FINAL
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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 III

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San Juan, Puerto Rico

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Corporación del Proyecto ENLACE
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For review by:
U.S. Army Corps of Engineers

This document has been prepared by the *Corporación del Proyecto ENLACE del Caño Martín Peña* and its consultants Atkins Caribe, LLP, Atkins North America, and Estudios Técnicos, Inc., for review by the U.S. Army Corps of Engineers.

FINAL
ENVIRONMENTAL IMPACT STATEMENT
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 and the Commonwealth of Puerto Rico (the Commonwealth), acting through the Department of Natural and Environmental Resources (DER), are the non-Federal cost-sharing partners for the project.

Abstract: This Final Environmental Impact Statement examines the environmental consequences of the implementation of the Caño Martín Peña Ecosystem Restoration Project (CMP-ERP). The purpose of the CMP-ERP is to re-establish the tidal connection between the San José Lagoon and the San Juan Bay, and thus, the eastern and western sections of the San Juan Bay Estuary. The CMP-ERP consists of the dredging of approximately 2.2 miles of the eastern half of the CMP, starting from the San José Lagoon towards the west, in the vicinity of the Luis Muñoz Rivera Avenue Bridge. The CMP-ERP would improve dissolved oxygen levels and salinity stratification, increase biodiversity by restoring or enhancing, among others, fish habitat and benthic conditions, and overall health of the San Juan Bay Estuary System. The CMP-ERP 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. Recreational navigation will also be reestablished in the area, allowing for increased public and commercial use of the entire estuary. A 100-foot-wide by 10-foot-deep channel was chosen as the Recommended Plan for the implementation of the CMP-ERP. It proved to be the alternative that best meets the study objectives, is the most acceptable, cost effective and best buy. In addition to the contributions to ecosystem restoration, the implementation of the Recommended Plan would also contribute to improve socioeconomic conditions of adjacent communities.

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

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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 Report 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 submits this Final 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 EIS describes the proposed action, the affected environment and discusses the potential environmental consequences of alternatives on the affected environment. This EIS has been prepared following the National Environmental Policy Act (NEPA) of 1969, as amended, and its implementing regulations, and associated rules and regulations of the Council on Environmental Quality (CEQ) and the USACE Procedures for Implementing NEPA, 200-2-2 (33CFR-230).

Project Purpose and Need

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 (SJB), which would improve dissolved oxygen levels and 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), which is administered in the Commonwealth by the San Juan Bay Estuary Program (SJBEP). The SJBE's watershed covers 97 square-miles and it is heavily urbanized with over 5,000 people per square-mile. The SJBE includes over 33% of the mangrove forests on the Island, with over 124 species of fish and 160 of birds. The eastern half of the CMP, historically between 200 and 400 feet wide and navigable, has a current depth of between 3.94 feet to 0 foot towards the San José Lagoon. Due to years of encroachment and filling of the mangrove swamps along the CMP, the channel no longer serves as a functional connection between the SJB and the San José Lagoon. Sedimentation rates within the Eastern CMP are nearly twice as high as in other parts of the SJBE due to infilling and extremely limited water flow. Open waters in areas closer to the San José Lagoon have been lost, as the area has started transitioning into emergent wetlands and uplands. Sediments include a combination of debris, household refuse, and other waste accounting for 10% of its composition. In some sites, thickness of this material is close to 10 feet below the bottom.

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 San José Lagoon has been compromised, as a reduced number of species are found when compared with other lagoons throughout the SJBE. Habitat degradation has in turn decreased the ability of those species still found to respond to natural changes, disease and other stressors, reducing ecosystem functions and values, including losses of economic and recreational opportunities.

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. This has caused strong salinity stratification, which in turn limits dissolved oxygen levels in the 702 acres of the lagoon's bottom with depths below 4 to 6 feet, severely affecting benthic habitats. Reduced flushing capacity has also led to an increase in sedimentation rates. Habitat for many species of fauna is then lost as reduced mangrove coverage and health decreases forage opportunities and reproductive success.

Ecological degradation within the estuary has also begun to affect human health and safety of surrounding communities. Inability to implement flood risk management measures due to the lack of conveyance capacity in the Eastern CMP leads to localized flooding. Subsequent human contact with CMP's waters has been associated with higher rates of asthma, dermatitis and gastrointestinal diseases. 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 cy of vegetation and mixed material; dredging approximately 680,000 cubic yards (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. After dredging and construction of mangrove planting beds, 20.42 acres of open water and 39.62 acres of mangrove wetland would be restored.

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. After dredging and construction of mangrove planting beds, 25.57 acres of open water and 34.48 acres of mangroves would be restored.

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. After dredging and construction of mangrove planting beds, 30.97 acres of open water and 29.08 acres of mangroves would be restored.

For Alternative Plans 1, 2, and 3, 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 Ciudad Deportiva Roberto Clemente staging area. Total construction time for all three Alternatives 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% 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 with Alternatives 1 and 3, with average annual equivalent costs of $9,300,000 and $9,100,000, respectively.

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 Recommended Plan. It is the National Ecosystem Restoration (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.

Recommended Plan Elements

Construction schedule: Alternative Plan 2 construction is proposed or expected to last between October 2018 and December 2020. However, project construction may be sequenced in order to get some sites within the Project Area worked in advance.

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 4 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. Riprap 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. A temporary turbidity containment coffer dam would be constructed to the east of the Martín Peña Bridge.

Disposal of dredged material: A barge-mounted mechanical clamshell dredge would be used to widen and deepen the Eastern CMP channel, and would place dredged material into dump scows. Approximately 76,200 cy of solid waste (10%) would be screened from the 762,000 cy of dredged material and transported from the staging area to the Humacao Regional Landfill site, which is located approximately 32 miles from the CMP-ERP site. Approximately 37,800 cy of in situ sediments would be used to complete the sheet pile construction and mangrove bed restoration.

After screening and removal of solid waste debris, the remaining 648,000 cy of in situ sediments would be encapsulated within geotextile fabric bags, and transported by shallow-draft barges to the San José Lagoon artificial subaqueous pits (SJ1 and SJ2). Additional water quality and sediment testing, such as bioassays, would be conducted prior to placement to ensure their suitability for disposal. Prior to disposal operations, SJ1 and SJ2 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 both sites and deposited within the SJ 3/4/5 artificial subaqueous pits. 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. The proposed layer of sand capping would also help reduce benthic burrowing organisms from reaching and disturbing the sediments. 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 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 cofferdam would be removed. Solid waste and dredged sediment would be placed into trucks and hauled to the Humacao regional sanitary landfill.

Materials within the CMP-East include various types of solid waste, debris, and other materials. Such materials would 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 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 regional landfill site.

Erosion Control: A weir would be constructed at the western end of the Project Area to mitigate water flows into the adjacent waterways. The dimensions of the weir would be 800 feet in length, 115 feet wide. At the site where the weir would be installed, the channel would be 115 x 6.5 feet. It would replicate the cross sectional area of Alternative 1 (75 x 10 feet), and by providing a transition area to reduce bottom water velocities, would prevent scour around bridges, bulkheads, and other marine structures west of the Project Area. The weir would be constructed with an articulated concrete bottom, while the remainder of the Eastern CMP channel would be earthen bottom.

Non-Structural Measures: No non-structural measures were identified to restore circulation to San José Lagoon. Other non-structural measures are related to structure acquisitions and relocations within the confines of the Federal project have been retained and included in the development of alternatives, as well as activities outside of the CMP-ERP that would be conducted by the non-Federal sponsors. Overall, the non-structural measures considered and used in the development of alternatives included the acquisition of approximately 393 residential structures and relocation of 394 owners/families/occupants, as well as other measures independent of the Federal project to be implemented by the non-Federal sponsor and adjacent communities, such as enforcement of illegal dumping, stormwater and sewer improvements and community education.

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.

Additonal Project Components: Additional project components are: Recreation Plan, Project Monitoring and Adaptive Management Plan, Nuisance and Exotic Vegetation Control, and Draft Project Operating Manual. The Recreation Plan includes water access areas that would replace lost functions within the Project Area.

Environmental Consequences of the Recommended Plan

The environmental consequences of the Recommended Plan and the proposed measures include:

- The Recommended Plan would significantly improve the tidal exchange and circulation in the CMP and San José Lagoon and, in turn, improve water quality and ecological conditions in the Project Area. Residence time for the San José Lagoon would be reduced from 16.9 to approximately 3.9 days and consequently salinity stratification resulting in an increase in bottom DO in -4 to -6 feet of water within San José Lagoon. The proposed expanded channel bottom would provide new benthic community area and channel walls would provide encrusting invertebrate community habitat. The colonization of invertebrates is not expected to affect water velocities.
- The Recommended Plan could provide benefits toward reducing the effects of climate change. Expected net gains of vegetated wetlands and uplands could decrease heat island effects and provide additional means to cope with future increases in temperature. This additional vegetated land cover area would also reduce runoff waters reaching the CMP, therefore, reducing flood frequency, given the expected extreme precipitation events. Indeed, frequent or moderate floods, as well as the 100-year flood risk (without storm surge), would be reduced under the Recommended Plan, albeit not substantially.
- No significant impacts to geology are anticipated as a result of the Recommended Plan, while significant beneficial impacts to soils in the Eastern CMP are anticipated as a result of the removal of debris used as fill material. Substrate at the Eastern CMP channel behind the

sheet pile, would be left without garbage and thus under a suitable condition that would promote its colonization by sediment boring organisms and mangrove.

- No significant permanent adverse impact is anticipated to Essential Fish Habitats (EFH) or federally managed fishery species in the CMP and surrounding waters. Direct impacts to EFH would occur due to proposed dredging activities, and vertical steel sheet pile and concrete bulkhead walls installation. Temporary project construction losses of 34.46 acres of mangrove wetlands and 7.40 acres of open water would occur during construction. However, it would be compensated by restoring mangrove wetlands with greater functional value and, ultimately, a net increase in wetlands with respect to mangroves and open water habitat for fish and wildlife in the SJBE. The Recommended Planwould restore 34.48 acres of mangrove and 25.57 acres of open waters, for a net gain of 1.02 acres and 18.17 acres, respectively.
- There are no endangered or threatened species listed under the Endangered Species Act (ESA) in the Project Area. However, 19 federally listed species have been documented in the Study Area (4 species of flora and 15 species of fauna). The Puerto Rico Department of Natural and Environmental Resources (DNER) has designated other 9 species as threatened, endangered or critically endangered under the Regulation for Threatened and Endangered Species of the Commonwealth of Puerto Rico (Reg. 6766). Under current conditions, most mobile species are not able to thrive in the Eastern CMP. Once the connection is established by the CMP-ERP, there is a potential for the San José Lagoon to be utilized as habitat by the West Indian Manatee (*Trichechus m. manatus*) which presently uses the SJB, and has been sighted in the Western CMP and the Puerto Nuevo River. Available foraging habitat for listed species such as terns would be improved with the increase in open water habitat. During CMP dredging, monitoring for potential manatee occurrences would be implemented. In addition, during construction, bird species present in the Project Area may be impacted by the noise, odor, and exhaust from equipment.
- Dredging of sediments would result in short-term, localized deterioration of water quality. Best Management Practices (BMPs) (e.g., turbidity controls and monitoring) and construction of a weir at the western end of the Project Channel would minimize short-term and long-term erosion of the western half of the CMP by reducing sedimentation and water velocities that result in scour.
- Other temporary adverse effects include noise and vibrations during construction. Hydrogen sulfide may be emitted as the dredged material is removed. However, management measures would be implemented if needed.
- During construction, the channel section at the Ponce de León Avenue towards the western half of the CMP, would be closed to minimize the dispersion of contaminants, by placing a sheet pile in the eastern face, under the Martín Peña Bridge. An increase in flood risk at the CMP under a no storm surge scenario is another temporary adverse effect from “plugged” conditions that would be addressed by keeping close coordination with the adjacent community to establish local emergency management strategies.
- Socioeconomic adverse impacts would include the relocation of 394 housing units from the Eastern CMP. Efforts would be made to relocate people to other areas within the same community. Some temporary disproportionate adverse effects would be felt by low income and minority communities during the construction phase, however final actions would have

a significant positive outcome, improving their living conditions and their quality of life. Also, no disproportionate risks to children are anticipated under the Recommended Plan.

- The Recommmended Plan would result in the direct and indirect creation of 4,275 construction jobs.

Areas of Controversy and Unresolved Issues

Throughout the scoping process, some issues have been raised, which are addressed in the Feasibility Report/Environmental Impact Statement (FR/EIS). The most important areas of concern are related to water quality, dredging, and disposal of dredged material, including potentially contaminated sediments. The public has also raised concerns regarding temporary impacts during construction such as noise, odors, vibrations and structure stability, and vectors. The final EIS discusses recommendations to reduce these impacts.

Among unresolved issues are the sources of sand for capping of the disposal sites of the dredged sediments. Although several sources have been identified, ENLACE and the DNER, the non-Federal sponsors, are working on selecting the most economic and environmentally sound source of capping material. Proper coordination with infrastructure agencies were also raised and the possibility to find archeological material in the Eastern CMP. This Final EIS discusses recommendations to reduce these impacts. Furthermore, alternatives presented in the final FR/EIS were discussed and analyzed with stakeholders.

Major Findings and Conclusions

The most significant adverse impacts of the CMP-ERP are temporary and are associated with the construction phase; namely, the erosion, and turbidity impacts of the dredging operation, and the management and disposal of the dredged material in the deep artificial pit of the San José Lagoon. There are standard management practices that significantly reduce these impacts, and which the current Federal and Commonwealth's regulatory framework thoroughly addresses.

Once the ERP is complete, the water residence time in the San José Lagoon would be reduced from approximately 17 days to less than 4 days. Increased flushing rates should also improve larval recruitment and survivability for many of the organisms that comprise the encrusting community of red mangrove prop roots, therefore increasing the health of that habitat, considered essential to fisheries.

A single species of mussel, *Mytilopsis domingensis* (false mussel), presently dominates the areal coverage of the mangrove roots throughout the San José Lagoon. Increased flushing is expected to result in a red mangrove prop root fouling community that would include multiple types of mollusks, as well as sponges, crabs, polycheate worms, and ascideans. Benthic communities in areas with a maximum depth of 4 to 6 feet are also expected to improve due to higher dissolved oxygen levels and water transparency, possibly allowing proper habitat conditions for the establishment of sea grass beds in some areas of the San José Lagoon.

An increase in tidal flushing would also cause the salinity and dissolved oxygen to increase in the surface layer of the CMP and the San José Lagoon. Both of these parameters have an adverse impact upon bacteria, thus reducing coliform bacteria concentrations and the potential health hazards due to direct or indirect contact with these waters.

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Appendices

Abbreviations and Acronyms

ac	acres
adICPR	advanced Interconnected Pond Routing
ACGIH	American Conference on Governmental Industrial Hygienists
ACM	Articulated concrete mats
AHS	Actionable Hazardous Subtances
ALOHA	Areal Locations of Hazardous Atmospheres
ASTM	American Society for Testing Materials
ATSDR	Agency for Toxic Substances and Disease Registry
BACT	Best Available Control Technology
BDL	Below Detection Limit
BI	Benthic Index
BMP	Best Management Practice
C&D	Construction and demolition debris
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
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*
CMP	Caño Martín Peña
CO	Carbon monoxide
CO_2	Carbon dioxide
COC	Contaminants of Concern
CORRACT	Federal Corrective Actions List
CRIM	Municipal Tax Revenue Collection Center

CSD	Combined Sewer Discharge
CSO	Combined Sewer Overflow
CSS	Combined Sewer System
cy	cubic yards
CZMP	Coastal Zone Management Program
dB	decibel
dB(A)	A-weighted decibel
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
DNER	Puerto Rico Department of Natural and Environmental Resources
DMMP	Dredged Material Management Plan
DO	Dissolved oxygen
DTPW	Puerto Rico Department of Transportation and Public Works
E	East
EA	Environmental Assessment
ECC	ENLACE's Community Committee
ECO-PCX	Ecosystem Restoration Planning Center of Expertise
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EO	Executive Order
EPG	Emergency Power Generator
ER ERDC	USACE's Engineer Research and Development Center
ERM	Effective Range Median
ERNS	Federal Emergency Response Notification System
ERP	Ecosystem Restoration Project
ERPG	Emergency Response Planning Guidelines
ESA	Endangered Species Act
EUA	Ecological Uplift Assessment
FDA	Food and Drug Administration
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
FMP	Reef Fish Fishery Management Plan
FONSI	Finding of Non-Significant Impact
fps	feet per second
FR	Feasibility Report

FRM	Flood Risk Management
ft^3/s	cubic feet per second
ft/s	feet per second
ft/y	feet per year
FWCA	Fish and Wildlife Coordination Act
FWPRA	Federal Water Project Recreation Act
g	grams
G-8	Group of the Eight Communities bordering the Caño Martín Peña
GHG	Greenhouse gas
GIS	Geographic Information System
H	Hybrid
H&H	Hydrology and Hydraulics
H_2S	Hydrogen sulfide
ha	hectare
HAP	Hazardous Air Pollutant
HAPC	Habitat Areas of Particular Concern
Hg	Mercury
HIA	Health Impact Assessment
HTRW	Hazardous, Toxic, and Radioactive Waste
HU	Habitat Unit
HW	Household Waste
HHW	Household Hazardous Waste
IA	Initial Assessment
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
Kg	kilograms
kV	kilovolt
L_{10}	Noise value exceeded 10% of the time
L_{eq}	Equivalent (or average) noise level
LBC	Level Bottom Capping
LEERD	Lands, easements, rights-of-way, relocations, and disposal area
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^3/d	Million cubic meters per day
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mg/mg^3	milligrams per cubic milligrams
mhw	mean high water
mi	miles
mi^2	square miles
mllw	mean lower low water
mlw	mean low water
mm/yr	millimeters per year
mph	miles per hour
MPRSA	Marine Protection, Research, and Sanctuaries Act
MTZ	Maritime Terrestrial Zone
msl	mean sea level
NAAQS	National Ambient Air Quality Standards
NE	North-East
NED	National Economic Development
NEP	USEPA's National Estuary Program
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
NMFS	National Marine Fisheries Service
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides
NOA	Notice of Availability
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
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
NTU	Nephelometric Turbidity Unit
NWI	National Wetland Inventory
O_3	Ozone
ODMDS	San Juan Bay Ocean Dredged Material Disposal Site

OGPe	Puerto Rico Permit Management Office (for its Spanish acronym)
O&M	Operation and Maintenance
OMRR&R	Operation and Maintenance, Repair, Replacement and Rehabilitation
OPA	Otherwise Protected Areas
OSHA	Occupational Health and Safety Administration
P&G	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 Planificación Especial del Caño Martín Peña)
PDT	Project Delivery Team
PED	Preconstruction Engineering and Design
PEL	Probable Effect Level
PL	Public Law
PM	Particulate Matter
$PM_{2.5}$	Particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 microns
PM_{10}	Particulate matter with an aerodynamic diameter less than or equal to a nominal 10 microns
ppm	parts per million
ppt	parts per thousand
PR	Puerto Rico
PRASA	Puerto Rico Aqueduct and Sewer Authority
PRCZMP	Puerto Rico Coastal Zone Management Program
PREPA	Puerto Rico Electric Power Authority
PREQB	Puerto Rico Environmental Quality Board
PRHTA	Puerto Rico Highway and Transportation Authority
PRPB	Puerto Rico Planning Board
PRWQSR	Puerto Rico Water Quality Standards Regulation
psu	Practical salinity unit
PUD	Permanent Upland Disposal
RCRA	Federal Resource Conservation and Recovery Act
REC	Recognized Environmental Conditions
RfC	Reference Concentration (for Chronic Inhalation Exposure)
ROD	Record of Decision
ROW	Right-of-Way

SGC	Subaqueous geotextile confinement
SHPO	State Historic Preservation Office
SHWS	State Hazardous Waste Sites
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
SJMA	San Juan Metropolitan Area
SLR	Sea Level Rise
SO_2	Sulfur dioxides
SOx	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
TEL	Threshold Effect Level
TKN	Total Kjeldahl Nitrogen
TLV	Threshold Limit Value
TOC	Total Organic Carbon
tpy	tons per year
TSCA	Toxic Substances Control Act
TSD	RCRA Treatment, Storage, or Disposal List
TSP	Tentatively Selected Plan
TSS	Total Suspended Solids
µg/L	micrograms per liter
URA	Uniform Relocaton Assistance and Real Property Acquisition Act
U.S.	Unites States of America
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard

USDA	U.S. Department of Agriculture
USDJ	U.S. Department of Justice
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VCS	State Voluntary Cleanup Sites
VOC	Volatile Organic Compounds
WES	Waterways Experiment Station
WRDA	Water Resources Development Act
yr	year
Zn	Zinc

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1.0 ACTION PURPOSE AND NEED

1.1 ACTION AUTHORIZATION

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 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 a multipurpose 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 National Ecosystem Restoration (NER) analysis. As a result, it was concluded that the CMP-ERP 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 Recommended Plan sections of this Report. Federal recreation features have also been included in the CMP-ERP consistent with ER 1105-2-100.

1.2 LOCATION OF ACTION

The CMP is a tidal channel 3.75 miles long in San Juan, Puerto Rico. It is part of the San Juan Bay Estuary (SJBE), found in the northern coast of Puerto Rico and the largest system of its kind in the Island. The SJBE is the only tropical estuary in the National Estuary Program and the only one found outside the continental Unites States and is located within the San Juan Metropolitan Area (SJMA), the most urbanized and densely populated region in Puerto Rico.

The SJBE is characterized by a network of lagoons, channels, man-made canals, a bay and wetlands permanently and seasonally flooded with woody and herbaceous plants. Associated marine ecosystems include those hard (e.g., coral and rock reefs) and soft (e.g., seagrass beds and sandy bottoms) substrates found north of the SJBE. These are influenced by the exchange of ocean waters and the discharges of waters exiting the estuarine system. The SJBE's network includes the San Juan Bay (SJB), the Condado Lagoon, the San José Lagoon, Los Corozos Lagoon, La Torrecilla Lagoon, and the Piñones Lagoon, as well as the interconnecting CMP and San Antonio Channels and the Suárez Canal. Estuarine waters are exchanged with those of the Atlantic Ocean through three openings or outlets in the SJBE: Boca del Morro at the SJB, El Boquerón at the Condado Lagoon, and Boca de Cangrejos at La Torrecilla Lagoon.

The SJBE's watershed includes parts of eight municipalities: Toa Baja, Cataño, Bayamón, San Juan, Guaynabo, Carolina, Loíza, and Trujillo Alto, covering an area of approximately 97 square miles

(mi^2). Fresh water flows into the system from the creeks and rivers flowing mostly north from its watershed, which include the Puerto Nuevo River, Juan Méndez Creek, San Antón Creek, and the Blasina Creek. During medium to extreme flood events, fresh water is also received from the Río Grande de Loíza River. Several flood control pump stations and stormwater sewers also discharge into the system. The SJBE and its associated marine ecosystems are considered the "Study Area," since the proposed ERP is expected to have direct, indirect, and cumulative beneficial effects on this whole region (Figure 1-1).

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 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 (Las Piedritas), 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 nearby San José Lagoon pits, and the five pits in San José Lagoon (Figure 1-2). The approximate distance between the Project Area's western and eastern limits is 6.27 km (3.90 miles), following the contours of the CMP. The approximate linear distance between these two points is 5.60 km (3.48 miles). The Project Area is divided between the Municipality of San Juan, to the West, and the Municipality of Carolina, to the East. The Project Area is found between latitudes 18.4463 N and 18.4134 S and longitudes 66.0079 E and -66.0603 W (WGS 1984 decimal degrees); Lambert Coordinates Easting (X): 244945.734 and 239404.699 Northing (Y): 267885.442 and 264256.914 (State Plane NAD 83).

Most of the detailed descriptions discussed in this Final EIS are limited to the three distinctive areas where direct construction activities, and thus most expected impacts would take place: the Eastern CMP, the San José CAD site and the CDRC. Detailed descriptions on the San José Lagoon and Los Corozos Lagoon (hereinafter, collectively referred to as "the San José Lagoon") are made in this Final EIS. The San José Lagoon and the Eastern CMP are the SBJE's water bodies that are expected to experience the most significant, quantifiable benefits from the proposed ERP, and thus, merit special attention.

Figure 1-1. CMP-ERP Study Area

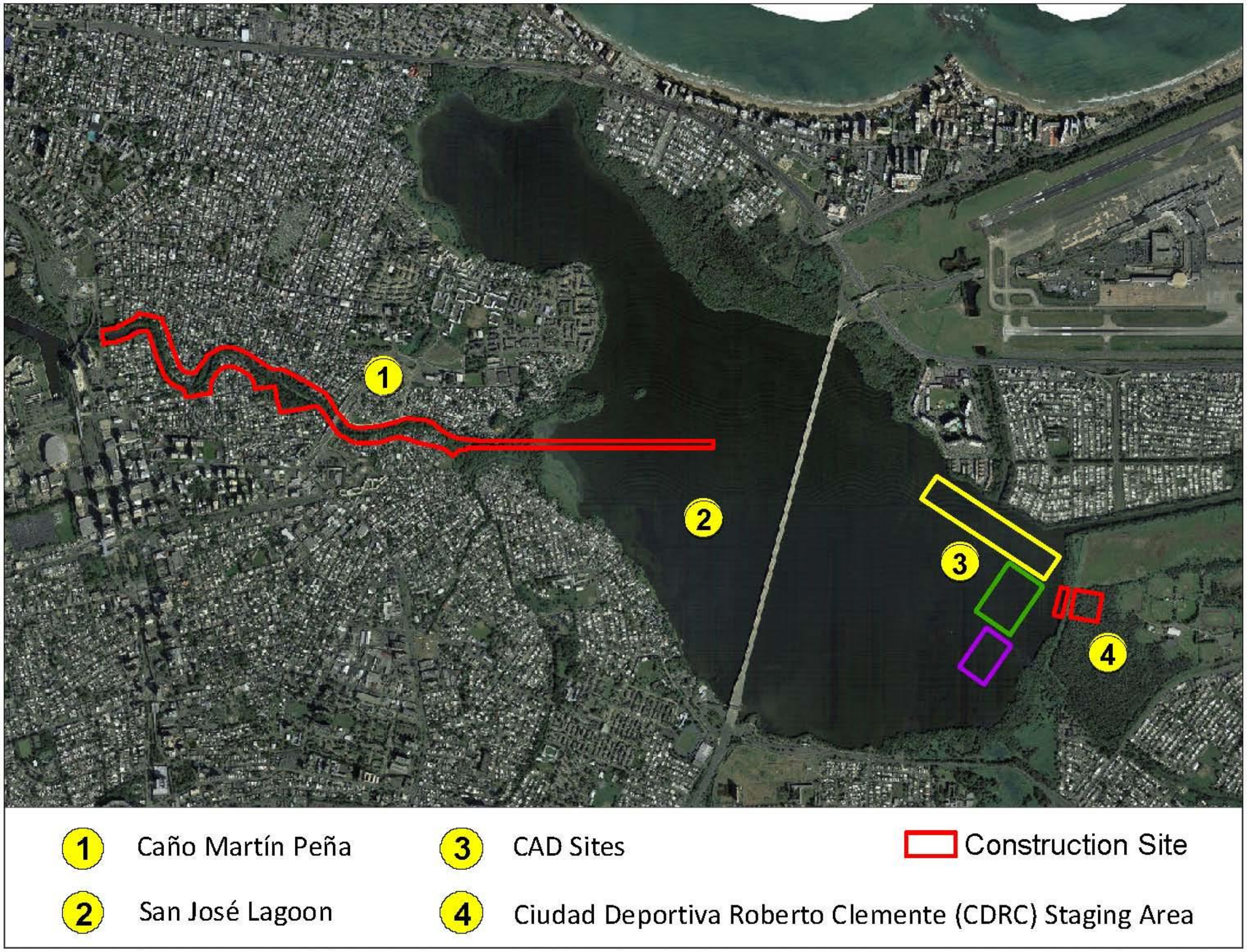


Figure 1-2. CMP-ERP Project Area

1.3 PURPOSE OF ACTION

The CMP-ERP has been formulated and evaluated as a single-purpose ecosystem restoration project for the environmental restoration of the CMP. The following objectives have been developed for the CMP-ERP.

- Improve fish habitat in the SJBE system by increasing connectivity and tidal access to estuarine areas.
- 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.
- 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.

Unless otherwise noted, the objectives are intended to begin being met immediately upon construction of the CMP-ERP and deliver ecosystem restoration benefits throughout the project's life. The timing and duration for the objectives would occur over the period of analysis, beginning at the end of project construction in year 2020 and continuing for 50 years.

1.4 HISTORICAL BACKGROUND

1.4.1 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 was made around year 1519 and 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, while still allowing flow. This "paso" divided the channel nearly in half, and was located in the general area where various bridges have been built since 1579. The latest and still in use, the Ponce de León Bridge (Martín Peña Bridge), was built in 1939 (De Figueroa, 1519).

In 1776, Thomas O'Daly drafted a map of San Juan, which is one of the earliest and best detailed descriptions of most of the SJBE and adjacent uplands. This map shows the CMP fringed by mangrove forests next to a marsh of considerable size at its northwestern half, as well as a chain of haystack hills or "mogotes" in its northeastern side. The western half of the CMP is shown to have been between 10 and 14 feet in depth, while the eastern segment is shown with a depth varying between 5 and 10 feet. The San José Lagoon, named at that time as Laguna de Cangrejos, was fringed by mangroves, the biggest stand found to its north. Extensive marshes appeared to the northwest and southeast of the lagoon. The lagoon was depicted as not exceeding 9 feet in depth (O'Daly, 1776) (Figure 1-3).

Figure 1-3. Close up look of Study Area as depicted on map drafted in 1776 by Juan de Villalonga, Ramón de Villalonga and Thomas O'Daly (Sepúlveda, 1989).

By the time the O'Daly map was completed, many areas previously occupied by fresh water wetlands and marshes adjoining the SJBE had begun to be gradually converted into agricultural use. Urban development started to become an important factor in the transformation of uplands located north of the CMP. The area, known at that time as Cangrejos-Santurce, took in the population that could not be accommodated in the already densely populated area of the San Juan Islet (Sepúlveda & Carbonell, 1988).

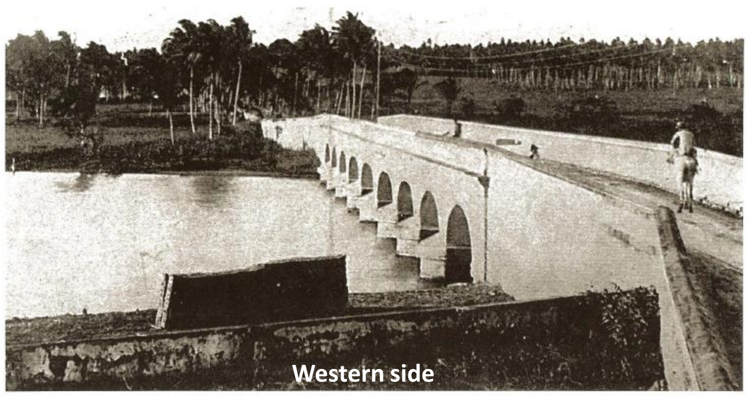
In 1899, the United States government conducted an investigation on Puerto Rico's aquatic resources and fisheries, which included observations and field sampling work at the CMP (Evermann, 1900). The study's findings described the CMP as follows:

> *With the cutter, Messrs. Evermann, Moore, Marsh, and Wilson went to the head of the harbor, then up Martin Peña Inlet some 4 miles to beyond the railroad bridge and the military road. This inlet is from 30 to 150 ft wide, 2 to 10 ft deep, and extends through low-tide flats covered with a dense growth of low mangrove bushes. The water was more or less stained with vegetable juices and the bottom was usually of black mud or mixed mud and broken shells. The only fishes seen were a few young mullets. Beginning a few rods above the mouth of the inlet and continuing well toward the railroad bridge we found the mangrove stems thickly covered with the shells of the small native oyster (a form of Ostrea virginica). The majority of these shells were alive, though many, particularly those highest on the stems, were dead. On these stems we also found many small barnacles, an occasional Mytilus exustus, and groups of bryozoans, and among the stems were a good many small crabs and an occasional individual of a larger species with red back and white claws (Goniopsis cruentata).*

At one place on this inlet the low ground or mangrove swamp is quite narrow on the south side and a considerable hill of cherty limestone rises from near the water's edge. In this hill are three or four small caves in which a few bats were found, apparently all of one species, Artibeus perspicillatus.

During the subsequent days spent at San Juan other trips were made up this inlet and the boat dredge was used at several places. The bottom, however, proved quite barren, and very little life of any kind was found. Fishes were extremely rare and mollusks and crustaceans were scarcely less so. Among the mangroves several specimens of water birds were seen, the kingfisher (Ceryle alcyon), brown pelican (Pelecanus fuscus), great blue heron (Ardea Herodias), little blue heron (Ardea caerulea), little green heron (Ardea virescens), a species of rail and a sandpiper. On the shore a number of land birds were seen, among them the American redstart (Setophaga ruticilla), a fly-catcher called pitirre by the natives (Tyrannus dominicensis), summer yellow-bird (Dendroica petechia ruficapilla), a vireo (Vireo calidris), and several others which we did not know and of which no specimens were obtained.

In 1915, a third bridge was completed with a new railway servicing the steam train that circled Puerto Rico and ended in the port area of what is Old San Juan. It crossed the CMP west and next to the tram bridge that had been built in 1880, very close to the area where the Martín Peña Bridge is presently found (Morrison, 2012; Sepúlveda, 2003) (Figure 1-4). These structures signaled the beginning of profound changes in the surrounding mangrove and open water landscape of the CMP.



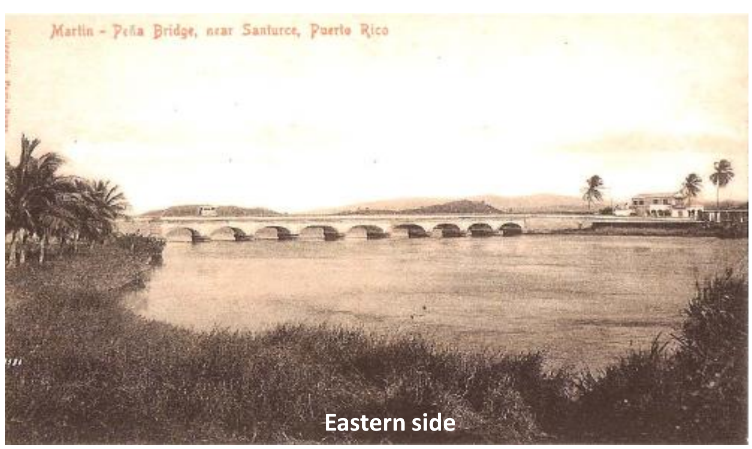


Figure 1-4. Photos of western and eastern sides of masonry bridge over the CMP (circa, 1890s)

1.4.1.1 Filling and settlements in the CMP

In the late 1910s and early 1920s, most mangroves associated to the SJB and the San Antonio Channel, especially those that used to be found where the Puerto Nuevo Port facilities stand today, were filled or used as disposal sites for the material dredged from the San Juan Harbor Project. The development of this port and storage facilities affected or eliminated more than 80% of the original mangrove acreage that was found in this area. In addition, the western half of the CMP was dredged and straightened to improve navigation between the SJB and the Hato Rey Ward.

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). In 1927, Puerto Rico's Legislature authorized the sale of mangrove lands, erroneously associated with the propagation of malaria mosquitos, with the condition that these were drained and filled. This action officially allowed the extensive filling process that took place in the mangroves and open waters of the CMP during the following decades (Legislatura de Puerto Rico, 1927).

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 in 1927 and 1932, respectively. These events, compounded by the later downfall of the sugar cane industry, force thousands of people from rural communities to flee and migrate to San Juan in search of a living. Many of these migrants informally settled around the CMP by building their homes on stilts, and afterwards, by depositing vegetative material, garbage, and debris into the swampland until it became firm enough to support the makeshift homes they built from salvaged wood and corrugated tin.

An aerial photograph of 1936 shows a 200- to 400-foot-wide natural channel in the eastern half of the CMP, as well as the first settlements in the area (USACE, 2004) (Figure 1-5). Mangrove forests immediately east of the Ponce de León Avenue and south of the CMP were eliminated to build houses, in what is known today as the Parada 27 neighborhood. The same can be observed in the mangroves north of the channel, east of the Ponce de León Avenue, in what are today the Barrio Obrero-Marina neighborhood and the western half of the Buena Vista-Santurce neighborhood. 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 producing construction aggregates and as a source of material to fill the adjoining mangroves. By 1948, informal settlements replaced all of the mangrove swamps along the north shore of the CMP and on the eastern half of its southern shore.

The western half of the CMP experienced the same process, especially in its northern shorelines. By the mid-1940s, all of the mangroves in this area were filled for the construction of housing in what would be called the Buenos Aires and Marruecos neighborhoods.

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 expand 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 at the eastern half of the CMP.

During the 1950s, the Municipality of San Juan, with Federal assistance, implemented urban renewal policies and initiated an intense eviction project to eliminate all the neighborhoods established over mangroves on the north shore of the Western CMP. The project displaced thousands of residents to public housing projects. Displacement policies continued through the early 1980s with the use of eminent domain in the Tokyo community of Hato Rey.

Between 1984 and 1988, the AcuaExpreso ferry mass transit project (originally known as "Agua-Guagua") was developed with Federal assistance, and inaugurated in March 1991. As part of this project, the western half of the CMP was dredged and bulkheaded with a 10-foot-deep by 200-foot-wide channel to allow navigation by ferryboats (Fagerburg, 1998). The Enrique Martí Coll Linear Park was built on top of the bulkhead. Between the late 1990s and the early 2000s, a new bridge for the Tren Urbano rail system was built over the Western CMP, between the Muñoz Rivera Avenue and the Ponce de León Aveenue bridges.

Most of the area formerly occupied by the displaced communities along the Western CMP was eventually redeveloped with parks, government facilities, a sports complex, the José Miguel Agrelot Puerto Rico Arena and numerous residential and commercial structures. Most housing units targeted mid to high-income families (Figure 1-5).

Several maintenance dredging works have been conducted in the Western CMP during the 1990s and 2000s. Mangroves have reestablished along both shorelines of this western segment of the CMP, the biggest stands found in its southern banks. Flow and water quality have also slightly improved in that segment (USACE, 2004). To protect this area from further urban encroachment, it was designated in 2003 as a Natural Reserve.

In contrast, 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 ft, 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 up to 9 ft 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 1-5. Historic and recent conditions of the CMP

The eight communities located at the eastern half of the CMP still remain. The lack of adequate infrastructure, including absence of sanitary sewers, storm sewers full of sediments and debris, narrow streets and alleys, poor quality of public spaces and few water dependent recreation opportunities, as well as inadequate housing, characterize large areas of these communities.

The unsanitary and unsafe conditions experienced by the inhabitants of the eight communities living near the Eastern CMP have prompted a concerted effort to restore its ecological functions and values. In 2001, the eight communities adjacent to the CMP created the G-8, Inc., a grassroots nonprofit organization, while the ENLACE Project flourished as an entity that brings together the community, the private sector and the government around the CMP-ERP, among other environmental justice and comprehensive development initiatives according to PR Law 489-2004. The CMP Land Trust was created under this law as an innovative land titling initiative, intimately related to the new regularization approach and the maritime terrestrial zone (public domain lands) adjacent to the CMP were also delimited by the DNER.

These initiatives have resulted in the relocation of 500 families that lived along the Eastern 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 Eastern CMP than the previous one to allow for the navigation of barges and other machinery needed as part of the CMP-ERP.

1.4.2 San José Lagoon

Many of the negative alterations affecting the CMP have also been made to the San José Lagoon, significantly reducing the ecological health of this section of the SJBE, and the system as a whole. One of the most significant impacts has been the dredging of about 17% of the San José Lagoon, increasing its original volume by about 30% (Ellis, 1976). The San José Lagoon, which had a natural average depth of 6 feet, not exceeding 8.2 feet, began to be dredged as a source of sand and fill material by the late 1950s (Ellis, 1976; Conde-Costas, 1987). During the 1960s, the eastern part of the lagoon was dredged to as much as 35 feet in depth (Conde-Costas, 1987) to obtain fill material for the area north of the San Antón Creek and for the site where the Laguna Gardens high rise residential complex was later built (Ellis, 1976). The area north of the San José Lagoon, north of the Cantera Península, was also dredged for fill material to depths ranging from 20 to 25 feet (Conde-Costas, 1987). The dredged material was used to fill the construction site for Las Margaritas Public Housing Project (Ellis, 1976). All of these dredging works resulted in the creation of seven artificial depressions in the Lagoon.

Dense salt or brackish water entering the San José Lagoon flows underneath the fresh water discharged by streams and storm water pumping stations. In deep areas of the lagoon, tidal currents and wind action are often not sufficient to produce mixing between these two water masses and the water stratifies (Ellis, 1976). Once this stratification occurs, oxygen exchange between the surface and the bottom is not possible, which impairs water quality and living resources. Anaerobic or oxygen-depleted zones trap nutrients and, through various chemical reactions, also become a source of more nutrients. Excess nutrient loading from this and other sources leads to the formation of a dense algae population. Although these populations produce oxygen during daylight, at night they consume oxygen, further decreasing the ability of the lagoon to sustain life. The nutrients accumulating in these pits produces eventual algae blooms, which are suspected to be the main cause for the occasional overnight fish kills in the San José Lagoon (SJBEP, 2000).

Increased sediment runoff and nutrient inputs, especially from direct and indirect sewage discharges coming from the CMP have, in turn, increased water turbidity to the extent that benthic primary production is no longer possible in many locations of these lagoons and the channel itself. Water quality is extremely poor in many areas of this waterbody due to eutrophication and fecal coliform bacteria contamination. Solid waste management is still a problem within the CMP as a result of inadequate disposal and waste collection.

All these water quality impairments in the San José Lagoon have been compounded by very limited water exchange with the ocean. The dredging works in the Suárez Canal during the 1960s helped increased tidal influence in this lagoon. However, any effects which those works had were offset by the dredged pits made about the same time in the San José Lagoons and in the Suárez Canal itself. As previously stated, the dredged pits increased the original volume of the San José Lagoon by more than 30%, increasing as well the time it takes to renew their waters. This condition has worsen even further due to the filling and accumulation of debris in the Eastern CMP during the last decades, blocking and eliminating the lagoon's natural connection with the ocean through the channel and the SJB. Fish and wildlife habitat loss and degradation have been especially pervasive in this section of the SJBE, as a result of these impacts (SJBEP, 2000).

The filling of those areas surrounding the San José Lagoon has also changed its mangrove coverage. The San José Lagoon, with the exception of its northern shorelines, is either denuded or has a narrow strip of mangroves. In 1994, the Teodoro Moscoso Bridge was inaugurated, crossing the San José Lagoon from north to south. A small island or mudflat was created close and northeast of the bridge's toll station, as mitigation for the unauthorized disposal of debris into the lagoon during the bridge's construction. The mitigation project did not succeed since wind and the lagoon's currents rapidly eroded the mudflat.

At present, the CMP has little to no apparent ability to convey flows into and out of San José Lagoon, as it has been nearly completely blocked. Clogging of the CMP has resulted in little to no tidal exchange between SJB, located west of the CMP, and the San José Lagoon (Bunch et al., 2000; Cerco et al., 2003; USACE, 2004).

1.5 CONTEXT

For more than 50 years, different Commonwealth and Federal government administrations have discussed the need to dredge and channel the eastern portion of the CMP in order to achieve the ecological restoration of the water bodies that make up the SJBE system, as well as to improve the socioeconomic and living conditions of the communities adjacent to the CMP.

The SJBE system has provided valuable resources to the residents and visitors of the SJMA for centuries. It is an irreplaceable natural, recreational, and economic resource. More than a million people live within the SJBE drainage basin, in eight of the most populated municipalities of Puerto Rico. Population density within the Municipality of San Juan is 7,968 inhabitants per square mile (PRCS, 2012). The SJBE's land surface is dominated by an urban and constructed cover (80%), 11% is surface water, and 8% is forests, wetlands, and green areas. Despite this low percent of natural land cover, one third of Puerto Rico's remaining mangrove forests lie within the SJBE.

The System comprise critical infrastructure that is essential to the Island's economy. The SJB has one of busiest container ports on the east coast of the United States and one of the largest port facilities in the Caribbean. More than 80% of all imported materials entering Puerto Rico are transported through the SJB. This Bay is also the port-of-call of dozens of cruise ships lines, receiving more than 1.2 million of their passengers per year. Moreover, the Luis Muñoz Marín International Airport is the main gate to and from Puerto Rico and other Caribbean islands, with over 8 million passenger loadings per year. The natural beauty and ecological diversity of the SJBE also support tourism and water-based recreational activities, which generate significant revenue (SJBEP, 2000).

Notwithstanding, urban growth resulted in the exploitation, degradation, and destruction of many of this estuary's ecosystems, functional values, and natural services. The main impacts to the SJBE system include a lack of flushing capacity, uncontrolled urban expansion, water pollution, illegal sewage discharges, and aquatic debris, among many others. These are all direct results of past human settlements and uses and of the need to increase public awareness, education, and involvement (SJBEP, 2000).

1.5.1 San Juan Bay Estuary System

Recognizing the continued threats facing the SJBE system, the Governor of Puerto Rico nominated it for the USEPA's National Estuary Program (NEP) on April 16, 1992. The NEP is a place-based program established under Section 320 of the 1987 Clean Water Act Amendments, addressing the need to protect and restore the water quality and ecological integrity of 28 estuaries across the United States. With inclusion in the NEP, the SJBE was designated as an "estuary of national significance" (SJBEP, 2000).

The SJBE system is unique when compared to other NEP in the United States. It is the only program located in a tropical geographic region and outside the main continental area. Its tropical nature is evidenced by the diversity of habitats and species within the estuary, with over 160 species of birds, 19 reptiles/amphibians, and 300 wetland plant species, including endangered, threatened, endemic, and rare species. Its multiple openings increase the influences on and from nearby coastal zones (SJBEP, 2000).

On August 2000, the San Juan Bay Estuary Program (SJBEP) completed the Comprehensive Conservation and Management Plan (CCMP) for the SJBE. The SJBE's CCMP is a long -term plan containing 49 specific targeted 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 environmental 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's approval" (CCMP, 2000). Three are directly related to the CMP-ERP:

Action WS-2: Relocate families living adjacent to the CMP

Action WS-5: Improve flow in the CMP

Action WS-6: Fill artificial depressions at the Suárez Canal and at the San José, and La Torrecilla lagoons.

1.5.2 Caño Martín Peña Special District

On 2002, the Puerto Rico Planning Board (PRPB) created the CMP Special District (District) and later, in 2006, approved the District's Land Use and Comprehensive Development Plan (District's Plan). The non-Federal sponsor, ENLACE, is responsible for the District's Plan implementation, which 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 1-6).

Due to previously established public policies, the community of Península de Cantera is not part of the District. Notwithstanding, Península de Cantera participates through the G8[1] and benefits from the implementation of the District's Plan. It is in charge, however, of implementing its own Comprehensive Development Plan as well as relocating many of the families in the community, as part of the CMP-ERP.

[1] The G8 is the organization comprising the eight communities adjacent to the CMP: (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, (7) Israel- Bitumul, and (8) Península de Cantera.

Figure 1-6. Location of each of the communities adjacent to the Eastern CMP (Shaded communities are part of the District)

The District's Plan, which is backed by Puerto Rico Law No. 489-2004, 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. The CMP-ERP addresses the District's Plan issues pertaining to environmental improvements, specifically the CMP's dredging, channelization, and ecosystem restoration. The CMP-ERP is only one of the principal elements of the Plan's 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.

1.6 NEED

Ecological restoration of the Eastern CMP is needed to increase its flow conveyance, in order to induce and facilitate water exchange in the San José Lagoon, and thus restoring hydraulic connectivity, as well as improving natural habitat conditions in the SJBE. As previously described, the Eastern CMP has little to no apparent ability to convey tidal and other flows into and out of the San José Lagoon. This current hydrological and hydraulic state of the CMP has resulted in the following hardships:

- Water quality degradation;
- Natural habitat degradation; and
- Ongoing health and flood risks to the adjacent communities.

Those areas that used to be open water in the Eastern CMP closer to the San José Lagoon are currently transitioning into emergent wetlands and uplands, as water hyacinths give way to other aquatic weeds and more terrestrial species. The water quality within the Eastern CMP and its adjacent water bodies has been repeatedly shown to be very poor as a result of the channel's reduced flushing capacity, the loads of untreated sanitary discharges, and stormwater runoff received daily (Kennedy et al., 1996; Webb and Gómez-Gómez, 1998; SJBEP, 2000; Otero, 2002; EQB, 2008). Due to the channel's decreased flushing and deteriorated water quality, the existing natural habitat associated to wetlands, forests, and benthos is also significantly degraded.

The Commonwealth of Puerto Rico has invested and will continue to invest a considerable amount of public funds in solving the many housing, infrastructure, and social problems affecting the Eastern CMP and its surrounding communities. Notwithstanding, without the collaboration of Federal assistance for this ERP, it is expected that the CMP and the SJBE system will continue to deteriorate. The lack of action would ultimately lead to a complete blockage of the channel and the segregation of this estuary of national importance. As a direct result, increased degradation to water quality and fish and wildlife habitats will continue to occur throughout this segment of the SJBE, and eventually, to the rest of the estuarine system. Area inhabitants will continue to experience social stresses associated with substandard living conditions, deteriorated air and water quality, frequent flooding events, and associated public health hazards.

The CMP-ERP represents a unique ecosystem restoration opportunity. Its dredging would remove most sediment deposited along the Eastern CMP and would induce circulation of ocean water across the estuary. It will significantly enhance water quality and fish and wildlife habitats in the SJBE system. The proposed restoration may also create new recreation, navigation, and tourism opportunities for the SJMA and Puerto Rico.

1.7 RELATED ENVIRONMENTAL DOCUMENTS

This Final EIS is the most significant and recent planning effort towards the restoration of the ecological functions and values of the SJBE system through improvements in its water and habitat quality. The CMP-ERP has a history of related environmental documentation that served as guidance and reference in the development and analysis of this Final EIS. The following documents were used as the principal sources of information:

Hydrodynamic and Water Quality Model Study of San Juan Bay Estuary (2000). A hydrodynamic and water quality model study of SJBE for use in determining effective alternatives for water quality improvement and predicting the impacts of future development, was conducted by the U.S. Army Engineer Research and Development Center in Vicksburg, MS, from January 1996 through May 1999. Management alternatives considered included methods to increase system flushing and reduce pollutant loadings. Ten sets of simulations were run to assess the impact that proposed remediation management strategies would have upon water quality. Scenario 1a was a base condition (including approved maintenance dredging of the San Juan Harbor navigational channels and flood control channel dredging for the Puerto Nuevo River) against which the other nine would be judged. Scenario 1b involved dredging the Eastern CMP to 50 feet wide and 3 feet deep; scenario 1c consisted of widening the Eastern CMP to 150 feet and to a depth of 9 feet below the water surface. Scenario 2 simulated filling all San José Lagoon artificial dredge pits down to a depth of 6 feet below the water surface. Scenario 3 consisted of removing the constriction at the Ramón Baldorioty de Castro Expressway Bridge on the Suárez Canal by widening to 100 feet and deepening to 12 feet below the water surface. Scenario 4 simulated the same conditions as in Scenario 3, plus the installation of a tide gate. Scenario 5a included the removal of unsewered loadings into the CMP. Scenario 5b simulated loading reductions into the San José Lagoon by removing discharges from the Baldorioty de Castro pump station. Scenario 6a combined scenarios 1c, 5a and 5b. Scenario 6b combined scenario 6a plus scenario 2. Scenario 6b, involving dredging the Eastern CMP to 150 feet wide and 9 feet deep, among other improvements, was determined to be the most cost-effective alternative for improving water and sediment quality in the SJBE (Villanueva et al., 2000; Bunch et al., 2000).

Dredging of Caño Martín Peña, Project Design Report and Environmental Impact Statement (2001). This report and EIS was prepared by USACE's Planning Division (Jacksonville District) under the Support for Others Program, at the request of the DNER. All alternatives proposed dredging the existing CMP 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 Aveenue Bridge. USACE's 2001 Design Report also evaluated three alternatives for the disposal of CMP's dredged material, which included: ocean disposal, land disposal, and in-bay disposal. The study recommended in-bay disposal to be used to fill two of the largest artificial deep holes/pits located at San José Lagoon. In 2002, the USACE further evaluated the in-bay disposal alternative through the CAD design study developed by the Engineer Research and Development Center (ERDC).

Draft Environmental Site Assessment, Phase I, Martin Peña Channel Rehabilitation (2002). Prepared by the PRHTA to comply with Puerto Rico's Environmental Public Policy Act.

Design of Contained Aquatic Disposal (CAD) Pits for Martín Peña Canal, San Juan, Puerto Rico (2002). Described the results of a design for a constructed CAD pit as a dredged material disposal option in the San José Lagoon. The study was conducted by the Environmental Laboratory of the USACE ERDC, Waterways Experiment Station (WES), Jacksonville District.

Draft Environmental Impact Statement (2003). Prepared by the ENLACE Project and the PRHTA to comply with Puerto Rico's Environmental Public Policy Act.

Reconnaissance Report, Section 905(b) (WRDA 86) Analysis, Caño Martín Peña Ecosystem Restoration (2004). The USACE prepared this report to demonstrate its interest in actively participating in the cost shared feasibility phase study for the CMP. The report evaluates the ERP based on previous studies and determined potential costs associated to its implementation, which would serve for planning purposes.

Feasibility Report for the CMP Ecosystem Restoration (2016, in progress). As part of the development of this Final EIS, a Feasibility Report (FR) was developed concurrently. The purpose of the FR is to evaluate the economic feasibility of the CMP-ERP and to support funding requests to the United States Congress for the CMP-ERP's implementation.

Technical Reports. In addition, over 30 technical reports were elaborated to build the baseline and comparative data and information required for the Final EIS's analysis. The most relevant of these technical reports are included as Appendices or are referenced in the corresponding text. The following list provides an overview of some of the most relevant technical reports which supported the development of this Final EIS:

- Existing Wildlife Habitat Technical Memorandum
- Essential Fish Habitat Assessment
- Sports Fisheries Studies Technical Memorandum
- Ecosystem Benefits Evaluation/Estimate of Ecosystem Habitat Units
- Water and Sediment Quality Studies Technical Memorandum
- Hydrodynamic-Water Quality Modeling Efforts Technical Memorandum
- Hazardous, Toxic, and Radioactive Waste Assessment Documentation
- Geotechnical Studies
- Dredged Material Management Plan
- Recreation Resources Assessment
- Aesthetic Studies and Resource Assessment
- Cultural and Historic Resource Study
- Air Quality Study
- Reconnaissance Report – Finca La Marina and the Suárez Canal Dredge Pit Restoration

1.8 DECISIONS TO BE MADE

At this stage, it is been proposed to encapsulate the dredged sediments for CAD disposal in geotextile bags, which would reduce dramatically the exposure of the sediment to the surrounding waters; therefore, it is highly unlikely that the porewater concentrations for the constituents of concern exceed relevant criteria. Testing results, would inform the specific methods and materials to be used which may confirm the need to use the proposed geotextiles, type of geotextile pore size and continued need for capping, in order to select the most appropriate method for disposal and containment at the PED stage.

Selecting the source of the capping material is another decision to be made. Although quarry sand has been identified as a potential source, other alternatives are being evaluated as an acceptable source for the sand cap, such as dredged sediments from the San José Lagoon and recycled glass. These analyisis would be developed in further detail in future stages of the planning process. A brief alternatives' analysis of dredge material capping sources is provided in Chapter 2. Notwithstanding, a more in-depth alternatives and impacts analysis for the dredge material capping source should be established.

Decisions to be made may also include the barge navigation route that would be used to transport the dredged sediments and debris through the San José Lagoon for final disposal.

2.0 ALTERNATIVES

The USACE and the non-Federal sponsors (ENLACE, DNER) are proposing the environmental restoration for the Caño Martín Peña. The proposed action would address the water quality and habitat improvements directly related to the CMP and the San José Lagoon by restoring hydraulic connectivity between these two waterbodies. For the CMP-ERP to meet this specific goal, the following conditions must take place, regardless of the selected alternative:

- The widening and dredging of the eastern segment of the CMP to reestablish the tidal flow and circulation in the CMP and its connectivity between the SJB and the San José Lagoon;
- The improvement and/or construction of adequate sanitary sewer and stormwater systems to areas with deficient or non-existing services to eliminate discharges of untreated sewage directly into the CMP;
- The increase in mangrove coverage in the SJBE water bodies to create and enhance fish and wildlife habitat in the CMP and the SJBE, through an ecosystem restoration process that promotes a healthy benthic community in the San José Lagoon as well as mangrove growth within the margins of the CMP.

A Project Delivery Team (PDT) consisting of ENLACE, USACE, and consultant personnel was assembled to conduct the USACE six step planning process. ENLACE convened a Technical Committee (TC) comprised by Federal and Commonwealth natural resources agencies to assist them with conducting the Final integrated FR/EIS as part of the public engagement process. The plan formulation process for the CMP-ERP builds directly on these previous planning and design efforts:

- SJBEP Comprehensive Conservation and Management Plan for the SJBE (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 District (2004)

The PDT defined the ecological problems and restoration opportunities in the Project Area, inventoried the existing conditions, and forecasted future conditions that would take place without any Federal action. This information was used to develop problem, opportunity, constraint statements and planning objectives. A performance measure was identified for each objective as a mean to evaluate plan effectiveness and compare plan alternatives.

Once the PDT established the set of viable management measures, four alternative plans were formulated, including the No-Action Alternative. These plans were described and analyzed in detail and compared against each other to gauge effectiveness in meeting the various objectives of the planning process. The PDT developed these alternatives and selected a preferred one to present to the public as the Tentatively Selected Plan (TSP). The remainder of this section provides greater detail on the process conducted to reach this conclusion. After public scrutiny, the TSP was deemed as the plan that best meets the planning objectives, thus it was designated as the National Ecosystem Restoration (NER) Plan recommended by the PDT.

2.1 MANAGEMENT MEASURES

Management measures were initially developed and screened to address the CMP-ERP's planning objectives. These can be a feature (a structural element) or an activity (a nonstructural action) that can stand alone or be combined with other management measures to form alternative plans. These measures were derived from a variety of sources including prior studies, the NEPA public scoping process (further detailed in Chapter 6 of this document), and the TC. For the CMP_ERP, four categories of management measures were created: Channel Dredging, Beneficial Use of Dredged Material, Mangrove Planting Bed Construction, and Non-Structural Measures.

