the existing channel of the CMP would be a necessary feature for any structural alternative that is formulated.

Two types of channel cross sections were considered for the Project Channel, rectangular cross-section and a hybrid design. A rectangular channel would utilize sheet piles with concrete caps along the entire length to prevent erosion. The hybrid channel employs sheet pile in areas that would be subject to erosive conditions and 5- to 1-foot earthen slopes in other areas. Based on initial calculations, the hybrid design would add 50 to 75-feet to the channel width and would only be feasible within the widest portions of the area.

Based on construction of the Rio Puerto Nuevo Flood Control Project, the construction of a sloped bank in the Project Channel is not likely feasible. Sloped banks were constructed as part of the Margarita Channel and were later replaced with sheet pile walls after consistent sloughing of fluvial sediment was causing poor project performance. The CMP project is located within a similar part of San Juan within the SJBE, and sloughing of material would also be anticipated within the Project Channel. A 5- to 1-foot sloped bank would also reduce the area available for mangrove restoration. For these reasons, the rectangular cross-section channel dredged design was retained and the hybrid design was eliminated for use in the Project Channel. Steel sheet pile was the selected structural treatment for the vertical edge, chosen over concrete sheeting due to its ease of handling and ability to be installed without the need for tie-backs. Although gabions are used for construction of vertical edges, they were not chosen due to their difficulty of construction underwater and their susceptibility to damage or wear.

5.2.4.2 Beneficial Use of Dredged Material

Several different possibilities were considered for this measure: expanding existing islands/habitat, constructing new diked or undiked islands, and constructing new marsh areas. All of these measures were eliminated due to sediments with possible high concentrations of contaminated pollutants being exposed to environmental conditions. Although the dredged material could be capped, the proximity and exposure to wave action and high winds could prompt failure of the structure during tropical weather. Unlike contained aquatic disposal (CAD) within anoxic borrow pit areas, these sites would be completely exposed to weather events, and given the high likelihood of experiencing future tropical events, there could be a significant risk of containment failure. In addition, the volume of material is extremely large, and, if constructed within a lagoon, it would eliminate a substantial area of open water and benthic habitat similar to the lagoon level measure. Other areas to construct ecological features are unavailable due to the densely populated nature of

San Juan. As a result, this measure was eliminated from further consideration due to possible environmental impacts and acting conversely to project objectives.

5.2.4.3 Mangrove Planting Bed Construction

There are still some mangrove wetlands, albeit of extremely low functional quality, along the CMP. If the CMP was dredged, much of these wetlands would be within the construction area and impacted by the project. In order to maintain a mangrove fringe of wetlands along the CMP for habitat, nutrient reduction, water quality, and other wetland functions, mangrove wetlands could be re-established in areas along a dredged canal. This measure would provide immediate restoration within the project area, as the existing low quality mangrove areas would be removed along the CMP channel for construction purposes and replaced by high functioning mangrove wetlands. The north and south slopes of the channel above the sheet pile would be graded to receive tidal influence and then planted with appropriate mangrove species. Microtopography would be added to diversity habitat. A minimum of approximately 32 feet was considered as the recommended width for mangrove fringe (Fischer and Fischenich 2000). This measure was retained.

5.2.4.4 Non-Structural Management Measures

No non-structural measures were identified to restore circulation to San José Lagoon. Non-structural measures related to structure acquisitions and relocations within the public domain boundary (and confines of the Federal project) have been retained and included in the development of alternatives, as well as activities outside of the project that would be conducted by the non-Federal sponsors. Overall the non-structural measures considered and used in the development of alternatives included:

- Structure acquisition and relocation
- Increased enforcement of illegal dumping
- Community education

Structure acquisition and relocation was retained as a measure that would be considered in all action alternatives under the Federal project. There are a substantial number of residential buildings that have been constructed within the Project Area (within the Public Domain limit), including within the actual footprint of the pre-existing channel, and acquisition and demolition of these structures would be necessary for any restoration of tidal flow, and the families would need to be relocated. Notwithstanding the need to remove the structures because they are within the Public Domain limit, the removal of these structures would help reduce the potential for the deposition of solid waste and sewage discharges into the CMP.

Additionally, ENLACE has an extensive community education program that focuses on explaining the benefits of restoration to the CMP, and preventing future harm to the watershed. Along with

ENLACE, the community has also banded together to erect barriers to prevent illegal dumping. These areas are patrolled by the residents to ensure that future dumping and degradation of the CMP does not occur. The USACE does not have authority to implement and/or cannot enforce these two measures; however, they would be necessary in conjunction with any alternative that is selected.

5.2.4.5 Elements other than Management Measures

Elements other than management measures described here include dredged material disposal options and erosion control features.

5.2.4.5.1 Dredged Material Disposal

Five categories of dredged material disposal options were considered: CAD, Landfill Disposal, Permanent Upland Disposal (PUD), Ocean Disposal, and Onsite Disposal. Beneficial Use of Dredge Material was considered as a management measure and eliminated earlier in this section. All the disposal options are dependent on dredging of the existing CMP channel. Table 7 displays the different Dredged Disposal Management Options and reasons for elimination. Disposal options were eliminated for a number of reasons, including:

- Insufficient capacity at the site;
- Extent of sediment and solid waste mixing;
- Engineering/infrastructure considerations such as proximity next to flowing water or insufficient roadways;
- Impacts to adjacent communities by noise or air pollution or by undiluted containment of solid waste;
- Elimination of subaqueous, benthic habitat within the estuarine system; and,
- Exposure to wind and wave action that could cause failure of containment.

Table 7. Summary of Elimination of Dredged Disposal Options

Dredged Material Disposal Options	Reason for Elimination					
	Insufficient capacity	Extent of Sediment and Solid Waste Mixing	Engineering/ infrastructure considerations	Impacts to adjacent communities	Elimination of benthic habitat	Exposure to current or wind and wave action
Suarez Canal CAD (sediment and small pieces of debris)	X		X			X
Los Corozos Lagoon CAD pit disposal (sediment and small pieces of debris)	X			X		
Lagoon level bottom capping/containment (sediment and small pieces of debris)					X	X
San José Lagoon CAD with geotextile containment (sediment and small pieces of debris)						
Landfill disposal (sediment and solid waste)			X	X		
Landfill disposal (solid waste only)						
Permanent Upland Disposal (sediment and small pieces of debris)						
Ocean disposal (sediment only)		X				
Onsite Disposal	X		X	X		
Non-Structural	Refer to text for discussion					

5.2.4.5.1.1 Contained Aquatic Disposal

Contained aquatic disposal refers to the placement of dredged sediments within the aquatic environment, then capping of the material with clean sand. Based upon a CAD analysis performed by the USACE ERDC in 2002 for the CMP-ERP, sand is the recommended sediment to be used as the capping material. Capping would involve the placement of the dredged sediments and capping them with a 2-foot sand layer to contain the migration of any potential contaminants. The overall performance objective for a CAD alternative is to control direct exposure of benthic organisms to potentially contaminated sediments such that toxicity or unacceptable levels of bioaccumulation do not occur. To meet this objective, a cap must be placed on the dredged materials at a thickness designed to isolate potentially contaminated materials from the water column and benthic environment, and to be maintained over the long term. Furthermore, the materials should be placed in the CAD site in a manner such that water column impacts from potential contaminant losses during placement are acceptable, and the loss of dredged material from the site is minimal.

The Suarez Canal location is an indention along the waterway that could possibly be backfilled to align with the rest of the shoreline. It was eliminated due to insufficient capacity for sediment at the location, and the fact that it would require containment of the material behind a sheet pile bulkhead that would be exposed to currents and possible wave action during storms and tropical events. The Los Corozos location, an anoxic borrow area in the bottom of the lagoon, was eliminated as there is insufficient capacity within the pits at the location (maximum depth of the Los Corozos pit is currently at a -18 feet MSL), and also because the pits are immediately adjacent to the shoreline, which would likely interfere with the adjacent communities, docks and navigation, and other shoreline activities. Filling the Los Corozos Lagoon pit would also eliminate a location for tarpon feeding and could adversely impact recreational and charter fishermen. Lagoon level placement would be established on existing benthic habitat rather than placement in anoxic borrow areas as in other options. This option would impact an area of rare island habitat, and other options could be utilized to avoid these detrimental effects. As a result, lagoon level placement was eliminated from consideration.

The San José Lagoon pits disposal option could occur within 5 existing artificial, subaqueous anoxic pits in the bottom of the lagoon. They include (Figure 9):

- San José Lagoon 1 – Maximum depth at this site is -27 feet MSL with a surface area of 897,190 square feet (ft^2). At a controlled fill depth of the site of -16 feet MSL, there would be a total available capacity of 260,516 cubic yards.

- San José Lagoon 2 – Maximum depth at this site is -27 feet MSL with a surface area of 956,000 ft^2. At a controlled fill depth of the site of -16 feet MSL, there would be a total available capacity of 245,450 cubic yards.

- San José Lagoon 3/4/5 – Maximum depth at this site is -24 feet MSL with a surface area of 1,591,070 ft^2. At a controlled fill depth of the site of -16 feet MSL, there would be a total available capacity of 275,373 cubic yards.

There is sufficient capacity, and impacts to habitat would be extremely low. These areas would be protected from most wave action, and impacts to existing communities would be lower than the Los Corozos option. As such, the San José Lagoon option was retained. Monitoring and possibly adaptive management techniques would likely be necessary to avoid any water quality impacts from CAD due to the possible concentrated levels of any contaminants in dredged sediment.

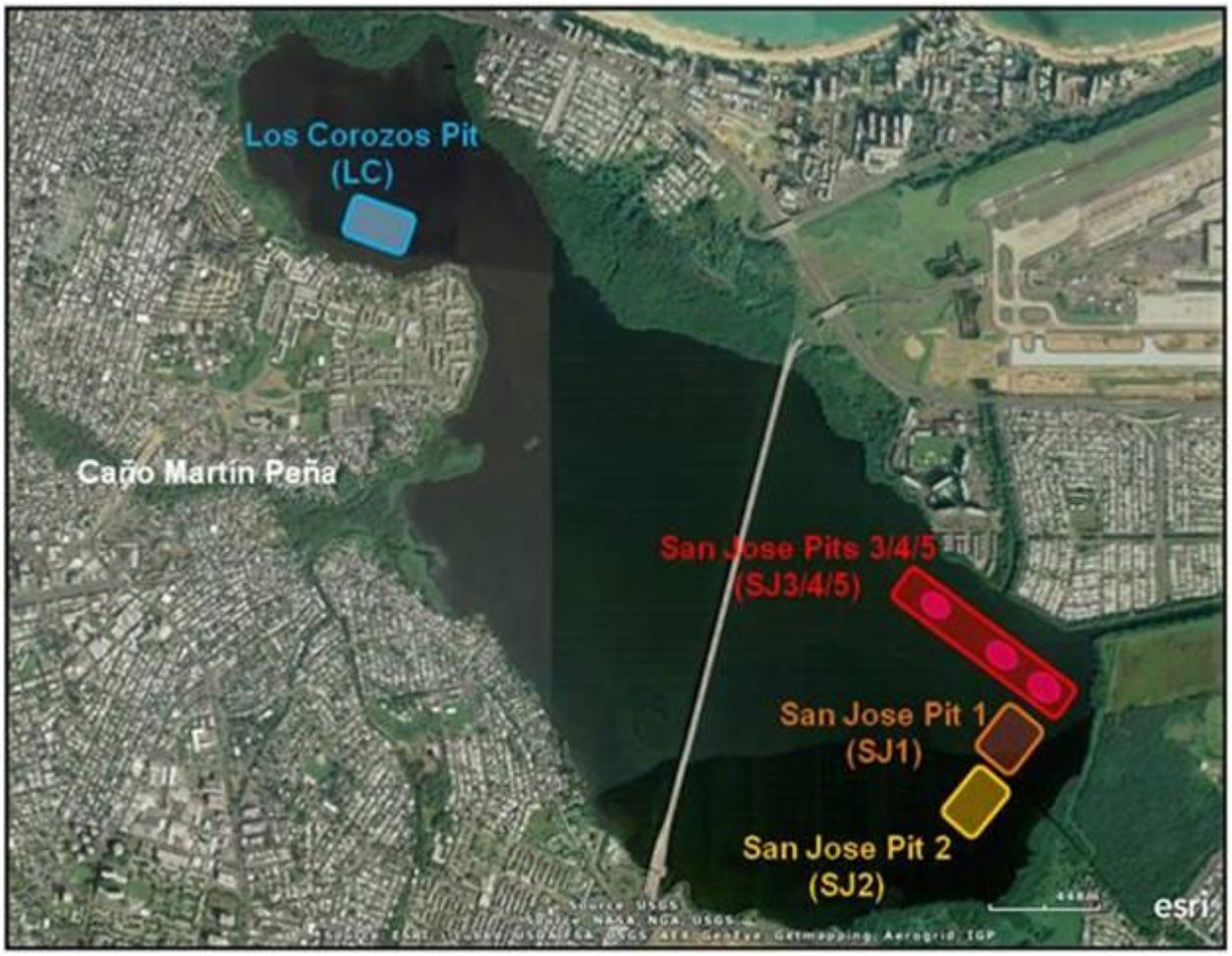

Figure 9. Artificial Pit Locations – San José & Los Corozos Lagoons

5.2.4.5.1.2 Landfill Disposal

Landfill disposal was evaluated for both dredged sediment and solid waste, and also for solid waste only. Analysis indicated that the entire volume of sediment and solid waste together is too great to be considered for existing landfills within the San Juan area, as the capacity is not available. As Puerto Rico is an island, there is an extremely limited area for landfill disposal. While there is capacity at existing landfills elsewhere on the island, the distance between the project site and these landfills (as much as 70 miles) is great enough that the disposal of both sediment and solid waste is not feasible. Additionally, much of the infrastructure (roads) adjacent to the CMP cannot accommodate large dump trucks. All material would need to be pumped or barged to a staging area, and then trucked to the disposal site, leading to immense cost increases. Noise, traffic, and air quality impacts would be expected due to the large number of trucks that would be constantly traveling to and from the site. Landfill disposal for both sediment and solid waste was subsequently eliminated.

Landfill disposal for solid waste only would require a much smaller capacity that is available at current landfills in the San Juan area. The material would need to be transported to a staging area and trucked to the landfill. There would be some noise and air concerns with the dump truck traffic, but levels (and duration of impacts) would be more acceptable than those associated with disposal of both sediment and solid waste. As such, landfill disposal for solid waste only was retained as an option, but would need to be combined with a sediment disposal option to be viable.

5.2.4.5.1.3 Permanent Upland Disposal

This option would be similar to landfill disposal, but would rely on acquiring and constructing a new area for single use upland disposal, essentially a new private landfill. Any PUD would need to be located within 10-miles of San Juan (and the project site). Similar to landfill disposal, PUD would impact infrastructure and create noise, traffic, and air quality impacts. Several potential sites have been identified with sufficient acreage and configurations to accommodate the volume of dredged material from the project. Permanent Upland Disposal was retained as an option.

5.2.4.5.1.4 Ocean Disposal

Ocean disposal would occur at a currently EPA-approved Ocean Dredged Material Disposal Site (ODMDS) located approximately 1.6 miles from the mouth of San Juan Bay. Section 103 testing would need to be completed and approved for use of the site consistent with the EPA/USACE *Evaluation of Dredged Material Proposed for Ocean Disposal, Testing Manual* as amended (otherwise known as the "Green Book"). Preliminary testing of the sediment has indicated ocean disposal could be a viable option; however, after coordination with the USEPA on the issue of ocean disposal of sediments for the CMP-ERP, it was determined that sediment mixed with small pieces of solid waste/debris would not be suitable for ocean disposal. After analysis of the existing geotechnical information associated with the dredged material from the CMP-ERP, a conservative apportionment was determined such that, for planning purposes, 55 percent of the dredged material would be pure sediment, while 45 percent would be a mixture of sediment and solid waste. At such a ratio, the effort to transport the sediment/solid waste mixture to an approved landfill coupled with the cost to mobilize for ocean disposal would result in costs well beyond the 902 (b)(1) authorized cost. More importantly, there would be significant problems associated with infrastructure and noise, traffic, and air quality impacts associated with the hauling of dredged material. As a result, ocean disposal of sediment was not retained as an option.

5.2.4.5.1.5 Onsite Disposal

Onsite disposal would consist of placement of dredged material within upland areas outside of the planned channel. Onsite disposal would reduce the amount of onsite mangrove restoration that could occur, and would also have impacts to recreation opportunities in the area by eliminating available lands. This option could also require additional acquisition and demolition of structures, as well as more relocations if impacts to recreation were to be avoided. Sediment would likely be

stockpiled high on the banks and capped, leading to aesthetic impacts by creating large berms along each side of the CMP. The local sewer and drainage system would also likely need to be modified to account for the changes in land contours and elevation. As a result of these factors, this option was eliminated.

5.2.4.5.2 Erosion Control Features

Preliminary hydrologic modeling for different channel configurations indicated that if the channel dredging measure was implemented, erosion control features would be necessary to protect the CMP channel from scouring, and to protect existing bridges and shoreline stabilization structures in the Western CMP such as sheet piles. Three erosion control features were formulated, evaluated, and retained for these purposes. These erosion control features are all dependent on dredging of the existing CMP channel. First, articulated concrete mats (ACMs) would be required to provide scour protection for any high velocity dredged channel configurations. The soils in the CMP Project Channel are predominantly hard silts and clays at a depth of 10 to 15 feet below the existing bottom, and these soils could be subject to scour at velocities greater than approximately 4.0 feet per second. Table 8 provides within-channel bottom velocities that could be produced by the different channel dimensions. Those indicated in red would require ACM to prevent channel scouring. The other configurations are considered wide enough to slow within-channel velocities to an acceptable rate, and a 100-foot-wide channel would be the most marginal that could be acceptable.

Table 8. Maximum Bottom Velocities
Within the CMP Project Channel

Channel Dimensions (feet wide x feet deep)	CMP Bottom Velocity (ft/s)
(75 x 10)	4.22
(100 x 10)	4.09
(125 x 10)	3.95
(125 x 15)	3.45
(150 x 10)	3.85
(150 x 15)	3.13
(200 x 10)	3.13

Second, riprap would be a necessary feature for protection along any structures such as bridges. Lastly, initial hydrologic analysis for the project determined that a weir would be necessary to slow velocities in the western portion of the CMP above channel dimensions greater than 75 x 10 feet.

Two main project constraints for the proposed project is that the plan should not damage the shoreline and sheet pile structures in the downstream Western CMP, and that the foundations of the existing four bridges in the western portion of the Project Channel must be protected. During recent years, three bridges and shoreline stabilization projects have been constructed in the Western CMP, and these structures were not designed with a wider, higher velocity CMP channel in

mind. Preventing erosion is essential to maintaining a functional project as any effects to the structures in the Western CMP could require major construction and cost for repairs in the future, thus impacting funding for general channel maintenance. To evaluate this constraint, Western CMP velocities were calculated and evaluated for the potential to damage bridges and sheet pile structures (Table 9). With the exception of the 75-x-10-foot channel, every other channel dimension would be considered unacceptable.

Table 9. Maximum Bottom Velocities Within the CMP and the Adjacent Western Channel

Channel Dimensions (feet wide x feet deep)	Western CMP Bottom Velocity (ft/s)
(75 x 10)	2.20
(100 x 10)	2.80
(125 x 10)	3.25
(150 x 10)	3.65
(200 x 10)	4.09

Because a 75-foot-wide by 10-foot-deep channel was the only dimension that resulted in a bottom velocity that was low enough to prevent unacceptable scour in the Western CMP, every larger channel dimension that was modeled (e.g., 100-, 125-, 150-, and 200-foot widths) must include a design component to reduce water flow at the western end of the Project Channel consistent with the model output for the 75-x-10-foot channel if they were to be retained as viable, feasible dimensions. The inclusion of a weir (115-foot-wide by 6.5-foot-deep) would enable the larger channels to replicate the cross-sectional area of the smaller 75-x-10-foot channel, and, in turn, maintain the same flow characteristics. With such a weir in place, the potential for unacceptable scour in the Western CMP would be resolved while accommodating wider channel widths in the rest of the Project Channel.

In order to protect the structural integrity of the four bridges in the western portion of the Project Channel, it was recommended that channel depths in their vicinity do not extend below 6.5 feet in depth, which is consistent with the weir depth; however, in light of this depth restriction around the bridges, the 75-x-10-foot channel must also include the 115-x-6.5-foot weir. Thus, the inclusion of the weir in the 75-x-10-foot channel is in response to the protection of the existing bridges, not because of the need to reduce water flows to an acceptable bottom velocity in the Western CMP, as is the case with the 100, 125, 150, and 200-foot-wide channels.

Although the western and Eastern CMP channel segments have different cross-sectional areas and bottom elevations, water flow through a tidal system such as the CMP is, and would continue to be, restricted by the smallest cross-sectional area. More specifically, the water flow characteristics of potential wider channel configurations with the weir would be not significantly different than those associated with that narrower channel configuration of 75 feet.

5.2.5 Formulation of the Initial Array of Alternatives

To create an Initial Array of Alternatives from management measures, appropriate scales for channel dredging were formulated as this would determine the number of alternatives. The following section describes the bracketing analysis that was conducted to create scales of channel widths and depths for inclusion in alternatives.

5.2.5.1 Channel Dimension Bracketing Analysis

Several considerations were identified that limited channel widths to distances between 75 feet and 200 feet, and channel depths to 10 feet. These factors included: geotechnical, hydrodynamics, scour potential, dredging volumes, mangrove restoration, recreation, navigation, and constructability.

5.2.5.1.1 Width

When considering channel widths, hydrodynamics, scour potential, mangrove restoration, recreation, navigation, and constructability were primary factors.

Greater than 200 feet wide – Mangrove restoration is an essential element of the project. The project is being conducted with the confines of the public domain and the area available for restoration is extremely limited. There has been substantial public participation in the project and there is a strong desire to maintain the overall aesthetics of the CMP, which includes wetland areas that were historically present along the canal. Channel designs with smaller widths would allow for more mangrove restoration potential than those designs with greater widths, especially considering the need for a minimum of approximately 32 feet of mangrove fringe on each side of the CMP (Fisher and Fischenich 2000). Additionally, enlarging the entire length of the CMP to widths greater than 200 feet could create a much wider CMP for certain areas than has historically existed and would essentially create an artificial waterway that would not meet the definition of restoration.

Recreation is an important secondary element of the project and is essential to maintain recreational opportunities in the highly urbanized area. Channel designs with smaller widths provide more area for recreational elements than those designs with greater widths. Continued navigational access is essential for public acceptance of the proposed project, and elimination of recreation in the area would be viewed as a secondary project impact. As a result of these factors, channel widths greater than 200 feet were not considered for the proposed project.

Less than 75 feet wide – A restored CMP would provide opportunities for recreational (shallow draft and sailboats) and some commercial navigation, primarily small fishing vessels, travelling between San Juan Bay and San José Lagoon. Vessel size and type would be limited as a result of the low clearances (10 feet above the water surface) for several of the western bridges in the CMP. The waterway should be wide enough for safe two-way passage of vessels while also accommodating

the mooring of vessels along possible bulkheads and marginal wharves. Channel footprints at least 75 feet wide would be the minimum necessary to ensure safe navigation through any restored CMP channel.

Constructability is also of concern in determining channel design as two barges would be required to work side-by-side during the operation. These barges would need enough room for maneuverability to pass one another, and wider channel footprints would allow more space for these construction vessels to operate.

As 75 feet was determined to produce unacceptable scouring, channel widths were bracketed at this limit and only alternatives at 75 feet or wider were included. Navigational safety and constructability were also considered factors in maintaining alternative widths at 75 feet or wider.

Another factor in restricting channel widths to those 75 feet or greater is the ability of the area to mimic natural conditions. The CMP was historically 200-400 feet wide, and much smaller dimensions would not reflect prior conditions. During public coordination, members of the community expressed an opinion for the CMP to be restored nearest to historical conditions as possible, making dimensions at least 75 feet wide more acceptable.

Conclusion – As a result of these factors, channel widths greater than 200 feet were eliminated from consideration due to loss of restoration potential and recreational impacts. Widths less than 75 feet were eliminated due to navigational safety, scour potential, constructability, and ability to mimic historic conditions.

5.2.5.1.2 Depth

Geotechnical issues and secondary impacts were primary considerations for channel depths.

Less than 10 feet deep – In regard to geotechnical considerations, the CMP and channel banks contain solid waste from the surface to -10 feet. Thus, channel depths less than 10 feet could leave behind waste in the proposed channel's side slopes and bottom, which could work loose over time and be released into the estuary.

Greater than 10 feet deep – There are portions of the CMP channel, notably near the eastern end adjacent to the San José Lagoon, where limestone can be found at depths of -10.5 feet. In these areas, it is likely that substantial rock removal through blasting and disposal would have to be considered for parts of the channel. As this project site is within a highly urban setting, substantial amounts of blasting would likely violate the constraint of avoiding secondary impacts within the communities adjacent to the CMP. While historic depths within the CMP are unknown, it is believed that depths were not greater than 10 feet based on the presence of limestone rock at -10.5 feet in depth and in light of the fact that solid waste can be found as deep as -10 feet. Increasing depths to 10–15 feet would cause irreversible change to the CMP by the removal of rock, further altering the

tributary and creating a much deeper CMP that does not mimic the natural conditions that previously existed.

Conclusion – Water depths were scaled at 10 feet. Depths less than 10 feet would likely leave solid waste to be carried downstream and into other aquatic habitat. Depths greater than 10 feet would likely require blasting, violating a primary project constraint. Also, depths greater than 10 feet would not reflect the natural, historical depths of the CMP.

5.2.5.2 Initial Array of Alternatives

After the bracketing analysis, five combinations of widths and depths were chosen for an Initial Array: 75 x 10 feet, 100 x 10 feet, 125 x 10 feet, 150 x 10 feet, and 200 x 10 feet. The mangrove planting bed measure and all four non-structural measures were combined with each width and depth combination. Erosion control features were also added to each alternative, as appropriate. All measures contain riprap and a weir, and the 75-x-10-foot alternative contains ACM through the Project Channel due to the higher bottom velocities it would create in the Project Channel. Lastly, in order to incorporate the two different disposal options, the number of alternatives was doubled into Series 1-5, and Series 1B-5B. Series 1-5 contains the San José Lagoon pits disposal option, while Series 1B-5B contains the permanent upland disposal option.

5.2.5.2.1 No Action Alternative

Federal planning guidelines require the evaluation of the "No Action" Alternative plan. Taking no additional Federal actions would result in the future without-project condition (Section 3) occurring over the planning horizon. The No Action Alternative plan provides a basis for comparing the project effects of alternative plans to conditions that can reasonably be expected to occur without constructing the project. As part of the No-Action Alternative, ENLACE would undertake other elements of the CDLUP, but would not continue with the demolition of existing structures within the Public Domain Limit of the CMP Project Area, and the associated relocation of families, unless living conditions required so.

5.2.5.2.2 Alternative Plan 1 – 75-Foot Channel Width, 10-Foot Depth

Alternative Plan 1 includes the following measures: 1) 75-foot-wide, 10-foot-deep rectangular channel with concrete-capped steel sheet pile walls (with variations in channel width and depth at the 4 bridges in the western portion of the Project Channel, the Barbosa Bridge, and terminus of the CMP with the San José Lagoon); 2) trapezoidal channel with 5:1 earthen side slopes exiting from the CMP and extending approximately 4,300 feet into San José Lagoon, 3) disposal of dredged material in the San José Lagoon pits; 4) a weir in the western end of the Project Channel with articulated concrete mat bottom and rip rap protection for the bridges, 5) ACM paving throughout the Project Channel, 6) mangrove planting along the channel margins; and 7) non-structural measures.

5.2.5.2.3 Alternative Plan 2 – 100-Foot Channel Width, 10-Foot Depth

Alternative Plan 2 includes the following measures: 1) 100-foot-wide, 10-foot-deep rectangular channel with an earthen bottom and concrete-capped steel sheet pile walls (with variations in channel width and depth at the 4 bridges in the western portion of the Project Channel, the Barbosa Bridge, and terminus of the CMP with the San José Lagoon); 2) trapezoidal channel with 5:1 earthen side slopes exiting from the CMP and extending approximately 4,300 feet into San José Lagoon; 3) disposal of dredged material in the San José Lagoon pits; 4) erosion control weir in the western end of the Project Area with associated rip rap for bridges and ACM for the channel bottom; 5) mangrove planting along the channel margins; and 6) non-structural measures.

5.2.5.2.4 Alternative Plan 3 – 125 Foot Channel Width, 10-Foot Depth

Alternative Plan 3 includes the following measures: 1) 125-foot-wide, 10-foot-deep rectangular channel with an earthen bottom and concrete-capped steel sheet pile walls (with variations in channel width and depth at the 4 bridges in the western portion of the Project Channel, the Barbosa Bridge, and terminus of the CMP with the San José Lagoon); 2) trapezoidal channel with 5:1 earthen side slopes exiting from the CMP and extending approximately 4,300 feet into San José Lagoon; 3) disposal of dredged material in the San José Lagoon pits; 4) erosion control weir in the western end of the Project Area with associated rip rap for bridges and ACM for the channel bottom; 5) mangrove planting along the channel margins; and 6) non-structural measures.

5.2.5.2.5 Alternative Plan 4 – 150-Foot Channel Width, 10-Foot Depth

Alternative Plan 4 includes the following measures: 1) 150-foot-wide, 10-foot-deep rectangular channel with an earthen bottom and concrete-capped steel sheet pile walls (with variations in channel width and depth at the 4 bridges in the western portion of the Project Channel, the Barbosa Bridge, and terminus of the CMP with the San José Lagoon); 2) trapezoidal channel with 5:1 earthen side slopes exiting from the CMP and extending approximately 4,300 feet into San José Lagoon; 3) disposal of dredged material in the San José Lagoon pits; 4) erosion control weir in the western end of the Project Area with associated rip rap for bridges and ACM for the channel bottom; 5) mangrove planting along the channel margins; and 6) non-structural measures.

5.2.5.2.6 Alternative Plan 5 – 200-Foot Channel Width, 10-Foot Depth

Alternative Plan 5 includes the following measures: 1) 200-foot-wide, 10-foot-deep rectangular channel with an earthen bottom and concrete-capped steel sheet pile walls (with variations in channel width and depth at the 4 bridges in the western portion of the Project Channel, the Barbosa Bridge, and terminus of the CMP with the San José Lagoon); 2) trapezoidal channel with 5:1 earthen side slopes exiting from the CMP and extending approximately 4,300 feet into San José Lagoon; 3) disposal of dredged material in the San José Lagoon pits; 4) erosion control weir in the western

end of the Project Area with associated rip rap for bridges and ACM for the channel bottom; 5) mangrove planting along the channel margins; and 6) non-structural measures.

5.2.5.3 B-Series Alternatives

The B-Series of alternatives is identical to the five above, except that disposal of dredged material would occur within a permanent upland disposal site within 10 miles of the project site instead of the San José Lagoon pits.

5.2.6 Screening of Initial Array

5.2.6.1 Screening of Permanent Upland Disposal Alternatives (B-series)

In order to determine an appropriate Final Array, a screening analysis was conducted to determine whether one of the disposal methodologies was preferable for reasons other than cost. A comparison of the Principles and Guidelines (P&G) Criteria indicated that the Permanent Upland Disposal alternatives (1B-5B) were less acceptable than San José Lagoon pits alternatives (1–5). The permanent upland disposal alternatives would result in significant amounts of heavy truck use through the San Juan area and secondary roads and neighborhoods to reach the upland disposal site(s). The impacts to infrastructure as well as associated noise, air quality, and community impacts would be significant and controversial.

Public input, particularly from recreational and charter fisherman within the San José Lagoon area, has also indicated that there are concerns with lagoon disposal; however, the temporary closure of the San José Lagoon pits is considered more acceptable than sustained trucking impacts to a broad group of residents and businesses along the hauling routes to the permanent upland disposal site(s). In addition, the cost difference between the San José Lagoon pits and permanent upland disposal is estimated to be within approximately $20 million, with San José Lagoon pits being the more cost-effective solution. As a result, it was determined that San José Lagoon was more cost effective and acceptable than permanent upland disposal. There are no significant differences between San José Lagoon and permanent upland disposal in regard to meeting the objectives and constraints, the P&G four accounts (see Section 5.4.2 for more information), or any other factors that could be considered. Therefore, alternatives 1B, 2B, 3B, 4B, and 5B were screened as these plans, based on the P&G Criteria of cost effectiveness and acceptability, would not have been selected as a NER and Recommended Plan.