2.1.1 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 SJB 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, an hybrid design and a rectangular cross-section. The hybrid design would require a sloped bank in the Project Channel, which is not feasible because of the potential to affect Project's performance. While a rectangular channel with steel sheet pile was the selected structural treatment for the vertical edge to prevent erosion. Channel configuration alternatives are discussed in section 2.3.

2.1.2 Beneficial Use of Dredged Material

Several possibilities were considered for this measure: expanding existing islands/habitat, constructing new diked or undiked islands, and constructing new marsh 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. As a result, all of these measures were eliminated from further consideration due to possible environmental impacts and acting conversely to project objectives.

The use of dredged material as a capping source in landfills was considered at an initial stage of the planning process, but not presented as a further option. A place to handle and store the material would be needed. It would result in significant amounts of heavy truck use through the surrounding communities to reach the staging/storage area and, later, transport it to landfills or brownfields. Infrastructure impacts (e.g., roads), and those associated to noise and air quality could be significant. In addition, calls were made to landfill administrators, but they expressed no interest in using this material as cover in their facilities. Notwithstanding, if for some reason an opportunity arises in the future during PED or project construction for using this material for landfill capping, it will be furthered evaluated at that time.

Given this situation, dredged material disposal options were developed and screened in order to determine the preferred dredged material disposal site for all channel configuration alternatives, as further discussed in section 2.2.5.

2.1.3 Mangrove Planting Bed Construction

Dredging would affect existing mangrove wetlands, albeit of extremely low functional quality, within the construction area. Mangrove wetlands could be re-established in areas along a dredged canal. 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: *Rhizophora mangle* (red mangrove), *Avicennia germinans* (black mangrove), *Laguncularia racemosa* (white mangrove), and the associated species *Conocarpus erectus* (buttonwood). Microtopography would be added to diversify habitat (see Figure 2-1).

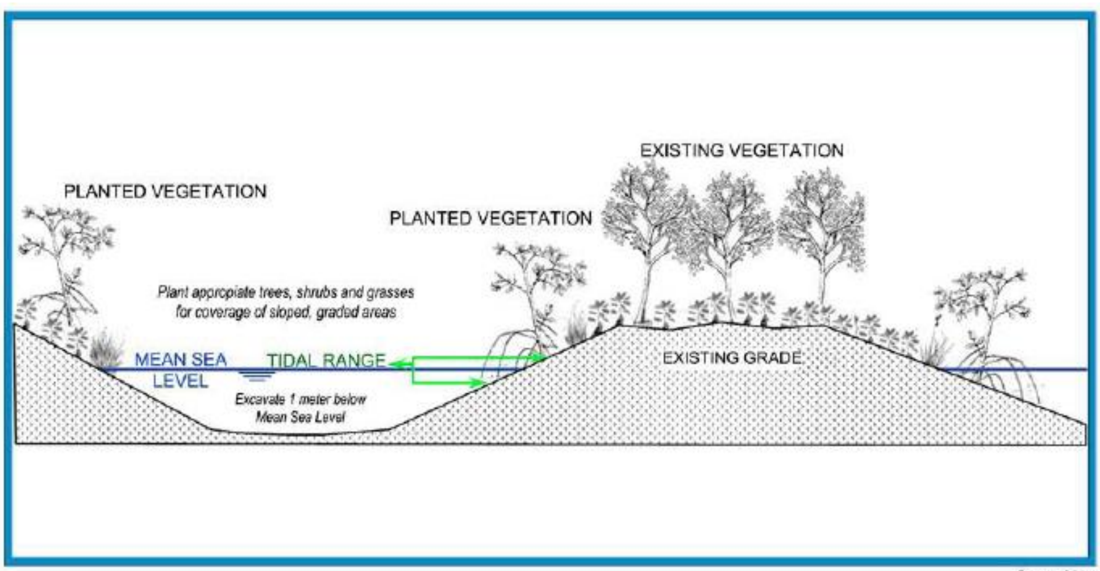


Figure 2-1. Conceptual mangrove restoration microtopography for the CMP

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. The minimum width for mangrove fringes would be approximately 32 feet on either side of the CMP, as recommended by Fischer and Fischenich (2000). This measure was retained. Mangrove restoration would include 34.48 acres of wetlands.

2.1.4 Non-structural 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 CMP-ERP that would be conducted by the non-Federal sponsors. Overall the non-structural measures considered and used in the development of alternatives include structure acquisition and relocation, community education, and increased enforcement of illegal dumping.

Structure acquisition and relocation 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. Acquisition and demolition of these structures would be necessary for any restoration of tidal flow, and the families would need to be relocated. There are a total of 393 residential structures that would be acquired and 394 relocations that would occur as part of the CMP-ERP. 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.

2.2 ADDITIONAL PROJECT FEATURES

2.2.1 Channel Bulkhead

A cantilevered steel sheet pile wall with no tie-backs and a concrete cap would be used as the channel bulkhead for all the channel configuration alternatives. The channel bulkhead would be aligned along the sides of a dredged and restored CMP waterway. The cantilevered installation method would allow for the least ground disturbance of all the methods commonly available. Selection criteria and process is discussed in the Engineering Appendix.

2.2.2 Erosion Control Measures

Preliminary hydrologic modeling for seven 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 (Atkins, 2012e). Three erosion control features were formulated, evaluated and retained for this purpose: articulated concrete mats (ACM), riprap, and weir.

ACM – Would be required to provide scour protection for any high velocity dredged channel configurations. The soils in the CMP 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 feet per second (ft/s). Table 2-1 provides within-channel bottom velocities that could be produced by the different channel dimensions. All configurations, except 75 x 10 feet, 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. A 75-x-10-foot configuration would require ACM to prevent channel scouring.

Table 2-1. Maximum bottom velocities that could be produced by channel dimensions

Channel Dimensions (ft wide x ft 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

Riprap – Riprap would be a necessary measure for protection along any structures such as bridges.

Weir – Initial hydrologic analysis for the CMP-ERP determined that a weir would be necessary to slow velocities in the western end of the CMP for all proposed channel dimensions. A main project constraint for the proposed project is that the plan should not damage the shoreline and sheet pile structures in the downstream Western CMP area. 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 a major construction and cost for repairs in the future, affecting funding for general channel maintenance. In order to evaluate this constraint, Western CMP velocities were calculated and evaluated for the potential to damage bridges and sheet pile structures. The velocities, ranging from

2.20 in the 75 x 10 channel to 4.09 in the 200 x 10 channel were considered unacceptable and thus a weir was required for each alternative. The weir's dimensions would be 800 feet in length and 115 feet wide. The weir would reduce the depth of the channel on the entrance of the western bridges channel to 6.5 feet. Since it would reduce water velocities in the CMP, the weir should also ease installation of turbidity controls.

2.2.3 Recreational Features

All channel configurations would have recreational features as part of their design. 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 intended to protect the investment in ecosystem restoration by facilitating appropriate uses of the area after it is constructed. This approach facilitates the creation of larger, uninterrupted restored ecosystem, 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.

The recreation plan would consist of three types of recreation access areas, which would allow for major recreational use in some areas and median use in others. These are a linear park, recreation access parks and recreation parks (see Figure 2.2).

Linear Park – Would consist of a trail, walk, and/or footbridge that extends the existing Enrique Marti Coll linear park located to the Western CMP. It would be constructed over the sheet pile bulk head in the Eastern CMP (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 western bridges in the Project Area and terminating at the first recreation access area in the Parada 27 community. The area would include educational signs 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.

Recreation Access Park – 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 have educational signs on the ecosystem restoration project, 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. These parks would provide for navigation access to the CMP.

Recreation Parks – Would be smaller in scale than the proposed recreational access park, and would be scaled to accommodate fewer people for passive recreation. The natural mangrove forest will serve as a backdrop; the twelve recreation parks would be strategically located along the Paseo del Caño 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 the CMP. They would also have educational signs. A gate and fence, or wall, would be placed along the recreational park and CMP, where applicable, for safety and to discourage the disposal of materials into the CMP. (Refer to the Recreation Plan Appendix for more details.)

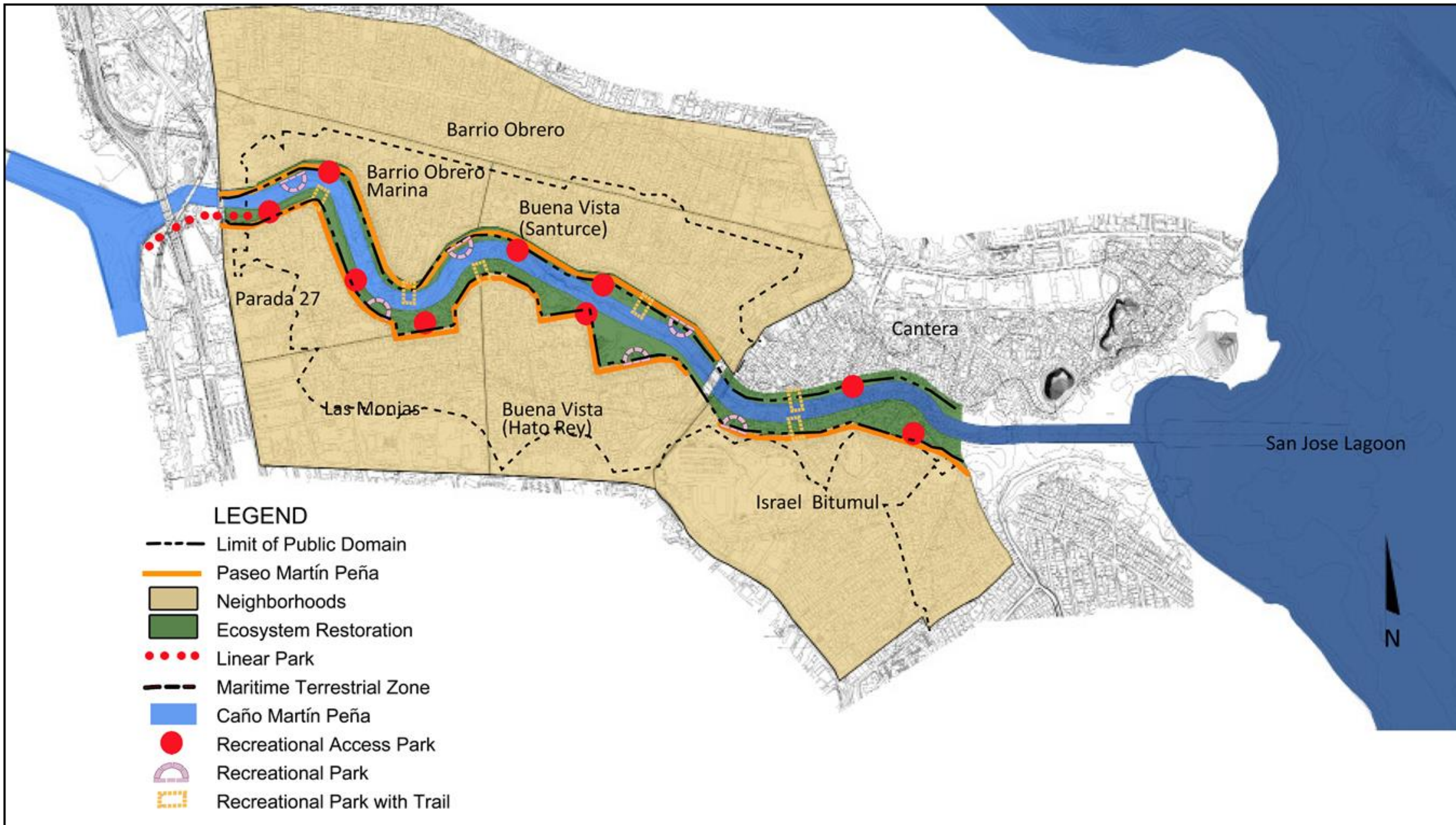


Figure 2-2. Proposed Federal Recreation Plan

2.2.4 Maintenance Dredging Requirements

Sediment transport from surrounding uplands, the San José Lagoon, and the existing western channel are expected to deposit up to 1.5 inches per year (in/yr) 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 cubic yards (cy) annually expected to be deposited in flood-tide shoals. It is noted that this value 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). The 6.7 feet per year (ft/year) sedimentation rate at the outlet of the Juan Méndez Creek is therefore considered 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. Based on a sedimentation rate of 1.5 in/yr, it is assumed that maintenance dredging activities would occur on a 5-year cycle. At this time it is anticipated that each maintenance dredging activity is expected to take ~30–45 days, depending on the volume of sediment that might be needed to be dredged. During PED, an additional study will be undertaken to determine the sedimentation rate at the outlet of the Juan Méndez Creek and the need and frequency of maintanance dredging.

Disposal of these sediments is not expected to require CAD or upland disposal, as the shoaling material is expected to be uncontaminated. The assumption that this material in not contaminated is based on the premise that all of the works required under the two Consent Decrees between USEPA-PRASA and USEPA-Municipality of San Juan as well as the management measures proposed under the SJBE Program's CCMP, will significantly reduce the amount of sediment and improve the quality of water entering the estuary system. In particular, will reduce the Juan Mendez Creek sediment deposition from upland sources at the confluence of the CMP and San José Lagoon. The material resulting from maintanance dredging would be loaded into scows and transported to the San Juan ODMDS or to the artificial dredged pits left in the San José Lagoon for their restoration, as proposed under the SJBE Program CCMP, for unconfined open water disposal. All necessary Regulatory permits would be secured at that time by the DNER, which is the entity responsible for the CMP-ERP maintenance dredging as part of the OMRR&R.

2.2.5 Dredged Material Disposal Management

The bottom of the CMP is mainly composed of peat, organic clays, and silts of varying thickness within the proposed dredge footprint. Native sediments are covered by sludge, trash, and debris that have accumulated over the last six decades. As such, it is estimated that trash and debris would make up approximately 10% of the total material to be dredged from the CMP.

Five dredged material disposal alternatives were evaluated to identify a preferred plan for its disposal: CAD, Landfill Disposal, Permanent Upland Disposal (PUD), Ocean Disposal, and Onsite Disposal. All the disposal options are dependent on dredging of the existing CMP channel.

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.

This elimination process resulted in the selection of the San José Lagoon CAD site for the disposal of dredged sediments, and landfill disposal for solid waste only. San José Lagoon CAD site is the option that most contributes to the ecosystem restoration goal since it allows a beneficial use of the sediments, and thus, is the most complete sediment management option. Prior to the disposal of the dredged sediments, additional water quality and sediment testing, such as bioassays, would be conducted, in accordance with Section 404 of the Clean Water Act. This is in order to confirm the sediments suitability to be disposed within the San José Lagoon CAD site.

The Humacao Regional Landfill, which is located approximately 32 miles from the CMP-ERP site, is the preferred solid waste disposal site for the dredged debris because of the higher certainty it affords to receive all the trash and debris that would be originated from this project.

Table 2-2 displays the different Dredged Disposal Management Options and the reasons for their elimination or further consideration.

Table 2-2. Summary of Elimination of Dredged Material Disposal Options

Dredged Material Disposal Options	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	Discussion
Suárez Canal CAD (sediment and small pieces of debris)	X		X			X	Eliminated due to insufficient capacity at the location. In addition, 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.
Los Corozos Lagoon CAD pit disposal (sediment and small pieces of debris)	X			X			Eliminated due to insufficient capacity within the pits at the location. In addition, its use as a CAD pit could temporarily interfere with improvised docks and navigation, and other shoreline activities.
Lagoon level bottom capping/ containment (sediment and small pieces of debris)					X	X	Was eliminated due to the potential impact to an area of rare island habitat, and other options could be utilized to avoid these detrimental effects.
San José Lagoon CAD with geotextile containment (sediment and small pieces of debris)							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. This was retained as an option as further explained.
Landfill disposal (sediment and solid waste)			X	X			Eliminated due to the insufficient capacity in existing landfills within the San Juan area to accommodate the entire volume of sediment and solid waste. Disposal in existing landfills elsewhere on the island is not feasible due to engineering considerations, costs and environmental impacts such as noise, traffic, and air quality due to the large number of trucks that would be constantly traveling to and from the site.
Landfill disposal (solid waste only)							Several landfills were evaluated, such as the ones in Juncos, Carolina, Fajardo, Salinas, Yauco and Ponce. The Humacao Regional Landfill, however, was chosen as the recommended disposal site. It would require a much smaller capacity that is available at current landfills in the San Juan area. (Additional information can be found in Volume 2. Appendix G – Engineering, Section 5.4.7.2.) The material would need to be transported to a staging area and trucked to a 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 the disposal of both sediment and solid waste. Was retained as an option, but would need to be combined with a sediment disposal option to be viable.

Table 2-2, cont'd

Dredged Material Disposal Options	**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**	**Discussion**
Permanent Upland Disposal (sediment and small pieces of debris)				**X**			Would require the acquisition and construction of a new area for single use upland disposal, essentially a new private landfill. This was retained as an option pending Section 404 testing of the dredged material. However, this is not warranted at the present time based on the results of several technical studies, thus it was not selected as the preferred alternative. Any PUD would need to be located within 10-miles of San Juan (and the CMP), an area that is densely populated. A screening analysis was conducted of over 60 upland sites to identify potential PUD sites. Several potential sites have sufficient acreage and configurations to accommodate the volume of dredged material from the CMP-ERP. However, the PUD alternative was less cost effective than San José Lagoon CAD and its impacts in surrounding communities could be greater. It 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.
Ocean disposal (sediment only)		**X**					Section 103 testing would need to be completed and approved for use of the San Juan Ocean Dredged Material Disposal Site (ODMDS). Preliminary testing of the sediment has indicated ocean disposal could be a viable option; however, after coordination with the USEPA, 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, a conservative apportionment was determined such that, for planning purposes, 55% of the dredged material would be pure sediment, while 45% 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 exceed Project's authorized cost. Environmental impacts would include noise, traffic, infrastructure and air quality impacts associated with the hauling of dredged material. As a result, this was not retained as an option.
Onsite Disposal	**X**		**X**	**X**			Would consist of placement of dredged material within upland areas outside of the planned channel. It was not retained as an option due to impacts such as: a reduction in the amount of onsite mangrove restoration that could occur, the elimination of available lands for recreation opportunities, the requirement of additional acquisition and demolition of structures, as well as more relocations if impacts to recreation were to be avoided. In addition, 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.

Larger, easily accessible pieces of debris that may be found at the surface, such as remains of discarded automobiles and refrigerators, would be collected using hydraulic excavators. Collected debris would be loaded onto trucks, where accessible to uplands, and then transported to a municipal landfill. Dewatering is not expected to be necessary since solid waste would air dry during transportation to the landfill. When feasible, practical and legal, recycling of materials would be pursued (see discussion in section 5.7.7.2 Engineering Appendix).

A barge-mounted mechanical clamshell dredge would be used to widen and deepen the CMP, and would place dredged material into dump scows. Trash would be separated from the dredged sediments by a metal sieve that overlays the dump scow opening where the dredged material would be placed after being dredged. The sieve allows the sediments to fall into the hull of the scow while the trash and debris remains on top, and can then be collected and removed to an awaiting debris barge. Sediments hauled on dredge scows are typically dewatered via gravity into the surrounding waters at the site of the dredging operation.

The debris barge would then navigate to a staging/management area for further processing and rehandling of the trash and debris for eventual overland transport of the material to a municipal or private landfill.

During the PED phase, additional methods of handling the dredged material would be further investigated, such as "raking" of the material at the CRDC upland staging area.

2.2.5.1 Staging area

Numerous sites surrounding the CMP, the San José and Los Corozos Lagoon, and the Suárez Canal were considered for the staging and dredged material management area. Nonetheless, many of the available lands are estuarine and marine wetlands and therefore are unsuitable sites to construct a temporary staging and dredged material management area. Urban locations within the Study Area could also be considered as potential sites for a staging and dredged material management area, but these sites would have to be cleared and require the relocation of homes and/or businesses to make room for the staging operations. These processes could result in diverse environmental, social, and economic impacts, such as air emissions (carbon and hydrogen sulfide), traffic congestion, increased noise levels, potential localized degradation of water quality, degraded aesthetics, indirect impacts to recreation, further community displacement, and substantial increase in project costs.

An identified site is a 35-acres property at the eastern end of the Project Area, located between the east bank of the San José Lagoon and the CDRC sport complex. The CRDC is a recreational complex owned and operated by a non-profit organization. It occupies 304 acres in the Municipality of Carolina, on the outskirts of San Juan, consisting of baseball, football, and soccer fields, a swimming pool, tennis courts, training facilities, and meeting rooms.

Within the previously disturbed 35-acre parcel at CDRC, there is a 6 acres parcel on the southeast shore of San José Lagoon, that could be used as the staging and dredged material management site for the CMP-ERP. The parcel is composed of 5 acres of upland and 1 acre of wetland. (see Figure 2-3).

Figure 2-3. Staging Area at CDRC

This site has enough capacity to accommodate portable facilities including trailers, offices, and access to the San José Lagoon. The temporary dock for the barges for loading/unloading the dredged material to be transported to the landfill would be built by the construction contractor, as well as a temporary access road for the trucks to pick up the trash and debris or bring the construction materials to be used in the installation of the sheet pile walls. The dock for access to the lagoon is not proposed to be left in place after the CMP-ERP is completed.

The temporary pier/dock can be built as a pontoon system, and would not require special reinforcement or protection given the low energy environments within the San José Lagoon. No dredging would be required within the lagoon to provide for a barge access channel to the pier/dock, since water depths immediately adjacent to the shoreline of the San José Staging and dredge material management area are sufficient to allow fully loaded shallow-water barges to navigate safely to the constructed pier/dock. These deeper depths are a result of dredged pits being in close proximity to the staging and management area shoreline.

The barges and scows that would be used to dredge most of the Eastern CMP, including those that would be used to install the sheet pile walls and transport the dredged material either to the San

José dredged pits or the CDRC staging area for final disposal, would be transported overland and deployed into the lagoon through this temporary dock.

In addition, access to the pier/dock areas may require the partial removal of mangroves along the shorelines of the staging and management area. It is expected that the construction contractor will coordinate with the Municipality of Carolina and resource management agencies, prior to selecting the final site for the dock/pier area to ensure impacts to the mangroves are kept to a minimum. Details regarding the size, installation method, removal method (if applicable), and materials for dock construction, as well as its exact location, will be determined during PED. The dock's location will be selected, among other criteria, to create the least disturbance to existing wetlands in the area, including access roads and other land clearing activities that may need to take place in order to use the dock.

Since the vicinity of the dredged material management site has been used in the past as a temporary minor staging area for debris and trash, it is anticipated that terrain preparation for truck access and traffic should not represent any concern. Processing of dredged debris, along with other construction related support activities at this area, would be a continuous operation throughout most of the dredging operations. The collected trash and debris would then be transported by truck to the Humacao Regional Landfill.

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 for activities related to the installation of the weir in the western end of the Project Channel (see Figure 2-4). This is a 2.2-acre upland parcel locally known as Las Piedritas Stadium. This property belongs to the Caño Martín Peña Community Land Trust. It is adjacent to the CMP, and the Muñoz Rivera Avenue. At present, the property is used by the surrounding communities as an improvised softball park.

Equipment and materials would be staged on floating barges. The barges that would be used to dredge and build the weir would reach the western edge of the Project Area through the San Juan Bay and the western half of the CMP. These would be deployed from existing port facilities or ramps in the San Juan Bay.

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 would be placed into trucks and hauled to the Humacao Regional Sanitary Landfill.At the CDRC staging area, the material would be off-loaded, placed into trucks, and hauled for disposal at the Humacao Regional Landfill.

Figure 2-4. Upland staging area to be used during construction of the western weir and cofferdam

2.2.5.2 San José Lagoon CAD site

As presented in the Bailey et al. (2002) report, the artificial depressions (pits) within the San José Lagoon were analyzed to potentially serve as CAD sites for the CMP dredged sediments not encapsulated with geotextile containers. These pits are identified as San José 1 (SJ1), San José 2 (SJ2), San José 3/4/5 (SJ3/4/5), and another identified as Los Corozos (LLC). Any combination of these artificial depressions could serve as potential CAD site for the CMP-ERP's dredged sediments (see Figure 2-5).

These four man-made depressions found within, or adjacent, to Project Area have been identified as sources of water quality problems in the CCMP for the SJBE (SJBEP, 2000 p. 96). Filling these man-made depressions has been recommended as one of the most cost-effective alternatives for improving the water and sediment quality in the Project Area (USACE, 2000; SJBEP, 2000). In fact, the SJBEP's CCMP identified the filling of all these pits as a priority and urgent action needed to improve the water quality and habitat conditions of the entire estuarine system (Action WS-6) (SJBEP, 2000). Therefore, the use of the CAD alternative is attractive because it would give the dredged material a beneficial reuse.

Bailey et al. (2002) concluded that 2 feet of clean sand are necessary to maintain a physical barrier between contaminated dredged sediments to be disposed at the CAD pits and the benthic community above (USACE, 2002). This 2-foot sand cap would contribute in preventing the release of contaminants at concentrations above water quality standards. In addition, an analysis of the currents and water circulation occurring in the lagoon was performed and it was established that the energy within the lagoon and around the CAD sites is low, which means there is a very low risk of erosion of the cap within the CAD sites.

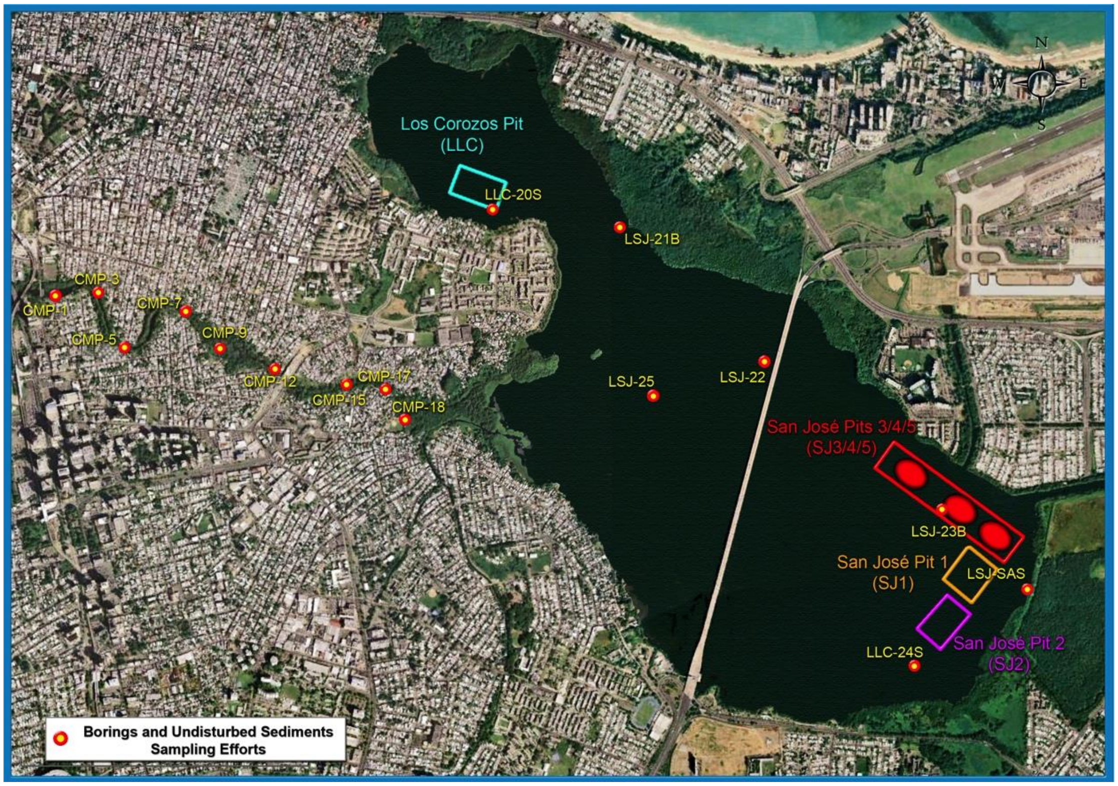


Figure 2-5. Artificial Pits at the San José Lagoon

In the report, Bailey et al. (2002) also analyzed the long-term pore water flux from the three CAD sites due to consolidation following the mechanical disposal of dredged material and its capping with clean sand. The cumulative flux for the CAD sites is large enough to displace at least two pore volumes in the caps (nearly five pore volumes for LLC cap). However, it was concluded that the pore water flux through the cap decreases significantly in 2 to 3 years and virtually goes to zero in about 5 years. Therefore, if constructed correctly, no long-term adverse water quality impacts from contaminants are anticipated from the CAD sites. The organic contaminants have limited mobility and are predicted to move a maximum of only about 15 cm (0.5 foot) into the cap. Moreover, in addition to the capping material, the CMP-ERP's dredged sediments would be encapsulated in geotextiles.

The available existing capacities within each artificial pit to a controlled fill depth of −16 feet (for SJ1, SJ2, and SJ3/4/5 Pits) and −6 feet (for LC Pit) are shown in Table 2-3. For the San José Lagoon artificial pits, a −16-foot top-of-fill was selected to ensure uncontrolled dredged and cap sediments spill over into adjacent pits does not occur. For the LC Pit, a −6-foot top-of-fill was selected to ensure the dredged and cap sediments do not protrude above the natural bottom depth.

Table 2-3. Artificial Pit Existing Capacities – San José & Los Corozos Lagoons

Artificial Pit	Existing (Max) Floor Depth (feet)	Fill Depth (feet)	Existing Pit Capacity (cy)*
SJ1	–27	–16	260,516
SJ2	–27	–16	245,450
SJ3/4/5	–24	–16	275,373
LC	–18	–6	166,210
		TOTAL	**947,549**

* Capacities derived from 1996 bathymetric survey.

The total existing capacity (947,549 cy) for the six artificial pits is sufficient to receive the bulked CMP dredged sediments volume (814,000 cy); however, additional capacity would be needed to allow for the geoencapsulated sediments to be capped with 2 feet of clean sediments. This would be achieved by enlarging the pits. Based upon surface areas at the targeted fill depths, the combination of SJ1 and SJ2 (prior to expansion) would result in least amount of capping material, and thus be more cost effective. Modification of the SJ1 and SJ2 pits would entail excavating the pits to their original borrow depths of –32 and –30 feet, respectively. Existing side slopes of 17H:1V would be maintained for stability purposes as the SJ1 and SJ2 pits are deepened. The geoencapsulated dredged sediments from the CMP would be placed within the modified SJ1/2 pits to a fill elevation of –18 feet. The placed geoencapsulated dredged sediments would be capped with 2 feet of clean sand to an unconsolidated fill depth of –16 feet.

The existing pit capacities for SJ1 and SJ2 to the –16-foot fill depth are 260,516 cy and 245,450 cy, respectively, for a total existing capacity of 505,966 cy. The revised capacities of the modified SJ1 and SJ2 pits to the –16-foot fill depth are 880,000 cy for the dredged sediments and 198,347 cy for the 2 feet of capping material, for a total of 1,078,347 cy. This provides sufficient capacity to place the 814,000 cy of dredged sediments and the 198,347 cy sand cap with an excess capacity of 66,000 cy. Therefore a total of 506,381 cy of sediments would need to be excavated from the SJ1 and SJ2 pits to acquire the total capacity needed to place the geoencapsulated dredged sediments and capping material within the two pits.

In light of concerns from charter fishermen, filling of the LC Pit was not considered in plan formulation. As such, placement of the 506,381 cy of dredged material from the enlargement of SJ1/2 would need to be placed in SJ3/4/5. In order to accommodate all of the dredged sediment from SJ1/2 into SJ3/4/5, the pits would be filled to an elevation of approximately -13.0 feet. It is unlikely that a 2-foot sand cap would be needed to cover the filled SJ 3/4/5, but if necessary, the top elevation would rise to -11.0 feet. Note that where SJ1/2 adjoins SJ3/4/5, a submerged berm would have to be built to prevent dredged sediments from sloughing onto the sand cap.

It is assumed that the excavated pit material is clean and therefore is suitable for unconfined open water disposal. A preliminary sediment analysis was conducted in 2011 for two locations in the San

José Lagoon pits (LSJ-23 and LSJ-24 on Figure 2-4), as part of the geotechnical study (Atkins, 2011e). NOAA's sediment quality guidelines (SQG) were used as the comparative value. The SQGs are not promulgated as regulatory criteria or standards. SQGs were only available for trace metals (ppm, dry wt.) that included nine parameters. Two guideline values are used for each chemical: the Effects Range–Low (ERL) and Effects Range–Median (ERM). It is important to understand that these values were not derived as toxicity thresholds. That is, there is no assurance that there will be a total lack of toxicity when chemical concentrations are less than the ERL values. Similarly, there is no assurance that samples in which ERM values are exceeded will be toxic. Toxicity, or lack thereof, must be confirmed with empirical data from toxicity tests, which would be conducted during PED. Chemicals often occur in saltwater sediments as complex mixtures. Preliminary results identified eight trace metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc) that were above detection limits. Of these eight, six were detected at levels below their ERL values, and arsenic and mercury were detected at levels that slightly exceeded their ERL values. Based on these preliminary findings, sediments to be dredged from the SJ1 and SJ2 pits could be disposed in an unconfined manner into SJ3, SJ4, and SJ5, subject to the approval of the corresponding regulatory agencies. Furthermore, if the excavated pit material is suitable for use as sand cap, then 198,347 cy less sediments need be placed in SJ 3/4/5/LC.

It should be noted that testing of those sediments that would be dredged from SJ1 and SJ2 would be conducted during PED and as part of Section 404(b), in order to determine or assess their baseline condition prior to any disposal or transfer into the SJ 3/4/5 pits. After consultation with all relevant regulatory agencies regarding the testing results, and if testing results identified contaminant exceedances for thresholds 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 for all five pits.

2.2.5.2.1 Disposal site capping source alternatives

Since the dredged sediments would be encapsulated in geocontainers prior to placement in the pits, other clean sediment could possibly be used as capping material in lieu of clean sand. Commercial sand availability is a problem in the San Juan Metropolitan area due to the limited geological resources. An early source of consideration was one of the remaining mogotes at the Península de Cantera. This source was dismissed because the surrounding area is densely populated, truck access is very difficult and mining and transportation would cause significant disturbances to nearby residents. Other alternatives evaluated as acceptable sources for capping are discussed in Table 2-4.

Table 2-4. Acceptable sources for capping material

Mine sand from the bottom of the San José and Los Corozos Lagoons	The presence of the silica sand in the north portion of the lagoon is an indication that there may be a presence of sand elsewhere in the system. Two borings from geotechnical investigation revealed sand layers: 8 feet and 17 feet in thickness, respectively. However, additional geophysical sub-bottom profile survey would have to be conducted to identify and quantify the potential layers of sand available in the system. In addition, the quality of the sand needs to be tested. Dredging within the Lagoon could occur without creating new pits. Dredging areas could be managed for minimum impacts by making the dredging of the sand as shallow as possible and then filling the depressions with material from different sources, including the sediments coming from the San Antón and Juan Méndez creeks, as well as the sediments removed to make space in the SJ1/SJ2 pits. In order to reduce the impact of the sand removal, the operation would be managed by a small hydraulic cutter head, which would reach only the areas where the sand is available in the geologic profile. The sand removed would be pumped or deposited directly to the new SJ1 and SJ2. The use of sand in the lagoon is not weather dependent, except for during big storms or hurricanes. However, the dredging of this sand has brought up concerns with the local sponsor, ENLACE, their TC, and regulatory agencies. After a series of meetings with ENLACE, this alternative source continues to be a concern because new depressions may adversely affect habitat or other parts of the ecosystem.
SJB Sand Source	The potential for sand to be available from the SJB is limited, but may be found at its entrance (USEPA, 1982; USACE, 1982), at La Esperanza Península (USACE, 1999), and/or with maintenance dredged material within San Juan Harbor (USACE, 2002). Depending on the location and characteristics, some geotechnical data may be needed as part of the sediment source analysis. Other testing and permitting for the quantities needed for the cap would also be needed. The sandy material could be dredged with a clamshell and barged to the CAD sites, or hydraulic dredged and pumped directly to the CAD site.
Boca of the Cangrejos-Torrecilla Lagoon Sand Source	This may be available by dredging the marina located within the Torrecilla Lagoon. The amount of sediments at the marina is currently not known and would require testing and permits. This site is at approximately 5 miles of the San José Lagoon (one way). The sandy material could be dredged with a clamshell, trucked and barged (rehandled) to the CAD sites, or hydraulic dredged, and pumped directly to the CAD site. Transport operation would involve crossing public and private properties, roads and navigable channels, which would temporarily and adversely impact traffic, air quality and noise quality within the affected communities.
Commercially Purchased (Upland Quarry) Sand Source	The capping material would be purchased commercially from a private borrow site and transported to staging area and then to the final disposal site. Private sources of sand are available in northern Puerto Rico (See Engineering Appendix). Based on the estimated 198,347 cy of clean sand that would be needed for the cap, approximately 13,223 truckloads would be needed using 15-cy (20-ton) dump trucks to transport the sand from the quarry to the loading site (approximately 35 miles one way). The sand could be stock piled at the CRDC 5 upland acres (without modifying CDRC). Access to the water would be also an important component, since the trucks would have to get close enough to the water so that they can either offload directly onto scows or into a storage area where a pipeline would be connected to transport the sand. The rate of supply is not clear, a factor that can determine the rate of capping in the lagoon. The source would also have to be tested regularly for quality assurance. The transportation of sand would have to be coordinated with the local Police Department for safety issues, traffic controls, and security concerns, as well as per the potential environmental concerns that the spills of sand coming from the trucks can create in the streets. Finally, the recreational activities at the CDRC would have to be considered during the operation, which can also cause delays in the operation, while the operation to remove the solid waste would have been concluded by the time the sand for capping operation is needed, so it is anticipated that these two activities are not going to interfere with each other.

Table 2-4, cont'd

Recycled Glass Converted to Sand	This alternative was presented by one of the members of ENLACE's TC. ENLACE has been discussing this alternative with the Puerto Rico Environmental Quality Board (PREQB). The use of recycled glass as a supplement to natural sand is an alternative that could potentially reduce sand mining costs, as well as its environmental impacts. In addition, it could become an Island- wide glass recycling and public engagement initiative in favor of the restoration of the SJBE, the CMP, and its adjacent water bodies. The use of this material as capping source would have to be tested to determine the size of the grains that would be necessary, in addition to chemical contents, presence of potential contaminants, among other. Recycled glass has been studied as a potential source for beach nourishment in Broward County, in the State of Florida. Geotechnical comparisons of sand and glass cullets (grain, size distribution, color, carbonate content, and grain angularity) concluded that both were found to be geologically compatible. The samples were also analyzed for fecal coliform, enterococci bacteria, lead, mercury, semi-volatile organics, petroleum hydrocarbons, and total salt, and the contaminants were found to be within the acceptable regulatory limits specified for sand. Aquarium tests were also conducted to determine any adverse impacts for lower invertebrates, as an indicator of potential impacts to higher vertebrates (Foye, Burton and Gutner, 2005). Based on the demonstration project's initial findings, using recycled glass cullet for beach nourishment was technically feasible because of its physical and chemical similarities and publicly accepted. Final project implementation phase was not achieved due to lack of public funding sources, as indicated by the staff of Broward County in June 2012 to ENLACE.

After studying available alternatives for capping source material, quarried sand was identified as the preferred, due to the possibility that the excess material to be removed from the SJ1/2 pits may not be suitable capping material. However, if suitable sand is found in the excess material proposed to be removed from the SJ1/2 pits to increase their capacity, it would be utilized because is the most readily accessible and logistically viable cap material source for the SJ1 and SJ2 CAD sites. To determine the suitability of sediments as capping material, sand grain size would be visually selected. Samples would be cored from various sections and depths in the pits. Once generally located, material would be visually selected for its use as cap, if said option is acceptable from regulatory and logistical purpose. However, if it is definitively determined through future investigations that there is no longer sufficient quantity of sand remaining in the pits, then an upland quarry site would be a reasonable secondary alternatives for cap material sand sources.

Environmental studies are recommended during the PED to determine whether recycled 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 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.

2.3 CMP CHANNEL CONFIGURATION ALTERNATIVES

Channel geometric configuration alternatives vary by width, depth, shoreline, and channel bottom treatment. The hydraulic characteristics for each alternative were evaluated in detail in the Hydrodynamic and Water Quality Modeling Efforts Technical Memorandum (Atkins, 2011a). All channel configuration alternatives presented follow the same centerline and have the same length. They are all rectangular channels except where they pass under bridges, where the channel shallows and widens to the span of the abutments. They all have similar sheet pile support, mangrove planting bed construction, erosion control measures and recreational features. In addition, all would have the same characteristics entering the San José Lagoon, at the confluecen of the San José Lagoon with the Juan mendez Creek, and under the western bridges.

San José Lagoon Entrance Channel: Since the San José Lagoon is shallower than the proposed depth of the alternative channels, each alternative utilizes a trapezoidal channel section with 5 to 1 side slopes that extends ~4,300 feet into San José Lagoon. The entrance channel's width would be the same as the main channel alternatives.

Confluence with the Juan Mendez Creek: The Quebrada 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 Creek. 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- to 1-foot earthen side slopes, rather than the steel sheet pile walls.

Western bridges channel: Similarly, the proposed channel alternatives transitions to wider and shallower channel configurations at the José Celso Barbosa Avenue Bridge, and from the Ponce de León Avenue Bridge to the channel terminus west of the Luis Muñoz Rivera Avenue Bridge (western bridges channels). The channel section under the Ponce de León Avenue Bridge, the Tren Urbano Guideway, and the Luis Muñoz Rivera Avenue Bridge (western bridges channels) widens to 115 feet with a depth of 6.5 feet, with riprapped side slopes and a paved channel bottom.

2.3.1 Channel Dimensions

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

2.3.1.1 Width

Greater than 200 feet wide: Mangrove restoration is an essential element of the CMP-ERP. The CMP-ERP 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 and there is a strong desire to maintain the overall aesthetics of the CMP, which includes wetland areas that have historically existed along the canal. Channel designs with smaller widths would allow for more mangrove restoration potential than those designs with greater widths.

Additionally, recreation is an important secondary element of the CMP-ERP, and is needed to maintain water dependent 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 for recreational (shallow draft and sailboats) and some commercial navigation, primarily small fishing vessels, travelling between SJB 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 to allow for safe two-way passage of vessels while also considering 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.

Another factor in restricting channel widths to those 75 feet or greater is the ability of the area to mimic natural conditions since 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, constructability and ability to mimic historic conditions.

2.3.1.2 Depths

Less than 10 feet deep: For channel depths, geotechnical issues and secondary impacts were primary considerations.[2] In regards 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.

[2] All elevations and depths referenced are relative to mean lower low water (mllw) at the NOAA tide station number 9755371 in the SJB, unless otherwise noted.

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.

Conclusion: As a result of these conditions, depths less than 10 feet were eliminated due to the likelihood that solid waste be carried downstream and into other aquatic habitat. Depths greater than 10 feet were also eliminated because these would likely require blasting, violating a primary project constraint.

2.3.2 Initial Array of Alternatives

After the bracketing analysis, five combinations of widths and depths were chosen for an Initial Array: 75 x 10, 100 x 10, 125 x 10, 150 x 10 and 200 x 10. The mangrove planting bed measure and all four non-structural measures were combined with each width and depth combination. Additionally, erosion control and recreational features were added to each alternative as appropriate. All measures contain riprap and a weir, and the 75 x 10 alternative contains an articulated concrete mat due to the higher velocities (see Table 2-5).

Table 2-5. Description of Channel Configuration Alternatives

Alternative	Description
75 ft wide by 10 ft deep Rectangular Paved	This alternative has a 75-ft-wide by 10-ft-deep rectangular cross section. The side walls are supported by steel sheet pile and the channel bottom is paved with an articulated concrete mat.
100 ft wide by 10 ft deep Rectangular	This alternative has a 100-ft-wide by 10-ft-deep rectangular cross section. The side walls are supported by steel sheet pile and the channel bottom is earthen.
125 ft wide by 10 ft deep Rectangular	This alternative has a 125-ft-wide by 10-ft-deep rectangular cross section. The side walls are supported by steel sheet pile and the channel bottom is earthen.
150 ft wide by 10 ft deep Rectangular	This alternative has a 150-ft-wide by 10-ft-deep rectangular cross section. The side walls are supported by steel sheet pile and the channel bottom is earthen.
200 ft wide by 10 ft deep Rectangular	This alternative has a 200-ft-wide by 10-ft-deep rectangular cross section. The side walls are supported by steel sheet pile and the channel bottom is earthen.

2.3.3 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 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 feet, 125 feet, 150 feet, and 200 feet would progressively result in additional, albeit marginal, benefits as a result of the increased water flows and reduced water residence times.

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 (10 feet). Velocities in 10-foot-deep channels would be slightly higher than those modeled 9-foot-deep channels (see Table 2-6).

Table 2-6. 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.

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 in Alternative 3 (125-x-10-foot channel), additional acquisitions and relocations become necessary. This would increase Project’s costs substantially, but moreover, the main dilemma with implementing one of the larger channel configurations would be acceptability. Many families have lived within the neighborhoods adjacent to the CMP for generations, and significant negotiation is necessary to implement even a smaller alternative plan. Implementation of a larger alternative could cause significant delays in the CMP-ERP and would likely be rejected by the local community.

Results: As a result of the larger channel alternative screening analysis, the 175- and 200-foot-wide channel alternatives were eliminated from further consideration due to costs and public acceptability. The 75-x-10, 100-x-10, and 125-x-10-foot channel alternatives were retained to carry forward into a Final Array.

2.3.4 Final Array of Alternative Plans

The Final Array of Alternative Plans consisted of the No-Action Alternative Plan, Alternative Plan 1 (75 x 10), Alternative Plan 2 (100 x 10), and Alternative Plan 3 (125 x 10). The following sections provide a more thorough description of each alternative plan.

All of these channel alternatives, except for the No Action Alternative, would entail a mangrove planting bed, and the same non-structural measures, recreational features, erosion control measures, a riprap and a weir. In addition, all would have the same dredged material disposal management.

All channel alternatives would include the construction of a weir(115 feet wide x 6.5 feet deep x 800 feet in length) at the western end of the Project Area. The estimated amount of material that would be dredged to build the weir is 46,866 cy. Equipment and materials would be staged on floating barges. A 2-acre upland staging area (Las Piedritas) east of the Martín Peña bridge would be used to temporarily stockpile and transfer the dredged material from collected solid waste excavated during the dredging process resulting from the construction of the weir. Solid waste and dredged sediment resulting from the weir's construction would be placed into trucks and hauled for disposal at the Humacao Regional Sanitary Landfill. 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 proposed under all Project Channel alternatives would be removed.

In addition, 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 is completed under any of the Project Channel alternatives.

Clearing and grubbing activities for all channnel alternatives would remove on average 12 inches from the Project Area within the CMP channel, and would 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 Regional Sanitary Landfill.

2.3.4.1 No Action Alternative

No further Federal actions would be implemented under the No Action Alternative. The lack of tidal flushing, degraded water quality, and increased potential for flooding would continue to affect the greater SJBE. The environmental conditions would continue to have socioeconomic impacts upon residents, recreational and charter anglers, , tourism, and land values within the communities and the entire region.

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. The overall ecological restoration benefits offered by the CMP-ERP would not be achieved. Moreover, as confirmed by the hydrodynamic and water quality model of the SJBE system, the No Action Alternative would lead to further environmental degradation of the entire SJBE (Atkins, 2011a).

2.3.4.2 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, with slight variations in channel width and depth at the four bridges in the western portion of the CMP, the Barbosa Bridge, and terminus of the Eastern CMP with the San José Lagoon (see Figure 2-6). 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% of the total material to be dredged from the CMP, and the dredged sediments would bulk up to 126% of their in situ volume.

The walls of the 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 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 CMP. The dimensions of the weir would replicate the cross sectional area of the rest of the channel configuration (75 feet 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 channel. The weir would be constructed with an articulated concrete bottom.

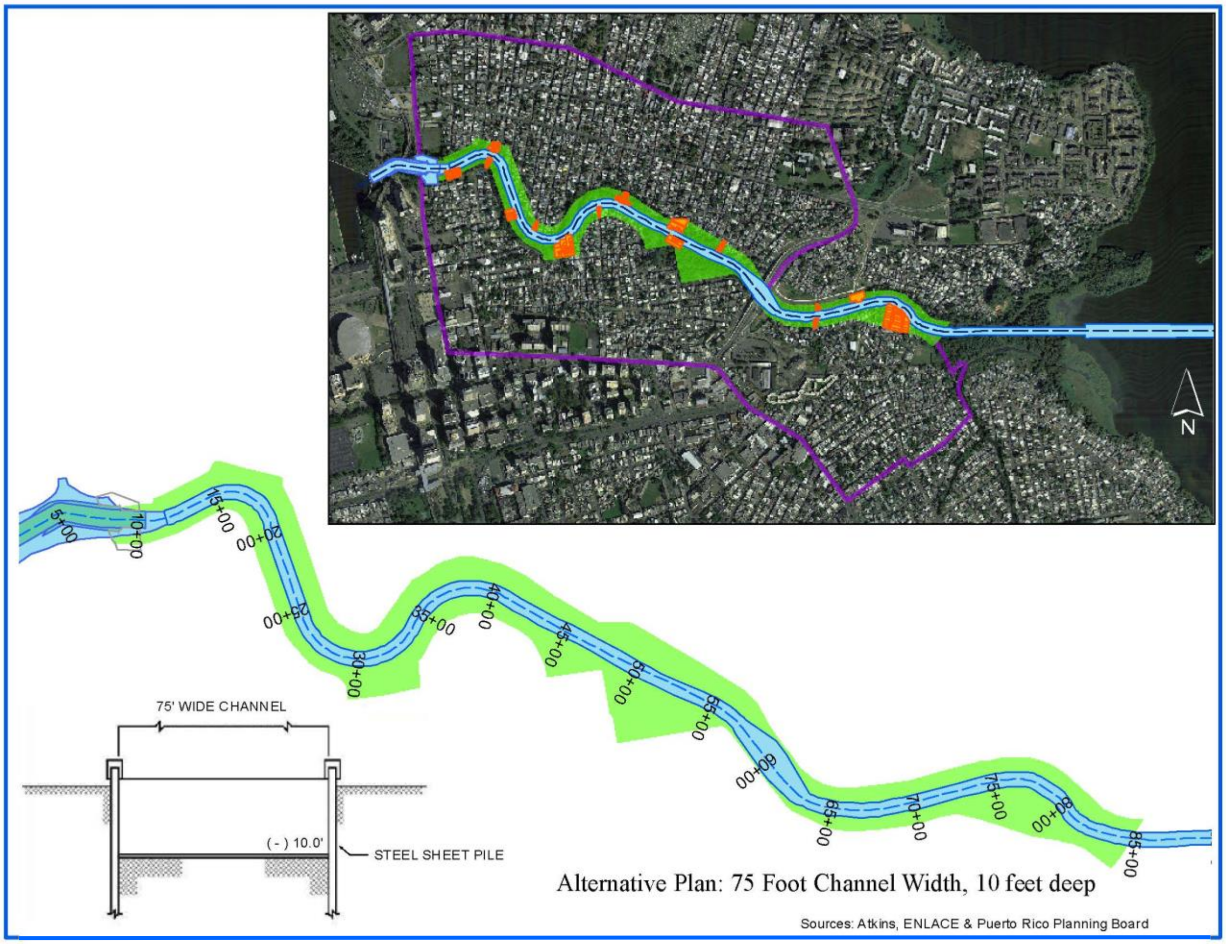


Figure 2-6. Alternative Plan 1 – 75-Foot Channel Width, 10-Foot Depth

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 CMP. 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. Riprap would be placed at the four bridges.

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 would be transported from the staging area to the Humacao Regional Landfill site, which is located approximately 32 miles from the CMP-ERP site. A 6-acre parcel at CDRC would be outfitted as the staging area, including a dock for loading/unloading the dredged material to be transported to the landfill.

After screening and removal of solid waste debris, the remaining sediments would be transported in barges to the San José Lagoon CAD pits. Approximately 574,200 cy of in situ sediments would be encapsulated in geotextile containers, disposed within the SJ1/SJ2 CAD sites up to −18-foot elevation and capped with the selected material up to −16 feet. Approximately 37,800 cy of in situ sediments would be used to complete the sheet pile construction and mangrove bed restoration (see Figure 2-5).

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 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 CMP's maritime terrestrial zone, 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: No non-structural measures were identified to restore circulation to San José Lagoon. Other measures included the acquisition of 393 residential structures and 394 relocations within the confines of the Federal project. Other measures outside of the Federal project to be implemented by the non-Federal sponsors are the enforcement of illegal dumping, storm-water and sewage improvements, and community education.

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

Like Alternative 1, total construction time for Alternative Plan 2 is approximately 27 months.

Channel: Alternative Plan 2 consists of dredging approximately 2.2 miles of the Eastern CMP to a width of 100 feet and a depth of 10 feet. As previously described, there would be slight variations in channel width and depth at the 4 bridges in its the western portion, the Barbosa Bridge, and terminus of the CMP with the San José Lagoon (see Figure 2-7).

The walls of the channel would consist of vertical concrete-capped steel sheet piles with hydrologic connections to the surrounding lands. The sill depth of the window would also be set at mean low water so that tidal exchanges are facilitated to the mangrove beds. Riprap would be placed at the four bridges.

Like Alterntaive 1, 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. Under this alternative, it is also estimated that the dredged solid waste debris would make up 10% of the total material to be dredged from the CMP, and the dredged sediments would bulk up to 126% of their in situ volume. Solid waste debris would also be transported by barge to the CDRC staging area for subsequent landfill disposal. Sediments would be transported by barge for disposal at the SJ1 and SJ2 CAD pits.

Figure 2-7. Alternative Plan 2 – 100-Foot Channel Width, 10-Foot Depth

Erosion Control: This alternative would also feature a weir at the western end of the Project Area for mitigating water flows into the adjacent waterways and to protect the structural integrity of the four bridges. The dimensions of the weir 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. Like Alternative 1, the weir would be constructed with an articulated concrete bottom, while the remainder of the Eastern CMP would be earthen bottom.

Disposal: This alternative would follow the same debris and dredged material plan from Alternative 1. Approximately 648,000 cy of in situ sediments would be placed in the SJ 1/2 CAD sites and approximately 37,800 cy of in situ sediments would be used to complete the sheet pile construction and mangrove bed restoration.

Mangrove Restoration: This alternative would also impact the same acreage of mangrove as the previous alternative. Restoration of the disturbed mangrove fringe would be accomplished following the same procedure described for the previous alternative. After dredging and construction of mangrove planting beds, the Eastern CMP channel would consist of 25.57 acres of open water and 34.48 acres of mangrove wetland.

Non-Structural Measures: These measures would be the same as for Alternative 1.

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

Total construction time for Alternative Plan 3 is also expected to take approximately 27 months, including mobilization, site preparation, construction, and demobilization.

Channel: Alternative Plan 3 consists of dredging approximately 2.2 miles of the Eastern CMP to a width of 125 feet and a depth of 10 feet, with slight variations in channel width and depth at the four bridges in its western portion, the Barbosa Bridge, and terminus of the channel with the San José Lagoon (see Figure 2-8). Similar to Alternatives 1 and 2, 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. Dredged solid waste debris would also make up 10% of the total material to be dredged from the CMP, and the dredged sediments would bulk up to 126% of their in situ volume. Like the previous alternatives, solid waste debris would be transported by barge to the CDRC staging area for subsequent landfill disposal. Sediments would also be transported by barge for disposal at the SJ1/2 CAD sites.

The walls of the channel would also be constructed with vertical concrete-capped steel sheet piles with hydrologic connections to the surrounding lands. Sill depth of the window would also be set at mean low water as well, so that tidal exchanges are facilitated to the mangrove beds.

Erosion Control: Like Alternatives 1 and 2, 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 Eastern CMP. It would share the same dimensions and features as the previous alternatives.

Disposal: This alternative would follow the same debris and dredged material plan from Alternatives 1 and 2. However, under this alternative, approximately 747,000 cy of in situ sediments would be placed in the SJ1/2 CAD sites.

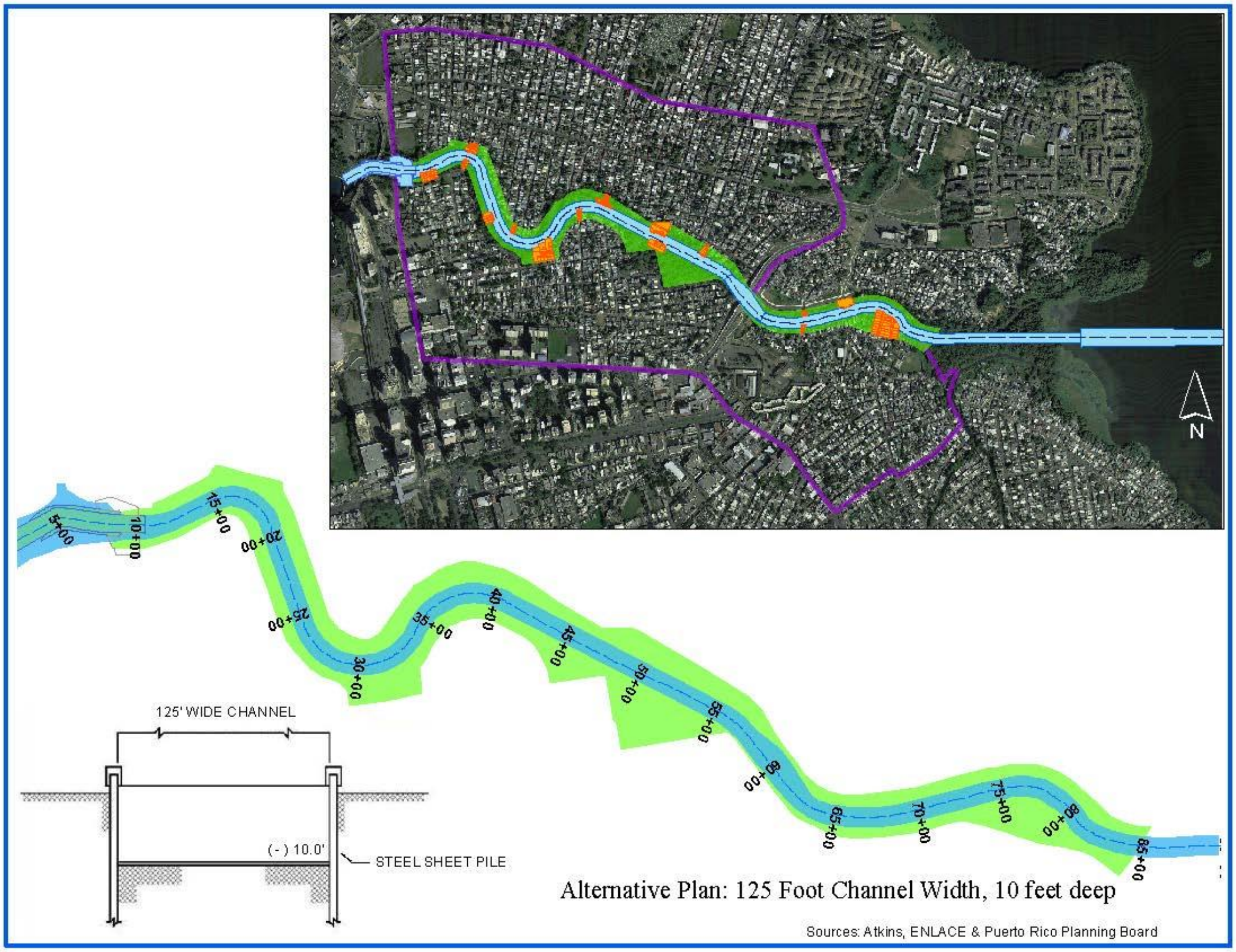


Figure 2-8. Alternative Plan 3 – 125-Foot Channel Width, 10-Foot Depth

Mangrove Restoration: This alternative would also impact the same acreage of mangrove as the previous alternatives. Restoration of the disturbed mangrove fringe would be accomplished following the same procedure described for the previous alternatives. After dredging and construction of mangrove planting beds, the Eastern CMP would consist of 30.97 acres of open water and 29.08 acres of mangrove wetland.

Non-Structural Measures: These measures would be the same as for Alternatives 1 and 2.

2.4 EVALUATION OF FINAL ARRAY OF ALTERNATIVE PLANS

The final array of alternatives were screened using: (1) an ecological uplift assessment for each alternative against the Planning Objectives presented in Section 1.3, (2) costs, and (3) Principles and Guidelines (P&G) Criteria (completeness, effectiveness, efficiency, and acceptability).

2.4.1 Benefit evaluation: Planning objectives

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 national ecosystem restoration (NER). Contributions to NER 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 non-monetary habitat units (HU).

In order to calculate HU, performance metrics were developed from project planning documents, and relationships and hypotheses developed in the Conceptual Ecological Model (CEM). The CEM displays relationships demonstrating that the planned CMP-ERP would result in expanded connectivity to habitat for fish and fisheries, improved tidal flow and circulation within the SJBE system, and improved water quality and conditions. These parameters were then associated with the appropriate attributes of the CMP-ERP's objectives: fish habitat, benthic habitat, and the mangrove root community (Atkins, 2015a). Results are summarized in Table 2-7.

Table 2-7. Summary of Net Average Annual Habitat Units for the Models

Project Condition	Planning Objective 1 Fish Habitat	Planning Objective 2 Benthic Index	Planning Objective 3 Mangrove Habitat	Total
No Action	0	0	0	0
75-foot-wide Alternative	5,050.93	294.54	787.69	6,133.16
100-foot-wide Alternative with weir	5,055.98	294.54	782.66	6,133.17
125-foot-wide Alternative with weir	5,061.27	294.54	777.37	6,133.17

Source: Atkins, 2015a.

Fish Habitat: Planning objective 1 aims to improve fish habitat in the SJBE system by increasing connectivity and tidal access to estuarine areas. Currently, fish within SJB cannot directly access the mangroves, seagrass meadows, and open water habitats of San José Lagoon, the Suárez Canal, Torrecillas Lagoon and Piñones Lagoon, just as fish within those waterbodies cannot directly access the habitats afforded by SJB. Due to the current condition of the CMP, there is essentially no tidal exchange between SJB and the San José Lagoon (i.e., the eastern and western sides of SJBE system) creating essentially two estuary systems connected independently to the ocean waters by inlets.

It is expected that the restoration of the CMP would benefit fisheries outside of these water bodies by allowing easier access to the variety of fish habitat (e.g., open water, seagrass meadows, hard bottom, mangrove fringes) found throughout the newly inter-connected waters of the entire SJBE system (Atkins, 2015a).

Benthic Habitat: The second objective is the restoration of 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.

Benthic habitat is evaluated using an index originally developed for the SJBEP to report on the status and trends of the health of the SJBE and its individual component water bodies. The Benthic Index (BI) 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 BI is designed to increase as beneficial factors increase (e.g., species richness, species evenness, and presence of pollution-sensitive taxa). Conversely, if species richness and/or evenness decline and the proportion of pollution-tolerant taxa increases, the BI would decline. An extensive database on benthic species composition by Rivera (2005) was used to produce BI scores throughout SJBE. In the original report (PBS&J, 2009) it was determined that BI scores in the SJBE were the lowest in the CMP 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 BI scores than water depth.

The HU 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).

Mangrove Root Community: Another Project's objective is to 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 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 Torrecillas 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. This relationship uses the connectivity of habitat described above for fish habitat.

2.4.2 National Ecosystem Restoration and Recommended Plan

The Final Array was further evaluated using the P&G Criteria: completeness, effectiveness, efficiency, and acceptability. Also, a Cost Effectiveness and Incremental Cost Analysis was performed. (See section 5.3 in the FR for a detailed description.)

Table 2-8 summarizes the results of each evaluation metric against each Alternative Plan and demonstrates that: (1) each alternative equally achieves Planning Objectives, and results in significant improvements to the natural and human communities in the region of the CMP and the

SJBE; (2) each action alternative is complete, effective, and acceptable and (3) Alternative Plans 1 and 3 are not cost effective (efficient), whereas Alternative Plan 2 is cost effective (efficient).

Table 2-8. Comparison of Alternative Plans

Evaluation Metric	No Action Alternative Plan	Alternative Plan 1 (75-x-10-ft Channel)	Alternative Plan 2 (100-x-10-ft Channel)	Alternative Plan 3 (125-x-10-ft 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	N/A	$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.

Results: Alternative Plan 2 has been selected as the NER and Recommended Plan for the CMP-ERP. The NER and Recommended Plan meets the projects objectives, is both cost effective and a best buy, and has been demonstrated to be more acceptable to state and local agencies as well as the public. The plan is also compatible with all applicable laws and policies.

Alternative Plan 2 implementation or construction is proposed or expected to last between October 2018 and December 2020. However, project construction may be sequenced in order to get some sites within the Project Area worked in advance.

3.0 AFFECTED ENVIRONMENT

3.1 CLIMATE

3.1.1 Temperature and Precipitation

The National Weather Service's Luis Muñoz Marín (LMM) International Airport automated weather station, collects data on rainfall and temperature that is representative of the Project Area's climatic conditions. It is located close to an elevation of 9 feet, at approximately 0.53 mile northeast of the San José Lagoon. The LMM Station reports an average annual precipitation of 56.35 inches. The lowest average monthly precipitation is reported in March, with 1.95 inches, while the highest average monthly precipitation is in November, with 6.35 inches of rain.

A recent study reported a positive trend of increasing annual rainfall for the San Juan Metropolitan Area (SJMA) between 1955 and 2009 (Méndez-Lázaro, Nieves-Santiago, and Miranda-Bermúdez, 2014). The winter months of January and February had an increase in monthly rainfall, although winter is normally a dry season in the Puerto Rico. Regarding dry days, an annual decreasing trend was found, also specifically in winter. Heavy rains were found to be more common in summer and fall in accordance with the hurricane season, whereas the most intense rainfall episodes tended to occur in spring.

The average annual temperature in the LMM International Airport automated weather station is approximately 27.3°C (81.1°F), the average low annual temperature is approximately 24.1°C (75.4°F), and the average high annual temperature is approximately 30.4°C (86.7°F). The coldest month of the year is January, with an average monthly temperature of 25.3°C (77.6°F), although both January and February have an average low monthly temperature of 22.2°C (72.0°F). The hottest month is August, with an average monthly temperature of 28.7°C (83.7°F), although both, August and September, have an average high monthly temperature of 31.8°C (89.2°F) (see Table 3-1).

Table 3-1. Summary of average annual and monthly temperature, rainfall and humidity for the LMM International Airport Automated Weather Station

NCDC 1981-2010	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average High (°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	86.7
Average Low (°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	75.4
Average Rain (inches)	3.76	2.39	1.95	4.68	5.90	4.41	5.07	5.46	5.77	5.59	6.35	5.02	56.3
Humidity	75	71.5	69	69	72	71	73	73.5	73	73.5	74.5	74.5	72.5

Source: National Climatic Data Center. (2011). Monthly Station Normals of Temperature, Precipitation, and Heating and Cooling Degree Days 1981--2010, Puerto Rico. National Oceanic and Atmospheric Administration.

Puerto Rico's temperature for 2050 is expected to increase 0.8°C (33.44°F) due to climate change (PRCCC, 2013). Puerto Rico is warming up and extreme heat events in San Juan are increasing in both intensity and frequency (Méndez-Lázaro, et al., 2015). Although there is a lot of uncertainty in the magnitude of precipitation changes in the Caribbean, current evidence suggests a decrease in annual precipitation for Puerto Rico (PRCCC, 2013). Extreme precipitation events are expected to occur more frequently, however, resulting in more rain falling in less time.

3.1.2 Wind Speed and Wind Direction

The prevailing or average wind direction in the Project Area is from the East (E) – Northeast (NE), with an average wind speed of 8.3 miles per hour (mph), based on the average annual wind direction and speed climatic data of San Juan (Atkins, 2012f) (see Table 3-2).

Table 3-2. Average monthly wind direction and speed (mph) in the San Juan Area

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Wind Direction	E	ENE	ENE	ENE	ENE	ESE	E	E	E	ESE	E	ENE	-
Wind Speed	8.3	8.7	9.1	8.8	8.3	8.9	9.6	8.7	7.5	6.6	7.4	8	8.3

Source: Atkins, 2012g.

3.2 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 part of the Island and sections of the southern coastal plains.

The coastal plain of the SJMA shows a surficial geology dominated by lagoon and estuarine environments, covered by fluvial and eolian deposits that have dictated the geomorphologic evolution of this region. 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.

The Project Area in the eastern half of the CMP consists of middle Tertiary limestone in sporadic outcrops, mostly forming prominent hills, locally known as "mogotes". On top of the limestone lies the upper Tertiary and Quaternary coastal, lagoon, fluvial and eolian sediments, mainly from the late Pleistocene and Holocene, which cover older deposits (Pease & Monroe, 1977). This area's geology is characterized by a middle Tertiary Aymamón limestone formation (Tay), composed of a light pale, very porous fossile ferous, massive to thick limestone beds (Alemán, 2010; Lugo et al., 2001). In the CMP, east of the José Celso Barbosa Bridge, limestone can be found at depths as shallow as 10.5 feet (Atkins, 2011f).

A few surficial karst features or outcrops still remain as "mogotes", two of which are found in the northeastern banks of the CMP, and in the western shore of the San José Lagoon, in the form of two small islands locally known as Guachinanga and Guachinanguita. Although the maximum exposed thickness for the Aymamón formation is mentioned by Pease and Monroe (1977) to be 32.8 feet, there are other older limestone formations below this unit, which control the structure of the regional area.

Overlying the limestone are late Tertiary and Pleistocene deposits. The late Tertiary deposits consist of older alluvial units (Qtt) composed of weathered clay, silt, and sandy sediments that include fragments of the Mucabarones sand and the relicts of the San Sebastian Formation from the Oligocene age. The thickness of this formation appears to be greater than 328 feet. Fragments from the older alluvial deposits can also be found. The Pleistocene deposits correspond to the alluvial fans deposits (Qf), which include reworked rocks and sediments from older formations formed of weathered clay, silt and sandy sediments. They consist of mottled red and light gray deposits and are the sediments forming the banks of the CMP and some of the submerged areas in the San José Lagoon.

Finally, swamp deposits and alluvium are the most recent deposits in the area. Swamp deposits (Qs) consist mostly of sandy muck, clayey sand, and peats in areas with very organic sediments associated with low energy estuary environments and mangrove areas. These deposits have been intensively and artificially filled within the CMP. The alluvium deposits (Qa) are made up of recent fluvial sands, clays and sandy clays. Thickness of this formation a few miles west of the CMP was reported to be 66 feet.

3.3 SOILS

The native soils close to the Project Area's water bodies belong to three main soil associations as described by the USDA Natural Resources Conservation Service (NRCS). Soils originally found close to the shores of the CMP corresponded to the Almirante-Vega Alta-Matanzas association. These have been described as formed by transported materials, deep, gently sloping to sloping, well drained on terraces and alluvial fans of the coastal plain (Boccheciamp, 1978).

Soils encountered during soils surveys conducted in the CMP were almost entirely organic silt and clay layered with peat. Minor amounts of silty sand were present near its western end. The soil materials were very soft, with very low bearing strength to depths of 25 to 30 feet or more beneath the channel centerline. Soils of the CMP are predominantly hard silts and clays at a depth of 10 to 15 feet below the existing bottom.

Today, most of the soils in the Eastern CMP have been severely altered and are mainly composed of artificial fill consisting of sand, limestone and volcanic rock. The superior soil layers in those areas once occupied by wetlands or open water, where substandard housing has been established, also include a combination of debris, rip-rap, rubble, household waste, trees and vegetation, discarded furniture, abandoned cars, metal and other waste, accounting for 10% or more of the soil composition (Atkins, 2011f). In some areas, the thickness of this material can exceed 10 feet below the surface. Most areas now covered by artificial fill are underlaid by swamp deposits.

In contrast, soils in the San José Lagoon are predominantly sands and have been excavated due to their value as fill. There are scattered patches of swamp deposits consisting of sandy muck and clayey sand generally underlaid by peat formed by mangrove swamps, such as those found along the northern, eastern and southeastern shores of the San José Lagoon (Boccheciamp, 1977; 1978).

Soils in the eastern shore of the San José Lagoon north of the Quebrada San Antón creek have been classified as Made land (Md). These have been altered by earthmoving operations during the past (Boccheciamp, 1977). Most of the sediments that were dredged from the Suárez Canal when it was deepened and widened during the 1960s were deposited in these areas. Vegetation, however, has reestablished itself in this location during the last three decades.

3.4 HYDROLOGY

The CMP connects the San Juan Bay (SJB) and the San José Lagoon across a 3.75-mile tidal channel (see Figure 1-1). Maximum elevations along the CMP's northern watershed are approximately 100 feet-MLLW, and street slopes are approximately of 4%. Elevations along the communities located south of the canal are gentler, with maximum elevations of approximately 33 feet-MLLW and street slopes averaging 1% (Atkins, 2013b).

Historically, the waterway of the CMP had an average width of at least 200 feet and a depth between 6 and 8 feet. It was used as an inland route to navigate the north coast of the Island within the Study Area. Today, the Eastern CMP has an approximate length of 1.89 miles, up to its outlet to the San José Lagoon. The widest, open water section of the Eastern CMP has approximately 131.2 feet, about 285.4 feet east of the Ponce de León Avenue running over the Martín Peña Bridge. Water depth in the Eastern CMP ranges from approximately 3.94 feet, about 328 feet west of the Barbosa Avenue Bridge, to basically none. The latter is located east of the Barbosa Avenue Bridge, where mangroves and other vegetation have grown over sediments, refuse and other debris deposited or used as fill material over the past decades (Webb and Gómez-Gómez, 1998).

The San José Lagoon is divided into two sections named Los Corozos Lagoon to the northwest and the San José Lagoon, to the southeast. These have a combined surface area of approximately 1,129 acres (SJBEP, 2000). For this Final EIS, both are referred to as the San José Lagoon. There is no direct connection between this lagoon and the ocean. Ocean waters have access to it across the Suárez Canal, which connects to La Torrecilla Lagoon. The connection provided through the Suarez Canal, however, is constricted in its middle section, where the Román Baldorioty de Castro Expressway Bridge crosses the canal. La Torrecilla Lagoon connects to the ocean through the Boca de Cangrejos outlet.

The San José Lagoon receives fresh water discharges and runoff from two major urbanized creeks: Juan Méndez, in its southwestern end, and San Antón, 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 LMM International Airport, exits into the northeastern corner of the lagoon. In addition, it receives significant fresh water inputs from two storm water pump stations that discharge into its northern shores. The first services the Villamar residential community and is operated by the Municipality of Carolina. The second, managed by the Puerto Rico Department of Natural and Environmental Resources (DNER), services a rather large area, and receives combined sewer overflows from the Luis Lloréns Torres public housing project, the Villa Palmeras community, and a section of the Román Baldorioty de Castro Expressway (Road PR-26) (Atkins, 2013b).

The natural average depth of the San José Lagoon was 6 feet, and it did not exceeded 8.2 feet (Ellis, 1976; Conde-Costas, 1987). The lagoon was dredged for sand and fill mining between the late-1950s and 1960s, altering about 17% of its bottom surface and, as a result, several artificial depressions or dredged pits are found today.

The dredged pit at the northwestern section of the San José Lagoon (i.e., Los Corozos Lagoon) is known to have an approximate depth of 17.5 feet. Other two dredged areas can be distinguished. 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 dredged pits, with depths varying from approximately 15 to 28.4 feet. 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 dredged pits; approximately 28.4 feet to 32 feet deep. It is worth noticing that, while the bottom of one of these pits was originally measured to be 32 feet deep, recent measurements show that this depth was reduced to 27 feet, and that at least three other of these pits have been partially filled since the last bathymetric survey in 1996 (see Figure 3-1).

The sedimentation rate analysis performed by Moffatt & Nichol Engineers in 2003 estimated an in-fill rate of 1.53 in/yr for the San José Lagoon, due to the low-energy waters and the dredged pits. While rates in other lagoons in the SJB system range from 0.09 in/yr to 0.24 in/yr. Within the CMP's outlet at San José Lagoon, the sedimentation rate was estimated at 6.7 ft/yr, which is due to sediment discharges from the Juan Méndez Creek.

The 2.3 mile long Suárez Canal, located southeast of Luis Muñoz Marín International Airport, connects the San José and La Torrecilla lagoons. It receives runoff from part of the airport and the Los Angeles development. La Torrecilla Lagoon, located east of the airport, discharges into the Atlantic Ocean through Boca de Cangrejos and receives runoff from the urban watershed of the Blasina Canal. La Torrecilla Lagoon actually connects to Piñones Lagoon through the Blasina Canal via the Piñones Channel, which is located 850 meters upstream of Blasina's mouth at La Torrecilla Lagoon.

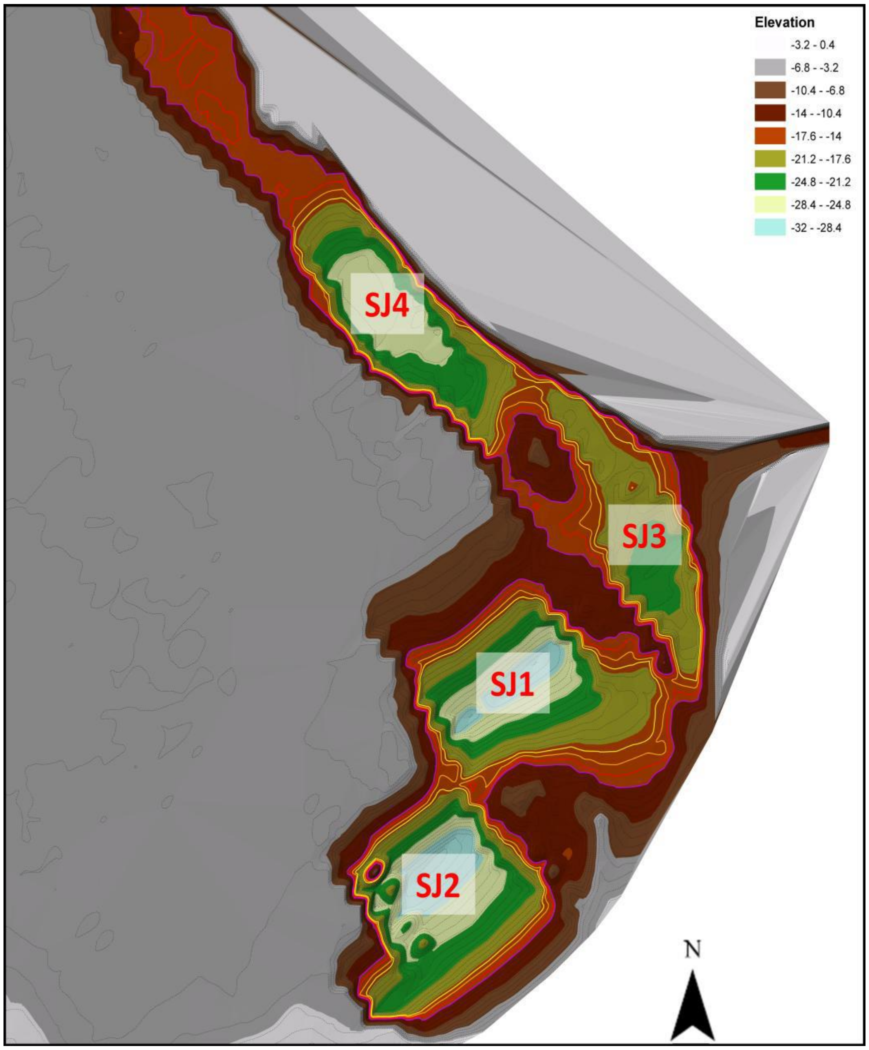


Figure 3-1. San José Lagoon Existing (1996) Pit Bathymetry (elevations in feet)

On the other hand, tides in the Study Area have a mean range of 1.10 feet and a diurnal range of 1.58 feet. The highest observed water level in this station was 2.785 feet Mean Lower Low Water (MLLW) in 1998, while the lowest was -1.085 feet.[3] 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 the surface areas of each waterbody. According to Webb and Gómez-Gómez (1998), tidal oscillations in the San José Lagoon, for example, are limited to about 1.97 inches. They also reported that it is common for river and storm-water discharges to dominate tidal flow patterns in the SJBE, especially in waterbodies such as the CMP and the San José Lagoon with restricted connections to the open ocean.

[3] The tidal station referenced for the CMP-ERP is the La Puntilla station, number 9755371. It is located across the San Juan Bay at the U.S. Coast Guard Station on La Puntilla, latitude 18° 27.5' N, longitude: 66° 6.9' W, NOAA Chart #25670.

At present, the CMP has no apparent ability to convey flows into and out of San José Lagoon, as it has been nearly completely blocked as a result of siltation, accumulation of household and construction debris, and the encroachment of housing and other structures. Due to the clogging of the CMP, there is little to no tidal exchange between the SJB (located to the west of the CMP) and the San José Lagoon (Bunch et al., 2000; Cerco et al., 2003; USACE, 2004). Under existing conditions, the average residence time of waters within San José Lagoon is estimated at 16.9 days.

3.4.1 Runoff & Floods

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

The existing storm sewer system was designed more than 35 years ago, and it most likely does not comply with current regulations and requirements (Atkins, 2013b). In addition, the storm sewer's hydraulic capacity has been compromised by an unknown amount of sanitary sewage that enters the combined system (Atkins, 2013b).

According to the NOAA Atlas 14, published in October 26, 2006, the rainfall depth for a 100-year event in the Study Area is 1.96 inches for a half hour period, and 11.43 inches for a 24-hour period.

Because drainage areas adjacent to the Eastern CMP are heavily urbanized, stormwater runoff tends to reach the Eastern CMP quickly and in large quantities. Time of concentration[4] along adjacent basins to the Eastern CMP varies from 10 to 45 minutes, while the curve number is 98[5] (Atkins, 2013b), which implies small drainage areas and mostly impermeable surface. This results in peak discharges along the drainage basins adjacent to the CMP that range from 92 cubic feet per second (ft^3/s) for a 2-year event, to 1,108 ft^3/s for a 100-year event. The total runoff volume to reach the Eastern CMP for a 24-hour and 0.5-inch rainfall event is estimated to be 897,000 ft^3 (Atkins, 2013b).

According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) a large portion of the CMP channel banks are located within a flood prone area with 100-year base flood elevation of 5.9 feet. The 100-year floodplain extends up to 1,150 feet south and up to 1,800 feet north from the channel. These base flood levels are influenced by the storm surges at

[4] The time of concentration is the time required for a drop of water falling on the most distant point of the watershed to influence discharge at the watershed exit.
[5] Curve Number represents the runoff potential within a watershed and is estimated based on soil type (hydrologic soil group), land use and Antecedent Moisture Condition (AMC).

the San José Lagoon and the SJB. Due to the CMP's lack of conveyance to manage stormwater discharges, the communities bordering it frequently suffer flooding events, not only under major rainfall (e.g., 100- or 50-year rainfall), but also from minor and more frequent rainfall (e.g., 2-, 5-, or 10-year rainfall).

On the other hand, it is expected that sea level rise (SLR) is going to impact drainage and flood levels in the Study Area. The lands adjoining the Eastern CMP and the San José Lagoon are leveled, and thus, their drainage capacity is limited. The effects of SLR would start to become more noticeable as outflows from the area's storm sewer system begin to be restricted and, eventually, overrun or permanently flooded by the progressively increasing levels of these two water bodies.

3.5 WATER AND SEDIMENT QUALITY

The Study Area's water quality has been significantly altered from its natural state. In places, the SJBE is hypereutrophic or overwhelmed with nutrients, has anoxic or oxygen-lacking bottom waters, its sediments contain heavy metals, trace elements, and organic compounds; and receives raw-sewage from combined storm sewer overflows and direct discharges from housing along parts of its perimeter (Kennedy et al., 1996; Webb, R.M.T. and Gómez-Gómez, 1998; SJBEP, 2000; PREQB, 2008). Pollutant loadings impacts from land use activities have been compounded by the modification of the estuary's hydraulic properties through the dredging and filling of most of its waterbodies.

3.5.1 Water Quality

Datasets collected by the SJBEP in 2008 and 2009 in three stations located within the CMP and the San José Lagoon show high nutrient levels, low concentrations of dissolved oxygen (DO), high turbidity, and high concentrations of fecal coliform (Atkins, 2011l).[6] 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

[6] The most appropriate dataset for assessing the current status of water quality is from the SJBEP, while the most appropriate dataset for assessing trends (if any) in water quality is from station 50049820 from the USGS. Other water quality sampling efforts present several limitations to be used in water quality status and trends determinations since these were collected for different purposes (i.e., calibration of water quality models, investigation of potential problems, etc.), and/or are only available for specific sites and time periods.

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 regards to its public health risks. Finding these significant levels of colonies confirms the presence of direct human waste pollution.

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 CMP water column. Water quality data from these stations are consistent with most of the other water quality sampling efforts conducted during the last decades in the CMP and the San José Lagoon, which reported seldom compliance with Federal and local water quality standards (SJBEP, 2000) (see Table 3-3). The source of these impairments can be related to reduced flushing, wastewater loads from direct and indirect untreated sewage discharges, urban storm runoff, subsurface seepage in areas littered with household waste, and direct household waste dumping (Webb and Gómez-Gómez, 1998).

Table 3-3. Percent of values that exceeded PREQB's standards or SJBEP proposed criteria in the CMP and San José Lagoon during the months of November 2009 to August 2010

Location	DO (mg / l)	Turbidity (NTU)	pH (SU)	Secchi Disk (Inches)	TKN (mg / l)	NOx (mg / l)	TP (mg / l)	Chl-a (µg / l)	BOD (mg / l)	Fecal Coliform Bacteria (# /100 ml)
CMP	100	20	0	7	75	0	0	25	25	100
LSJ 1	30	60	0	60	100	0	0	100	33	100
LSJ 2	30	30	0	80	100	0	0	66	33	100

Source: Atkins, 2011l.

CMP's waters seem to have a strong influence on the San José Lagoon's waters in terms of DO2. However, waters in the San José Lagoon can be just as likely, if not more prone than those from the CMP, to exceed proposed guidance criteria for turbidity, Total Kjeldahl Nitrogen and chlorophyll-a (Atkins, 2011l). Reduced tidal flushing in this lagoon is compounded by urban runoff and other wastewater loadings leading to limited light penetration and eutrophic conditions. Fecal coliform bacteria levels in the CMP, nevertheless, are still much higher than those values found in the San José Lagoon (Atkins, 2011l).

Reduced water circulation or exchange with ocean waters, in turn, may have exacerbated water column stratification in the San José Lagoon, where two well defined salinity layers exist. Although acceptable DO2 levels exist in areas that are, approximately, shallower than 4 feet or 6 feet, hypoxic to anoxic conditions are characteristic of those deeper below the pycnocline[7] (Atkins, 2011b). As a result, surface waters have a salinity of 5 to 18 parts per thousand (ppt), while waters with a

[7] Boundary or stratification layer that separates two liquid layers of different densities.

salinity of 18 to 30 ppt are found below this stratification layer (Atkins, 2011b). This has been determined to be a long-term condition due to the lack of water exchange within the San José Lagoon that significantly affects the number and diversity of fish and other aquatic resources, and that is worsen by the raw sewage and other polluted discharges still taking place.

Data from the SJBEP showed that for the period between 2008 and 2013, water quality had improved based on samples collected at the CMP station, although it was still deemed very poor (Bauzá-Ortega, 2013). Limited improvements could have been the result of a new sanitary sewer system that was built for a sector of the Cantera community during said period and that, until recently, used to discharge its untreated sewage directly into the eastern end of the CMP. This data, however, seem to indicate that a reduction in pollutant loads was not enough to offset a general trend towards poorer water quality in the San José Lagoon, overall (Bauzá-Ortega, 2013). This may be due to limited circulation or reduced water renewal in the San José Lagoon, a condition that has become worse as the Eastern CMP has become almost completely clogged since the late 1990s.

On the other hand, the USGS water quality station (500495280), located at the San José Lagoon near its confluence with the CMP, collects data from the 1970s, allowing to assess long-term water quality trends (Atkins, 2011l). Some of the water quality parameters (temperature, DO2, nitrogen, phosphorus) appear to be trending over time, while others are highly variable (specific conductance), as discussed below:

- Water temperatures at this location appear to be trending upwards. Perhaps due to issues related to climate change, but more likely due to localized factors such as the increasing isolation of waters in the San José Lagoon as the CMP has closed over time, and the heat island effects due to the surrounding and increasing urban landscape.
- Levels of DO2 in the San José Lagoon exhibit a pattern that appears to reflect both, an overlying trend of a reduction in the maximum levels recorded, as well as an increase in the minimum levels recorded, when comparing values from the late 1990s to present versus values in the 1970s and 1980s. These data are suggestive of a situation of reductions in levels of phytoplankton biomass in the San José Lagoon over time, as elevated levels of phytoplankton would be expected to bring about both DO2 higher high values (through elevated rates of photosynthesis) as well as lower low values (through greater respiration rates). A stabilization of these DO2 values over time suggests that at least this portion of San José Lagoon might be experiencing reduced levels of eutrophication, even if the average DO2 concentration has declined over time (Webb and Gómez-Gómez, 1998).
- There is some evidence of a potential downward trend in values of total nitrogen in San José Lagoon over the past few decades. There is also a very strong downward trend of total phosphorus concentrations at this site, perhaps reflecting improvements in wastewater treatment previously noted at various locations throughout the SJBE watershed (Webb and Gómez-Gómez, 1996 and 1998; Webb et al., 1998). In addition, household detergents have phase out the use of phosphates in recent years. As such, phosphorus inputs, even those coming from untreated wastewaters, could have also diminished, helping this downward trend in total phosphorous concentrations. Perhaps associated with declining levels of

phosphorus concentrations at this site, there is evidence of improved water clarity as well. This positive trend would be expected if phytoplankton biomass was at least partially limited by phosphorus availability, which has decreased at this same location. Unfortunately, there is not a long-term record of chlorophyll-a at this same location, so potential trends in phytoplankton levels are inferred from the reduction in phosphorus, the positive trend in water clarity, and the apparent pattern of more moderate levels of DO2 (lower highs and higher lows) at this site in western San José Lagoon.

- Specific conductance has been highly variable over time, and no clear pattern exists to suggest an overall monotonic trend. However, low values during the late 1990s and early 2000s appear to be lower than the lowest values recorded in the 1970s to 1980s possibly showing the isolation and reduced inflow of ocean waters due to the increasing constriction in the CMP.

Combined, these sources of information suggest that prior activities to ratchet back on point source discharges, discussed in Webb and Gómez-Gómez (1998), and the partial elimination of direct sewage discharges from the Cantera community into the Eastern CMP, have already brought about some improvements in certain water quality parameters for at least this portion of the San José Lagoon, momentarily. The ongoing and reduced ecological integrity of 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).

3.5.2 Sediment Composition and Quality

Sediments are materials carried and settled at the bottom of rivers, harbors, and lakes. Typical sediments are a mix of fine soil particles from runoff and wind erosion mixed with decomposing organic material. In urban and farming areas sediment may include manmade materials like petroleum products, pesticides, and metals. The typical sediment is a mixture of clay and silt that may contain traces of minerals, heavy metals (silver, arsenic, cadmium, chromium, copper, mercury, nickel, lead, zinc), pesticides, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and may have an hydrogen sulfide (H_2S) smell (or like rotten egg smell). In some cases, sediments may also have traces of petroleum products and ammonia.

Fill material within the CMP comprises a mix of sediment and solid waste. Solid waste is any discarded material, abandoned, inherently waste-like, and not excluded by law. It is estimated that solid waste would make up approximately 10% of the total material to be dredged in the CMP. In some sites, the thickness of this material exceeds 10 feet below the surface (Atkins, 2011l).

The estimated in-fill rate within the CMP's outlet at San José Lagoon is 6.7 ft/yr. Discharges in the lower reaches of the Juan Méndez Creek are the primary contributor of sediments deposited within the channel's outlet. On the other hand, the sedimentation rate for the entire CMP was estimated to be 1.5 inches per year. Illegal filling and combined sewer discharges have been identified as the primary sources for sedimentation in the entire CMP.

The sediments that characterize the first 10 feet of the CMP eastern half are generally formed of soft to very soft black organic mud, clays and silts with some lenses of sandy material. The sediments that characterize the first 40 feet of 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 swamp and alluvium appear to be most unconsolidated deposits in this region of the Eastern CMP channel. Gravels, cobbles and boulders may be present east of the Barbosa Avenue Bridge (Atkins, 2011l).

At one sediment core analyzed in the northwestern section of the San José Lagoon (i.e., Los Corozos Lagoon), superficial sediments 0 to 10.2 inches were found to be dark green, organic-rich, mud with abundant shell fragments, and made up of 1% gravel, 4% sand, 59% silt and 36% clay, by weight percent (Webb, R.M.T. and Gómez-Gómez, 1998). Superficial sediments have been described at another core studied in the San José Lagoon as being poorly consolidated, dark grey organic rich mud with abundant shell fragments. Their grain has been found to be 10% gravel, 12% sand, 38% silt, and 40% clay by weight percent (Webb, R.M.T. and Gómez-Gómez, 1998). These have also been reported as being generally made up of 32% sand, 48% silt and 20% clay. Sediments with the highest sand (48%) and lowest clay (11%) content have been found closer to the outlet of the CMP, while those with the highest silt content are closest to the Suárez Canal outlet (Negrón-González, 1988).

Sediment quality tests are generally useful to characterized overall environmental trends within a waterbody. When undisturbed, bottom sediments cores can provide a sequence of those water quality and aquatic biota conditions present during different time frames. Sediments sampled over the years in the CMP and the San José Lagoon can be characterized as severely degraded, being generally anoxic, with more than normal high organic content due in part to wastewater loads and reduced tidal flushing, as evidenced by previous environmental documents related to the SJBE (eg. EA, EIS, survey reports, and management plans). These conditions are more severe in the CMP and in the artificial dredged pits found in the San José Lagoon (Atkins, 2011b).

The artificial dredge pits and the lack of overall water conveyance in the San José Lagoon are two factors that may have acted as a sediment trap, explaining in part the average total organic carbon (TOC) concentrations sampled. The hydrologic characteristics leading to the high TOC values registered could have been compounded even further by the wastewater loads discharges affecting the CMP and the San José Lagoon. Even if this is the case, it is important to clarify that coastal sediments experiencing no anthropogenic inputs are substantially loaded by organic compounds due to natural processes common to coastal areas in Puerto Rico, namely organic production by mangroves and plankton in coastal lagoons (Otero & Meléndez, 2011).

Pérez-Villalona et al. (2015) recently reported that nutrient loadings in the SJL are at the hypereutrophic level, with the relative high-water residence time potentially fueling nutrient recycling. High rates of sediment respiration and the consequent high ammonium fluxes result in high rates of sediment N recycling. The high rates of release of ammonium help support the high water column ammonium concentrations observed in this lagoon. The relatively invariable high water temperature and restricted circulation, in addition, promotes high respiration rates from efficient particulate trapping, thus exacerbating the sediment oxygen deficit. The persistent smell of sulfide emitted from sediments during coring of sediments at the SJL suggests that sulfate reduction may result in an underestimation of the metabolism by the O_2 fluxes, but also suggest potential poisoning of nitrifying microbes (Pérez-Villalona et al., 2015).

Webb and Gómez-Gómez (1998) measured the concentrations of seven trace metals in sediment core samples in the SJBE representing deposition time periods of 1925–1949, 1950–1974, and 1975–1995. Analytical results revealed that only mercury and lead concentrations had increased in the most recent sediment strata (1975–1995), compared to levels in older sediment strata. The highest concentrations of mercury and lead were homogeneous throughout the SJBE, lead levels varied with location from an average of 370 μg/g, in samples collected from San José Lagoon, to concentrations ranging from 20 to 50 μg/g, in samples collected at the remaining sampling stations.

Polychlorinated Biphenyls (PCBs), DDT, lead and mercury, were the most abundant contaminants encountered in bottom sediments in the SBJE (SJBEP, 2000). Bis (2-ethylhexyl phtahalate), a common plasticizing agent, was encountered in CMP's bottom sediments in concentrations up to 20,000 micrograms per kilogram (mg/kg). Webb and Gómez-Gómez (1998) found significant levels of PCBs, organochlorine pesticides and semi-volatile organic compounds. They found a total PCB concentration in excess of 450 μg/g in the CMP and the San José Lagoon.

More recently, CMP elutriate samples statistics for the measurable organic and inorganic parameters and corresponding water quality criteria listed by PREQB (2010), and NOAA's SQuiRTs screening levels were analyzed (Atkins, 2013d). [8] For several of the parameters, sediment screening levels were not available (e.g., TOC, ammonia, aroclor 120, chromium trivalent, chromium VI, cyanide, TPH DRO, TPH ORO, TPH GRO, and total solids). For those with screening levels, concern in the CMP was identified for anthracene, antimony, arsenic, copper, dieldrin, lead, mercury, selenium, silver and zinc; as well as other pesticides and various other compounds. The percent of exceedances of the minimum screening criteria were calculated in order to identify if any of the 10 sediment sampling sites collected in a previous Water and Sediment Quality Study conducted by Atkins (2011l) had consistently elevated concentrations.[9] For each site, the number of parameters with values exceeding, the TEL or AET was calculated and a percent exceedance was determined and results are presented in Tables 3-4, 3-5, and 3-6.

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[8] NOAA's Office of Response and Restoration Screening Quick Reference Tables (SQuiRTs) provide multiple screening levels or concentrations for estuarine and marine sediments that are used for comparative purposes.
[9] In 2010, Atkins prepared a report reviewing existing water quality data from 2009 and 2010 and comparing the sediment and porewater data from 2000 and 2004 to SQuiRTs.

Table 3-4. USACE CMP Sediment Concentrations (Bailey et al., 2002) with corresponding NOAA SQuiRTs levels

Parameter	CMP Sediment Concentration (mg/kg)	NOAA-SQuiRTs Values (mg/kg)							
		T20	TEL	ERL	T50	PEL	ERM	AET	EcoTox EqP
2-Methylnaphthalene	0.0863	0.021	0.0202	0.07	0.128	0.201	0.67	0.064	
Acenapththylene	<.032	0.014	0.00587	0.044	0.14	0.128	0.64	0.071	
A-Endosulfan	<0.00265							0.0029	
Aldrin	0.00523							0.0095	
Anthracene	0.0703	0.034	0.0469	0.0853	0.29	0.245	1.1	0.28	
Antimony Total	1.17	0.63			2.4			9.3	
Arsenic	12.4	7.4	7.24	8.2	20	41.6	70	35	
B-Endosulfan	<.0053							0.014	
Benzo(a) Pyrene	0.3	0.069	0.0888	0.43	0.52	0.763	1.6	1.1	
Benzo(a)anthracene	0.302	0.061	0.0748	0.261	0.466	0.693	1.6	0.96	
Benzo(b)fluoranthene	0.548	0.13			1.107			1.8	
Benzo(g,h,i) Perylene	0.595	0.067			0.497			0.67	
Benzo(k) Fluoranthene	0.173	0.07			0.537			1.8	
Cadmium	9.59	0.38	0.68	1.2	1.4	4.21	9.6	3	
Chlordane	<.0265		0.0026	0.0005		0.00479	0.006	0.0028	
Chromium	47.5	49	52.3	81	141	160	370	62	
Chrysene	0.463	0.082	0.108	0.384	0.65	0.846	2.8	0.95	
Copper	181	32	18.7	34	94	108	270	390	
Dibenz(a,h)Anthracene	0.299	0.019	0.00622	0.0634	0.113	0.135	0.26	0.13	
Dieldrin	0.0203	0.00083	0.00072	0.00002	0.0029	0.0043	0.008	0.0019	
Fluoranthene	0.941	0.119	0.113	0.6	1.034	1.494	5.1	1.3	
Fluorene	0.0703	0.019	0.0212	0.019	0.114	0.144	0.54	0.12	0.54
Heptachlor	<.00265							0.0003	
Heptachlor Epoxide	<.00265	0.0006				0.00274			
Indeno(1,2,3-c,d) Pyrene	0.509	0.068			0.488			0.6	
Lead Total	281	30	30.24	46.7	94	112	218	400	
Mercury	2.44	0.14	0.13	0.15	0.48	0.7	0.71	0.41	
Methoxychlor	<.0265							0.019	
Naphthalene	0.0554	0.03	0.0346	0.16	0.217	0.397	2.1	0.23	0.48
Nickel	32.3	15	15.9	20.9	47	42.8	51.6	110	
Phenanthrene	0.158	0.068	0.0867	0.24	0.455	0.544	1.5	0.66	
PPDDD	0.013		0.00122	0.002		0.0781	0.02	0.016	
PPDDE	0.0379		0.00207	0.0022		0.374	0.027	0.009	
PPDDT	0.0237		0.00119	0.001		0.00477	0.007	0.012	
Pyrene	1.08	0.125	0.153	0.665	0.932	1.398	2.6	2.4	
Selenium	1							1	
Silver	3.4	0.23	0.73	1	1.1	1.77	3.7	3.1	
Sulfide	696							4.5	
Toxaphene	<.0265		0.0001					0.028	
Zinc	1050	94	124	150	245	271	410	410	

Source: Atkins, 2013. Note: Cells highlighted in yellow denote exceedances of various criteria. Cells with light shading denote instances where minimum detection limit is higher than the screening criteria.

Table 3-5. CMP sediment sample statistics for the measurable organic and inorganic parameters and corresponding NOAA-SQuiRTs values

Parameter	MDL (mg/kg)	Statistics (mg/kg)			NOAA-SQuiRTs Values (mg/kg)						
		n	Average	Maximum	T20	TEL	ERL	T50	PEL	ERM	AET
TOC	0.5	10	35.8	62.7							
Ammonia	6	10	73.2	19							
Antimony Total	0.45	10	0.5	0.5	0.63			2.4			9.3
Aroclor 1260	0.02	10	0.02	0.0							
Arsenic Total	0.25	10	6.6	14.6	7.4	7.24	8.2	20	41.6	70	35
Beryllium Total	0.01	10	0.01	0.01							
Cadmium Total	0.05	10	0.7	1.3	0.38	0.68	1.2	1.4	4.21	9.6	3
Chromium- Total	2.5	10	24.0	51.4	49	52.3	81	141	160	370	62
Chromium-trivalent	0.1	10	24.0	51.4							
Chromium VI	1	10	1.0	1.0							
Copper Total	1	10	45.7	105	32	18.7	34	94	108	270	390
Cyanide Total	0.3	10	0.3	0.5							
Lead Total	1.6	10	68.0	155	30	30.24	46.7	94	112	218	400
Mercury Total	0.02	10	0.5	1.1	0.14	0.13	0.15	0.48	0.7	0.71	0.41
Nickel Total	0.4	10	7.8	13	15	15.9	20.9	47	42.8	51.6	110
Selenium Total	0.5	10	1.04	2.3							1
Silver total	0.1	10	1.5	2.4	0.23	0.73	1	1.1	1.77	3.7	3.1
TPH DRO	4	10	320	652							
TPH GRO	.015	10	0.1	0.7							
TPH ORO	4	10	2287	4502							
Zinc total	0.25	10	230	678	94	124	150	245	271	410	410
Thallium Total	0.5	10	0.7	1.3							
Sulfide	0.2	10	573	1240							4.5
Di-n-butyl phthalate	.005	10	0.1	0.6							0.058
Total Solids %	0.01	10	0.01	0.01							

Source: Atkins, 2013.

Note: Yellow highlighted cells indicate screening values that were exceeded by the maximum value reported.

Table 3-6. Canal Elutriate Assessment (ATKINS, 2015c)

Boring	CMP '02 results[2]	CMP-01	CMP-03	CMP-05	CMP-06	CMP-07*	CMP-09	CMP-12	CMP-15	CMP-17	CMP-18	Statistics					Sediment Toxicity Threshold	LDR 40 CFR 268	Regional Screening Levels under CERCLA
Contaminant[1]	Elutriate (mg/L)	Elutriate (mg/L)	Elutriate (mg/L)	Elutriate (mg/L)	Elutriate (mg/L)	Elutriate (mg/L)	Elutriate (mg/L)	Elutriate (mg/L)	Elutriate (mg/L)	Elutriate (mg/L)	Elutriate (mg/L)	n	Average	Range Low	Range Hi	Estimated TCLP (value/20)	(mg/l unless otherwise noted)	(mg/kg unless noted as "mg/l TCLP")	SSL protect-tive of Ground-water
TOC	4.5	16.0	10.2	8.3	12.2	3.8	11.0	13.8	17.7	7.4	15.5	10.0	11.6	3.8	17.7	0.885	NA	NA	
Ammonia		5.2	15.5	2.7	9.3	1.3	4.1	24.3	27.2	7.8	0.6	10.0	9.8	0.6	27.2	1.36	--	--	--
Antimony Total	0.012	0.006	0.003	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	2.000	0.004	0.003	0.006	0.000275	1.15	1.15 mg/l TCLP	0.0352
Aroclor 1260		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0	ND	0.00	0.00	0	10 mg/kg	10	0.0273
Arsenic Total	0.031	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0	BDL	0.00	0.00	0	5	5.0 mg/l TCLP	0.00151
Beryllium		BDL	BDL	BDL	BDL	0.0002	BDL	BDL	BDL	BDL	BDL	1	0.00	0.00	0.00	0	1.22	1.22 mg/l TCLP	--
Cadmium Total	<0.0002	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0	BDL	0.00	0.00	0	1	0.11 mg/l TCLP	0.0693 (water)
Chromium	<0.0010	0.0045	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1	0.00	0.00	0.00	0	5	0.60 mg/l TCLP	1.8E+05 (water)
Chromium $^{+3}$	<0.0010	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0	BDL	0.00	0.00	0	--	--	*4040000*
Chromium $^{+6}$		BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0	BDL	0.00	0.00	0	5	0.60 mg/l TCLP	0.000667
Copper Total	<0.001	BDL	BDL	0.096	0.073	BDL	BDL	0.087	0.082	BDL	0.003	5.000	0.068	0.003	0.096	0.00479	--	--	*2.8*
Cyanide Total		0.0020	0.0019	0.0020	0.0027	0.0015	0.0018	0.0023	0.0014	0.0024	0.0008	10	0.00	0.00	0.00	0.000135	590 mg/kg	590	0.00148
Lead	0.004	BDL	0.0032	BDL	BDL	BDL	0.0246	0.0227	BDL	0.0047	0.0061	5	0.01	0.00	0.02	0.00123	5	0.75 mg/l TCLP	--
Mercury	<0.00010	0.0002	BDL	0.0002	0.0003	BDL	0.0002	0.0002	BDL	0.0002	BDL	6	0.00	0.00	0.00	0.000015	0.2	0.2 mg/l TCLP	0.00327
Total Metals	--	--	--	--	--	--	--	--	--	--	--						NA	NA	N/A
Nickel Total	0.005	BDL	BDL	0.0134	BDL	BDL	BDL	BDL	BDL	0.0052	BDL	2	0.01	0.01	0.01	0.00067	11	11 mg/l TCLP	--

Table 3-6, cont'd

Boring	CMP '02 results[2]	CMP-01	CMP-03	CMP-05	CMP-06	CMP-07*	CMP-09	CMP-12	CMP-15	CMP-17	CMP-18	Statistics					Sediment Toxicity Threshold	LDR 40 CFR 268	Regional Screening Levels under CERCLA
Contaminant[1]	**Elutriate (mg/L)**	**Elutriate (mg/L)**	**Elutriate (mg/L)**	**Elutriate (mg/L)**	**Elutriate (mg/L)**	**Elutriate (mg/L)**	**Elutriate (mg/L)**	**Elutriate (mg/L)**	**Elutriate (mg/L)**	**Elutriate (mg/L)**	**Elutriate (mg/L)**	**n**	**Average**	**Range Low**	**Range Hi**	**Estimated TCLP (value/20)**	**(mg/l unless otherwise noted)**	**(mg/kg unless noted as "mg/l TCLP")**	**SSL protect-tive of Ground-water**
Selenium	0.101	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0	BDL	0.00	0.00	0	1	5.7 mg/l TCLP	0.0519
Silver total	<0.002	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0	BDL	0.00	0.00	0	5	0.14 mg/l TCLP	0.0799
TPH DRO		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0	ND	0.00	0.00	0	NA	NA	239
TPH GRO		0.517	ND	0.02	0.119	ND	ND	ND	ND	ND	ND	3	0.22	0.02	0.52	0.02585	NA	NA	0.88
TPH ORO		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0	ND	0.00	0.00	0	NA	NA	0.145
Zinc Total	0.042	0.011	0.006	0.132	BDL	0.005	0.088	BDL	BDL	0.072	0.016	7.000	0.047	0.005	0.132	0.0066	4.3	4.3 mg/l TCLP	37
Thallium	<0.002	BDL	ND	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0	BDL	0.00	0.00	0	0.2	0.20 mg/l TCLP	0.00142
Sulfide	<1.0	--	--	--	--	--	--	--	--	--	--	0	N/A	0.00	0.00	0	NA	NA	--
Di-n-butyl phthalate		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0	ND	0.00	0.00	0	28 mg/kg	28	--
Di(2-ethylhexyl) phthalate		ND	ND	ND	ND	ND	0.0268	ND	ND	ND	ND	1	0.03	0.03	0.03	0.00134	28 mg/kg	28 mg/kg	--
Total Solids **%**		--	--	--	--	--	--	--	--	--	--	0	N/A	0.00	0.00	0	NA	NA	NA

BDL: Below Detection Limit; ND: Not Detected; -- Data not available; NA: Not Applicable
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.
Red values indicate exceedance in the allowed maximum concentration established by PRWQSR.
Red values in the TCLP Statistical Column indicate exceedance in the Toxicity Characteristic Threshold Value.

Indicates non-CERCLA contaminant.

Indicates Specific CERCLA contaminant.

Channel and lagoon sediment results from the 2011 monitoring event were compared to the toxicity characteristic values of hazardous waste and their disposal, including those for groundwater protection. These and other analytical methods used suggested that hazardous concentrations of lead may be present in the Eastern CMP sediments. [10]

3.5.2.1 Sediment quality and fish and blue crab tissue contamination

Analysis of seven trace metals in tissues of blue crab, mojarra fish and false mussel in the San José Lagoon indicated moderately elevated levels of mercury (Pérez et al. 1999; Rodríguez Sierra & Jiménez, 2002). However, mercury concentrations in some samples approached or exceeded the Food and Drug Administration's (FDA) action level for human consumption of 1 μg/g in edible fishes. Similarly, lead concentrations were moderately high with some samples exceeding FDA action level of 0.5 μg/g. Sampling locations showing action-level exceedances appeared to correspond to areas with high potential for receiving human derived pollution.

Acevedo-Figueroa et al. (2006) examined trace metals in San José Lagoon and found concentrations of mercury, lead and zinc above the effective range median (ERM) level that predict toxic effects to aquatic organisms.[11] These authors calculated the metal to aluminum enrichment factor for these and other metals to determine if the source of the pollutants was anthropogenic. They found evidence of anthropogenic pollutant loads for some of the San José Lagoon sampling sites. Data analyzed within that report also showed evidence of contamination of sediments within the San José Lagoon.

In 2011, Otero and Meléndez published a report commissioned by the SJBEP to assess sediment, fish and blue crab tissue contaminants within the estuary system as the basis for the development of a long-term environmental indicator program. Contaminant concentrations in bottom-sediment samples were compared against the Threshold Effects Level (TEL) and the Probable Effects Level (PEL) for marine sediments.[12] The concentrations of trace metals in sediments at the stations sampled that coincide with those of previous studies were compared to qualitatively evaluate if

[10] 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 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 hazardous concentrations of lead may be present in the canal sediments.

[11] The ERM level is the sediment quality guideline that represents the concentration above which adverse effects frequently occur to aquatic organisms.

[12] The TEL represents an estimate of the concentration below which adverse effects only rarely occur in biota. The PEL is an estimate of the concentration above which adverse effects frequently occur in biota.

changes in those stations had occurred. They concluded that increments in trace metals had occurred in the sampling station in the eastern outlet of the CMP, towards the San José Lagoon (7MPSJ). With the exception of mercury in the station found southeast in the San José Lagoon (17SJ), all other stations in this lagoon and the CMP showed an increase for this parameter from previous levels. Concentrations for the remaining trace metals had not changed or were lower at those remaining stations in the San José Lagoon and that immediately west of the eastern half of the CMP (Otero & Meléndez, 2011).

This research also found that except for bis (2-ethylhexyl phthalate), organic analytes were not detected in sediment samples. Bis was found at concentrations of 1,510 and 333 µg/kg in station 6MP and 17SJ, respectively, at the CMP and the San José Lagoon. The concentration at station 6MP falls midway between the TEL and PEL for this compound. None of the targeted organic analytes, including PAHs, chlordanes and DDTs, exceeded their respective PEL values indicating that detrimental effects to biota are not probable. In addition, PCB data obtained from this report suggested that concentrations in sediments have not reached levels of contamination likely to cause widespread detrimental effects (Otero & Meléndez, 2011). This study also compared the concentrations of contaminants of concern sampled in fish and crab-tissue against USEPA default Screening Values (SV). The SV for each chemical contaminant is defined as the concentration of the chemical in fish and shellfish tissue that is of potential public health concern (USEPA, 2004).

Arsenic, copper, selenium, zinc and mercury were detected in fish tissue in those sampling stations at the mid-section of the CMP (6MP-A and 6MP-B) (i.e., Acuaexpreso Ferry Terminal), the area next to the outlet of the CMP to the San José Lagoon (7MPSJ), the northwest section of the San José Lagoon (i.e., Los Corozos Lagoon) (8SJ-C), and the area in the San José Lagoon next to the outlet of the Suárez Canal (10-CS). Antimony, lead, and thalium were detected in samples at station 6MP-A. Cadmium was not detected in the fish tissues analyzed. Arsenic exceeded the USEPA Cancer Risk 10^{-4} level at station 6MP. Overall, these results suggest low accumulation of the target trace metals in fish tissue sampled at the CMP and the San José Lagoon stations (Otero & Meléndez, 2011).

Pesticides found by Otero and Meléndez (2011) in fish tissue samples in the CMP and the San José Lagoon were mostly DDT and its degradation products, as well as chlordane related products. Chlordane, endrin aldehyde, lindane and total PCBs, based on aroclor equivalents, were found in the easternmost station of the San José Lagoon (10CS) and in the station found in the middle of the CMP (6MP-B). Chlordane was detected in fish tissue at concentrations approaching the USEPA screening value for subsistence fishers (14 µg/kg) at stations 10 CS (13.80 µg/kg) and 6MP (12.20 µg/kg). Total PCBs were also found in fish tissue samples at the station located in the western part of the San José Lagoon, next to the CMP's outlet, at concentrations (92.2 µg/kg) exceeding the USEPA screening value for recreational fishers (20 µg/kg). PAHs were not detected in fish tissue (see Table 3-7).

Table 3-7. Concentrations of contaminants of concern sampled in fish tissue from selected sampling stations at the CMP and the San José Lagoon

METAL	Sampling Stations and Concentrations (in milligrams per kilogram (wet weight))				
	6MP-A	6MP-B *	7MPSJ	8SJC	10-CS
Antimony	0.012J	<0.0042	<0.0039	<0.0044	<0.0043
Arsenic	0.21	0.47	0.19	0.25	0.19
Copper	0.26J	0.26J	0.26J	0.25J	0.24J
Lead	0.012J	<0.011	<0.0096	<0.011	<0.011
Selenium	0.30	0.26	0.32	0.31	0.31
Thallium	0.018J	<0.011	<0.0099	<0.011	<0.011
Zinc	9.5	9.3	13.6	13.4	11.4
Mercury	0.024	0.023	0.014J	0.028	0.017J

Source: Otero & Meléndez, 2011. Notes: <= Concentration below the method detection limit. J: Estimated value for the analyte is below the Laboratory Reporting Limit but above the method detection limit. *Field duplicate of Sample 6MP-A.

Similar to fish tissue, Otero & Meléndez (2011) detected arsenic, copper, selenium, zinc and mercury in blue crab tissue collected at all stations in the CMP and the San José Lagoon. Silver was also detected in all crab tissue samples in contrast with fish tissue. The concentration of arsenic exceeded the USEPA Cancer Risk 10^{-4} level in all stations. Content of arsenic in blue crabs and fish tissue correlated significantly, suggesting that environmental variation in the SJBE influence the arsenic content in these species. DDTs and Alpha-BHC were the only pesticides residue detected in crab tissue at the San José Lagoon.