5.2.6.2 Screening of Larger Channel Alternatives

Benefits for the CMP-ERP are directly related to water flow, which controls differences in residence time and tidal range. With respect to benefits derived from the various channel alternatives, there is a significant benefit to the San José Lagoon (based on the benthic index score) once the CMP channel is widened to 75 feet due to tidal amplitude, or volume of water flowing into and out of the

lagoon. Increasing channel widths to 100, 125, 150, and 200 feet would progressively result in additional, albeit marginal, benefits as a result of the increased water flows and reduced water residence times (Table 10). The model could only run in increments of 3 feet, hence the differences between descriptions of model runs as they relate to alternatives (9 feet) versus tables that identify alternatives being considered in the Feasibility Report (10 feet). Velocities in 10-foot-deep channels would be slightly higher than the modeled 9-foot-deep channels.

Table 10. Channel Configuration Comparisons

	Channel Configuration (depth by width)						
	3 by 33*	**9 by 75**	**9 by 100**	**9 by 125**	**9 by 150**	**9 by 175**	**9 by 200**
Area (ft^2)	99	675	900	1,125	1,350	1,575	1,800
Hydraulic Conveyance	184.2	2,530.4	3,487.2	4,450.0	5,416.1	6,384.0	7,353.3
Residence Time (days)	16.90	3.86	3.23	2.87	2.66	2.49	2.38
Benthic Index Score	1.33	2.84	2.90	----	2.96	----	2.98
Max. Bot. V-CMP-East (ft/s)	1.25	4.22	4.09	3.95	3.85	3.52	3.13
Max. Bot. V-CMP-West(ft/s)	0.74	2.20	2.80	3.25	3.65	3.89	4.09
Tide Range (feet)	0.33	1.36	1.61	1.75	1.85	1.96	2.05

* Model configuration for existing conditions.

If these benefits were used for project justification, it is likely that Alternative 5, at 200 x 10 feet, would be selected as a cost effective plan and best buy; however, once a weir is included in channel alternatives, water flow is restricted for all alternatives in the Initial Array to the level identified for the 75-x-10-foot channel. This results from the fact that water flow in the CMP is tidal and peaks every 12 hours before reversing direction. As a result, large accumulations of flow or head beyond the channel restriction or weir do not occur. This is different than flow in a riverine system not influenced by tides, as water flow would normally be traveling in one direction and the restricting channel would raise the head upstream from a channel constriction, thereby raising water flow. As a result, the flow and thus benefits resulting from larger alternatives with a weir is essentially identical to the flow and benefits identified for the 75-x-10-foot alternative, and larger, costlier alternatives would not be cost effective as they would produce the same benefits as smaller, cheaper alternatives.

Additionally, alternatives with smaller channel configurations would not require as many difficult Real Estate actions as larger alternatives. Once the project footprint becomes larger than that presented for Alternative 3 (125-x-10-foot channel), additional acquisitions and relocations become necessary, and the ability to meet the recommended minimum for mangrove fringe (~32 feet) is not feasible. As a result of the larger channel alternative screening analysis, Alternatives 4 and 5 were eliminated from consideration. None of these alternatives would be cost effective if a Cost Effectiveness/Incremental Cost Analysis was conducted, and they would be difficult to implement due to public acceptability and feasibility related to mangrove restoration minimums. Alternatives 1, 2, and 3 were retained to carry forward into a Final Array.

5.2.6.3 Further Bracketing of Alternatives

As there would only be three alternatives within the Final Array (excluding the No-Action), concerns were raised that additional alternatives could have been established to provide an even more comprehensive comparison. In regard to possible alternatives with channel dimensions between 100 and 125 feet wide, these alternatives would have the same benefits due to the weir restrictions, and cost would increase as channel width increases. As a result, nothing would be gained by adding another plan, as the 125-x-10-foot alternative successfully brackets a high end cost alternative that would not have better performance.

Alternative 3, with channel dimensions of 125 x 10 feet, is considered to be the largest channel configuration that would not cause detrimental within-channel scouring. Although numerous alternatives could have been formulated with channel dimension sizes between Alternatives 1 and 2, all of these plans would have required concrete matting to prevent erosion in the Project Channel, would cost more than Alternative 2, and would produce the same benefits as Alternative 2. No new information would be gained from including these additional plans in the analysis.

5.2.7 Final Array of Alternative Plans

The Final Array of Alternative Plans consisted of the No-Action Plan and Alternatives 1, 2, and 3. The following sections provide a more thorough description of each alternative plan, and are followed by plan evaluation, comparison, and selection.

5.2.7.1 No Action Alternative Plan

No further Federal actions will be implemented under the No Action Alternative.

5.2.7.2 Alternative Plan 1 – 75-Foot Channel Width, 10-Foot Depth

Total construction time for Alternative Plan 1 is approximately 27 months, including mobilization, site preparation, construction, and demobilization.

Channel

Alternative Plan 1 consists of dredging approximately 2.2 miles of the eastern end of the CMP to a width of 75 feet and a depth of 10 feet (Figure 10), with slight variations in channel width and depth at the four bridges in the western portion of the Project Channel, the Barbosa Bridge, and terminus of the Project Channel with the San José Lagoon. The walls of the Project Channel would be constructed with vertical concrete-capped steel sheet piles with hydrologic connections to the surrounding lands. The sill depth of the window would be set at mean low water so that tidal exchanges are facilitated to the mangrove beds. A temporary coffer dam would be constructed to parallel the shoreline at low-lying areas, such as the bend at Barrio Obrero Marina, to protect the

area(s) until the dredging and permanent sheet pile construction was completed. A temporary turbidity containment coffer dam would be constructed east of the Martín Peña Bridge.

At the terminus of the Project Channel with the San José Lagoon, an extended channel would be dredged east into the San José Lagoon (over a distance of approximately 4,300 feet) as a hydraulic transition from the CMP. This extended channel would transition from the 10-foot-deep Project Channel to the 6-foot-deep areas of San José Lagoon. The extended channel would maintain the Project Channel's 75-foot width but replace its steel sheet pile walls with a trapezoidal configuration with 5-foot to 1-foot earthen side slopes.

Clearing and grubbing activities would remove on average 12 inches from the project area within the CMP channel and result in the removal of approximately 91,909 cy of vegetation and mixed material and 642 cy of asphalt paving. Transport of this material would occur by truck and would be hauled for disposal to the Humacao landfill site.

A barge-mounted mechanical clamshell dredge would be used to widen and deepen the CMP, and would place dredged material into dump scows. Of the 680,000 cy of mixed materials, screens would separate solid waste debris (estimated at 68,000 cy) from sediments. It is estimated that the dredged debris would make up 10 percent of the total material to be dredged from the CMP, and the dredged sediments would bulk up to 126 percent of their in situ volume. Solid waste debris would be transported by shallow-draft barge to the CDRC staging area for subsequent landfill disposal. A majority of the sediments would be transported by barge for aquatic disposal, while some sediment would be used to complete the sheet pile construction and mangrove bed restoration. Additional technical investigations and studies are required for the CMP-ERP during Pre-construction, Engineering and Design (PED).

A weir would be constructed at the western end of the project area to protect the structural integrity of the existing four bridges in the western portion of the Project Channel. The dimensions of the weir (115 x 6.5 feet) would replicate the cross sectional area of the rest of the channel configuration (75 x 10 feet), which would prevent scour around bridges, bulkheads, and other marine structures west of the project area by providing a transition area to reduce unacceptable bottom velocities between the project area and the adjacent channels. The weir would be constructed with an articulated concrete bottom and would extend approximately 800 feet in length. The estimated amount of material that would be dredged to build the weir is 46,866 cy.

Erosion Control

Articulated concrete mats would be placed along the entire length of the dredged channel bottom to mitigate for high channel velocities that would occur in the Project Channel. This feature is expected to prevent scour along the bottom of the channel, which may threaten the stability of the sheet pile walls and increase sedimentation. Rip rap would be placed at the four western bridges and adjacent slopes, and at the Barbosa Bridge.

Disposal

Materials within the Caño Martín Peña include various types of solid waste, debris, and other materials. Such materials will require further testing prior to and/or during project construction, as appropriate, in accordance with an agreed sampling plan. If the testing determines that any materials contain hazardous substances at levels that are not suitable for unregulated disposal, they will be managed in accordance with the applicable laws and regulations of the relevant regulatory agencies. Solid waste and debris from the dredging of the CMP channel would be transported from the CDRC staging area to the Humacao landfill site, which is located approximately 32 miles from the CMP-ERP site. A total of 6 acres are included within the project footprint of the CDRC staging area on the southeast shore of San José Lagoon. Of these 6 acres, five acres are upland habitat and 1 acre is mangrove fringe. The staging area includes a dock for loading/unloading the dredged material to be transported to the landfill. The five upland acres are within a previously disturbed 35-acre parcel. After all solid waste has been disposed in the upland landfill, the 5-acre staging area would be restored with native upland vegetation, and the 1 acre of mangrove fringe would be restored with mangroves.

For activities related to the installation of the weir in the western end of the Project Channel, a 2-acre upland staging area (Las Piedritas) east of the Martín Peña bridge would be used to temporarily stockpile and transfer the collected solid waste excavated during the dredging process. Equipment and materials would be staged on floating barges. After the construction of the weir, and once the dredging from the eastern portion of the Project Channel opened the CMP, the temporary turbidity containment coffer dam would be removed. Solid waste and dredged sediment would be placed into trucks and hauled for disposal at the Humacao upland landfill.

After screening and removal of solid waste debris, the remaining sediment and smaller pieces of solid waste would be encapsulated within geotextile fabric bags, and transported by shallow-draft barges to the San José Lagoon artificial subaqueous pits. Sediments would be placed utilizing CAD in the SJ1 and SJ2 pits. Prior to disposal operations, both of these sites would be modified to increase capacity to accommodate the majority of dredged sediments and the required 2-foot sand cap. Approximately 506,381 cy of material would be removed from SJ1 and SJ2 and deposited within the San José 3/4/5 artificial subaqueous pits. The resulting depth of SJ3/4/5 would be approximately -13 feet MSL, as the combined capacity at -16 feet MSL would not accommodate the entirety of the relocated dredged material from SJ1 and SJ2. Enlarging SJ1 and SJ2 is the cost-effective approach versus disposing of dredged sediment across all five San José Lagoon artificial subaqueous pits because the surficial area in the latter approach would require significant more area for a sand cap. During the CMP-ERP disposal operations, approximately 574,200 cy of in situ sediments would be placed in the SJ1 and SJ2; however, additional water quality and sediment testing, such as bioassays, would be conducted prior to placement to ensure their suitability for disposal. Approximately 37,800 cy of in-situ sediments would be used to complete the sheet pile construction and mangrove bed restoration.

The SJ1 and SJ2 CAD sites would be capped with a 2-foot layer of sand. Material for the sand cap will be quarried from upland quarry sites and transported by trucks to the construction staging area for transfer to dump scows for placement. Silt curtains would also be employed around the CAD pits in the San José Lagoon. In critical areas, the curtains may double ring the active area for additional precautions. The curtains would be constructed to the full depth of the water where they are placed.

Mangrove Restoration

Approximately 34.46 acres of wetlands would be disturbed for construction activities, including 33.46 acres within the Project Channel and 1 acre at the CDRC staging area. Restoration of the disturbed mangrove fringe would be accomplished by grading the site to between 0 foot MLLW and 2 feet above MLLW, and planting with native vegetation. The width of the planting beds would vary depending upon the land availability, but in general would extend from the channel wall to the limit of the MTZ-CMP, excluding only areas set aside for recreation elements. Four species of mangrove would be considered for use in the mangrove planting beds depending on micro topography and the associated levels of tidal inundation, period, and salinity. After dredging and construction of mangrove planting beds, the CMP would consist of 20.42 acres of open water and 39.62 acres of mangrove wetland.

Non-Structural Measures

In total, 393 structures and 394 relocations would be acquired and completed, respectively, as part of the Federal CMP-ERP. In addition to the 96 structure acquisitions and 62 relocations already completed and/or in-process as part of the Federal project, the plan would include the acquisition and removal of an additional 297 residential structures, along with relocation of an additional 332 affected families. Enforcement of illegal dumping regulations, storm water and sewage improvements, and community education would be implemented by the non-Federal sponsors outside of the Federal project. Relocation of the Borinquen Water Transmission Line, the Rexach Trunk Sewer, and the 115-kV overhead transmission line would also be components of the CMP-ERP. No non-structural measures were identified to restore circulation to San José Lagoon.

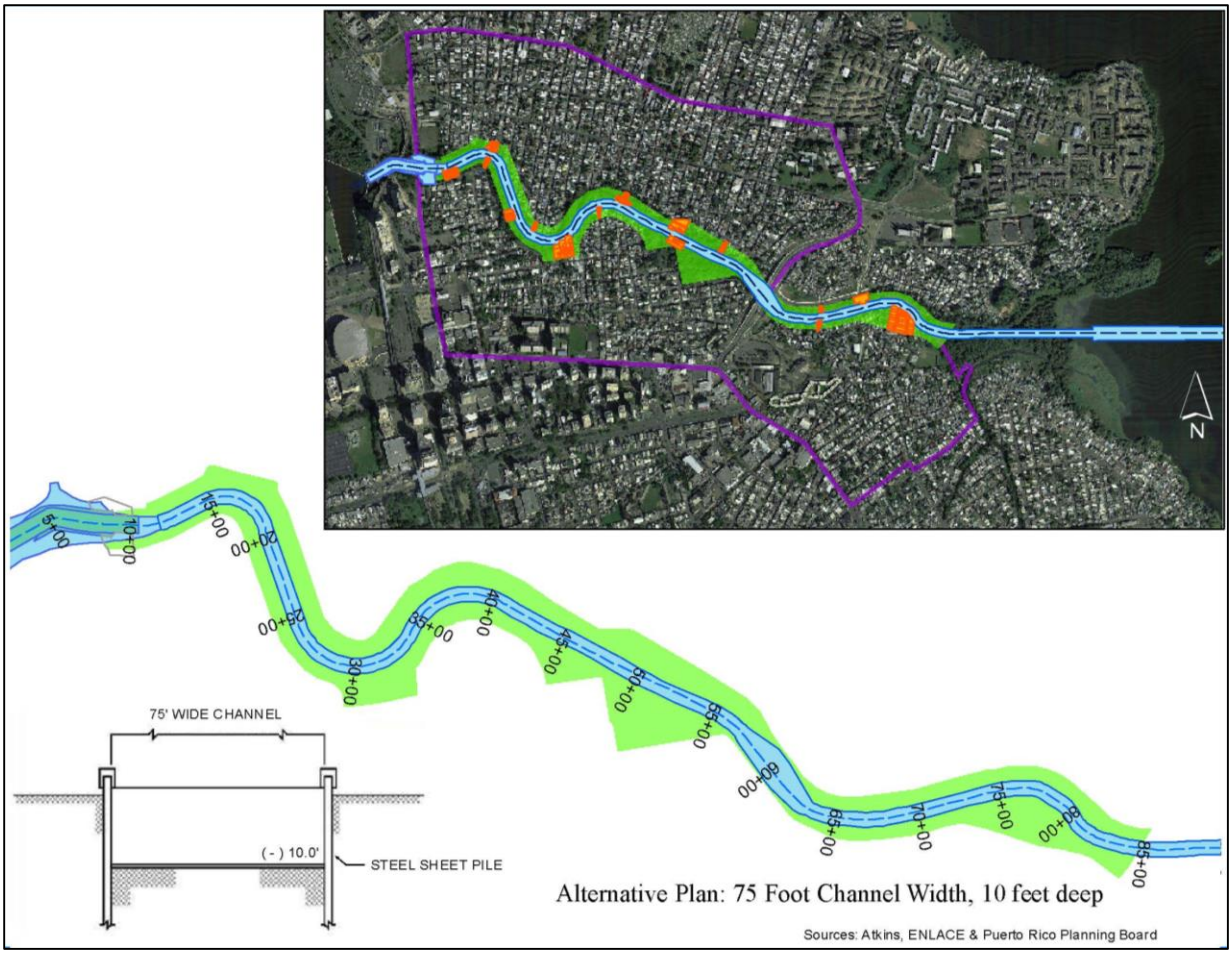

Figure 10. Alternative Plan 1 – 75-Foot Channel Width, 10-Foot Depth

5.2.7.3 Alternative Plan 2 – 100-Foot Channel Width, 10-Foot Depth

Total construction time for Alternative Plan 2 is approximately 27 months, including mobilization, site preparation, construction, and demobilization.

Channel

Alternative Plan 2 consists of dredging approximately 2.2 miles of the eastern end of the CMP to a width of 100 feet and a depth of 10 feet (Figure 11), with slight variations in channel width and depth at the 4 bridges in the western portion of the Project Channel, the Barbosa Bridge, and terminus of the CMP with the San José Lagoon. The walls of the Project Channel would be constructed with vertical concrete-capped steel sheet piles with hydrologic connections to the surrounding lands. The sill depth of the window would be set at mean low water so that tidal exchanges are facilitated to the mangrove beds. A temporary coffer dam would be constructed to parallel the shoreline at low-lying areas, such as the bend at Barrio Obrero Marina, to protect the

area(s) until the dredging and permanent sheet pile construction was completed. A temporary turbidity containment coffer dam would be constructed to the east of the Martín Peña Bridge.

At the terminus of the Project Channel with the San José Lagoon, an extended channel would be dredged east into the San José Lagoon (over a distance of approximately 4,300 ft) as a hydraulic transition from the CMP. This extended channel would transition from the 10-foot-deep Project Channel to the 6-foot-deep areas of San José Lagoon. The extended channel would maintain the Project Channel's 100-foot width but replace its steel sheet pile walls with a trapezoidal configuration with 5-foot to 1-foot earthen side slopes. Additional technical investigations and studies are required for the CMP-ERP during PED.

Figure 11. Alternative Plan 2 – 100-Foot Channel Width, 10-Foot Depth

Clearing and grubbing activities would remove on average 12 inches from the project area within the CMP channel and result in the removal of approximately 91,909 cy of vegetation and mixed material and 642 cy of asphalt paving. Transport of this material would occur by truck and would be hauled for disposal at the Humacao landfill site.

A barge-mounted mechanical clamshell dredge would be used to widen and deepen the CMP channel, and would place dredged material into dump scows. Of the 762,000 cy of mixed materials, screens would separate solid waste debris (estimated at 76,200 cy) from sediments. It is estimated that the dredged solid waste debris would make up 10 percent of the total material to be dredged from the CMP, and the dredged sediments would bulk up to 126 percent of their in situ volume. Solid waste debris would be transported by barge to the CDRC for subsequent landfill disposal. Sediments would be transported by shallow-draft barge for aquatic disposal.

Erosion Control

A weir would be constructed at the western end of the project area to mitigate water flows into the adjacent waterways, in addition to the need to protect the structural integrity of the four bridges in the western portion of the Project Channel. The dimensions of the weir (115 x 6.5 feet) would replicate the cross sectional area of Alternative 1 (75 x 10 feet), and would prevent scour around bridges, bulkheads, and other marine structures west of the project area by providing a transition area to reduce unacceptable bottom velocities between the project area and the adjacent channels. The weir would be constructed with an articulated concrete bottom and would extend approximately 800 feet in length, while the remainder of the project channel would be earthen bottom. Rip rap would be placed at the four western bridges and adjacent slopes, and at the Barbosa Bridge. The estimated amount of material that would be dredged to build the weir is 46,866 cy.

Disposal

Materials within the Caño Martín Peña include various types of solid waste, debris, and other materials. Such materials will require further testing prior to and/or during project construction, as appropriate, in accordance with an agreed sampling plan. If the testing determines that any materials contain hazardous substances at levels that are not suitable for unregulated disposal, they will be managed in accordance with the applicable laws and regulations of the relevant regulatory agencies. Solid waste debris from the dredging of the CMP channel would be transported from the CDRC staging area to the Humacao landfill site, which is located approximately 32 miles from the CMP-ERP site. A total of 6 acres are included within the project footprint of the CDRC staging area on the southeast shore of San José Lagoon. Of these 6 acres, five acres are upland habitat and 1 acre is mangrove fringe. The staging area includes a dock for loading/unloading the dredged material to be transported to the landfill. The five upland acres are within a previously disturbed 35-acre parcel. After all solid waste has been disposed in the upland landfill, the 5-acre staging area would be restored with native upland vegetation, and the 1 acre of mangrove fringe would be restored with mangroves.

For activities related to the installation of the weir in the western end of the Project Channel, a 2-acre upland staging area (Las Piedritas) east of the Martín Peña bridge would be used to

temporarily stockpile and transfer the collected solid waste excavated during the dredging process. Equipment and materials would be staged on floating barges. After the construction of the weir, and once the dredging from the eastern portion of the Project Channel opened the CMP, the temporary turbidity containment coffer dam would be removed. Solid waste and dredged sediment would be placed into trucks and hauled for disposal at the Humacao upland landfill.

After screening and removal of solid waste debris, the remaining sediment and smaller pieces of solid waste would be encapsulated within geotextile fabric bags, and transported by shallow-draft barges to the San José Lagoon artificial subaqueous pits. Sediments would be placed utilizing CAD in the SJ1 and SJ2 pits. Prior to disposal operations, both of these sites would be modified to increase capacity to accommodate the majority of dredged sediments and the required 2-foot sand cap. Approximately 506,381 cy of material would be removed from SJ1 and SJ2 and deposited within the San José 3/4/5 artificial subaqueous pits. The resulting depth of SJ3/4/5 would be approximately -13 feet MSL, as the combined capacity at -16 feet MSL would not accommodate the entirety of the relocated dredged matrial from SJ1 and SJ2. Enlarging SJ1 and SJ2 is the cost-effective approach versus disposing of dredged sediment across all five San José Lagoon artificial subaqueous pits because the surficial area in the latter approach would require significant more area for a sand cap. During the CMP-ERP disposal operations, approximately 648,000 cy of in situ sediments would be placed in the SJ1 and SJ2; however, additional water quality and sediment testing, such as bioassays, would be conducted prior to placement to ensure their suitability for disposal. Approximately 37,800 cy of in-situ sediments would be used to complete the sheet pile construction and mangrove bed restoration.

The SJ1 and SJ2 CAD sites would be capped with a 2-foot layer of sand. Material for the sand cap will be quarried from upland quarry sites and transported by trucks to the construction staging area for transfer to dump scows for placement. Silt curtains would also be employed around the CAD pits in the San José Lagoon. In critical areas, the curtains may double ring the active area for additional precautions. The curtains would be constructed to the full depth of the water where they are placed.

Mangrove Restoration

Approximately 34.46 acres of wetlands would be disturbed for construction activities, including 33.46 acres within the Project Channel and 1 acre at the CDRC staging area. Restoration of the disturbed mangrove fringe would be accomplished by grading the site to between 0 foot MLLW and 2 feet above MLLW, and planting with native vegetation. The width of the planting beds would vary depending upon the land availability, but in general would extend from the channel wall to the line of public domain, excluding only areas set aside for recreation elements. The minimum width for mangrove fringes would be approximately 32 feet on either side of the CMP. Four species of mangrove would be considered for use in the mangrove planting beds depending on micro topography and the associated levels of tidal inundation, period, and salinity. After dredging and

construction of mangrove planting beds, the Project Channel would consist of 25.57 acres of open water and 34.48 acres of mangrove wetland.

Non-Structural Measures

In total, 393 structures and 394 relocations would be acquired and completed, respectively, as part of the Federal CMP-ERP. In addition to the 96 structure acquisitions and 62 relocations already completed and/or in-process as part of the Federal project, the plan would include the acquisition and removal of an additional 297 residential structures, along with relocation of an additional 332 affected families. Enforcement of illegal dumping, storm water and sewage improvements, and community education would be implemented by the non-Federal sponsors outside of the Federal project. Relocation of the Borinquen Water Transmission Line, the Rexach Trunk Sewer, and the 115-kV overhead transmission line would also be components of the CMP-ERP. No non-structural measures were identified to restore circulation to San José Lagoon.

5.2.7.4 Alternative Plan 3 – 125-Foot Channel Width, 10-Foot Depth

Total construction time for Alternative Plan 1 is approximately 27 months, including mobilization, site preparation, construction, and demobilization.

Channel

Alternative Plan 3 consists of dredging approximately 2.2 miles of the eastern end of the CMP to a width of 125 feet and a depth of 10 feet (Figure 12), with slight variations in channel width and depth at the four bridges in the western portion of the Project Channel, the Barbosa Bridge, and terminus of the Project Channel with the San José Lagoon. The walls of the Project Channel would be constructed with vertical concrete-capped steel sheet piles with hydrologic connections to the surrounding lands. The sill depth of the window would be set at mean low water so that tidal exchanges are facilitated to the mangrove beds. A temporary coffer dam would be constructed to parallel the shoreline at low-lying areas such as the bend at Barrio Obrero Marina to protect the area(s) until the dredging and permanent sheet pile construction was completed. A temporary turbidity containment coffer dam would be constructed to the east of the Martín Peña Bridge.

At the terminus of the Project Channel with the San José Lagoon, an extended channel would be dredged east into the San José Lagoon (over a distance of approximately 4,300 ft) as a hydraulic transition from the CMP. This extended channel would transition from the 10-foot-deep Project Channel to the 6-foot-deep areas of San José Lagoon. The extended channel would maintain the Project Channel's 125-foot width but replace its steel sheet pile walls with a trapezoidal configuration with 5-foot to 1-foot earthen side slopes.

Clearing and grubbing activities would remove on average 12 inches from the project area within the CMP channel and result in the removal of of approximately 91,909 cy of vegetation and mixed

material and 642 cy of asphalt paving. Transport of this material would occur by truck and would be hauled for disposal at the Humacao landfill site.

A barge-mounted mechanical clamshell dredge would be used to widen and deepen the CMP, and would place dredged material into dump scows. Of the 872,000 cy of mixed materials, screens would separate solid waste debris (estimated at 87,200 cy) from sediments. It is estimated that the dredged solid waste debris would make up 10 percent of the total material to be dredged from the CMP, and the dredged sediments would bulk up to 126 percent of their in situ volume. Solid waste debris would be transported by barge to a staging area for subsequent landfill disposal. Sediments would be transported by shallow-draft barge for aquatic disposal. Additional technical investigations and studies are required for the CMP-ERP during PED.

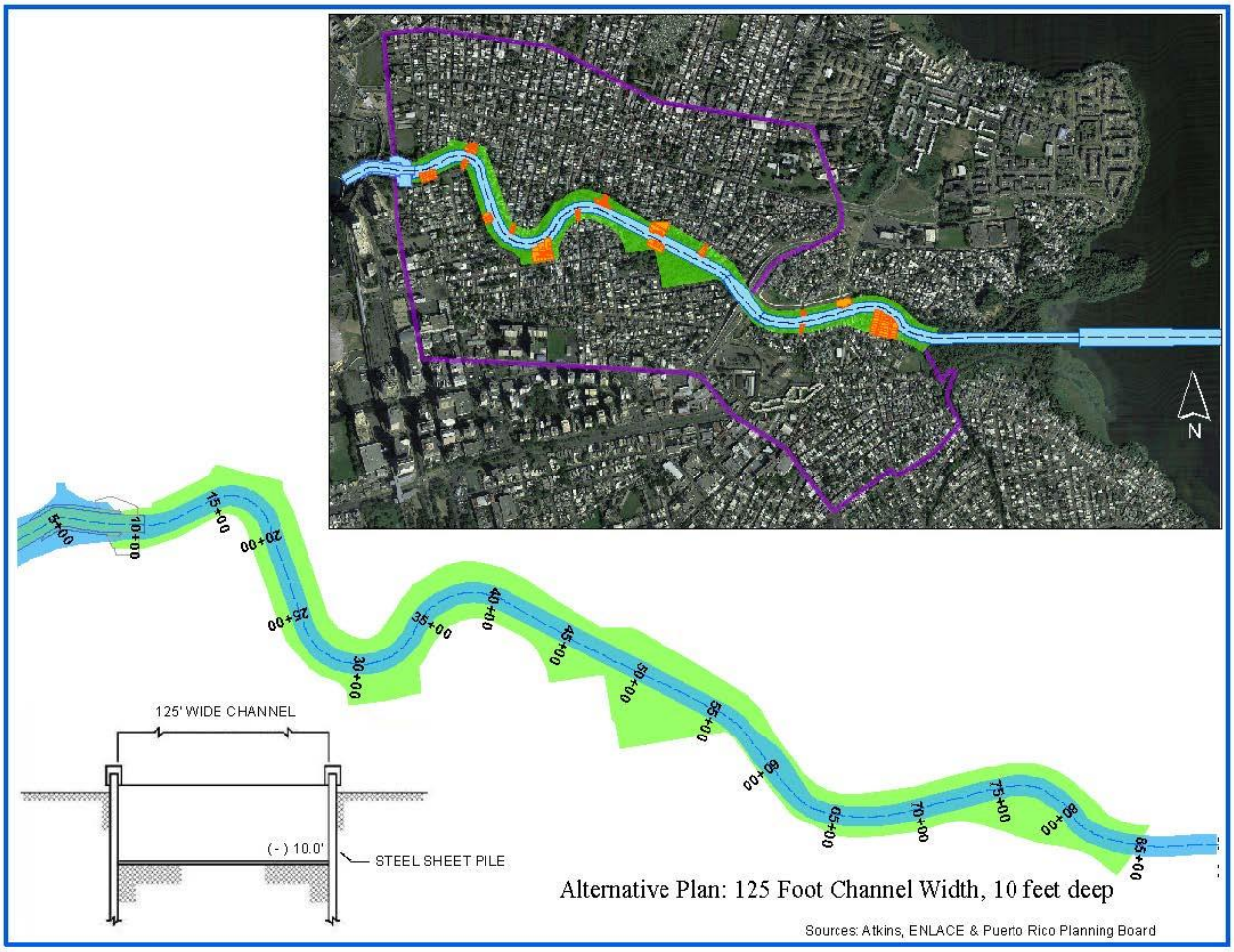

Figure 12. Alternative Plan 3 – 125-Foot Channel Width, 10-Foot Depth

Erosion Control

A weir would be constructed at the western end of the project area to mitigate water flows into the adjacent waterways, in addition to the need to protect the structural integrity of the four bridges in the western portion of the Project Channel. The dimensions of the weir (115 x 6.5 feet) would replicate the cross sectional area of Alternative 1 (75 x 10 feet) and would extend approximately 800 feet in length, and would prevent scour around bridges, bulkheads, and other marine structures west of the project area by providing a transition area to reduce unacceptable bottom velocities between the project area and the adjacent channels. The weir would be constructed with an articulated concrete bottom, while the remainder of the project channel would be earthen bottom. Rip rap would be placed at the four western bridges and adjacent slopes, and at the Barbosa Bridge. The estimated amount of material that would be dredged to build the weir is 46,866 cy.

Disposal

Materials within the Caño Martín Peña include various types of solid waste, debris, and other materials. Such materials will require further testing prior to and/or during project construction, as appropriate, in accordance with an agreed sampling plan. If the testing determines that any materials contain hazardous substances at levels that are not suitable for unregulated disposal, they will be managed in accordance with the applicable laws and regulations of the relevant regulatory agencies. Solid waste debris from the dredging of the CMP channel would be transported from the CDRC staging area to the Humacao landfill site, which is located approximately 32 miles from the CMP-ERP site. A total of 6 acres are included within the project footprint of the CDRC staging area on the southeast shore of San José Lagoon. Of these 6 acres, five acres are upland habitat and 1 acre is mangrove fringe. The staging area includes a dock for loading/unloading the dredged material to be transported to the landfill. The five upland acres are within a previously disturbed 35-acre parcel. After all solid waste has been disposed in the upland landfill, the 5-acre staging area would be restored with native upland vegetation, and the 1 acre of mangrove fringe would be restored with mangroves.