3.6 AIR QUALITY

Currently, no monitored counties outside the continental United States, including the Municipality of San Juan, violate the proposed eight hour ozone National Ambient Air Quality Standards NAAQS[13]. The major producers of air emissions in the Municipality of San Juan are highway and off-

[13] The Clean Air Act (CAA) regulates air emissions from area, stationary, and mobile sources. The CAA requires the USEPA to establish National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment. The CAA establishes two types of NAAQS. Primary standards, define the maximum levels of air quality considered necessary, with an adequate margin of safety, to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards define the maximum levels of air quality considered necessary to protect public welfare, including the protection against decreased visibility, and damage to animals, crops, vegetation, and buildings. Air quality is generally considered acceptable if pollutant levels are less than or equal to these established standards on a continuing basis.
The USEPA has set NAAQS for seven principal pollutants, called "criteria" pollutants. They are carbon monoxide (CO), nitrogen dioxide (NO2), ozone (O3), lead (Pb), inhalable particulate matter (PM) with an aerodynamic diameter less than or equal to a nominal 10 microns (PM10), fine particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 microns (PM2.5), and sulfur dioxide (SO2). The CAA also requires the USEPA to assign a designation to each area regarding compliance with the NAAQS results for the ambient air quality monitoring data in that area. The USEPA categorizes the level of compliance or noncompliance with each criteria pollutant as follows: Attainment: area currently meets NAAQs; Maintenance: area currently meets the NAAQs, but has previously been out of compliance and Nonattainment: area currently does not meet the NAAQs.

highway vehicles, marine vessels, airplane exhaust fumes, and those emissions produced by the Puerto Rico Electric Power Authority's (PREPA) Puerto Nuevo Power Plant Station. Area sources contribute to PM, VOC and SO_2 emissions. A summary of 2002 emissions for the Municipality of San Juan, the most recent data available from the USEPA database (USEPA, 2011a) is presented in Table 3-8. The Municipality of San Juan is in attainment or unclassifiable with all the NAAQs (Atkins, 2012f).

Table 3-8. Summary of 2002 Air Emissions Inventory for the Municipality of San Juan (tons per year)

Source Category	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC
Area	246	497	222	63	1,351	1,885
Highway Vehicles	49,051	4,244	118	84	219	4,467
Off-Highway Vehicles	35,660	2,864	307	295	322	3,083
Aircraft	376	4	7.6	5	0.4	15
Marine Vessels	821	4,324	136	133	648	59
Total	86,154	11,933	790	580	2,540	9,509

Source: USEPA, 2011.

Hydrogen sulfide traces have been reported during field studies for this Final EIS, as well as by community residents living close to the Eastern CMP (Atkins, 2012f). Hydrogen sulfide, which is a colorless gas, with an unpleasant or offensive, rotten-egg odor at low concentrations, besides occurring naturally in certain instances, is also a product of the decomposition of sulfur- containing matter in oxygen deprived environments, such as those found in many wetlands. The specific gravity of hydrogen sulfide makes it heavier than air, so it remains in the environment for longer periods of time and affects smaller stature populations with more ease, such as children. The gas can remain in the environment for about 18 hours (USEPA, 2003 as cited in Atkins 2012g). Hydrogen sulfide rapidly oxidizes and dissolves in water to form sulfurous and sulfuric acids, potentially contributing to the production of acid rain.

Hydrogen sulfide can be toxic at low concentrations when inhaled, in addition to causing strong irritation when in contact with the eyes and mucous membranes. Exposure at low concentrations may cause headache, conjunctivitis, sleeplessness, and pain in the eyes. Among the biggest chronic exposure effects is difficulty breathing, in particular vulnerable populations such as asthmatics, and other negative effects to the respiratory system. Other potential effects are lethargy, lack of coordination, headaches, loss of short-term memory and motor dysfunction due to an affected nervous system (ATSDR, 2006).

Hydrogen sulfide in the Eastern CMP ambient air may be a cause of concern, since significant concentrations have been found within some of the sediments samples. 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 (RfC) is 0.002mg/mg^3 or 0.001 ppm (USEPA, 2003 as cited in Atkins 2012g). This is the reference value used for chronic exposure among children. 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 RfC levels acceptable for inhalation of the contaminant in a chronic exposure situation.

The USEPA has not established a NAAQS for hydrogen sulfide. However, the American Conference on Governmental Industrial Hygienists (ACGIH), which is responsible for the determination of Threshold Limit Values (TLVs), has set the TLV for hydrogen sulfide at 10 ppm. TLVs are doses that, based on available data, have no evident harm to most workers who are exposed based on a conventional 8-hour workday and 40-hour workweek. This time-weighted average allows for a Short-Term Exposure Limit of up to 15 ppm for a period less than 15 minutes.

The U.S. Occupational Safety and Health Administration (OSHA) have established permissible concentrations of hydrogen sulfide. These include an acceptable ceiling concentration of 20 ppm based on an 8-hour work shift and an acceptable maximum peak of 50 ppm. Thus, an employee's exposure to hydrogen sulfide may not exceed 20 ppm at any time during an 8-hour shift, except once for a 10-minute period, during which the concentration may be as high as 50 ppm.

3.7 NOISE

The Study Area is found within a densely populated region with residential, recreational, commercial and industrial elements. In the Project Area, vehicular traffic, commerce and industry all contribute to background noise. A heavy rail train and two four-lane highways are found in or close to the western half of the CMP. A four-lane avenue cuts through the middle of the eastern half of the CMP. Further, the Project Area lies under one of the principal approach vectors for all aircrafts landing at the LMM International Airport.

A study conducted in 2004, averaged L_{eq} and L_{10} noise values over a 24-hour period based on data from 14 noise stations in San Juan (Alicea-Pou et al., 2004).[14] According to the Puerto Rico Environmental Quality Board Regulation No. 8019, L_{10} noise levels should not exceed 50–75 decibels (dB), depending on whether it occurs in residential, commercial, industrial, or quiet areas. This study indicated that values of nearly 68 dB are exceeded 10% of the time.

[14] The Commonwealth of Puerto Rico Noise Contamination Control Regulation, No. 8019 of 2011, establishes that no person shall deliver or allow the emission of any sound, which when crossing the site sound originator property boundary, exceeds the parameters in dB (A) established for each of the designated zones. Commonly used noise measures include the L_{eq}, or equivalent level, which is a measure of the central tendency of the noise over time, and the L_{10}, which is the noise value, exceeded 10% of the time. L_{10} is typically used for road traffic noise because it corresponds well with close proximity to busy roads as well as more rural situations.

Noise levels measured in four of the Eastern CMP communities as part of a 2003 traffic study ranged from 76.3dB (night time) to 80.4 dB (daytime). These values indicate relatively high ambient noise levels (CMA, 2003) (see Table 3-9).

Table 3-9. Sound levels in communities in or adjacent to Eastern CMP

WARD	DAYTIME SOUND LEVEL DB(A)	NIGHTIME SOUND LEVEL DB(A)
Las Monjas, Bo. Obrero Marina	79.6	75.7
Buena Vista Hato Rey and Buena Vista Santurce	79.8	75.9
Israel y Bitumul	80.2	76.3
Cantera	80.4	76.5

Source: CMA, 2003.

3.8 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, household waste, Construction and Demolition (C&D) debris, and other materials, which would require further testing 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 multiplefamily 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.

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.

3.8.1 Hazardous Waste

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 U.S.C.1344) and 103 of the Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972 (33 U.S.C. 1413).

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 (NPL). 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 (MPRSA) of 1972 (33 U.S.C. 1413) is not a hazardous waste." 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.

As part of the CMP-ERP studies, an Initial Assessment (IA) was performed to identify indicators of potential HTRW or waste issues (Atkins, 2014b). This report was conducted in conformance with the scope and limitations of the American Society of Testing and Materials (ASTM) Practice E1527-05, and in accordance with ER 1165-2-132. Environmental issues within the ASTM standard are referred to as "Recognized Environmental Conditions" (RECs) in connection with the Study Area. The term RECs, as defined in ASTM E1527-05, refers to the presence or likely presence of any *hazardous substances or petroleum products* on a *property* under conditions that indicate an existing release, a past release, or a *material threat* of a release of any *hazardous substances or petroleum products* into structures on the *property* or into the ground, ground water, or surface water of the *property*. The term includes *hazardous substances or petroleum products* even under conditions in compliance with laws.

The IA performed for the Study Area to identify potential HTRW problems and to provide recommendations relied on existing information, observations made trough database research, site visits, aerial photographs and the review of available historical documentation (Atkins, 2014b). The site description for this HTRW IA is divided into two areas: Project area and Study area.

Standard Environmental Record Sources: The following Federal and Commonwealth's regulatory database reports were reviewed:

- Federal National Priority List (NPL);
- Federal Comprehensive Environmental Response Compensation and Liability Information System (CERCLIS) Database;
- Federal Resource Conservation and Recovery Act (RCRA) Corrective Actions List (CORRACT);
- Federal RCRA Treatment, Storage, or Disposal List (RCRA-TSD);
- Federal RCRA Generators List (RCRA-G);
- Federal Emergency Response Notification System (ERNS) list;
- State-equivalent CERCLIS/State Hazardous Waste Sites (SHWS);
- State Underground Leaking Storage Tank List (LUST);
- State Voluntary Cleanup Sites (VCS);
- Other ascertainable records such as RCRA non-generators, which do not presently generate hazardous waste.

A total of seven records were identified within the Study Area with the various regulatory agency database searches and none were found for the Project Area. The seven database records are associated with the following six facilities or locations in the Study Area.

- Two CERCLIS sites: R. Maldonado Pesticide Warehouse: 0.54 mile south-southeast from CMP; and American International Plaza: ±0.68 mile west-southwest from CMP;
- One LUST site: Citibank N.A. - Hato Rey: ±0.68 mile west-southwest from CMP.
- Two underground storage tank (UST) facilities: Rod-Rodder Services, Inc.: ±0.38 mile south-southeast from CMP; and Rosa Elena Jiménez (residential): ±0.49 mile south from CMP.
- Two RCRA Nongenerator sites: Texaco PR Inc.: ±0.37 mile south from CMP; and Rod-Rodder Services, Inc.: ±0.38 mile south-southeast from CMP.

Site Reconnaissance: Several site visits were performed to document conditions within the CMP. Based on the Project Area's land use history and transformation, and its current conditions, there are essentially two types of solid waste found within the material in the Project Channel: Household Waste (HW) and Construction and Demolition (C&D) materials. In addition, is expected that most of the sediment is found in the lower layer in the bottom and center of the channel and that most of the solid waste is on the banks of the former channel.

Within the Project Area, the potential of hazardous substances appears to be minimal. This assessment has revealed no evidence of RECs in connection with the Project Area, except for the following, including their associated potential environmental impacts in the Project Area (see Table 3-10).

Table 3-10. RECs and Associated Potential Environmental Impact to the Project Area

RECOGNIZED ENVIRONMENTAL CONDITION(REC)	POTENTIAL ENVIRONMENTAL IMPACT
Unidentified solid waste disposal adjacent and within the CMP	Low
White goods and automobile parts disposed adjacent to CMP	Low to Moderate
Presence of pesticide warehouse within 0.54 miles of CMP Project Area	Moderate
Maritime transportation traffic on western portion of the CMP	Low
± 92 potential unmapped listings, based on type of record	Low

User Provided Information: A review of previous reports and studies conducted on nearby areas for other USACE-sanctioned projects that required dredging and material disposal did not find cause of concern for HTRW, even though elevated levels of contaminants were found from water samples.

A Preliminary Site Characterization of the CMP prepared by Roy F. Weston, Inc. for the USACE in 1997 states that:

> *Solid waste disposal represents the most significant problem related to the canal. Local dumping of household waste and construction and demolition debris has resulted in terraces restricting the canal channel and allowing further development of the area. The management of these solid wastes would be subject to RCRA Subtitle C or Subtitle D regulation, depending on the types of waste encountered.*

The report further states that waste accumulation within the CMP consists of two types: 1) primary waste disposal points and 2) transport of waste by tidal currents and the subsequent deposition due to sinking or accumulation. The first type generally contains large volumes of household items, wood debris, concrete, white goods, furniture, engine parts, and rubbish and are mostly associated with local dwellings or easy point of access. The second type consists mostly of plastic garbage bags containing household refuse or discarded items with a lesser buoyancy than water, such as furniture, refrigerators, and bottles.

Chemical analysis and geotechnical testing was done from sediment and water samples collected from the CMP (10 samples), adjacent lands (5 samples), and the San José Lagoon (5 samples). The tests revealed elevated concentrations of mercury and lead, as well as lesser concentrations of other compounds. Several wastewater and stormwater outfalls were observed across the sampling site. Contaminant levels were similar across the CMP and the San José Lagoon.

The CMP Environmental Site Assessment report prepared by ECG, Inc. for the USACE in 1998 also echoes many of the findings in the 1997 Preliminary Site Characterization. Chemical analysis was performed on 10 soil samples and 10 water samples from the CMP. The Report states the following regarding its findings on the CMP:

> *Although unsightly and highly unsanitary, solid waste material within the organic rich clay layer is non-hazardous. Upland disposal should not pose a threat to environmental integrity or human health and safety.*

The report also deemed the waste layer and surrounding area as non-hazardous, based on its thorough soil and groundwater sampling and analysis. Regarding water and sediment quality, the chemical analysis revealed that, besides barium, no other contaminant form the sample reached detection levels. Also, no leachable contaminants were found in the CMP. Waste found in the CMP is classified as household waste, solid waste, and construction debris. Examples include wood debris, household trash, locally used needles, concrete debris, metal debris, and tires, among others.

The CMP Draft Phase 1 Environmental Site Assessment prepared by CMA Architects and Engineers, LLP for the PRHTA in 2002, sheds further light on the matter. Major findings from the report include:

- The main sources of pollution in the CMP are the accumulation of filling material and debris for residential construction purposes and untreated wastewater discharges at the site;
- Filling material and debris used for residential construction purposes may lead to the presence of asbestos containing materials and lead-based paint, the sedimentation of heavy metals and other chemicals into the channel sludge at the bottom;
- The severity of the water quality in the CMP is mainly due to low levels of dissolved oxygen and the presence of organic pollutants; and
- Several illegal dumping sites were found around the CMP.

Besides the findings presented on these reports, studies conducted on nearby areas for other USACE-sanctioned projects that required dredging and material disposal did not find cause of concern for HTRW, even though elevated levels of contaminants were found from water samples. The 1984 Survey Report for the Puerto Nuevo River Flood Control Project states that elevated levels of contaminants were found in the waters of the CMP-ERP. Solid waste and sediments were was also found at the site. However, these were not deemed hazardous and would be disposed at the ocean in the USEPA-approved ocean disposal site north of San Juan, pursuant to Section 103 of the CWA.

In section III.A.5 of the 1983 Agua-Guagua EIS (known today as AcuaExpreso) it is stated that the Western CMP has been plagued by water quality problems, mostly due to the construction of structures over the water, untreated wastewater 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 stated 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.

Results: Based on the Project Area's condition there is no evidence of RECs in connection with the CMP. Possible exceptions to the aforementioned statement are the nondescript solid waste content (e.g., substances remaining within bottles), discarded appliances, and equipment that are evident at the ground surface. Although there is evidence of historical REC supporting either past or ongoing contamination to the Study Area (in accordance with ASTM E1527-05), the potential for HTRWs within the CMP Project Area appears to be minimal. The solid waste found within the Study Area may include C&D and HW materials, and whether they contain Actionable Hazardous Substances (Section 7.2.1.2 of the Feasibility Report) will be determined in accordance with a sampling plan to be agreed by the parties.

3.9 HABITATS

The SJBE natural landscape and that of its surroundings has been significantly altered; first, by agriculture and cattle ranching, and later, by urban encroachment. A significant part of its vegetated wetlands, open waters, and benthic communities, have been either dredged, drained or filled, severely limiting or hampering tidal influence and water exchange, all of which have been further compounded by raw sewage and other pollutant discharges. Its habitats functions and values, even though degraded, are still considered very important for fish and wildlife resources, when compared to other areas in Puerto Rico.

The Study Area habitats are very diverse, exemplified by 26 land cover classes based on climate, geology, topography, hydrology and land use history. These include, among others, sandy, gravy, and rocky shorelines, mangroves and herbaceous non-saline wetlands, moist alluvial, riparian, calcareous or non-calcareous shrublands and woodlands, as well as young to mature secondary evergreen and semi-deciduous forests (Gould et al., 2007).

Some of these habitats, such as mangroves, have been included within some of the 51 palustrine, estuarine or marine wetlands and deepwater habitats that have been classified in the Study Area by the US Fish and Wildlife Service (USFWS), or the 15 benthic habitat types identified by the NOAA

(Kendall et al., 2001; Cowardin, et al., 1979).[15] Coral communities and seagrass beds, for example, are two of the benthic habitat types that have been classified in the Study Area by the USFWS and NOAA (see Figure 3-2).

Those habitats in the Project Area that are expected to experience the most notable or significant effects from the proposed CMP-ERP are the ones described in detail in this Final EIS in order to simplify and facilitate their understanding. Overall, these can be classified into two broad categories: surface habitats and submerged habitats. Mangroves have been included in both categories, although differencing for its corresponding surface and submerged zones.

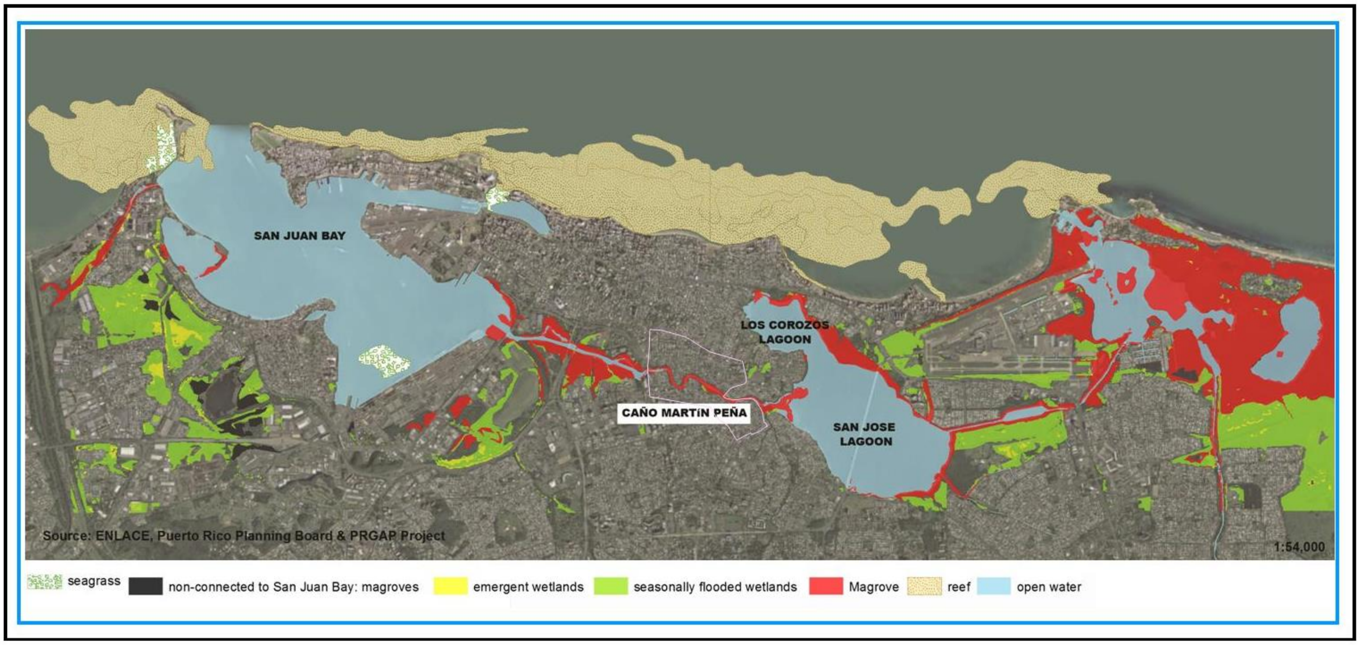


Figure 3-2. Habitats in the Study Area

3.9.1 Surface Habitats

Surface habitats have been generally classified as part of the subtropical moist forest life zone, the most extensive of the six life zones found in Puerto Rico, based on the Holdridge's model (Ewel, J.J. & Whitmore, J. L., 1973). [16] Miller and Lugo described the vegetation of this life zone as one characterized by trees up to 66 feet tall, with rounded crowns, where many of the woody species are deciduous during the dry season, and epiphytes are common but seldom completely cover

[15] NOAA's National Ocean Service acquired aerial photographs for the nearshore waters of Puerto Rico and the U.S. Virgin Islands in 1999. These images were used to create maps of the region's coral reefs, seagrass beds, mangrove forests, and other important marine habitats. Mapped areas encompass the insular shelf between the shoreline and shelf edge except where turbidity prevented visualization of the bottom. Twenty-one distinct benthic habitat types within eight zones were mapped directly into a geographic information system (GIS) using visual interpretation of orthorectified aerial photographs.

[16] The Holdridge's classification system uses a combination of parameters such as latitudinal region, altitudinal belt, humidity province, mean annual precipitation and mean annual biotemperature to characterize forests.

branches and trunks (Miller, G.L., and A.E. Lugo, 2009). Uplands and wetlands are two basic surface habitats in the Project Area that can be distinguished based on substrate water saturation, soil parental origin and forest succesional stage.

3.9.1.1 Uplands

3.9.1.1.1 Karst forest

This habitat is found in the upland portion of the two limestone outcrops, locally known as Guachinanga and Guachinanguita islets, found close to the western shore of the San José Lagoon. Karst forest is the smallest of all surface habitats in the Project Area.

The karst forest found in Guachinangua Islet exhibits most of the physical features, from top to bottom, of a haystack hill or "mogote". Miller and Lugo (2009) has described the vegetation at the ridgetop of "mogotes" as being of a small height and diameter, where it is rocky, with little soil but a fair amount of accumulated dry organic matter on the top layer, and where plants express morphological features typical of warmer and dryer conditions, such as having small, hard (i.e., sclerophyllous) leaves, many of which are spiny or with dense pubescence (i.e., "hairy"). Forest vegetation at the base of a "mogote" is much taller, with larger diameter trees having larger, less thick leaves, not sclerophyllic, where soil is deeper and moister.

Seventy nine (79) plant species have been identified in upland areas within Guachinanga, of which 65 are native, 13 exotic and 1 endemic. Some of the native vegetation at the top and slopes of Guachinanga include trees such as the pigeon plum (*Coccoloba diversifolia*), gumbo limbo (*Bursera simaruba*), white bully (*Sideroxylon salicifolium*), *Calophyllum brasiliense*, and leadwood (*Krugiodendron ferreum*). At the base of Guachinanga, other native species include the white cedar (*Tabebuia heterophylla*), the bayrum tree (*Pimenta racemosa*), as well as the exotic mango tree (*Mangifera indica*), the tamarind (*Tamarindus indica*) and the Spanish lime (*Melicoccus bijugatus*); the latest three are indicative of human activities in the past (INCICO y Corporación Proyecto Península de Cantera, 2009).

In Guachinanguita, 4 species of upland plants have been documented, 3 of which are native and 1 is exotic. These include *Bunchosia glandulosa*, the pigeon plum (*Coccoloba diversifolia*) and the bay-leaved caper (*Cynophalla flexuosa*) (INCICO y Corporación Proyecto Península de Cantera, 2009).

3.9.1.1.2 Young secondary forest

The dominant vegetation in this habitat are exotic species that have been either planted (e.g., fruit and ornamentals) or established by natural dispersion on moist soils that are mostly made up of fill material deposited during the past decades. In the Project Area, this habitat is found on uplands, in the "backyards" of some of the substandard dwellings built in the historic footprint of the Eastern CMP's open waters and wetlands, and at the CDRC staging area.

Some of the exotic tree species found in this habitat along the Eastern CMP include the Spanish lime (*Melicoccus bijugatus*), the monkey pod (*Pithecellobium dulce*), the Indian almond (*Terminalia catappa*), the coconut palm tree (*Cocos nucifera*), *Peltophorum pterocarpum*, and royal poinciana (*Delonix regia*). Native trees include the Puerto Rico royal palm (*Roystonea borinquena*), *Calophyllum brasiliense*, and the gregorywood (*Bucida buceras*) (Atkins, 2011c).

The young secondary forest at the CDRC staging area is dominated by an almost pure stand of the exotic tall albizia (*Albizia procera*) (Atkins, 2011c).

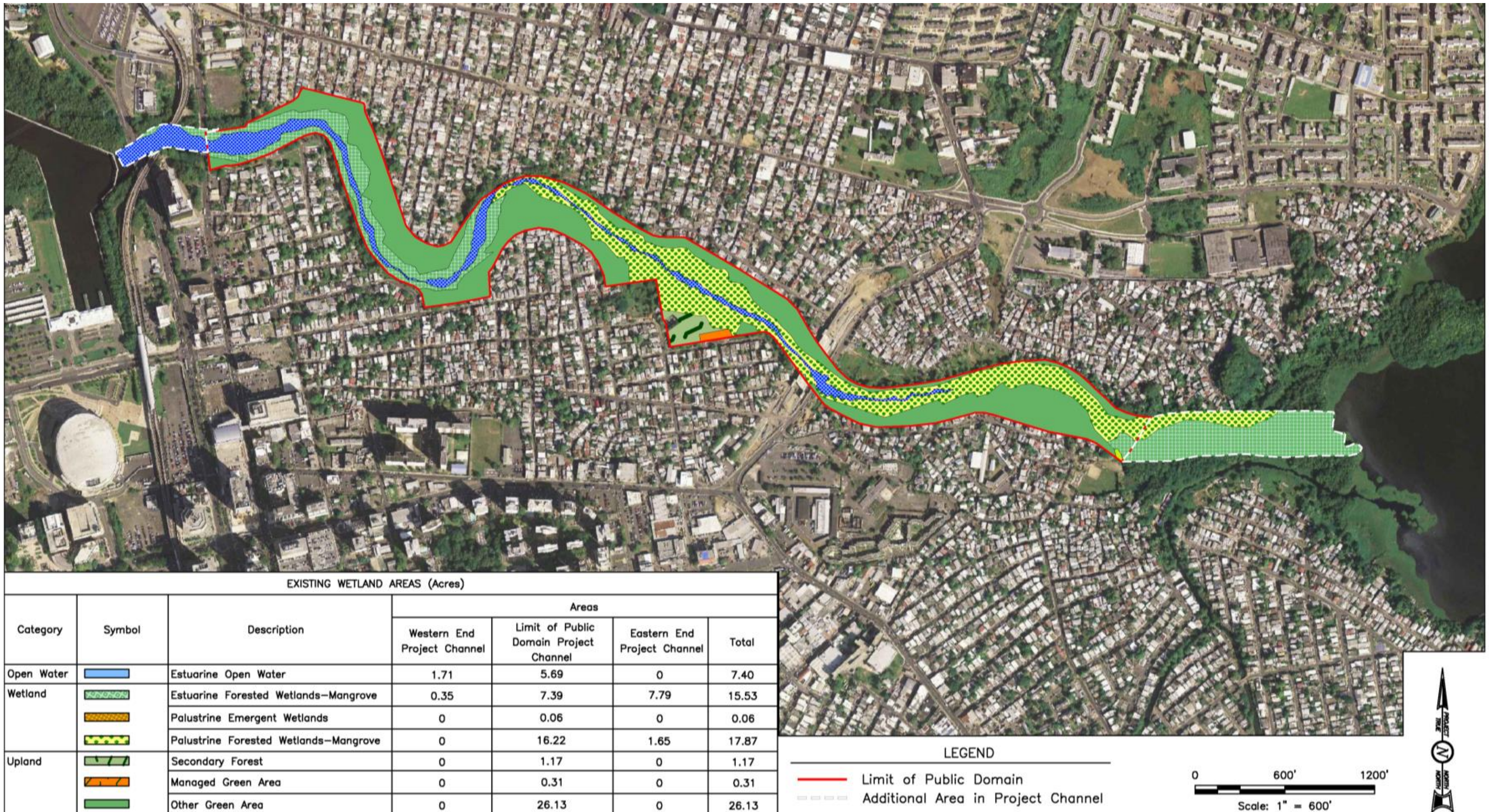
3.9.1.2 Wetlands

Within the Eastern CMP, there are 7.39 acres of estuarine forested wetlands, 16.22 acres of palustrine forested/emergent wetlands, and 0.06 acre of palustrine emergent wetlands. The ensuing discussion will delve deeper on the characterization of these wetlands (see Figure 3-3).

3.9.1.2.1 Marshes

Marshes have been defined in the Project Area as wetlands dominated by nonwoody, emergent vegetation, and include species such as coco yam or wild taro (*Colocasia esculenta*) para grass (*Urochloa mutica*) climbing dayflower (*Commelina diffusa*), Mexican crowngrass (*Paspalum fasciculatum*) and the darkeye morninglory (*Ipomoea tiliacea*). Based on the Cowardin classification (1979) these can be classified as palustrine wetlands.

Marshes are located between the mangroves and the dwellings found at the north bank of the easternmost section of the CMP (Atkins, 2011c). This area is permanently flooded or remains very saturated for extended periods of time, mostly as a result of urban runoff and wastewaters discharges draining on a daily basis from the adjoining communities lacking a storm and a sanitary sewer system.



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 3-3. Existing Wetland Areas

3.9.1.2.2 Mangrove forest

Mangroves are characterized by woody vegetation growing in permanently flooded to very saturated, organic rich soils, influenced by tides. Based on the Cowardin classification (1979) these can be classified as estuarine and palustrine wetlands.

The dominant tree species in mangroves are the red mangrove (*Rhizophora mangle*), the white mangrove (*Laguncularia racemosa*) and the black mangrove (*Avicennia germinans*). Other species that are found at the landward, less saline and water saturated soils in this habitat, such as those transitioning into young secondary forests include: the portia tree (*Thespesia populnea*) and the exotics Indian almond and the coconut palm tree. The golden leatherfern (*Achrosticum aureum*) can also be observed growing among mangrove trees in those sites where water and soil salinity is low, especially next or in transition towards marshes (Atkins, 2011c). A small stand of dragonsblood tree (*Pterocarpus officinalis*) has been identified close to the southeastern end of the Eastern CMP, associated to the outlet of the Juan Méndez creek.

Mangrove forests in the Project Area are found along most of the Eastern CMP banks, and especially in its eastern most end, where a relatively big stand exists. It is also found fringing most of the San José Lagoon, including the shorelines of the CDRC staging area, as well as the Guachinanga and Guachinanguita islets.

Mangrove forests in the Project Area can be classified as basin forests, based on their physiographical characteristics, (Lugo and Snedaker, 1974). Martínez, Cintrón and Encarnación (1979) reported that this type of mangrove forest is characterized by sheet flows over wide areas of very small topographic relief. The dominant species of mangroves are the white and black mangroves, although where the sheet flows converge into channels, the banks of these become lined with red mangroves.

3.9.1.2.3 Floating vegetation

This habitat is present in those sites within the Eastern CMP channel that are permanently flooded and clogged, and thus with very little to no current, where waters are deep enough to prevent the establishment of rooted vegetation associated to mangrove forests or marshes. Instead, free floating vegetation has developed, although confined to the top or surface layer of the water column where salinity levels are at their lowest. The dominant species are the exotic common water hyacinth (*Eichhornia crassipes*), the lesser duckweed (*Lemna aequinoctialis*) and the water lettuce (*Pistia stratiotes*) (Atkins, 2011c).

The biggest mat of floating vegetation, however, is found at the southwestern shores of the San José Lagoon, south of the Eastern CMP's outlet, associated to the outlet of the Juan Méndez Creek. At this site, floating vegetation has accumulated due to the general prevailing winds and water currents that have pushed much of this free floating vegetation, and concentrated it at this section of the San

José Lagoon. Floating vegetation can also be found within the outlet of the San Antón creek, at the southeastern corner of the San José Lagoon, immediately south of the CDRC staging area.

3.9.2 Submerged Habitats

Submerged or benthic habitats are those that support plants and animals on or in the bottom of water bodies, also known as the benthos. Differences in these habitats are dictated by the chemical and physical characteristics (e.g., salinity) of the substrate and the water column. To facilitate their analysis, submerged habitats in the Study Area have been classified into two general categories: estuarine and marine.

It is important to consider that the submerged habitats that have been individually classified within the Study Area are part of an overall seascape where separation of habitats for most management purposes is extremely difficult. Although many species spend their entire life almost exclusively in one of these habitats (e.g., hardgrounds - corals or cnidarians), for others, its use is not constant. Many species of fish, for example, spend their early life stages in mangroves or coastal lagoons and later migrate to the ocean, in order to inhabit seagrass beds or coral reef to complete their adult stage (ontogenetic migration). In addition, submerged habitats rely or depend on many of the services or functions provided by each other. For example, mangroves produce a tremendous amount of leaf litter or detritus that is exported and then used, among others, by organisms associated to seagrass beds. Coral reefs, in turn, help reduce wave energy, which allows the establishment of seagrass beds and mangrove forests close to the shore. Management of individual submerged habitats, as a result, must consider the overall seascape in order to conserve key ecological functions and relationships necessary for their sustenance (Atkins, 2015a; Appeldoorn et al., 2011; Pittman et al., 2006 2007).

3.9.2.1 Estuarine

Estuarine submerged habitats include those communities that are tidally or permanently flooded and attached to mangrove roots, those associated to the water column and other benthic communities at the bottom of the Eastern CMP and the San José Lagoon.

The existing high sedimentation rates, presence of toxins within the sediments, low DO levels, and salinity stratification within the Eastern 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) (PREQB, 2008; Otero, 2011; SJBE, 2000; Kennedy et al., 1996). Benthic habitats in and around the Eastern CMP are highly degraded due to the contaminant loads and reduced tidal flushing, which result in limited light penetration, poor water quality, and anoxic, highly organic sediments. In the San José Lagoon, those areas that are shallower than four to six feet such as its outer periphery and Los Corozos Lagoon section are somewhat typical of other coastal lagoons in Puerto Rico, with deeply colored, mesohaline or brackish waters (salinity of 5 to 18 ‰) that support a variety of organisms. Those areas that are deeper than four to six feet in the San José Lagoon do not present viable habitat for flora and fauna due to hypoxic to anoxic conditions, especially in those areas where the artificial dredged pits are found.

3.9.2.1.1 Mangrove prop roots

Mangrove prop root habitat is found among those areas that are tidally inundated, either seasonally or permanently, among the aerial roots of black and white mangrove (i.e., pneumatophores) and those of red mangrove. Atkins (2011b) reported that the majority of organisms identified within the red mangrove prop root encrusting community in the CMP, the San José and Los Corozos lagoons, the Suárez Canal, and La Torrecilla Lagoon were the Mollusca (mussels, oysters and gastropods), Crustacea (barnacles) and Annelida (polychaete worms) phyla.

In the phyla Crustacea and Annelida, a decreasing trend in percent cover was evident along a gradient related to distance from the Ocean, from Zone A to Zone C, with no individuals found in Zones D, E, and F (see Figure 3-4). In essence, barnacles and polychaetes, which were abundant on the red mangrove prop roots in La Torrecilla Lagoon (Zone A) and the Suárez Canal (Zone C), were not found on those examined in San José Lagoon (Zone E) nor the CMP (Zone F). In the phylum Mollusca, the greatest coverage was in the Suárez Canal (Zone C) and numbers declined moving toward both the La Torrecilla and San José lagoons. Presently, a single species of bivalve, the false mussel (*Mytilopsis domingensis*), dominates the areal coverage of the mangrove roots and other hard substrates (e.g., seawalls and rip-raps) found at shallow depths throughout the lagoons and parts of the Suárez Canal.

Sponges were only found in La Torrecilla Lagoon, which is closest to the source of tidal flushing. Stations located farther from the tidal flushing (Zones B, C, D, E, and F) had no sponges living in the red mangrove prop roots (Atkins, 2011b).

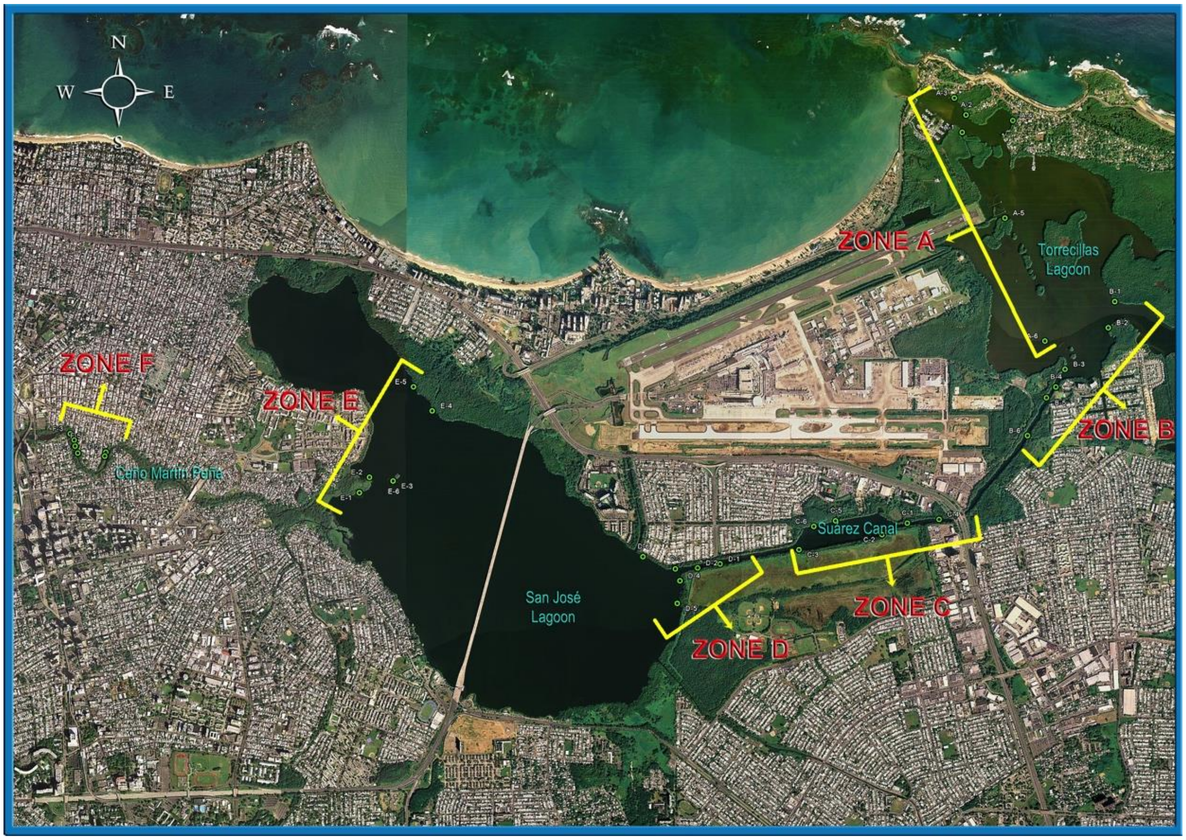


Figure 3-4. Mangrove prop root habitat sampling segments (Atkins, 2011b)

Polychaetes were only found closer to the source of tidal flushing (at Zones A, B and C). Stations located farther from the tidal flushing (Zones D, E, and F) had no Polychaete worms living in the red mangrove prop roots. Ascidians (phylum Cordata) were only found closest to the source of tidal flushing at La Torrecilla Lagoon (Zone A). Stations located farther from the tidal flushing (Zones B, C, D, E, and F) had no Ascidians living in the red mangrove prop roots (see Figure 3-5).

In summary, species abundance and diversity (important indicators of healthy habitats) of the encrusting community of red mangrove prop roots is higher in 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 severely limited within the CMP. This could be related to low dissolved oxygen as well as with salinity concentrations.

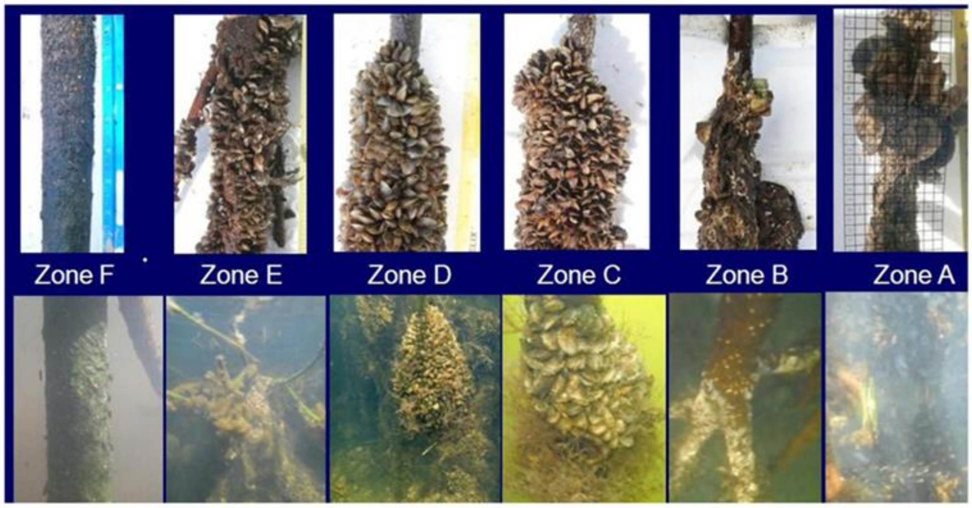


Figure 3-5. Mangrove prop root habitat fouling community in various portions of the SJBE (Atkins 2011b).

Poor water quality has been found to be especially pervasive in mangrove basin forests such as those in the Project Area, when compared to other types of mangrove forests. Martínez, Cintrón and Encarnación (1979) reported that in basin forests where weak but constant fluxes occur, there is oxygenation, nutrient transport, remineralization and there is no accumulation of toxic substances like H_2S and salts. In stagnant basins there is oxygen depletion; mineralization and nutrient recycling is slowed down and salt may accumulate in the sediments. A greater proportion of the gross productivity must be utilized by the system to provide for root ventilation (production of pneumatophores) and to survive at the higher salinity levels. Thus less energy is available for growth. As such, some basin forests may be subjected to higher natural stresses, and therefore be more sensitive to additional stressors.

3.9.2.1.2 Water column

Studies on phytoplankton and zooplankton composition in the Eastern CMP and the San José Lagoon are very limited. Negrón-González (1986) reported that plankton diversity in the San José Lagoon was not diverse, and limited to 15 genera. Based on a study conducted in 1974, he informed that chlorophytes (i.e., green algae) was the most common group (61%), followed by diatoms (i.e., algae) (25%), cyanophytes (i.e., cyanobacteria) (17%), euglenophytes (i.e., flagellate protist) (4%) and dinoflagellates (1%). The most genera (7) belonged to diatoms. The most abundant genera throughout the year was that of Chlamydomonas (i.e., unicellular green algae) (54%), otherwise, Oocystis (i.e., predominantly fresh water green algae) (7%) and Oscillatoria (i.e., unbranched filamentous cyanobacteria) (8%). Other genera included Anabaena (i.e., nitrogen-fixing filamentous cyanobacteria), Anacystis (i.e., cyanobacteria), and Geminella (i.e., algae). The most dominant group through most of the year was cyanobacteria.

Periodic episodes of massive fish kills in the San José Lagoon during the past 40 years have been associated to poor water quality conditions related to excess nutrient inputs and lack of circulation, which have led to algae blooms, and in turn, to lethal, high dissolved ammonia and low dissolved oxygen concentrations (Webb and Gómez-Gómez, 1998). Recent significant fish kill episodes have been reported in October of 2009, October 2013, May 2014, and October 2015. The October 2013 event was thoroughly studied by the SJBE Program, and was determined to be related to a *Spirulina* cyanobacteria bloom (Bauza, J., June 3, 2014, personal communication).

Negrón-González (1986) also reported that nauplius (i.e., crustaceans) constituted the dominant group of zooplankton larvae in the San José Lagoon, followed by cyclopoids (i.e., copepods) and rotifers (i.e., mostly microscopic, multicellular animals). Blue crabs (*Callinectes* sp.), mojarra (*Diapterus* sp.), snooks (*Centropomus* sp.) and tarpon (*Megalops atlanticus*) are some of the common nekton, as well as the most sought out species that are fished in the San José Lagoon.

The artificial dredged pits in the San José Lagoon appear to be important habitats for tarpon possibly due to the aggregation of food sources along the haloclines (salinity stratification layers) that occur within the dredged holes. Phytoplankton and zooplankton tend to accumulate at haloclines which, in turn, attract fish and crabs that prey upon the plankton. Larger fish can be attracted to these concentrations of small fish and crabs, which may be one of the reasons that tarpon are often caught within the deeper waters over the dredge pits. It is likely that tarpon take advantage of these haloclines, hiding in the darkness below this layer, to prey upon suitable-sized organisms that congregate or come to feed at these features. Tarpon may not be able to feed in this manner in the more shallow regions of the San José Lagoon, where water masses are not sufficiently deep below the halocline (Atkins, 2011b).

3.9.2.1.3 Benthos

A number of benthic characterization studies have been undertaken in the Study Area (PBS&J, 2009; Kendall et al., 2001; Rivera, 2005). The black, organic-rich sediments, with a strong hydrogen sulfide odor, and the lack of any significant floral or faunal communities provide, together, strong evidence of an ecologically unhealthy environment at water depths greater than four to six feet in the San José Lagoon.

Rivera (2005) found 599.3 acres of this bare mud benthic habitat in this waterbody. He also estimated the presence of a "reef" consisting of the false mussel (*Mytilopsis domingensis*) over an area of 66.7 acres in the San José Lagoon. He hypothesized that this mussel reef is a "large source of food for the Lagoon" and provides a water filtering function "which must help maintain the water quality" of an otherwise worse condition than presently found.

PBS&J (2009) collected twenty-nine sediment samples in shallow water depths (less than 3.05 m or 10 feet deep) in the San José Lagoon. Blue-green algae were found on the surface of ten of the sediment sites. Live mussel reefs were identified at seven of the locations, all in water depths less than 5 feet. Associated with the mussel reefs were polycheate worms, penaeid shrimp, fish and blue crabs (e.g., *Callinectes* sp.). In all of the shallow water sediment samples, the majority of the sediments consisted of organic, black unconsolidated material with shell fragments. Detritus was also identified in several of the samples. All samples had a strong hydrogen sulfide odor, indicating the long-term absence of dissolved oxygen. These shallow water conditions indicate that deeper than five feet sediments have the potential to support benthic communities if the water quality above is improved.

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

In summary, the results of the benthic habitat survey conducted by PBS&J (2009) indicate that diverse and healthy biological communities are restricted to the shallowest (less than four feet) regions of the San José Lagoon, where salinity stratification does not occur, and where sufficient levels of DO exist. These are the conditions that support a healthy fishery, particularly for the smaller species that make-up the catch for sustenance fishermen in the Lagoons (Atkins, 2011b). However, at the minimal dissolved oxygen conditions found in waters deeper than four feet in this waterbody, the presence of hydrogen sulfide in the sediments is a strong indicator that the water layer above the sediments is also hydrogen sulfide laden (see Figure 3-6).

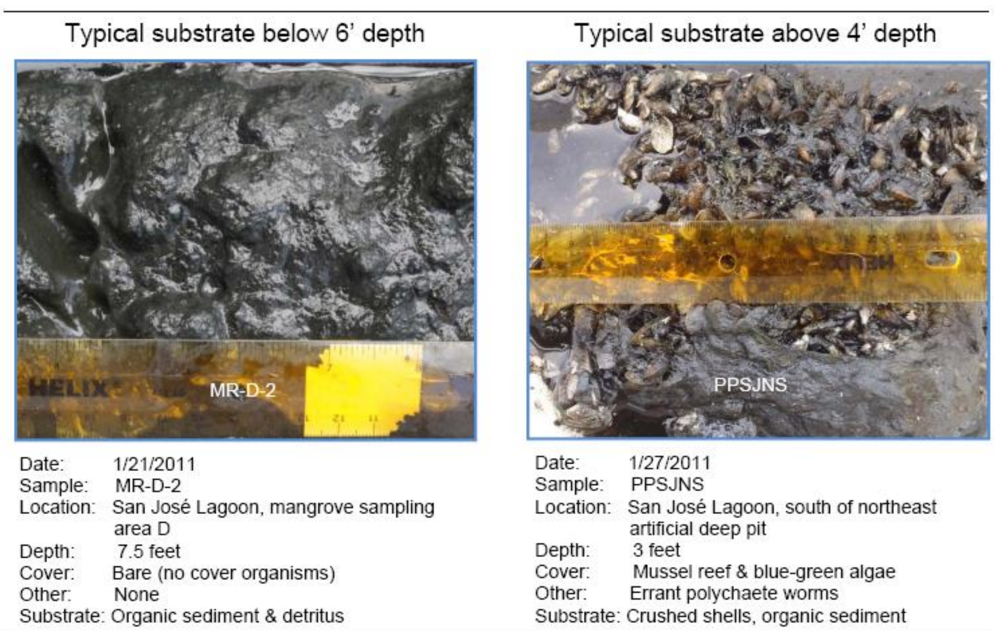


Figure 3-6. Typical benthos in the San José Lagoon (PBS&J, 2009)

3.9.2.2 Marine

Marine submerged habitats are those that are part of the ocean water column and benthic communities near shore, north of the SJBE.

3.9.2.2.1 Near shore water column and benthos

The Study Area benthic habitats north of the SJBE have been delineated by the NOAA, based on interpretation of aerial photos from 1999 (Kendall et al., 2001). Benthic habitats were classified as colonized bedrock, colonized pavement, linear reef, macroalgae, patch reef, sand, scattered coral/rock in unconsolidated sediment and seagrass (see Figure 3-7).

Colonized bedrock was defined as exposed bedrock contiguous with the shoreline that has coverage of macroalgae, hard coral, gorgonians, and other sessile invertebrates that partially obscures the underlying rock. Colonized pavements are flat, lowrelief solid carbonate rock with coverage of macroalgae, hard coral, gorgonians, and other sessile invertebrates that are dense enough to partially obscure the underlying carbonate rock. Linear coral reefs are linear coral formations oriented parallel to the shore or the shelf edge. Patchy macroalgae were described as discontinuous macroalgal patches with coverage values reaching approximately 50% or more in some areas, but with breaks in coverage that are too diffuse or irregular, and result in isolated patches. Patch reef are clustered patch reefs that individually are too small or are too close together to map separately. Sand is coarse sediment typically found in areas exposed to currents or wave energy. Scattered coral and rock in unconsolidated sediment and seagrass was defined as primarily sand or seagrass bottom with scattered rocks or small, isolated coral heads that are too small to be delineated individually (i.e., smaller than individual patch reefs). Patchy seagrass are discontinuous seagrass with breaks in coverage that are too diffuse or irregular, or result in isolated patches of seagrass that are too small to be mapped as continuous seagrass (Kendall et al., 2001).

Several detailed benthic surveys, although for very narrow, long corridors or transects, have been conducted for the submarine installation of various fiber optic cables in the shallow, coastal waters north of the SJBE, in the vicinity of Isla Verde and El Condado (CSA Architects & Engineers, LLP, 2014; Environmental Resources Management [ERM], 2013; Glauco A. Rivera & Associates, 2011; Coll Rivera Environmental, 2005). Some of the benthic communities identified include sand plains, algal associations, seagrass beds and colonized hardgrounds. These are inhabited, accordingly, by seagrasses and algae (e.g., turf, coralline, fleshy), sessile and motile macro invertebrates such as poriferans (i.e., sponges), cnidarians (e.g., hydrozoans, zoanthids, soft and hard corals), mollusks and echinoderms (ERM, 2013; Glauco A. Rivera & Associates, 2011). The distribution, extent and species composition of each of these habitats varies along the Study Area’s nearshore waters (CSA Architects & Engineers, LLP, 2014; ERM, 2014; Glauco A. Rivera & Associates, 2011; Kendall, M.S., et al., 2001).

The most prominent marine benthic feature in the Study Area is a narrow, discontinuous linear or fringing "reef" consisting of corals covering fossil sand dunes (i.e., eolianites) trending in an east-west direction and extending, in some sites, up to 0.9 miles off shore. In some areas, the fossil sand dunes rise above the water, forming small, rocky islets (e.g., Isla de Cabra, Peñon de San Jorge, Isla de Piedra, Isla Verde, and Isla Cancora) (Caribbean Fisheries Management Council [CFMC], 2004).

ID	TRACT	Area	Acres	Hectares
2	Central Reef Tract	10043820	2481.9	1004.4
3	East Near Inlet Reef	1252094	309.4	125.2
1	West Near Inlet Reef	3128130	773	312.8

Date: 5/21/2014

Sources and Credits:
Kendall, M.S.1, M.E. Monaco1, K.R. Buja1, J.D. Christensen1, C.R. Kruer2, and M. Finkbeiner3, R.A. Warner1. 2001. (On-line). Methods Used to Map the Benthic Habitats of Puerto Rico and the U.S. Virgin Islands Puerto Rico Planning Board Aerial images 2009-2010
Atkins

Figure 3-7. Reef habitat north of the SJBE, within the Study Area (Atkins, 2015a)

Species zonation has been observed in the Study Area's fringing reefs. Intense wave action, light penetration, currents along the shore and sediment abrasion generated by lateral transport are some of the factors that control coral reef development and distribution (ERM, 2013; Glauco A. Rivera & Associates, 2011; Miller and Lugo, 2009).

Turf, coralline and fleshy algae inhabit the reef and its surroundings; the most common or dominant species been *Halimeda* spp., *Dictyota* spp., *Amphiroa* spp., *Acanthophora spicifer* and *Sargassum* spp. Giant barrel sponges (i.e., *Xetospongia muta*), branching vase sponges (e.g., *Callyspongia vaginalis*), tube shape sponges (e.g., *Aplysina* spp.) and ball shape sponges (e.g., *Ircinia campana*) are also quite conspicuous. *Plexaura* spp. is generally the dominant soft coral, although others species can be found (e.g., *Eunicea* spp., *Gorgonia* spp.) (ERM, 2013; Glauco A. Rivera & Associates, 2011).

Most of the hard coral species identified grow in platy or encrusting forms, or as small domes. The most common species observed include the great star coral (*Orbicella cavernosa*), the maze coral (*Meandrina meandrites*), the mustard hill coral (*Porites astreoides*), the lettuce coral (*Agaricia* *agaricites*), the massive starlet coral (*Siderastrea siderea*), and the symmetrical brain coral (*Diploria strigosa*). Others include the domed star coral (*Dichocoenia stokesii*) and the mountainous star coral (*Orbicella faveolata*) (ERM, 2013; Glauco A. Rivera & Associates, 2011).

Low cover percentage of both soft and hard coral groups in the Study Area corresponds with data from other similar surveys in Puerto Rico and the general status of coral communities in the Caribbean (Glauco A. Rivera & Associates, 2011; García-Sais, et al. 2008). However, those reefs close and west of the Boca de Cangrejos outlet, in the Isla Verde area, have been significantly stressed or affected from sedimentation due to extensive dredging and organic pollution coming from La Torrecilla Lagoon, and probably, from other waterbodies in the SJBE (e.g., Canal Suárez, San José Lagoon, and the CMP) that have been also impacted by these same activities (CFMC, 2004). This is evident by a remarkably high frequency of hard coral colonies been impacted by Black Band Disease, which suggests poor water quality, which could also be acting as a vector for pathogenic organisms (Coll Environmental, 2005). It should be noted that chronic eutrophication and turbidity are critical detrimental factors impacting coral reef ecosystems, adversely affecting their ecological functions, services, benefits, and resilience across multiple spatial scales and over prolonged periods of time (Díaz-Ortega and Hernández-Delgado, 2014).

Some of the macroinvertebrates that had been observed inhabiting the Study Area's reef community include the white encrusting zoanthid (*Palythoa caribaeorum*), the octopus (*Octopus vulgaris*), the long spindled sea urchin (*Diadema antillarum*), the rock boring urchin (*Echinometra lucunter*), the spiny lobster (*Panulirus argus*) and the cushioned star (*Oreaster reticulatus*) (ERM, 2013; Glauco A. Rivera & Associates, 2011).

Many of the species reported for the linear reef can also be observed growing in the "lagoon" found between the rear or backreef zone and the beach shoreline. The habitats found in this general area include large sand flats, rodoliths, hardbottom substrates, dispersed rocky patch reefs, seagrass beds and macroalgal plains. The four seagrass species reported for Puerto Rico, the seaturtle grass (*Thalassia testudinum*), the manatee grass (*Syringodium filiforme*), the paddle seagrass (*Halophila decipiens*) and the shoalweed (*Halodule wrightii*) have been observed; the latest close to the Boca de Cangrejos outlet. The West Indian fighting conch (*Strombus pugilis*), the queen conch (*Strombus gigas*) and the green sea urchin (*Lytechinus variegatus*) have been documented in this habitat within the Study Area (ERM, 2013; Glauco A. Rivera & Associates, 2011).

3.10 FLORA AND FAUNA RESOURCES

The SJBE system is home to a very rich biodiversity. Approximately, 160 bird species, 8 amphibian species, 12 reptile species, 124 fish species, and 300 wetland plant species, including others of special concern (i.e., rare, endemic, threatened or endangered), have been documented in this region (SJBEP, 2000).

Those flora and fauna species that have been documented in the CMP and the San José Lagoon are the ones considered for analysis in this Final EIS. It should be noted, however, that other species observed within the Study Area other than the Project Area, could well be found, even if these have not been officially documented. This is very likely due to the capacity of many fauna species to move across the widely distributed mangrove forests in the SJBE. Such is the case, for example, with those bird species inhabiting the CMP. A considerable number of the bird species documented in the CMP were observed in the mudflats once found in its western end. For this Final EIS, these species have been included as found in the eastern half. Nevertheless, an effort has been made to distinguish or identify those that have a higher probability of being found within the Project Area.

3.10.1 Flora

In Eastern CMP, Atkins (2011c) identified 152 species of vascular plants, among 61 plant families. Of the plant species, 68 (44.7%) are introduced to Puerto Rico and 84 (55.3%) are native to the island (see Table 3-11). There were no Federally-listed terrestrial flora species (nor Commonwealth) found during the survey in the Eastern CMP and at the CDRC staging area.

Table 3-11. Some of the terrestrial Flora Identified in the Eastern CMP

SCIENTIFIC NAME	COMMON ENGLISH NAME	FAMILY	ORIGIN
Dalbergia ecastaphyllum	coinvine	Papilionoideae	Native
Delonix regia	flamboyant	Caesalpinioideae	Introduced
Dieffenbachia maculata	spotted dumb cane	Araceae	Introduced
Dieffenbachia seguine	dumb cane	Araceae	Native
Digitaria ciliaris	southern crabgrass	Poaceae	Native
Echinochloa polystachya	creeping river grass	Poaceae	Native
Echinocloa colona	jungle rice	Poaceae	Introduced
Eleocharis mutata	scallion grass	Cyperaceae	Native
Eleocharis cellulosa	Gulfcoast spikerush	Cyperaceae	Native
Eleusine indica	Indian goosegrass	Poaceae	Introduced
Enterolobium cyclocarpum	Elephant ear tree	Fabaceae	Introduced
Erythrina poeppigiana	Mountain immortelle	Papilionoideae	Introduced
Eugenia monticola	Birdcherry	Myrtaceae	Native
Euphorbia heterophylla	Mexican fireplant	Euphorbiaceae	Native
Ficus citrifolia	Wild bayantree	Moraceae	Native
Ficus elastica	Rubber tree	Moraceae	Introduced
Ficus lancifolia	N/A	Moraceae	Introduced
Gossypium hirsutum	Upland cotton	Malvaceae	Introduced
Hydrocotyle umbellata	Dollarweed	Umbelliferae	Introduced
Ipomoea tiliacea	Choisy	Convolvulaceae	Native
Ixora ferrea	Palo de hierro	Rubiaceae	Native
Jatropha curcas	Barbados nuts	Euphorbiaceae	Introduced
Lagerstroemia speciosa	Queen’s Crape-myrtle	Lythraceae	Introduced
Laguncularia racemosa	White mangrove	Combretaceae	Native
Lemna perpusilla	Minute duckweed	Lemnaceae	Native

Table 3-11, cont'd

SCIENTIFIC NAME	COMMON ENGLISH NAME	FAMILY	ORIGIN
Leucaena leucocephala	White leadtree	Lamiaceae	Introduced
Livingstonia chinensis	Chinese fan palm	Arecaceae	Introduced
Ludwigia octovalvis	Mexican primrose-willow	Onagraceae	Native
Malachra capitata	Brazil jute	Malvaceae	Native
Malpighia emarginata	Barbados cherry	Malpighiaceae	Native
Mangifera indica	Mango	Anacardiaceae	Introduced
Megathyrsus maximus	Guinea grass	Poaceae	Introduced
Melanthera aspera	"Yerba de cabra"	Asteraceae	Native
Melicoccus bijugatus	Spanish lime	Sapindaceae	Introduced
Merremia umbellata	Hogvine	Convolvulaceae	Native
Mimosa pellita	Lollipop mimosa	Mimosoideae	Introduced
Mimosa pudica	Sensitive plant	Mimosoideae	Native
Momordica charantia	Balsampear	Cucurbitaceae	Introduced
Morinda citrifolia	Indian mulberry	Rubiaceae	Introduced
Murraya exotica	Chinese box	Rutaceae	Introduced
Musa paradisiaca	Banana tree	Musaceae	Introduced
Muntingia calabura	Strawberry tree	Elaeocarpaceae	Native
Nephrolepis multiflora	Asian swordfern	Polypodiaceae	Native
Nephrolepsis exaltata	Boston swordfern	Polypodiaceae	Native
Neptunia plena	Water dead and awake	Fabaceae	Native
Ochna jabotapita	Bird's eye bush	Ochnaceae	Introduced
Oeceoclades maculata	Monk orchid	Orchidaceae	Introduced
Paspalum conjugatum	Hilograss	Poaceae	Native
Paspalum fasciculatum	Mexican crowngrass	Poaceae	Native
Paspalum millegrana	"Paja brava"	Poaceae	Native
Paulinnia pinnata	Sweet gum	Sapindaceae	Native
Peltophorum pterocarpum	Yellow poinciana	Fabaceae	Introduced
Persea americana	Avocado tree	Lauraceae	Introduced
Petiveria alliacea	Guinea henweed	Phytolaccaceae	Introduced
Philodendron radiatum	-	Araceae	Introduced
Phyla nodiflora	Turkey tangle fogfriut	Verbenaceae	Native
Phyllanthus acidus	Malay gooseberry	Euphorbiaceae	Introduced
Phyllanthus juglandifolius	"Gamo de casta"	Euphorbiaceae	Native
Pimenta racemosa	Bayrum tree	Myrtaceae	Native
Piper aduncum	Spiked pepper	Piperaceae	Native
Pithecellobium dulce	Monkeypod	Mimosoideae	Introduced
Psidium guajava	Guava	Myrtaceae	Native
Pterocarpus officinalis	Bloodwood	Papilionoideae	Native
Ptychosperma macarthurii	Macarthur palm	Arecaceae	Introduced
Pueraria phaseoloides	Kudzu	Papilionoideae	Introduced
Ravenala madagascariensis	Traveller's palm	Musaceae	Introduced
Rhizophora mangle	Red mangrove	Rhizophoraceae	Native
Rhynchospora nervosa	Beak rush	Cyperaceae	Native
Ricinus communis	Castor oil	Euphorbiaceae	Introduced

Table 3-11, cont'd

SCIENTIFIC NAME	COMMON ENGLISH NAME	FAMILY	ORIGIN
Roystonea borinquena	Royal palm	Arecaceae	Native
Roystonea regia	Cuban royal palm	Arecaceae	Introduced
Ruellia brittoniana	Mexican petunia	Acanthaceae	Introduced
Ruellia tuberosa	Minnieroot	Acanthaceae	Introduced
Saccharum officinarum	Sugarcane	Poaceae	Introduced
Sansevieria trifasciata	Snake plant	Liliaceae	Introduced
Schefflera actinophylla	Umbrella tree	Araliaceae	Introduced
Senna alata	Emperor's candlestick	Caesalpinioideae	Introduced
Senna bicapsularis	Christmasbush	Caesalpinioideae	Native
Senna siamea	Casod tree	Caesalpinioideae	Native
Serjania polyphylla	Basketwood	Sapindaceae	Native
Sesbania sericea	Papagayo	Papilionoideae	Introduced
Sida acuta	Common wireweed	Malvaceae	Native
Sida rhombifolia	Arrowleaf sida	Malvaceae	Native
Sideroxylon salicifolium	White bully	Sapotaceae	Native
Solanum torvum	Turkey berry	Solanaceae	Native
Sorghum halepense	Johnson grass	Poaceae	Introduced
Spathodea campanulata	African tulip	Bignoniaceae	Introduced
Spondias dulcis	June plum	Anacardiaceae	Introduced
Sterculia apetala	Panama tree	Sterculiaceae	Introduced
Syngonium podophyllum	Arrowhead plant	Araceae	Introduced
Syzygium jambos	Malabar plum	Myrtaceae	Introduced
Tabebuia heterophylla	White cedar	Bignoniaceae	Native
Tamarindus indica	tamarin	Caesalpinioideae	Introduced
Terminalia catappa	Indian almond	Combretaceae	Introduced
Thespesia populnea	Portia tree	Malvaceae	Native
Tillandsia Sp.	Tilansia	Bromeliaceae	Native
Triumfetta semitriloba	Sacramento burbark	Tiliaceae	Native
Typha domingensis	Southern cattail	Typhaceae	Native
Veitchia merrillii	Christmas palm	Arecaceae	Introduced
Wedelia trilobata	Wedelia	Asteraceae	Native
Zantedeschia aethiopica	Cala lilly	Araceae	Introduced
Zoysia matrella	Manila grass	Poaceae	Introduced

Source: Atkins, 2011c.

In the benthic, nearshore waters north of the SJBE and within the Study Area, 37 algae species and 4 seagrass species have been identified (CSA Architects & Engineers, 2014; ERM, 2013; Glauco A. Rivera & Associates, 2011; Coll Rivera Environmental, 2005) (see Table 3-12).

Table 3-12. Benthic flora identified in nearshore waters north of the SJBE, within the Study Area

ALGAE		
Acanthophora spicifera	*Dictyosphaeria* spp.	*Padina sanctae-crucis*
Amphiroa spp.	*Galaxaura oblongata*	*Penicillus* spp.
Asparagopsis taxiformis	*Gracilaria* spp.	*Sargassum* spp.
Avrainvillea spp.	*Halimeda incrassata*	*Scinaia complanata*
Bryothamnion triquetrum	*Halimeda discoidea*	*Trichogloea* spp.
Caulerpa cupressoides	*Halimeda monile*	*Udotea cyathiformis*
Caulerpa mexicana	*Halimeda opuntia*	*Udotea* spp.
Caulerpa prolifera	*Halimeda* spp.	*Wrightiella blodgettii*
Caulerpa racemosa	*Halymenia floresia*	Unidentified chlorophyta
Caulerpa sertularioides	*Hypnea* spp.	Unidentified phaeophyta
Chondria spp.	*Laurencia* spp.	Unidentified rhodophyta
Codium isthmocladum	*Neomeris annulata*	
Dictyopteris spp.	*Padina gymnospora*	
SEAGRASSES		
Halodule wrightii	*Syringodium filiforme*	
Halophila decipiens	*Thalassia testudinum*	

Source: CSA Architects & Engineers, 2014; ERM, 2013; Glauco A. Rivera & Associates, 2011; Coll Rivera Environmental, 2005.

3.10.1.1 Invasive Flora

The cayeput tree (*Melaleuca quinquenervia*), originally from Australia and introduced as an ornamental, is known to aggressively invade freshwater herbaceous wetlands outside its natural range. Although not properly found in the Project Area, it has been recorded growing in pure stands, covering several acres south of the Suárez Canal, east of the Project Area.

The exotic water hyacinth (*Eichhornia crassipes*) is found in the juncture between the CMP and the San José Lagoon, and at the outlets of the Juan Méndez and San Antón Creeks. It grows in fresh to extremely low saline or brackish waters. Originally from South America, it was introduced as an ornamental. The water hyacinth is a very fast growing plant, with populations known to double in as little as 12 days. Infestations of this weed block waterways, limiting boat traffic, swimming and fishing. Water hyacinth also prevents sunlight and oxygen from reaching the water column and submerged plants. Its shading and crowding of native aquatic plants dramatically reduces biological diversity in aquatic ecosystems (Atkins, 2013f).

3.10.2 Fauna

In the Project Area, 133 species of birds, 8 amphibian, 9 reptiles, and 27 fish and have been documented (Atkins, 2012a; INCICO & Expediciones Península, 2011; Atkins, 2011c; Rivera-Herrera, 1996). In the Eastern CMP and the CDRC staging area, 127 fauna species among 59 families have been identified (Atkins, 2011c). Of these, 91 are birds species classified within 19 families;

6 are amphibian species classified within 3 families; 9 are reptilian species classified within 5 families, and 3 are mammal species classified within 3 families.

In the benthic, nearshore waters north of the SJBE and within the Study Area, 9 sponge species, 14 soft coral species, 41 hard coral species and 49 macroinvertebrate species have been identified (CSA Architects & Engineers, 2014; ERM, 2013; Glauco A. Rivera & Associates, 2011; Coll Environmental, 2005) (see Table 3-13).

Table 3-13. Benthic fauna documented in nearshore waters north of the SJBE, within the Study Area

SPONGES		
Agelas spp.	*Cinachyra* spp.	*Ircina* spp.
Aplysina spp.	*Geodia neptuni*	*Neofibularia nolitangere*
Callyspongia vaginalis	*Ircina campana*	*Xetospongia muta*
SOFT CORALS		
Briareum asbestinum	*Gorgonia ventalina*	*Plumapathes* spp.
Ellisella spp.	*Muricea* spp.	*Pseudoplexaura* spp.
Erythropodium caribaeorum	*Muriceopsis flavida*	*Pseudopterogorgia* spp.
Eunicea spp.	*Plexaura homomalla*	*Pterogorgia guadalupensis*
Gorgonia flabellum	*Plexaurella* spp.	
HARD CORALS		
Acropora cervicornis	*Eusmilia fastigiata*	*Montastraea cavernosa*
Acropora palmata	*Favia fragum*	*Mussa angulosa*
Acropora prolifera	*Helioceris cucullata*	*Mycetophyllia aliciae*
Agaricia agaricites	*Isophyllia rigida*	*Mycetophyllia ferox*
Agaricia fragilis	*Isophyllia sinuosa*	*Oculina difusa*
Agaricia humilis	*Leptoseris cucullata*	*Porites astreoides*
Agaricia lamarcki	*Madracis decactis*	*Porites porites*
Colpophyllia natans	*Meandrina meandrites*	*Scolymia* spp.
Dendrogyra cylindrus	*Millepora alcicornis*	*Siderastrea radians*
Dichocoenia intersepta	*Millepora complanata*	*Siderastrea siderea*
Dichocoenia stokesii	*Millepora squarrosa*	*Stephanocoenia intersepta*
Diploria clivosa	*Montastraea annularis*	*Stylaster roseus*
Diploria labyrinthiformis	*Montastraea faveolata*	*Tubastraea coccinea*
Diploria strigosa	*Montastraea franksi*	

Table 3-13, cont'd

MACROINVERTEBRATES		
Aurelia aurita	*Eucidaris tribuloides*	*Pinna carnea*
Acanthopleura granulata	*Hermodice carunculata*	*Plectreurys conifera*
Actinoporus elegans	*Holothuria mexicana*	*Sabellastarte magnifica*
Alpheus spp	*Isostichopus badionotus*	*Scyllarides aequinoctialis*
Bispira brunnea	*Lima scabra*	*Sepioteuthis sepioidea*
Carpilius corallinus	*Linckia guildingii*	*Spirobranchus giganteus*
Cassis flammea	*Lytechinus variegatus*	*Stenophus hispidus*
Charonia variegata	*Mytrax sculptus*	*Stichodactyla helianthus*
Cinetorhynchus manningi	*Octopus briareus*	*Strombus costatus*
Cittarium pica	*Octopus vulgaris*	*Strombus gigas*
Clypeaster subdepressus	*Ophionereis reticulata*	*Tripneustes ventricosus*
Condylactis gigantea	*Opiothrix suensoni*	*Viatrix globulifera*
Condylactis helianthus	*Oreaster reticulatus*	annelids
Cyphoma gibbosum	*Palythoa caribaeorum*	Diogenid-hermit crab
Diadema antillarum	*Panulirus argus*	Ophiuroid-brittle star
Echinometra lucunter	*Panulirus guttatus*	
Echinometra viridis	*Percnon gibbesi*	

Source: CSA Architects & Engineers, 2014; ERM, 2013; Glauco A. Rivera & Associates, 2011; Coll Rivera Environmental, 2005.

3.10.2.1 Invasive Fauna

Three introduced species that have the potential to alter mangrove habitats or that could prey on native fauna species have been sighted on a regular basis in most of the Study Area, including the Project Area.

The small Indian mongoose (*Herpestes javanicus*) was originally introduced from Asia between 1877 and 1879 to control rats in sugar cane fields. Today, it is Puerto Rico's most detrimental predator on ground-nesting birds and lizards (Weaver and Schwagerl, 2009). This species is known to occur in a wide variety of habitats including dry forest, disturbed dry forest, scrub, grasslands, cattle pastures, cane fields, urban areas, woodlands, montane wet forests, and rain forests (Gould, et al. 2007). Mongoose populations are greatest in coastal grassy areas where fresh water is available and low in forested areas (Pimentel, 1955). The mongoose is entirely diurnal and can swim and climb trees, although it rarely does so. It does not voluntarily enter water deeper than about 2 inches (Nellis and Evarard, 1983). The Small Indian Mongoose is an opportunistic feeder that is known to eat reptiles, amphibians, birds, invertebrates, plants, seeds, fruits and carrion (Nellis and Small 1983 as cited in Gould, et al. 2007). In Puerto Rico, reptiles and insects form the bulk of its diet (Pimentel, 1955).

The green iguana (*Iguana iguana*), originally introduced as a pet, is a large and widely distributed arboreal lizard, found from México and the Caribbean, to northern Argentina in South America. It has become established in Puerto Rico, mostly found in coastal areas, although it can also be found in higher elevations near streams and rivers. A study conducted by Carlo and García (2008) to examine the distribution, abundance patterns, and ecological and social impacts of this species in the SJBE ecosystem concluded that green iguanas clump in mangrove trees found in disturbed areas, especially near edges and urban settlements. These also fed nonrandomly on mangrove species, and clearly preferred black mangrove (*Avicennia germinans*) when available. According to the authors, the combined effects of spatial clumping at the local and landscape scale resulted in a concentration of iguana herbivory in already disturbed mangrove stands, causing high defoliation and mortality rates for mangroves where iguanas aggregate near edges and urban settlements.

A study conducted by the SJBEP in 2010 concluded that the spectacled caiman is widely distributed within the SJBE watershed. In the Project Area, it is found in greater numbers at the outlet of the Juan Méndez Creek (SJBEP, 2010). The spectacled caiman (*Caiman cocodrilus*) is native to Central and South America and was probably introduced into Puerto Rico as a result of released or escaped pets in the 1960s. This species has become established in the Island and now occurs in parts of the northern coastal plain and other localities. Because the ecology and natural history of *Caiman crocodilus* has not been studied in Puerto Rico, its effects on local biodiversity are not known. However, there are reasons for concern because the spectacled caiman has been reported to prey on numerous vertebrates and invertebrates, is aggressive and dangerous to humans, and serve as vector of foreign pathogens and/or diseases. The spectacled caiman is a highly adaptable species, found in virtually all lowland wetland and riverine habitats throughout its range, although generally preferring areas of still water, such as lakes, ponds and marshes, as well as slower-flowing rivers (Ross, 1998 as cited in SJBEP, 2010). It can also tolerate a reasonable degree of salinity (Web Crocodilian Species List, 2009, as cited in SJBEP, 2010).

Dogs, cats, rats, and mice are other introduced mammal species found in the Study Area. When found in considerable numbers, these can have an impact on native wildlife, mostly as predators of reptiles and birds.

3.10.2.2 Fish

3.10.2.2.1 Caño Martín Peña and San José Lagoon fish species

A total of 124 fish and one (1) crustacean (*Callinectes* sp.) species have been identified as part of the nekton (free swimming) found in the SJBE (Rivera-Herrera, 1996; Yoshiura & Lilyestom, 1999). The following table provides a subset list of 82 fish species that have been found in the CMP and the San José Lagoon, as informed by Rivera-Herrera (1996), and in the San José and La Torrecilla lagoons, as reported by Yoshiura & Lilyestrom (1999). Seventeen (17) of these species have been classified and included by the CFMC in it's the Reef Fish Management Plan (CFMC, 2004) (see Table 3-14).

Table 3-14. Fish species found in the CMP, the San José and La Torrecilla lagoons

SCIENTIFIC NAME	SPANISH COMMON NAME	ENGLISH COMMON NAME	REEF FISH FMP*
Abudefduf saxatilis	Sargento mayor	Sergeant major	✓
Ablennes hians	Agujón sable	Flat needlefish	
Achirus lineatus	Suela listada	Lined sole	
Anchoa hepsetus	Manjúa listada	Striped anchovy	
Anchoa spinifer		Spicule anchovy	
Anchovia clupeoides	Hachudo	Zabaleta anchovy	
Anisotremus virginicus	Burro payaso	Porkfish	✓
Archosargus rhomboidalis	Sargo amarillo	Sea bream	✓
Bairdiella ronchus	Ronco rayado	Ground drummer	
Bairdiella sanctaeluciae	Ronco caribeño	Striped croaker	
Bothus ocellatus	Chueco playón	Eyed flounder	
Caranx crysos	Cojinúa	Blue runner	✓
Caranx latus	Jurel blanco	Horse-eye jack	✓
Cetengraulis edentulus	Bocónn	Atlantic anchoveta	
Centropomus ensiferus	Róbalo espinoso	Swordspine snook	
Centropomus parallelus	Robalito	Fat snook	
Centropomus pectinatus	Róbalo prieto	Tarpon snook	
Centropomus undecimalis	Róbalo blanco	Common snook	
Chaetodipterus faber	Chabela	Atlantic spadefish	✓
Citharichthys arenaceus	Lenguado arenero	Sand whiff	
Conodon nobilis	Ronco canario	Barred grunt	
Diapterus auratus	Mojarra guacha	Irish ponpano	
Diapterus rhombeus	Mojarra de estero	Rhomboid mojarra	
Diodon hystrix	Puerco espín	Porcupine fish	✓
Elops saurus	Banano	Ladyfish	
Eucinostomus argenteus	Mojarra plateada	Spotfin mojarra	
Eucinostomus gula	Mojarra española	Silver jenny	
Eucinostomus harengulus	Mojarra costera	Tidewater mojarra	
Eucinostomus havana	Majarrita manchada	Bigeye mojarra	
Eucinostomus jonesii	Mojarra flaca	Slender mojarra	
Eucinostomus lefroyi	Mojarra pinta	Mottled mojarra	
Eucinostomus melanopterus	Mojarra bandera	Flagfin mojarra	
Eugerres plumieri	Mojarra plateada	Striped mojarra	
Gambusia affinis	Gupi	Mosquito fish	
Gerres cinereus	Mojarra blanca	Yellowfin mojarra	

Table 3-14, cont'd

SCIENTIFIC NAME	SPANISH COMMON NAME	ENGLISH COMMON NAME	REEF FISH FMP*
Gobioides broussonnetii	Esmeralda de río	Violet goby	
Gobiomorus dormitor	Guavina bocón	Bigmouth sleeper	
Gobionellus oceanicus	Esmeralda de mar	Highfin goby	
Gymnothorax funebris	Morena verde	Green moray	✓
Haemulon album	Ronco jallao	Margate	✓
Haemulon chrysargyreum	Ronco boquichica	Smallmouth grunt	
Haemulon flavolineatum	Ronco condenado	French grunt	✓
Haemulon parra	Ronco blanco	Sailors choice	
Haemulon plumierii	Ronco arará	White grunt	✓
Haemulon sciurus	Ronco amarillo	Bluestriped grunt	✓
Haemulon steindachneri	Ronco latino	Latin grunt	
Labrisomus nuchipinnis	Sapito cabezón	Hairy blenny	
Lophogobius cyprinoides	Gobio gallo	Crested goby	
Lutjanus analis	Pargo criollo	Mutton snapper	✓
Lutjanus cyanopterus	Pargo cubera	Cubera snapper	
Lutjanus griseus	Pargo mulato	Gray snapper	✓
Lutjanus jocu	Jocú	Dog snapper	✓
Lutjanus synagris	Biajaiba	Lane snapper	✓
Megalops atlanticus	Sábalo	Tarpon	
Micropogonias furnieri	Verrugato	Whitemouth croaker	
Mugil curema	Lisa blanca	White mullet	
Mugil liza	Lebrancho	Liza mullet	
Myrophis punctatus	Safío pecoso	Speckled worm eel	
Oligoplites saurus	Zapatero	Leatherjack	
Ophioscion adustus	-	Snake croaker	
Opisthonema oglinum	Machuelo	Atlantic thread	
Oreochromis mossambicus	Tilapia mosambica	Mozambique tilapia	
Poecilia vivipara	Gupi mino	Top minnow	
Polydactylus virginicus	Barbu	-	
Pomadasys corvinaeformis	Ticopa gris	Roughneck grunt	
Pomadasys crocro	Ticopa	Burro grunt	
Rypticus saponaceus	Jabonero grande	Greater soapfish	✓
Sardinella aurita	Sardina española	Spanish sardine	
Scomberomorus regalis	Cero	Painted mackerel	
Scorpaena plumieri	Escorpión negro	Spotted scorpionfish	
Sphoeroides spengleri	Tamboril manchado	Bandtail puffer	

Table 3-14, cont'd

SCIENTIFIC NAME	SPANISH COMMON NAME	ENGLISH COMMON NAME	REEF FISH FMP*
Sphoeroides testudineus	Tamborial rayado	Checkered puffer	
Sphyraena barracuda	Picúa	Great barracuda	
Stegastes diencaeus	Chopita miel	Longfin damselfish	
Stegastes planifrons	Chopita amarilla	Threespot damselfish	
Strongylura timucu	Agujón timucú	Longjaw	
Tilapia rendalli	Tilapia	Redbreast tilapia	
Trachinotus carolinus	Pámpano amarillo	Florida pompano	
Trachinotus falcatus	Pámpano	Permit	
Trachinotus goodei	Palometa	-	
Trichiurus lepturus	Sable	Atlantic cutlassfish	
Tylosurus crocodilus	Agujón lisero	Houndfish	
Umbrina coroides	Roncador	Sand drum	

*FMU: Species included as part of the Reef Fish Management Unit, as classified by the CFMC.

3.10.2.2.2 Near shore waters fish species

A total of 126 species of fish have been identified in the marine, coastal waters found north of the SJBE (CSA Architects & Engineers, LLP, 2014; ERM, 2013; Glauco A. Rivera & Associates, 2011). Seventy six (76) of these species have been classified and included by the CFMC in it's Reef Fish Management Plan (CFMC, 2004). Twenty (20) of these have been also found either in the CMP, the San José Lagoon and/or La Torrecilla Lagoon. The red hind, the yellowtail snapper, the banded butterfly fish and the foureye butterfly fish are managed by the CFMC (see Table 3-15).

Table 3-15. Fish species found in nearshore waters north of the SJBE, within the Study Area

SCIENTIFIC NAME	SPANISH COMMON NAME	ENGLISH COMMON NAME	REEF FISH FMP*
Abudefduf saxatilis	**Sargento mayor**	**Sergeant major**	✓
Abudefduf taurus	Sargento	Night sargent	
Acanthostracion polygonia	Chapín	Honeycomb cowfish	
Acanthostracion quadricornis	Chapín	Scrawled cowfish	
Acanthurus bahianus	Barbero	Ocean surgeonfish	✓
Acanthurus chirurgus	Barbero rayado	Doctorfish	✓
Acanthurus coeruleus	Barbero azul	Blue tag	✓
Amblycirrhitus pinos	Rayadito	Redspotted hawkfish	✓
Anchoa lyolepis	Anchoa mulata	Dusky anchovy	
Anisotremus virginicus	**Burro payaso**	**Porkfish**	✓
Apogon maculatus	Cardenal manchado	Flamefish	✓

Table 3-15, cont'd

SCIENTIFIC NAME	SPANISH COMMON NAME	ENGLISH COMMON NAME	REEF FISH FMP*
Atherinomorus stipes	Cabezote	Hardhead silverside	
Aulostomus maculatus	Trompeta del Atlántico	Trumpetfish	✓
Balistes vetula	Cochino	Queen triggerfish	✓
Bodianus rufus	Pez perro español	Spanish hogfish	✓
Bothus lunatus	Lenguado lunado	Peacock flounder	✓
Calamus calamus	Pez de pluma	Saucereye porgy	
Calamus pennatula	Bajonao plateado	Pluma porgy	✓
Cantherhines macrocerus	Lija de lunares blancos	Whitespotted filefish	✓
Cantherhines pullus	Lija colorada	Orangespotted filefish	
Canthigaster rostrata	Tamboril narizón	Sharpnose puffer	✓
Caranx crysos	**Cojinúa**	**Blue runner**	✓
Caranx latus	**Jurel blanco**	**Horse-eye jack**	✓
Caranx ruber	Cojinúa carbonera	Bar jack	✓
Carcharhinus perezii	Tiburón coralino	Caribbean reef shark	
Cephalopholis cruentata	Cherna enjambre	Graysby	✓
Cephalopholis fulva	Cabrilla roja	Coney	
Chaetodon capistratus	Mariposa ocelada	Foureye butterflyfish	✓
Chaetodon ocellatus	Mariposa perla amarilla	Spotfin butterflyfish	✓
Chaetodon sedentarius	Mariposa parche	Reef butterflyfish	
Chaetodon striatus	Mariposa arrayada	Banded butterflyfish	✓
Chromis cyanea	Cromis azul	Blue chromis	✓
Chromis insolata	Cromis sol	Sunshinefish	
Chromis multilineata	Cromis prieto	Brown chromis	
Clepticus parrae	Doncella mulata	Creole wrasse	
Coryphopterus glaucofraenum	Gobio con brida	Bridled goby	
Coryphopterus personatus	Gobio enmascarado	Masked goby	
Dasyatis americana	Raya americana	Southern stingray	
Decapterus macarellus	Antonino caballita	Mackerel scad	
Diodon holocanthus	Pez erizo	Balloonfish	
Diodon hystrix	**Puerco espín**	**Porcupine fish**	✓
Echeneis naucrates	Rémora rayada	Sharksucker	
Echidna catenata	Morena cadena	Chain moray	✓
Elacatinus evelynae	Gobio tiburoncito	Sharknose goby	
Epinephelus guttatus	Cabrilla colorada	Red hind	✓
Equetus lanceolatus	Payasito obispo	Jacknife-fish	✓
Equetus punctatus	Payasito punteado	Spotted drum	✓
Ginglymostoma cirratum	Tiburón gata	Nurse shark	
Gramma loreto	Loreto	Royal gramma	✓
Gymnothorax funebris	**Morena verde**	**Green moray**	✓
Gymnothorax moringa	Morena manchada	Spotted moray	
Gymnothorax vicinus	Morena amarilla	Purplemouth moray	

Table 3-15, cont'd

SCIENTIFIC NAME	SPANISH COMMON NAME	ENGLISH COMMON NAME	REEF FISH FMP*
Haemulon aurolineatum	Ronco jeníguaro	Tomtate	✓
Haemulon carbonarium	Ronco carbonero	Caesar grunt	
Haemulon flavolineatum	**Ronco condenado**	**French grunt**	✓
Haemulon macrostomum	Ronco español	Spanish grunt	
Haemulon parra	**Ronco blanco**	**Sailors choice**	
Haemulon plumierii	**Ronco arará**	**White grunt**	✓
Haemulon sciurus	**Ronco amarillo**	**Bluestriped grunt**	✓
Halichoeres bivittatus	Doncella rayada	Slippery dick	
Halichoeres garnoti	Doncella cabeciamarilla	Yellowhead wrasse	✓
Halichoeres maculipinna	Doncella payaso	Clown wrasse	✓
Halichoeres poeyi	Doncella ojinegra	Blackear wrasse	
Halichoeres radiatus	Doncella azulada	Puddingwife	✓
Harengula humeralis	Sardina de ley	Redear herring	
Heteropriacanthus cruentatus	Catalufa espinosa	Glasseye snapper	
Holacanthus ciliaris	Angel reina	Queen angelfish	✓
Holacanthus tricolor	Chabelita tricolor	Rock beauty	✓
Holocentrus adscensionis	Candil de vidrio	Squirrelfish	✓
Holocentrus rufus	Candil rufo	Longspine squirrelfish	✓
Hypleurochilus bermudensis	Borracho de barras	Barred blenny	
Labrisomus nuchipinnis	**Sapito cabezón**	**Hairy blenny**	
Lachnolaimus maximus	Pez perro	Hogfish	✓
Lactophrys bicaudalis	Chapín pintado	Spotted trunkfish	✓
Lactophrys triqueter	Chapín común	Smooth trunkfish	✓
Lutjanus apodus	Cají	Schoolmaster	✓
Lutjanus analis	**Pargo criollo**	**Mutton snapper**	✓
Lutjanus griseus	**Pargo mulato**	**Gray snapper**	✓
Lutjanus jocu	**Jocú**	**Dog snapper**	✓
Lutjanus synagris	**Biajaiba**	**Lane snapper**	✓
Malacanthus plumieri	Matajuelo blanco	Sand tilefish	✓
Megalops atlanticus	**Sábalo**	**Tarpon**	
Melichthys niger	Negrito	Black durgon	✓
Microspathodon chrysurus	Chopita de cola amarilla	Yellowtail damselfish	✓
Monacanthus ciliatus	Lija de clavo	Fringed filefish	
Mulloidichthys martinicus	Chivo amarillo	Yellow goatfish	✓
Myrichthys ocellatus	Safío ocelado	Goldspotted eel	✓
Myripristis jacobus	Candil barreado	Blackbar soldierfish	✓
Neoniphon marianus	Carajuelo mariano	Longjaw squirrelfish	
Ocyurus chrysurus	Colirubia	Yellowtail snapper	✓
Ophioblennius atlanticus	Blenio	Redlip blenny	✓
Ophioblennius macclurei	Blenio bembirrojo	Redlip blenny	

Table 3-15, cont'd

SCIENTIFIC NAME	SPANISH COMMON NAME	ENGLISH COMMON NAME	REEF FISH FMP*
Opistognathus aurifrons	Bocón cabeza amarilla	Yellowhead jawfish	✓
Pempheris schomburgki	Barrendero transparente	Glassy sweeper	
Pomacanthus arcuatus	Gallineta café	Gray angelfish	✓
Pomacanthus paru	Gallineta negra	French angelfish	✓
Priacanthus arenatus	Catalufa toro	Bigeye	✓
Prognathodes aculeatus	Mariposa narigona	Longsnout butterflyfish	
Pseudupeneus maculatus	Chivo manchado	Spotted goatfish	✓
Pterois volitans	Pez león	Lion fish	
Rypticus maculatus	Jabonero albipunteado	Whitespotted soapfish	
Scarus iseri	Loro listado	Striped parrotfish	
Scarus taeniopterus	Loro princesa	Princess parrotfish	✓
Scarus vetula	Loro reina	Queen parrotfish	✓
Scorpaena grandicornis	Escorpión plumeado	Plumed scorpionfish	
Scorpaena plumieri	**Escorpión negro**	**Spotted scorpionfish**	
Serranus annularis	Serrano naranja	Orangeback bass	✓
Serranus baldwini	Serrano linterna	Lantern bass	✓
Serranus tabacarius	Jácome	Tobaccofish	✓
Serranus tigrinus	Serrano arlequín	Harlequin bass	✓
Sparisoma aurofrenatum	Loro manchado	Redband parrotfish	✓
Sparisoma chrysopterum	Loro verde	Redtail parrotfish	✓
Sparisoma radians	Loro dientuso	Bucktooth parrotfish	
Sparisoma rubripinne	Loro coliamarilla	Redfin parrotfish	✓
Sparisoma viride	Loro brilloso	Stoplight parrotfish	✓
Sphoeroides spengleri	**Tamboril manchado**	**Bandtail puffer**	
Sphyraena barracuda	**Picúa**	**Great barracuda**	
Stegastes adustus	Chopita prieta	Dusky damselfish	
Stegastes fuscus	Damicela	Dusky damselfish	
Stegastes leucostictus	Chopita de cola amarilla	Beaugregory	
Stegastes partitus	Chopita bicolor	Bicolor damselfish	
Stegastes planifrons	**Chopita amarilla**	**Threespot damselfish**	
Stegastes variabilis	Chopita cacao	Cocoa damselfish	
Synodus intermedius	Lagarto manchado	Sand diver	✓
Thalassoma bifasciatum	Cara de cotorra	Bluehead wrasse	✓
Xyrichtys splendens	Doncella de lunar	Green razorfish	

Source: CSA Architects & Engineers, 2014; ERM, 2013; Glauco A. Rivera & Associates, 2011. *FMP: Species included as part of the CFMC Reef Fish Management Plan. Species in bold have been also found either in the CMP, the San José Lagoon and/or La Torrecilla Lagoon.

3.10.2.2.3 Invasive fish

The invasive red lionfish (*Pterois volitans*), although not documented in the CMP and the San José Lagoon, has been found at the Boca del Morro outlet and the Boca de Cangrejo outlet in the SJB and La Torrecilla Lagoon, respectively, and in the near shore reefs within the Study Area (CSA Architects & Engineers, 2014; ERM, 2013; Glauco A. Rivera & Associates, 2011). It is native from the Western and Central Pacific and Western Australia. The initial confirmed lionfish sighting in the United States occurred in 1985, off Dania Beach, Florida; today, it is fully established as a aquarium escapee throughout the Southeast United States, the Caribbean Sea, and much of the Gulf of Mexico, and reported as the first marine reef fish invasive species to this region (Morris, 2012).

Lionfish have broad diet and can inhabit various marine and near shore habitats. As such, have the potential to affect the structure and function of many Atlantic marine communities- from the sea surface to depths exceeding 1,280 feet, and across habitats ranging from coral and hardbottom to artificial reefs, mangroves, seagrass beds and even brackish estuaries (Zachary, Nichols & Layman, 2014; Morris, 2012).

Higher densities of lionfish have been found in deeper reefs (33-98 feet) than in other shallow habitats (e.g., seagrass beds, mangroves, sheltered reefs), which may suggest a preference on the former (Brightman-Claydon et al., 2012). However, these and other authors have found evidence that demonstrate that lionfish can feed, colonize and thrive in mangrove habitats; at least as opportunistic forages, as this species can tolerate broad salinity concentrations (Zachary, Nichols and Layman, 2014; Pimiento et al., 2013; Barbour et al., 2010).

Morris (2012) reported that lionfish may trigger cascading impacts through their disruption of the food web due to its consumption of herbivorous fishes that could reduce the functional role of herbivores in keeping algae in check, a process known to be important for the health of coral reefs. Lionfish may also compete for resources — principally food and space — with economically important species, such as snapper (Lutjanids) and grouper (Epinephelids); may occupy similar habitats and consume similar prey to many species of native fish predators and macroinvertebrates, and competition with this invasive species may affect the behavior, distribution, growth, survival, and, ultimately, population size of these ecologically similar native species (Morris, 2012).

3.11 SPECIES OF SPECIAL CONCERN

3.11.1 Federally Listed Species

In the Study Area, there are four federally listed species of flora and 15 species of fauna under the Endangerd Species Act (ESA). Table 3-16 shows those federally listed species that have been found in the municipalities of the Study Area (i.e., Cataño, Guaynabo, San Juan, Carolina and Loíza), as identified by the USFWS in the Caribbean Endangered Species Map as well as other sources. None of these, however, have been found in the Project Area.

3.11.1.1 Flora

According to the The USFWS Caribbean Endangered Species Map (2012)[17], federally listed plant species include:

- 2 threatened, Schoepfia arenaria and Stahlia monosperma; and
- 2 endangered, Banara vanderbiltii and beautiful goetza (Goetzea elegans).

All have been documented in the Study Area, but none of these are found within the Project Area.

3.11.1.2 Fauna

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 seaturtles 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.*

However, after reviewing many published reports and historical records, reports documenting the presence of any sea turtles species in the immediate vicinity of the Martín Peña Channel were not found. No sightings have been reported in the inner San Juan Bay (e.g., Army Terminal, Graving Dock, and Puerto Nuevo navigational channels area), the Puerto Nuevo-CMP outlet, or in the western half of the CMP, where no suitable sea turtle habitat exists. The closest sightings are those at the opposite end in the San Juan Bay, at the Boca del Morro outlet, where hawksbill sea turtles have been observed foraging in its hard bottoms and submerged rocky shorelines.

[17] The USFWS Caribbean Endangered Species Map (2012) provides the latest official reference for the identification of general locations (municipalities) where federally listed species, according to the Endangered Species Act (ESA), may be found. This publication presents the best available information, although it does not represent the absolute distribution of a particular species since additional sightings may occur.

Table 3-16. Federally threatened and endangered listed species in the Study Area

SCIENTIFIC NAME	COMMON NAME (ENGLISH / SPANISH)	GROUP	STATUS	GENERAL DISTRIBUTION	DESCRIPTION
FLORA					
Banara vanderbiltii	No common name/ Palo de Ramón	Plant	E	Karst and volcanic forests	Originally reported in the early twentieth century in the "mogotes" adjacent to the CMP. This species, however, has not been documented ever since in this vicinity, probably eliminated due to limestone and fill mining, and the consequent destruction of these "mogotes" during the mid-decades of that century. It is believed to no longer persist in this area (USFWS, 2014).
Goetzea elegans	Beautiful goetzea/Matabuey	Plant	E	Karst forests	Trees were planted immediately west of the San José Lagoon as part of a restoration project conducted by the SJBEP during the early 2000s, in an upland buffer strip between the mangrove fringing the lagoon and a local road adjoining Las Margaritas Public Housing Project, in the Cantera community.
Schoepfia arenaria	No common name/ No tiene nombre común	Plant	T	Karst and coastal forests	Originally reported in the early twentieth century. Was first documented in the sandy coastal thickets north of the San José Lagoon, but it has not been recorded ever since in that area.
Stahlia monosperma	No common name/ Cóbana negra	Plant	T	Coastal forests	Trees were planted immediately west of the San José Lagoon as part of a restoration project conducted by the SJBEP during the early 2000s, in an upland buffer strip between the mangrove fringing the lagoon and a local road adjoining Las Margaritas Public Housing Project, in the Cantera community.
FAUNA					
Chelonia mydas	Green sea turtle / Peje blanco	Reptile	T, CH	Nearshore waters	Found in marine habitats. Inhabits and feeds on seagrass beds. Have been reported in the nearshore waters at the Study Area. It is highly improbable for sea turtles to use or be present in the CMP and the San José Lagoon given that it does not provide habitat conditions for nesting or their sustenance.
Dermochelys coriacea	Leatherback sea turtle / Tinglar	Reptile	E, CH	Ocean waters	Is a pelagic species. There are records of *D. coriacea* nesting in the sandy beaches that are also part of the Study Area (CSA Architects & Engineers, LLP, 2014; ERM, 2013; Glauco A. Rivera & Associates, 2011; CFMC, 2004). Leatherback marine turtles approach the north shore of Puerto Rico during their nesting season (March-June) and may be present in offshore waters during this time, but basically spend the rest of their adult lives as a pelagic species in deep waters of the Atlantic Ocean. Has been reported in the nearshore waters at the Study Area. It is highly improbable for sea turtles to use or be present in the CMP and the San José Lagoon given that it does not provide habitat conditions for nesting or their sustenance.
Eretmochelys imbricata	Hawksbill sea turtle / Carey	Reptile	E, CH	Nearshore waters	Found in coral reefs and other hard bottom communities. Has been sighted foraging in the rocky shores of Boca del Morro, at the outlet of SJB, as well as in the nearshore coral reefs within the Study Area. Highly improbable in the CMP and the San José Lagoon.

Table 3-16, cont'd

SCIENTIFIC NAME	COMMON NAME (ENGLISH / SPANISH)	GROUP	STATUS	GENERAL DISTRIBUTION	DESCRIPTION
Epicrates inornatus	Puerto Rican boa / Boa puertorriqueña	Reptile	E	Forested hills	No Puerto Rican boas (*Epicrates inornatus*) have been reported in the Project Area. Although suitable but limited habitat for this boa exists in the remaining haystack hills or "mogotes" found close to the Eastern CMP, these have been isolated for many years due to urban encroachment. The latest may have become a physical barrier that could have limited this species dispersal into other forested areas nearby, resulting in no reports of its presence in the mangroves fringing the channel.
Trichechus m. manatus	Antillean manatee / Manatí	Mammal	E	Nearshore waters	Has been documented in ocean waters within the Study Area. It has been observed in the SJB and the estuary portion of the Puerto Nuevo River and ranges freely between marine and freshwater habitats. This species has specific habitat requirements that include adequate feeding areas, freshwater drinking sources and areas protected from surf and wind where they can rest. Manatees are herbivores that feed opportunistically on a wide variety of marine, estuarine, and freshwater plants, including submerged, floating, and emergent vegetation, including: cord grass, algae, turtle grass, shoal grass, manatee grass, eel grass, water hyacinth, water lettuce and other plant types, some of which are found within the Project Area. In addition, there are a number of freshwater sources, such as stormwater discharges and those from the Juan Méndez and San Antón creeks, that discharge into the San José Lagoon and that this species could use for drinking, although not suitable due to their poor quality.
Agelaius xanthomus	Yellow-shouldered black bird / Mariquita	Bird	E	Coastal forests	Occurs regularly, but only locally, along the southwestern coast of Puerto Rico and on Mona Island. It is decidedly uncommon elsewhere. The species is found primarily in mangroves and arid scrublands, foraging both in trees and on the ground, feeding on insects, seeds and nectar. Is critically endangered mostly due to nest parasitism, but also as a result of expansive habitat loss. Other threats include mongoose and rat predation (Raffaele et al., 1998). In the Study Area, it has been reported in Las Cucharillas Marsh and in the Piñones-Vacía Talega-Torrecillas complex; the latter has suitable, ample habitat for this species. Was documented at the western half of the CMP in the early 1980s, (Rivera Herrera, 1996). Habitat loss from severe urban encroachment, the improper disposal of household waste and predation by rats, could have deterred its presence in the Eastern CMP and the San José Lagoon, where no sightings have been reported.

Table 3-16, cont'd

SCIENTIFIC NAME	COMMON NAME (ENGLISH / SPANISH)	GROUP	STATUS	GENERAL DISTRIBUTION	DESCRIPTION
Sterna dougallii	Roseate tern / Palometa	Bird	T	Coastal waters and wetlands	This West Indies subspecies of the roseate tern is found in coastal areas, harbors and lagoons, nesting in a sand or coral scrape, or in a rock depression, usually in colonies on an offshore cay. The Virgin Islands and islets off southwestern Puerto Rico support the largest population of roseate tern in the tropical Atlantic (Raffaele et al., 1998). The subspecies has been documented in the Piñones-Vacía Talega-Torrecillas complex, at the eastern end of the Study Area. In the early 1980s, it was sighted with other terns, gulls and shorebirds on the mudflats that once existed in the western end of the CMP, at its outlet to the SJB (Rivera Herrera, 1996). This tern subspecies has not been reported in the Eastern CMP or the San José Lagoon. Poor water quality (i.e., low DO) and its detrimental effect over fish populations, low water transparency which difficult visibility, and thus, fish capture opportunities, present marginal to poor feeding habitat conditions for this species in these two water bodies.
Calidris canutus	Red knot / Playero gordo	Bird	T	Tidal saltflats and mudflats	Found in the Study Area. This species, considered one of the longest distance migrants in the animal kingdom. Depends on horseshoe crabs' eggs for the energy it needs to make its twice-yearly trips between South America and the Canadian Arctic. Thus, as crab populations decline due to harvest by the fishing and biomedical industries, so do the red knot's. The bird is also threatened by habitat destruction and climate change. It is generally rare through the West Indies in September and October during its southbound migration. It apparently flies long distances between stops, many birds likely overflying the region. It is generally found in sandy tidal flats (Raffaele et al, 1998). In the early 1980s, it was sighted with other shorebirds on the mudflats that once existed in the western end of the CMP, at its outlet to the SJB (Rivera Herrera, 1996). It has not been sighted since then in the Study Area. Its occurrence in the Project Area is unlikely due to the absence of proper habitat conditions to support its presence.
Acropora palmata	Elkhorn coral / Coral cuerno de alce	Coral	T	Nearshore waters	Found in the Study Area, north of the SJBE. Was formerly the dominant species in shallow water reefs 3 to 16 feet deep throughout the Caribbean, forming extensive, densely aggregated thickets (stands) in areas of heavy surf. Coral colonies prefer exposed reef crest and fore reef environments in depths of less than 20 feet., although isolated corals may occur to depths of 65 feet. Over the last 10,000 years, this species has been one of the three most important Caribbean corals contributing to reef growth and development, providing essential fish habitat.[18]

[18] http://www.nmfs.noaa.gov/pr/species/invertebrates/elkhorncoral.htm

Table 3-16, cont'd

SCIENTIFIC NAME	COMMON NAME (ENGLISH / SPANISH)	GROUP	STATUS	GENERAL DISTRIBUTION	DESCRIPTION
Acropora cervicornis	Staghorn coral / Coral cuerno de ciervo	Coral	T	Nearshore waters	Found in the Study Area, north of the SJBE. The staghorn coral is also another of the three most important Caribbean corals in terms of its contribution to reef growth and fish habitat found in reefs within the Study Area. This species occur in back reef and fore reef environments from 1 to 100 feet deep. The upper limit is defined by wave forces, and the lower limit is controlled by suspended sediments and light availability.[19]
Dendrogyra cylindrus	Pillar coral/Coral pilar	Coral	T	Nearshore waters	Found in the Study Area, north of the SJBE. Has been reported in most reef environments, although in some regions it appears to be absent in nearshore hard bottoms, nearshore patch reefs, and backreef environments and more common on forereef spurand-groove habitats. It has been reported in water depths ranging from 6.6 to 82.0 feet.
Mycetophyllia ferox	Rough cactus coral/Coral cactus áspero	Coral	T	Nearshore waters	Found in the Study Area, north of the SJBE. Has been reported to occur in shallow reef environments, in water depths ranging from 16.4 to 98.4 feet.
Orbicella annularis	Lobed star coral/Coral estrella	Coral	T	Nearshore waters	Found in the Study Area, north of the SJBE. *Orbicella* spp. are a common, often dominant component of Caribbean mesophotic reefs suggesting the potential for deep refugia (Smith et al., 2010 as cited in Brainard et al., 2011). The lobed star coral (*O. annularis*) has historically been one of the primary reef framework builders of the western Atlantic and Caribbean, ranging in depths from 3.3 to 98.4 feet, and has been considered a highly plastic species with multiple growth forms ranging from columnar, to massive, to platy.
Orbicella faveolata	Mountainous star coral/Coral Estrella laminar	Coral	T	Nearshore waters	Found in the Study Area, north of the SJBE. Has been reported in most reef habitats, often the most abundant coral found between 32.8 and 65.6 feet, in forereef environments, but also found between 1.6 to 131.2 feet.
Orbicella franksi	Knobby star coral/Coral Estrella masivo	Coral	T	Nearshore waters	Found in the Study Area, north of the SJBE. Occupies most reef environments, and has been reported from water depths ranging from 16.4 to 164.0 feet. It tends to have a deeper distribution than the other two species in the *Orbicella* complex.

Table legend: E: Endangered / T: Threatened / CH: Critical Habitat

Sources: ERM, 2013; USFWS, 2012; NOAA, 2014.

[19] http://www.nmfs.noaa.gov/pr/species/invertebrates/staghorncoral.htm

The same applies to most of La Torrecilla Lagoon. Hawksbill and green sea turtles have been documented foraging in the submerged hard bottom communities and seagrass beds found in the Isla Verde area, respectively, on the ocean side of the Boca de Cangrejos outlet, and very rarely, in the vicinity of the Boca de Cangrejos Yacht Club, in the northernmost part of the Lagoon. There is no suitable habitat available for sea turtles farther south in La Torrecilla Lagoon nor the Suárez Canal; both waterbodies need to be cross in order to reach the San José Lagoon from the East, including the shallow, narrow mid-section of the Suárez Canal that is severely constricted by the Ramón Baldorioty De Castro Expressway bridge pilings. Thus, and for practical purposes, this segment of the Suárez Canal constitutes an obstruction for these species. Therefore, sea turtles sightings in the CMP-ERP Study Area have only been reported outside and quite distant (Boca del Morro: ±4.5 miles to the northwest; Boca de Cangrejos: ±3.5 miles to the northeast) from the Project Area (i.e., Eastern CMP and the San José Lagoon).

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.

After reviewing many published reports and historical records, no reports documenting the presence of manatees within the Project Area were found. The closest manatee sightings have been reported in the Puerto Nuevo River Channel, where the CMP empties towards the West. Manatees have been also observed foraging in the seagrass beds found in the Isla Verde area, respectively, on the ocean side of the Boca de Cangrejos outlet, and very rarely, in the vicinity of the Boca de Cangrejos Yacht Club, in the northernmost part of La Torrecilla Lagoon. Access to the San José Lagoon from the East is limited by the Boca de Cangrejos outlet and south, through La Torrecilla Lagoon; more so through the mid-section of the Suárez Canal where the Baldorioty De Castro's Bridge pilings severely restrict flow. There is no access for manatees into or through the Eastern CMP. As a result, it is extremely unlikely for manatees to be found in those sections of the Project Area where the proposed construction activities would take place within the Eastern CMP and the San José Lagoon.

Birds: The federally endangered 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.

3.11.2 Commonwealth Listed Species

The DNER has designated 39 species of special concern under the Regulation for Threatened and Endangered Species of the Commonwealth of Puerto Rico (Reg. 6766). These include nineteen (19) species listed under ESA, in addition to other nine (9) species that have been designated as threatened, endangered or critically endangered by the DNER. The remaining eleven (11) species have been designated or classified under other categories. (see Table 3-16).

Two species of seahorses, listed as a threatened are found in the Study Area, but none in the Project Area. These are the lined seahorse (*Hippocampus erectus*) and the longsnout seahorse (*Hippocamus reidi*). There are 12 species of listed 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 slyder (*Trachemys s. stejnegeri*) that can be found in the Study and Project areas. Likewise, two species of crustaceans are listed as data defficient, 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*). The description and occurrence of these Commonwealth listed species is included in Table 3-17.

3.11.2.1 Other Commonwealth critical elements[20]

There are 3 species of plants identified as critical elements (i.e., of special concern) by the DNER: *Ceiba pentandra, Coccoloba rugosa and Guaiacum officinale* (see Table 3-18). These are found immediately adjacent or within the Project Area. *C. pentandra, C. rugosa* and *G. officinale* are planted

[20] The DNER maintains a list of critical elements that includes species important to the Puerto Rican heritage or some endemics that, although very abundant, are considered critical elements, besides those federally or locally listed species.

Table 3-17. Additional species listed by the Commonwealth of Puerto Rico reported in the Study Area

SCIENTIFIC NAME	COMMON NAME (ENGLISH/ SPANISH)	GROUP	STATUS	GENERAL DISTRIBUTION	DESCRIPTION
Hippocampus spp.	Sea horses / Caballitos de mar	Fish	T	Marine	These are two species of seahorses reported for Caribbean waters, although uncommon to rare (Humman, 1994). These use gorgonians branches, seagrass leaves as holdfasts, and occasionally can be seen floating free over seagrass, reefs, and in sargasum. Individuals have been reported in the Study Area, within the Condado Lagoon, where seagrasses and coral communities are present. These might also be found in nearby ocean waters north of SJBE where suitable habitat conditions exist. As such, it is improbable that seahorses inhabit the CMP and the San José Lagoon, since habitat requirements are not available.
Ammondramus savanarum	Grasshopper sparrow / Gorrión chicharra	Bird	DD	Savannas	Is a secretive, small bird and year-round resident. It has been documented at the eastern and western ends of the Study Area, in Las Cucharillas Marsh and the Piñones-Vacía Talega-Torrecillas complex, respectively, where suitable habitat such as marshes and pastures with tall grasses abound (Raffaele et al., 1998). With the exception of a small and limited weedy field adjoining the southeastern, landward side of the San José Lagoon, between the mangroves and an adjoining state road (PR-8) this type of habitat is not found in the Project Area. As a result, there is no record for this species in the Project Area and its occurrence is unlikely.
Nomonix dominica	Masked duck/Pato dominico	Bird	EN	Ponds	Has been documented in the Study Area, but only in the Piñones-Vacía Talega-Torrecillas complex (Rivera-Herrera, 1996). It is a rare native species that frequents thick, aquatic vegetation in fresh water swamps and canals (Raffaele et al., 1998). These same habitat characteristics are found in the southern and eastern sections of the Piñones-Vacía Talega-Torrecillas complex, where seasonal ponds and drainage canals exist (SJBEP, 2000). The outlets of the Juan Méndez and San Antón creeks flowing into the San José Lagoon tend to accumulate floating vegetation, although these covered a relatively small surface area. Besides been estuarine or brackish in nature, this area is also more of an open water habitat. The lack of historical records and proper habitat characteristics could explain the absence of this species in the Project Area.

Table 3-17, cont'd

SCIENTIFIC NAME	COMMON NAME (ENGLISH/ SPANISH)	GROUP	STATUS	GENERAL DISTRIBUTION	DESCRIPTION
Oxyura jamaicensis	Ruddy duck/Pato chorizo	Bird	T	Coastal lagoons	Has been reported in a man-made fresh water lagoon at Las Cucharillas Marsh, within the Study Area (Rivera-Herrera, 1996). Native to Puerto Rico, it is a diving duck, found predominantly in deep, open freshwater bodies but also in brackish lagoons (Raffaele et al., 1998). Even though the San José Lagoon presents, at the least, marginal habitat requirements for this species, its low water quality and overall poor natural condition may have precluded the ruddy duck from the Project Area. There is no record for this species in the Project Area.
Dendrocygna arborea	West Indian whistling duck/ Chiriría antillana	Bird	CR	Coastal lagoons	Native to Puerto Rico, is a rare and local species. Its decline appears primarily due to habitat destruction, hunting, and to a lesser extent, introduced predators. Flocks are observed most regularly in early evening flying from mangroves or freshwater swamps where they roost during the day to nocturnal feeding grounds which include stands of the royal palm (*Roystonea borinquena*) and agricultural fields. Its habitat includes also wooded swamps, lagoons and uplands (Raffaele et al., 1998). Has been reported in Las Cucharillas Marsh and the Piñones-Vacía Talega-Torrecillas complex, where a matrix of mangroves, lagoons, swamps (*Pterocarpus offinalis*), fresh water ponds, marshes and grasslands of considerable size and in close connection can still be found (SJBEP, 2000; Rivera Herrera, 1996). The overall degradation of forested wetlands in the Project Area due to urban encroachment and improper household waste disposal, in addition to the resulting fragmentation of the natural landscape and high numbers of introduced predators (e.g., rats and cats), may have been enough of a cause for the absence of a single record for this species in this area, even though there seems to be at least marginal habitat characteristics to sustain its presence.
Charadrius alexandrinus	Snowy plover/ Playero blanco	Bird	CR	Sand, mud, salt flat	In the Study Area, it was found in the early 1980s at the western end of the CMP, in the mudflats that once existed at the channel's outlet to the SJB (SJBEP, 2000; Rivera Herrera, 1996). It inhabits, primarily, beaches and lagoon borders with extensive salt flats. None of these habitat requirements are found in the Eastern CMP and the San José Lagoon, possibly explaining the reason why no snowy plovers have ever been recorded to this date (Raffaele et al., 1998).

Table 3-17, cont'd

SCIENTIFIC NAME	COMMON NAME (ENGLISH/ SPANISH)	GROUP	STATUS	GENERAL DISTRIBUTION	DESCRIPTION
Anas bahamensis	White-cheeked pintail / Pato quijada colorada	Bird	T	Coastal swamps	In the Study Area, it is found in Las Cucharillas Marsh and the Piñones-Vacía Talega-Torrecillas complex. In the early 1980s, it was reported at the western half of the CMP (Rivera Herrera, 1996). Locally uncommon in the Island, it is a surface feeder, primarily on fresh water, but also salt ponds (Raffaele et al., 1998). Low water quality, depth and overall poor natural condition may have deterred its presence in the Eastern CMP and the San José Lagoon, from which there are no records of its presence.
Icterus dominicensis	Black cowled oriole/ Calandria	Bird	DD	Forested areas	Has been reported at the Study Area, in the western half of the CMP and the Piñones-Vacía Talega-Torrecillas complex, but not in Eastern CMP and the San José Lagoon (Rivera Herrera, 1996). This endemic species is found in forests, forest edges, woodlands and gardens from the coast to mid-elevations in the mountains, particularly where palms are available for nest sites. It feeds on fruits, insects, flowers and nectar, often on the undersides of palm fronds (Raffaele et al., 1998). Has been heavily affected by bird parasitism and may be in decline.
Falco peregrinus	Peregrine falcon/ Halcón peregrino	Bird	CR	Coast	This species is decidedly uncommon to rare, and a local non-breeding winter resident throughout the West Indies primarily from October to April. Peregrine falcons are found in offshore cays and rocks, wetlands, and sometimes inland, including high buildings and church steeples, hunting for seabirds, shorebirds, waterfowl and rock doves (*Columba livia*), among other birds these can prey, accordingly (Raffaele et al., 1998). It has been recorded in Las Cucharillas Marsh, the Piñones-Vacía Talega-Torrecillas complex, and flying over the CMP and the San José Lagoon (INCICO & Expediciones Península, 2011; Rivera Herrera, 1996). Was de-listed from Federal regulations on October, 2006 due to its population recovery (71 Federal Register 60563). However, it is still classified as CR by the Commonwealth's government.