For activities related to the installation of the weir in the western end of the Project Channel, a 2-acre upland staging area (Las Piedritas) east of the Martín Peña bridge would be used to temporarily stockpile and transfer the collected solid waste excavated during the dredging process. Equipment and materials would be staged on floating barges. After the construction of the weir, and once the dredging from the eastern portion of the Project Channel opened the CMP, the temporary turbidity containment coffer dam would be removed. Solid waste and dredged sediment would be placed into trucks and hauled for disposal at the Humacao upland landfill.

After screening and removal of solid waste debris, the remaining sediment and smaller pieces of solid waste would be encapsulated within geotextile fabric bags, and transported by shallow-draft barges to the San José Lagoon artificial subaqueous pits. Sediments would be placed utilizing CAD in

the SJ1 and SJ2 pits. Prior to disposal operations, both of these sites would be modified to increase capacity to accommodate the majority of dredged sediments and the required 2-foot sand cap. Approximately 506,381 cy of material would be removed from SJ1 and SJ2 and deposited within the San José 3/4/5 artificial subaqueous pits. The resulting depth of SJ3/4/5 would be approximately -13 feet MSL, as the combined capacity at -16 feet MSL would not accommodate the entirety of the relocated dredged matrial from SJ1 and SJ2. Enlarging SJ1 and SJ2 is the cost-effective approach versus disposing of dredged sediment across all five San José Lagoon artificial subaqueous pits because the surficial area in the latter approach would require significant more area for a sand cap. During the CMP-ERP disposal operations, approximately 747,000 cy of in situ sediments would be placed in the SJ1 and SJ2; however, additional water quality and sediment testing, such as bioassays, would be conducted prior to placement to ensure their suitability for disposal. Approximately 37,800 cy of in-situ sediments would be used to complete the sheet pile construction and mangrove bed restoration.

The SJ1 and SJ2 CAD sites would be capped with a 2-foot layer of sand. Material for the sand cap will be quarried from upland quarry sites and transported by trucks to the construction staging area for transfer to dump scows for placement. Silt curtains would also be employed around the CAD pits in the San José Lagoon. In critical areas, the curtains may double ring the active area for additional precautions. The curtains would be constructed to the full depth of the water where they are placed.

For activities related to the installation of the weir in the western end of the Project Channel, an upland staging area near the four western bridges would be used to temporarily stockpile and transfer the collected solid waste excavated during the dredging process. Equipment and materials would be staged on floating barges. After the construction of the weir, and once the dredging from the eastern portion of the Project Channel opened the CMP, the temporary coffer dam would be removed, and the stockpiled solid waste would be placed into shallow-draft barges for transport to the CDRC staging area. At the CDRC staging area, the material would be off-loaded, placed into trucks, and hauled for disposal at the Humacao upland landfill.

Mangrove Restoration

Approximately 34.46 acres of wetlands would be disturbed for construction activities, including 33.46 acres within the CMP and 1 acre at the construction staging area. Restoration of the disturbed mangrove fringe would be accomplished by grading the site to between 0 foot MLLW and 2 feet above MLLW, and planting with native vegetation. The width of the planting beds would vary depending upon the land availability, but in general would extend from the channel wall to the limit of the MTZ-CMP, excluding only areas set aside for recreation elements. The minimum width for mangrove fringes would be approximately 32 feet on either side of the CMP. Four species of mangrove would be considered for use in the mangrove planting beds depending on micro topography and the associated levels of tidal inundation, period, and salinity. After dredging and

construction of mangrove planting beds, the CMP would consist of 30.97 acres of open water and 29.08 acres of mangrove wetland.

Non-Structural Measures

In total, 393 structures and 394 relocations would be acquired and completed, respectively, as part of the Federal CMP-ERP. In addition to the 96 structure acquisitions and 62 relocations already completed and/or in-process as part of the Federal project, the plan would include the acquisition and removal of an additional 297 residential structures, along with relocation of an additional 332 affected families. Enforcement of illegal dumping, storm water and sewage improvements, and community education would be implemented by the non-Federal sponsors outside of the Federal project. Relocation of the Borinquen Water Transmission Line, the Rexach Trunk Sewer, and the 115-kV overhead transmission line would also be components of the CMP-ERP. No non-structural measures were identified to restore circulation to San José Lagoon.

5.3 EVALUATION OF FINAL ARRAY OF ALTERNATIVE PLANS

5.3.1 Benefit Evaluation

5.3.1.1 Federal Objective

Ecosystem restoration is one of the primary missions of the USACE Civil Works program. The USACE objective in ecosystem restoration planning is to contribute to NER. Contributions to NER, or NER outputs, are increases in the net quantity and/or quality of desired ecosystem resources. Measurement of NER is based on changes in ecological resource quality as a function of improvement in habitat quality and/or quantity and expressed quantitatively in physical units or indexes (but not monetary units). These net changes are measured in the planning area and in the rest of the Nation. As a single purpose ecosystem restoration feasibility study, the alternative plans were evaluated in terms of their net contributions to increases in ecosystem value, expressed in non-monetary habitat units. Results of the NER analyses are presented in Section 5.3.1.2, Habitat Units.

With respect to benefits derived from the various channel alternatives, modeling concludes that there is a significant benefit to the San José Lagoon (based on the benthic index score) once the CMP channel is widened to 75 feet due to tidal amplitude, or volume of water flowing into and out of the lagoon. Increasing channel widths to 100 and 125 feet would progressively result in additional, albeit marginal, benefit as a result of the increased water flows and reduced water residence times. Although the western and eastern segments of the Project Channel have different cross-sectional areas and bottom elevations for the 100- and 125-foot alternatives with the weir, water flow through a tidal system such as the CMP is, and would continue to be, restricted by the smallest cross-sectional area. Accordingly, once the weir is included in the larger channel configurations, there is no further benefit to residence time in San José Lagoon with channel widths wider than 75

feet, and thus no additional NER benefits. Therefore, the NER benefits related to ecological uplift for all alternatives would be the same as the 75-foot channel alternative. The only difference would be the variation in habitat scores as it related to open water and mangrove habitat within the Project Channel.

The performance metrics/models for the benefits analysis were mostly based on assessments developed from existing efforts and from the relationships and hypotheses developed in the Conceptual Ecological Model (CEM) contained in the NER Benefits Evaluation Appendix (Appendix A). These prior efforts include a hydrodynamic model originally produced for San Juan Bay by Bunch et al. (2000), which was recreated with various potential tidal reestablishment scenarios by Atkins (2011a). The hydrodynamic model used was the Curvilinear-grid Hydrodynamics model in 3 Dimensions, developed by USACE researchers from the Waterways Experimental Station model (i.e., Curvilinear Hydrodynamics in 3 Dimensions, WES version = CH3D-WES). The physical boundaries of the hydrodynamic model (Bunch et al. 2000) are consistent with the physical boundaries of the estuary and nearshore waters used by the San Juan Bay Estuary Program in developing its various resource management programs. The hydrodynamic model is an approved model by USACE Headquarters, and the habitat models have been evaluated by the USACE Ecosystem Restoration Planning Center of Expertise (ECO-PCX) and approved for single-use by the Model Certification Team, USACE HQ.

5.3.1.2 Habitat Units

In order to calculate habitat units, performance metrics were developed from project planning documents, and relationships and hypotheses developed in the CEM. The CEM displays relationships demonstrating that the planned CMP-ERP would result in:

1. Improved fish habitat in the SJBE system by increasing connectivity and tidal access to estuarine areas;
2. Restored benthic habitat in San José and Los Corozos lagoons by increasing dissolved oxygen in bottom waters and improving the salinity regime to levels that support native estuarine benthic species; and
3. Increased the distribution and population density and diversity of native aquatic fish and invertebrates in the mangrove community by improving hydrologic conditions in the SJBE system.

These parameters were then associated with the appropriate attributes of benthic habitat, fish habitat, and mangrove habitat.

5.3.1.2.1 Fish Habitat Model

The restoration of the inter-connectedness of mangrove forests, seagrass meadows, open water and coral reefs as the “seascape” is essential to improving the health, viability and number of fish within

the SJBE. Currently, fish within San Juan Bay cannot directly access the mangroves, seagrass meadows, and open-water habitats of San José Lagoon, the Suarez Canal, La Torrecilla Lagoon and Piñones Lagoon, just as fish within those waterbodies cannot directly access the habitats afforded by San Juan Bay (located to the west of the western end of the CMP). Due to the current condition of the CMP, there is essentially no tidal exchange between San Juan Bay and the San José Lagoon, i.e., the eastern and western sides of San Juan Bay Estuary system, creating essentially two estuary systems connected independently to the ocean waters by inlets.

The restoration of the CMP is not only expected to benefit water quality and fish habitat within the Caño Martín Peña, San José Lagoon, and Los Corozos Lagoon (Atkins 2011a), it would benefit fisheries outside of these water bodies by allowing easier access to the variety of fish habitat (i.e., open water, seagrass meadows, hard bottom, mangrove fringes) found throughout the newly inter-connected waters of San Juan Bay, San José Lagoon, the Suarez Canal, La Torrecilla Lagoon and Piñones Lagoon (i.e., the entire San Juan Bay Estuary system).

The quantification of benefits to the fish habitats that constitute the seascape features of the SJBE is based on a two-step process. The first step involves the use of existing Geographic Information System (GIS) maps to quantify acreage associated with the habitats of open water, seagrass meadows, and nearby coral reefs. Model boundaries were those previously delimited by the SJBEP. The acreage estimates for the combined areas of open water and seagrass habitat were quantified using GIS for each of the following waterbodies: 1) Los Corozos Lagoon, 2) San José Lagoon, 3) Caño Martín Peña (from the existing condition and project alternatives), 4) eastern San Juan Bay, 5) western San Juan Bay, 6) Suarez Canal, 7) La Torrecilla Lagoon, 8) Piñones Lagoon, and 9) Condado Lagoon. For the reef tract, GIS coverage was divided between West Near Inlet, East Near Inlet, and Central Reef Tract portions.

The second step was to scale the habitats. The fish habitats associated with open waters and seagrass meadows (if present) in Caño Martín Peña, San José Lagoon, the Suarez Canal, and Los Corozos Lagoon would directly benefit from the restoration of the historical tidal connection between San Juan Bay and San José Lagoon, and therefore the anticipated ecological uplift with project implementation is calculated by multiplying acres of open-water habitat by a scaling factor of 1.0. For areas other than San José Lagoon, an approach was used whereby the relative degree of connectivity between a given location and San José Lagoon would be the basis for scaling habitat uplift estimates. The scaling factor decreased in increments of 0.25 for every intervening waterbody between a location and San José Lagoon, until reaching the farthest locations for any reasonable expectations of environmental benefit. Thus, the fish habitat benefits associated with open waters and seagrass meadows (if present) in San Juan Bay and La Torrecilla Lagoon are less direct than in San José Lagoon, and the anticipated ecological uplift is calculated by multiplying their acres of habitat by the scaling factor of 0.75. For Condado and Piñones Lagoons, the fish habitat uplift associated with open waters and seagrass meadows (if present) are less direct still, and the

anticipated ecological uplift with project implementation is calculated by multiplying habitat acres by a scaling factor of 0.50.

Although it is anticipated that reef habitats will benefit from the restored water quality that would occur in San José Lagoon and the CMP, a conservative approach to quantifying anticipated ecological uplift is appropriate. Consequently, the fish habitat uplift associated with the reef tract upon project implementation is calculated by multiplying reef acreage estimates in the eastern near inlet and western near inlet regions by a scaling factor of 0.25. For the Central Reef Tract, a scaling factor of 0.125 is used.

Table 11 provides the location/habitat feature, existing acreage of habitat, scaling factor, and open-water habitat units for the proposed, preferred channel alternative (the 100-foot-wide channel with the weir) within the Caño Martín Peña representing the "with" benefits improvement of that alternative. There are habitat units that exist within the system with the No Action Alternative (existing condition) represented by the net habitat units "without" benefits column in Table 11. Under the No Action Alternative, it is expected that the current conditions for open water/seagrass and reef habitat would remain the same and/or continue to degrade within the San Juan Bay Estuary system and the Caño Martín Peña.

To be clear, the acres of habitat within the San Juan Bay Estuary system only change for each project alternative within the Caño Martín Peña where that location/habitat feature is represented by real acres of existing and constructed acres of open-water habitat. The real, constructed habitat represents the benefits within the Caño Martín Peña. Those changes between the project alternatives are represented in Table 12.

The construction of the CMP-ERP would result in the eventual benefit to open water and reef habitat of additional net habitat units based upon the scaling factors and the proposed Caño Martín Peña channel alternatives (5,154.0 HUs for the 75-foot Alternative; 5.159.2 HUs for the 100-foot Alternative with weir; and 5,164.6 HUs for the 125-foot Alternative with weir). The net average annual habitat units (AAHUs) for the Fish Habitat Model varies between the proposed Caño Martín Peña channel alternatives (Table 13) (5,050.9 AAHUs for the 75-foot Alternative; 5,056.0 AAHUs for the 100-foot Alternative with weir; and 5,061.3 AAHUs for the 125-foot Alternative with weir) and is based upon the recovery time of 3 years (linearly from the existing condition to the predicted, modeled score) and a project period of 50 years.

Table 11. Quantification of Open Water/Seagrass and Reef Habitat Unit Benefits with Project Implementation

Location / Habitat Feature	Acres of Habitat	Scaling Factor[1]	Net Habitat Units with Benefits	Net Habitat Units without Benefits
San Juan Bay	3,483.4	0.75	2,612.6	870.8
Condado Lagoon	77.6	0.50	38.8	38.8
San José Lagoon	1,039.9	1.00	1,039.9	0.0
La Torrecilla Lagoon	642.0	0.75	481.5	160.5
Piñones Lagoon	242.6	0.50	121.3	121.3
Suárez Canal	63.9	1.00	63.9	0.0
Caño Martín Peña	7.4	-	18.2	7.4[2]
Los Corozos Lagoon	202.2	1.00	202.2	0.0
Western near Inlet Reef	773.0	0.25	193.3	579.8
Eastern near Inlet Reef	309.4	0.25	77.4	232.0
Central Reef Tract	2,481.9	0.125	310.2	2,171.7
SUBTOTAL	**9,323.3**	**-**	**5,159.2[3]**	**4,182.3[3]**

[1] For the CMP, instead of a scaling factor, Net Habitat Unit Benefits were calculated by comparing the existing habitat units of the CMP (No Action Alternative) versus the projected habitat units of the CMP under the NER Plan (see Table 12.

[2] For the CMP, the existing 7.4 acres/habitat units are not included as part of, or added to, NER benefit calculations.

[3] Under the NER Plan, the amount of open water within the CMP would increase from the existing 7.4 acres/habitat units to 25.6 acres/habitat units, thus increasing the overall total open-water habitat from 9,323.3 acres/habitat units to 9,341.6 acres/habitat units.

Table 12. Quantification of Open-Water Habitat Unit Benefits for the No Action and Project Alternatives within the Caño Martín Peña

Project Alternative	Existing Acres in CMP	Net Increase of Habitat Units in CMP	Total Net Habitat Units with Benefits
No Action	7.4	0.0	0.0
75-foot-wide	20.4	13.0	5,154.0[1]
100-foot-wide with weir (NER Plan)	25.6	18.2	5,159.2
125-foot-wide with weir	31.0	23.6	5,164.6[2]

[1] For the 75-foot-wide alternative, the total net habitat units with benefits includes the increase of 13 HUs within the CMP and the 5,141 HUs for all other SJBE features identified in Table 11 (Net Habitat Units with Benefits).

[2] For the 125-foot-wide alternative, the total net habitat units with benefits includes the increase of 23.6 HUs within the CMP and the 5,141 HUs for all other SJBE features identified in Table 11 (Net Habitat Units with Benefits).

Table 13. Performance of Alternative Plans
Against Planning Objective 1

Project Condition	Net Average Annual Habitat Units (AAHUs)
No Action Alternative	0.0
Alternative Plan 1 (75-x-10-foot Channel)	5,050.9
Alternative Plan 2 (100-x-10-foot with weir)	5,056.0
Alternative Plan 3 (125-x-10-foot with weir)	5,061.3

5.3.1.2.2 Benthic Index Model

Benthic habitat is evaluated using an index originally developed for the SJBE Program to report on the status and trends of the health of the SJBE and its individual component water bodies. The technique is consistent with the wider body of literature on how such indices should be constructed, and it is consistent with guidance provided by USEPA (2008) on the requirements of a benthic index which is a refinement of the standard diversity index for SJBE. The index combines information on benthic community diversity, the presence or absence of pollution-tolerant benthic taxa, and the presence or absence of pollution-sensitive taxa (PBS&J 2009). The Benthic index is designed to increase as beneficial factors (i.e., species richness [number of species present], species evenness [number of individuals present from each species is not dominated by one species in particular]), and presence of pollution-sensitive taxa increase. Conversely, if species richness and/or evenness decline and the proportion of pollution-tolerant taxa increases, the Benthic Index will decline. An extensive database on benthic species composition by Riviera (2005) was used to produce benthic index scores throughout SJBE. In the original report (PBS&J 2009), it was determined that benthic index scores were lowest in SJBE in the Caño Martín Peña, followed by the San José Lagoon and that distance from the Atlantic Ocean, used as a surrogate for tidal influence, was a better predictor of benthic index scores than water depth.

Output from the hydrodynamic model was used to determine whether the correlation between benthic index scores and distance from the Atlantic Ocean could be replicated with residence time. The model variables used for the linked hydrodynamic-Benthic Index Model are the hydrodynamic model (CH3D-WES) output of residence time (as an independent variable) and benthic index scores (as a potentially statistically significant independent response variable). The model assumptions are that residence time affects benthic index scores, and the derived mathematical equation reveals the direction of the relationship, the variability associated with the derived relationship, and the statistical significance of the relationship. The Benthic Index Model was properly associated with

the residence time within San José Lagoon because the benthic index improvement in San José Lagoon depends upon the water within the Lagoon turning over with the reduced residence time and increased dissolved oxygen levels are anticipated in bottom waters of San José Lagoon as a function of decreased salinity stratification (which is currently occurring in the lagoon), brought about through increasing the exchange of more saline surface waters. Larger, deeper waterbodies like San Juan Bay proper will not experience a significant reduction in residence time with the opening of the Caño Martín Peña; whereas, smaller, fairly shallow waterbodies like San José Lagoon will experience significant reductions in residence time.

To estimate the spatial extent of benthic communities expected to benefit, with regard to the benthic index model, the water quality surveys conducted in the Hydrodynamic and Water Quality Modeling Effort (Atkins 2011a) were examined in greater detail. A close examination of the water column profiles contained in that report shows that salinity stratification and bottom water hypoxia/anoxia occurs at depths greater than about 4 feet. Waters shallower than 4 feet do not show evidence of salinity stratification. There are a number of deep dredge pits in the San José Lagoon, mostly in the southeastern portion of the lagoon. The deep waters of these dredge pits grade down to depths in excess of 20 feet from a more typical depth within the lagoon of approximately 6 feet. It was thus concluded that waters shallower than 4 feet would not likely benefit from enhanced tidal circulation, as they are too shallow to exhibit hypoxia/anoxia brought about by salinity stratification. Those bottom areas associated with deep dredge pits which will likely continue to be problematic in terms of hypoxia and anoxia.

Those portions of San José Lagoon that are between 4 and 6 feet in depth represent the portions of the lagoon that are anticipated to have improved benthic index scores upon restoration of the historical tidal connection between San Juan Bay and San José Lagoon. The spatial extent of the bay bottom to benefit in this manner is quantified at 702 acres.

The performance of the Benthic Index Model (Table 14) is based on achieving a Benthic Index value of 3.0, which would be approximately the maximum predicted value for the Benthic Index in San José Lagoon after restoring the CMP to its original width and depth of an estimated 200 feet by 10 feet. The Habitat Unit score is based upon the project performance and the maximum spatial extent of the area of San José Lagoon that would benefit from the opening of the CMP (702 acres). The net AAHUs (294.5 habitat units) for the Benthic Index Model is based upon the recovery of the area in San José Lagoon to the predicted, modeled Benthic Index HUs (663.8) starting from no action (363.0 habitat units) with the expected time of recovery of 3 years (linearly from the existing condition to the predicted, modeled score) and the project period of 50.

Table 14. Performance of Alternative Plans Against Planning Objective 2

Alternative Plan (feet wide x feet deep)	Residence Time (days)	Benthic Index	Scaled Benthic Index (based on a maximum of 3.0)	Habitat Units (relative benthic index x 702 acres)	Net Benthic Index HU	Net Average Annual HU
No Action	16.9	1.55	52%	363.0	0.0	0.0
Alternative Plan 1 (75 x 10)	3.9	2.84	95%	663.8	300.9	294.5
Alternative Plan 2 (100 x 10 with weir)	3.9	2.84	95%	663.8	300.9	294.5
Alternative Plan 3 (125 x 10 with weir)	3.9	2.84	95%	663.8	300.9	294.5

5.3.1.2.3 Mangrove Habitat Model

The Sport Fisheries Study (Atkins 2011b) includes an assessment of the red mangrove prop root community within the CMP and within zones in designated distances away from the CMP. It was found that the numbers and diversity of the attached (e.g., mussels and oysters) and mobile (e.g., crabs) organisms found on the roots increased from the CMP and western San José Lagoon out to La Torrecilla Lagoon, thus providing an indicator of water quality improvement that would likely respond to the improvements provided by the opening of the CMP. Through this preliminary study, a significant relationship was found between the number of crabs found on mangrove prop roots and distance from the CMP (Figure 13). This relationship uses the connectivity of habitat described above for fish habitat and may be expanded to further species individuals and groups or overall density and diversity of organisms with further data collection.

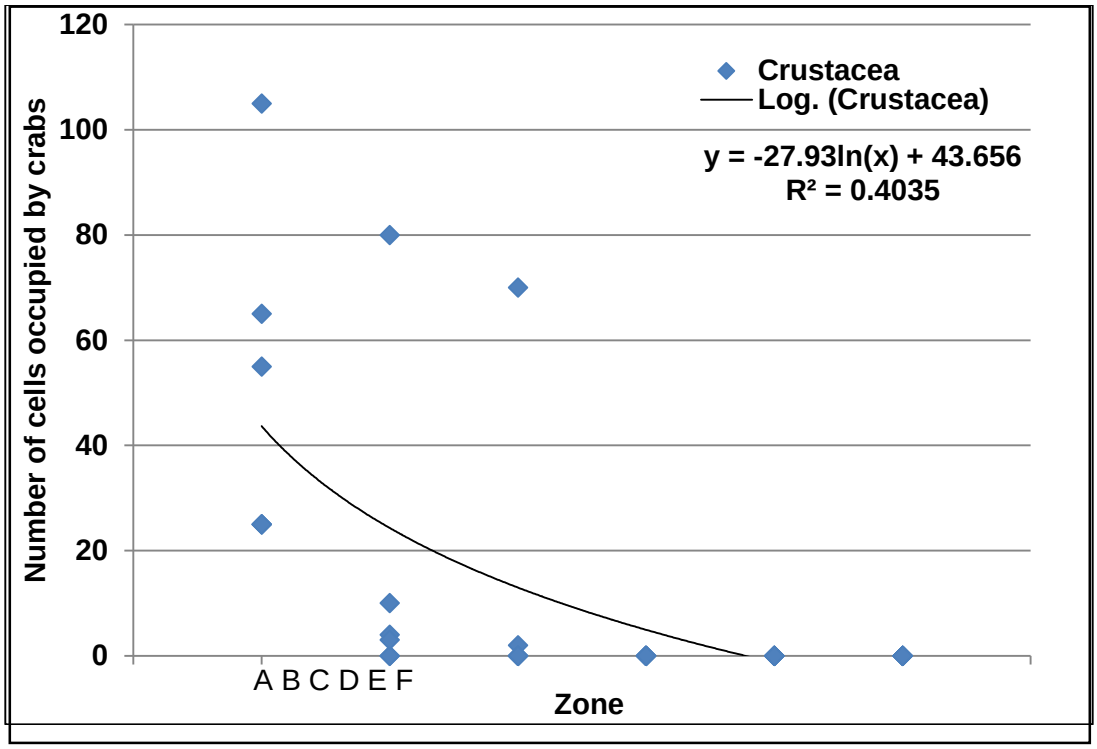

Figure 13. Relationship of the Number of Crabs and the Distance from the Caño Martín Peña (Atkins 2011c).

As with the fish habitats, existing GIS maps were used to quantify acreage associated with the mangrove habitats in SJBE. The scaling method for the Mangrove Habitat Model uses the differential in tide phase within San Juan Bay Estuary system reported by Fagerburg (1998) in the field data study for the hydrodynamic model calibration. Opening the Caño Martín Peña will nearly equilibrate the tidal phase within the central portion of the San Juan Bay Estuary system as tidal waters are able to enter the central portion of the estuary system from both the east and the west. The greatest benefits will occur within the Caño Martín Peña, San José Lagoon, and Los Corozos Lagoon. Suárez Canal and the western portion of the Caño Martín Peña will also benefit greatly, but less so, as evidenced by tidal phasing. The scaling factor decreased in increments of 0.125 based on the relative degree of similarity of tidal phases. The mangrove habitat (e.g., vegetation health and seed distribution) and the organisms (e.g., fish and invertebrate life stages) associated with that habitat in Caño Martín Peña and San José Lagoon would directly benefit from the restoration of the historical tidal connection between San Juan Bay and San José Lagoon. The mangrove habitat in eastern San Juan Bay and Suarez Lagoon is somewhat more distant, and the anticipated ecological uplift is less direct; benefits are calculated by multiplying acres of mangrove habitat by the scaling factor of 0.75. Mangrove uplift for La Torrecilla Lagoon is quantified as acreage multiplied by 0.25. For the more distant areas of western San Juan Bay, Condado Lagoon and Piñones Lagoon, anticipated ecological uplift of mangrove habitat is quantified by multiplying acres of mangroves by 0.125.

Table 15 displays the location, existing acreage of mangrove habitat, scaling factor, and resulting habitat units for the mangrove habitat model. The net habitat units "with" benefits, as with the fish model, represents the benefits of the preferred alternative (100-foot-wide channel with the weir). Again, as with the fish model, there are mangrove habitats units within the San Juan Bay Estuary system in the No Action Alternative (existing condition) represented by the "without" benefits column. Under the No Action Alternative, it is expected that current conditions for mangrove habitat would remain the same and/or continue to degrade within the San Juan Bay Estuary system and Caño Martín Peña.

The net habitat units for each alternative only changes with the additional acres of mangrove habitat added to the Caño Martín Peña with channel construction. Table 16 provides the mangrove habitat units for the existing condition and proposed channel alternatives within the Caño Martín Peña. The 125-foot alternative with a weir does indicate a net loss of 4.4 habitat units within the Caño Martín Peña.

Table 15
Quantification of Mangrove Habitat Unit Benefits With Project Implementation

Location	Existing Acres of Habitat	Scaling Factor[1]	Net Habitat Units with Benefits	Net Habitat Units without Benefits
Western San Juan Bay	34.2	0.125	4.3	29.9
Eastern San Juan Bay	207.3	0.75	155.5	51.8
Condado Lagoon	NM[2]	0.125	NM	NM
San José Lagoon	157.5	1.00	157.5	0.0
La Torrecilla Lagoon	1,066.5	0.25	266.6	799.9
Piñones Lagoon	568.5	0.125	71.1	497.4
Suárez Canal	118.5	0.75	88.9	29.6
Caño Martín Peña	33.5	-	1.0	33.5[3]
Los Corozos Lagoon	53.8	1.00	53.8	0.0
SUB-TOTAL	**2,241.8**	**-**	**798.6[4]**	**1442.2[4]**

[1] For the CMP, instead of a scaling factor, Net Habitat Unit Benefits were calculated by comparing the existing habitat units of the CMP (No Action Alternative) versus the projected habitat units of the CMP under the NER Plan (see Table 16).

[2] NM = none mapped / not shown in GIS data files

[3] For the CMP, the existing 33.5 acres/habitat units of mangroves are not included as part of, or added to, NER benefit calculations.

[4] Under the NER Plan, the amount of mangrove habitat within the CMP would increase from the existing 33.5 acres/habitat units to 36.5 acres/habitat units, thus increasing the overall total mangrove habitat from 2,239.8 acres/habitat units to 2,240.8 acres/habitat units.

Table 16
Quantification of Mangrove Habitat Unit Benefits for the
No Action and Project Alternatives Within the Caño Martín Peña

Project Alternative	Existing Acres in CMP	Net Increase of Habitat Units in CMP	Total Net Habitat Units with Benefits
No Action	33.5	0.0	0.0
75-foot-wide	39.6	6.2	803.8[1]
100-foot-wide with weir (NER Plan)	34.5	1.0	798.6
125-foot-wide with weir	29.1	-4.4	793.2[2]

[1] For the 75-foot-wide alternative, the total net habitat units with benefits includes the increase of 6.2 HUs within the CMP and the 797.6 HUs for all other SJBE features identified in Table 15 (Net Habitat Units with Benefits).

[2] For the 125-foot-wide alternative, the total net habitat units with benefits includes the increase of -4.4 HUs within the CMP and the 797.6 HUs for all other SJBE features identified in Table 15 (Net Habitat Units with Benefits).

The net HUs would be those HUs (803.8 HUs for the 75-foot Alternative; 798.6 HUs for the 100-foot Alternative with weir; and 793.2 HUs for the 125-foot Alternative with weir) gained with each project alternative above the no action alternative. The net AAHUs for the Mangrove Habitat Model (Table 17) (787.7 for the 75-foot Alternative; 782.7 for the 100-foot Alternative with weir; and 777.4 for the 125-foot Alternative with weir) is based upon the recovery time of 3 years (linearly from the existing condition to the predicted, modeled score) and a project period of 50 years.

Table 17. Performance of Alternative Plans
Against Planning Objective 3

Project Condition	Net Average Annual Habitat Units (AAHUs)
No Action Alternative	0
Alternative Plan 1 (75-x-10-foot Channel)	787.7
Alternative Plan 2 (100-x-10-foot with weir)	782.7
Alternative Plan 3 (125-x-10-foot with weir)	777.4

5.3.1.2.4 Benefit Evaluation Result

The results of the benefit evaluation are presented in Table 18.

Table 18
Average Annual Habitat Unit Lift for the Project Alternatives

Project Condition	Residence Time (days)	Benthic Index[1]	Benthic Index Project Perfor-mance	Benthic Index Habitat Units (HU)[2]	Benthic Index Net HU	Net Benthic Index Net Average Annual HU[3]	Fish Habitat Model Net HU[4]	Fish Habitat Model Net Average Annual HU[3]	Mangrove Habitat Model Net HU[4]	Mangrove Habitat Model Net Average Annual HU[3]	Total Net Habitat Units	Total Net Average Annual HU[5]
No action	16.9	1.55	51.70%	362.95	0	0	0	0	0	0	0	0
75-ft-wide Alternative	3.9	2.84	94.56%	663.81	300.86	294.54	5,154.01	5,050.93	803.77	787.69	6,258.64	6,133.16
100-ft-wide Alternative with weir	3.9	2.84	94.56%	663.81	300.86	294.54	5,159.16	5,055.98	798.63	782.66	6,258.65	6,133.17
125-ft-wide Alternative with weir	3.9	2.84	94.56%	663.81	300.86	294.54	5,164.56	5,061.27	793.23	777.37	6,258.65	6,133.17

[1] Based upon a maximum Benthic Index Score of 3.0 (see text for further explanation).

[2] Based upon an expected area to benefit = those regions between -4 and -6 feet in water depth within San José Lagoon (= 702 acres maximum).

[3] Average annual habitat unit lift from existing condition based upon a 3-year recovery time after project construction.

[4] See text for explanation.

[5] Combined Benthic Index Average Annual HU lift, Fish Habitat Model Average Annual HU lift and Mangrove Habitat Model HU lift based upon a 3-year recovery time after project construction [Columns F + H + J = K].

5.3.2 Cost Effectiveness/ Incremental Cost Analysis

Pursuant to the calculation of habitat units, planning level cost estimates were developed for the Final Array. As described below, a cost effective analysis was conducted to determine which plans reasonably maximize ecosystem restoration benefits compared to costs. Additionally, an incremental cost analysis was then conducted to identify the most efficient plan.

5.3.2.1 Average Annual Costs and Ecosystem Benefits

Construction and maintenance costs presented in this report are based on a project life of 50 years, a Federal Discount Rate of 3.5 percent, and a base year of 2019. All costs, construction and operation and maintenance, are estimated as year-end values. The costs discussed in this paragraph include ecosystem restoration; costs associated with recreation facilities are not included. Three alternatives, the 75-x-10-foot paved channel, the 100-x-10-foot channel, and the 125-x-10-foot channel were carried into the final array to be considered in this analysis. Because Micro-Computer Aided Cost Estimating System (MCACES) level costs were only developed for the 100-x-10-foot alternative, planning level cost estimates were used for the cost effectiveness/incremental cost analysis (CE/ICA). First costs range from $0 for the No Action Alternative to $171,700,000 for the 75-foot-wide by 10-foot-deep channel alternative. Average Annual Operation and Maintenance (O&M) costs range to $0 for the No Action alternative to $1,700,000 for the 75-foot-wide by 10-foot-deep alternative. Total average annual equivalent costs range from $0 for the No Action alternative to $8,700,000 for the 100-foot-wide by 10-foot-deep alternative. Total first cost, interest during construction, annual operation and maintenance, and average annual equivalent cost are presented in Table 19.

Table 19. Project Costs for the Final Array of Alternative Plans

Alternative	Total First Cost w/o Recreation	Interest During Construction	Total Investment Costs (incl. IDC)	Avg. Ann. Total Costs	Avg. Ann. O&M @ 1% of Subtotal	Total Avg. Ann. Costs incl. O&M
No Action	$ -	$ -	$ -	$ -	$ -	$ -
75' x 10' Paved	$171,700,000	$5,800,000	$177,500,000	$7,600,000	$ 1,700,000	$ 9,300,000
100' x 10'	$ 161,300,000	$ 5,400,000	$ 166,700,000	$7,100,000	$ 1,600,000	$ 8,700,000
125’ x 10’	$167,200,000	$ 5,600,000	$172,800,000	$7,400,000	$ 1,700,000	$9,100,000

Notes: Costs do not include recreation features. Annualized over 50 years at 3.5%; Interest during construction (IDC) calculated based on 23-month construction schedule; 1% of total first cost (without recreation) assumed for annual O&M.

5.3.2.2 Cost Effectiveness and Incremental Cost Analysis

Traditional benefit-cost analysis is not appropriate for environmental preservation and enhancement projects since there is not a consistent national standard for monetary valuation of environmental outputs. CE/ICA procedures provide an evaluation approach that is consistent with

the planning framework established in the P&G for Water and Related Land Resources Implementation Studies (U.S. Water Resources Council 1983). All CE/ICA procedures used in this report are based on the USACE Institute for Water Resources (IWR) Planning Suite User's Guide, November 2006, and are consistent with the P&G.

Cost effectiveness analysis is conducted to ensure that the lowest cost alternative is identified for each possible level of environmental output, and that for any level of investment, the maximum level of output is identified. Cost effective means that for a given level of non-monetary output, no other plan costs less to produce the same output, and no other plans yields more output for less money. The analysis then identifies the subset of cost-effective plans that are superior investments through incremental cost analysis. These "best buys" provide an increase in output for the lowest average cost. The first best buy is the most efficient plan, producing output at the lowest average cost per unit. The next best buy is the most efficient plan for producing additional output, and so on. Each additional best buy is calculated starting from the previous "best buy."

For the purpose of this project, average annual equivalent costs were compared to average annual habitat units to determine which alternatives are most cost-effective. Fish, mangrove, and benthic Index habitat units were considered to be combinable for purposes of the CE/ICA. Habitat units for each project alternative were compared to the No Action Alternative. The average annual equivalent cost and the average annual net habitat units (Fish, Mangrove, and Benthic Index) for each alternative are presented in Table 20.

Table 20. Average Annual Costs and
Habitat Units Used in Incremental Cost Analysis

Alternative	Avg. Ann. Cost	AAHU	Avg. Ann. Cost per HU	Cost Effective
No Action	$ -	0	Not applicable	Yes
75' x 10' Paved	$ 9,300,000	6,133	$ 1,510	No
100' x 10'	$ 8,700,000	6,133	$ 1,420	Yes
125' x 10'	$9,100,000	6,133	$ 1,480	No

Note: 1) Mangrove wetland replacement acreage values for the CDRC staging area were not included in the CE/ICA, as these were not congruent values for comparison to Habitat Units, and also were only intended to replace impacted areas within CDRC rather than be utilized for project justification.

Three with-project alternatives were analyzed. Each alternative was considered independent and not combinable with the other alternative. Each alternative provides the same level of output as a similarly sized weir is included in all alternatives, which serves to control the velocities in and out of the Caño Martín Peña, which in turn equates the flow-dependent habitat units. While the determination of the NER Plan for this analysis could be explained as a least cost evaluation, a traditional cost effectiveness/incremental cost analysis was conducted. The 100-x-10-foot plan costs less than both the 75-x-100-foot and the 125-x-10-foot plans (see Table 20). Consequently, only the 10-x-100-foot plan is cost effective, and was also identified as a Best Buy in the ICA (Figure 13). The 100-x-10-foot plan yields 6,133 AAHUs at an average annual cost of $8,700,000, with an average annual cost per average annual habitat unit of $1,420.

5.3.3 Principles and Guidelines Plan Evaluation Criteria

Although an initial evaluation was conducted during the B-series screening analysis, the Final Array was further evaluated using the P&G Criteria. The following section provides a more-detailed description of the merits of each alternative in regard to each criterion. As specified in ER 1105-2-100, the four P&G Criteria that were considered are: completeness, effectiveness, efficiency, and acceptability.

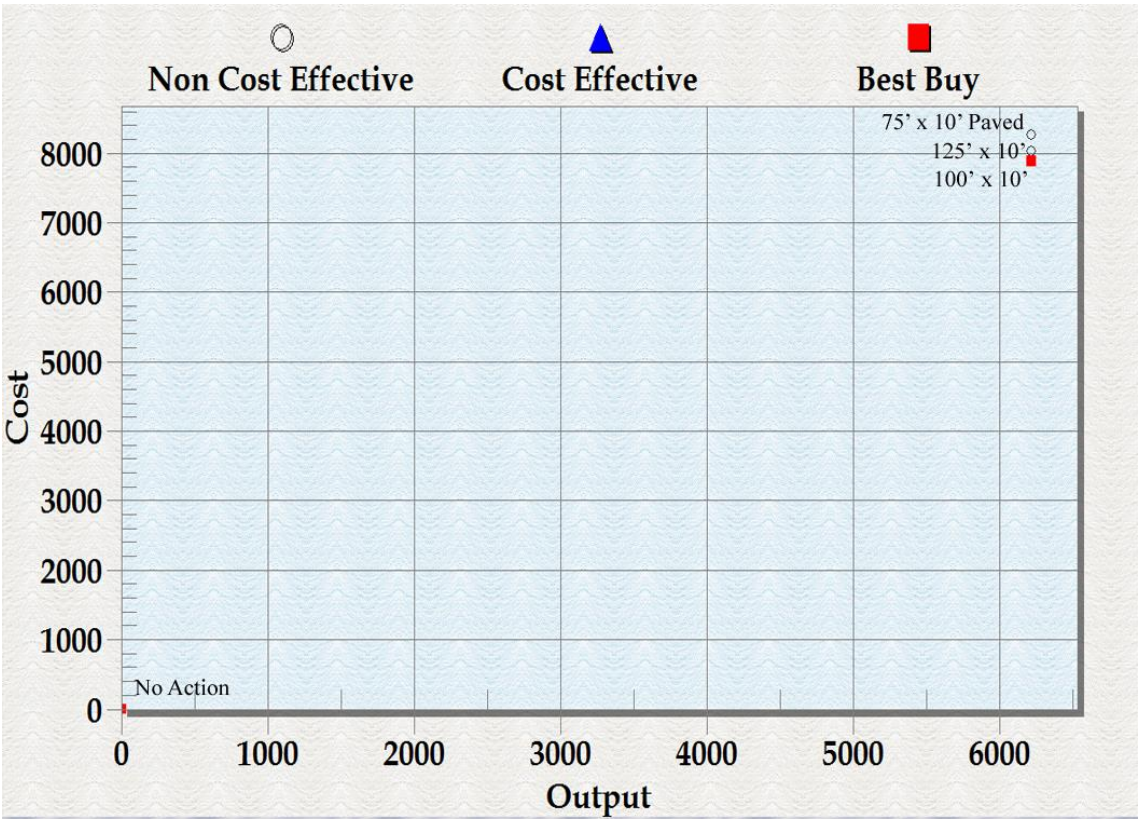

Figure 14. CE/ICA Analysis for the Final Array of Alternatives

5.3.3.1 Completeness

Completeness is the extent that an alternative plan provides and accounts for all investments and actions required to ensure the planned output is achieved. Completeness includes consideration of real estate issues, O&M, monitoring, and sponsorship factors. Adaptive management plans formulated to address project uncertainties may also to be considered.

The No Action Alternative plan is by definition an incomplete plan. Alternative Plans 1, 2, and 3 are complete plans. The plans address present and future restoration opportunities in the study area. Additionally, the plans provide for acquisition and removal of affected structures as well as relocation of affected families. Operations and maintenance has been analyzed and addressed for the period of analysis, and both a monitoring and adaptive management plan have been created.

5.3.3.2 Effectiveness

The No Action alternative plan is by definition ineffective in achieving the planning objectives as no Federal Action is proposed to address the identified problems. Alternative Plans 1, 2 and 3 are all equally effective in addressing the problems and realizing the opportunities, and all three plans would equally meet the project objectives.

5.3.3.3 Efficiency

Efficiency means the project is a cost effective means of addressing the problem and/or realizing the opportunities. The plan outputs cannot be produced more cost effectively by another institution or agency. The No Action Alternative plan is by definition an efficient plan, as it is both cost effective and a best buy. Alternative Plans 1 and 3 are not cost effective in relation to Alternative Plan 2. Alternatives 1 and 3 are more costly than Alternative 2 and produce similar benefits. Alternative Plan 2 is considered cost effective and would also be considered a best buy.

5.3.3.4 Acceptability

As established in Section 2-3c(2) of ER 1105-2-100, "[a]cceptability is the extent to which the alternative plans are acceptable in terms of applicable laws, regulations and public policies." The primary dimension to the applicability criteria is compliance with Federal and local law, regulations and policies. A secondary dimension to acceptability is the satisfaction that a particular plan brings to government entities and the public. The project should be acceptable and have evidence of broad-based public support. Alternatives Plans 1, 2, and 3 are considered implementable and do not rely on any new technology, significant socioeconomic factors, or other elements that could render the project infeasible. Additionally, Alternatives 1, 2, and 3 would be considered acceptable with regard to compatibility with existing Federal and local laws, regulations, and public policies; however, extensive public involvement over the course of the study effort has determined a public preference for a wider, restored CMP. As such, Alternative Plan 3 is preferable to Alternative 2, as Alternative 2 would be considered preferable to Alternative 1.

5.4 COMPARISON OF ALTERNATIVE PLANS

5.4.1 Planning Objectives and P&G Criteria

Table 21 summarizes the effectiveness of the final array of alternative plans. Each alternative plan equally achieves Planning Objectives, and results in significant improvements to the natural and human communities in the region of the CMP and the SJBE. Each action alternative is complete, effective, and acceptable; however, Alternative Plan 1 and Alternative Plan 3 are not cost effective (efficient), whereas Alternative Plan 2 is cost effective (efficient).

Table 21. Comparison of Alternative Plans

Evaluation Metric	No Action Alternative Plan	Alternative Plan 1 (75' x 10' Channel)	Alternative Plan 2 (100' x 10' Channel)	Alternative Plan 3 (125' x 10' Channel)
Planning Objective 1 (Changes in Habitat Units for Fish Habitat in the SJBE)	There is no net change in habitat units of fish habitat over the planning horizon	A net increase of 5,050.9 AAHUs of fish habitat in comparison to the No Action Alternative.	A net increase of 5,056.0 AAHUs of fish habitat in comparison to the No Action Alternative.	A net increase of 5,061.3 AAHUs of fish habitat in comparison to the No Action Alternative.
Planning Objective 2 (Changes in Benthic Habitat Units)	There is no net change in benthic habitat area over the planning horizon.	A net increase of 294.54 benthic AAHUs in comparison to the No Action Alternative.	A net increase of 294.54 benthic AAHUs in comparison to the No Action Alternative.	A net increase of 294.54 benthic AAHUs in comparison to the No Action Alternative.
Planning Objective 3 (Changes in Habitat Units for Mangrove Habitat in the SJBE)	There is no net change in habitat units for mangrove habitat over the planning horizon	A net increase of 787.7 AAHUs of mangrove habitat in comparison to the No Action Alternative.	A net increase of 782.7 AAHUs of mangrove habitat in comparison to the No Action Alternative.	A net increase of 777.4 AAHUs of mangrove habitat in comparison to the No Action Alternative.
Cost Effectiveness/ Incremental Cost Analysis	Not applicable.	$1,510 annual cost/ annual habitat unit. Not as cost effective as Alternative Plan 2, which has the same benefits for a lower average cost per unit.	$1,420 annual cost / annual habitat unit. Cost effective. No other alternative plan produces the same benefits for lesser costs.	$1,480 annual cost/ annual habitat unit. Not as cost effective as Alternative Plan 2, which has the same benefits for a lower average cost per unit.
P&G Criteria: Completeness	Not complete.	Complete.	Complete.	Complete
P&G Criteria: Effectiveness	Not effective. Does not meet project objectives.	Meets the project objectives.	Meets the project objectives.	Meets the project objectives.
P&G Criteria: Efficiency	Cost effective and a best buy.	Not cost effective.	Cost effective and a best buy.	Not cost effective.
P&G Criteria: Acceptability	Not acceptable.	Acceptable.	More Acceptable.	Most Acceptable.

5.4.2 P&G System of Accounts

Four accounts are established by the P&G to evaluate and display effects of alternative plans, and can be used to produce a plan-by-plan comparison. The four accounts in the system of accounts are the: (a) national economic development (NED) account that displays changes in the economic value of the national output of goods and services; (b) environmental quality (EQ) account that displays non-monetary effects on significant natural and cultural resources; (c) regional economic development (RED) account that addresses changes in the distribution of regional economic activity; and (d) other social effects (OSE) account that addresses urban and community impacts (life, health, and safety factors; displacement; long-term productivity; and energy requirements and energy conservation from perspectives, not reflected in the other three accounts) (ER 1105-2-100, 22 Apr 2000).

Since this is an NER project, beneficial changes to the NED account would not be expected to significantly change, with the exception of recreation, and changes in the EQ account are captured in the NER benefit analysis documented in detail in the NER Benefits Evaluation Appendix (Appendix A). The CMP-ERP is evaluating ecosystem restoration and the System of Accounts analysis primarily focuses on the RED and OSE accounts. The analysis includes a description of the contributions to these accounts for the No Action Alternative (Without-Project), Alternative Plan 1 (75-x-10-foot Channel), Alternative Plan 2 (100-x-10-foot Channel), and Alternative Plan 3 (125-x-10-foot Channel).

5.4.2.1 NED

This section discusses the effects of No Action Alternative, Alternative Plan 1, and Alternative Plan 2 on the NED account.

5.4.2.1.1 No Action (Without-Project) Alternative

Under the No Action Alternative the Federal government would not participate in ecosystem restoration activities and no NED effects would be produced.

5.4.2.1.2 Alternative Plans

As the proposed project is a single-purpose, ecosystem restoration project, NED benefits were not produced for the primary project mission; however, the proposed project would produce recreation NED benefits and incidental flood risk management benefits. Recreation net benefits in the amount of $5,698,618 would occur with implementation of all three alternatives, reflecting a benefit/cost ratio of 6.4 to 1.0.

With respect to incidental flood risk management benefits, all three alternative plans would reduce potential flooding since they require flood prone structures to be removed from the floodplain.

Additionally, all three alternatives would result in a restored tidal connection between San Juan Bay and the San José Lagoon, thus facilitating removal of storm water from the CMP. While this study effort did not calculate flood risk NED benefits associated with the CMP-ERP, relevant data associated with flooding in Puerto Rico indicates that average assistance from FEMA during past flood events in Puerto Rico has ranged from $3,000 to almost $14,000 per affected household. FEMA FIRM and GIS data from the Municipal Revenue Collection Center and the PRPB show that approximately 4,700 buildings adjacent to the CMP are within the 100-yr frequency AE Flood Zone (with storm surge). Real Estate sales records from previous relocations made by ENLACE show that property prices for flood-prone structures vary from $25,000 to $157,000. Past studies have estimated content value of buildings to be 55 percent of the value of the structure. Such figures point to the possibility that substantial or major damages would take place if a 100-yr flood with storm surge were to occur, and that a restored CMP should result in significant reductions in flood-related damages in the future (see Section 3.31 of the EIS for additional information). In addition, improved drainage conditions from a dredged CMP would reduce the duration that flood waters threaten developed areas.

In addition, recreational navigation benefits would be produced by the proposed project. Although the CMP is considered a navigable water of the United States, the waterway has become completely severed and can no longer serve navigational purposes. All three alternatives would result in re-opening this waterway, allowing for possible extension of the local river taxi and safe passage of other vessels. While no economic analysis was conducted and therefore no NED benefits were calculated, recreational navigation in adjacent waters that includes public boating and sport fishing suggests that these activities would increase with implementation of the proposed project.

5.4.2.2 EQ

This section discusses the effects of No Action Alternative, Alternative Plan 1, and Alternative Plan 2 on the EQ account, which is detailed in the NER Benefits Evaluation Appendix (Appendix A).

5.4.2.2.1 No Action (Without-Project) Alternative

Under the No Action Alternative the Federal government would not participate in ecosystem restoration activities. If the No Action Alternative were selected, there would be no effects on the EQ account from Federal participation in National Ecosystem Restoration, and the existing acreage (23.67 acres) of low functioning wetlands would remain.

5.4.2.2.2 Alternative Plans

EQ output for the proposed project was measured in terms of changes in the AAHUs for the Benthic Index, Fish Habitat, and Mangrove Habitat attributes. All three alternative plans would produce EQ output of 6,133 AAHU. Additionally, Alternative 1 would provide 39.62 acres of mangrove wetland

replacement within the CMP, Alternative 2 would provide 34.48 acres of CMP mangrove wetlands, and Alternative 3 would provide 29.08 acres.

5.4.2.3 RED

EC 1105-2-409 states: "the regional economic development account registers changes in the distribution of regional economic activity that result from each alternative plan". The RED account describes the effects alternatives would have on regional changes in jobs, income, and tax revenues. This section discusses the effects of No Action Alternative and Alternative Plans 1, 2, and 3 on the RED account.

5.4.2.3.1 No Action (Without-Project) Alternative

Under the No Action Alternative, the Federal government would not participate in ecosystem restoration activities. If the No Action Alternative were selected, there would be no increase in jobs, income, and tax revenues in the region from Federal participation in National Ecosystem Restoration.

5.4.2.3.2 Alternative Plans

The RED output from the implementation of Alternative Plans 1, 2, and 3 is practically identical with less than a 1 percent difference in the annual costs among the three plans. All three alternative plans would result in significant RED output through increases in jobs, income, and tax revenues in the region from construction expenditures and demand for construction labor and construction support services, providing short-term (over a 2-year period) regional economic benefits. In addition to construction labor demand and increased manufacturing labor demand, the private sector would benefit from the project through contracted construction management, architecture, and other construction related employment opportunities. Expenditures for construction materials, labor, and services should have secondary effects throughout the region as increased employment opportunities and higher overall earnings would generate spending and inter-industry economic activity.

Implementation of Alternative Plan 1 would result in the direct and indirect creation of 4,525 construction jobs, revenues to government generated from construction activities of $25.38 million, and salary income generated by construction activities of $103.43 million. Implementation of Alternative Plan 2 would result in the direct and indirect creation of 4,275 construction jobs, revenues to government generated from construction activities of $23.95 million, and salary income generated by construction activities of $97.72 million. Implementation of Alternative Plan 3 would result in the direct and indirect creation of 4,400 construction jobs, revenues to government generated from construction activities of $24.7 million, and salary income generated by construction activities of $100.5 million. Improvement in fish habitat will likely increase regional

income from charter and recreational fishing; however, computation of RED output for these parameters is not feasible due to a lack of reliable data.

The basis for the jobs and income figures presented in the report were the industry multipliers published by the PRPB (PRPB 2002). Government revenue was calculated by applying the corresponding effective average tax rates, including income taxes, sales taxes, and property and other municipal taxes to the construction expenditures. All figures are adjusted for inflation to prevent overestimation of benefits. RED impacts would only be for the period of construction.

5.4.2.4 OSE

A recently published OSE handbook by the USACE Institute for Water Resources entitled "Applying Other Social Effects in Alternatives Analysis" identifies the social factors recommended for consideration when evaluating the social effects of alternatives (USACE 2013). Under the No Action Alternative Plan, impacts from future conditions on the social factors shown below would be significantly adverse.

- Health and Safety – Perceptions of personal and group safety and freedom from risks
- Economic Vitality – Personal and group definitions of quality of life, which is influenced by the local economy's ability to provide a good standard of living
- Social Connectedness – Community's social networks within which individuals interact; these networks provide significant meaning and structure to life
- Identity – Community members' sense of self as a member of a group, in that they have a sense of definition and grounding
- Social Vulnerability and Resiliency – Probability of a community being damaged or negatively affected by hazards and its ability to recover from a traumatic event
- Participation – Ability of community members to interact with others to influence social outcomes
- Leisure and Recreation – Amount of personal leisure time available and whether community members are able to spend it in preferred recreational pursuits (USACE 2009)

One of the causes of the adverse social effects is the frequency of flooding in the neighborhoods surrounding the CMP. Under the No Action Alternative, the percentage of residents reporting flooding problems would be expected to remain unchanged or worsen. Interviews with 645 residents conducted in 2011 by the Ponce School of Medicine and Health Sciences included questions regarding flood frequency. Frequency of positive responses to various flooding question presented in Table 22.

Another component parameter of adverse social effects evaluated in the interviews with neighborhoods adjacent to the CMP was the rates for gastroenteritis in the area population. The interviews were conducted between November 2011 and April 2012 using transversal sampling design

included housing that had exposure to waste waters through flooding or the presence/absence of a sanitary sewer system. Results indicated that 31 percent of the population in the affected neighborhoods reported gastrointestinal symptoms as compared to the 22 percent background rate for Puerto Rico. People exposed to flood water were twice as likely to have gastrointestinal symptoms.

Table 22. Frequency of Flooding Reported by CMP Neighborhood Residents

Flooding within or near the houses of study participants	Response Yes (%)
Does your house or backyard flood even if it has not rained?	16.4
Does your street flood even if it has not rained?	21.9
Does your house or backyard flood when it rains?	53.4
Does your street, or any house in the street, flood when it rains?	69.5
Did your house or backyard flood in 2011?	53.6
Did your house or backyard flood in the past three months?	33.1
Did your street flood in the past three months?	51.4

In June 2012, an interview effort was undertaken to evaluate the prevalence of asthma and atopic dermatitis with 122 adults responsible for children under 18 living adjacent to the CMP. A transversal design selected houses randomly for participation. Households included in the interview effort were selected from blocks of houses adjacent to and not adjacent to the CMP. The adult responsible for children under 18 was interviewed regarding the characteristics of the household. One minor was randomly selected from each household for an interview. Information requested about the minor included social, anthropometric and health characteristics, including a diagnostic test for asthma and atopic dermatitis. Bronchial asthma prevalence among children under 18 years of age living within the communities bordering the CMP was 23.2 percent. The number for children under five was 44.5 percent, more than double the 21.5 percent rate reported for that age group in Puerto Rico. Atopic dermatitis rates for children within the CMP communities was 35.3 percent, over 10 percent higher than the 24.8 percent rate reported for that age group in previous studies. Although not statistically significant, there is a clear trend that blocks closer to the CMP have a higher likelihood of suffering from one of the ailments focused on in this interview effort.

5.4.2.4.1 No Action (Without-Project) Alternative

Under the No Action Alternative rates for three identified conditions, Gastroenteritis, asthma in children and atopic dermatitis in children, are expected to remain similar or worsen from present rates. The communities surrounding the Caño Martín Peña in Puerto Rico reliant on the CMP for removal of floodwaters and other socio-economic factors such as subsistence fishing would continue to experience a very poor quality of life. The reduced drainage capacity would likely

continue to worsen, along with the water quality in this area, already leading to high rates of disease in the community that continues to worsen. Members of the surrounding communities would continue to experience a disproportionately adverse economic and environmental burden compared to the surrounding areas of San Juan, the rest of Puerto Rico, and the United States with respect to health, safety, and quality of life.

5.4.2.4.2 Alternative Plans

The information above was used to derive an estimate of health care costs under current conditions within the CMP communities related to Gastroenteritis, asthma in children, and atopic dermatitis in children (Table 23). Under Alternative Plans 1, 2, and 3, prevalence rates are expected to drop to the Puerto Rico average, resulting in health care cost reductions of $775,927 per year, or $38,796,361 over the 50 year project life. Human health, safety and quality of life within the area surrounding the CMP would be expected to improve, not only with reduced rates of disease, but with reduced flooding effects and better water quality.

Table 23. Health Care Costs Related to Three Common Health Conditions in the CMP Neighborhoods

Condition	CMP Prevalence	Puerto Rico Prevalence[1]	CMP Population	Costs per year[2] ($/case/year)	Existing Population Affected	Existing Health Costs	Improved CMP Population affected[3]	Improved CMP Health Costs
Gastroenteritis	31%	21%	1,8074	$325	5,603	$1,820,956	3796	$1,233,551
Asthma (children under 5 years old)	44.5%	22%	1046	$654	465	$304,417	225	$147,078
Dermatitis (Children 5–9 years old)	35.3%	24.8%	958	$310	338	$104834	238	$73,651
					TOTAL	$2,230,207	TOTAL	$1,454,280

[1, 2] Source: Puerto Rico Department of Health

[3] Assumes prevalence rate drops to Puerto Rico prevalence rate.

5.5 PLAN SELECTION

5.5.1 Identification of the National Ecosystem Restoration Plan

For ecosystem restoration projects, a plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective, shall be selected and designated as the NER plan. The NER plan must be shown to be cost effective and justified to achieve the desired level of output. Alternative Plan 2, the 100-x-10-foot channel, was selected as the NER and

Recommended Plan as it reasonably maximizes the amount of environmental restoration compared to costs. This alternative is an economically viable solution to the problems identified for the proposed project and would produce significant and meaningful improvements to the natural environment of the SJBE.

5.5.2 National Ecosystem Restoration Plan

Alternative 2 is the NER and Recommended Plan for the CMP-ERP. Alternative 2 would meet all three of the project objectives and would not violate any project constraints. The NER and Recommended Plan is both cost effective and a best buy, and has been demonstrated to be acceptable to state and local agencies as well as the public. The plan is also compatible with all applicable laws and policies.

Fish habitat within the SJBE would be restored with populations more resilient to change through increased genetic diversity. Charter, recreational, and subsistence fishing would be improved as populations of native fish recover from currently degraded environmental conditions. The restoration of mangrove habitat will serve to provide increased habitat for juvenile fish, while increasing populations of native crabs and other invertebrates. Benthic habitat within the San José and Los Corozos Lagoons would be restored, with corresponding improvements to species such as wading birds that utilize the area for foraging grounds.

Alternative 2 would also provide a mechanism to evacuate floodwaters from the areas surrounding the CMP. Combined with ENLACE's Comprehensive Plan, rates of disease in the area should be reduced as the rate of flooding is reduced. Additionally, approximately 394 structures within flood prone areas would be removed as part of the CMP-ERP.

A complete description of the NER and Recommended Plan is found in Section 6.2.

5.6 RISK AND UNCERTAINTY

Potential areas of risk and uncertainty associated with the NER and Recommended Plan were analyzed and have been addressed below.

5.6.1 Relative Sea Level Change

The increase in water level elevation as a result of sea level change (Section 3.4.1) will not affect future navigation or maintenance of the CMP since the depth of the channel is to be constructed and maintained as measured from the water surface. The proposed sheet pile wall's top (cap) elevation is 3.0 feet and present mean high high water (MHHW) elevation is 0.80 feet. With the estimated sea level changes presented in Table 24, mean high water elevations will remain below or near the top of wall for the low, intermediate, and high sea level change estimates. After construction, the MHHW elevation with SLC would rise 0.47 to 0.79 feet over the sheet pile cap. The main

consequence associated with water levels overtopping the walls to this minor extent is a hazard to navigation as the tops of the wall will not be visible under certain tidal conditions. Channel markers may be required to adequately mark the position of the wall to minimize the hazard. With increases in tidal amplitude due to the proposed project, it is also likely that sea level change would further raise water levels within the CMP. The PRASA is the entity responsible for designing and constructing the sewer and drainage improvements as part of the Comprehensive Plan, and the Municipality of San Juan is responsible for designing and constructing the storm water improvements. Both entities are part of the TC that meets bi-yearly in San Juan. Coordination during the September 2013 meeting ensure that the Municipality of San Juan is aware of the potential water level changes due to the proposed project combined with sea level change, and future improvements to the basin will include proper design and construction to prevent induced flooding.

Table 24. Sea Level Change Estimates – Relative to Proposed Top of Sheet Pile Wall

Location	Top of Sheet Pile Cap	MHHW (preconstruction)	MHHW (SLC) (pre-construction)	MHHW (post-construction)	MHHW (SLC) (post-construction)
San Juan Bay	3.0	1.12	3.15	1.76	3.79
San Jóse Lagoon	3.0	0.80	2.83	1.44	3.47

5.6.2 Geotechnical Considerations

The geotechnical analyses presented in this Feasibility Report were based on maximizing the use of available data and minimizing new data collection in order to complete the planning level of analysis. This methodology was followed as conditions in the Project Area are relatively uniform and similar to projects previously constructed in the immediate vicinity. Additional geotechnical sampling and analysis will be performed during the PED phase, and it is possible, but not considered likely, that modifications to the project design would be required that significantly increase the project cost. These additional investigations would help refine the NER and Recommended Plan.

5.6.3 Water Quality

In preparation of the Water Quality sections, the best available data was used to characterize existing conditions, and best professional judgment was used to predict the project's impacts. Water quality parameters will be further modeled as part of the hydrologic modeling effort conducted during the PED phase. If the results of these modeling efforts suggest that the project's water quality impacts will differ from those currently anticipated, then a supplemental NEPA document may be prepared as appropriate. If further analysis during PED indicates that the project is likely to have significant adverse impacts to water quality, then the project's features and/or operation will be refined to mitigate the adverse impacts to the fullest extent possible, consistent

with the project's overall goals. The project will also be adaptively managed post-construction to maximize the project's ability to meet its goals and objectives and minimize adverse impacts.

5.6.4 Suitability of Dredged Material

As mentioned in the assumptions for this section, sampling data was utilized to assess suitability of dredged material for disposal. Materials within the Caño Martín Peña include various types of solid waste, debris, and other materials. Such materials will require further testing prior to and/or during project construction, as appropriate, in accordance with an agreed sampling plan. If the testing determines that any materials contain hazardous substances at levels that are not suitable for unregulated disposal, they will be managed in accordance with the applicable laws and regulations of the relevant regulatory agencies. Although Section 404 testing could further confirm the suitability of dredged material for aquatic disposal, additional testing will not be conducted until the PED phase. As a result, although risk has been reduced by utilizing the existing sampling data and coordinating with the USEPA and the PREQB, there is a possibility that Section 404 testing could indicate unsuitable material within the CMP, potentially leading to a requirement for reformulation, which in turn could potentially lead to cost increases. If CMP material were found unsuitable for aquatic disposal, the sediment/solid waste would need to be disposed of in an upland landfill or other approved location. If testing results identified contaminant exceedances for thresholds for existing sediments within SJL Pits 1/2 that would eliminate unconfined disposal in SJ 3/4/5, another option would be to place CMP-ERP dredged sediments (contained within geotextile bags) across all five SJL pits. This option could be achieved using a 2-foot sand cap and would result in a depth of approximately -13 feet MSL for all 5 pits.