Table 3-17, cont'd

SCIENTIFIC NAME	COMMON NAME (ENGLISH/ SPANISH)	GROUP	STATUS	GENERAL DISTRIBUTION	DESCRIPTION
Vireo latimeri	Puerto Rican vireo/ Bienteveo	Bird	LR	Forested areas	Has been observed in the Study Area in Las Cucharillas Marsh, in the mangroves of the Piñones-Vacía Talega-Torrecillas complex where it is common, and in the western half of the CMP. It has also been documented in the Eastern CMP (Atkins, 2011c; Rivera Herrera, 1996). This endemic species avoids open areas and is found in forests of all types and at all elevations, including mangroves, dry coastal scrub, moist limestone hills and wet mountain forests, including shade coffee plantations. It is most common in the haystack hills of the north coast and in the more heavily forested valleys among the hills of the south coast of the Island. Puerto Rican vireos forages at all levels, but more frequently near the ground. It feeds primarily on insects, but eats some plant matter (Raffaele et al., 1998). As such, habitat in the Eastern CMP and the San José Lagoon is of poor to marginal conditions due to overall environmental degradation (e.g., improper household waste disposal, high numbers of introduced predators such as rats and cats, etc.), may be limiting the presence of the species in this area.
Sterna a. antillarum	Least tern/ Gaviota chica	Bird	DD	Coast	Its habitat includes coastal areas, harbors and lagoons. It is a generally common, but local breeding resident in the Greater Antilles. The least tern race inhabiting the West Indies also breeds on both coasts of the United States where some local populations are considered endangered. While human disturbance and introduced predators have doubtless impacted the West Indian population, the limited information available on the bird's status in the Caribbean does not warrant this tern being classified as threatened (Raffaele et al., 1998). In the Study Area, the least tern has been observed in the San Juan Bay, the Piñones-Vacía Talega-Torrecillas complex, and the western half of the CMP. In has also been observed flying over the San José Lagoon (INCICO & Expediciones Península, 2011; Rivera Herrera, 1996). Poor water quality (i.e., low DO) and its detrimental effect over fish populations, low water transparency which difficults visibility, and thus, fish capture opportunities, present marginal to poor feeding habitat conditions for this species in the Eastern CMP and the San José Lagoon.

Table 3-17, cont'd

SCIENTIFIC NAME	COMMON NAME (ENGLISH/ SPANISH)	GROUP	STATUS	GENERAL DISTRIBUTION	DESCRIPTION
Patagioenas leucocephala	White-crowned pigeon / Paloma cabeciblanca	Bird	DD	Coastal forests	Is a highly gregarious, arboreal species typically occurring in flocks, primarily on coastal woodlands and mangroves when breeding, but also well inland into the mountains as they follow available food resources in the non-breeding season. It is a locally common resident remaining year-round in Puerto Rico. Formerly abundant through most of its range, this species has declined dramatically due to habitat loss, severe over-hunting, harvesting of nestlings for food and introduced predators (Raffaele et al., 1998). In the Study Area, the species has been reported in the Piñones-Vacía Talega-Torrecillas complex, as well as in the San José Lagoon (INCICO & Expediciones Península, 2011; Rivera-Herrera, 1996). Urban encroachment and overall habitat degradation could be significant factors that have discouraged or limited its presence in the Eastern CMP and the San José Lagoon.
Fulica caribaea	Caribbean coot/ Gallinazo antillano	Bird	T	Swamp, marsh	Is an uncommon and local year-round resident in Puerto Rico, primarily found in open freshwater bodies where it dives profficiently. This species has apparently diminished greatly throughout the West Indies because of hunting, habitat degradation and due to introduced predators (Raffaele et al., 1998). In the Study Area, this species has been located in Las Cucharillas Marsh, the Piñones-Vacía Talega-Torrecillas complex, and the San José Lagoon (INCICO & Expediciones Península, 2011; Rivera- Herrera, 1996). Less than marginal habitat conditions in the San José Lagoon, to even poorer in the CMP due to low water quality and overall natural degradation could presently be discouraging or severely limiting Caribbean coots in these two water bodies.
Trachemys s. stejnegeri	Puerto Rican slyder/ Jicotea	Reptile	DD	Waterbodies	Found in fresh (i.e., rivers, streams, creeks, ponds and drainage channels) and brackish (i.e., lagoons) waterbodies all around the coast, mostly at low elevations, although some populations have also been reported in the Island's interior. The species, however, is restricted to those waterbodies with abundant aquatic plants and soft soils in their banks. With the possible exception of the SJB, the Puerto Rican slyder can be sighted in the rest of the Study Area, where it is quite common, including the CMP and the San José Lagoon. This fresh water turtle has been affected by loss or degradation of habitat and the predation of its eggs by the introduced mongoose. Other introduced predators that may be affecting the Puerto Rican slyder include the spectacled caiman (León, A. and R. L Joglar, 2005). The main reason for concern is habitat competition and possible hybridization with the Red-eared slyder (*Trachemys scripta elegans*) an exotic, fresh water turtle introduced as a pet that has been successfully established in the Island.

Table 3-17, cont'd

SCIENTIFIC NAME	COMMON NAME (ENGLISH/ SPANISH)	GROUP	STATUS	GENERAL DISTRIBUTION	DESCRIPTION
Uca sp.	Fiddler crab/ Cangrejo violinista	Crab	DD	Mangroves	Very few sites in the Project Area, especially within the CMP, display the faunal communities typically associated with mangrove wetlands due to the huge amount of fill material, scrap and trash deposited. Virtually absent are the fiddler crabs of the genus *Uca*, the mangrove crabs of the genus *Goniopsis*, *Aratus* and *Ucides*, and the land crab of the genera *Cardisoma*. This condition, although much less severe, is still apparent in the San José Lagoon. Mangrove forests and other vegetated areas are more extensive in this lagoon when compared to that of the Eastern CMP, providing more fauna habitat and refuge from the encroaching urban landscape. However, low water quality is still pervasive. Although classified as low risk by the Commonwealth government, and thus, not listed as threatened or endangered, it is worth noticing that these crab species are staples for egrets, herons, and other wetland dwellers, contributing to the overall food web, and as a result, are an essential component of the mangrove forest ecosystem.
Goniopsis cruentata	Mangrove root crab/ Cangrejo de mangle	Crab	LR	Mangroves	
Aratus pisonii	Mangrove tree crab/ Juey de mangle	Crab	DD	Mangroves	
Cardisoma guanhumi	Common land crab/ Juey común	Crab	LR	Coastal wetland	
Ucides cordatus	Swamp ghost crab / Juey pelú	Crab	LR	Mangroves	

Source: DNER Regulation for Threatened and Endangered Species of the Commonwealth of Puerto Rico, No. 6766.

Table legend: DD: Data deficient / EN: Endangered / T: Threatened / CR: Critically Endangered / LR: Low Risk)

Table 3-18. Species identified as critical elements by the DNER in the Study Area

SCIENTIFIC NAME	COMMON NAME (ENGLISH / SPANISH)	GROUP	STATUS	GENERAL DISTRIBUTION	DESCRIPTION
Ceiba pentandra	Silk-cotton tree/ Ceiba	Plant	CE	Forest, riverbanks	*C. pentandra* is a tree native to tropical America. In Puerto Rico, it is more abundant in the dry south, generally found in forests on hillsides and river banks, at lower elevations.
Coccoloba rugosa	Tree / Ortegón	Plant	CE	Karst, coastal forests	*C. rugosa* is an endemic, small tree, local and uncommon in moist coastal and lower Cordillera forests, including the karst region.
Guaiacum officinale	Lignum vitae/ Guayacán	Plant	CE	Forest, thickets	*G. officinale* is a tree native to tropical America. In Puerto Rico, is normally found in woodlands, thickets, on plains and hillsides, at lower elevations, in the dry southern and southwestern region of Puerto Rico.

Source: DNER. List of Critical Elements under the Natural Heritage Program. 2008.

Table legend: CE: Critical element.

immediately west of the San José Lagoon, in uplands between the mangroves fringing the lagoon and a local road adjoining Las Margaritas Public Housing Project, in the Cantera community, where the SJBEP conducted a restoration project during the early 2000s. Individuals of *C. rugosa* have been found in upland at the Guachinanga islet (INCICO and Corporación Proyecto Península de Cantera, 2009).

3.12 LAND USE AND INFRASTRUCTURE

3.12.1 Land Use

The Study Area is located within the SJMA, whose population and urban landscape is the densest and most developed in Puerto Rico, respectively. The lands adjoining the Eastern CMP and the San José Lagoon are characterized by two general or broad types of land use: (1) high density urban development and (2) open waters and green areas.

High density urban development corresponds to those communities surrounding the Eastern CMP. Those areas are characterized by substandard housing built on top of what were originally mangrove forests and open waters of the CMP. In the Eastern CMP, green areas are mostly restricted to a narrow strip of mangroves that have grown intermingled on top of debris used to fill its wetlands and open waters. Mangrove forests of variable width are found fringing the shores of the San José Lagoon. An upland secondary forest is found in the CDRC staging area. While open waters in the Project Area include the San José Lagoon and a small section of the Eastern CMP.

Four natural areas within the Study Area have been protected in recognition of their extraordinary biological value: Las Cucharillas Marsh Nature Reserve, the Caño Martín Peña Nature Reserve (western half), the Piñones State Forest Nature Reserve and the Isla Verde Reefs Nature Reserve. In addition, and although not geographically defined by the CFMC, the SJBE, including the Project Area, can be considered as a Habitat Areas of Particular Concern (HAPC) since estuaries have been generically identified as such due to their importance as nursery grounds for commercially important fish species.

3.12.2 Infrastructure

Several critical infrastructure components of the SJMA are found in the Project Area, such as highway bridges, regional water transmission lines and trunk sewers, among others.

3.12.2.1 Bridges

There are four bridges crossing the Eastern CMP (see Figure 3-8):

- The Luis Muñoz Rivera Avenue Bridge carries two lanes of traffic from Luis Muñoz Rivera Avenue and three lanes of traffic from Fernández Juncos Avenue in the southbound direction, as well as a dedicated northbound bus lane. Curb and gutter with sidewalks exist on both sides of the south approach and along Fernández Juncos Avenue to the north. No sidewalks are currently provided on the bridge. The total bridge deck is 80.1 feet wide. The total bridge length is 810 feet, as measured between the face of the abutments. Existing vertical clearance measures approximately 10.5 feet (HDR, 1999, as cited in Atkins 2014b). The bridge has two piers within the channel. It shows evidence that additional lanes have been added to its structure. Also evident are signs of considerable deterioration (Atkins 2014b).

- The Tren Urbano railway carries the Puerto Rico Department of Transportation and Public Works heavy rail system, serving the municipalities of San Juan, Bayamón and Guaynabo. The portion of the railway over the CMP includes three spans varying in length from 89.24 feet to 157.45 feet. Clearances above the water surface are more than 40 feet. The guideway is supported by cylindrical concrete columns on concrete pile caps.
- The Juan Ponce de León Bridge (Martin Peña Bridge) carries Highway 25 traffic in the northbound direction, with a dedicated southbound bus lane. This is a historic bridge built in 1939. It is 55.4 feet wide and carries four northbound lanes with a raised sidewalk and a pedestal and decorative rail type barrier on both sides. The structure is comprised of five spans for a total length of 241 feet as measured between the face of the abutments. Existing vertical clearance measures approximately 10.2 feet (HDR, 1999 as cited in Atkins, 2013b).
- The Barbosa Avenue Bridge carries Highway 27 traffic in both the northbound as well as the southbound direction. It was constructed in 2007, immediately west of its predecessor. The bridge is 79.9 feet wide and has two lanes and a sidewalk in each direction, plus one bike lane. The structure is comprised of three spans for a total length of 355.6 feet, as measured between the face of the abutments. Its highest point is elevation 35.5 feet.
- The Martí Coll Linear Park is part of a 1 mile long raised pedestrian walkway connecting the Hato Rey financial district to the Parque Central Sport Complex in Santurce. The structure is an 8 foot-wide concrete walkway with metal railing supported on concrete piles running along the improved section of the CMP western segment. The structure is outside of the CMP-ERP limits but immediately adjacent. The Teodoro Moscoso Bridge spans over the San José Lagoon.

3.12.2.2 Wastewater and stormwater

A segment of the San José trunk sewer, approximately 656 feet, runs from east to west within the adjoining Eastern CMP. It is a 66-inch diameter sewer pipe and 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.

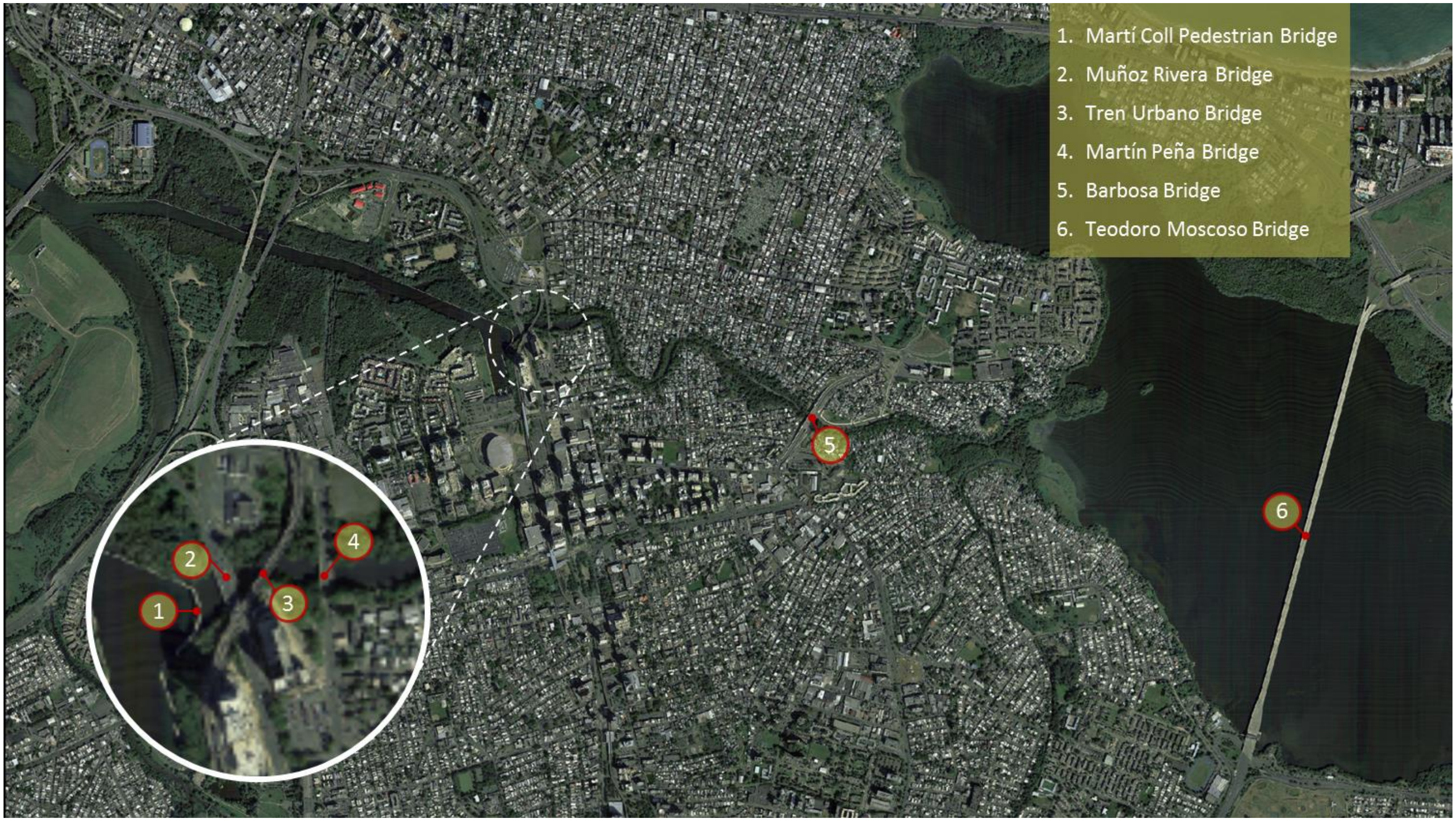
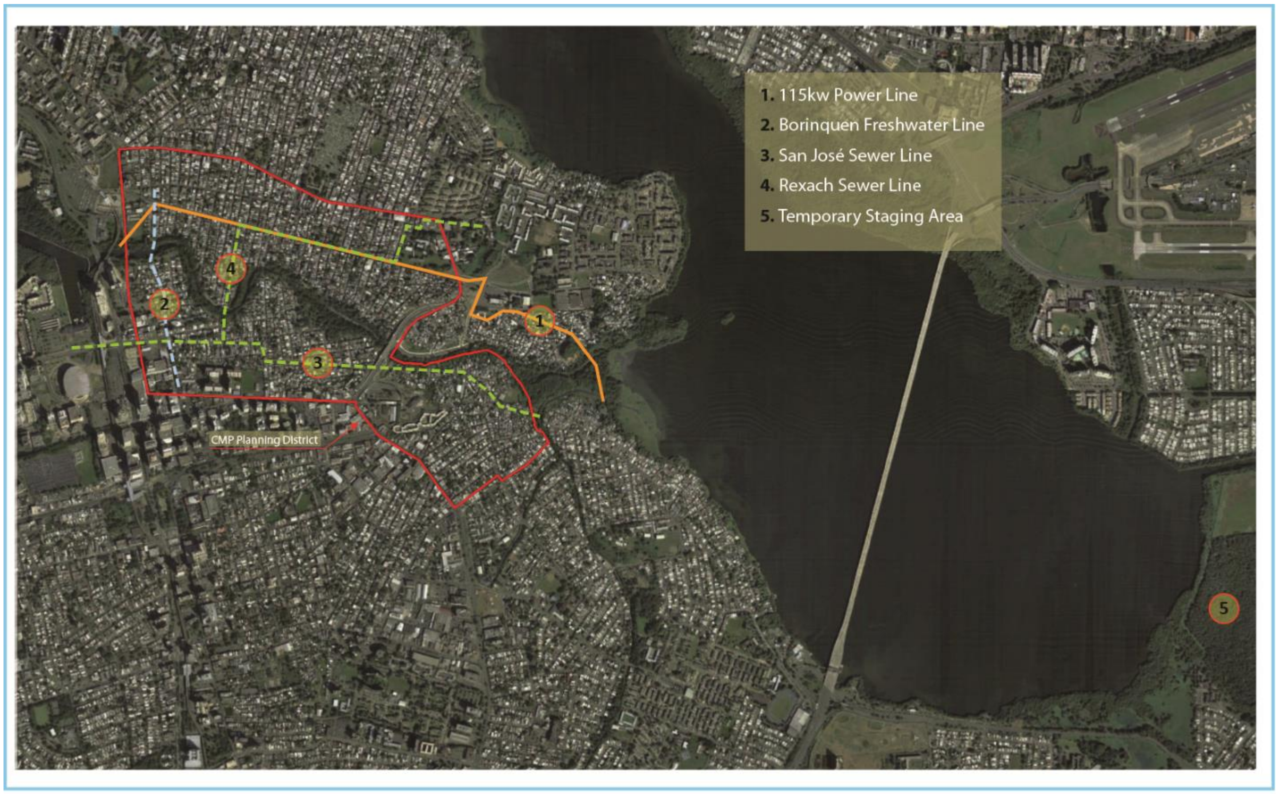


Figure 3-8. Location of bridges in the Project Area

The Rexach trunk sewer is also one of the main San Juan area trunk sewers and conveys wastewater from areas such as 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 Eastern 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 MLLW. The design and relocation of the Rexach Trunk Sewer is ongoing and will be completed prior to the dredge of the CMP (see Figure 3-9).



Source: ENLACE & Puerto Rico Planning Board

Figure 3-9. Water and energy infrastructure

The Borinquen water transmission line is a 36-in. diameter pipe traveling from south to north along the Uruguay and Gardel Streets of the Parada 27 community, crossing the Eastern CMP, and continuing on Argentina Street of the Barrio Obrero-Marina community. The transmission line has only 3 feet of cover where it crosses the Eastern CMP. The design and relocation of the Borinquen Water Transmission Line is ongoing and will be completed prior to the dredge of the CMP.

The majority of stormwater flowing towards the Eastern CMP is runoff that arrives either from overland flow from streets and yards from the adjacent communities or as discharges from storm sewers. The Rexach Avenue flood control pump station, operated by the Municipality of San Juan, services the Buena Vista-Santurce community. It discharges into the northern shore of the Eastern CMP, west of the Barbosa Avenue Bridge.

Similar to the storm sewer infrastructure, many of the streets within the Eastern CMP limits contain underground sanitary sewer collection piping. About 40% of dwellings in, or neighboring, the Eastern CMP lack a sanitary sewer system, and thus, discharge directly or indirectly, through storm sewers, into the Eastern CMP (ENLACE, 2004) (see Figure 3-10).

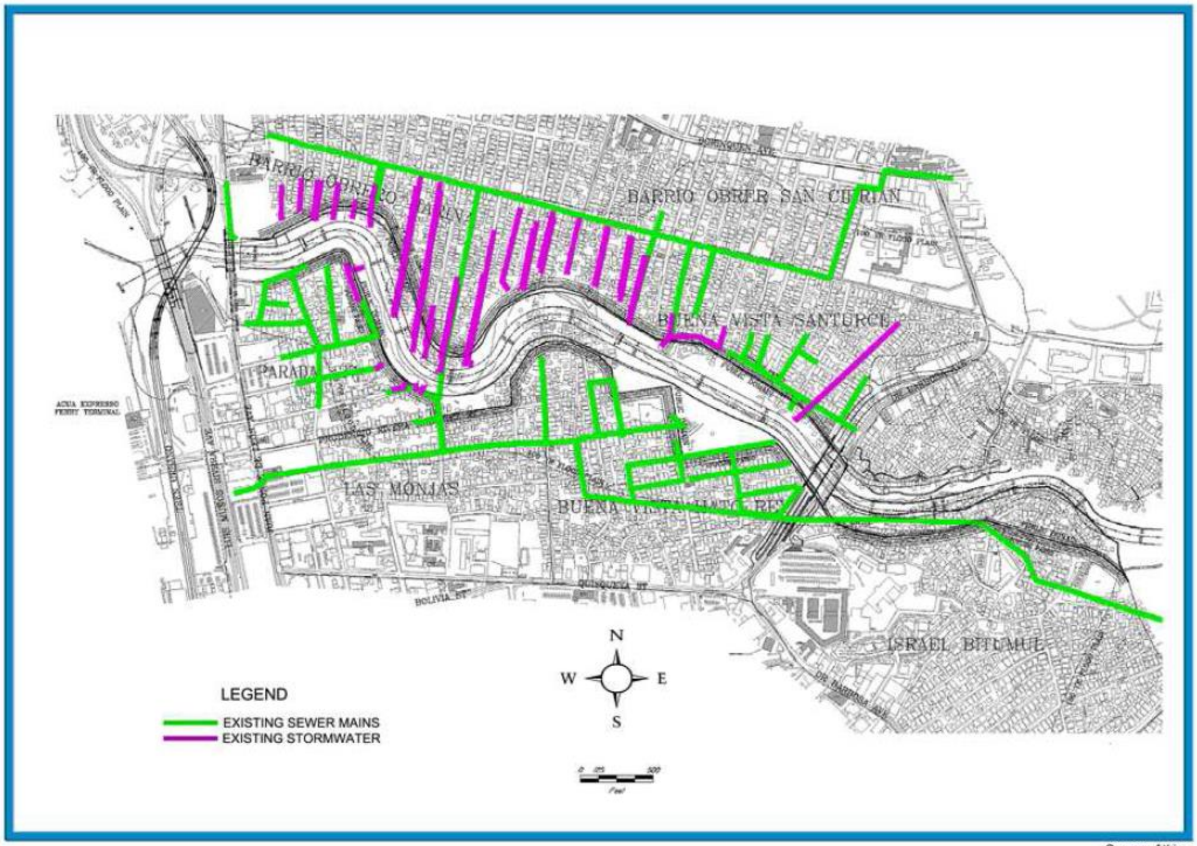


Figure 3-10. Some of the existing sanitary and stormwater sewers servicing the communities in Eastern CMP.

3.12.2.3 Energy

A 115-kV overhead transmission line runs from a substation near the Tren Urbano railway. It then runs east via Rexach Avenue, crossing the Eastern CMP close to its outlet at the San José Lagoon. In this latest section, a support tower is found on the north bank of the Eastern CMP, in the Cantera Peninsula area. Most of the transmission system infrastructure is old and in poor condition.

The 115-Kv overhead transmission line has been relocated as a component of the CMP-ERP. Works included raising the height of the line sixty feet in the section crossing the CMP close to the San José lagoon, to allow the passage of the dredging machinery.

In addition, the following power lines exist within the Project Area:

- L-38,900 de 115KV crosses the CMP at a height of approximately 50 feet.
- L-3,200 de 38KV crosses the CMP at a height of approximately 50 feet.

- L-3,600 de 38KV crosses the existing bridge anchored with supports.
- L-17,100 de 38KV crosses the existing bridge anchored with supports.
- L-39,300 de 115KV is part of the Metropolitan Area buried system. It was installed using a horizontal directional drilling method, crossing the CMP near the bridge on Muñoz Rivera Avenue. The approximate depth under the CMP is 30 feet.

3.13 SOCIOECONOMICS

Selected socioeconomic characteristics are presented for the Study Area as discussed in the following sections: (1) communities adjacent to the Eastern CMP and (2) communities surrounding the San José Lagoon (see Figure 3-11).

Figure 3-11. Communities adjacent to the Project Area

3.13.1 Communities Adjacent to the Eastern CMP

The communities adjacent to the CMP dredging site include Península de Cantera, Barrio Obrero San Ciprián, Buena Vista Santurce, Barrio Obrero Oeste, Parada 27, Las Monjas, and Buena Vista Hato Rey. Table 3-19 summarizes the socioeconomic characteristics of these communities.

Table 3-19. Selected socioeconomic characteristics

	Península Cantera	Barrio Obrero - San Ciprián	Buena Vista Santurce	Barrio Obrero Oeste	Parada 27 - Las Monjas	Buenas Vista - Hato Rey	Israel - Bitumul	All communities	Puerto Rico
Population	7,399	1,363	4,221	2,449	1,968	1,994	4,026	23,420	3,725,789
Pop. density (people/km²)	8,109	7,473	10,264	11,244	5,949	8,761	8,898	8,775	419
Households	2,756	602	1,744	1,040	823	807	1,622	9,394	1,376,531
Occupied housing units	87.8%	87.6%	81.3%	80.8%	87.6%	81.6%	84.2%	84.8%	84.1%
Population with college degree (%)	4%	7%	8%	4%	10%	7%	6%	6%	20%
Median household income ($)	$10,505	$10,737	$10,459	$15,159	$10,555	$10,498	$15,536	$12,268	$18,791
Households with income below poverty level	72%	46.9%	57.1%	54.5%	52.0%	64.7%	41.6%	59.0%	47.5%

Source: 2010 American Community Survey, Census Bureau.

Population: There are approximately 23,420 inhabitants (Census, 2010) in the communities adjacent to the CMP dredging site, representing about 6% of San Juan's population. Population density (8,775 people/km²) is very high; more than twice that of San Juan (3,417) and more than twenty times higher than Puerto Rico's (419). Communities with the highest population density are Barrio Obrero Oeste (11,244), followed by Buena Vista-Santurce (10,264).

Household Income: Median household income for communities adjacent to the Eastern CMP is $12,268, which is considerably lower from Puerto Rico's median household income ($18,791). Most households fall below the poverty level (59%), quite higher than San Juan's rate (37%) and Puerto Rico's rate (47.5%). More than 72% are below the poverty level in Península de Cantera community.

Education: Only 6% of the residents of the communities adjacent to the Eastern CMP have completed college degree, which is significantly lower than the value measured for Puerto Rico (20%). Parada 27/Las Monjas is the community with the largest proportion of residents with a college degree (10%), followed by Buena Vista Santurce (8%).

Housing: Communities adjacent to the Eastern CMP have a slightly higher housing occupancy rate (84.8%) than Puerto Rico's (84.2%). However, the occupancy rate in Barrio Obrero Oeste (80.8%), Buena Vista Santurce (81.3%), and Buena Vista Hato Rey (81.6%) is lower than Puerto Rico's.

3.13.2 Communities surrounding San José Lagoon

Communities surrounding the San José Lagoon have very heterogeneous characteristics, as seen in the following table. Embalse San José has the highest population density. The occupation of the housing units in these communities is between 73 to 89%.

Population with college degree significally ranges between 13% at Playita and 59% at Villamar. The lowest median household income is in Playita and the highest corresponds to Laguna Gardens and Villamar, both in Carolina. Playita also reports 100% of its households with income below poverty level, while Laguna Gardens and Villamar report 26% each (see Table 3-20).

Table 3-20. Selected socioeconomic characteristics

	Playita	Embalse San José	Villa Prades	Los Ángeles	Laguna Gardens	Villamar
Population	1,158	2,025	790	1,017	1,867	720
Pop. density (people/km^2)	9,160	11,289	3,804	10,471	5,959	1,054
Households	498	770	309	407	921	355
Occupied housing units	75%	80%	89%	89%	73%	73%
Population with college degree (%)	13%	37%	37%	51%	56%	59%
Median household income ($)	$10,197	$15,548	$20,043	$30,024	$40,092	$40,092
Households with income below poverty level	100%	97%	85%	43%	26%	26%

Source: 2010 American Community Survey, Census Bureau.

3.14 HUMAN HEALTH AND SAFETY

The communities adjacent to the Eastern CMP are subject to conditions that adversely affect their health, safety and quality of life. Their unplanned and informal settlement pattern as well as their high population density, greatly increases potential damages from floods. Since these communities are settled almost immediately adjacent to the Eastern CMP, in low-level areas, they are not only vulnerable to flooding under major rainfall (e.g., 100- or 50-year rainfall), but are also vulnerable to floods resulting from minor and more frequent rainfall (e.g., 2-, 5-, or 10-year rainfall).

Hurricane Irene is the most recent tropical storm event whose trajectory directly impacted Puerto Rico. On August, 2011, this hurricane made its way and caused damage throughout the Island, including the communities adjacent to the Eastern CMP. Water from the channel reached homes, businesses, and streets, damaging property. Besides property losses and damages, flooding in businesses resulted in income losses for many of the residents, while damages at schools resulted in additional government expenditure in repairs, maintenance, and management, as well as extended periods of class suspensions.

On July 18, 2013, however, moisture associated to a strong tropical wave was responsible for the repeated development of convective showers over San Juan, resulting in a historic rain event. The

National Weather Service weather station at the Luis Muñoz Marín (LMM) International Airport registered 9.23 inches of rain, breaking the previous record of 8.84 inches, which occurred as Hurricane Hugo came onshore on September 18, 1989. Unofficially, another record was broken, that of the highest 1-hour rainfall recorded at the airport, of 2.89 inches (since 1967). It was estimated that more than 3 to 5 inches of rain fell across most of the area, with a maximum well over 9 inches at and around the airport. Based on the frequency of 24-hour precipitation at the LMM International Airport, it is suggested that this event has a 50-year recurrence. Due to thick clouds and frequent rain, the airport also set a record for the coolest July 18th. Almost 3,500 lightning strikes were recorded within 40 km of the airport (Votaw et al., 2014).

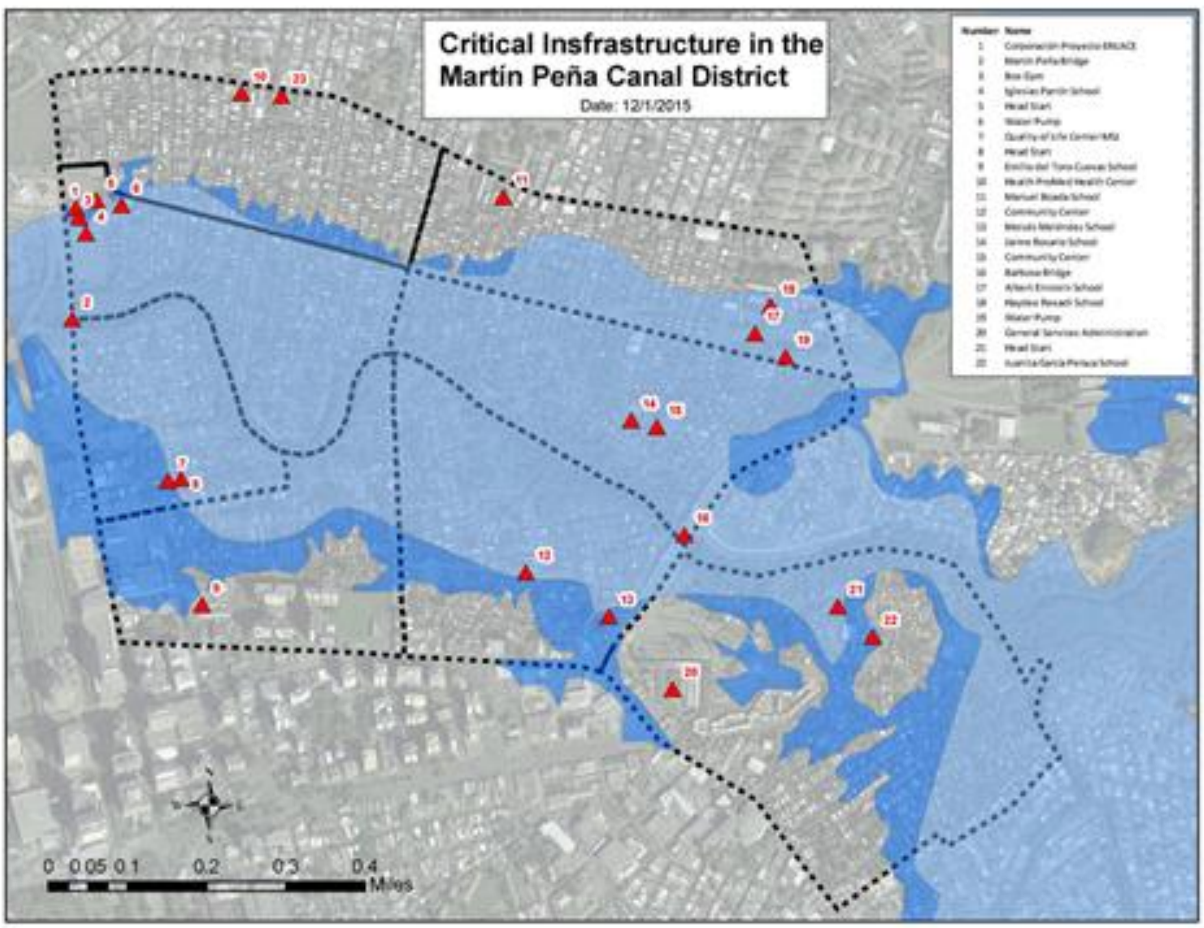


Figure 3-12. Critical infrastructure in the CMP Special Planning District affected due to flooding on July 18, 2013.

Media reports informed that all airplane arrivals and departures from the LMM International Airport had to be suspended for about 3½ hours. Fifteen flights were affected; 12 of these had to be diverted to the Aguadilla Airport, delaying the arrival of nearly 800 passengers to San Juan. In addition, close to 500 homes were partially or totally affected by flooding or other rain related damages in San Juan, accounting for $1.5 million estimated losses, and 88 people had to take temporary shelter at facilities owned by the municipality. Some of the structures affected by flooding were located within the Project Area. Due to the damages reported, the Governor of Puerto Rico issued an executive order declaring a state of emergency in the municipalities of San Juan and Carolina, releasing $1,000,000 for emergency assistance (OE-2013-055).

Flooding situation becomes critical because of the high residence time and 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. Communities adjacent to the CMP have experienced multiple flooding events in the past that have resulted in damages, loss of property, and health risk increase because of exposure to polluted waters.

Gastroenteritis is an important health problem, principally caused by exposure to waters polluted with fecal waste pathogens. In 2011, a study was conducted to measure the level of gastrointestinal symptoms in the communities adjacent to the Eastern CMP, and to examine if there was a correlation between documented symptoms and flood events. The study found that these communities had a higher prevalence of gastroenteritis symptoms and those 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 (Ponce School of Medicine and Health Sciences, 2011).

Another study conducted in 2012, documented the prevalence of dermatitis (skin infections) and asthma for the population under 18 years in the communities adjacent to the Eastern CMP (Community Laboratory of the University of Puerto Rico, 2013). The study's objective was to research if there was a correlation between asthma and dermatitis cases and distance from residence to the CMP. Although not statistically significant, the study shows that residents closer to the Eastern CMP have a higher likelihood of suffering from one of the conditions focused on in this study. Children under 5 years living in the communities adjacent to the Eastern CMP have double the prevalence of asthma than that reported for the island of Puerto Rico and atopic dermatitis rates for children within the Eastern CMP communities was over 10% higher than the 24.8% rate reported for that age group in previous studies (see Table 3-21).

Table 3-21. Common health conditions found in the Eastern CMP neighborhoods

Condition	CMP Prevalence	Puerto Rico Prevalence[1]	Eastern CMP Population	Existing Population Affected
Gastroenteritis	31%	21%	18,074	5,603
Asthma (children under 5 years old)	44.5%	22%	1,046	465
Dermatitis (children 5-9 years old)	35.3%	24.8%	958	338

Source: Ponce School of Medicine (2011); UPR, 2013.

More recently a Health Impact Assessment (HIA) conducted by the Icahn Mount Sinai Medical School (2014) concluded that there are higher levels of chronic and acute diseases among residents of the communities adjacent to the Eastern CMP, than among the general population of Puerto Rico, which may be attributable to the deteriorated environmental conditions of the CMP.

Poor water and sediment quality reported in the Eastern CMP has raised concern that aquatic organisms might be contaminated, although there is very limited human consumption of fish from the CMP. Indeed, on August 1999, the DNER and the PREQB issued a public advisory recommending that fish and other organisms (e.g., blue crabs) from the CMP, the San José Lagoon, La Torrecilla Lagoon and the Suarez Canal not be consumed, based on concerns that these might be contaminated based on the poor water and sediment quality. Signs were placed in the surroundings of these water bodies to inform the general public about the advisory (SJBEP, 2000).

3.15 CULTURAL RESOURCES

Archival research, field investigations and informal consultations with the State Historic Preservation Office (SHPO) and the Institute for Puerto Rican Culture (IPRC) have been conducted to determine the cultural, historic and archeological resources value of the Eastern CMP and the San José Lagoon.

The Martín Peña Bridge is the only known structure of cultural importance found in the Eastern CMP. Built in 1939, it is characterized by its *art deco* design. It was included in the National Register of Historic Places (08000856) by SHPO on August 27, 2008. It was also declared an historic monument by the Commonwealth's government on August 15, 2007. This bridge is the latest of many built on or in the immediate vicinity of the Eastern CMP, to service the main access road between Old San Juan and mainland Puerto Rico for nearly four centuries. This site is also where one of the most important military battles in Puerto Rico's history took place, when the Spaniards and the local militia helped repelled invading English forces in 1797.

At present, no previously recorded sub-aquatic prehistoric cultural resources have been identified in Eastern CMP and the San José Lagoon, and there is no historic evidence of smaller marine vessels encountered. It is important to note, however, that the investigations conducted in the immediate vicinity of the Martín Peña Bridge have been limited due to restricted access and pollution in the channel. Therefore, it may be possible to encounter remains from the old bridges constructed in the area since the sixteenth century, as well as materials associated to the fishing corrals and trash middens from the first settlements built during the early twentieth century.

Any archeological resources that may exist in the Eastern CMP and the San José Lagoon have suffered extensive impacts and modifications (e.g., fill, trash, dredging), which have likely already depreciated their historical integrity (Atkins, 2011d). Nonetheless, SHPO has stated that the possibility of encountering submerged cultural remains within the CMP and the rest of the 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.

3.16 RECREATION

Tarpon (*Megalops atlanticus*) sport fishing is possibly the most important water dependent recreational activity in the inner waterbodies of the Project Area, focusing in the artificial dredged pits along the northern and eastern shores of the San José Lagoon (Atkins, 2011b). Several sport fishing charter boating companies run successful business operations based on this species, considered one of the best in the Caribbean, even luring tourists to the Island for this specific purpose. This catch-and-release fishery is an important income generator in San José Lagoon, generating over 1,200 half-day fishing trips, mainly with out-of-town visitors (Yoshiura and Lilyestrom, 1999 as cited in Atkins, 2011b).

Also, there is a small boating operation launched from the Cantera Península, which provides sightseeing tours of the San José Lagoon and those lagoons farther to the east within the SJBE. In the northern shore of the Cantera Península there is a makeshift dock and boat ramp that provides access to the San José Lagoon and it is operated by Los Laguneros Fishermen Association. Other makeshift boat ramps and small docks are found in other areas of the San José Lagoon. Some of these are frequently used to deploy jetskis and other small vessels to navigate east towards La Torrecilla Lagoon and to gain access to the ocean. In the San José Lagoon, the Teodoro Moscoso Bridge, is also used for an international race known as the World's Best 10k, held every February.

Recreational opportunities in the Eastern CMP are impaired and unsafe compared to the restored section of the Western CMP. In the eastern segment of the CMP, except for the three bridges crossing the channel, there are no formal access points through which residents may gain access for fishing or bird watching activities.

Other recreational facilities close to the Project Area, but not within it are: the Roberto Clemente Sports Complex (CDRC), found east of the San José Lagoon; the Adolfo Dones linear park, found next to the southeastern shores of the San José Lagoon; and the Rebekah Colberg sports complex, found west of the Teodoro Moscoso Bridge.

Beside the abovementioned activities, existing recreational opportunities close to the CMP and the San José Lagoon are limited to various basketball courts, a few solitary backboards and three fairly new and small playgrounds, as presented in Table 3-22.

Table 3-22. Existing Recreational Resources in the communities found along Eastern CMP

WARD	FACILITY	LOCATION
Bo. Obrero – San Ciprián	Basketball-volleyball court	Albert Einstein School
Bo. Obrero – Marina	Basketball-volleyball court	Santiago Iglesias Pantin School
	Basketball-volleyball court	St. 10 Sur
Buena Vista Santurce	Basketball-volleyball court	El Faro St.
	Basketball-volleyball court	William St.

Table 3-22, cont'd

WARD	FACILITY	LOCATION
Cantera	Basketball-volleyball court	Barbosa Avenue y Calle San Miguel
	Baseball field	Colegio San Juan Bosco
	Sport Center	Colegio San Juan Bosco
	Sport Center	Constitución St.
	Basketball-volleyball court	Los Padres St.
	Football field	Colegio San Juan Bosco
	Recreational Association	Santa Elena St.
Parada 27	Linear park and boat ramp	San José St.
	Basketball-volleyball court	San José St.
	Multi use court	Santiago Iglesias St.
Las Monjas	Basketball-volleyball court	Emilio del Toro School
	Basketball-volleyball court	Quisqueya St.
	Baseball field	Dolores St.
Buena Vista Hato Rey	Basketball-volleyball court	#3 St.
Israel-Bitumul	Basketball-volleyball court	Juanita García Peraza School
	Basketball-volleyball court	Alcaniz St.
	Baseball field	Alcaniz St.

3.17 AESTHETIC RESOURCES

In contrasts with the green views provided by the mangroves and other vegetation fringing the western half of the CMP, the Eastern CMP aesthetic value is severely compromised by urban encroachment, and the disposal of garbage, debris and other refuse. Its foul smelling waters further discourage its enjoyment.

The San José Lagoon offers a scenic oasis within the urban landscape encompassing this section of the Project Area due, in part, to the access and views provided by the Teodoro Moscoso Bridge, which crosses the lagoon from north to south. Where mangroves still fringe the lagoons, the views offer a pleasant contrast against the urban backdrop of the densely populated SJMA.

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4.0 ENVIRONMENTAL CONSEQUENCES

This section presents an evaluation of the potential environmental impacts of each of the four alternatives: the No Action Alternative, the Recommended Plan (originally Alternative 2), the Alternative 1 and Alternative 3, for both, the Project Area and the Study Area, as defined in Section 1.2. An impact is defined as a change to the human or natural environment as a result of an action. Impacts can be beneficial or adverse and can be permanent or long lasting (long term) or temporary and of short duration (short term). An impact is a direct result of an action, which occurs at the same time and place or an indirect result of an action, which occurs later in time or in a different place and is reasonably foreseeable. Impacts can vary in degree from a slightly noticeable change to a total change in environment.

Impacts are based on significance criteria. National Environmental Policy Act (NEPA) Regulations adopted by the Council on Environmental Quality (CEQ) (40 C.F.R. 1500–1508), define significance based on the twin criteria of context and intensity (40 C.F.R. 1508.27). Significance criteria developed for the affected resource categories, and for many of the categories, are necessarily qualitative in nature. Quantitative criteria can be established when there are specific numerical limits established by regulation or industry standard. These criteria are based on existing regulatory standards, scientific and environmental documentation, and/or professional judgment. Technical reports with detailed analyses are referenced as appropriate to avoid redundancy in the Final EIS.

Impacts are considered adverse unless identified as beneficial. The analyses presented here for the environmental consequences consider context and intensity with respect to significant impacts to resources, based on the data available for each resource. Cumulative effects are addressed in Section 4.18. If the impact is significant, it might be reduced or not. Unless otherwise indicated, no compensatory action is required. Potential effects are detailed within this section and summarized in Table 4-1.

Table 4-1. Summary of Environmental Consequences

Resource	NO ACTION ALTERNATIVE No changes to existing condition along CMP	RECOMMENDED PLAN 100-foot-wide x 10-foot-deep channel	ALTERNATIVE 1 75-foot-wide x 10-foot-deep channel	ALTERNATIVE 3 125-foot-wide x 10-foot-deep channel
Climate	The abnormal levels of hydrogen sulfide and methane presently produced in the Eastern CMP, the latest considered a greenhouse gas, would continue or even worsen. More extreme precipitation events mean that flooding in the Eastern CMP and the San José Lagoon would be exacerbated under the present condition of reduced drainage and conveyance of waters.	All alternatives have the potential to release hydrogen sulfide and methane as the dredged material is removed, transported, and managed for final disposal. Also during construction, all of these would result in the combustion of fossil fuel emissions due to the use of machinery, vehicles and vessels. The alternatives could provide benefits toward reducing the effects of climate change. An increase in vegetation and open water areas in the Eastern CMP would help offset expected increases in average temperatures. In addition, the alternatives would initially, at least, reduce flooding from significant or extreme rain events due to the CMP improved water conveyance capacity. The relocation of structures and families currently located in flood prone areas related to the Eastern CMP would also help reduce their exposure to this risk.		
Geology	No impacts are expected to the Project Area's geology.	Rock outcrops may be encountered at depths of -10.5 feet at the eastern end of the Project Channel. However, with a proposed channel depth above -10.5 feet, and slightly adjusting the channel's configuration to maintain the design cross section, no impacts are anticipated.	Changes are the same as those described for the Recommended Plan. Underlying geology would not change and would not be compromised as a result of Alternative 1.	The wider cross section (125 feet) of the proposed channel could require the excavation of limestone rock. The remnants of a small karst hill or "mogote" are found in the Eastern CMP, north of its eastern end, and relatively close to what would be the proposed channel alignment. As such, impacts to geology could result.
Soils	Impacts to soils would continue due to past disposal of household waste, rock and other debris used as fill material within the Eastern CMP. Soils would continue to include debris, which along the Eastern CMP may reach depths more than 10 feet below land surface. These would continue to be a source of concern due to their impact on soil structure, composition and the flora and fauna that could be directly or indirectly in contact with it.	Approximately 762,000 cy of material, including 76,200 cy of debris would be removed. Substrate, at the Project Channel behind the sheet pile, would be left without garbage and thus under a suitable condition that would promote its colonization by sediment boring organisms (e.g., crabs, etc.) and mangrove.	Approximately 680,000 cy of materials, including 68,000 cy of debris would be removed. Alternative 1 would have less beneficial effects than those described for the Recommended Plan and Alternative 3. It would leave 8,200 cy or 19,200 cy of debris within the soils at both banks of the Eastern CMP, when compared to the Recommended Plan and Alternative 3, respectively.	Approximately 872,000 cy of materials, including 87,200 cy of debris would be removed. Alternative 3 would have more benefits than the Recommended Plan and Alternative 1, but it would also have a larger impact on soils adjacent to the CMP because of its larger construction footprint.

Table 4-1, cont'd

Resource	NO ACTION ALTERNATIVE No changes to existing condition along CMP	RECOMMENDED PLAN 100-foot-wide x 10-foot-deep channel	ALTERNATIVE 1 75-foot-wide x 10-foot-deep channel	ALTERNATIVE 3 125-foot-wide x 10-foot-deep channel
Hydrology	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. Under existing conditions, the average residence time of water in San José Lagoon is estimated at 16.9 days. At present, average tidal range for the San José Lagoon, is 0.33 foot, reflecting the influence of the filled CMP. Inadequate drainage would continue to cause flooding. Frequent floods would continue to occur and would disrupt normal residential daily life, business operations, and provision of essential services like education in flood-prone schools. Low elevations in communities preclude adequate stormwater. Over 4,700 structures would continue to be under flood risk.	Model (CH3-WES) results indicate restored CMP would significantly improve (reduce) residence time and water quality in the CMP and lagoons without adverse impacts to the Study Area. Residence time for the San José Lagoon would be reduced from 16.9 days to approximately 3.9 days. Flows would not exceed 3 f/s (typically 2 f/s) to avoid channel scour. Vertical concrete-capped steel sheet piles, with hydraulic connections to mangrove wetlands would line the channel for erosion control and channel stability.	Significant improvements to hydrologic connections and associated tidal influence and residence time, water quality, and flooding attenuation. Residence time would be 3.9 days.	Alternative 3 would also result in significant improvements to hydrologic connections and associated tidal influence and residence time, water quality, and flooding attenuation. Residence time for this alternative would be reduced to 3.9 days.

Table 4-1, cont'd

Resource	NO ACTION ALTERNATIVE No changes to existing condition along CMP	RECOMMENDED PLAN 100-foot-wide x 10-foot-deep channel	ALTERNATIVE 1 75-foot-wide x 10-foot-deep channel	ALTERNATIVE 3 125-foot-wide x 10-foot-deep channel
Water Quality and Sediments	Adverse impacts to existing water and sediment quality are anticipated to persist and may worsen. Areas deeper than -4 to -6 feet would continue to exhibit stratification, low DO, and poor benthic habitat and would not be improved.	Restoring hydraulic conveyance and tidal influence would significantly improve water circulation and water quality in San José Lagoon by reducing salinity stratification and improving DO levels in shallow (<6 feet) water. Water quality improvements are also anticipated due to reduced waste and stormwater runoff and flooding. In addition, temporary short term (2 years) adverse impacts would occur to water quality as a result of construction activities. Dredging and sediment disposal activities works would result in short term localized deterioration of water quality. This impact would be minimized and contained through the use of sediment control and containment measures, such as the use of turbidity curtanins, the use of geotextile tubes or bags to encapsulate dredged sediments and further capping of these with 2 feet of sand to prevent leaching of contaminants into ground and surface waters. Capping the dredged material would reduce potential for contaminant leaching into the water column by >95 percent.	Significant improvements to water quality, almost similar to those described under the Recommended Plan. However, articulated concrete mats would need to be placed along the entire length of the dredged channel under Alternative 1 to control erosion, prevent scour, and protect sheet pile walls. During construction, BMPs would be used to minimize short-term and long-term sedimentation, erosion, turbidity, and total suspended solids (TSS), the same as for the Recommended Plan.	Significant improvements to water quality, almost similar to those described under the Recommended Plan. Like the Recommended Plan and Alternative 1, BMPs would also be used to minimize short-term and long-term sedimentation, erosion, turbidity, and total suspended solids (TSS).

Table 4-1, cont'd

Resource	NO ACTION ALTERNATIVE No changes to existing condition along CMP	RECOMMENDED PLAN 100-foot-wide x 10-foot-deep channel	ALTERNATIVE 1 75-foot-wide x 10-foot-deep channel	ALTERNATIVE 3 125-foot-wide x 10-foot-deep channel
Water Quality and Sediments, cont.		BMPs (i.e., turbidity controls) and construction of a weir at the western end of the Project Channel would minimize short-term and long-term sedimentation, erosion, turbidity, and total suspended solids (TSS). Dredged sediments from the Eastern CMP would be used to partially fill two excavated sand pits. Three artificial pits would be partially filled with dredged sediments from the San José Lagoon. These two actions would further reduce water renewal time in the San José Lagoon, and significantly reduce water quality impairments in the deepest areas of this water body caused precisely and in part by their unnatural depth.		
Air Quality	The No Action Alternative would allow abnormal levels of hydrogen sulfide and methane presently produced in the Eastern CMP to continue or even worsen due to the lack of water flow and excacerbated decomposition of organic material trapped in this water body.	Emissions from construction activities would result in minor short-term impacts in the immediate vicinity and no significant impacts to ambient air quality are anticipated once construction is complete. Dredging would increase emissions < 1% over the emissions inventory for existing sources in the San Juan area. These emissions are not anticipated to exceed National Ambient Air Quality Standards (NAAQS) during dredging; therefore attainment status would not be affected. Chronic exposure is unlikely due to relocation of residential housing prior to construction. Development and implementation of a H_2S monitoring program during dredging operations is recommended. During dredging, gas releases are expected and a plan is recommended to manage/mitigate any release of H_2S. Confirmed, high concentrations of H_2S would require aggressive management efforts that may include: (1) temporary relocation (evacuation) of individuals anticipated to be impacted, (2) In situ chemical treatment of the sediments to sequester the H_2S or convert it into a less harmful substance, (3) Collection and scrubbing of the air at the site of sediment disturbances to sequester hydrogen sulfide, (4) Air collection and delivery to safe zone above ground or middle of the San José Lagoon where dilution/dispersal can occur safely. The management plan should address health and safety of the public, the construction workers and equipment subject to H_2S related corrosion and recommend personal protective equipment, such as respirators and/or other oxygen assistance gear, and monitoring equipment and procedures. Education and training regarding H_2S poisoning would be provided for workers.		

Table 4-1, cont'd

Resource	NO ACTION ALTERNATIVE No changes to existing condition along CMP	RECOMMENDED PLAN 100-foot-wide x 10-foot-deep channel	ALTERNATIVE 1 75-foot-wide x 10-foot-deep channel	ALTERNATIVE 3 125-foot-wide x 10-foot-deep channel
Noise	No significant adverse impacts are anticipated since no new activities would occur.	No long term significant impacts to surroundings are anticipated from any of the project alternatives. Dredge operations typically have noise level between 58 and 70 dB at a distance of 50 feet from the source, less than ambient noise in San Juan, and may occur for 2 years. During construction, a localized deterioration of noise quality is anticipated from heavy-equipment, demolition, and pile driving. Dredging activities could result in short-term displacement of seabirds and shorebirds, but they are expected to resume normal use of the Project Area when project is completed. Demolition of the dwellings that are located within the public domain areas would generate noise and dust. Effects from these may be characterized as nuisance conditions, yet on sensitive populations, such as children and the elderly, asthma and nervousness may result in significant impacts to local residents. Noise and construction vibration from heavy machinery and pile driving equipment may adversely impact sensitive equipment. A vibration and noise mitigation plan is recommended to address structures with sensitive equipment (i.e., precision instruments), monitoring vibrations during construction, and implement mitigation measures such as installation of temporary sound barriers in critical areas. Other measures may include mandating the use of heavy equipment that is less likely to create noise and vibration issues.		
Solid Waste	Analytical methods used to characterized sediment quality have suggested that hazardous concentrations of lead may be present in the Eastern CMP. However, no evidence on HTRWs has been found in the Project Area. No additional impacts are anticipated without the CMP-ERP.	Materials within the Caño Martín Peña include various types of solid waste, debris and other materials. Such materials would 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, these would be managed in accordance with the applicable laws and regulations of the relevant regulatory agencies.		

Table 4-1, cont'd

Resource	NO ACTION ALTERNATIVE No changes to existing condition along CMP	RECOMMENDED PLAN 100-foot-wide x 10-foot-deep channel	ALTERNATIVE 1 75-foot-wide x 10-foot-deep channel	ALTERNATIVE 3 125-foot-wide x 10-foot-deep channel
Habitat	Eastern CMP would continue to deteriorate resulting in significant adverse impacts to its wetlands (i.e., mangroves) and submerged habitats (i.e., mangrove prop root community, water column and benthos). The reduced salinities could support a greater number of freshwater species, such as the invasive water hyacinth, and its siltation would eventually cause it to shift or resemble an upland habitat. As a result, most species sustained or dependent on wetland and submerged habitats would be permanently displaced by those favoring upland habitats. Continued impairments to open waters and submerged habitats in the San José Lagoon would continue or worsen and the CMP becomes completed clogged. The SJBE would be fragmented into two distinct segments.	This alternative would result in the temporary construction loss of 33.46 acres of mangroves and 7.40 acres of open or water column habitat. However, with the proposed open channel configuration and mangrove restoration in its banks, the amount of available mangrove habitat within this segment of the CMP would increase to 34.38 acres. This would mean a net gain of 1.02 acres. Open or water column habitat, as well as restored benthic habitat, would increase in the Eastern CMP by 18.17 acres. Mangrove wetland and mangrove prop root habitat is expected to be greater in acreage under the Recommended Plan than for Alternative 3, but less in terms of open or water column habitat area.	Is expected to result in the greatest mangrove wetland and mangrove prop root area of all project channel alternatives, with a net increase of 6.16 acres. However, this would be at the expense of open or water column habitat, with a net increase of 13.02 acres. The Recommedned Plan and Alternative 3 would entail a net increase of 18.17 and 23.57 acres, respectively, for this type of habitat. The proposed armored concrete bottom could preclude burrowing creatures and other organisms associated with soft bottom benthic habitats from living, as formerly, in this section of the CMP. Encrusting creatures (e.g., barnacles), however, are anticipated to be able to settle on the hard bottom (Atkins, 2012a).	This project channel alternative that would result in a permanent reduction in mangrove area, with a net loss of 4.38 acres. However, it would provide the most water column habitat area, with a net increase of 23.57 acres. The same acreage would be restored for benthos within the Eastern CMP. Alternative 3 would provide more area for benthos within the Eastern CMP than Alternative 1, but at the expense of less mangrove prop root habitat in this same section of the Project Area.