Prior to clearing, grubbing, and dredging activities, a sampling and remediation plan would be developed and approved by ENLACE, USACE, USEPA, and PREQB to ensure that hazardous substances are identified, managed, and disposed of according to applicable Federal, state, and local rules and regulations.

5.6.5 Ecosystem Response

Recovery of the SJBE is expected to follow a logarithmic scale, with substantial growth in fish, benthic, and mangrove communities due to an abundance of functional habitat and resources. Initial growth will be inevitably slow and will be followed by a more gradual, positive recovery as competition between resources begins to balance. Climatic or human-induced events such as chemical spills could slow the projected growth, particularly in certain geographic portions of the estuary that have been impacted in the past. During PED, an aquatic model will be used to further analyze the project's potential effects on fisheries resources; however, given the relative simplicity of the restorative actions of the project (i.e. dredging a clogged channel), no changes to the NER and Recommended Plan are anticipated. Post-construction monitoring will be employed to maximize

the project's ability to meet its goals and objectives, and any modifications to the project or it operation and maintenance would be conducted as part of the Adaptive Management process.

5.6.6 Potential for Induced Flooding During and After Construction

Existing flooding in the vicinity of the Project has been documented at various levels. During community meetings, residents have indicated observations of overflowing storm and sanitary sewers and flooding in streets and low-lying areas of the community. FEMA mapping places much of the adjoining community within the 100-year floodplain with a base flood elevation of 5.9 feet MSL.

Water levels along the CMP are directly influenced by the storm surge at San Juan Bay and San José Lagoon. Hydraulic analysis with storm surge compared the water levels in the channel prior to and during construction. During construction, the channel flow would be plugged. Storms lower than 25 years in return interval had virtually the same surface elevation for the existing and plugged condition. Storms 25 years or greater experienced maximum increases of 0.5 foot for the existing condition and 0.86 foot for the plugged condition. Storm events without storm surge are the ones most affected by the blocking of channel flow with the 100-year event increasing the water surface from 1.28 feet for the existing condition and 3.94 feet for the plugged condition, a change of 2.66 feet.

Modeling indicates that under the proposed condition, that is, after the channel has been constructed, storm surge elevations controls water levels for all return interval rainfall events. During rainfall events without storm surge, water levels are less than the existing condition due to the reestablishment of the direct connection between water levels at CMP, the San Juan Bay and San José Lagoon because standing water levels at CMP would be lower at the beginning of the storm event.

The proposed Project Channel, along with its sheet pile walls and adjoining mangrove beds, are intended to form the floodway to contain the frequent storm events. Flood control measures, such as the construction of suitable protective structures between the channel waters and the adjoining low areas, will be incorporated to mitigate water backflow effect. Other alternatives may include the installation of a temporary sheet pile wall with local select backfill to buttress the structure. These temporary flood protection solutions would remain in place until the proposed sheet pile channel wall and upland embankment of the mangrove bed are installed. Proper construction (e.g., elevation) of the Paseo and related structures would provide additional, ancillary community flood protection.

Earthwork activities involving removal and placement of fill would probably be required for the foundations of the Paseo del Caño roadway. These works would be performed outside of the CMP-ERP footprint, and thus, would not be part of the Federal project. An elevated road could perform as

an inland levee, depending on how high or elevated it is finally designed. Thus, it would help control flood waters rising from the dredged channel and its fringing mangroves that would be restored as part of the restoration project, protecting adjacent communities from these floods. However, if the elevation of the Paseo del Caño is higher than that of nearby areas, it could impact adjacent structures and cause runoff waters to pond in low lying areas. This would require additional infrastructure measures to address this potential problem.

Tidal amplitude within the CMP and San José Lagoon would increase as a result of construction of the channel. The lagoon's tide range is expected to increase 1.28 feet after construction, which would equate to a 0.64-foot increase in average monthly water levels. The water surface rise may affect extremely low-lying structures around San José Lagoon and Los Corozos Lagoon. Preliminary analysis indicates that there are four areas adjacent to San José Lagoon and Los Corozos Lagoon where approximately 18 urban structures may be affected from the restoration of tidal activity upon completion of the CMP-ERP. This risk has been addressed in the Cost Schedule Risk Analysis (Appendix D of the Feasibility Report). In addition, storm sewers from the airport, at the north of the Suarez Canal, outfall into the SJL. The airport has been present for decades and presumably operating prior to the filling of the CMP. The airport is higher than its outfalls and thus may be able to build up a hydraulic head in its conduit to offset these monthly events. Nevertheless, a storm water management investigation will be conducted to determine any potential impact to the effectiveness of the airport's existing storm water sewers with the completion of the CMP-ERP.

Additional hydraulic and hydrologic (H&H) modeling and analyses are needed to confirm the potential for induced flooding as a result of the implementation of the CMP-ERP. This additional technical investigation would be completed before the conclusion of preconstruction engineering and design (PED).

A discussion related to the CMP-ERP's compliance with Executive Order 11988 is located in Section 4.22 of the EIS. Executive Order 11988 requires Federal agencies to avoid to the extent possible the long- and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative

6.0 THE NATIONAL ECOSYSTEM RESTORATION PLAN

Alternative Plan 2, the 100-foot-wide by 10-foot-deep channel alternative (Figure 11), was identified as the NER and Recommended Plan because: (1) it reasonably maximizes ecosystem restoration benefits compared to costs as a Cost Effective plan; (2) it would produce significant ecosystem restoration outputs that are recognized in terms of institutional, public, and/or technical importance; (3) it meets the four evaluation criteria of acceptability, completeness, effectiveness, and efficiency in the Economic and Environmental P&G for Water and Related Land Resources Implementation Studies; and (4) it fulfills the three study objectives. The NER and Recommended Plan would result in restoration of tidal flow and circulation, which would improve water quality, and create, preserve, and restore fish and wildlife habitat in the CMP and the SJBE.

6.1 PLAN ACCOMPLISHMENTS AND RATIONALE FOR SELECTING THE NATIONAL ECOSYSTEM RESTORATION PLAN

The NER and Recommended Plan would meet all the Goals and Objectives of the study. The improved conditions would reconnect the SJBE as one system with continuous and frequent renewal of ocean water (less than 4 days compared to approximately 17 days at present). Increased connection and conveyance would oxygenate the bottom waters of the shallow lagoons, improving the benthic habitat in the San José Lagoon for shrimp, crabs, mollusks, and other species vital to the health of the estuary. Fish habitat would be restored within the SJBE and offshore reef areas, as the increased connectivity would allow full movement and utilization of the estuary for juvenile stages of important species such as Nassau Grouper and Lane Snapper. The increased tidal flushing would improve water quality within mangrove habitat where 80 percent of commercially harvestable fish and shellfish spend part of their life cycle (USDA 2009).

The CMP-ERP would provide incidental flood risk reduction benefits by eliminating the blockage in the CMP that prevents local storm water systems from properly draining. Just as the natural environment improves, the social environment will also benefit from the dredging of the CMP. Exposure to flood waters would be significantly reduced and the stresses related to frequent floods and infrastructure deficiencies will be diminished. Human health conditions would significantly improve to levels commensurate with Puerto Rico as a whole.

The removal of combined sewers, structure and household relocations, and construction of formalized access to the CMP (which would facilitate strict enforcement of trash-dumping regulations) should address the main sources of sedimentation within the CMP. Sedimentation resulting from discharges of the Juan Méndez Creek would be addressed by scheduled maintenance dredging in the CMP's outlet to the San José Lagoon.

6.1.1 Significance of Ecosystem Restoration Benefits

6.1.1.1 Public Significance

Although public significance can be recognized through authorization of the project in the WRDA 2007 and the statutes passed by the Government of Puerto Rico, perhaps more significant than the governmental recognition is the community adhesion and grassroots efforts that have contributed to the advancement of the project. Conditions in the CMP have worsened to the point that not only has fish and wildlife habitat been destroyed, but the ecosystem is actually causing deteriorating human health conditions in the adjacent areas. Human contact with the stagnant waters of the Caño Martín Peña has been shown to cause higher rates of gastrointestinal sickness, dermatitis and asthma; however, this problem would be alleviated by the proposed project, potentially saving over $38 million in associated public health care costs over the life of the project. Residents in these communities have actively been working to do what is possible to take care of the area, creating homemade blockades to prevent dumping and pollution, and have become an active voice for ecological restoration in Puerto Rico. The proposed project has the potential to improve habitat within the estuary, and perhaps just as important, improve socio-economic conditions for thousands of residents within the surrounding communities.

6.1.1.2 Institutional Significance

The San Juan Bay Estuary, at 93.44 square-miles, was the first tropical island estuary accepted into NEP in October 1992. The NEP was established in 1987 by amendments to the Clean Water Act to identify, restore, and protect estuaries of significance. The population of the coastal municipalities surrounding the SJBE was almost 1.18 million people in 2000, and the population density was 5,055 persons/mi2 (USEPA 2007), the highest observed for any of the 28 NEPs. The area is unique to the NEP due to the high density of population in the surrounding areas, and the severe poverty faced by those people inhabiting the project study area. Critical areas in the SJBE include coral communities, sea grass beds and mangrove forests, which would all be significantly restored by the proposed project.

Institutional significance can also be recognized by the Government of Puerto Rico through PR Law 489-2004, known as the Caño Martín Peña Special Planning District Comprehensive Development Act. Additionally, nearly the entire study area is considered EFH under the Magnuson-Stevens Fisheries Act. The proposed project will reverse a trend of direct and indirect habitat losses within the SJBE that have resulted in a diminished capacity to support existing fishing levels. Restoration of benthic areas, increased connectivity and improvements to mangrove habitat will in turn increase spawning, breeding, feeding and growth of fish within the SJBE, leading to a more sustainable regional commercial, charter, and recreational fishery.

6.1.1.3 Technical Significance

Thirty-three percent of the island's mangrove forests exist in the SJBE. Mangrove forests are one of the highest primary and associated secondary biologically productive ecosystems in the world, and form a base of the marine, arboreal and estuarine food webs. In 1995, over 324,500 lbs of finfish were landed in four municipalities within the SJBE (Cataño, San Juan, Loíza, and Carolina) (SJBEP 2000). Restoration of the mangrove habitat will boost numbers of sport and commercial fisheries through providing higher quality habitat and nursery grounds for juvenile marine and estuaries species. Increased connectivity within the estuary will also serve to increase biodiversity within the system, decreasing the effects of disease and eliminating the fragmentation that has caused severe degradation of the ecosystem. Increases in dissolved oxygen and the restoration of salinity levels within the San José Lagoon will benefit sport fisheries such as Tarpon, while providing food for a high number of sustenance fishermen in the area.

Endangered, threatened, endemic, and/or rare species in the estuary's watershed and associated areas include the Roseate Tern, the Yellow-shouldered Blackbird, the Leatherback Turtle, the Green Turtle, the Hawksbill Turtle, the Antillean Manatee, and 17 plant species. These species either reside in or utilize the project area and would experience direct benefits from the project as a result of water quality improvements, increases of prey species, and restoration of foraging, nesting and other habitat areas.

6.2 DESCRIPTION OF PLAN COMPONENTS

The descriptions below summarize the different components of the NER and Recommended Plan. In addition to the channel dredging, disposal, non-structural measures, erosion control and construction of mangrove planting beds, the NER and Recommended Plan also includes a number of secondary project components that did not factor into the primary formulation and evaluation of the proposed project. These components are as follows: Recreation Plan, Project Monitoring and Adaptive Management Plan, Nuisance and Exotic Vegetation Control, and Project Operating Manual.

For additional engineering details, please refer to the Engineering Appendix. For additional information on the cost estimates for each of the plan features, please refer to the Cost Engineering Appendix.

6.2.1 Channel Dredging

The CMP-ERP consists of the dredging of approximately 2.2 miles of the eastern end of the CMP to a width of 100 feet and a depth of 10 feet (with the variations in channel width and depth for the Barbosa Avenue Bridge and terminus of the CMP with the San José Lagoon). The Project Channel would comprise 59.03 acres. The walls of the Project Channel would be constructed of vertical concrete-capped steel sheet pile embedded either 17 or 27 feet below the bottom of the channel. This depth is required for stability of the sheet pile as no connections to the surrounding lands are anticipated and to allow for some limited scour in channel bend areas. Typical cross sections for

areas under bridges (Figure 15) and the main channel (Figure 16) are below; refer to the Engineering Appendix for additional cross section figures. A temporary coffer dam would be constructed to parallel the shoreline at low-lying areas such as the bend at Barrio Obrero Marina to protect the area(s) until the dredging and permanent sheet pile construction was completed. A temporary turbidity curtain coffer dam would be placed to the east of the Martín Peña Bridge for the duration of construction activities.

Dredging of the sediments would begin at the western end of the Project Channel to allow for the construction of the weir. Concurrently, mobilization for dredging at the confluence of the CMP and San José Lagoon would be undertaken, and subsequent dredging activities would commence from east to west in the Project Channel. Given the restricted physical environment within the CMP (shallow water, low bridge clearances), and the characteristics of the material to be dredged, the dredge type to excavate the CMP material would be a small clamshell mechanical dredge. The clamshell dredge could easily switch out between an open bucket (to excavate solid waste and stiff sediments) and an environmental bucket (to excavate unconsolidated contaminated sediments). The preparation and dredging of SJ1 and SJ2 would also commence during clearing and grubbing activities within the CMP. Both of these sites would be modified to increase capacity to accommodate the majority of dredged sediments and the required 2-foot sand cap. Approximately 506,381 cy of material would be removed from SJ1 and SJ2 and deposited within the San José 3/4/5 artificial subaqueous pits. Clearing and grubbing is estimated to include the stripping of approximately 57 acres (91,909 cy) of surficial vegetative debris to 12 inches, including the removal and grubbing of 31.7 acres of light- to medium-density trees, and 1.6 acres (642 cy) of asphalt paving.

At the terminus of the Project Channel with the San José Lagoon, an extended channel would be dredged east into the San José Lagoon (over a distance of approximately 4,300 ft) as a hydraulic transition from the CMP. This extended channel would transition from the 10-foot-deep Project Channel to the 6-foot-deep areas of San José Lagoon. The extended channel would maintain the Project Channel's 100-foot width but replace its steel sheet pile walls with a trapezoidal configuration with 5-foot to 1-foot earthen side slopes. The extended channel would comprise 9.44 acres.

The Quebrada Juan Méndez (Juan Méndez) and the eastern end of the Project Channel meet at their confluence with San José Lagoon. The two channels are presently separated by a narrow band of mangroves, growing on built-up sediment deposits from the Juan Méndez (Figure 17). To minimize silt laden flow from the Juan Méndez entering the Project Channel, construction would include preserving and enhancing the sediment deposit berm between the channels. In this manner, sedimentation of the Project Channel would be reduced along with the subsequent need for maintenance dredging. To minimize potential damage to channel structures during maintenance dredging, the portion of the Project Channel paralleling the Juan Méndez would have a trapezoidal configuration with a 100-foot-wide bottom and 5-foot to 1-foot earthen side slopes, rather than the steel sheet pile walls.

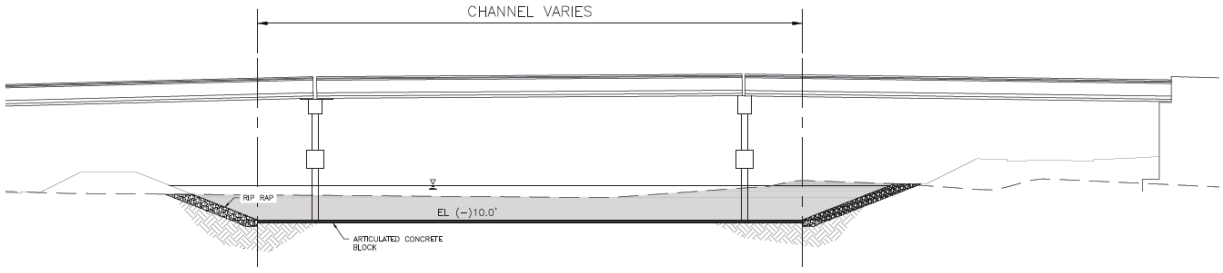

Figure 15. Typical Cross Section of the CMP Under Bridges

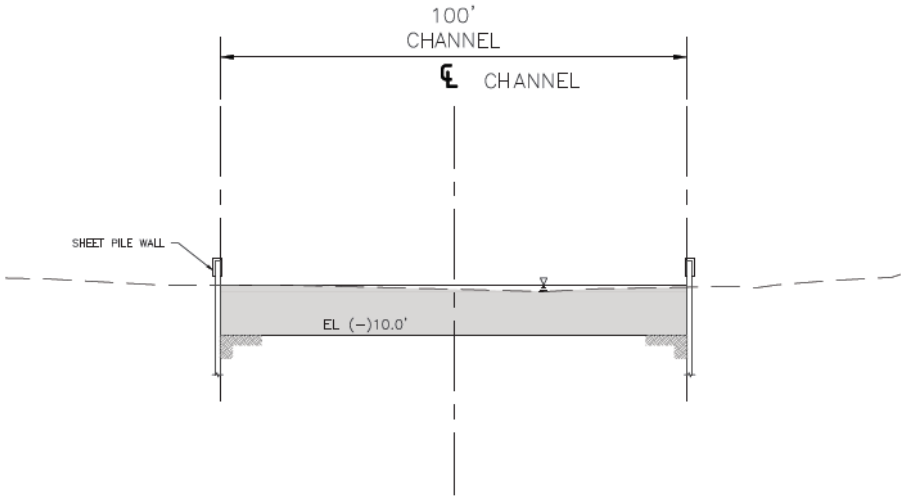

Figure 16. Typical Cross Section of the Open CMP

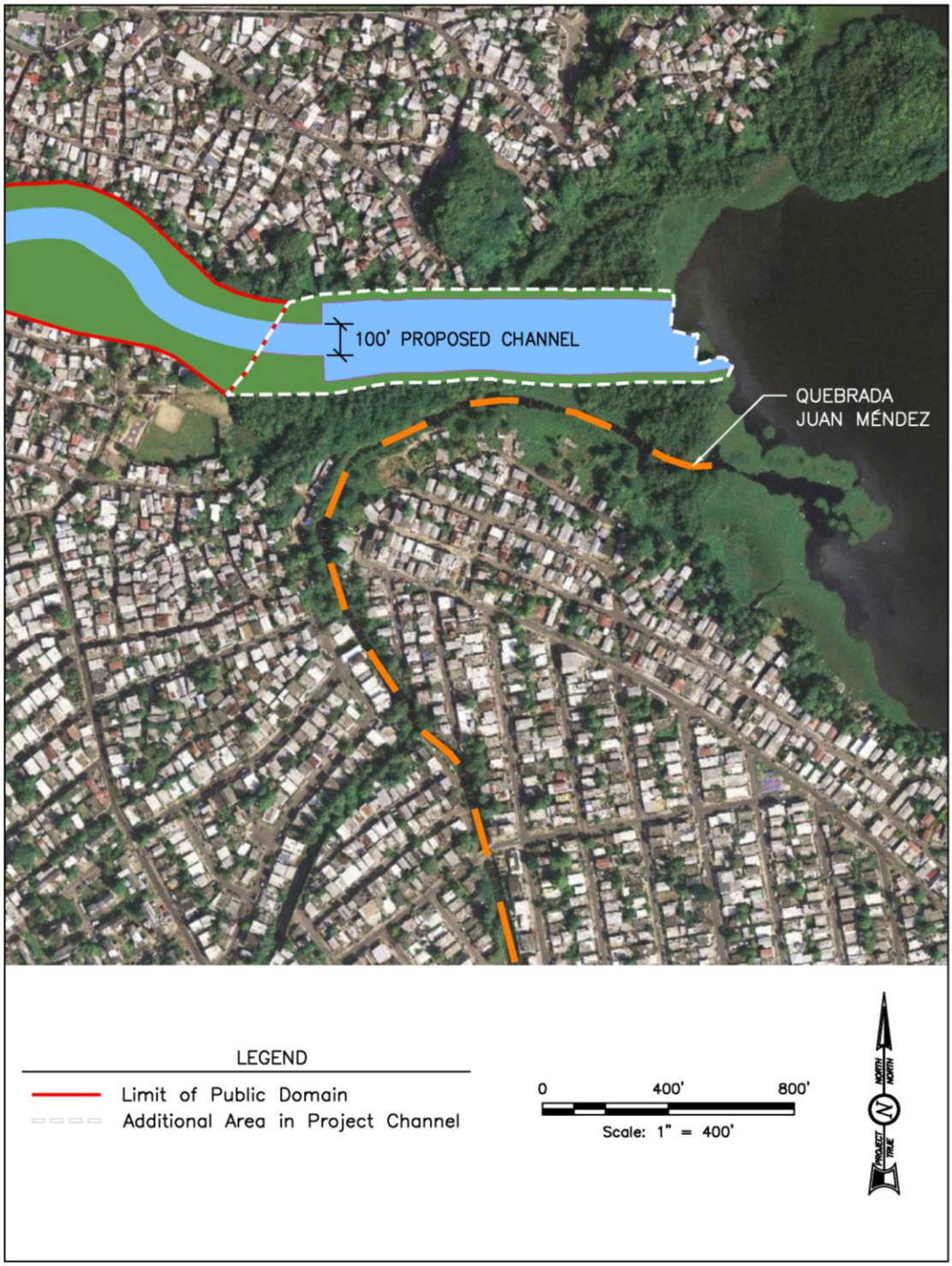

Figure 17. Quebrada Juan Méndez

6.2.2 Dredged Material Disposal

Approximately 10 percent of the dredged material is expected to be solid waste not suitable for aquatic disposal and will need to be screened. Metal sieves would be placed on top of the dump scows to allow for separation of the dredged material. The solid waste would be collected, processed, and transported to a 6-acre staging area at CDRC on the southeast shore of San José Lagoon. This staging area would be outfitted with a temporary dock for loading/unloading the dredged material prior to its transport to the Humacao landfill site, which is located approximately 32 miles from the CMP-ERP site. While there is not a dewatering component for the sediments or solid waste, the solid waste and associated debris would air dry during transport. After all solid waste has been disposed in the upland landfill, the 5-acre upland staging area would be restored with native upland vegetation, and the 1 acre of mangrove fringe would be restored with mangroves.

For activities related to the installation of the weir in the western end of the Project Channel, an upland staging area near the four western bridges would be used to temporarily stockpile and transfer the collected solid waste excavated during the dredging process. Equipment and materials would be staged on floating barges. Solid waste and sediment dredged during the construction of the weir would be taken to the Las Piedritas staging area and trucked to an upland landfill (Humacao).

After screening and removal of solid waste debris, the remaining sediment and smaller pieces of solid waste would be encapsulated within geotextile fabric bags, and transported by shallow-draft barges to the San José Lagoon artificial subaqueous pits. Sediments would be placed utilizing CAD in the SJ1 and SJ2 pits. During the CMP-ERP disposal operations, approximately 648,000 cy of in situ sediments would be placed in the SJ 1 and SJ2; however, additional water quality and sediment testing, such as bioassays, would be conducted prior to placement to ensure their suitability for disposal. Approximately 37,800 cy of in-situ sediments would be used to complete the sheet pile construction and mangrove bed restoration.

The SJ1 and SJ2 CAD sites would be capped with a 2-foot layer of sand. Material for the sand cap will be quarried from upland quarry sites and transported by trucks to the construction staging area for transfer to dump scows for placement. Silt curtains would also be employed around the CAD pits in the San José Lagoon. In critical areas, the curtains may double ring the active area for additional precautions. The curtains would be constructed to the full depth of the water where they are placed.

6.2.2.1 Applicability of Statutory and Regulatory Exclusions/Exemptions

The extent to which one or more potential exclusions or exceptions apply to the specific materials excavated during the project will depend upon the specific conditions and circumstances existing at the time of excavation.

For example, under the definition of HTRW in USACE Engineering Regulation 1165-2-132, dredged materials and sediments beneath navigable waters, including those that contain CERCLA hazardous substances or RCRA hazardous wastes, qualify as HTRW only if they are within the boundaries of a site undergoing a CERCLA response action or on the National Priorities List. Further, under USEPA's hazardous waste exclusion for dredged material under RCRA, 40 C.F.R § 261.4(g), "dredged material that is subject to the requirements of a permit that has been issued under 404 of the Federal Water Pollution Control Act (33 U.S.C.1344) or section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972 (33 U.S.C. 1413) is not a hazardous waste."

Final determination of the excavated materials' regulatory status will be made by the appropriate Federal and Commonwealth of Puerto Rico (the Commonwealth) regulatory authorities and would be a matter for discussion between the Commonwealth, as the responsible party, and those regulatory agencies.

6.2.2.2 Actionable Hazardous Substances

The CMP Ecosystem Restoration Federal project will not include costs associated with the management or disposal of any "Actionable Hazardous Substances," as defined herein. The Commonwealth shall be responsible for ensuring that the development and execution of Federal, State, Commonwealth, and/or locally required response actions to address Actionable Hazardous Substances are accomplished at 100 percent non-project cost. The Commonwealth also shall be responsible for and pay all costs associated with the generation, release, management, or disposal of any Actionable Hazardous Substances identified by sampling. The Commonwealth may request the services of the USACE to perform such actions outside of the Federal project.

All dredged or excavated materials will be tested for the presence of hazardous substances in accordance with a sampling plan to be agreed upon by the parties. All Actionable Hazardous Substances shall be segregated.

"Actionable Hazardous Substances" is defined for purposes of this project as any material that:

(1) contains a hazardous waste, as defined in USEPA's RCRA regulations;

(2) contains a hazardous substance as identified in 40 C.F.R. 302.3 and 302.4 in concentrations that pose a threat to human health or the environment as determined by USEPA; or,

(3) cannot, without additional treatment, be disposed of legally in a Subtitle D municipal solid waste landfill located within the Commonwealth of Puerto Rico, and is not environmentally appropriate, as determined by the Puerto Rico Environmental Quality Board, in consultation with USEPA, for disposal, without additional treatment, in open water or in the San José Lagoon Contained Aquatic Disposal areas.

Materials may constitute Actionable Hazardous Substances under the above definition regardless of whether such materials are subject to disposal pursuant to 33 U.S.C. 1344 or 33 U.S.C. 1413 or of such materials' jurisdictional status.

Disposal of classes or categories of materials determined not to be an "Actionable Hazardous Substance" as defined above shall be documented with an affirmative determination (by the appropriate regulator entity) supporting the proposed disposal methodology and location.

6.2.2.3 Establishment of Separate Memorandum of Agreement

In addition, prior to or concurrently with the execution of a Project Partnership Agreement (PPA) associated with the Federal project, the parties shall execute a separate MOA between the USACE and the Commonwealth. In accordance with the MOA, the Commonwealth shall be responsible for any Actionable Hazardous Substances encountered during the project. The MOA will explicitly provide that:

- All increased costs associated with the generation, release, management, and disposal of Actionable Hazardous Substances that exceed the cost of normal project design, engineering, and construction activities, and that are necessary to implement the Federal project features shall be excluded from total project costs and shall be paid by the Commonwealth under the terms of the MOA.
- After the discovery of Actionable Hazardous Substances, any further site characterization associated with the Actionable Hazardous Substances; development, planning, selection, and execution of appropriate response and disposal actions; and establishment and future management of disposal areas for all Federal, State, Commonwealth, and locally required actions to address those Actionable Hazardous Substances shall be paid 100 percent by the Commonwealth.
- The Commonwealth shall indemnify the Federal Government for any future liability associated with the generation, release, management, or disposal of any Actionable Hazardous Substances excavated or dredged during the project work.
- The Commonwealth may request USACE assistance in the removal and proper disposal of any Actionable Hazardous Substances necessary for the execution of the Federal project. Such work shall not be considered a Federal project cost and, as such, the only funds ultimately available shall be those funds provided by the Commonwealth under the MOA specifically for those purposes.
- Any future costs associated with such Actionable Hazardous Substances that exceed the scope of the MOA shall be the sole responsibility of the Commonwealth and shall be outside the Federal project.

6.2.2.4 Establishment of Escrow Account

Prior to the initiation of construction, the Commonwealth will establish an escrow account, with interest accruing to the Commonwealth, in an amount to be agreed upon that is sufficient to

prevent delays in the execution of project work in the event that Actionable Hazardous Substances are encountered. Such escrow account will be maintained during the course of the project and will be used by the USACE in the execution of work relating to Actionable Hazardous Substances under the MOA, unless other funds are provided by the Commonwealth in time to prevent the suspension of work under the Federal project.

6.2.3 Erosion Control

The primary erosion control for the project is the construction of a weir at the western end of the project channel (Figure 18). This feature is expected to prevent scour around bridges, bulkheads, and other marine structures by providing a transition area to reduce flow, and unacceptable bottom velocities, between the Project Area and the Western CMP. The weir, with a dimension of 6.5 x 115 feet, yields identical bottom velocities to Alternative Plan 1 (75 x 10 feet).

6.2.3.1 Turbidity Control

Turbidity controls will focus on minimizing dispersal of silt-laden waters from the project limits. To minimize dispersal of turbid water from the channel during dredging, a temporary turbidity containment coffer dam would be constructed east of the four bridges, and potentially at the channel's entrance to San José Lagoon (if access to the lagoon is not required for construction activities).

Silt curtains would be employed within the channel corridor and around active dredging and excavations adjacent to the water; and around the San José Lagoon pits. Typically fabricated of flexible, polyester-reinforced thermoplastic (vinyl) fabric, the curtain is maintained in a vertical position by floatation material at the top and ballast chain along the bottom. In critical areas, the curtains may double ring the active area for additional precautions. The curtains would be constructed to the full depth of the water where they are placed; the coffer dam(s) would be sized and constructed in such a way as to prevent flooding impacts to adjacent areas.

During construction, best management practices (BMPs) would be used to minimize short-term and long-term sedimentation, erosion, turbidity, and total suspended solids (TSS). These BMPs during the construction phase would include seeding for temporary plant cover, retention blankets, silt fencing, and/or earthen diversions. Long-term turbidity and TSS management would be accomplished with storm water dispersion systems, paved discharges, blankets, matting, vegetative filter strips, and berms.

Sedimentation and erosion control devices would be deployed at the interface of the channel dredging and the uplands. Storm water from the project uplands would be filtered through these devices prior to discharge into the channel corridor. Storm water from existing community storm sewers would be directed into the channel corridor through temporary channels and flumes. Further treatment within the channel would be handled as turbidity control.

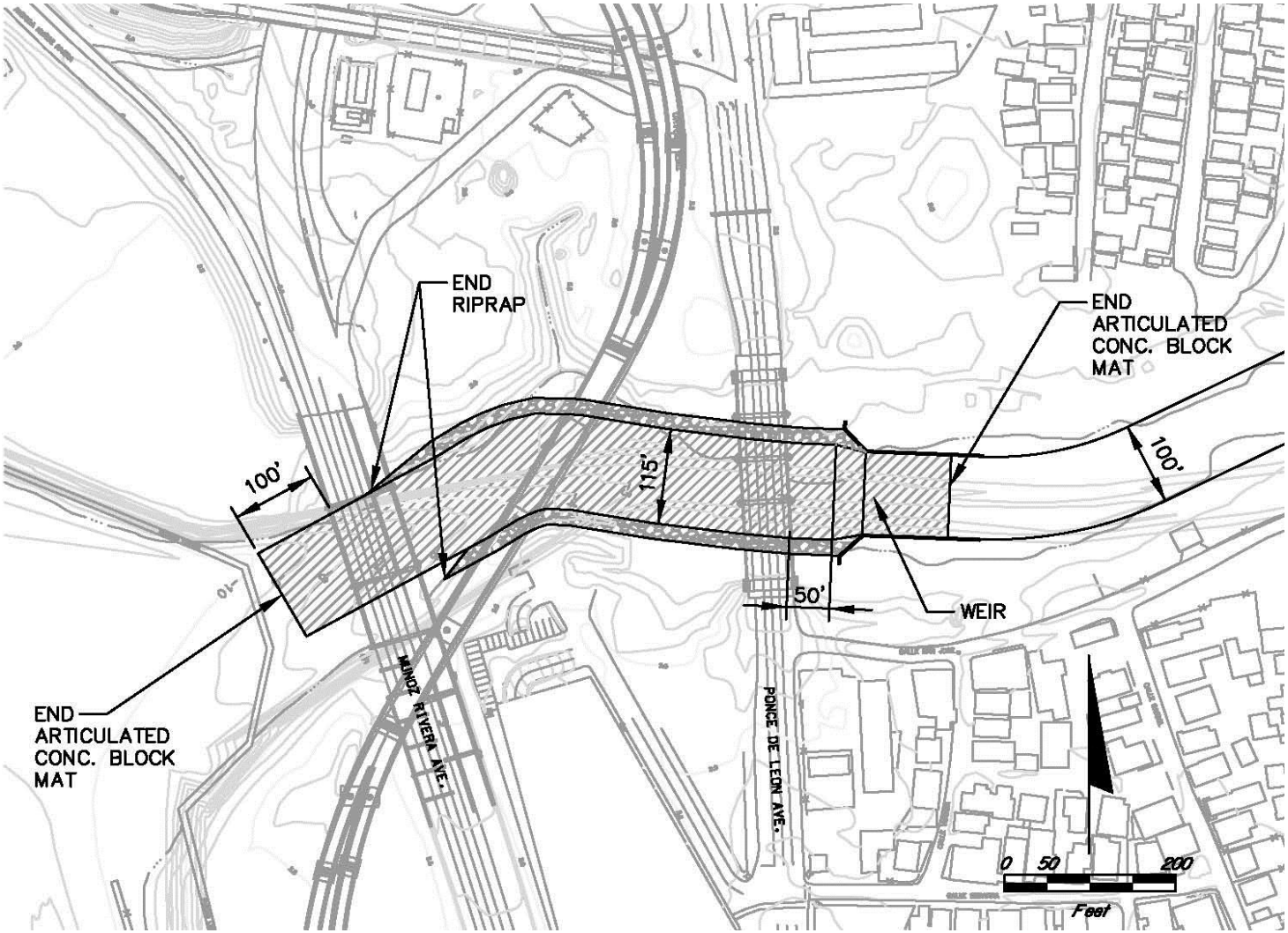

Figure 18. Weir, Overall Plan

6.2.4 Mangrove Planting Bed Construction

Four species of mangrove would be considered for planting in the mangrove planting beds adjacent to the newly dredged CMP: *Rhizophora mangle* (red mangrove), *Avicennia germinans* (black mangrove), *Laguncularia racemosa* (white mangrove), and the associated species *Conocarpus erectus* (buttonwood). The flow of water from the channel to the mangrove planting beds would be facilitated by building hydraulic connections, or windows, in the bulkhead at regular intervals. The sill depth of the window would be set at mean low water so that tidal exchanges are facilitated to the mangrove beds. The width of the planting beds would vary depending upon the land availability, but in general would extend from the channel wall to the line of public domain, excluding only areas set aside for recreation elements of the NER Plan. The minimum width for mangrove fringes would be approximately 32 feet on either side of the CMP. Mangrove restoration would include 34.48 acres of wetlands.

Construction of the sheet pile walls would require the removal of existing soils along the channel. Care should be taken in the selection of replacement soils to ensure that they closely replicate the existing condition in a reference site for the project. Stockpile for reuse of excavated soils from dredging and bulkhead construction would be accomplished to maximize favorable conditions for natural recruitment and succession.

Monitoring of the mangrove restoration in both the CMP and CDRC planting areas has been included as part of the project cost.

6.2.5 Non-Structural Measures

Non-structural measures that would be implemented as a cost-shared part of the project would include structure acquisition and relocation. This measure is described more thoroughly in Section 6.5 and the Real Estate Appendix of this report. Increased enforcement of illegal dumping and community education would be implemented by ENLACE and the residents of the CMP outside the authority of this project. The community already has a program to erect barriers and patrol cleared areas to ensure illegal dumping is not conducted. ENLACE and the surrounding communities also have already implemented a community education program that informs the public on the importance of CMP health and effects on the local population. Continuation of the program is considered imperative to continue the environmental stewardship that has already begun and to encourage future generations in the area to prevent a return to present conditions. No non-structural measures were identified to restore circulation to San José Lagoon.

6.2.6 Recreation Plan

The CDLUP and State Comprehensive Recreational Opportunity Plan are the foundation of recreational features selected for the project. The recreation features and final recreation measures that are identified in the Federal Recreation Plan were developed and selected through an intensive

public participation and feedback process from the population in the surrounding communities. Over 700 public activities were conducted to promote effective participatory planning, decision making, and implementation over a two year period leading up to the initiation of the Feasibility Report.

Recreational features have been refined to ensure that they are in compliance with Exhibit E-3 of ER 1105-2-100, and thus allowable for use in the Federal recreation plan. The following is a list of the recreational features identified as acceptable for the Federal recreation plan.

- Trails
- Walks
- Steps/ramps
- Footbridges
- Picnic tables
- Trash receptacles
- Benches
- Entrance/Directional Marker
- Instructional signs
- Interpretive markers
- Gates
- Guardrails
- Lighting
- Handrails
- Walls

The non-Federal sponsor, ENLACE, will continue to work with the local community to implement the CDLUP. As part of the CDLUP, ENLACE proposes to include improvements to the aesthetic appearance and include additional opportunities in the Federal recreation plan areas. ENLACE will continue to refine the improvements and additional opportunities with the community in a timely manner to incorporate them into the construction of the Federal recreation plan, at 100 percent non-Federal cost. ENLACE is currently considering the addition of betterments to the lights, including figures or statues, and incorporating exercise stations, fishing, and kayak or canoeing opportunities. Navigation access would be provided through the Federal recreation access parks.

The Federal Recreation Plan would consist of 3 types of recreation access areas (Figure 19) on approximately 5 acres. The 3 types allow for major recreational use in some areas and median use in others. Two types would be adjacent to the proposed Paseo (whose construction is not a part of this federal ecosystem restoration project). This approach allows for large uninterrupted areas of restoration with major recreation areas that have access to the water, and median use areas along the smaller neighborhoods while connecting to the Paseo along the CMP.

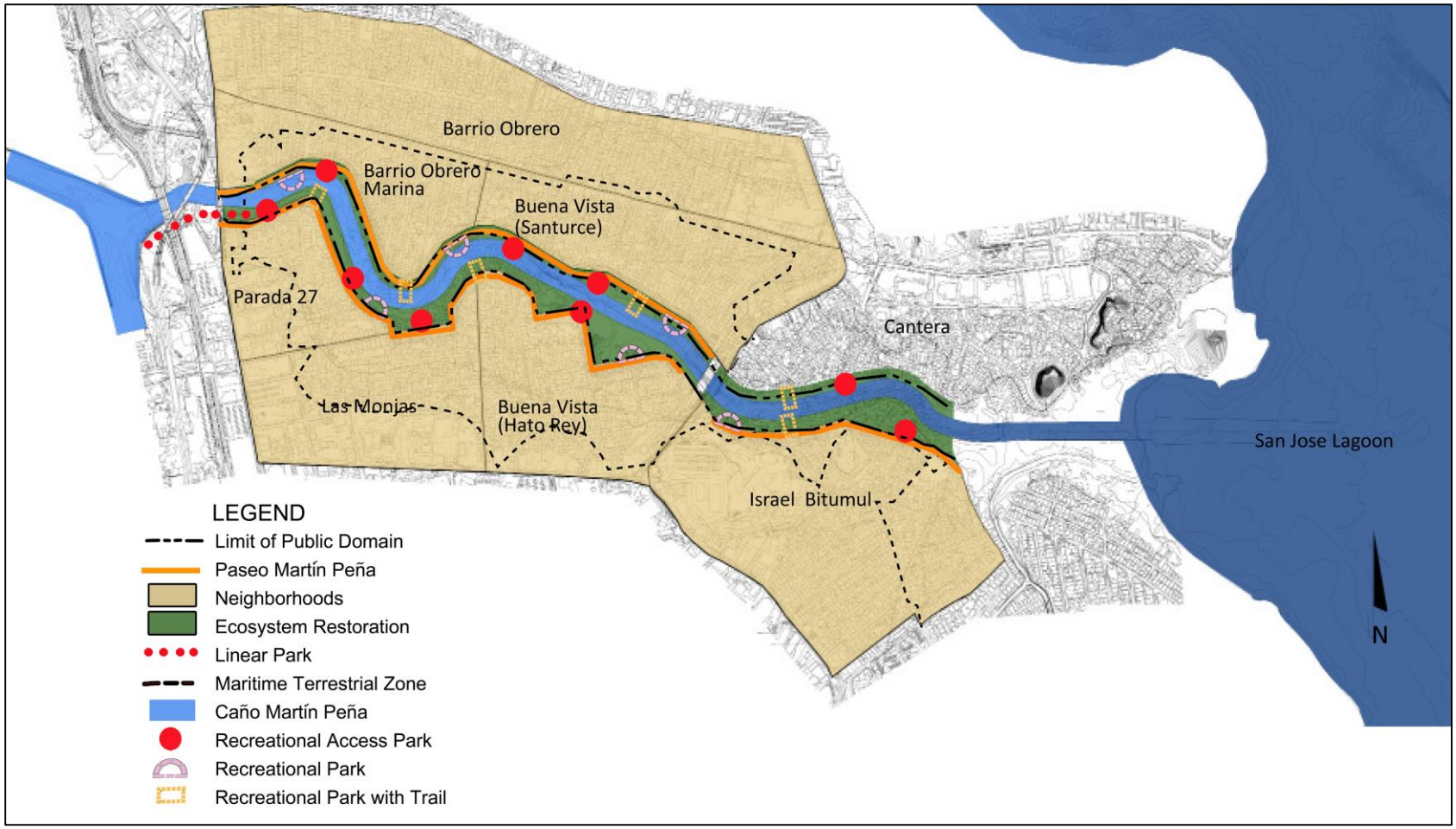

Figure 19. Proposed Federal Recreation Plan

1) **Linear Park**. This recreation area would consist of a trail, walk, and/or footbridge that extends the existing linear park located to the west of the Project Channel. The extended linear park trail would be constructed over the sheet pile bulk head in the channel (with the mangrove fringe between the linear park trail and the Paseo), and would be located on the southern side of the CMP, extending past the four western bridges in the project area and terminating at the first recreation access area in the Parada 27 community. In the vicinity of the western bridges, where the sheet pile wall is replaced with a riprap edge, the trail would be constructed on piles. If possible, benches may be placed in strategic locations to provide rest and or observation areas. The area would have an entrance sign, instructional signs and interpretive signs to educate the public on the CMP-ERP, proper use of the recreational area, and educational facts about the restored ecosystem. A gate and fence, or wall, would be placed along the CMP for safety and to discourage the disposal of materials into the CMP. Guardrails, handrails, steps, ramps, and lighting would be used, as appropriate, to maintain a safe and accessible recreation area. The linear park would fall within the navigational servitude.

2) **Recreation Access Park**. This type of recreational area would have open access to the restored CMP and would be scaled to accommodate more than 100 persons for passive recreation (Figure 20). The nine recreation access parks would provide visual openings through mangrove forest to the CMP, providing a strong community connection at these strategic locations. Each would be located strategically at the intersection of the Paseo del Cano walkway and an important community transportation artery. They would include picnic tables and benches to encourage educational gatherings and nature enthusiasts to enjoy the restored ecosystem. Each recreation access park would have an entrance sign, instructional signs and interpretive signs to educate the public on the CMP-ERP, proper use of the recreational area, and educational facts about the restored ecosystem. A gate and fence, or wall, would be placed along the CMP for safety and to discourage the disposal of materials into the CMP. Guardrails, handrails, steps, ramps, and lighting would be used, as appropriate, to maintain a safe and accessible recreation area. The recreation access parks would provide for navigation access to the CMP.

3) **Recreation Park**. This type of recreational area would be smaller in scale than the proposed recreational access park, and would be scaled to accommodate less than 100 persons for passive recreation. With the natural mangrove forest serving as a backdrop, the twelve recreation parks would be strategically located along the Paseo del Cano walkway corridor to serve immediately adjacent blocks. In six of the recreation parks, a trail would be built through the forest to allow access to CMP (Figure 21). The recreation parks would include benches to create an outdoor classroom and be strategically positioned to enhance nature watching. They would have an entrance sign, instructional signs and interpretive signs to educate the public on the CMP-ERP, proper use of the recreational area, and educational facts about the restored ecosystem. A gate and fence, or wall, would be placed along the recreation park and CMP where applicable for safety and to discourage the disposal of materials into the CMP. Guardrails, handrails, steps, ramps, and lighting would be used as appropriate to maintain a safe and accessible recreation area.

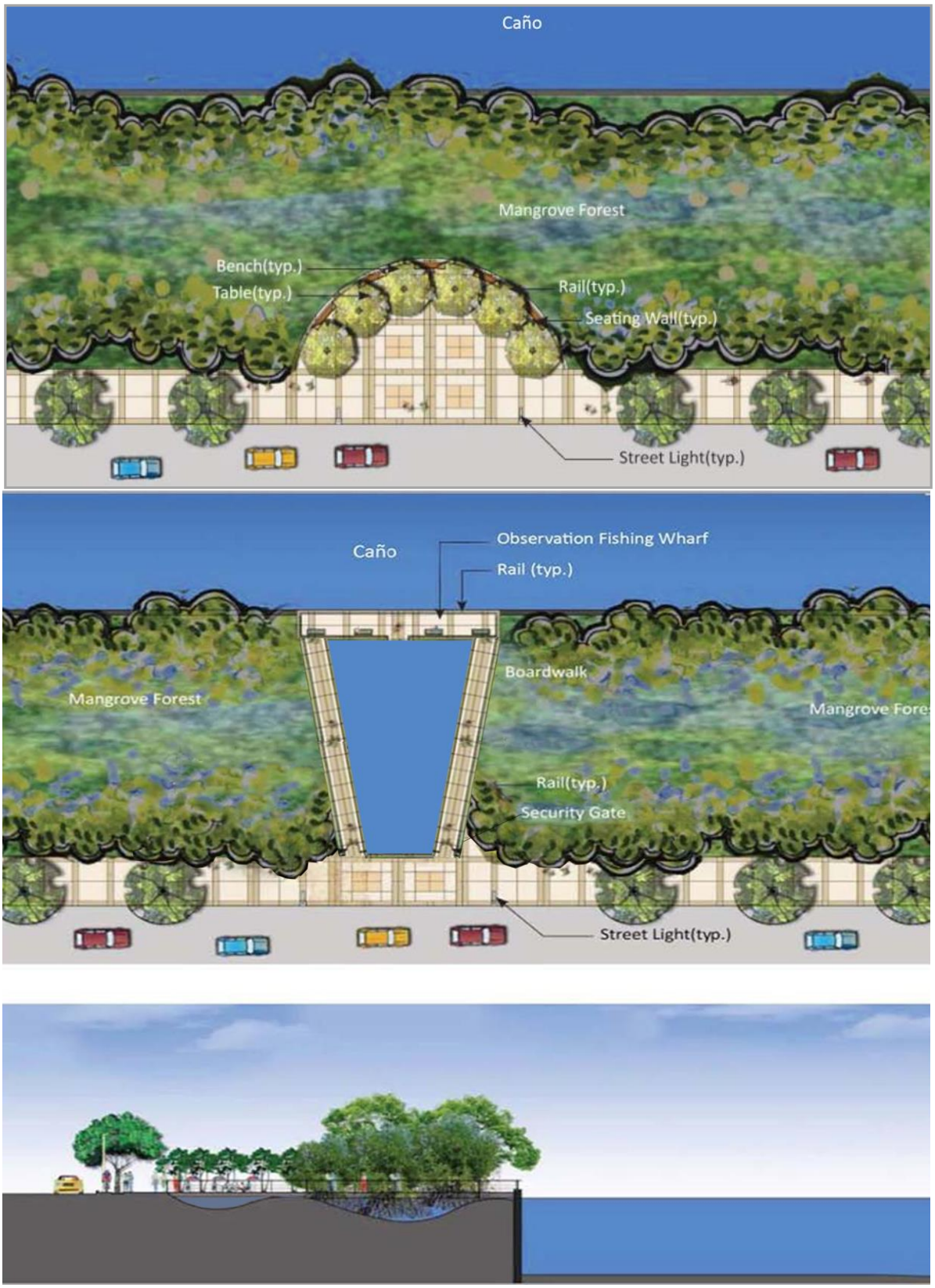

Figure 20. Prototype Recreation Park Design (a) no trail (b) with trail

There are no water-related recreation features currently within the Project Area, and as a result, there is no current or historic visitation information available for the types of proposed water-related recreational facilities. The existing land-related basketball/volleyball courts within the Project Area would be removed under the No-Action Alternative because they are in the public domain boundary. They will be replaced on a 1-1 usage basis and located outside the public domain using 100 percent non-Federal funds, and undertaken as part of the CDLUP. Their relocation is not associated with the CMP-ERP.

The Federal recreation plan is considered an essential component of the ecosystem restoration plan as it provides for a significant increase in recreational opportunities along the CMP, as well as helping alleviate the historic primary cause of ecosystem degradation in the area. The proposed recreational features are compatible with the ecosystem outputs for which the project is designed. They are compatible with the ecosystem restoration purpose by providing an appropriate interface within the urban environment and the aquatic environment. The features are appropriate in scale and have no impacts to the ecosystem restoration benefits that justify the CMP-ERP. The acreage necessary for the recreation features does not result in a loss of mangroves as the existing acreage of wetlands would be replaced with a net increase of higher functioning wetlands in the CMP, even with the 5 acres reserved for recreational features. In addition, the tidal connectivity for mangroves would still occur through the water, and the fish and wildlife that inhabit the mangroves would still be able to connect to other mangrove areas along the CMP through this water connection.

The recreational features are incrementally justified. The individual recreation elements are similar to each other and would thus provide a similar level of benefits. The combined recreational features have a benefit-to-cost ratio of 6.8 to 1 and appropriately cost-shared 50 percent non-Federal and 50 percent Federal. The total recreation facilities first cost is $11,285,000 (includes facilities cost, PED, and CM costs) and the Federal share is $5,642,000, or 4.3 percent of the estimated non-recreation Federal cost share of $131,866.000 for the ecosystem restoration project. The 4.3 percent is in compliance with the requirement of not exceeding 10 percent of the non-recreation Federal project cost. The non-Federal sponsor, DNER, would be 100 percent responsible for operation and maintenance of recreation features.

Figure 21. Sample design of recreation access park

The linear nature of the project area provides recreational uses for all eight neighboring communities; careful placement of these measures throughout the project area is also intended to protect the investment in ecosystem restoration by facilitating appropriate uses of the project area after the CMP-ERP is constructed. This approach facilitates the creation of larger, uninterrupted restored ecosystems, allows for easy access for project maintenance, and discourages improper and unmanaged uses of the area. It also aids education programs in increasing the environmental stewardship of this urban wetland. For example, improved and formalized access to the CMP and the resulting community engagement would facilitate strict enforcement of trash-dumping regulations and incentivize local conservation, thus avoiding future degradation in the process.

Provision of recreational access infrastructure has been demonstrated to foster community connection to the restored ecosystem and build and maintain a positive connection to their local landscapes (Golet et al. 2006; Ulrika Åberg & Tapsell 2013). Additionally, increases in recreational activities such as wildlife viewing, hunting, and fishing often translate to increases in support for conservation actions (Ulrika Åberg & Tapsell 2013). These activities provide the basis for new and existing community-based enterprises to flourish (e.g., Excursiones Eco, Bici-Caño).

6.2.7 Project Monitoring and Adaptive Management Plan

A Monitoring and Adaptive Management Program for the CMP-ERP has been developed to ensure the project achieves the desired restoration outcomes. The program focuses on project performance indicators that can be evaluated and predicted through modeling, and measured and monitored in the field.

The success of the project would be determined by initial physical changes in the system as a result of the opening of the CMP and eventual chemical (e.g., water quality) and biological changes. Project benefits are based upon a decrease in residence times within San José Lagoon following the dredging of the Project Channel, which would result in a decrease in the salinity stratification that currently is observed in the lagoon waters. The hydrodynamic and benthic index models suggest that increased flushing would decrease salinity stratification, increase the dissolved oxygen levels in bottom waters, and dramatically increase the ecological value of bottom waters in most of San José Lagoon. With increased dissolved oxygen within this area, benthic communities are expected to become more diverse, with a greater percentage of pollution-sensitive organisms and a smaller percentage of pollution-tolerant organisms. This series of changes outlines the parameters to be monitored that would reflect short-term and long-term response:

- Short-term: residence time (tidal exchange); water quality (dissolved oxygen)
- Long-term: fauna response; flora response

Based on previous studies, positive responses are "likely to occur" within a year of restoration of flushing and decrease in residence time, and substantial improvements in ecological health of the benthic and mangrove communities are "likely to occur" over a period of 2 or 3 years (Atkins 2011a).

Tidal velocities, estuarine residence time, water quality, Benthic Index scores, and diversity and function of the mangrove root community are performance indicators to be monitored and measured. The basic elements of the program include the following components.

1. Mangrove restoration – Ten 1,000 m^2 plots would be established along the restored CMP channel to assess seedlings survival.
2. Tidal and water quality stations – Four permanent tidal and water quality stations are proposed. The tidal stations would measure tidal fluctuations for translation into tidal exchange and residence time. The water quality stations would at minimum measure temperature, salinity/conductivity, dissolved oxygen, and pH.
3. Water quality profiles – Ten water quality profiles are proposed to be monitored on a monthly basis. Minimum parameters to be measure would be temperature, salinity/ conductivity, dissolved oxygen, and pH.
4. Benthic sampling stations – Thirty stations would be sampled (three grabs per station) and the organisms sorted and identified sufficient to create Benthic Index scores yearly at each station. The stations would be spaced through the SJBE with samples intensified within the 702 acres between -4 and -6-foot depth within San José Lagoon. Included in this effort are creel studies and interviews with recreational and charter fisherman to help determine changes in fish abundance and diversity.
5. Mangrove prop root community study – Sampling of the stations in and around the Project Area to evaluate the encrusting community diversity and juvenile fish diversity.
6. Post-construction sedimentation rate – Bathymetric surveys to determine post-construction sedimentation rates and maintenance dredging requirements within the CMP.

The costs associated with implementing the monitoring program were estimated based on current available data and information developed during plan formulation (Table 25). Cost calculations for monitoring were calculated for a 5-year (maximum) period, consisting of 1-year pre construction, and 4-year post construction. If ecological success is determined earlier (prior to 4 years post construction), the monitoring program would cease and costs would decrease accordingly.

Table 25. Ecosystem Restoration Monitoring Plan Cost Estimate

Monitoring Plan Element	Estimated Equipment Cost	Estimated Annual Maintenance, Monitoring, and Reporting	Total Estimated Maintenance/ Monitoring/Reporting
Pre-construction baseline studies and mapping	$15,000	$60,000[1]	$60,000
Four permanent tidal/water quality stations	$40,000	$34,000[2]	$170,000
Inspection and bathymetric survey	–	$23,000[3]	$115,000
Ten water quality profile stations (Lab/field)	$10,000	$20,000[2]	$100,000
Thirty benthic sampling stations	$10,000	$80,000[2]	$400,000
Mangrove prop root community monitoring	–	$50,000[2]	$250,000
Creel survey	$5,000	$10,000	$50,000
End of monitoring period benthic mapping	–	$60,000[1]	$60,000
Data Analysis Evaluation and Assessment	–	$50,000[2]	$250,000
Equipment maintenance/transportation	–	$8,000[2]	$40,000
SUBTOTALS	**$80,000**	**$395,000**	
		Total Equipment and 5 Year Cost	**$1,575,000**
		Total 5-Year Cost with 3% Inflation	**$1,622,250**

[1]Single time cost / [2]Five year monitoring period / [3]1st. year for initial survey, $25,000; following 5 years, $18,000. Total of $115,000, or an annual average of $23,000.00.

The data collected through the proposed monitoring plan would provide information on whether selected targets have been achieved. Proposed adaptive management actions would be initiated if specific values for selected parameters or "triggers" are detected or measured during monitoring efforts.

Mangrove restoration success and water flow through the Eastern CMP are the two major uncertainties that would be addressed by several actions proposed as part of the Adaptive Management Plan. For mangrove restoration along the Eastern CMP, replanting mangrove species propagules has been proposed to replace those that could be lost due to natural or man-made factors. Increasing the area of the inlets (windows) in the sheet pile walls and/or conducting minor grading of the mangrove planting bed along the Eastern CMP would improve periodic tidal flow in case the topographic relief is unsuitable for the establishment of red mangrove trees. These actions would be triggered if the number of red mangrove propagules is reduced below 85% of those originally planted, and their implementation selected after first assessing and identifying those factors (natural or man-made) responsible for propagule mortality.

Adaptive management measures for tidal flow, bottom channel velocities and residence time would be triggered if (1) there is a decrease of 20% or more in tidal oscillation between the San Juan Bay and the San José Lagoon; (2) bottom velocities in the Eastern CMP are conducive to its

sedimentation; and/or (3) result in scouring of the channel. These conditions would be addressed either by:

1. A one-time dredging event to provide a sump to store additional sedimentation at the confluence of the CMP and the Juan Méndez Creek prior to a 5-year cycle maintenance dredging scheduled.
2. Placement of boulders, rip rap, and/or other appropriate concrete structure at those sites that may result scoured in the Eastern CMP, including, if necessary, on either side of the weir's channel to constrict flow if flow velocities are stronger than expected.

Efforts to eliminate or reduce watershed based loadings from point and nonpoint sources of pollution would be encourage as a mean to improve water quality and overall habitat conditions in the event that adaptive actions to improve tidal flow and reduce water residence time prove to be insufficient to achieve expected targets or performance measures. The costs associated with implementing the Adaptive Management Program were estimated based on current available data and information developed during plan formulation (Table 26).

Table 26. Ecosystem Restoration Adaptive Management Plan Cost Estimate

Management Actions	Costs
One-time early dredging	$5,371,800
Placement of boulders, rip rap, and/or concrete structures in scoured areas	$1,325,843
Placement of rip-rap on either side of weir's channel to constrict flow	$13,258
Increase size of inlets within sheet piles	$3,859
Elevate mangrove planting bed relief	$130,076
Lower mangrove planting bed relief	$12,512
Replanting of mangrove planting bed	$56,393
Total	**$6,913,741**

Assumptions:

One-time early dredging would be performed as an adaptive management action. Subsequent dredging (annual dredging) is included in the O&M costs.

Mangrove re-planting would be carried out to replace dead mangroves propagules in order to increase up to 85% the number of trees initially planted.

Actions related to the implementation of best management practices to reduce erosion and sedimentation within San José Lagoon and the CMP watershed and eliminating/reducing raw sewage and polluted storm water discharges in coordination with related agencies would be funded by existing or future government watershed management programs.

Grading of mangrove planting beds could require either elevating or lowering its topography, or combining a limited scope of both actions. As such, total costs would be lower than those shown under any of these two cases for the total expenses related to the implementation of proposed management measures.

In light of the uncertainties remain as to the exact project features, monitoring elements, and adaptive management opportunities, the costs estimates may need to be refined in PED during the development of the detailed monitoring and adaptive management plans.

6.2.8 Nuisance and Exotic Vegetation Control

Initial control of invasive species would be provided during construction of the mangrove planting beds. Visual surveys and removal of identified invasive vegetation would be accomplished by physical removal or herbicide application as applicable. Over the life of the project, monitoring for invasive species establishment in the mangrove planting areas has been included as part of the project cost, and additional physical removal or herbicide application would be utilized as necessary. The project would be designed to provide optimal conditions for native vegetation, reducing the probability for establishment and spread of invasive species.

6.2.9 Draft Project Operating Manual

There are no day to day operating elements of the NER plan, so a draft operating manual has not been prepared at this time. An O&M Manual will be prepared during PED to guide project implementation to achieve project goals, purposes, and benefits outlined in this report and will encompass all reasonable foreseeable conditions that may be encountered during the project life. All costs associated with the maintenance of the project will be funded through O&M. At a minimum, the O&M manual would include discussions on maintenance requirements related to dredging, recreation, and mangrove restoration.

6.2.10 Description of Construction Activities and Sequence

Prior to the commencement of construction activities, all real estate activities would be completed, including the identification of real estate structures and issues, acquisition of structures, relocation of affected residents, and demolition and/or relocation of the structures. Concurrent with this activity would be the execution of agreements with one or more construction contractors to complete the CMP-ERP, typically preceded by a solicitation period to prospective bidders, receipt and review of bid submittals, selection of a successful bid, final negotiations and construction contract award.

Upon giving a Notice to Proceed to the selected contractor(s), the start and completion dates for the construction are finalized. Mobilization and site preparation activities would then commence. Mobilization is the period or periods during which the contractor deploys personnel and equipment to the site. These periods may take place in phases over various times during the construction. These activities would typically include the initial installation of construction fencing, sediment and erosion control devices, and the establishment of staging areas. Staging for the eastern end of the channel would be constructed at the CDRC. Staging for the western bridges would be a floating platform, comprised primarily of barge-mounted equipment, as well as a location on adjacent uplands near the Martín Peña Bridge (Las Piedritas). The boats, barges, cranes, dredges, grizzlies, and other dredge equipment would be deployed. It is anticipated that equipment to be utilized for the dredging of the eastern channel would be brought in through San José Lagoon, and equipment slated for work under the western bridges would enter via the

western branch of the Caño Martín Peña after originally being deployed from existing port facilities and/or boat ramps in the San Juan Bay. This work would be performed in close conjunction with the clearing and grubbing activities. Should construction at the western bridges precede the eastern channel, the pits would have to be prepared and dredge equipment deployed overland.

During clearing and grubbing activities, trees, brush, root balls, and grasses would be stripped from the surface. All of the vegetation, sediment, and solid waste within an average of 12 inches throughout the Project Area would then be hauled to the upland landfill for disposal (Humacao). The stripped vegetation, including root balls, sediment, and solid waste evident on the surface and within the 12 inches, would be removed, loaded into trucks, and hauled to the upland landfill. Final adjustments to the construction fencing, sediment and erosion control devices, and staging areas would be completed during this activity. During clearing and grubbing activities, the turbidity curtain(s) would be installed at the SJ pits, and the preparation and dredging of the SJ1 and SJ2 would commence.

Upon completion of the above activities, staging areas and driveways for temporary placement of solid waste and dredged sediment from construction of the weir would be constructed near the western portion of the CMP project footprint. Temporary sheet pile coffer dams would be placed to the west of the last of the four western bridges and along segments of low-lying areas along the Project Channel, particularly the bend at Barrio Obrero Marina.

With the completion of the temporary sheet pile dams, the excavation (dredging) and earthwork associated with the Project Channel would begin. Dredging activity would begin on both ends of the Project Channel concurrently. On the western end of the Project Channel by the four western bridges, dredging and related activities would take place to install the weir. Tasks associated with the installation of the weir include the preparation of the channel subgrade, placement of geotextile fabric, and the articulated concrete mat. Concurrent with this operation is the placement of scour protection (rip rap) around the bridge abutments, bridge pile caps and bridge columns, and along the channel side slopes. At the eastern end of the Project Channel, the 4,300-foot channel from the CMP into the San José Lagoon would be dredged, and dredging activities would take place in the Project Channel, from east to west, eventually connecting with the completed weir by the four western bridges. The equipment utilized for the installation of the weir would be scaled down for working near and under the bridge structures.

During the dredging of the channel, solid waste would be separated from the sediments and hauled by shallow-draft barge to the CDRC, where it would be offloaded onshore and reloaded into trucks for disposal at the upland landfill (Humacao). In the event that construction of the weir begins prior to the eastern channel, all barge related activities would become overland trucking tasks. The remaining sediments and small pieces of debris would be trucked to a landfill such as the Humacao landfill. Sediments that slough off the side of the channel would be dredged up and placed upland

for use as backfill behind the sheet pile wall. In order to manage storm water and tidal flows, the work under the bridges, including construction of the weir, must be completed prior to opening of the channel east of the weir.