Table 4-1, cont'd

<table>
<tr><th>Resource</th><th>NO ACTION ALTERNATIVE
No changes to existing condition along CMP</th><th>RECOMMENDED PLAN
100-foot-wide x 10-foot-deep channel</th><th>ALTERNATIVE 1
75-foot-wide x
10-foot-deep channel</th><th>ALTERNATIVE 3
125-foot-wide x
10-foot-deep channel</th></tr>
<tr><td>Flora and Fauna Resources</td><td>This Alternative would prolong deterioration trends for fish and wildlife habitat due to the hydrologic interruption that present conditions in the Eastern CMP have caused throughout the entire SJBE. Fish and shellfish that may be contaminated and caught by in the San José Lagoon would have the potential to affect the health of those who consumed these organisms. Low salinity concentrations in the remaining open water areas within the Eastern CMP could allow the proliferation of invasive flora dependent on freshwater conditions, further reducing its value for fish and wildlife.</td><td colspan="3">Improved tidal exchange under any of the three project channel alternatives would increase average salinities, from 6.5 to 8.5 psu to approximately 20 to 26 psu, in the San José Lagoon, from the surface down to between 4 to 6 feet deep. This would reduce/eliminate invasive freshwater species such as the water hyacinth that are intolerant of such salinities, and preclude the potential establishment of others, such as the bluegill (Lepomis macrochirus) and members of the family Loricariidae (Plecostomus, or sucker fish). Aquatic species (e.g., fish, invertebrates) dependent on connectivity of the seascape (e.g., mangrove prop root habitat, seagrass beds and coral communities), and those that feed on these would be greatly benefited. An increase in diversity and population of those species that are least tolerant to water pollution or impairments is expected.</td></tr>
<tr><td>Species of Special Concern</td><td>Existing impaired habitat conditions due to a severely limited hydrologic connection between San Juan Bay and San José Lagoon, and poor water quality in Eastern CMP and the San José Lagoon would persist and worsen. Such continuous impacts would result in permanently impaired conditions that would prevent any significant T&E species presence or recovery of these populations in these two areas, possibly affecting other segments of the SJBE.</td><td>The Recommended Plan would have more potential benefits on those T&E species that could inhabit mangrove forests (i.e., yellow shouldered blackbird, black cowled oriole, Puerto Rican vireo, and white crowned pigeon) once restored in the Eastern CMP, than those from Alternative 3. The latter would have a net gain of -4.38 acres of mangroves while the Recommended Plan would result in a net gain of 1.02 acres. This difference in mangrove acreage and potential use by T&E species, however, is expected not to be significant.
The Recommedned Plan would temporary affect, but is not likely to adversely affect four federally listed species: Antillean manatee, Hawksbill and Green sea turtles, and the Puerto Rican Boa. Overall, the CMP-ERP would result in a permanent beneficial impact for these listed species and other found in the Study Area such as the Leatherback sea turtle and the coral listed species.</td><td>Alternative 1 would result in more mangrove acreage available for any T&E species that inhabit this type of forest, when compared to the the Recommended Plan and Alternative 3. Alternative 1 would have a net gain of 6.16 acres of mangrove, which is a significant increase from the Recommended Plan's gain of 1.02 acres, and Alternative 3's gain of -4.38 acres. It is worth noticing, however, that Alternative 1 would be more expensive to implement than the Recommended Plan.
Impacts on T&E species would be similar as with the Recommended Plan. The narrower channel that Alternative 1 would provide is expected to be less effective in allowing its potential use of manatees to reach the San José Lagoon, when compared to the Recommended Plan or Alternative 3.</td><td>Alternative 3 would result in less mangrove acreage than either the Recommended Plan or Alternative 1. Impacts on T&E species would be similar as with the Recommended Plan and Alternative 1.
Alternative 3, however, would provide the widest channel configuration (i.e., 125 feet) that would potentially allow manatees to reach the San José Lagoon through the CMP. It would be, however, more expensive to construct than the Recommended Plan.</td></tr>
</table>

Table 4-1, cont'd

Resource	NO ACTION ALTERNATIVE No changes to existing condition along CMP	RECOMMENDED PLAN 100-foot-wide x 10-foot-deep channel	ALTERNATIVE 1 75-foot-wide x 10-foot-deep channel	ALTERNATIVE 3 125-foot-wide x 10-foot-deep channel
Land use and infrastructure	No changes to land use and/or infrastructure would be anticipated as a result of the No Action Alternative. In terms of land use, the area along the Eastern CMP would continue to be of Public Domain. However, its continuous use for residential or waste disposal purposes would continue to be incompatible with the area's natural and physical characteristics, as well as with those public policies that promote an efficient use of lands, open space, surface waters and other natural resources.	The Recommended Plan would cause fewer impacts to transportation than those from Alternative 1 and 3, although more impacts to navigation than those from Alternative 1. The Recommended Plan would cause fewer impacts to navigation than Alternative 3. All of these unavoidable, temporary impacts related to construction.	Alternative 1 would result in more impacts to transportation than those that could be caused by the Recommended Plan. Alternative 1 would require less material to be dredged than the Recommended Plan, and thus, less debris to be hauled out of the Project Area for final disposal into the Humacao Regional Landfill. However, it would require additional trips to carry the articulated concrete mats that would be placed along the bottom and entire length of the Eastern CMP. Otherwise, any construction aggregates would have to be transported if the articulated concrete mats are to be made at the CDRC staging area. Alternative 1 would result in fewer impacts to navigation than those expected by the Recommended Plan and Alternative 3, since the latest two would involve additional material to be dredged from the Eastern CMP, requiring more scow and barge trips to dispose off the dredged sediments and dredged debris, respectively.	Alternative 3 would result in more impacts to transportation than those that could be caused by either the Recommended Plan or Alternative 1. Unlike Alternative 1, Alternative 3 would require more material to be dredged, and thus, more debris to be hauled out of the Project Area for final disposal into the Humacao Regional Landfill. Alternative 3 would also result in more impacts to navigation than those expected from the Recommended Plan and Alternative 1, since both would involve less material to be dredged from the Eastern CMP, requiring less scow and barge trips to dispose off the dredged sediments and dredged debris, respectively.

Table 4-1, cont'd

Resource	NO ACTION ALTERNATIVE No changes to existing condition along CMP	RECOMMENDED PLAN 100-foot-wide x 10-foot-deep channel	ALTERNATIVE 1 75-foot-wide x 10-foot-deep channel	ALTERNATIVE 3 125-foot-wide x 10-foot-deep channel
Socioeconomics	No activities resulting in new economic opoortunities would occur. Lack of water conveyance through the CMP and associated flooding and poor water quality would continue, resulting in economic impacts to local commerce, tourism and land values, including eventually, the tarpon charter industry occurring in the San José Lagoon.	The Recommended Plan would create 4,275 jobs during construction and would also provide opportunities for future job creation in the surrounding communities associated with outdoor recreation related concessionaires. Road improvements, water, sewage, stormwater, and electrical infrastructure systems would eliminate much of the environmental burden currently impacting the residents of the communities adjacent to the CMP. Significant adverse impacts are anticipated due to the 394 relocations from the Public Domain lands to facilitate the restoration. All efforts would be made to relocate people within their same community and strategies to maintain community cohesion, which include a community land trust to prevent community displacement.	Similar benefits to the community would result as in the Recommended Plan. It is estimated that Alternative 1 would create 4,525 jobs during construction.	Similar benefits to the community would result as in the Recommended Plan. It is estimated that Alternative 3 would create 4,400 jobs during construction.

Table 4-1, cont'd

Resource	NO ACTION ALTERNATIVE No changes to existing condition along CMP	RECOMMENDED PLAN 100-foot-wide x 10-foot-deep channel	ALTERNATIVE 1 75-foot-wide x 10-foot-deep channel	ALTERNATIVE 3 125-foot-wide x 10-foot-deep channel
Socioeconomics, cont.		Temporary or short term unavoidable impacts would occur on charter boat operator's income lasting over the construction period, forcing these to resort to other areas of the San José Lagoon or the SJBE where tarpons may congregate and take advantage of sudden depths changes to feed. It is important to notice that charter boat operators would be benefited in the long term by any of the CMP-ERP alternatives. Significant improvements to submerged habitat conditions are expected, resulting in an increase in the number and diversity of potential nekton species upon which tarpon would prey, thus benefiting this sport fishery.		
Cultural Resources	Dredging of the Eastern CMP would not occur, thus no disturbance to the Project Area would take place and any as yet undiscovered resources would remain in place. No additional investigations for cultural resources would be undertaken.	No significant impacts to cultural resources are expected. Permanent sheet pile walls, weirs, and other structures during construction would protect the Martin Peña Bridge; photo-documentation would be recorded for this historic 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 for cultural resources as each clamshell bucket of dredged material is laid onto the screen during the construction (dredging) process. 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. Evaluation of three to four areas from the deepest sediments in the Eastern CMP to identify debris that may be considered of historical value is also recommended (Vélez Vélez, 2001; Vega 2002). A Phase IA Cultural Resources Assessment for the proposed temporary disposal site at the CDRC staging area found a very low potential for cultural resources due to extensive impacts and modifications in the area. No additional archeological investigations were recommended for this site.		

Table 4-1, cont'd

Resource	NO ACTION ALTERNATIVE No changes to existing condition along CMP	RECOMMENDED PLAN 100-foot-wide x 10-foot-deep channel	ALTERNATIVE 1 75-foot-wide x 10-foot-deep channel	ALTERNATIVE 3 125-foot-wide x 10-foot-deep channel
Health and Safety	Communities would continue to be exposed to health and safety concerns associated to direct and indirect contact with unsanitary waters, related pathogens and air quality impairments (H_2S). 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.	Significant improvements to quality of life and health and safety conditions for vulnerable communities are anticipated. Disease vectors associated with trash and debris and contaminants would be significantly reduced under the Recommended Plan. A monitoring and analysis plan is recommended to better characterize H_2S conditions and prevent exposure to children. Development and implementation of a monitoring program is recommended. Disproportional impacts to children and the elderly would be alleviated and significant improvements to child health and safety are anticipated.	Alternative 1 has less impact on flood reduction due to the smaller water capacity channel, and therefore may not improve health and safety to the same extent described for the Recommended Plan.	Alternative 3 would have a greater impact on flood reduction due to a larger water capacity channel, and therefore may improve health and safety to a greater extent than described for the Recommended Plan and Alternative 1.
Recreation Resources	Residents would not have the opportunity to experience many of the potential outdoor benefits associated with a restored SJBE system. Limits to recreation opportunities for disadvantaged neighborhoods would persist, and access to the designated Public Domain would continue to be limited to those residents living within it.	Recreation woluld be significantly improved. Five acres of small parks, water plazas, and linear parks would provide access, connectivity, and recreational facilities to concentrate community activities and minimize future impacts to the restored natural areas. Outdoor-passive recreation areas would be available for all citizens.	Significant benefits, similar to the Recommended Plan, are expected.	
Aesthetic Resources	The quality of the views from within the CMP would be progressively compromised by the lack of definition of the channel and debris that has collected under the mangroves and upland areas.	The Recommended Plan's improvements to the CMP, including its recreational features, would positively alter the visual quality of the CMP. The proposed actions offer the community new open spaces suitable for the appreciation of an enhanced ecological scene.	Similar visual and aesthetic benefits to the community would result from Alternative 1.	Alternative 3 would also provide significant visual and aesthetic benefits to the community.

4.1 CLIMATE

Project alternatives were evaluated in relation to climate change based on their potential contributions to greenhouse gas (GHG) emissions and their impact to local ambient temperatures.[21]

Hydrogen sulfide and methane are intrinsically or naturally produced in the Project Area as part of the decomposition of organic matter. The Recommended Plan, Alternative 1 and Alternative 3, have the potential to exacerbate the release hydrogen sulfide and methane as the dredged material is removed, transported, and managed for final disposal in the CDRC staging area. This impact would be temporary, until construction work is completed. The No Action Alternative, however, would allow the abnormal levels of hydrogen sulfide and methane presently found in the Eastern CMP to continue or even worsen, since these gases are produce in large part due to the excessive accumulation and decomposition of organic material in its stagnant waters.

4.1.1 No Action

Because temperature is expected to increase in Puerto Rico (see Section 3.1.1) due to climate change, temperature in the CMP would likely increase as well, and would be exacerbated due to heat island effects in the adjacent urbanized areas.

4.1.2 Recommended Plan

The Recommended Plan could provide benefits toward reducing climate change and heat-island effects, such as an increase in average temperatures at the Eastern CMP.

The Recommended Plan would result in net gains of vegetated wetlands and uplands, increasing forest cover in the Project Area. This, in turn, could decrease heat island effects and provide additional means to cope with future increases in temperature, a benefit of particular value in a densely urbanized landscape such as that of the Study Area.

4.1.3 Alternative 1

The net gain in mangrove area (6.16 acres) along the Eastern CMP would result in equivalent increments in its potential to cool ambient temperatures, although not significantly different from that of the Recommended Plan.

[21] Other impacts due to climate change have been included or discussed, if applicable, in the following subsections about the environmental consequences that the project alternatives could have on specific topics or resources.

4.1.4 Alternative 3

The net loss in mangrove area (-4.38 acres) along the Eastern CMP would result in equivalent reductions in its potential to cool ambient temperatures, although not significantly different from that of the Recommended Plan.

4.2 GEOLOGY

Impacts to the Project Area's geology, as a result of any of the project alternatives, would be considered significantly adverse if the underlying geology (i.e., karst composition) is significantly altered or if the local geology is compromised (e.g., sinkhole formation). Subsurface investigations indicate that rock or limestone outcrops may exist at depths of –10.5 feet in the eastern end of the Eastern CMP.

4.2.1 No Action

The No Action Alternative would not result in any impacts to the Project Area's geology.

4.2.2 Recommended Plan

The Recommended Plan would be dredged above –10.5 feet, avoiding the need to dredge rock from the channel section by allowing the rock to remain in place and slightly adjusting the channel's configuration to maintain the design cross section.

Results of geotechnical analyses (Atkins, 2011f) indicated no concerns regarding the stability of the Eastern CMP channel with respect to the proposed dredging, nor those involving sheet piling installation. No significant impacts to geology are anticipated as a result of the Recommended Plan.

4.2.3 Alternative 1

Significant impacts to geology are not anticipated with implementation of Alternative 1 and changes are the same as those described for the Recommended Plan, since both alternatives would consist of a channel 10 feet deep.

4.2.4 Alternative 3

Significant impacts to geology could result with implementation of Alternative 3. Its wider cross section (125 feet) when compared to the Recommended Plan (100 feet) and Alternative 1 (75 feet) could require the excavation of limestone rock. The remnants of a small karst hill or "mogote" are found in the Eastern CMP, north of its eastern end, and relatively close to what would be the proposed channel alignment under Alternative 3.

4.3 SOILS

Significant impacts to soils would be those that alter their physical conditions (e.g., compaction or excavation) making them unsuitable for habitat or for reuse in the system (e.g., debris or high organic content). Storm water and soil stabilization controls would be installed to limit siltation caused by silt laden runoff coming from upland during construction activities related to all three project alternatives that involve action. Potential contamination of soils is addressed in Section 4.5. Water and Sediment Quality.

4.3.1 No Action

Further impacts to soils could continue due to the disposal of household waste, rock and other debris used as fill material within the Eastern CMP. Soils would continue to include debris, which along the Eastern CMP may reach depths more than 10 feet below land surface. Even if improper waste disposal activities are completely halted, refuse that has been used as fill within the Eastern CMP would continue to be a source of concern due to its impact to soil structure, composition and the flora and fauna that could be directly or indirectly in contact with it.

4.3.2 Recommended Plan

Significant beneficial impacts to soils in the Eastern CMP are anticipated as a result of the removal of debris used as fill material, thereby benefiting local fish and wildlife, as well as humans. Under the Recommended Plan, approximately 762,000 cy of material, consisting of 76,200 cy of debris would be excavated from the Eastern CMP and transported to a landfill and about 648,000 cy (in situ sediment volume) of dredged sediments would be placed in the San José CAD. Substrate, at the Eastern CMP channel behind the sheet pile, would be left without garbage and thus under a suitable condition that would promote its colonization by sediment boring organisms (e.g., crabs, etc.) and mangrove, respectively.

4.3.3 Alternative 1

This alternative would result in the dredging of approximately 680,000 cy of material, consisting of 68,000 cy of debris that would be transported to a landfill, and approximately 574,200 cy of sediments (in situ sediment volume) that would be placed in the San José CAD. Alternative 1 would require less space or capacity from the Humacao Regional Landfill to be compromised from the disposal of dredged debris than that from the Recommended Plan and Alternative 3. However, Alternative 1 would have less beneficial effects on the Project Area than those described for the Recommended Plan and Alternative 3. It would leave 8,200 cy or 19,200 cy of debris within the soils at both banks of the Eastern CMP, when compared to the Recommended Plan and Alternative 3, respectively.

4.3.4 Alternative 3

Dredging under this alternative would result in approximately 872,000 cy of material, consisting of 87,200 cy of debris that would be transported to a landfill, and approximately 747,000 cy of sediments (in situ sediment volume) that would be placed in the San José CAD. Because of the greater dredged material volume, Alternative 3 would provide more benefits to soils in the Study Area than both the Recommended Plan and Alternative 1. Alternative 3, however, would compromise or require a bigger area within the Humacao Regional Landfill to dispose an additional 11,000 cy of debris, when compare to that required by the Recommended Plan.

4.4 HYDROLOGY

Hydrological effects of the channel alternatives have been considered based on their impacts on hydrodynamics, bathymetry, and coastal processes. [22]

Impacts to hydrodynamics in the Study Area would be considered significant if the project alternative resulted in significant changes in hydraulic conveyance patterns and volumes, flood levels, current or tidal patterns, storm surge characteristics, and/or salinity gradients among these water bodies. Adverse impacts to the project's alternatives caused by environmental changes resulting from sea level rise were also considered.

Impacts to bathymetry in the Eastern CMP and the San José Lagoon as a result of the project alternatives would be considered significant if bathymetric contours were modified as a result of additional dredging or sediment disposal and subsequently alter the use by living resources, including humans.

Impacts to coastal processes would be considered significant if tidal exchange and sedimentation were altered such that circulation patterns, water quality, and/or sedimentation in the SJBE system were substantially altered.

An elongated weir under the Martín Peña, Tren Urbano, and Luis Muñoz Rivera bridges involving a 115-foot-wide by 6.5-foot-deep channel is considered for all of the three project channel configurations alternatives evaluated. This structure would limit water conveyance in the same way for all three project channel alternatives. Fouling of the sheet pile walls by encrusting organisms and its effect on water velocities was considered negligible to differentiate among the three project

[22] Methods used to evaluate impacts of the proposed project on the hydrology and hydrodynamics of the SJBE included the CH3-WES hydrodynamic model and the advanced Interconnected Pond Routing (adICPR) model. The CH3-WES hydrodynamic model was used to identify circu¬lation patterns to determine ecological improvement potential for various tidal restoration alternatives. The adICPR model was used to develop hydrographs and evaluate subsequent effects of flood levels with and without storm surge and with the CMP open and closed. Potential scour was determined using equations from the FHWA HEC-15 (2005). Hydrologic and hydrodynamic models, and results, are detailed in Atkins (2011a).

channel alternatives, and thus, is not expected to change the roughness coefficient significantly enough to affect any of the channel's hydraulics.

Modeling indicates that under the evaluated project channel alternatives, that is, after any of these have been built, storm surge elevations would control water levels for all return interval rainfall events.

Water levels would be less than the existing condition under all project channel alternatives during rainfall events without storm surge; standing water levels at CMP would be lower at the beginning of the storm event due to its augmented water conveyance capacity.

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. For all three project channel alternatives during construction, the channel flow would be plugged towards the western half of the CMP, under the Ponce de León Avenue bridge, to minimize the dispersion of sediments. A sheet pile would be placed in the eastern face, under the Ponce de León Avenue Bridge to shut off flow temporarily at the CMP. This would keep the CMP in a temporary "plugged" condition. 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. To minimize the extent of floods during plugged conditions, the temporary sheet pile wall would be placed at an elevation that allows flood waters to overtop and flow west, but still high enough to limit or impede tidal flow into the Project Area.

The proposed channel along with its sheet pile walls and adjoining mangrove beds are intended to form the floodway to contain the frequent storm events under the three project channel alternatives.

In its existing topographic condition are low-lying areas with poor drainage due to their low elevations (near mean lower low water) or their lack of adequate receiving channels. Water, influenced by the tides and storms, would backflow into the any of the three project channel while in construction. Without proper controls, structures in these low-lying areas may be at risk of adverse impacts from high water events. Possible flooding impacts on adjoining communities are discussed in detail on Section 4.14 - Human Health and Safety.

Residence time for the San José Lagoon would be reduced from 16.9 days to approximately 3.9 days under all three project channel alternatives. Reducing the residence time would also significantly reduce the salinity stratification (and associated low DO) at –4- to –6-foot depths (MSL) in the San José Lagoon.

Tidal amplitude within the CMP and the San José Lagoon would increase as a result of construction of the channel, decreasing from west to east. That is, increases are expected to be higher at the weir than at the San José Lagoon. 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. 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 (1950s) and presumably when there was significant flow through the CMP prior to its filling. 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.

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 approximately in 2018 and completing in 2020, sea level change was calculated. Table 4-2 provides a summary of all estimated sea level change rates based on the updates to the NRC Equations and extending the calculation 50-years from a construction completion date of 2020. As further reference, Ernesto Diaz (Diaz, 2010) provides monthly sea level data for San Juan between 1962 and 2010 and estimates a change in sea level in 2100 of 0.414 meter (1.36 feet) using the regression formula $y = 0.0017x - 3.1565$. Using this equation, the estimated sea level change in 2069 would be 0.36 meter (1.18 feet), which would be in the intermediate range of the sea level change estimate.

Table 4-2. 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

All project alternatives (i.e., Recommended Plan, Alternative 1 and 3), with the exception of the No Action alternative, would contribute to mitigate or reduce some of the potential impacts of sea level rise (SLR) on surrounding communities. Some of these benefits, however, could be offset in the long term by SLR. Negative effects of climate change on the Eastern CMP and the San José Lagoon may be reduced through the implementation of adaptive management strategies.

SLR would overtop the elevations necessary to maintain the existing and planned mangrove planting areas for all three project alternatives (Atkins, 2013a). Mangrove forests are able to cope with higher water levels depending on how fast this change takes place and the resulting water depth. Red mangrove (*Rhizophora mangle*), for example, can develop new aerial roots to compensate for those that become drowned from a gradual, slow pace increase in water level, in order to maintain gas exchange between the roots and the atmosphere. Newly formed aerial roots also help maintain structural stability of individual trees.

In the event none of these morphological adaptations prove enough to deal with the effects of SLR under the channel configurations considered in all of the three project channel alternatives, mangrove trees would be able to colonize newly flooded lands adjacent to the Paseo del Caño. These lands would be proposed to be conserved as an upland buffer between any of the three channel configurations evaluated and the adjoining communities.

The new mangrove forest adjoining the Eastern CMP considered by the three channel configuration alternatives would provide different degrees of protection against storm surge damage aggravated by SLR than none from the No-Action Alternative. Saudamini & Vincent (2009) found that mangrove width was the most significant factor to mitigate storm surges. Therefore, increased mangrove acreage fringing the Eastern CMP would likely reduce risk associated with farther reaching storm surges as a result of SLR.

Increases in water elevations due to sea level change (Section 3.4.1) would not affect future navigation of the Eastern CMP under any of the CMP-ERP alternatives since the depth of any of these would be constructed and maintained as measured from the water surface. The proposed sheet pile wall's top (cap) elevation would be 3.0 feet and present mean high water is elevation

1.31 feet. Based on the estimated sea level changes, mean high water elevations would remain below the top of wall for the low and intermediate sea level change estimates and rise to 0.5 foot above the top of wall for the high estimate. The main consequence associated with water levels overtopping the walls to this minor extent would be a hazard to navigation as the tops of the wall would not be visible under certain tidal conditions. Channel markers may be required to adequately mark the position of the wall to minimize the hazard.

If sea level change occurs at rates exceeding the planning levels, several options may be considered to help counteract the effects of rising water in the adjacent communities, as well as to the CMP-ERP itself. These might include raising the top of the sheet pile wall and constructing a secondary flood wall. Raising the sheet pile wall would require retrofitting a modified concrete cap on top of the existing cap. Handling the extra load and forces might require that during the initial design, the steel panels be thickened and possibly embedded deeper. The cap might also require modification in anticipation of later accepting the higher wall cap. A second method would be to initially install the sheet pile wall to a higher elevation, say elevation 6.0 rather than 3.0. The consequences of both of the above solutions would be that the wall could not have the flushing windows to service the mangroves and views of the water from the Paseo del Caño would be reduced.

A more appropriate solution may be the installation of a floodwall at the top of the slope, adjacent to the sidewalk of the Paseo del Caño. This wall would have a top elevation of 6 or 7 feet. With the Paseo at between 2 to 4 feet in elevation, the floodwall would only be 3 to 5 feet high, essentially a seat wall along the promenade. The seawall embedment would be shallow compared to the sheetpile wall, and not have to retain earth. It should be less costly that modifying the sheetpile wall and would not impair the mangrove bed.

Overall, the CMP-ERP would contribute to mitigate some of the potential impacts of sea level change on surrounding communities. The acquisition of 393 residential structures and 394 relocations within the confines of the Federal project, in the maritime terrestrial zone, would reduce the amount of people exposed to flooding. In addition, the increased mangrove acreage fringing the Eastern CMP would likely reduce risk associated with farther reaching storm surges as a result of sea level change.

4.4.1 No Action

The No Action Alternative would result in no changes to existing flows between water bodies or circulation patterns, tides, wave action, or salinity in the San José Lagoon. Existing conditions due to impeded channel conveyance would persist. No changes to the 100-year floodplain, hydraulic conveyance volumes or patterns, runoff volumes, current or tide patterns, storm surge, or salinity are anticipated under this alternative. Poor tidal exchange, flooding, and poor water quality conditions would continue to adversely impact both the ecological and human health and integrity of the Study Area. Frequent floods would continue to occur and would disrupt normal residential daily life, business operations, and provision of essential services like education in flood-prone schools.

Under existing conditions, the average residence time of water in San José Lagoon is estimated at 16.9 days. At present, average tidal range for the San José Lagoon, is 3.93 in, reflecting the influence of the filled CMP. The absence of adequate tidal exchange between SJB and San José Lagoon and associated sedimentation and poor water quality would persist or worsen in the CMP and San José Lagoon under the No Action Alternative.

Impacts to bathymetry would be significant since sedimentation of the Eastern CMP would continue, incrementing with time, leading to its complete filling. Sedimentation would continue in the Eastern CMP due to low or no tidal exchange, and thus, no water conveyance capacity able to export or transport suspended sediments. Connectivity between the western and eastern section of the Study Area through the SJBE would not be possible for navigation nor for aquatic organisms.

4.4.2 Recommended Plan

The channel configuration of 100-foot-wide resulted in a peak channel bottom velocity of 2.80 fps, one of the lowest peak channel bottom velocities in the western end of the CMP. The analysis of potential scour for the channel scenarios indicates that the 100-foot channel configuration is the smallest channel suitable for an earthen bottom (as opposed to a protected bottom) based on shear stress limitations (0.072 to 0.094 pound/ft^2).

4.4.3 Alternative 1

The modeled cross-sectional area of the 75-foot-wide channel is 675 ft^2, compared with 900 ft^2 for the 100-foot-wide channel. This reduced area results in an increase in velocities and scour under Alternative 1, thereby requiring protection of the channel bottom. To address this issue, Alternative 1 would have to include paving with articulated concrete mats comprising flexible, interlocking, machine-formed blocks connected by cables for additional scour protection against higher velocities in the narrower channel.

4.4.4 Alternative 3

The modeled cross-sectional area of the 125-foot-wide channel is 1,125 ft^2, compared with 675 ft^2 and 900 ft^2 for the 75-foot and 100-foot-wide channel, respectively. Bottom velocities and potential scour would be less under this alternative when compared to the 75-foot alternative and the Recommended Plan, and would not require channel bottom protection.

4.5 WATER AND SEDIMENT QUALITY

Water quality impacts are based on relationships of water quality parameters to tidal exchange and water depth in the SJBE system. Sediment quality is based on an evaluation of the potential for contaminants in the sediments of the Eastern CMP. Impacts to water and sediment quality are considered significant if pollutants are demonstrated to exceed regulatory standards and impacts are long term.

For those alternatives involving dredging of the Eastern CMP (Recommended Plan, Alternative 1 and Alternative 2), the San José Lagoon and San Juan Bay would be reconnected and tidal exchange through the CMP would be restored. Hydraulic conveyance and tidal influence would significantly improve water circulation and water quality in the CMP and the San José Lagoon; the latest by diminishing water residence time to 3.9 days or less. This, in turn, would help diminish salinity stratification and improve DO levels in the lagoon, especially in shallow waters (<6 feet). Partially filling some of the subaqueous artificial dredged pits would also reduce water residence time and eliminate those areas with the worse water and sediment quality (e.g., anoxia, high hydrogen sulfide concentrations) in the San José Lagoon. The sediments and the water layer immediately above these, within the subaqueous artificial dredged pits could be consider “dead zones” due, in part, to the harmful processes and effects associated to their unnatural depth.

Temporary adverse impacts to water quality are anticipated from construction activities involving the Recommended Plan, Alternative 1 and Alternative 3. Dredging of sediments would result in short term localized deterioration of water quality. Both the sediments and the sediment pore water of the CMP are characterized by elevated levels of various contaminants. Exceedances of sediment quality guidelines were found for anthracene, antimony, arsenic, copper, dieldrin, lead, mercury, selenium, silver and zinc, along with others. The porewater within the sediments of the CMP are also characterized by exceedances of relevant criteria for multiple parameters. Problematic results were found for chromium, copper, lead, mercury, nickel, and zinc; however, dilution processes involved with the formation of the slurry for hydraulic dredging should reduce porewater concentrations of chromium, lead, nickel, and zinc to values below the irrelevant water quality criteria, even within the CMP itself (Atkins, 2013d).

Levels of copper and mercury would likely exceed criteria during the dredging operation, within the area where active dredging would occur. Exceedances for copper and mercury within the actively dredged area would occur mostly due to the fact that the surface waters of Eastern CMP and/or San José Lagoon already exceed relevant criteria. Concentrations of total cyanide are expected to exceed the free cyanide surface water quality standards in the area actively being dredged. For cyanide, a complication exists in that the relevant standard is for “free” cyanide, while much of the existing water quality is for the larger category of “total” cyanide.

Water quality impacts have been assessed based on concentrations expected during sediment disposal within the San José Lagoon CAD, but outside of a 1,000-foot mixing zone around those disposal sites.

Based on earlier work by Bailey et al. (2002) selenium concentrations would be expected to be reduced by 74% outside of a 1,000-foot mixing zone, during sediment disposal activities. After applying the expected 74% reduction in selenium to the other metal concentrations, there would be no anticipated exceedances of existing criteria for any of the metals examined outside of a 1,000-foot mixing zone, except for the ongoing impairments for copper and mercury of the waters of San José Lagoon itself (Atkins, 2013e).

After the completion of the sediment disposal activities into the San José Lagoon pits, Bailey et al. (2002) also anticipated that a sediment cap of clean sand would reduce the "migration" of selenium into the overlying water column by approximately 90%. After applying a 90% reduction in expected metal concentrations, based on results previously proposed for selenium, there would be no anticipated exceedances of existing criteria for any of the metals examined in the waters of San José Lagoon, even inside of the previously described 1,000-foot mixing zone used during sediment disposal operation. Exceptions would be for the ongoing impairments for copper and mercury of the waters of San José Lagoon itself (Atkins, 2013e).

The sediments themselves also exceed relevant guidance criteria; however, features associated with the option of disposal within the deep pits of the San José Lagoon and/or ocean disposal may limit the environmental impact of sediment contamination. Sediment disposal within the deep pits of the San José Lagoon may not cause adverse environmental impacts, as besides the sand cap, the waters of the pits are anoxic below a depth of about 6 feet and bio-accumulation is unlikely to occur in a location of such limited biological activity. While for the extreme depths of the ODMDS (averaging in excess of 900 feet) would likely result in a dispersion of sediments such that its distribution, once they reach the sea floor, would be dispersed enough to not cause adverse environmental impacts. A combination of sediment fate modeling and bioassays would be required to verify this outcome.

While previous sediment analysis and available data indicate that some contaminants in the sediments of the Eastern CMP exceed relevant guidance criteria, testing of those sediments that would be dredged from the Eastern CMP and SJ1 and SJ2 dredged pits would be conducted during PED and as part of Section 404(b), in order to determine or assess their baseline condition prior to project implementation or construction. The proposed monitoring plan, including bioassays, will be defined in detail in consultation with all relevant regulatory agencies. It should be noted that on October 30, 2015, the USACE, the USEPA, the Commonwealth of Puerto Rico, and ENLACE signed a MOU for the CMP-ERP. This MOU, among other provisions, commits the USEPA to designate a full-time staff person to work with the community and local and Commonwealth agencies and provide technical assistance with respect to the dredging as part of the CMP-ERP, including the review of sampling plans and other technical plans, and by providing input and guidance for assessing the character of the dredge material in accordance with the management and or disposal of any "Actionable Hazardous Subtances" (AHS). AHS are defined in the MOU as "any material that (a) contains a hazardous waste, as defined in USEPA's RCRA regulations; (b) 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 the USEPA; or, (c) cannot, without additional treatment, be disposed by legally in a Subtitle D municipal solid waste landfill located within the Commonwealth and is not environmentally appropriate, as determined by the EQB, in consultation with the USEPA, for disposal, without additional treatment, in open water or in the San José Lagoon Contained Aquatic Disposal areas.

Proposed features associated with dredging the Eastern CMP and disposing sediments into the San José CAD would help limit or control water and sediment contamination. Several measures would be adopted to reduce or minimize environmental impacts associated to the disposal of dredged sediment. Dredged sediments would be enclosed into geotextile bags or tubes, and turbidity curtains would be placed around the San José Lagoon CAD to limit sediment dispersion into the water column. After been filled, the geotextile bags would be place within the CAD and subsequently buried and capped with a 2-foot layer of sand, as recommended by Bailey et al. (2004) to reduce the "migration" of selenium into the overlying water.

During construction of the three project alternatives, best management practices (BMPs) would be used to minimize short-term and long-term sedimentation, erosion, turbidity, and total suspended solids (TSS). BMPs would include the temporary installation of a sheet pile wall or coffer dam across the western limit of the Project Area to control water flow. In addition, turbidity curtains would be place in the same area, both of which would help limit suspended sediments and other potential contaminants moving towards the western half of the CMP.

Within the channel corridor and around active dredging and excavations adjacent to the water, silt curtains will be deployed. 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.

Other stormwater and sediment BMPs would include temporary seeding, retention blankets, and earthen diversions. Storm water dispersion systems, paved discharges, matting, vegetative filter strips, and berms would be employed to minimize the long-term turbidity and TSS in the waters. Sedimentation and erosion control devices will be deployed at the interface of the channel dredging and the uplands (see section 5.11.2 of the Engineering Appendix for additional information).

Additional water quality monitoring and management measures that would be implemented during construction activities include sampling and analyses during relevant construction activities, twice daily, and would include background and compliance samples to document any visible plumes generated by construction activities. Data would be compiled daily and included in quarterly construction reports. If contaminant levels exceed thresholds, relevant project activities would immediately be stopped, and the appropriate authorities would be notified. Should the value outside the turbidity barrier and mixing zone exceeds the standard for ambient marine waters of 10

NTU, construction activities would also be suspended, unless the excessive turbidity is caused by natural events, as specified in Puerto Rico Water Quality Standards Regulation. Work would not resume until it can be conducted in compliance with these turbidity and contaminant limits or an accompanying variance, where applicable. In addition, a turbidity monitoring plan will be incorporated into the construction contract documents to include sampling and analyses.

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, if needed.

In summary, all three "action" alternatives would cause very similar long term, water and sediment quality improvements to the Project Area and the Study Area. Impacts to water and sediment quality among these three alternatives would be short term, mostly limited to their construction. These, however, are not expected to be significantly different from each other. Initial positive responses from all three project channel alternatives are likely to occur within a year at most, after completing construction, and substantial improvements in the ecological health of benthic communities are likely to occur over a period of 2 to 3 years or less (Atkins 2011a).

Testing of those sediments that would be dredged from the Eastern CMP and SJ1 and SJ2 dredged pits would be conducted during PED and as part of Section 404(b), in order to determine or assess their baseline condition prior to project implementation or construction. The proposed monitoring plan, including bioassays, will be defined in detail in consultation with all relevant regulatory agencies (e.g., EQB, EPA, etc.).

It should be noted that on October 30, 2015, the USACE, the USEPA, the Commonwealth of Puerto Rico and ENLACE signed a Memorandum of Understanding (MOU) for the CMP-ERP. This MOU, among other provisions, commits the USEPA to designate a full-time staff person to work with the community and local and Commonwealth agencies and provide technical assistance with respect to the dredging as part of the CMP-ERP, including the review of sampling plans and other technical plans, and by providing input and guidance for assessing the character of the dredge material in accordance with the management and or disposal of any "Actionable Hazardous Subtances" (AHS). AHS are defined in the MOU as "any material that: (a) contains a hazardous waste, as defined in USEPA's RCRA regulations; (b) 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 the USEPA; or, (c) cannot, without additional treatment, be disposed by legally in a Subtitle D municipal solid waste landfill located within the Commonwealth and is not environmentally appropriate, as determined by the EQB, in consultation with the 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 material's 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 regulatory entity) supporting the proposed disposal methodology and location."

4.5.1 No Action

Adverse impacts to existing water and sediment quality are anticipated to persist under the No Action Alternative: accumulation of debris and sediments and associated poor water and sediment quality would likely continue to worsen over time.

Under this alternative, renewal of the San José Lagoon's waters would continue to take 16.90 days, insufficient to allow for the breakdown or reduction of salinity stratification. This, in turn, would continue to promote low levels of dissolved oxygen in its waters, as well as anoxic conditions in most of its benthic habitat. Lack of water circulation would also continue to facilitate an above normal concentration of nutrients or eutrophic conditions which already have led to frequent algae blooms and fish kills.

4.5.2 Recommended Plan

Close to 730,000 cy of poor quality sediments from the Eastern CMP would be removed under the Recommended Plan. This is a larger volume of dredge material than that under Alternative 1, and thus, would result in better, long term improvements on the sediment quality of this segment of the SJBE. Temporary impacts related to suspended solids, turbidity and overall water quality, however, would be greater with the Recommended Plan due to the additional amount of dredge material and longer construction time needed to remove and dispose these when compare to Alternative 1.

4.5.3 Alternative 1

This alternative would entail the removal of approximately 638,000 cy of poor quality, dredged material, helping to improve the bottom conditions through the Eastern CMP. However, the entire length bottom of the Eastern CMP would have to be covered with articulated concrete mats to prevent its scour, eliminating its potential as a substrate for the development of benthic communities resembling those that may have originally been found in the channel. In addition, a larger volume of debris and other unnatural materials would remain within the banks of the new channel.

The removal of a lesser volume of dredge material proposed under this alternative than that entailed by the Recommended Plan and Alternative 3, should shorten construction time and those water quality impacts associated to the resuspension of sediments during dredging works and their disposal at the San José Lagoon CAD.

4.5.4 Alternative 3

Approximately 872,000 cy of dredged material would be removed under Alternative 3. This amount would provide better assurances for the removal of unsuitable, poor quality material that had been placed to fill both the open waters and associated mangrove wetlands along the historical footprint of the Eastern CMP, than that considered under the Recommended Plan and Alternative 1.

The removal of a larger volume of dredge material proposed under this alternative than that entailed by the Recommended Plan and Alternative 1, would extend construction time and those water quality impacts associated to the resuspension of sediments during dredging works, as well as those related to their disposal at the San José Lagoon CAD.

Improvements in the quality of those sediments that would remain along the bottom of the Eastern CMP would be the same among Alternative 3 and the Recommended Plan, since these would be dredged down to 10 feet below the surface water level under both alternatives.

4.6 AIR QUALITY

The Project Area's ambient air quality is defined by emissions from natural and anthropogenic sources. To estimate air quality impacts, air pollutant loadings determined by the magnitude of emissions expected for project alternatives were compared to ambient emissions. Significant impacts are those that would permanently change and degrade the air quality in the Project Area. No significant impacts are expected from the three "action" alternatives.

Under the Recommended Plan, Alternative 1 and Alternative 3, fugitive dust would be generated by the physical disturbance of soils caused by earth-moving activities and vehicle traffic taking place at land-based construction sites within the Project Area. These, however, are expected to be minimal since most of what would be handled is dredged material (e.g., sand, silt, and clay), and thus, should be moist. Demolition of the dwellings that are located within the public domain areas would also generate dust. Effects from these may be characterized as nuisance conditions, yet on sensitive populations, such as children and the elderly, asthma may result in significant, short term impacts to local residents. Management measures, such as the use of a water truck to reduce the air suspension of soil or dust would be employed as a precaution for mitigating purposes, if necessary.

Internal combustion engine emissions from dredging and construction equipment, pumps, barges and trucks used to transport materials, equipment, personnel and employee vehicles would occur as part of all three "action" alternatives. These would result in air emissions of CO_2, NO_x, PM, SO_2, and VOCs. The emissions from all of the three "action" alternatives, however, would result in an increase of less than 1% of those inventoried for existing sources in the San Juan area. Therefore, emissions from the proposed activities are not anticipated to cause or create an increase in the NAAQS.

Temporary short-term impacts from all "action" alternatives would also include an increase in Hydrogen Sulfide (H_2S) ambient concentrations as the dredged material is removed at different points along the Eastern CMP, as discussed in Section 2.2.5 of this EIS. An air quality dispersion model (i.e., Areal Locations of Hazardous Atmospheres or ALOHA), was used to predict the areal extent and maximum concentrations of H_2S that may be emitted (Atkins, 2012f). Potential emissions of H_2S may produce mild transient adverse health effects or a clearly defined, objectionable odor out to distances of 2.2 miles from the dredging sites. The model also predicted that concentrations may exceed the Toxic Level of Concern in some locations. Although very unlikely, a 100% sudden release of H_2S during dredging activities would exceed the chronic inhalation exposure criteria for children. The basis and assumptions used to arrive at these predicted concentrations, however, were conservative and the actual impacts are expected to be much less. Also, the resulting levels of H_2S concentrations from the models have not been observed in open air operations. The severity of H_2S emissions would be related to the amount or volume of material to be dredged and the time it takes to complete each of the alternatives considered.

Development of an H_2S monitoring program to be implemented during dredging operations for all project channel alternatives would be undertaken, nevertheless, to quantify ambient conditions and to manage/mitigate H_2S release as a precaution. Efforts may include: (1) water sprays near the source to reduce concentrations; (2) in situ chemical treatment of the sediments to sequester the hydrogen sulfide or convert it into a less harmful substance; (3) collection of the air at the site of sediment disturbances followed by air scrubbing to sequester hydrogen sulfide; and (4) collection of the air at the site of sediment disturbances and transmission to a safe zone (e.g., high above the ground or to the middle of the San José Lagoon) where dilution/dispersal can occur safely. As a last resort, individuals or residents located in the areas anticipated to be impacted by unsafe levels of hydrogen sulfide would be temporarily relocated (evacuation). The management plan should address health and safety of the public, the construction workers and equipment subject to H_2S related corrosion and recommend personal protective equipment, such as respirators and/or other oxygen assistance gear; the latest, if necessary as well as monitoring equipment and procedures. Education and training regarding H_2S poisoning would be provided for workers.

No significant objectionable odors are expected to be produced while solid waste is been transported to the Humacao Regional Landfill. Dewatering of the dredged material to be disposed in the Humacao Regional Landfill is expected occur mostly within the barges, while been separated from the dredged sediments in the Eastern CMP. Additional dewatering would occur, although significantly less, while on transit in the San José Lagoon to the CDRC staging area.

4.6.1 Recommended Plan

Minor, short-term and very localized air quality impacts related to the release of dust from the demolition of structures is expected. Objectionable odors related to short term releases of H_2S are also expected on those sites been actively dredged. Its concentrations, however, are not expected to caused any health issues on workers and nearby residents. Additional consideration will happen in Pre-construction, Engineering and Design (PED) regarding methods to be used in order to minimize hydrogen sulfide.

4.6.2 Alternative 1

Minor short-term air quality impacts, such as those determined for the Recommended Plan, are anticipated for Alternative 1. These impacts however, are expected to be somewhat less than those resulting from the Recommended Plan and Alternative 3, since Alternative 1 would entail the least amount of dredged material to be removed from the Eastern CMP.

4.6.3 Alternative 3

Air quality impacts under Alternative 3 are anticipated to be of the same kind as those described for the Recommended Plan. Short term impacts could be more severe than caused by the Recommended Plan and Alternative 1, since Alternative 3 would involve a greater amount of dredge material and thus, a longer construction time.

4.7 NOISE

Potential noise impacts from a project alternative would result primarily from temporary construction activities, including dredging, material transport, employee vehicles, and water vessels. Impacts deemed significant are those that result in permanent exceedances of ambient noise conditions.

For the Recommended Plan, Alternative 1 and Alternative 3, noise levels would be temporary. Average noise levels for typical dredging projects resembling these three alternatives are listed below.

- Sediment and water pumps operate at around 66 to 70 dB.
- Hydraulic dredges generate noise at around 60 to 80 dB at a distance of 50 feet.
- A backhoe or loader generates about 85 dB, while a generator operates at about 78 dB.
- Clam shovels and impact pile drivers would generate 87 dB and 101 dB, respectively, at 50 feet.

During construction, a localized deterioration of noise quality is anticipated from heavy-equipment, demolition, and pile driving in non-urbanized areas. Dredging activities could result in short-term displacement of seabirds and shorebirds, but they are expected to resume normal use of foraging and roosting areas when project is completed. Demolition of the dwellings that are located within the public domain areas would also generate noise.

Construction of the CMP-ERP presents unique challenges due to the type of construction and its close proximity to residential areas. The work would generate noise and construction vibrations from the operation of heavy machinery and pile driving equipment. Construction vibrations may not only annoy people but may also have detrimental effects on structures and sensitive equipment. The potential for these effects is dependent upon numerous variables, including distance from the source, types of soil, frequency of vibration, and other factors.

Presently, there are approximately 158 structures facing the CMP-ERP and approximately 20% (32) of these structures may be impacted due to vibrations. A vibration and noise mitigation plan would be prepared to include pre-construction surveys of adjacent structures and, if appropriate, distant structures with sensitive equipment (e.g., hospitals or businesses with precision instruments). In the event that damage is reported, the pre-construction survey becomes the baseline for comparing the pre and post-construction conditions.

Noise mitigation may include installation of temporary sound barriers in critical areas, mandating the use of heavy equipment less likely to create noise and vibration issues, such as the use of press-in sheet pile driving technology that generates noise no greater than 66 dB (52.5 feet) and minimum vibration. Establishing vibration monitoring equipment is recommended every 500 feet.

Sheet pile driving is the activity with the greatest potential for noise and vibration impacts under the three “action” alternatives. Noise and vibration caused by sheet pile driving would vary depending on the distance between where the sheet piles would be installed and the location of the receivers (e.g., local residents, structures). As described in the Engineering Appendix, the design of the sheet pile wall construction will be further refined during PED to avoid, if practicable, those areas where limestone might be found in order to ease dredging and sheet pile installation, and as a result, underwater noise. Management measures to reduce underwater noise during construction are discussed in Section 4.11 of this FEIS.

Noise and vibration impact time length is another difference between these alternatives, but that is associated to the time it would take for each of these alternatives to be constructed. No other noise or vibration impact differences are expected among the Recommended Plan, Alternative 1 and Alternative 3.

4.7.1 No Action

No adverse impacts to noise levels are anticipated as a result of the No Action Alternative. However, this alternative would not provide the noise reductions or dissipation benefits produced by the natural corridor that would be established along the Eastern CMP from the combination of the restored open waters and vegetated fringes under any of the three “action” alternatives, whose undeveloped acreage would be greater than that presently available in this area. This service is especially valuable in the Project Area, whose surroundings are characterized by a dense and noisy urban landscape.

4.7.2 Recommended Plan

The Recommended Plan has the potential of causing less noise and vibration impacts on potential recipients than those that would be expected from Alternative 3. The latest, as defined, would require the installation of sheet piles closer to the adjoining communities in order to allow for the dredging of a 125-foot open-water wide channel. In addition, the Recommended Plan would create a wider mangrove fringe along the Eastern CMP, thus creating a wider, vegetated, noise buffer strip than that which would exist under Alternative 3. Noise and vibration impacts during the construction of the Recommended Plan would also last less than those for Alternative 3, since the former would involve a less amount of material to be excavated from the Project Area.

4.7.3 Alternative 1

Temporary dredging noise and vibrations under Alternative 1 would last fewer days than those needed to complete the Recommended Plan and Alternative 3. The former would require less material to be dredged from the Eastern CMP, so construction time would be shorter.

Alternative 1 would entail the widest mangrove fringe among those consider under the three project channel alternatives. As a result, sheet piles would have to be placed farther away from those landward structures adjoining the Project Area. This would allow for a larger buffer area to dissipate noise and vibrations during construction when compared against the Recommended Plan and Alternative 1. In the long term, it would also provide a better barrier against noises caused in the Eastern CMP's urban surroundings when compared to the Recommended Plan and Alternative 1.

4.7.4 Alternative 3

Short term, construction noise and vibration impacts caused by Alternative 3 would be longer in time and in magnitude than those resulting from the Recommended Plan and Alternative 1. For this alternative, the noise and vibration source (machinery) from construction would be at a closer distance of the receiver (local residences).

4.8 SOLID WASTE

Potential impacts due to solid waste have been determined in relation to their effect on the area where these are been placed for final disposal. All project channel alternatives would have a beneficial effect on the ecological health of the Project Area and Study Area regarding solid waste currently affecting both sites, although at varying degree. Recycling of any materials that would be dredged (e.g., refrigerators, washing machines, etc.) or that could be recovered (e.g., rebar) was contemplated under all of the CMP-ERP alternatives evaluated, and would be encourage if finally deemed feasible, practical and legally permited.

It is anticipated that material dredged from the CMP will include material that can be reclaimed or recycled. In addition, It is estimated that about 65% of the debris that would result from the demolition of structures will be recyclable, mostly consisting of concrete (cement and block walls), wood (doors), metals (aluminum from windows and doors, pipes, gates and fences); and plastics. Specific type and volume of construction debris will be estimated as part of PEDs.

As a potential means to contribute to the goal of extending the useful life of Puerto Rico's landfill sites through efficient disposal management of solid wastes, recycling or reclamation of solid wastes generated by the dredging and demolition of structures would be considered. Construction debris such as fragmented concrete and/or rip-rap can be separated and directly applied to projects needing armor for streambank or shoreline stabilization, if aesthetically acceptable. Other solid waste or material that cannot be readily processed for reclamation can be transported to existing "Dirty" and/or "Clean" MRFs for recycling. "Dirty" MRFs will accept a mix of solid waste and will separate out the recyclable materials on site. "Clean" MRFs will accept comingled recyclable materials, but require the recyclable material be separated from the other solid waste prior to transporting the recyclable materials to the MRF. Given the limited daily capacities of the MRFs, it would likely be logistically more feasible to separate out the CMP recyclables from the solid waste dredged material at the CRDC. The separated recyclable material would be transported to one or more of the MRFs, with the nonrecyclable materials disposed at the Humacao landfill (see section 5.7.7.2 of Engineering Appendix for more information).

Impacts related to HTRW would be significant if the proposed channel widening resulted in any of the following:

- Creation of a significant hazard (a hazard that is an actual or potential source of serious harm, or harm that occurs over a period of time) to the public or the environment through the transport, use, or disposal of hazardous materials;
- Creation of a significant hazard to the public or the environment through reasonably foreseeable accident conditions involving the release of hazardous materials into the environment;
- Generate hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within ¼ mile of an existing or proposed school; or
- Be located on a site, which is included on a list of hazardous materials sites, and, as a result, create significant hazard to the public or the environment.

Analytical methods used to characterized sediment quality have suggested that hazardous concentrations of lead may be present in the Eastern CMP. However, no evidence on HTRWs has been found in the Project Area. Neverthless, 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 any HTRW materials that could be identified or detected, would be managed and disposed of according to applicable Federal, state, and local rules and regulations. All

Actionable Hazardous Substances would 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. Final determination of the excavated material's regulatory status would be made by the appropriate Federal and Commonwealth of Puerto Rico regulatory authorities and would be a matter for discussion between the Commonwealth, as the responsible party, and those regulatory agencies.

4.8.1 No Action

Solid waste improperly discarded and still found in the Eastern CMP would continue to impact the water and sediment quality, living resources and the aesthetic value of the Eastern CMP. These impacts include, among others, an increase in the proliferation of rats, insects, flies and other animals that transmit disease. 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.

4.8.2 Recommended Plan

It is estimated that a total of 762,000 cy of mixed materials would be dredged under this alternative from the Eastern CMP. About 10%, or nearly 76,000 cy is estimated to be solid waste debris, which would be separated and transported by barge to the CDRC staging area for subsequent fiinal disposal at the Humacao Regional Landfill.

4.8.3 Alternative 1

It is estimated that a total of 680,000 cy of mixed materials would be dredged under this alternative from the Eastern CMP. About 10%, or nearly 68,000 cy is estimated to be solid waste debris, which would be separated and transported by barge to the CDRC staging area for subsequent fiinal disposal at the Humacao Regional Landfill. This alternative, as a result, would be the one occupying the least volume within that available at this landfill, and thus, would entail the least impact to its capacity when compared to the amount of solid waste that would be deposited by the Recommended Plan and Alternative 3.

4.8.4 Alternative 3

It is estimated that a total of 872,000 cy of mixed materials would be dredged under this alternative from the Eastern CMP. About 10%, or nearly 87,200 cy is estimated to be solid waste debris, which would be separated and transported by barge to the CDRC staging area for subsequent fiinal disposal at the Humacao Regional Landfill. As such, this material would compromise or need a larger volume of the available capacity found at the Humacao Regional Landfill than that resulting from the disposal of solid waste due to the Recommended Plan or Alternative 1.

4.9 HABITAT

Alternatives were evaluated based on their expected potential to restore or improve upland, wetland, and submerged habitats resembling those originally found in the Project Area, which in turn could improve conditions needed to sustain associated living resources. Impacts were considered significant if those habitats identified in the Project Area are not expected to recover or improve as a result of the implementation of each individual alternative.

Direct impacts to surface and subsurface habitats may result from continuous filling, dredging and/or the management and disposal of dredged material. Indirect adverse impacts may occur due to changes in salinity, water quality (e.g., turbidity and reduced light availability), and/or water depth and inundation. Similarly, improved water quality and restored hydrology would improve fish and wildlife habitat.

The CH3D-WES hydrodynamic model was used to quantify the improvement (decrease) in residence time in the San José Lagoon and improved connectivity between this water body and the San Juan Bay as a result of increasing the cross-sectional area and thus, the water flow capacity of the CMP within the Project Area (Atkins, 2011b). The output on residence time was combined with data from a recently developed Benthic Index (BI) for the SJBE (PBS&J, 2009). The relationship between residence time and benthic community health in the San José Lagoon was found to be significant. It was determined, as a result, that restoring tidal flow through the CMP would improve the lagoon's circulation, helping to decrease water stratification and thus, hypoxic to anoxic conditions affecting its waters and associated submerged habitats. The greatest benefits are expected to occur at depths of 4 to 6 feet below the water surface, and extending over an approximate area of 702 acres (Atkins, 2011b) within the lagoon.

It is anticipated that the CMP-ERP alternatives would provide the following improvements in the ecological health of benthic communities within the Eastern CMP and the San José Lagoon:

- Upon completion, there would be an increase in the tidal flushing of the lagoon, reducing the residence time from approximately 16.9 days, which is the present condition represented by the No Action Alternative, to 3.9 days or less (Atkins 2011a).
- BI scores are expected to improve from 1.55 (No Action Alternative) to 2.84 (Recommended Plan, Alternative 1 and Alternative 3) (Atkins, 2012a).
- Increased BI scores would be indicative of conditions where the benthic community is characterized by: 1) increased species diversity, 2) a lower proportion of pollutant-tolerant taxa, and 3) a higher proportion of pollutant-intolerant taxa (Atkins 2009a).

The CMP-ERP alternatives are expected to produce almost similar benthic habitat benefits in the San José Lagoon by improving its water circulation. Water conveyance through the Eastern CMP would not be determined by the cross channel dimensions contemplated under any of the three “action” alternatives, but by the weir that would be placed on its western end. However, the different open water channel configurations considered in each of these would result in different mangrove wetland, mangrove prop root, water column and benthic habitat acreage along the Eastern CMP. Improvements in the quality of the resulting mangrove wetland, mangrove prop root and water column habitat would be very similar among all three “action” alternatives.

Mangrove prop roots have been documented as productive nursery habitat for a variety of aquatic organisms such as juvenile fishes, including commercial species. As such, the reestablishment of historical tidal connections from all three project channel alternatives would help restore those functions associated to the mangroves of the San José Lagoon as spawning grounds for aquatic organisms, and thus increase larval supply to the rest of the Study Area. Likewise, increase fish species diversity in the San José Lagoon is expected by the improved tidal connection provided by any of the CMP-ERP alternatives with the San Juan Bay and related ocean waters in the Study Area (Atkins 2011b).

Filling the deepest sections, and thus, raising the bottom of the subaqueous artificial dredged pits as proposed under all three project channel alternatives would help improve one of the most degraded areas, if not the worst, for benthos and the immediate overlying open water habitat in the San José Lagoon. Existing data on benthic communities and benthic index scores of zero in these locations indicate an absence of any significant biological communities (PBS&J 2009). The deepest parts of the dredged pits are specially affected by oxygen depletion and significant concentrations of hydrogen sulfide. These sites are where tidal currents and wind action are the least effective in the whole lagoon to produce mixing of the water column. Sunlight does not reach these water depths, and as a result, no photosynthetic activity is able to take place.

However, the uppermost waters of the dredge pits, especially the area of the halocline, have been shown to provide an important feeding ground for tarpon. The halocline that separates the water layers tend to concentrate phytoplankton, zooplankton and other small motile and non-motile organisms and particles. In turn, this layer would attract larger organisms, such as blue crabs and fish, upon which tarpon prey from the concealment of the dredge holes. As such, the proposed conversion of some of the San José Lagoon's subaqueous artificial dredge pits into a CAD site for the deposition of dredged sediments, as proposed by all three project channel alternatives, would cause inevitable short term impacts to this habitat. The two deepest dredge pits found in the southeastern section of the San José Lagoon (SJ1/SJ2) would be dredged and reshaped into one CAD site to accommodate the dredged sediments from the Eastern CMP. The resulting dredged material from the San José Lagoon CAD would be deposited in the artificial elongated dredged pits parallel to the northeastern shore of the lagoon (known as SJ3/SJ4/SJ5). During this process, the dredge pits and CAD would be surrounded by turbidity screens, impeding access to tarpon and to their anglers. This impact would last throughout the reshaping and disposal period. During this same time, water quality would be impaired by turbidity, suspended solids and from contaminants that may be present in the dredged material. The use of turbidity screens and geotextile tubes, the latest only for containing the dredged sediments from the Eastern CMP, would limit the extent and severity of these impacts.