In addition to the dredging, earthwork activities would be conducted upland of the dredged excavation to shape the surface of the soil along the project boundary and to collect and divert storm water to a temporary protected outfall into the channel. Earthwork would also involve backfilling behind the sheet pile wall after the concrete wall cap for the sheet pile has been installed.

Following behind the dredging activity in the channel would be a concurrent process to install the sheet pile walls for bank stabilization starting from the east end of the Project Channel. After sufficient length of channel has been dredged, installation of the sheet pile would begin, with further dredging proceeding to the west. The sheet piles would be barged to the site and driven into place. After the wall construction has progressed sufficiently, forming and pouring of the concrete cap would occur, followed by the backfilling of the wall discussed above under earthwork. The wall openings for tidal conveyance to and from the mangrove bed would then be constructed. After the bank stabilization activities have been completed, the mangrove planting beds would be constructed.

Construction of the recreation areas would begin concurrently with the construction of the channel. The recreation component would include the upland recreational structures, paving and landscaping, and the walls and steps that form the interface between the parks and the sheet pile wall of the channel.

Upon notification by the construction contractor that substantial completion has been reached, the work would be inspected by those with oversight of the project. It is possible that the work would be broken into phases with each phase having separate and distinct inspections and close out activities. Work deemed incomplete or not constructed in accordance with the construction contract documents would be documented in the form of a punch list. The contractor would be required to perform the necessary corrective actions to remedy the items on the punch list. Follow-up inspections would be performed to ensure that all punch list items have been completed. Upon completion of the punch list items and delivery by the construction contractor of all documents required for closeout, project acceptance would be issued, ending the construction contract.

6.3 COST ESTIMATE

A breakdown of the cost of the CMP-ERP including construction, lands and damages, ecosystem restoration elements, PED costs, recreation and interest during construction is included in Table 27. The total estimated project first cost is $214,156,000. Project costs were estimated at

1 October 2015 price levels and rounded to the nearest $1,000. Refer to the Cost Engineering Appendix for the full MCACES cost estimate.

The NER Plan yields 6,133 AAHUs at an average annual cost of $9,725,100, with an average annual cost per average annual habitat unit of $1,586 (based on the MCACES and associated operations and maintenance cost estimates versus those developed with the Planning Level Cost Estimate for initial plan evaluation and comparison).

Table 27. National Ecosystem Restoration Plan Cost Estimate

Feature	Estimated Cost including contingency	Project First Cost-constant dollar basis (Effective Price Level Date 1 October 2015)	Total Project Cost fully funded
Relocations (Cost to Date)	$270,000	$270,000	$270,000
Relocations	$12,410,000	$12,410,000	$12,926,000
Fish and Wildlife Facilities	$11,477,000	$11,477,000	$11,954,000
Channels and Canals	$51,241,000	$51,241,000	$53,371,000
Recreation Facilities	$9,813,000	$9,813,000	$10,221,000
Bank Stabilization	$62,062,000	$62,062,000	$64,642,000
Cultural Resources Preservation	$139,000	$139,000	$144,000
Construction Estimate Subtotal	$147,141,000	$147,141,000	$153,528,000
Lands and Damages	$44,674,000	$44,674,000	$44,674,000
Planning, Engineering, and Design	$13,243,000	$13,615,000	$13,915,000
Construction Management	$8,828,000	$9,077,000	$9,605,000
Total Cost Estimate	$214,156,000	$214,156,000	$221,722,000
Interest During Construction (IDC)		$3,346,200	
Total Investment Cost		**$217,502,2000**	
Average Annual Equivalent Cost		**$8,847,000**	
Average Annual OMRR&R		$1,070,000	
Total Average Annual Cost		**$9,725,100**	
Average Annual Cost per Average Annual Habitat Unit		**$1,586**	

Note: The NER and Recommended Plan cost estimate includes several cost updates as compared to the Planning Level Cost Estimate that was used for the evaluation and comparison of the final array of alternatives. Updates/revisions included: inclusion/updates of utility relocations, updated Federal Discount rate, updated escalation table, updated AM/MP cost, updated quote for sheet pile wall, and inclusion of new mitigation measures. All of the cost updates and revisions associated with the TPCS would be common elements to the final array of alternatives, and as such, the result of the CE/ICA would not be affected. Thus these cost updates were not reflected in the Planning Level Cost Estimate.

6.4 DESIGN AND CONSTRUCTION CONSIDERATIONS

Design and construction of the CMP-ERP will be coordinated with adjacent construction activities that are not part of the federal project, including residential relocations, perimeter road construction and sanitary sewer, water, and electrical transmission line relocations. Ongoing planning efforts by ENLACE as part of the CDLUP would establish proposed elevations for the adjoining infrastructure are compatible. This effort must be carefully coordinated with the design of the Project Channel. This comparative analysis cannot be conducted without detailed engineering of these adjoining areas.

The following additional technical investigations would help to refine the NER and Recommended Plan, not influence the selection of the NER and Recommended Plan. As a result, they can be delayed until PED. Furthermore, the risks associated with these additional investigations have been identified and, where applicable, modeled within the cost and schedule risk analysis (CSRA) in Appendix D of this Feasibility Report.

6.4.1 Engineering and Design

Additional technical investigations and studies are required for the CMP-ERP during PED. These investigations are recommended to be performed after the final project geometry is confirmed during PED. These investigations include items such as:

- Hydraulic and Hydrologic (H&H) modeling and/or analyses to:
    - Link tidal amplitude and flood surface elevations linearly from the western to the eastern ends of the channel to prepare a map that shows floodplain limits for various storm return periods. Based upon the topographic data, it is known that certain portions of the adjoining community are below base flood elevations. The preparation of a map that links tidal amplitude/flood elevations would provide a higher level of detail for determining where temporary flood protection of the adjoining community would be needed at the micro level while the project channel is under construction;
    - Link tidal amplitude and flood surface elevations for areas adjacent to the San José Lagoon and Los Corozos Lagoon to determine if the restoration of tidal activity would induce flooding of structures;
    - Update the existing H&H to determine allowable top of weir elevations for the installation of temporary turbidity curtain cofferdams that will not cause the inundation of structures within the Project limits. The top of the temporary turbidity curtain coffer dam at the western bridges must have a weir or spillway to control the maximum pool elevation of the water staging behind it. That elevation must be determined in conjunction with the top elevation of the temporary flood protection dams. This analysis would be a refinement of the work performed during the feasibility study;

- Evaluate the existing storm sewer system at the airport to determine if a rise in tidal amplitude on the San Jóse Lagoon would have any detrimental effects.
- Update the determination of scour rate through additional detailed sampling using FDOT procedure(s) for predicting scour rate for the type of material in the CMP. The soil investigation indicates that the silt clay material near the proposed channel bottom is predominantly hard and stiff, so there will be a time dependency for scouring. Extremely hard material can be very resistant to scour. Given that the peak tide velocities will occur for only several hours a day, this could be factored in to the design if the scour rate can be better predicted.
- Perform bridge scour and analysis in accordance with the following documents:
  - Bridge Scour and Stream Instability Countermeasures: Experience, Selection, and Design Guidance-Third Edition
  - Publication No. FHWA-NHI-09-111 HEC-23, September 2009
  - FHWA Technical Advisory T 5140.23, Evaluating Scour at Bridges
  - NCHRP WEB only Document 107, Risk-Based Management Guidelines for Scour at Bridges with Unknown Foundations
- Eastern CMP flows to and from the West is via the existing western channel, then into the Rio Puerto Nuevo and finally the San Juan Bay. The Rio Puerto Nuevo's drainage basin covers an area of approximately 24.2 square miles. A recent project to mitigate flooding in the Rio Puerto Nuevo's basin included the construction of enlarged, paved, high velocity channels. Concerns have been expressed over whether these improvements might have detrimental effects on the CMP-ERP. It is understood that the USACE modeled 10 scenarios resulting in hydrologic and water quality changes as part of the Hydrodynamic and Water Quality Model Study conducted for the SJBE Program in 2000. At least one of the scenarios, with a similar configuration as the NER and Recommended Plan for CMP-ERP, did not point to problems or issues such as backflow into the Lagoon, or significant increases in flood levels to those communities fringing the Eastern CMP. The model showed that levels in the San José Lagoon increased due to tidal influence. It is recommended that this and other modeling conducted as part of the Puerto Nuevo flood control project be further reviewed to determine whether the simulations accounted for the Eastern CMP's proposed configuration, whether there are any problems or issues such as backflow into the San José Lagoon, or a significant increase in flood levels resulting from the Puerto Nuevo Flood Control Project that would affect those communities fringing the Eastern CMP once it is dredged. Dependent upon the results of the review, further modeling may be warranted.

- Geotechnical studies to:
  - Determine the depths of the piles supporting the Ponce de Leon and Luis Munoz Rivera Avenue bridge foundations. It is also recommended that a detailed structural conditions analysis be conducted for these two bridges and the existing Linear Park pedestrian bridge. Since as-built plans of the bridges were unavailable, the feasibility study was conducted without accurate information of the bridge pile

cap elevations. Dredging under the bridges may not exceed the original construction depths. Otherwise, the bridge structures would become exposed and possibly require fortification. The additional studies would determine as-built pile cap elevations by performing non-destructive excavations (test pits and borings) to expose the bridge pile caps. Should it be determined that the preliminary plan for the channel under the bridges would expose bridge foundations, the proposed channel would be reconfigured around these structures and scour protection provided for their protection. It is anticipated that reconfiguration may widen the channel and adjust the channel invert in a manner that would maintain the cross sectional area required for the weir to function.

- Determine the volume and location of dredged sediments that would be suitable and/or unsuitable for unconfined open-water disposal, as well as to refine the current proportion of sediment to solid waste, 90 percent to 10 percent, respectively, using test pits or other suitable methods.
- The soil investigation indicates that the silt clay material near the proposed channel bottom is predominantly hard and stiff, so there will be a time dependency for scouring. Extremely hard material can be very resistant to scour. Given that the peak tide velocities will occur for only several hours a day, this could be factored in to the design if the scour rate can be predicted. During the design phase, consideration should be given to more detailed sampling of the soil to determine the scour rate. The FDOT has a procedure for predicting the scour rate of this type of material.
- Characterize the stability of the pits during or after a disposal operation. With the use of the San José Lagoon pits as the recommended option for the aquatic disposal of dredged sediment, this issue should be investigated in more detail to prevent potential landslides, mainly slumps during the disposal.
- Confirm sedimentation rates associated with the Juan Méndez, as the estimates used during the feasibility study are believed to be conservative. It is expected that a new investigation would identify a lower sedimentation rate because the 2003 study effort (Moffat and Nichol 2003) was conducted during the construction of 2 large developments along the Juan Méndez, and it is believed that the resulting sedimentation rates were elevated as a result of these activities. Moreover, the 2003 study effort did not account for mitigating factors such as improved tidal flow through the CMP, which may serve to disperse the sediments into lower energy environments. If a lower sedimentation rate is confirmed, the operation and maintenance costs of the CMP-ERP would be reduced, perhaps significantly reduced.

- Surveys to:
  - Determine clearances underneath bridges and utilities to fully document and inform choice of dredge plans, sheet pile driving equipment, and other construction methods so that the likelihood or accidents occurring would be minimized;
  - Determine depth of cover over bridge pile caps in vicinity of the proposed project channel to prevent disturbing these existing bridge structures during dredging;

  - Ensure that the final design of the project fully complies with setback requirements from existing structures that will remain in areas adjacent to the project after construction; and
  - Determine whether structures adjacent to San José Lagoon would be impacted by restored tidal activity through the CMP. This effort would require topographic surveys of adjacent structures in conjunction with modeling of tidal action.

- Recreation feature studies to:
  - Ensure each recreational feature is developed in further detail in a manner that expresses the wishes, and reflects the character, of the neighborhood they represent.

- Environmental studies to:
  - Determine whether ground glass and/or dredged material from SJ1 and SJ2 can be used as an alternative to upland quarry sand. Due to present uncertainties in logistics, regulatory compliance, and ecological suitability, this option has not been recommended as part of the NER and Recommended Plan. If further analysis during PED proves that this option is more reliable, cost efficient, and ecologically preferable, ground glass could be recommended to meet part or all of the cap sand requirements.
  - Additional technical investigations and studies may be required during PED to further investigate additional methods of handling dredged material to minimize the migration of large concentrations of hydrogen sulfide. For example, "raking" of the material at the upland staging area may be considered, as suggested by the EPA (see Public Comment Report, Appendix H-8 in EIS).
  - Additional chemistry data and bioaccumulation tests are required to verify the presence, concentrations, and toxicity of contaminants in the Project Channel and SJ1/2 (see Section 6.4.2, *Section 404 Testing*).

6.4.2 Section 404 Testing

Materials within the Caño Martín Peña include various types of solid waste, debris, and other materials. Such materials will require further testing prior to and/or during project construction, as appropriate, in accordance with an agreed sampling plan. If the testing determines that any materials contain hazardous substances at levels that are not suitable for unregulated disposal, they will be managed in accordance with the applicable laws and regulations of the relevant regulatory agencies.

Prior to disposal of dredged sediment within the San José Lagoon pits, additional water quality and sediment testing, such as bioassays, would be conducted in accordance with Section 404 of Public Law 92-217 (Clean Water Act of 1977). Coordination with the Puerto Rico Environmental Quality Board (PREQB) has been initiated, and a Water Quality Certification would be obtained prior to disposal. Specific testing requirements to be conducted during PED would be determined in consultation with the PREQB.

If any (or all) materials were to be found unsuitable for near-shore aquatic disposal in the San José Lagoon pits disposal, they would be collected and disposed of in an upland landfill and/or permanent upland disposal site(s). If the use of the San José Lagoon pits was ruled out entirely, the other feasible disposal option would include the use of permanent upland landfill disposal. The potential use of the permanent upland landfill disposal was eliminated from the final array as those alternatives were considered less complete than the San José Lagoon pits, primarily based on public acceptability. The cost difference between the San José Lagoon pits and permanent upland disposal is estimated to be within approximately $20 million, with San José Lagoon pits being the more cost-effective solution.

6.4.3 Construction Monitoring and Mitigation Measures

Construction monitoring and mitigation measures to be employed are discussed below.

6.4.3.1 Water Quality (Turbidity)

Single and/or double barrier turbidity curtains, as well as a coffer dam(s) would be employed. A temporary turbidity containment coffer dam would be constructed east of the four bridges. Silt curtains would be employed within the channel corridor and around active dredging and excavations adjacent to the water. The curtains would be constructed to the full depth of the water where they are placed; the temporary turbidity containment cofferdam would be sized and constructed in such a way as to prevent flooding impacts to adjacent areas. A double turbidity curtain would be placed around San José Lagoon subaqueous artificial pits during dredging and disposal operations. It is currently anticipated that the turbidity curtain(s) would have the ability to provide an entrance for the barge(s), and upon entering, the curtain could be closed. Once closed, the barge could dispose of the dredged sediment (either unconfined disposal in SJL Pits 3/4/5 or geotextile bags in SJL Pits 1/2) and/or dredging activities in the channel could commence. The temporary turbidity containment cofferdam at the western end of the Eastern CMP would remain in place for the full 27 months of anticipated project construction.

Seeding for temporary plant cover, retention blankets, silt fencing, and/or earthen diversions would be employed.

During project construction activities and during maintenance dredging activities (see Section 6.6), morning and afternoon turbidity readings would be taken twice daily with a nephelometer in the San José Lagoon, the Western CMP, and the area for disposal; monitoring would include comparison of turbidity in the water versus the baseline condition of the San José Lagoon and/or CMP. Turbidity curtains would be employed for any maintenance dredging events.

If turbidity levels exceed the allowed above background regulatory levels (10 Nephelometric Turbidity Unit [NTUs]), all dredging activity shall cease immediately. Dredging shall not resume until turbidity has returned to acceptable levels as determined by proper testing.

6.4.3.2 Water Quality (Contaminants)

Water columns would be sampled weekly at three locations, at a minimum: 1) within the actively dredged area, 2) a site inside the proposed 1,000-foot mixing zone near the disposal site, and 3) a site outside of the proposed 1,000-foot mixing zone, within the open waters of San José Lagoon. The following constituents, all of which have PREQB standards that results could be tested against, would be measured: antimony, arsenic, cadmium, cyanide (free CN), copper, chromium, fluoride, hydrogen sulfide, lead, mercury, nickel, nitrate plus nitrite, silver, selenium, thallium, and zinc.

If there is a contaminant problem, the response would be to stop work; determine the cause of the problem, and/or review procedures to determine means and methods that are effective.

6.4.3.3 Air Quality

Education and training about the symptoms and dangers of hydrogen sulfide poisoning would be provided for all individuals entering the work area. Personal protective equipment for workers such as respirators and/or SCUBA gear would be employed, as required. Air quality devices (portable on the land and stationary on the barges) would be used every day of construction (dredging) to measure air emissions near the dredging activities to ensure air quality standards are met, and to ensure H_2S levels do not exceed thresholds harmful for human health and safety.

If standards are exceeded, the response would be to stop work; spray water (with additives if necessary) on excavated sediments, trash racks and upland excavations to disperse hydrogen sulfide gas; await improved weather conditions that promote air movement; and/or review procedures to determine means and methods that are effective, such as moving the screening and separation to the more open staging area on the southeast side of San José Lagoon (e.g., the CDRC) where the distance to receptors is greater.

6.4.3.4 Noise

Temporary noise curtains would be installed to the north and south of the dredging operations. Dredging and construction operations would be limited to 12 hours a day, with no dredging or construction activities to be conducted on Sundays.

Noise levels in areas adjoining construction sites would be monitored with appropriate portable and/or stationary equipment to ensure the levels are under the maximum allowances. If maximum allowances are exceeded, the response would be to stop work; conduct noise producing operations during daylight hours; and/or review procedures to determine means and methods that are more effective.

An air bubble curtain would be employed across the Western CMP (to the west of the four western bridges) to minimize potential underwater noise impacts to Federally-listed species such as Antillean manatee and endangered sea turtles.

6.4.3.5 Vibration

Stationary vibration monitoring devices (4) along the border between the work and the adjoining structures, both north and south of the CMP, would be installed. In addition, a photo-survey of the exterior of existing structures facing and adjoining the work would be prepared to document pre-construction condition.

Measurements from the monitoring devices would be monitored for excessive levels of vibration, and visual observation of existing structures in areas adjoining construction sites would be conducted for visible damage. If excessive levels of vibration occurred, the response would be to stop work; avoid using equipment near adjoining structures that produces heavy vibrations; and/or review procedures to determine means and methods that are more effective. Alternative sheet pile installation methods such as "press-in" pile drivers or other drivers that produce less vibration may be used if available and feasible.

6.4.3.6 Environmental (Cultural Resources)

Photo-documentation would be recorded for the historic Martín Peña Bridge. A field archeologist (full-time), aided by a Supervising archeologist (part-time), would be employed to monitor construction activities near the bridge, as well as to monitor dredged materials during the construction (dredging) process. The archeologist would be on the materials barge where screening of dredged material occurs; if multiple dredges are operating simultaneously, at least one archeologist per dredge would be required. Cultural resources monitoring would be conducted as each clamshell bucket of material is laid onto the screen.

In the event that material of interest is observed by the archeologist during dredging and sorting operations, lifting of sediment would halt until the archeologist could determine whether the material is historic. If historic material is encountered, work in the immediate vicinity would halt until the SHPO, USACE, and the Institute for Puerto Rican Culture (IPRC) could be notified, and approval was given to proceed. Dredging could, however, shift to another area provided archeological monitoring occurs to avoid a stop-work situation.

6.4.3.7 Environmental (T&E Species)

A biologist (full-time) would monitor for the presence/absence of Threatened and Endangered species, as well as specifically for Antillean Manatee and sea turtles once the CMP channel is re-opened to San José Lagoon and/or the weir construction begins. The biologist would also be monitoring for the Puerto Rican Boa once clearing and grubbing activities commence. The CMP-ERP would employ the Standard Manatee Conditions for In-Water Work (2011) and the Sea Turtle and Smalltooth Sawfish Construction Conditions (2006).

If a manatee or other Threatened and Endangered species is located within the project area, the response would be to stop work until the individual(s) leaves the dredging and construction area, or relocation as authorized by appropriate state and/or Federal agency was provided and successfully implemented.

6.4.3.8 Human Health and Safety

Use of protective gear by contractors during dredging and construction operations would be required. In addition, a chain link fence would be constructed along the length of the 2.2 miles, both north and south sides to prohibit animals, such as caimans, from relocating to urban areas when avoiding construction activities in the CMP. Pest control measures would also be employed where rodent traps would be deployed within the Project Area adjacent to the chain link fence. Collection of used traps and replacement traps would occur throughout the duration of the construction activities within the CMP.

If there is a problem, the response would be to stop work, conduct emergency relocations as necessary, and/or review procedures to determine means and methods that are more effective. The chain link fence would be monitored for any disrepair or collapse, and repaired/re-installed.

6.5 LANDS, EASEMENTS, RIGHTS-OF-WAY, RELOCATIONS, AND DISPOSAL AREAS

Prior to construction, access to all lands necessary for construction, easements, and rights-of-way (ROW) will be provided and removal of all structures within the ROW of (a) the eastern segment of the CMP, between the Barbosa bridge and the San José Lagoon, as well as for (b) the protection of the Muñoz Rivera, Tren Urbano, Ponce de León (Martín Peña) and Enrique Martí Coll Lineal Park bridges will be completed. The lands within the MTZ-CMP are public domain lands, and require little, if any, further land acquisition.

6.5.1 Utility Relocations

In addition to the 96 structure acquisitions and 62 relocations already completed as part of the Federal project, the plan would include the acquisition and removal of an additional 297 residential structures, along with relocation of affected families. Those structures would be demolished, their utility services rerouted or terminated, and the debris removed. Existing raw sewage discharges and uncontrolled storm water runoff from the area would be stopped prior to dredging activities. The relocation of the three major utilities that are located within the project area (a 115-kV Power Line, the Borinquen Water Transmission Line, and the Rexach Sewer Line [see Figure 4]) would occur as part of the CMP-ERP. Improvements to the San José Sewer Line, which is adjacent to the CMP-ERP Project Area, would be implemented independent of the Federal CMP-ERP. Any costs associated with its relocation and/or improvement would be 100% non-Federal, and not included as a project cost. Only the costs for the relocation of the Rexach Sewer

Line, the Borinquen Water Transmission Line, and the 115-kV Power Line are included as part of the CMP-ERP.

6.5.2 Land Acquisition

Three hundred ninety three structures and site improvements located within the MTZ-CMP would be acquired and demolished as part of the dredging of the CMP. The appraised structures are located on land belonging to the Government of Puerto Rico. The 393 structures are mixed reinforced concrete with wood and zinc construction and primarily consist of residential units and a few commercial properties. Ninety six structures have already been acquired and/or are in-process to be acquired, with the remaining 297 structures to be acquired prior to the construction of the Federal CMP-ERP.

6.5.3 Relocation Assistance

The U.S. Army Corps of Engineers, Jacksonville District, has provided oversight and guidance to ENLACE related to the real estate acquisition and relocation process. In accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (URA), as amended (42 U.S.C. 9601 et seq.), relocation assistance will be provided to persons displaced as a result of the project. Neither lack of title nor failure to meet any length of occupancy criterion will disqualify a person from being treated as a displaced person eligible for relocation assistance. The nature and amount of assistance provided will be determined in accordance with the URA and the lead agency implementing regulations at 49 C.F.R. Part 24. All displaced persons will receive relocation assistance advisory services and be eligible for reimbursement of moving expenses. No residential owner-occupant or tenant who qualifies as a displaced person will be compelled to relocate unless comparable replacement housing is available. Because there is little comparable replacement housing available to displaced persons within the entire project area, last resort housing assistance will be necessary for the area as a whole. Of the 394 total relocations that would be conducted as part of the CMP-ERP, relocation assistance has already been provided and/or is in-process for 62 owner occupants and/or renters. The remaining 332 owner occupants and/or renters would receive relocation assistance prior to construction of the Federal CMP-ERP. Currently there is no estimate for the number of businesses within the project footprint.

6.6 OPERATIONS AND MAINTENANCE CONSIDERATIONS

Total operations and maintenance costs are estimated to be $59,422,721 (see Table 28). The Project Channel is considered to be self-operating with flow controlled by the incoming and outgoing tides. There are no mechanical systems in the CMP-ERP.

Table 28. Operations and Maintenance Costs

Recreation Features Maintenance Labor			Life Cycle Cost (2015 Constant Dollars)
Supervisory Labor	Removal of litter, fertilization of trees and shrubs; management of disease and/or insects in trees and shrubs either by cultural or chemical methods; sweeping, blowing, and power washing of walkways, and other hardscape surfaces; visual and physical examination of facilities to ensure compliance, safety, and proper operation; maintenance of equipment including drinking fountains, tables, trash receptacles, benches, bike racks, boat docks and gangways	2,080 Hours per Year at $13.96/Hr Plus Fringes and Benefits. Assume $3.00 for Fringes, plus Labor Multiplier of 2.5 for Insurance, Benefits, and Overhead	$4,409,600
Maintenance Labor		4,160 Hours per Year at $ 9.05/Hr plus Fringes and Benefits. Assume $3.00 for Fringes, plus Labor Multiplier of 2.5 for Insurance, Benefits, and Overhead	$6,266,000
Capital Repair and Replacement of Recreation Assets			
Utility Infrastructure	Decorative lighting	5 years repair, Repair Cost is estimated at 10% of the construction cost per year	$525,840
		20 year replacement	$1,029,648
	Yearly operating cost	Assume $350 per park area per month	$4,620,000
Park amenities	Handrails, bollards, tables, benches, trash receptacles, and bike racks	3 years repair, repair cost is estimated at 5% of the construction cost per year	$1,493,941
		10 years replacement	$3,845,885
Paving and hardscapes	Decorative pavement, tree grates, seawalls, and boardwalks	10 years repair, repair cost is estimated at 5% of the construction cost per year	$988,390
		25 years replacement	$6,592,560
Waterfront Equipment	Floating docks and gangways	5 years repair, Repair cost is estimated at 15% of the construction cost per year	$785,870
		25 years replacement	$3,614,986
		TOTAL Recreation O&M	**$34,172,721**
CMP Inspections, Surveys, and Dredging			
Inspection and survey	Perform underwater surveys of channel bottom and inspection of sheet pile structures and bank	Yearly	$2,500,000
Maintenance dredging	Maintenance dredging to remove deposits and sediment accumulations at the confluence of the CMP and the San Juan Lagoon	5-year dredging cycle, estimated at 35,000 cy per year, or 175,000 cy every 5 years	$22,750,000
		TOTAL CMP Inspections, Surveys, and Dredging O&M	**$25,250,000**
		TOTAL O&M	**$59,422,721**

The Project Channel is considered to be self-operating with flow controlled by the incoming and outgoing tides. Sediment transport from surrounding uplands, the San José Lagoon, and the existing western channel are expected to deposit up to 1.5 inches yearly in the Project Channel. Due to the self-cleaning channel velocities, most of the shoaling is expected to be concentrated at either end of the proposed channel outside of the dredged Project Channel footprint. The high channel velocities at the transition to the Western CMP indicate that shoaling in that area would be minimal. Shoaling in San José Lagoon at the outlet of the CMP and within the extended channel is of greater concern, with accumulations of up to 35,000 cy annually expected to be deposited in flood-tide shoals (6.7 ft/year sedimentation rate). It is noted that this estimate is based on an extreme 2003 estimate that developed sedimentation rates in the vicinity of the CMP but did not account for mitigating factors such as improved tidal flow through the CMP, which may serve to disperse the sediments into lower energy environments (Moffat and Nichol 2003). This estimate is therefore considered to be a worst case scenario.

These shoals should be monitored to ensure that the CMP outlets remain unobstructed for tidal flows; if shoaling begins to reduce tidal exchange, maintenance dredging would be required. As the shoaling material is expected to be uncontaminated, disposal of these sediments is not expected to require CAD or upland disposal. On September 15, 2015, under a settlement with the U.S. Department of Justice (USDOJ) and the USEPA, the Puerto Rico Aqueduct & Sewer Authority (PRASA) entered into a consent decree (Civil Action No. 3:15-cv-02283) that will require the latest to make major upgrades, improve inspections and cleaning of existing facilities within the Puerto Nuevo system and continue improvements to its systems island-wide. The Puerto Nuevo sewer system serves the municipalities of San Juan, Trujillo Alto, and portions of Bayamón, Guaynabo and Carolina; most of these areas are part of the San Juan Bay Estuary watershed. The settlement updates and expands upon legal settlement agreements reached with PRASA in 2004, 2006 and 2010. The improvements will supplement projects already being implemented under the previous settlements and PRASA's Capital Improvement Program, which includes construction of necessary infrastructure at wastewater treatment plants and sludge treatment systems, as well as the Puerto Nuevo collection system. Under this agreement, PRASA agreed to invest $120 million to construct sanitary sewers that will serve communities surrounding the Martín Peña Channel.

On October 25, 2015, under a settlement with the USDOJ and USEPA, the Municipality of San Juan entered into a consent decree (Civil Action No. 3:14-cv-1476-CCC) that will require the latest to make substantial upgrades to its storm sewer systems. The upgrades and related cleaning activities are aimed at eliminating or minimizing daily discharges of large volumes of raw sewage and will minimize discharges of other pollutants into nearby water bodies, including the San Juan Bay Estuary and the Martín Peña Channel. Through this agreement, the Municipality will come into compliance with their storm water permit, develop and implement a storm water management program to prevent pollutants from entering and being discharged from their storm sewer systems and to develop and implement a plan to identify and address issues within their systems, including eliminating illegal discharges. Illicit connections and discharges in some areas of San

Juan must be eliminated within 10 years and in other areas within 14 years. Within 8 years, the Municipality of San Juan must also submit a schedule for the completion of an investigation of and a design plan for eliminating all illegal connections and discharges to its municipal separate storm sewer systems in the remainder of the city of San Juan and San Juan must also implement the plan and complete construction within an EPA-approved schedule.

All of the works required under these two consent decrees, in addition to other watershed management measures proposed under the SJBE Program's CCMP, as well as those proposed under the CMP-ERP, are expected to significantly reduce the amount of untreated sewage and other contaminants entering the estuary system, and in particular, those impacting the Project Area. Similar results are expected on sediment quality, including any sediment or sand material that needs to be dredged from the restored channel or its premises as part of future project maintenance activities.

As the sediments that originate from the Juan Méndez Creek are not expected to be contaminated, disposal should not require confined disposal techniques. The sediments could be loaded into scows and transported to the San Juan ODMDS or to the remaining artificial dredged pits left in the San José Lagoon for unconfined open-water disposal. Conveyance of the dredged sediments to the ODMDS would require either pumping over the proposed weir at the western bridges or the use of light-loaded, shallow-drafting scows. Alternatively, the sediments could be offloaded at the CDRC and trucked to an upland site. All necessary regulatory permits would be secured at that time. It is assumed that maintenance dredging activities would occur on a 5-year cycle.

6.7 ENVIRONMENTAL OPERATING PRINCIPLES

The formulation of all of the alternatives considered for implementation was done in accordance with the USACE Environmental Operating Principles:

- Foster sustainability as a way of life throughout the organization.
- Proactively consider environmental consequences of all USACE activities and act accordingly.
- Create mutually supporting economic and environmentally sustainable solutions.
- Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the USACE, which may impact human and natural environments.
- Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs.
- Leverage scientific, economic and social knowledge to understand the environmental context and effects of USACE actions in a collaborative manner.
- Employ an open, transparent process that respects views of individuals and groups interested in USACE activities.

Planning for the CMP-ERP was based on over a decade of intense work to engage the public and stakeholders in developing management plans for the San Juan Bay Estuary in general and the CMP in particular. The planning process fully considered the relationship of a restored ecosystem to the socioeconomic wellbeing of the surrounding neighborhoods. The planning process has been open and transparent, and has fully leveraged the scientific, economic, and social knowledge of the project's stakeholders and Federal, Commonwealth, and local agencies. The NER and Recommended Plan has been designed to be sustainable in its own right, but also to contribute to the sustainability of the ecosystem and communities beyond the Project Area.

As part of its effort to transform the way it does business, the USACE developed its Campaign Plan to identify and establish the agency's priorities. Through implementation of the Campaign Plan, the organization would deliver superior performance, set the standard for the engineering profession, make a positive impact on the Nation, and build to last. Of the four goals of the Campaign Plan, Goal #2, "Transform Civil Works," is focused on delivering enduring and essential water resource solutions, utilizing effective transformation strategies. The conduct of the CMP-ERP is consistent with Goal #2 of the Campaign Plan, and the CMP-ERP is an example where the USACE would meet the objectives of the Campaign Plan to assist ENLACE with the building a sustainable ecosystem restoration project that would have a significant impact to the residents surrounding the CMP, the Commonwealth, and the Nation.

6.8 PROJECT COST AND REAUTHORIZATION

Section 902 of the WRDA of 1986 legislates a maximum total project cost. Projects to which this limitation applies and for which increases in costs exceed the limitations established by Section 902 require further authorization by Congress raising the maximum cost established for the project. No funds may be obligated or expended nor any credit afforded that would result in the maximum cost being exceeded, unless the House and Senate committees on Appropriations have been notified that Section 106 of the Energy and Water Development Appropriations Act of 1997 will be utilized. This maximum cost may not be exceeded, such as through the obligation of funds in excess of the 902 limit. The Section 902 maximum project cost has further guidance in ER 1105-2-100 (Planning Guidance), Appendix G, Section G-15-1, which states that the maximum project cost limit imposed by Section 902 is a numerical value specified by law which must be computed in a legally supportable manner. It is not an estimate of the current cost of the project. The limit on project cost must be computed including an allowance for inflation through the construction period. This limit will then be compared to the current project estimate including inflation through the construction period.

The authorized cost for the CMP Ecosystem Restoration project in WRDA 2007 is $150,000,000. After Section 902 guidance is applied, the adjusted budget (including inflation and adaptive management costs) of the project is $239,316,000, adjusted to 3Q 2018 dollars. The First Cost of construction estimate for the NER Plan is $214,156,000 and the Fully Funded NER Plan cost

estimate is $221,722,000 (mid-point of construction). While there is the potential for the fully funded cost estimate to exceed the Section 902 limit, the Local Sponsor would fund 100 percent of the overage through utilization of the Section 1023 of WRDA 2014 provision that requires Congressional notification and execution of a Contributed Funds MOA. Table 29 presents Authorized, Adjusted, and Recommended Plan Cost.

Table 29. Caño Martín Peña Ecosystem Restoration Project Authorized, Adjusted, and Recommended Plan Cost Table (FY 2017; 1,000s)

Line 1		
a.	Current Project estimate at current price levels:	$214,156
b.	Current project estimate, inflated through construction:	$221,722
c.	Ratio: Line 1b / line 1a	1.0353
d.	Authorized cost at current price levels:	$202,173
	(Column (h) plus (i) from table G-3)	
e.	Authorized cost, inflated through construction:	$209,316
	(Line c x Line d)	
Line 2	Cost of modifications required by law:	$0
Line 3	20 percent of authorized cost:	$30,000
	.20 x (table G-3, columns (f) + (g)	
Line 4	Maximum cost limited by Section 902:	$239,316
	Line 1e + line 2 + line 3	

Notes: The cost index applied to the current estimate through PED is derived from: EM 1110-2-1304, 31 March 2015 (Quarterly Tables), Civil Works Construction Cost Index System.

Real estate costs were not specifically defined in the authorization; therefore, real estate costs have not been escalated separately in the 902 tool.

7.0 PLAN IMPLEMENTATION

7.1 SCHEDULE

The following schedule outlines the remaining planning, PED, and construction tasks required to implement the NER and Recommended Plan.

Milestone	Schedule
Request PED Funding	January 2016
Final Report Approval (end of feasibility)	April 2016
Request Construction Funding	May 2016
Execute Cost Sharing Agreement for PED	October 2016
Begin Preconstruction Engineering and Design	October 2016
Execute Project Partnership Agreement (PPA)	April 2017
Start baseline monitoring	October 2017
Complete Design Documentation Report	April 2018
Complete Plans and Specifications	April 2018
Advertise Construction	May 2018
Award the contract	June 2018
Complete Real Estate Acquisition	August 2018
Start construction	October 2018
Complete Construction	December 2020
Turn Over Project to Local Sponsor	2020
Initiate Monitoring and Adaptive Management	January 2021
Complete Monitoring and Adaptive Management	2026

7.2 ITEMS OF LOCAL COOPERATION

The Commonwealth, acting through the DNER, jointly with ENLACE as the non-Federal sponsors for the CMP-ERP shall, prior to implementation, agree to perform all of the local cooperation requirements and non-Federal obligations. Local cooperation requirements and obligations include, but are not necessarily limited to:

a. Provide 35 percent of total project costs as further specified below:

   1. Provide 35 percent of design costs 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, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material;

perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the project;

3. Provide, during construction, any additional funds necessary to make its total contribution equal to 35 percent of total project costs;

b. Provide 50 percent of total recreation costs as further specified below:

1. Provide 50 percent of design costs allocated by the Government to recreation in accordance with the terms of a design agreement entered into prior to commencement of design work for the recreation features;

2. Provide, during the first year of construction, any additional funds necessary to pay the full non-Federal share of design costs allocated by the Government to recreation;

3. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the recreation features;

4. Provide, during construction, any additional funds necessary to make its total contribution for recreation equal to 50 percent of total recreation costs;

c. Provide, during construction, 100 percent of the total recreation costs that exceed an amount equal to 10 percent of the Federal share of total ecosystem restoration costs;

d. Shall 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 obligations for the unless the Federal agency providing the funds verifies in writing that such funds are authorized to carry out the project;

e. 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;

f. Shall not use the project or lands, easements, and rights-of-way required for the project as a wetlands bank or mitigation credit for any other project;

g. Comply with all 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 required for construction, operation, and maintenance of the project, including those necessary for relocations, the borrowing of materials, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;

h. For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, 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;

i. 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;

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

k. Keep and maintain books, records, documents, or 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, or other evidence are required, to the extent and in such detail as will properly reflect total project costs, 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 Code of Federal Regulations (CFR) Section 33.20;

l. 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 substantial 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 et seq.);

m. 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), Public Law 96-510, as amended (42 U.S.C. 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project; however, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;

n. 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 that the Federal Government determines to be required for construction, operation, and maintenance of the project;

o. 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, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA; and

p. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5b), and Section 103(j) of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2213(j)), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element.

7.2.1 Dredged Material Disposal

7.2.1.1 Applicability of Statutory and Regulatory Exclusions/Exemptions

The extent to which one or more potential exclusions or exceptions apply to the specific materials excavated during the project will depend upon the specific conditions and circumstances existing at the time of excavation.

For example, under the definition of HTRW in USACE Engineering Regulation 1165-2-132, dredged materials and sediments beneath navigable waters, including those that contain CERCLA hazardous substances or RCRA hazardous wastes, qualify as HTRW only if they are within the boundaries of a site undergoing a CERCLA response action or on the National Priorities List. Neither condition is considered applicable to this project. Further, under USEPA's hazardous waste exclusion for dredged material under RCRA, 40 C.F.R § 261.4(g), "dredged material that is subject to the requirements of a permit that has been issued under 404 of the Federal Water Pollution Control Act (33 U.S.C.1344) or section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972 (33 U.S.C. 1413) is not a hazardous waste."

Final determination of the excavated materials' regulatory status will be made by the appropriate Federal and Commonwealth regulatory authorities and would be a matter for discussion between the Commonwealth, as the responsible party, and those regulatory agencies.

7.2.1.2 Actionable Hazardous Substances

The CMP Ecosystem Restoration Federal project will not include costs associated with the management or disposal of any "Actionable Hazardous Substances," as defined herein. The Commonwealth shall be responsible for ensuring that the development and execution of Federal, State, Commonwealth, and/or locally required response actions to address Actionable Hazardous Substances are accomplished at 100 percent non-project cost. The Commonwealth also shall be

responsible for and pay all costs associated with the generation, release, management, or disposal of any Actionable Hazardous Substances identified by sampling. The Commonwealth may request the services of the USACE to perform such actions outside of the Federal project.

All dredged or excavated materials will be tested for the presence of hazardous substances in accordance with a sampling plan to be agreed upon by the parties. All Actionable Hazardous Substances shall be segregated.

"Actionable Hazardous Substances" is defined for purposes of this project as any material that:

(1) contains a hazardous waste, as defined in USEPA's RCRA regulations;

(2) contains a hazardous substance as identified in 40 C.F.R. 302.3 and 302.4 in concentrations that pose a threat to human health or the environment as determined by USEPA; or,

(3) cannot, without additional treatment, be disposed of legally in a Subtitle D municipal solid waste landfill located within the Commonwealth of Puerto Rico, and is not environmentally appropriate, as determined by the Puerto Rico Environmental Quality Board, in consultation with USEPA, for disposal, without additional treatment, in open water or in the San José Lagoon Contained Aquatic Disposal areas.

Materials may constitute Actionable Hazardous Substances under the above definition regardless of whether such materials are subject to disposal pursuant to 33 U.S.C. 1344 or 33 U.S.C. 1413 or of such materials' jurisdictional status.

Disposal of classes or categories of materials determined not to be an "Actionable Hazardous Substance" as defined above shall be documented with an affirmative determination (by the appropriate regulator entity) supporting the proposed disposal methodology and location.

7.2.1.3 Establishment of Separate Memorandum of Agreement

In addition, prior to or concurrently with the execution of a PPA associated with the Federal project, the parties shall execute a separate MOA between the USACE and the Commonwealth. In accordance with the MOA, the Commonwealth shall be responsible for any Actionable Hazardous Substances encountered during the project. The MOA will explicitly provide that:

- All increased costs associated with the generation, release, management, and disposal of Actionable Hazardous Substances that exceed the cost of normal project design, engineering, and construction activities, and that are necessary to implement the Federal project features shall be excluded from total project costs and shall be paid by the Commonwealth under the terms of the MOA.
- After the discovery of Actionable Hazardous Substances, any further site characterization associated with the Actionable Hazardous Substances; development, planning, selection, and execution of appropriate response and disposal actions; and establishment and future management of disposal areas for all Federal, State, Commonwealth, and locally required

actions to address those Actionable Hazardous Substances shall be paid 100 percent by the Commonwealth.

- The Commonwealth shall indemnify the Federal Government for any future liability associated with the generation, release, management, or disposal of any Actionable Hazardous Substances excavated or dredged during the project work.
- The Commonwealth may request USACE assistance in the removal and proper disposal of any Actionable Hazardous Substances necessary for the execution of the Federal project. Such work shall not be considered a Federal project cost and, as such, the only funds ultimately available shall be those funds provided by the Commonwealth under the MOA specifically for those purposes.
- Any future costs associated with such Actionable Hazardous Substances that exceed the scope of the MOA shall be the sole responsibility of the Commonwealth and shall be outside the Federal project.

7.2.1.4 Establishment of Escrow Account

Prior to the initiation of construction, the Commonwealth will establish an escrow account, with interest accruing to the Commonwealth, in an amount to be agreed upon that is sufficient to prevent delays in the execution of project work in the event that Actionable Hazardous Substances are encountered. Such escrow account will be maintained during the course of the project and will be used by the USACE in the execution of work relating to Actionable Hazardous Substances under the MOA, unless other funds are provided by the Commonwealth in time to prevent the suspension of work under the Federal project.

7.2.2 Preconstruction Engineering and Design

Detailed design of the CMP-ERP will be conducted by the USACE Jacksonville District, in coordination with and review by ENLACE.

7.2.3 Lands, Easements, Rights-of-Way, Relocations, and Disposal Areas

Lands, easements, rights of way, relocations, and disposal areas will be the responsibility of ENLACE.

7.2.4 Construction

The CMP-ERP will be constructed by the USACE, in coordination with ENLACE.

7.2.5 Operations, Maintenance, Repair, Rehabilitation, and Replacement

Operations, Maintenance, Repair, Rehabilitation, and Replacement will be the responsibility of the Puerto Rico Department of Natural and Environmental Resources (DNER). The USACE will develop an O&M manual detailing expected OMRR&R requirements and periodically inspect the project to ensure that DNER is implementing the identified procedures.

7.2.6 Floodplain Management and Flood Insurance Program Compliance

ENLACE agrees to participate in and comply with applicable Federal floodplain management and flood insurance programs consistent with its statutory authority. ENLACE shall publicize floodplain information in the area concerned and shall provide this information to zoning and other regulatory agencies for their use in preventing unwise future development in the floodplain and in adopting such regulations as may be necessary to prevent unwise future development and to ensure compatibility with the CMP-ERP.

ENLACE shall prescribe and enforce regulations to prevent obstruction of or encroachment on the authorized CMP-ERP or on the lands, easements, and rights-of-way determined by the Federal Government to be required for the construction, operation, maintenance, repair, replacement, and rehabilitation of the authorized CMP-ERP, that could reduce the benefits the authorized CMP-ERP affords, hinder operation or maintenance of the authorized CMP-ERP, or interfere with the authorized CMP-ERP's proper function.

7.3 COST SHARING

7.3.1 Non-Federal Sponsor Cost Contributions

The Commonwealth, acting through the DNER, jointly with ENLACE as the non-Federal sponsors for the CMP Ecosystem Restoration project, will execute a Project Partnership Agreement with the USACE upon approval and acceptance of the Feasibility Study. The cost share for the planning, design, and construction of the project will be 65 percent Federal and 35 percent non-Federal. Recreational features would be cost shared at 50 percent Federal and 50 percent non-Federal. The non-Federal sponsor, ENLACE, must provide all LERRDs required for the project, with the exception of Federal administrative LERRD costs, which would be cost shared at 65 percent Federal and 35 percent non-Federal. OMRR&R of the project would be a 100 percent DNER responsibility. Additionally, project monitoring and any Adaptive Management deemed necessary will be cost-shared at 65 percent Federal and 35 percent non-Federal for the first 5 years of the project life. Table 30 displays the expected cost sharing requirements for project implementation.

ENLACE would be responsible for providing 35 percent of the First Cost of implementing the NER Plan. The 35 percent share of the project cost includes ENLACE's responsibility for providing all LERRDs. The estimated costs are $57,955,000 in LERRD credit with $18,692,000 in cash. ENLACE is also responsible for OMRR&R of project features.

Table 30. Cost Sharing for Implementation of the National Ecosystem Restoration Plan ($1,000s)
(Based on Project First Cost, effective price level date 1 October 2015)

Item	First Cost	Non-Federal Cost Share %	Non-Federal Cost*	Federal Cost
Ecosystem Restoration				
Construction, Construction Management, PED		35	$13,050[1]	$130,605
LERRDs		100	$57,276	$0
LERRDs (Federal Admin)		35	$679	$1,261
Subtotal - Ecosystem Restoration	**$202,871**		**$71,005**	**$131,866**
Recreation		50		
Subtotal - Recreation	**$11,285**		**$5,642**	**$5,642**
Total First Cost	**$214,156**		**$76,647**	**$137,508**
OMRR&R				
Ecosystem Restoration Maintenance	$25,250	100	$25,250	$0
Recreation OMRR&R	$34,173	100	$34,173	$0
Subtotal - OMRR&R	**$59,423**		**$59,423**	**$0**
Total First Cost with Life Cycle Cost	**$273,579**		**$136,070**	**$137,508**

[1] The non-Federal requirement for construction, construction management, and PED, was adjusted to ensure the total non-Federal cost share for ecosystem restoration at 35% in light of non-Federal sponsor's responsibility for contributing all LERRDs for the project, as well as the crediting of the value of such LERRD contributions toward the non-Federal sponsor's required cost share. LERRDs are included in the total cost for ecosystem restoration.

7.3.2 Section 902 Limitations

The Project is currently authorized under Section 5127 of the WRDA 2007 for a total cost of $150,000,000. The basis for the Project 902 maximum cost is the total first cost of $239,316,000 (presented in Table 29), which includes PED, Construction, LERRDs, and construction-funded monitoring. The CMP-ERP project fully funded cost of $221,722,000 is below the 902 maximum cost limit. During PED, a limited Value Engineering analysis would be conducted to continue efforts to find cost savings measures.

7.3.3 Non-Federal Work-in-Kind

The non-Federal sponsor may be provided in-kind credit for project related work as described in Section 221 of the Flood Control Act of 1970, Public Law 91-611, as amended by Section 2003 of WRDA 2007, Public Law 110-114, and Section 1018 of the Water Resources Reform and

Development Act of 2014, Public Law 113-121. The Secretary of the Army, subject to certain limitations and conditions, may afford credit toward the non-Federal share of the cost of the project for the value of in-kind contributions that the Secretary of the Army determines are integral to the CMP-ERP.

Such credit would be applied toward the Non Federal sponsor's share of the costs associated with the implementation of the CMP-ERP, shall not include cash reimbursements, and shall be subject to:

a) the authorization of the CMP-ERP by law;

b) a determination by the Secretary of the Army that the construction work completed under the PPA is integral to the authorized CMP-ERP;

c) a certification by the District Engineer that the costs are reasonable, allowable, necessary, auditable, and allocable; and

d) a certification by the District Engineer that the activities have been implemented in accordance with USACE design and construction standards and applicable Federal and State laws. Also, per Section 601(e)(5)(E) of the Water Resources Development Act of 2000, in-kind credit is subject to audit by the Secretary.

7.4 PROJECT DESIGN

USACE Engineering Regulations typically provide rules and policies that engineers must follow to correlate their design parameters and decisions for approval. USACE Engineering Manuals typically provide general guidance in formulations and procedures that can be followed to complete design efforts for typical projects and will be utilized for design as applicable.

7.5 PROJECT MANAGEMENT PLAN

A Project Management Plan (PMP) draft was prepared in 2009 and reviewed by the USACE. This draft was updated in 2013, and approved by the USACE, Jacksonville District. The PMP will be updated for implementation of the NER Plan. The PMP describes activities, responsibilities, schedules, and costs required for the planning, PED phase, and construction of the project.

7.6 COMPLIANCE WITH ENVIRONMENTAL LAWS, STATUTES, AND EXECUTIVE ORDERS

Table 4-14 of the EIS provides detailed information regarding environmental compliance activities at the Federal level. Table 4-15 of the EIS provides detailed information regarding environmental compliance activities at the local level.

7.7 ENVIRONMENTAL COMMITMENTS

Measures to offset temporary project construction losses are proposed to avoid or minimize impacts that would otherwise occur as a result of the implementation of the preferred alternative

(see Section 6.43). These environmental and related commitments would be implemented by construction contractors or management authorities. Some commitments, such as monitoring or adaptive management, would continue beyond completion of construction. Throughout the planning process, efforts were made to avoid impacts to the extent practicable. When avoidance could not be achieved, mitigation measures were developed to reduce the magnitude and extent of the impact.

Best management practices would be included in construction specifications and they would be employed during construction activities to minimize environmental effects, such as, but not limited to double barrier turbidity curtain, sound barriers, protective gear and monitoring and emergency relocations.

Many of these BMPs are required by Federal, Commonwealth, or local laws and regulations, regardless of whether they are specifically identified in this document or not. Project implementation would comply with all applicable Federal, Commonwealth, and local laws, ordinances, regulations, and standards during the implementation of the NER Plan. Implementation of the environmental commitments would be documented to track execution and completion of the environmental commitments.

7.8 VIEWS OF THE NON-FEDERAL SPONSORS

The Commonwealth, ENLACE, and community residents, through the G-8, Inc., support the selection of the 100-foot-wide by 10-foot-deep with sheet-piling square bottom alternative for the CMP-ERP, including the recommended dredged material management plan and basic recreation elements. Specifically, the non-Federal Sponsors support project elements, such as the use of geotextile bags and disposal of sediments within San José Lagoon pits, to achieve restoration of the CMP and SJBE. Recreation elements that are to be conducted as part of the non-Federal costs will be further designed during PED. In addition, the Commonwealth and ENLACE agree that the 100-foot x 10-foot alternative is the cost effective alternative, and agree that relocations associated with the implementation of the recommended alternative must be undertaken. Lastly, monitoring and adaptive management efforts should be undertaken to comply with existing Federal and Commonwealth regulations during and after construction of the CMP-ERP.

8.0 SUMMARY OF COORDINATION, PUBLIC VIEWS, AND COMMENTS

8.1 PUBLIC VIEWS AS EXPRESSED IN PREVIOUS STUDIES

Both Puerto Rico and Federal environmental policies require a public participation component. Early engagement with the public and stakeholders is encouraged as a means to identify any issues up front that are subject to controversy and to guide a planning and analysis process that addresses issues of concern to affected parties. This section provides an overview of the public engagement process, including its basis in previous planning and technical analytical efforts, processes used to engage the public, and significant views and comments received. For additional details, please refer to the EIS.

8.1.1 San Juan Bay Estuary Program

In April 1992, the Governor of Puerto Rico nominated the SJBE for inclusion in the United States USEPA National Estuary Program. In October 1992, the USEPA approved the nomination and Federal funds were made available in 1993 to develop a Comprehensive Conservation and Management Plan to identify problems and recommend solutions to guide future management of the SJBE resources. The dredging of the eastern half of CMP is included in the CCMP that was approved by the Governor of Puerto Rico in August 2000.

8.1.2 Project Design Report for the Dredging of Caño Martín Peña

In October 1995, the Puerto Rico DNER (the custodian authority of public domain lands related to the Maritime Terrestrial Zone of the Caño Martín Peña) requested technical assistance from the USACE Jacksonville District for the planning, engineering, design, and environmental assessment for the dredging of the Project Channel under the Support for Others Program. The purpose of the study was to document the plan formulation and design for the dredging of the eastern half of CMP. On July 23, 1996, a general scoping letter requesting views, comments, suggestions, and information about natural, cultural and community resources, study objectives, and environmental features within the Study Area was sent by the Jacksonville District to all resources agencies.

The study considered three alternatives that varied in size and shape of a restored CMP. The alternatives were evaluated on the basis of their construction method and cost, environmental benefits, real estate requirements, impacts to bridges and utilities, disposal of dredged material, project O&M, tidal flow capacity, and the recreation and navigation potential. Based on this evaluation and coordination with resources and infrastructure development agencies, DNER selected one alternative. The detailed design and a Draft EIS were developed for the selected alternative. These information contained within these documents provided sound information on

technical considerations and public views, which were incorporated into the current planning effort.

In 2000, the ERDC performed hydrodynamic and water quality modeling of the alternatives with the cooperation of the San Juan Bay Estuary Program. On July 11, 2000, DNER circulated the final Project Design Report to all resources agencies requesting their views and comments on the recommended alternative. Many agencies provided comments and suggestions that must be considered during the feasibility phase. All agencies agreed with the urgent need for the proposed project. Some agencies provided comments and recommendations on disposal of dredged material, compensation from temporary mangrove loss, impacts to historic properties, recreation plans, and impacts to utilities.

A Public Notice inviting scoping comments for the Project Design Report Draft EIS was sent by the USACE Regulatory Division to all resource agencies on August 5, 2003. Preliminary coordination with DNER, the Puerto Rico Planning Board, the USFWS, and the U.S. Department of Agriculture indicate that these agencies generally support an ecosystem restoration project for the Study Area.

8.1.3 Caño Martín Peña Development Plan

With USACE's 2001 Design Report as a baseline reference, the ENLACE Project, within the PHRTA began a parallel and complementary effort to prepare an environmental impact statement in compliance with Puerto Rico's environmental policies. Further in the process, the PRHTA initiated the permitting process with the USACE, which led to the publication of a Notice of Intent and a formal scoping meeting with the participation of local and federal government agencies. This permitting process was interrupted by the ENLACE Project when Congress assigned funds that allowed the USACE Planning Section to prepare a Reconnaissance Report in compliance with Section 905(b) of the WRDA 1998.

The process led by the PRHTA included the preparation of a new technical document titled *Caño Martín Peña Waterway Improvements* (Moffat and Nichol Engineers 2003). In this document, the above-mentioned alternatives of the USACE's 2001 Design Report were reviewed and a new additional alternative was considered. This new alternative, which consisted of a rectangular 10 foot-deep canal with realignment and vertical steel bulkhead system, was developed as the PRHTA was interested in studying the feasibility of a faster route for waterway transportation. The proposed 180-foot-wide channel width was straight with minor bends. The proposed channel alignment followed the existing CMP channel from the Laguna San José to the existing oxbow, crossed the Barrio Obrero Marina peninsula to the north and ended west of the Luis Munoz Rivera Avenue Bridge, a distance of approximately 10,500 feet. The recommended alternative selected in this report was the same as the recommended alternative in the USACE's 2001 Design Report.

As part of the District Plan's participatory planning process, ENLACE held over 700 community meetings between 2002 and 2004, including round table discussions, public assemblies, work-

shops, presentations, and educational activities at local schools. As part of the discussion of the CMP dredging alternatives, ENLACE developed informational materials that were distributed throughout the District and the Cantera Peninsula. Residents opposed the CMP realignment proposed by PRHTA and favored the alternative recommended by the USACE. The final development plan was completed and approved by law in 2004; it was then adopted by the Puerto Rico Planning Board in 2007.

8.2 PUBLIC ENGAGEMENT FOR THE PROJECT

The process to develop the study has been highly participatory. In addition to public workshops and stakeholder meetings, ENLACE convened two committees to assist with development of the Project and provide inputs to the planning process (Table 31). The Technical Committee was constituted in 2009 to assist ENLACE in preparing a Request for Proposals and selecting consultants to provide technical services in support of conducting the feasibility study and drafting the Environmental Impact Statement. The Technical committee subsequently conducted reviews and provided comments on technical reports supporting the feasibility study, particularly regarding the channel dredging, dredged material disposal planning, and ecosystem restoration opportunities. Lastly, the Community Committee was convened to provide a direct linkage to the eight most affected communities in the vicinity of the CMP and provide an avenue for commenting on the feasibility study's planning and technical analyses. The Community Committee met monthly or bi-monthly, depending on the amount of technical documents produced and the need for community feedback. None of these committees were constituted as advisory committees as defined under the Federal Advisory Committee Act; their purpose was to assist ENLACE in the conduct of the feasibility study and the public engagement process.

A web page (www.dragadomartinpena.org) was created to inform the public and to provide contact information in order to provide additional feedback to the Project. The web page will continue to be used to inform the public, to provide contact information, and to provide feedback on the Project.

Kick-off community assemblies were held during October 2010 at each of the eight CMP communities to inform residents on the status of the project and document their concerns and suggestions. The results of the updated technical documents and hydrologic-hydraulic analysis suggested that the original proposed channel width for the Caño Martín Peña (150–230 feet wide, as established in the District's Plan based on USACE's 2001 Design Report) was not feasible due to channel flow velocities, volume of dredged sediments, wetland impacts, and direct and indirect costs. Therefore, a second round of community assemblies was carried out during October and November 2011 to receive community feedback and input regarding the optimization of the CMP proposed dredging of the canal.

Table 31. Committee Representation for the Public Engagement Process

Member Agencies/ Entities for the Technical Committee	Member Communities on the Community Committee
San Juan Bay Estuary Program	Barrio Obrero – San Ciprian Community
U.S. Environmental Protection Agency	Barrio Obrero – Marina Community
National Marine Fisheries Service	Barrio Obrero – West Community
U.S. Fish and Wildlife Service	Israel – Bitumul Community
State Historic Preservation Office	Las Monjas Community
PR Department of Natural and Environmental Resources	Buena Vista – Hato Rey Community
PR Environmental Quality Board	Buena Vista – Santurce Community
PR Planning Board	Parada 27 Community
Autonomous Municipal Government of Carolina	Tarpon Sports Fishermen
Municipal Government of San Juan	
G-8, Inc. (Community Stakeholder Organization)	
Institute of Puerto Rican Culture	
PR Aqueduct and Sewer Authority	
PR Electric Power Authority	
PR Solid Waste Authority	
Cantera Peninsula Company	
Solid Waste Administration	
University of Puerto Rico	

Prior to each assembly in the second round, ENLACE and community leaders distributed an informational bulletin which included contact information, described in plain language the five most feasible canal width measures once velocity and other considerations were factored in, and compared them to current conditions. The five channel dredging measures considered were:

1. No dredging scenario (a necessary comparison for this Final EIS No-Action scenario);
2. Rectangular section 100-foot-wide x 10-foot-deep canal width with earth bottom and sheet piles;
3. Hybrid section 100-x-10-foot channel width with earth bottom (mixed floor option) and sheet piles in some areas and slopes in others;
4. Rectangular section 75-foot-wide x 10-foot-deep canal with articulated cement bottom; and sheet piles; and
5. Hybrid section 75-foot-wide x 10-foot-deep canal with articulated cement bottom and sheet piles in some areas and slopes in others.

During the community assemblies, residents compared the alternatives, identified their advantages and disadvantages, and finally expressed their preferences related to the alternatives. This ballot was designed to provide residents the option to rank the alternatives based on their preferred order (1 being the favorite and 5 being the least favorite). Gathering ranked community preferences allowed ENLACE to have options validated by the community in case the selected alternative was later deemed unfeasible due to new technical information.

Through their votes, residents clearly expressed that they preferred the 100-foot channel width scenario, with either a rectangular or a hybrid section. Residents considered that the 100-foot channel width alternative was the most natural, the most reminiscent of what the CMP used to be, and the one that better accommodated their expectation for future uses of the CMP. Residents chose the rectangular section over the proposed hybrid section by a slight majority of votes. Although the hybrid channel measures were eliminated from further consideration prior to formulating alternative plans, the preference for a 100-foot-wide channel over a 75-foot-wide channel was noted during these assemblies.

A third round of community assemblies took place on May 2012 to discuss other relevant issues, such as the expected impacts to the communities during construction and the alternatives for the disposal of the dredge material.

In addition, ENLACE held several focused stakeholder meetings with sports fishing business owners, local subsistence fishermen, environmental advocacy organizations, the Autonomous Municipality of Carolina, and the SJBE Program Technical Committee.

Additional public engagement has also been included as part of the public review and comment process regarding the Draft EIS, which was also translated into Spanish for public hearings. ENLACE will continue to incorporate public participation throughout evaluation and preparation of the Final EIS.

8.3 NATIONAL ENVIRONMENTAL POLICY ACT SCOPING COMMENTS AND CONCERNS

A Notice of Intent (NOI) to prepare the Draft EIS was published on November 16, 2012, in the Federal Register. A scoping letter was sent out on February 22, 2013. During the scoping period, seven individuals and/or public agencies provided comment to the USACE, with 36 comments in total. Comments received during scoping are summarized under three categories: the public, Federal agencies, and the Commonwealth.

8.3.1 Public Comments and Concerns

- Flood-prone households should be relocated by the time dredging takes place.
- Community participation should be ensured throughout the project, including reaching a prior agreement as to where the dredged material disposal site should be located.
- Health impacts, especially respiratory illnesses, during dredging should be considered and addressed.
- Excessive noise during construction should be mitigated by relocating vulnerable households and by limiting working hours; there is concern that vibration by such noises could cause structural damage to residents' homes.

- Controls should be provided to reduce pest invasion to adjacent households.
- Precautionary measures should be implemented to avoid exposing children to machinery or dangerous areas.

8.3.2 Federal Agency Comments and Concerns

- The EIS should contain a detailed analysis of alternatives related to the dredging method, including access to the channel and any disposal sites for dredging material; proposed size of the channel (width, depth, and side slopes) under each of the alternatives; and proposed dredged material disposal sites.
- The reasons for the selection of the preferred alternative should include a thorough analysis of the environmental benefits of the preferred alternative versus other proposed alternatives, in particular related to the final channel size and flushing of the channel.
- There are concerns regarding some of the dredging material disposal alternatives, in terms of the potential for transport of contaminated sediments and potential fish kills from dispersal of anoxic waters during the proposed disposal of dredged materials in former dredge pits in the San José Lagoon.
- Provide information regarding the overall master plan for the area and not focus only on the CMP dredging.
- Since the project area contains habitats designated as EFH, any information related to EFH resources and conservation measures should be included in the EIS and project design, as well as EFH consultation requirements for the project.

8.3.3 Commonwealth Agencies

- There would be a need to coordinate with infrastructure-related agencies for infrastructure relocations and excavations would have to take place.
- There is concern as regarding the dredged material disposal route and coordination with the waterway transportation on the Western CMP.

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Other Relevant Documents and Reports

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