Upland habitat created by any of the CMP-ERP alternatives, although less in acreage than the No Action Alternative, would harbor a greater number and diversity of native plant species than the latest, which is characterized by a great number of exotic flora.

Sea level rise (SLR) is expected to eventually overtop existing elevations where mangroves are found today, as well as those planned for mangrove planting restoration under all three project alternatives (Atkins, 2013a). Mangrove forests are able to cope with higher water levels depending on how fast this change takes place and the resulting water depth. Red mangrove (*Rhizophora mangle*), for example, can develop new aerial roots to compensate for those that become drowned from a gradual, slow pace increase in water level, in order to maintain gas exchange between the roots and the atmosphere. Newly formed aerial roots also help maintain structural stability of individual trees.

In the event none of these morphological adaptations prove enough to deal with the effects of SLR under the channel configurations considered in all of the three project channel alternatives, mangrove trees would be able to colonize newly flooded lands adjacent to the Paseo del Caño. These lands have been set aside to act as a buffer strip between the restored mangrove area and adjoining communities under the three channel project configurations.

4.9.1 No Action

Limited tidal exchange in the San José Lagoon due to channel encroachment of the Eastern CMP, and consequently, poor water quality conditions, would eventually increase the area affected by high dissolved ammonia and low dissolved oxygen concentrations. This would also lead to more frequent or intense algae blooms, accompanied by resulting fish kills in the lagoon.

The No Action Alternative would allow the Eastern CMP to continue to deteriorate due to siltation, trash, and debris accumulation within its banks and remaining open waters, resulting in significant adverse impacts to its wetlands (i.e., mangroves) and submerged habitats (i.e., mangrove prop root community, water column and benthos). The reduced salinities could support a greater number of freshwater species, such as the invasive water hyacinth, and its siltation would eventually cause it to shift or resemble an upland habitat. As a result, most species sustained or dependent on wetland and submerged habitats that once occurred in the Eastern CMP would be permanently displaced by those favoring upland habitats. Notwithstanding, this area could eventually lose most of its vegetation by becoming urbanized, just as it has been gradually transformed during the last 70 years.

4.9.2 Recommended Plan

This alternative would result in the temporary construction loss of 33.46 acres of mangroves and 7.40 acres of open or water column habitat. However, with the proposed open channel configuration and mangrove restoration in its banks, the amount of available mangrove habitat within this segment of the CMP would increase to 34.38 acres. This would mean a net gain of 1.02 acres. Open or water column habitat, as well as restored benthic habitat, would increase in the Eastern CMP by 18.17 acres (see Table 4-3).

Mangrove wetland and mangrove prop root habitat is expected to be greater in acreage under the Recommended Plan than for Alternative 3, but less in terms of open or water column habitat area.

Table 4-3. Habitat loss/gain summary for the Recommended Plan

Description	Existing	Proposed	Net (increase or loss)
Recommended Plan	**Acres**	**Acres**	**Acres**
Open water	7.4	25.57	18.17
Wetlands/mangroves	33.46	34.48	1.02
Upland	27.61	3.42	-24.19
Upland (recreation)	0	5.0	5.0
Totals	**68.47**	**68.47**	**0**

4.9.3 Alternative 1

Alternative 1 is expected to result in the greatest mangrove wetland and mangrove prop root area of all project channel alternatives, with a net increase of 6.16 acres (see Table 4-4). However, this would be at the expense of open or water column habitat, with a net increase of 13.02 acres.

Table 4-4. Habitat loss/gain summary for Alternative 1

Description	Existing	Proposed	Net (increase or loss)
75-ft channel	**Acres**	**Acres**	**Acres**
Open water	7.4	20.42	13.02
Wetlands/mangroves	33.46	39.62	6.16
Upland	27.61	3.43	-24.18
Upland (recreation)	0	5.0	5.0
Totals	**68.47**	**68.47**	**0**

Placement of an armored concrete mat along the entire length of the Eastern CMP bottom, as proposed in Alternative 1, would be a significant difference with the other project channel alternatives. The proposed armored concrete bottom could preclude burrowing creatures and other organisms associated with soft bottom benthic habitats from living, as these formerly did, in this section of the CMP. Encrusting creatures (e.g., barnacles), however, are anticipated to be able to settle on the hard bottom (Atkins, 2012a).

4.9.4 Alternative 1

Alternative 1 would result in the greatest mangrove acreage restored in the Eastern CMP among all project channel alternative, and thus could be the one that results in the most benefits to mangrove or forest canopy dwelling species. However, this benefit would be at the expense of open water and benthic habitat dwelling species (e.g., fish, aquatic invertebrates) since this alternative would entail the narrowest channel among all other project channel alternatives. This difference in mangrove, water column and benthic habitat acreage, and its potential use by fish and wildlife species, however, is expected to be insignificant.

4.9.5 Alternative 3

Alternative 3 is the only project channel alternative that would result in a permanent reduction in mangrove area, with a net loss of 4.38 acres. However, it would provide the most water column habitat area when compared to the other two project channel alternatives, with a net increase of 23.57 acres. The same applies to the restoration of benthos within the Eastern CMP (see Table 4-5).

Table 4-5. Habitat loss/gain summary for Alternative 3

Description	Existing	Proposed	Net (increase or loss)
125-ft channel	**Acres**	**Acres**	**Acres**
Open water	7.4	30.97	23.57
Wetlands/mangroves	33.46	29.08	-4.38
Upland	27.61	3.42	-24.19
Upland (recreation)	0	5.0	5.0
Totals	**68.47**	**68.47**	**0**

4.10 FLORA AND FAUNA RESOURCES

Methods used to evaluate resulting impacts from all alternatives on the flora and fauna of the Study Area include mangrove and open water acreage; functional value of wetlands; habitat suitability indicators (e.g., access or connectivity, dissolved oxygen) for wildlife habitat as well as threatened and endangered species (Atkins, 2011c), and essential fish habitat (Atkins, 2011i). The National Ecosystem Benefit Evaluation Report and the ecological uplift report (Atkins, 2014) also discuss the metrics and evaluate the impacts of alternatives on fish and wildlife. Finally, the CH3-WES hydrodynamic model results was used to predict circulation patterns (residence time), which in turn were used to predict ecological improvement for various parameters, such as dissolved oxygen and salinity.

Impacts of invasive species on native communities are also evaluated. Impacts would be considered adversely significant if these cannot be managed or ultimately affect expected improvements in the Eastern CMP and the San José Lagoon due to the implementation of any of the alternatives evaluated. In the event that an invasive species is able to thrive in the Project Area due the construction of any of the CMP-ERP alternatives, these could be control primarily by mechanical removal (e.g., plants) and by promoting the reestablishment of other native vegetation that provide habitat for other native flora and fauna.

Improved tidal exchange under any of the three project channel alternatives (Recommended Plan and Alternatives 1 and 3) is anticipated to reduce residence time in the San José Lagoon by 13 days (from 16.90 to 3.9 days or less). As a result, the BI score is expected to nearly double. Literature cited in the CMP Benefits Evaluation prepared by Atkins (2012a, 2013) report a positive response of the benthic community within the first year of implementing a restoration project.

Restored circulation and tidal exchange is expected to substantially improve water quality and promote the establishment of more diverse and healthy fish and wildlife habitats throughout the SJBE. The Eastern CMP, which now has almost no tidal flushing and little to no depths, would have a full depth of oxygenated water to support fish and invertebrate populations providing adequate habitat for fish and wildlife (Atkins, 2011a). Improved tidal flushing would also increase the recruitment of marine and estuarine plants and animals. This is particularly true of the extensive mangrove forests fringing the San José Lagoon, which presently support a limited diversity of aquatic species associated with the roots of the trees that are able to cope with the limiting conditions of this poorly flushed water body. Improved tidal flushing would increase the probability of survival of sensitive organisms, such as sponges, via an expected moderation of salinity extremes (Atkins, 2011b). Flushing rates could also improve larval recruitment and survivability for many other organisms that comprise the encrusting community of the mangrove prop roots and other shallow surfaces, therefore increasing the health of that habitat, which is considered essential for fisheries. Whereas presently a single species of mussel, *Mytilopsis domingensis*, dominates the areal coverage of the mangrove roots throughout the San José Lagoon, increased flushing is expected to result in a red mangrove prop root encrusting community that resembles the existing conditions in La Torrecilla Lagoon, where it includes multiple types of mollusks, as well as sponges, crabs, polycheate worms, and ascideans. This added diversity of fauna would likely result in an improved sustenance fisheries resource for the SJBE (Atkins, 2011b).

In addition, all of the CMP-ERP alternatives would also help restore the estuary's connectivity with its immediate submerged marine ecosystems by addressing ecosystem fragmentation caused by the fill material blocking tidal flow through the Eastern CMP. This, in addition to proposed enhancements to water quality, would improve the overall habitat seascape in the Study Area. This would be especially beneficial for those fish and shellfish species that need mangroves or coastal lagoons for development during their early life stages, and later migrate to the ocean in order to inhabit seagrass beds or coral reefs to complete their adult stage (ontogenetic migration) (Atkins, 2015a; Appeldoorn et al., 2011; Pittmanet al., 2006, 2007).

Dredged sediment disposal within the San José Lagoon CAD is expected to not cause adverse impacts to living resources as the waters of the pits are anoxic below a depth of about 6 feet, and bio-accumulation is unlikely to occur in a location of such limited biological activity (Atkins, 2013e). The deposited dredged sediments would be also contained within geotextile bags or tubes and capped with a 2-foot layer of sand, further reducing their exposure to benthic and aquatic organisms. All project channel alternatives have the potential to temporarily benefit many wading bird species (e.g., plovers, sandpipers, herons) since mudflat habitat would be available for these up to the time mangrove trees reach an adult size and cover the adjoining banks of any of the alternative open water channel alternatives.

It should be noted that no additional mangrove acreage is proposed or expected in the shorelines of the San José Lagoon that would attract waterfowl or other wildlife that could result dangerous to the Luis Muñoz Marín International Airport operations as a result of any of the CMP-ERP alternatives, besides that currently existing in its periphery. The restored habitat, nevertheless, would not be attractive to large migratory waterfowl (ducks and geese). In fact, water salinity is expected to be saltier than current conditions, from 6.5 to 8.5 psu to approximately 20 to 26 psu, in the San José Lagoon, from the surface down to between –4 to –6 feet deep. As a result, water salinities would be less attractive to most of these species, which after all, are very rare at the present time in the Project Area. In addition, the flight path over the CMP, where mangrove forests would result as part of any of the CMP-ERP alternatives, is generally too high for bird strike hazards to increase. Most bird species found or associated to mangrove forests, properly, in the Project Area, are canopy dwellers (e.g., warblers) or spend most of their time in the forest floor (e.g., herons, sandpipers, plovers, rails) searching for food. Normally, these species do not fly or hover at an elevation as high as the flight path of airplanes approaching the airport over the CMP. As mentioned before, water quality conditions in this whole area are expected to be brackish from any of the CMP-ERP alternatives, resembling the salinity regime existing during the 1950s, when the airport began operations. Therefore, it is expected that said water quality salinities would not increase the presence or risk of large waterfowl impacting approaching airplanes or those leaving the airport. The increase in average salinities resulting from all of the CMP-ERP alternatives would reduce/eliminate invasive freshwater species such as the water hyacinth that are intolerant of such salinities, and preclude the potential establishment of others. In addition, native species would be benefited from the resulting environmental improvements, becoming more resilient and able to cope with some of the impacts caused by invasive species.

Dredging and construction activities related to the CMP-ERP alternatives could facilitate, however, the colonization of other invasive species that thrive in marine or brackish waters, specifically the red lionfish (*Pterois volitans*), due to the aquatic connection that would be reestablished through the Eastern CMP. This species has been observed mostly inhabiting marine benthic habitats. Its broad salinity tolerance may allow this species to colonize estuaries throughout their invaded range. Therefore, it is plausible that the lionfish would expand into most parts of the SJBE, with or without the CMP-ERP. In the event that lionfish invades the Project Area, management and control measures for the lionfish would be adopted following the Regional Strategy for the Control of Invasive Lionfish in the Wider Caribbean (Gómez-Lozano, et al., 2013) and Invasive Lionfish: A Guide to Control and Management (Morris, J.A., Jr. (Ed.), 2012). It is important to notice that with or without the CMP-ERP, lionfish management measures in the Project Area, as in the rest of Puerto Rico, are coordinated by the DNER.

Other invasive fauna species, such as the small Indian mongoose (*Herpestes javanicus*), the green iguana (*Iguana iguana*) and spectacled caiman (*Caiman cocodrilus*) are already well established within green areas or waterbodies, accordingly, in the Study Area. Although no significant changes are expected on the populations of these species in the Project Area, the small Indian mongoose could be displaced or affected by an increase in open waters and mangrove acreage in the Eastern CMP as a result of the three project channel alternatives. The spectacled caiman could also be impacted by the resulting increase in water salinity at the San José Lagoon as tidal influence is restored. Green iguanas are only expected to be temporarily impacted during construction activities, and until mangrove cover is reestablished on the fringes of any of the CMP-ERP alternatives.

4.10.1 No Action

The No Action Alternative would prolong deterioration trends for fish and wildlife habitat due to the hydrologic interruption that present conditions in the Eastern CMP have caused throughout the entire SJBE. The SJBE would be divided in half, for all practical purposes, thus limiting wildlife movement through the estuary, including its connectivity with adjacent marine habitats (e.g., seagrass beds, coral communities). The latest is especially troublesome for fisheries, particularly those species whose development depends on their migration from the estuary to the ocean to complete all of their life stages (ontogeny).

Invasive species often become established due to disturbance of native habitats and some have already become established in the Eastern CMP. Invasive plant species, such as the water hyacinth, may continue to thrive within the Eastern CMP, as well as in some areas of the San José Lagoon, due to high levels of nutrients, low to no water flows and low salinity levels. Other invasive species such as the small Indian mongoose, the green iguana and the spectacled caiman would continue to thrive in the Project Area since its current degraded environmental condition has allowed or facilitated their establishment.

Subsistence fishermen in the San José Lagoon would potentially continue to be at risk of ingesting contaminants found in fish and shellfish caught in this waterbody. Other people may as well be affected by the consumption of these organisms since subsistence fishermen sometimes sell their catch (Atkins, 2011b).

4.10.2 Recommended Plan

The Recommended Plan would restore a greater area of mangroves in the Eastern CMP than Alternative 3. Those species that depend on mangrove forests or inhabit forest canopies (e.g., warblers) can be expected to benefit more from the Recommended Plan than from Alternative 3. This difference in mangrove, open water and benthic habitat acreage, and its potential use by fish and wildlife species, however, is expected to be insignificant.

An Essential Fish Habitat (EFH) Assessment was conducted that determined the Recommended Plan would not have a significant adverse impact on EFH or federally managed fishery species in the CMP and surrounding waters. Impacts would only be unavoidable and short term while construction takes place. Once completed, the proposed project under the Recommeded Plan would result in greater connectivity and accessibility of species to EFH throughout the SJBE system and near offshore reef habitat.

On December 10, 2015, the USACE sent a letter to the NMFS initiating consultation under ESA and the Magnuson-Stevens Fishery Conservation and Management Act. On January 21, 2016, the NMFS replied offering two recommendations: 1) Modifying the design of the project to bring residence time down to 1 day or less, and 2) Ensure that sanitary sewer lines are available for all structures within the project watershed and that they do not drain into the storm sewer lines (see Appendix H-8d). On January 29, 2016, the USACE sent the completed checklist for the Endangered Species Act Section 7. On February 9, 2016, the NMFS replied to the checklist suggesting providing a worst-case scenario as well as acoustic mitigation measures to be employed in the water to reduce potential effects to enlisted NMFS species.

A main project constraint for the proposed project is that the Recommended Plan should not damage the shoreline and sheet pile structures in the downstream Western CMP area. 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. Thus the Recommended Plan is constrained in the flow that can be exchanged through the CMP channel and the resulting residence time. Infrastucture improvements related to the construction of a sanitary and sewer system for dwellings and other structures draining into the Eastern CMP are outside of the Project Area and the responsibility of entities other than the USACE. However, several projects, including two consent decrees, are planned or being developed to address improper sanitary discharges taking place in those lands within the Project Area's watershed. These are discussed in detail in Section 4.18 of this EIS.

4.10.3 Alternative 3

Alternative 3 would restore the greatest area of open water and benthic habitat in the Eastern CMP when compare to any of the other project channel alternatives. Thus, more habitat area for fish and benthic invertebrate species would be available under Alternative 3 than under the Recommended Plan and Alternative 1, but at the expense of additional mangrove forest area that could be restored in the Eastern CMP under the latest two alternatives. The difference in mangrove, water column and benthic habitat acreage, and its potential use by fish and wildlife species, however, is expected to not be significant.

4.11 SPECIES OF SPECIAL CONCERN

Impacts to threaten or endangered (T&E) listed species would be considered significant if these would lead to a reduction in numbers or further limit their distribution along the Study Area due to the implementation of each individual alternative. Possible adverse or beneficial effects cause to T&E listed species are expected to be very similar among any of the CMP-ERP alternatives. Any impacts, however, would be temporary and associated to construction activities. Appropriate management measures would be implemented under any of the CMP-ERP alternatives in order to reduce or avoid any impacts to T&E listed species found in the Project Area's premises.

The CMP-ERP may effect, but is not likely to adversely affect three marine ESA listed species and one terrestrial species: the Antillean manatee, the hawksbill, green sea turtles, and the Puerto Rican boa. These are found in the Study Area, but have not being documented in the Project Area, where no suitable habitat exists.

There is extremely unlikely of find the Antillean manatee, and the hawksbill and green sea turtles in the Project Area since there is no suitable habitat for these to thrive in the Project Area and due to existing access limitations. However, the aquatic access provided by the Western CMP still provides the possibility of having these species approaching the Project Area.

If such an extraordinary instance ever takes place during construction of any of the CMP-ERP alternatives, construction noise and barge traffic would likely spur these animals to vacate the area, thus causing an indirect, although insignificant effect, and thus, neither harmed nor harassed. Notwithstanding, all of the CMP-ERP alternatives would include several construction works that although originally intended to reduce and control water quality impacts and flow velocities during construction phase, would also help reduce possible impacts on sea turtles and manatees. These works include the placement of turbidity curtains on the western end of the Eastern CMP to reduce sediment dispersion and turbidity into the western half of the CMP while dredging and construction of the proposed weir takes place. As such, turbidity curtains would also act as a physical barrier that would discourage access from sea turtles and manatees into the Project Area, if such an event ever happens. Turbidity curtains would also help reduce or dissipate acoustic impacts from dredging, and from the installation of the articulated concrete mats that would be part of the weir during its construction.

During construction of the weir, an air bubble curtain would be employed to mitigate possible underwater noise impacts on sea turtles and manatees that might travel close to or near the western end of the Project Area. Another measure that would also help reduce impacts on sea turtles and manatees includes the placement of a cofferdam immediately east of the weir during all of the 27 months when construction works would be conducted. This cofferdam is intended to limit tidal influence and thus, sediment and other possible contaminants to disperse into the Western CMP while dredging is performed. This structure would also serve as a temporary barrier for sea turtles and manatees further into the Project Area, which already is inaccessible. The cofferdam, as with the turbidity curtains, would help to significantly reduce any acoustic impacts into the surrounding aquatic environment from dredging and sheet pile installation. The cofferdam would be installed while construction of the weir is taking place, and thus, the proposed air bubble would be operating during this same period of time.

In the San José Lagoon, turbidity curtains would also be placed around the dredged pits while these are been dredged and reconditioned, to reduce the dispersion of suspended sediments into surrounding waters. As mentioned before, the turbidity curtains would also act as a barrier, discouraging any sea turtles and manatees, however unlikely, to enter the CAD pits area while construction works are been conducted.

It should be noted that any possible impacts on sea turtles and manatees in the Project Area due to sediment resuspension and resulting contact with possible contaminants would be temporary, during construction only. In addition, these effects have been deemed insignificant, not only by the extreme unlikelihood of finding these species in this area, but also because any plausible effects are not expected to rise the level of constituting an adverse effect on those individuals found within the Study Area. In other words, they may be expected to be affected if found in the Study Area, but not harmed or harassed.

In addition to all of these measures, a spotter would be stationed to look for any sea turtles and manatees at the western end of the Eastern CMP while the weir is constructed, as well as in the vicinity of the proposed San José Lagoon dredged pits while these are been reconditioned and later use for confined (i.e., geotextile encapsulated dredged sediments) or unconfined disposal of dredged sediments for all of the CMP-ERP alternatives. All in-water operations, including vessels, would be shut down in the event that manatees or sea turtles comes within 50 feet of the construction area. Activities would not resume until the species has moved beyond the 50-foot radius of the project operation, or until 30 minutes elapses if the species has not reappeared within 50 feet of the operation. Animals would not be herded away or harassed into leaving. These and other management measures would be adopted following the Standard Manatee Conditions for In-Water Work (2011) and Sea Turtle and Smalltooth Sawfish Construction Conditions (2006).

All of the CMP-ERP alternatives are expected to improve the suitability of the Study Area for these marine T&E species. There is the possibility that improvements in water transparency might also allow the development of sea grass beds in the San José Lagoon that along with the restored connection through the CMP, could provide access into new foraging habitat for manatees. Therefore, the use of sediment curtains and spotters would also be adopted in any future maintenance dredging that might be needed for the CMP-ERP, when manatees and sea turtles would be able to access the Project Area through the unobstructed Eastern CMP.

All of the CMP-ERP alternatives would result in long term beneficial effects on these marine T&E species, including leatherback sea turtles, as well as listed coral reefs species discussed in Section 3.11.1. Some of the direct and indirect beneficial effects would include significant water quality improvements on the tidal flows exiting the SJBE (i.e., through the Boca de Cangrejos and Boca del Morro outlets) from the Project Area and into the marine habitats within the Study Area. These habitats include hard bottom coastal communities and sea grass beds where ESA listed coral species, sea turtles and manatees have been reported, accordingly. Thus project channel alternatives could help reduce chronic or localized mortality sources (local threat reductions) related to current sedimentation, nutrient, and contaminant impacts affecting T&E coral listed species in the Study Area (Ramos-Scharrón, Torres-Pulliza, Hernández-Delgado, 2014). Ecosystem-level actions such as those proposed under all three project channel alternatives would lead to improvements in habitat quality and restore keystone reef species and functional processes such as herbivory to sustain adult colonies and enable successful natural recruitment in the long term (National Marine Fisheries Service [NMFS], 2015).

With respect to the Puerto Rican boa, even though it is very unlikely that this species will be found in the Project Area during construction, a management protocol would be adopted and implemented as a precautionary measure. The protocol would include, among other actions, preconstruction meetings with construction personnel to inform these about *E. inornatus* physical appearance to facilitate its identification, penalties for harassing the species, and specific steps to be taken in the event a boa is sighted, such as ceasing any works on a 50 feet radius in order to capture and transport the species for relocation to a safe place. A wilderness specialist would be assigned to look for boas before construction is initiated every day, as well as to be in charge of handling the species in case any individuals are found. This specialist would also be responsible for drafting and submitting monthly reports to the USFWS and the DNER.

The USFWS, DNER, NMFS are a part of the ERP's Technical Committee, which has met several times since September 2010. Comments from these agencies have been incorporated into the preparation of this FEIS. A NEPA Scoping Letter was prepared and circulated on February 2013 and comments received during the scoping process were also addressed and included in Appendix H-7. Comments received during the public comment process were addressed and included in Appendix H-8. On December 10, 2015, the USACE sent a letter to the USFWS initiating consultation under ESA and responded to comments by the USFWS issued under the Fish and Wildlife Conservation Act. This letter stated that the project will develop and implement standard manatee protection measures, a spotter during construction to look for manatees, and a protocol to identify and remove the Puerto Rican Boa. On December 14, 2015, the USFWS sent a letter expressing the agency's concurrence with the determination that the proposed action may affect but is not likely to adversely affect federally listed species under its jurisdiction.

Commonwealth listed species

There are several Commonwealth's listed species that have been recently observed flying over or foraging in the Eastern CMP and the San José Lagoon, and that could be disturbed while construction activities are taking place at the CMP and the San José Lagoon from any of the CMP-ERP alternatives. These include the threatened Caribbean coot, the endangered brown pelican, the critically endangered peregrine falcon, the white crowned pigeon, the Puerto Rican vireo, the least tern, and the black cowled oriole. All of these birds, however, are highly mobile species that could temporarily move to other areas in the SJBE where suitable habitat conditions exist to help assure their survival. Future conditions in the Project Area, nevertheless, would benefit the reestablishment of all of these T&E listed birds, once any of the CMP-ERP alternatives is completed.

During construction of any of the CMP-ERP alternatives, the Puerto Rican slyder would have the capacity to move to other areas, especially outside the Eastern CMP when dredging activities would take place. Nevertheless, some individuals might be impacted during dredging operations. Improvements in water and habitat quality as a result any of the CMP-ERP alternatives would benefit this species once construction activities are completed.

Fiddler crabs individuals of the genus *Uca*, mangrove crabs of the genus *Goniopsis*, *Aratus* and *Ucides*, and the land crab of the genera *Cardisoma* may still be found in the Eastern CMP, and as a result, would be impacted by dredging activities under any of the CMP-ERP alternatives. Once any of these are completed, however, improvements in water quality, and mangrove substrate and cover would greatly benefit any of these species.

Beneficial effects to those species listed as T&E or as critical elements found in the Study Area, but not found or impacted in the Project Area, could result from any of the CMP-ERP alternatives, if seedlings or individuals are planted as part of the reforestation efforts to restore impacted upland sites during construction. All project channel alternatives are expected to temporarily benefit federally threatened species such as the roseate tern (*Sterna d. dougallii*) and the red knot (*Calidris canutus*), and the Commonwealth's critically endangered snowy plover (*Charadrius alexandrines*). Mudflat habitat would be available for these bird species up to the time mangrove trees reach an adult size and cover the adjoining banks of any of the CMP-ERP alternatives.

4.11.1 No Action

The filling and destruction of surface and submerged habitats in the Eastern CMP, its impact on its water quality, and the pervasive effect it also has caused on the ecological health of the San José Lagoon mangrove prop root habitat, water column and benthos, has significantly impacted the Project Area's capacity as a refuge for T&E listed species. This could be, at least, part of the reason explaining the "disappearance" of several T&E listed species that once inhabited the CMP, since these have not been observed again since decades ago. These include the federally listed yellow shouldered black bird and the West Indies subspecies of the roseate tern, or the Commonwealth listed white-cheeked pintail. Other T&E listed species, such as the masked duck and the West Indian whistling duck, could have been taking advantage of seemingly suitable habitat structure that exist for these in the CMP and the San José Lagoon. None of these however, have been documented in this area, presumably due its poor environmental quality.

These habitat impairments are expected to persist or worsen as the result of the No Action Alternative. Said situation is expected to prevent any significant T&E species presence or populations from inhabiting the Eastern CMP and the San José Lagoon, and to a lesser degree, the SJBE overall. This also includes the recovery of T&E coral species associated to the marine ecosystems found in the Study Area, especially those at or close to the Isla Verde area. The latest would be at an increased state of risk due to poor water quality discharges that would continue exiting the Project Area through the Boca de Cangrejos outlet, and the synergistic effect caused by forecasted climate change impacts (Díaz-Ortega and Hernández-Delgado, 2014).

4.11.2 Recommended Plan

The Recommended Plan would be more beneficial to those T&E species that thrive in mangrove forests (i.e., yellow shouldered blackbird, black cowled oriole, Puerto Rican vireo and white crowned pigeon) than what would be expected from Alternative 3. The latest would lead to a reduction of 4.38 acres of mangroves while the Recommended Plan would result in a net gain of 1.02 acres. This difference in mangrove acreage and potential use by T&E species, however, is expected to not be significant.

4.11.3 Alternative 1

Alternative 1 would result in more mangrove acreage available for any T&E species that inhabit this type of forest than any of the other project channel alternatives. Alternative 1 would have a net gain of 6.16 acres of mangrove, while the Recommended Plan would have a net gain of 1.02 acres. The difference in mangrove acreage between Alternative 1 and the Recommended Plan and its potential use by T&E species, however, is expected to be insignificant.

The narrower channel that Alternative 1 would provide is expected to be less effective in allowing its potential use by manatees in the event these try to reach the San José Lagoon, when compared to the Recommended Plan and Alternative 3.

4.11.4 Alternative 3

Alternative 3 would result in less mangrove acreage and its potential use by those T&E species that inhabit this kind of forest, when compared to the Recommended Plan and Alternative 1. Alternative 3, however, would provide the widest channel configuration (i.e., 125 feet) that would potentially allowed manatees to reach the San José Lagoon through the CMP.

4.12 LAND USE AND INFRASTRUCTURE

Land Use

Impacts that permanently alter uses in the area and have long-term impacts on the natural and human systems, as well as those that would require demolition, relocation or construction of infrastructure, would be considered significant.

All three project channel alternatives would permanently change land use along the current banks of Eastern CMP, which is use mostly for residential and waste disposal purposes. Instead, this segment of the CMP would be restored to conserve its natural landscape, consisting of open waters, wetlands and upland vegetation. This is consistent with the uses allowed by local law within public domain lands. Changes in land use along the Eastern CMP would also include public accesses to support recreational activities associated to the enjoyment of the surrounding natural landscape in order to discourage informal accesses and other undesirable activities that could compromise the restoration of the Project Area, and that of the overall efforts to improve the SJBE.

A temporary land use change would occur in the the upland staging area to be used during construction of the western weir and cofferdam. At present, this property is used by the surrounding community as an informal softball field. It is not vegetated, thus no additional clearing of vegetation is needed. The estimated amount of material that would be dredged to build the weir is 46,866 cy. It is estimated that once staged at this site it would have a height of 13.2 feet. To avoid impact on adjacent school and houses, sound barriers would be installed. An additional measure would include reducing the footprint by regular transport of trash and sediments offsite to the CRDC. Transporting these materials by truck would cause temporary traffic congestion at the exit of the weir's temporary staging area towards the Ponce de León Avenue. However, the area is close to a highway exit that would be used by trucks to transport the dredged material for final disposal (i.e., Luis Muñoz Marín Expressway), thus it is not expected that said activity is going to significantly impact traffic in the area.

Infrastructure

Existing infrastructure, such as roads, bridges, water and sewer lines, would be significantly impacted as a result of any of the CMP-ERP alternatives, since some would need to be relocated or removed. The CMP-ERP would require the relocation of 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. During construction of any of the CMP-ERP alternatives, 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 photographic survey of the exterior of existing structures facing and adjoining the work would be prepared to document preconstruction conditions. Measurements from the monitoring devices would be observed for excessive levels of vibration, and visual inspection of existing structure/infrastructure in areas adjoining construction sites would be conducted to detect possible related damages. 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 more-effective means and methods. 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.

Bridges

Potential impacts to the existing bridges located at the Eastern CMP were identified (USACE, 1999) as a result of restoring tidal flow through dredging and sheet pile wall construction. The effects of dredging on the existing bridges could not be assessed because as-built plans of the existing bridge foundations have not been found. However, it was known that the pile caps for the Luis Muñoz Rivera Bridge were at an elevation of –3 feet. Since the CMP-ERP calls for dredging to below –10 feet and the pile tip elevations of the existing bridge foundations were not known, it was not possible to determine the impact that the dredging would have on the capacities of the pile foundations of these bridges. The report recommended that these bridges be replaced before dredging closer than 100 feet. For the Martín Peña Bridge, the pile cap elevations were at –8 feet. However, because of the width of the proposed channel at this bridge location it was determined that the necessary hydraulic performance could be achieved even if the channel excavation under the bridge was limited to –8 feet. Because of the lack of as-built information on the Ponce de León Avenue and Luis Muñoz Rivera Avenue bridges foundations, it is recommended that further geotechnical studies be conducted to determine the depths of the piles supporting the bridges. It is also recommended that a detailed structural conditions analysis be conducted for these two bridges as well as the Linear Park pedestrian bridge.

During dredged material transportation and disposal, the scows and barges would navigate through the San José Lagoon and would cross under the José Celso Barbosa Avenue Bridge and the Teodoro Moscoso Bridge. These bridges provide sufficient clearance for the scows and barges. To avoid adverse long term impacts on bridges, a weir would be placed between the existing Western CMP channel and that section to be dredged under any of the CMP-ERP alternatives to reduce flow and prevent scouring of bridges west of the dredging site. Also, the CMP section under the Martín Peña Bridge, the Tren Urbano Guideway and the Luis Muñoz Rivera Bridge would be constructed to a width of 115 feet with a depth of –6.5 feet msl. Riprap would be placed on the side slopes, and the channel bottom would be paved with articulated concrete mats.

Water and Sewer infrastructure

The segment of the Rexach Trunk Sewer that crosses under the Eastern CMP is located above the bottom of the three project channel alternatives. Based on the available information, approximately 262.5 feet of the 48-inch-diameter pipe needs to be relocated prior to the dredging and channeling of the Eastern CMP (PRASA, 2008).

The Borinquen Water Transmission Pipeline crosses under the Eastern CMP at a depth of 3 feet. Since the CMP-ERP alternatives would consist of a depth of approximately 10 feet, this segment of the water pipeline needs to be relocated prior to the construction of any of the alternatives evaluated. It is estimated that 406 feet of this pipeline need to be relocated (PRASA, written communication 2015). The design and relocation of both, the Rexach Trunk Sewer and the Borinquen Water Transmission Pipeline is ongoing and will be completed prior to the dredge of the CMP. Water lines east of Pachín Marín Street and West of the D Street, on the south bank, in Hato Rey, and water lines for Calle 8, 9, 10, 11, 12, 13, 14, and Calle 15 in Barrio Obrero Ward would be impacted by any of the CMP-ERP alternatives.

The proposed perimeter road, the Paseo del Caño, between the Eastern CMP and the community, would incorporate new storm sewers to intercept overland flow. The existing storm piping would require demolition and interruption of the existing stormwater conveyance systems. Additionally community stormwater plans would be developed for necessary repairs to the impacted storm pipes and to provide a protected channel or piping to a new point of discharge. Local codes do not require the management of stormwater quantity or quality, thus all upland stormwater runoff may be discharged directly into any of the CMP-ERP alternatives.

Stormwater would be collected at the point of discharge and carried through underground piping to the Eastern CMP, in order to prevent uncontrolled overland flow that could result in erosion, loss of upland soils and siltation in the mangrove beds, resulting in impacts to restoration efforts. Silt could also flow into the Eastern CMP, causing shoaling and accelerating the timeline for maintenance dredging.

Construction of an oil/water/sediment separator structure is contemplated within the Public Domain, near its interface with the future Paseo, under all three project channel alternatives. Storm sewer piping interrupted by construction would be extended to this structure.

Similar to the storm sewer infrastructure, many of the streets within the demolition limits contain underground sanitary sewer collection piping that would be impacted by any of the CMP-ERP alternatives. These would provide for the removal of lengths of piping, requiring appropriate plugging at the new terminus and repairs to affected laterals adjoining this section of the Project Area.

The CMP-ERP alternatives would necessitate termination and relocation of some waterlines affected by the channel ROW. As with sanitary sewer, relocations would have to be coordinated with street construction outside the configuration proposed by all of the CMP-ERP alternatives.

Power Infrastructure

The 115-kilovolt (kV) overhead transmission line has been relocated as a component of the CMP-ERP. This line, that crosses the eastern end of the Eastern CMP, had to be raised for the construction of any of the CMP-ERP alternative. Its former height was not sufficient, posing a hazard to equipment needed for construction/dredging associated to the CMP-ERP.

In addition, approximately 438 residential services would require electrical service demolition. Seven streets on the south bank, east of Barbosa Avenue at the Israel-Bitumul neighborhood, Streets 10, 11, 12, 13, and Street 14 on the north bank at Barrio Obrero Ward, and Street Pachín Marín, and Streets 4, and 5 on the south bank at Hato Rey Ward, have residences also requiring demolition and service termination. Prior to initiating these activities, the affected service lines would be deenergized. Through service lines slated for termination would be relocated first; cable service to about 100 residential services would require demolition for any of the CMP-ERP alternatives.

Transportation and Navigation

Other temporary effects resulting from any of the CMP-ERP alternatives considered could include interference with navigation resulting from the barges carrying dredged debris and sediment laden scows transiting the San José Lagoon on their way to the San José Lagoon CAD and the CDRC staging area, respectively.

Transportation of debris for final disposal from the CDRC staging site to the Humacao Regional Landfill could also have temporary impacts on the Iturregui Avenue, which is a common access route for residences, the CDRC recreational complex and for the preferred staging/management area. An increase in traffic flow would be anticipated. It was estimated that 8,405 truck trips would be required to transport the solid waste to the Humacao landfill, based on 91,909 cy associated with clearing and grubbing (up to 12 inches in depth across Project Area); and 76,200-cy solid waste sorted from dredging operations, using a 20-cy truck.

Therefore, permits for traffic and safety may be required, along with implementing an approved access control plan to manage public access to the CDRC staging area and to the temporary docking area in the San José Lagoon.

Specific management measures to improve efficiency and reduce possible impacts to vehicle traffic and related infrastructure will be defined in PED phase. These could include, among others, determining the final route for trucks transiting from the CDRC staging area to the Humacao Regional Landfill, the specific type or size of trucks to be used, cease truck transit during the peak traffic hours, adopt strict guidelines to ensure that trucks will not carry any excess weight besides that for which these were design in order to reduce any unreasonable damage or wear to those roads on the selected route leading to the Humacao Landfill.

4.12.1 No Action

No changes to land use and/or infrastructure would be anticipated as a result of the No Action Alternative. In terms of land use, the area along the Eastern CMP would continue to be of Public Domain. However, improper residential or waste disposal practices affecting the Eastern CMP might not be deterred without an improvement in the area's environmental quality, thus facilitating or allowing the area to continue its degradation in terms of the efficient use of lands, open space, surface waters and other natural resources.

4.12.2 Recommended Plan

The Recommended Plan would cause fewer impacts to transportation than those from Alternative 1 and 3, although more impacts to navigation than those from Alternative 1. The Recommended Plan would cause fewer impacts to navigation than Alternative 3.

4.12.3 Alternative 1

Alternative 1 would result in more impacts to transportation than those that could be caused by the Recommended Plan, but not Alternative 3. Alternative 1 would require less material to be dredged, and thus, less debris to be hauled out of the Project Area for final disposal into the Humacao Regional Landfill. However, it would require additional trips to carry the articulated concrete mats that would be placed along the bottom and entire length of the Eastern CMP. Otherwise, any construction aggregates would have to be transported if the articulated concrete mats are to be made at the CDRC staging area.

Alternative 1 would produce fewer impacts to navigation than those expected by the Recommended Plan and Alternative 3, since the latest two would involve additional material to be dredged from the Eastern CMP, requiring more scow and barge trips to dispose off the dredged sediments and dredged debris, respectively.

4.12.4 Alternative 3

Alternative 3 would result in more impacts to transportation than those that could be caused by either Recommended Plan or Alternative 1. Alternative 3 would require more material to be dredged, and thus, more debris to be hauled out of the Project Area for final disposal into the Humacao Regional Landfill. Alternative 3 would also result in more impacts to navigation than those expected from the Recommended Plan and Alternative 1, since the latest two would involve less material to be dredged from the Eastern CMP, requiring less scow and barge trips to dispose off the dredged sediments and dredged debris, respectively.

4.13 SOCIOECONOMICS

NEPA provides no specific thresholds of significance for socioeconomic impact assessment. Significance varies, depending on the setting of the proposed action, but indirect effects may include those that are economic growth inducing and others related to induced changes in land use patterns, population density or growth rate (40 CFR 1508.27[a]) & 1508.8).

The socioeconomic data assess indicated that low income communities surround the Project Area, particularly Eastern CMP and San José Lagoon. Potential impacts of alternatives on these communities and economic impacts are evaluated in the following sections.[23]

The CMP-ERP alternatives would provide opportunities for job creation in the surrounding communities associated with recreational fisheries, and other outdoor recreation related concessionaires. These alternatives would also have a positive economic impact on the municipality and the Commonwealth in terms of construction fees and corporate, individual and sales taxes. Indirect socioeconomic benefits from any of the CMP-ERP alternatives would include increases in property value in the nearby communities, flood reductions, as well as recreation benefits that local and non-local residents would experience.

[23] The basis for the economic impact's 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.

However, significant adverse impacts due to implementation of any of the CMP-ERP alternatives would be expected as families would need to be relocated and infrastructure repaired or constructed. It is estimated that 393 structures would be acquired, resulting in a total of 394 relocations. Efforts would be made to relocate people to other areas within the same community. At the same time, strategies would be developed to maintain community cohesion and avoid fracturing communities, which have coexisted for decades in the area.

In fact, the non-Federal sponsor, ENLACE, has promoted meaningful public participation since the beginning of the planning process to ensure that residents are not disproportionately impacted by any of the CMP-ERP alternatives (see Section 6.2.1 Public Involvement). It has been documented that environmental restoration projects inadvertently, have resulted in the displacement of the communities they were meant to serve (NEJAC, 2006). To safeguard the community from future displacement due to potential land value increase after the ERP, the non-Federal sponsor, ENLACE, has worked closely with the community to create a land trust.

Temporary short term adverse, but not significant, impacts to water quality during dredging activities are anticipated from any of the CMP-ERP alternatives. Also significant, but temporary, adverse impacts are anticipated during the construction of any of these mainly due to interruption of services, such as energy and water service. The best measures to address potential services interruptions would be continuously worked with community residents to minimize impact.

Temporary or short term unavoidable impacts would occur on charter boat operator's income lasting over the construction period of any of the CMP-ERP alternatives. Charter boat operators would have to resort to other areas of the San José Lagoon or the SJBE where tarpons may congregate and take advantage of sudden depths changes to feed (i.e., La Torrecilla Lagoon, Suárez Canal) as in the dredged pits that would be used to deposit the dredged sediments. It is important to notice that charter boat operators would be benefited in the long term by any of the CMP-ERP alternatives. The proposed partial filling of the SJ1 and SJ2 artificial dredged pits to a depth of –16 feet, and that of the SJ3/4/5 artificial dredged pits to a depth of –13 feet, would not cause permanent impacts to this activity since there would still be a substantial difference in depth between these areas and that of the surroundings within the San José Lagoon. The resulting depths would provide 10 feet of water for the SJ1/2 dredged pits, and about 7 feet of water for the SJ3/4/5, under the halocline (–4 to –6 feet deep) for tarpon to traverse. As such, tarpon would still be able to use this depth difference in their advantage to ambush their prey, as it has been reported. In addition, significant improvements to submerged habitat conditions are expected, resulting in an increase in the number and diversity of potential nekton species upon which tarpon would prey, thus benefiting this sport fishery.

4.13.1 No Action

Adverse economic impacts to recreational and charter anglers, , tourism and land values in the communities within and immediately adjacent to the Project Area, and indirectly, in the Study Area would continue or worsen, particularly due to an increase in the severity to the exposure of health hazards and flooding, the degradation of the overall environmental health of the SJBE system, and the loss of new economic opportunities related to its sustainable development.

4.13.2 Recommended Plan

The Recommended Plan would have a positive impact on the nearby communities and significant economic benefits, both direct and indirect, are anticipated. Direct benefits would include 4,275 jobs to be created during construction. The Recommended Plan would provide the least socioeconomic benefits in terms of jobs creation and income among all of the CMP-ERP alternatives (see Table 4-6).

Table 4-6. Estimated economic benefits from construction of the Recommended Plan

Direct Jobs in Construction	1,881
Indirect & Induced Jobs in Construction	2,394
TOTAL CONSTRUCTION JOBS	**4,275**
Direct income	$ 45,665,037.00
Indirect and Induced Income	$ 52,058,142.18
Income from construction activity	**$ 97,723,179.18**
State construction permit	$ 855,521.19
Municipal construction taxes	$ 855,521.19
Municipal excise tax	$ 8,555,211.90
Personal income taxes from Construction	$ 6,674,493.14
Corporate taxes from Contractors	$ 2,566,563.57
Sales Taxes from Contractors	$ 4,446,404.65
Government Revenues from Construction	**$ 23,953,715.63**
Fiscal Revenue to Municipal Government	$ 13,857,137.74
Fiscal Revenue to State Government	$ 10,096,577.90

Source: Estimates by Estudios Técnicos, Inc. November 2014.

4.13.3 Alternative 1

Significant benefits to the community as a result of Alternative 1 would be similar to those described for the Recommended Plan. However, the 75-foot-wide channel would also result in slightly more jobs (4,525 jobs) and income from its construction than any of the other two project channel alternatives (see Table 4-7).

Table 4-7. Estimated economic benefits during contruction of Alternative 1

Direct Jobs in Construction	1,991
Indirect & Induced Jobs in Construction	2,534
TOTAL CONSTRUCTION JOBS	**4,525**
Direct income	$ 48,335,507.00
Indirect and Induced Income	$ 55,102,477.98
Income from construction activity	**$ 103,437,984.98**
State construction permit	$ 907,654.60
Municipal construction taxes	$ 907,654.60
Municipal excise tax	$ 9,076,546.03
Personal income taxes from Construction	$ 7,064,814.37
Corporate taxes from Contractors	$ 2,722,963.81
Sales Taxes from Contractors	$ 4,706,428.32
Government Revenues from Construction	**$ 25,386,061.74**
Fiscal Revenue to Municipal Government	$ 14,690,628.95
Fiscal Revenue to State Government	$ 10,695,432.79

Source: Estimates by Estudios Técnicos, Inc. 2014

4.13.4 Alternative 3

The construction of the 125-foot-wide channel would result in slightly more jobs (4,400 jobs) and income than the Recommended Plan, but less than those related to the construction of Alternative 1 (see Table 4-8).

Table 4-8. Estimated economic benefits from construction of Alternative 3

Direct Jobs in Construction	1,936
Indirect & Induced Jobs in Construction	2,464
TOTAL CONSTRUCTION JOBS	**4,400**
Direct income	$ 47,000,272.00
Indirect and Induced Income	$ 53,580,310.08
Income from construction activity	**$ 100,580,582.08**
State construction permit	$ 884,745.51
Municipal construction taxes	$ 884,745.51
Municipal excise tax	$ 8,847,455.07
Personal income taxes from Construction	$ 6,869,653.76
Corporate taxes from Contractors	$ 2,654,236.52
Sales Taxes from Contractors	$ 4,576,416.48
Government Revenues from Construction	**$ 24,717,252.84**
Fiscal Revenue to Municipal Government	$ 14,308,617.06
Fiscal Revenue to State Government	$ 10,408,635.78

Source: Estimates by Estudios Técnicos, Inc. 2014

4.14 HUMAN HEALTH AND SAFETY

Health and safety issues to the communities surrounding the CMP and San José Lagoon were considered. Health related water and air quality parameters were characterized for the Project Area and compared with available health criteria to quantify potential impacts under the CMP-ERP alternatives. Possible impacts resulting from potentially induced floodings are also discussed, as well as incidental flood reduction benefits.

Impacts are considered significant if they are shown to disproportionately impact the health and safety of low income or minority groups, if USEPA or other agency human-health and/or safety criteria are exceeded, including those specific to the health of children.

Section 4.4 of this FEIS discusses expected changes in hydrology and its effects on flood waters and tidal levels in the Project Area. Temporary impacts resulting from dredging works proposed by any of the CMP-ERP alternatives include a potential increase in flood risks to the communities contiguous to the Eastern CMP.

The temporary sheet pile wall that would be placed at the eastern face under the Martín Peña Bridge to control the dispersion of sediments from dredging works and to protect the pilings of the bridges could potentially increase flood levels during rain events. A 100-year storm event without storm surge would be the one that would most affect flood levels within the Eastern CMP as a result of the temporary sheet pile wall blocking the channel's flow. It would increase 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. To minimize the extent of floods during plugged conditions, the temporary sheet pile wall would be placed at an elevation that allows flood waters to overtop and flow west, but still high enough to limit or impede tidal flow into the Project Area.

During PED, a "sequence of events" based upon performance standards, must be established and incorporated into the construction contract documents. Flood risk from "plugged" conditions would also be addressed by keeping close coordination with the adjacent community to establish local emergency management strategies.

After construction of the channel, tidal amplitude within the CMP and the San José Lagoon would increase. The Lagoon's tide range is expected to increase 1.28 feet, from 0.33 feet preconstruction to 1.61 feet after construction. This represents a 0.64-foot increase to the high spring tide. Furthermore, tidal amplitude decreases from west to east. That is, increases are expected to be higher at the weir than at the San José Lagoon. The 0.64-foot increase is representative of conditions where the channel meets the lagoon. Surface elevations across the lagoon are expected to be somewhat lower.

Although no substantial flood risk reduction for the 100-year flood with storm surge would be provided by any of the CMP-ERP alternatives, the 393 residential structures and 394 relocations within the confines of the Federal project, would place the occupants of these structures out of danger. This would reduce the number of flood-prone structures for this type of flood from approximately 4,700 to 4,300. Such conditions entail that frequent or moderate floods, like the one experienced in 2011 under Hurricane Irene, as well as the 100-year flood risk (without storm surge), would be substantially reduced. Damages and government expenditure on relief, along with frequent disruptions to schools, businesses, and residential daily life, would be reduced considerably.

Any of the CMP-ERP alternatives would enhance environmental conditions and the quality of life in all of the communities adjacent to the Project Area. Restoring conveyance flows through the CMP is one of the easiest and most secure ways of eliminating the pollution hazards associated to direct and indirect contact with its waters and its effects on the health of residents in nearby communities.

Under any of the CMP-ERP alternatives, prevalence rates of gastroenteritis, asthma in children, and atopic dermatitis in children are expected to drop to the Puerto Rico average, resulting in health care cost reductions of $775,927 per year (see Table 4-9).

Table 4-9. 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%	18,074	$325	5,603	$1,820,956	3,796	$1,233,551
Asthma (children under 5 years old)	44.5%	22%	1,046	$654	465	$304,417	225	$147,078
Dermatitis (children 5–9 years old)	35.3%	24.8%	958	$310	338	$104834	238	$73,651
					TOTALs	***$2,230,207***		***$1,454,280***

[1,2] Source: Puerto Rico Department of Health.
[3] Assumes prevalence rate drops to Puerto Rico prevalence rate.

No further impacts are expected from direct or indirect contact with the Project Area's waters as a result of any of the three project channel alternatives. On the contrary and as mentioned before, flow and the associated water quality improvements should reduce exposure to contaminants, pathogens and other water borne health impairments presently found in the Project Area due to its degraded condition. No permanent human health impacts are expected from the disposition of dredged sediments into the CADs. Dredged sediments would be capped to reduce possible contaminant migration into the water column. The CAD upper layer would also be found at -16 feet below the lagoon's surface, and thus, deep enough to prevent direct human contact with the dredged sediments.

Expected water quality improvements resulting from any of the CMP-ERP alternatives would improve fisheries habitat and would reduce the risk of contaminants in edible species consumed by fishermen. The effect upon shallow fisheries in the Project Area would be very positive (Atkins 2011b). An increase in tidal flushing should effectively reduce concentrations of contaminants that may be affecting fish and shellfish, and the related potential effects on public health due to their consumption, as already noted by the public advisory installed by the DNER and the PREQB since 1999. Nevertheless, under all project channel alternatives, additional public advisory signs would be placed as a precautonary measure to inform citizens about the potential health risks of consuming fish and shellfish caught in the CMP and the San José Lagoon. Section 4.6 of this FEIS detail expected impacts and the precautonary measures that would be adopted to protect nearby residents and workers due to the release of H_2S from proposed dredging works in the Eastern CMP.

4.14.1 No Action

Under the No Action Alternative, high-density land uses due to human encroachment on the formerly natural system would continue to expose the communities to health and safety concerns. Low income communities nearby the proposed dredging site would continue to experience highly disproportionate and adverse burden due to lack of water conveyance through the CMP and associated floodings. Poor water quality would continue, resulting in adverse impacts to resident's properties and health. Prevalence rates for gastroenteritis, asthma in children, and atopic dermatitis in children are expected to remain similar to today's rate. Chronic impacts due to the inhalation of high concentrations of H_2S in ambient air would continue to affect residents living close to the Eastern CMP.

4.14.2 Recommended Plan

Under the Recommended Plan, flood risk would be less than that resulting from Alternative 1 due to the larger channel conveyance, and therefore may improve health and safety to a greater extent, although not as much as that which would be provided by Alternative 3.

4.14.3 Alternative 1

Alternative 1 has less impact on flood reduction due to the smaller channel conveyance, and therefore may not improve health and safety to the same extent described for the Recommended Plan and Alternative 3.

4.14.4 Alternative 3

Under Alternative 3 flood risk would be reduced due to the larger channel conveyance, and therefore may improve health and safety to a greater extent than described for the Recommended Plan and Alternative 1.

4.15 RECREATION

The potential impacts of the CMP-ERP alternatives were evaluated based on how these would affect existing recreational areas or facilities within or adjoining the Project Area, and how new opportunities could result from project implementation within the Study Area. Impacts that provide or remove recreation opportunities are considered significant. In addition, recreation opportunities that would negatively impact the restoration goal of the ERP would be considered adverse.

Temporary adverse impacts include the partial displacement of the use of the San José Lagoon pits by tarpon (*Megalops atlanticus*) charter operators during construction. The artificial deep pits in the lagoon appear to be their main angling site for this species. The partial filling of some of the artificial dredged pits in the lagoon for the disposal of dredged sediments would not cause permanent impacts to this activity. These would be filled to a depth of no more than –13 feet. As such, a significant depth gradient or difference in this area and that of the surroundings in the San José Lagoon would still remain, allowing tarpon to continue its use to ambush prey.

The halocline is expected to remain at depths of -6 feet, and as a result, a substantial part of the water column over SJ3, SJ4 and SJ5 (-13.2 feet). Therefore, there would still be at the least, about 7 feet, below the halocline for tarpons to ambush or hunt their prey. Tarpons would still be able to use these depressions in the future as before. The impacts would be temporary while construction takes place: temporary displacement of tarpons to other areas of the San José Lagoon. However, expected overall habitat improvements would lead to an increase in potential prey species, resulting in a long term beneficial impact to this activity.

Another temporary effect may be experienced by the users of the property that would be used as a temporary staging area for the installation of the weir/cofferdam. Is expected that associated construction works would take approximately 2 years. During that period the community would not be able to use the property. The non-Federal sponsor, ENLACE, would work closely with the communities and the Municipality of San Juan to identify other existing baseball fields or other sites that can be used for such purposes.

4.15.1 No Action

Under the No Action Alternative, the restoration of the CMP would not be implemented. Residents would not have the opportunity to experience many of the potential outdoor benefits associated with a restored SJBE system. Limits to recreation opportunities for disadvantaged neighborhoods would persist, and access to the designated Public Domain Lands woulld continue to be limited to local neighborhoods.

4.15.2 Recommended Plan

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. Most local resident anglers in the San José Lagoon target snook at locations along the periphery of the lagoon. Improvements to circulation that would benefit water quality of bottom waters are likely to benefit the fisheries targeted by local resident anglers by increasing the amount of bottom areas capable of supporting healthy biological communities (Atkins, 2011b).

The presence of recreation areas (e.g., water plazas) including the projected increased visitation to the CMP and the construction of the Paseo (a related project but not a part of the CMP-ERP), would help reduce the improper uses of the Eastern CMP such as the disposal of solid waste. Other related projects in the adjacent communities, such as the relocation of families and subsequent demolition of structures located in the public domain limit, and the improvements to storm water management infrastructure to reduce sedimentation, would address the other significant and historic causes of CMP's degradation. At the same time, these efforts help to ensure the restoration efforts in the CMP would be preserved after construction.

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 intended to protect the investment in ecosystem restoration by facilitating appropriate uses of the Project Area. 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 through the water plazas 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 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).

Temporary unavoidable impacts would occur in the recreational tarpon fishery in San José Lagoon, which is focused on the areas of the subaqueous artificial dredged pits, as described in the Socioeconomics section of this Chapter.

4.15.3 Alternative 1

Recreation benefits under Alternative 1 are the same as those described for the Recommended Plan. The width of the channel is not anticipated to affect the recreation benefits.

4.15.4 Alternative 3

Recreation benefits under Alternative 3 are the same as those described for the Recommended Plan . The width of the channel is not anticipated to affect the recreation benefits.

4.16 CULTURAL RESOURCES

Impacts to cultural resources would be considered significant if cultural resources listed or that are eligible for listing under the National Register of Historic Places (NRHP) are found in the Project Area and would be affected by any of the alternatives evaluated.

The Project Area was evaluated with respect to the potential presence of cultural and/or historic resources and the potential impacts that may occur as a result of project alternatives. Impacts to these resources can result from dredging, placement of dredged material, and direct or indirect disturbance during construction. Presence of resources would require coordination with appropriate agencies to determine proper actions and may include relocation, repatriation, recovering, or otherwise ensure proper management.

Results of site evaluations indicate that there is low potential to find cultural or historic resources in the Project Area due to its modifications and impacts. Consequently, adverse impacts to cultural resources due to dredging or sediment disposal from any of the project channel alternatives are not anticipated. Although there is one historic property in the Project Area listed in the NRHP, the Martin Peña Bridge, the CMP-ERP does not meet the Criteria of Adverse effect as stated in CFR 800.5 (a)(1). The CMP-ERP would not alter, directly or indirectly, any of the characteristics of this historic property that qualifies it for inclusion in the NRHP in a manner that would diminish its integrity in terms of location, design, setting, materials, workmanship, feeling, or association.

To protect the base of the Martín Peña Bridge, the CMP section under the bridge would be constructed under all three project channel alternatives to a width of 115 feet and a depth of 6.5 feet msl. Riprap would be placed on the side slopes, and permanent sheet pile walls, as well as the construction of a weir would protect the bridge’s pilings. Photo-documentation would be recorded for this historic bridge.

Construction activity monitoring for additional resources would be implemented during construction of any of the three project channel alternatives to ensure that, if additional cultural resources are found, they are identified and managed consistent with state and Federal regulations. 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 for cultural resources as each clamshell bucket of dredged material is laid onto the screen during the construction (dredging) process.

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. Evaluation of three to four areas from the deepest sediments in the Eastern CMP to identify debris that may be considered of historical value is also recommended (Vélez Vélez, 2001; Vega 2002).

4.16.1 No Action

No additional investigations for cultural resources in the Project Area would be undertaken, avoiding any possible discoveries and salvage of any artifacts that may merit protection. No disturbance to the Project Area's cultural resources would occur, although degradation of any possible cultural resources still unknown would continue to take place since these would remain in place.

4.16.2 Recommended Plan

Impacts to cultural resources are not anticipated under the Recommended Plan. The 100-foot-wide channel would require dredging a wider channel cross section than that for Alternative 1, leading to possible impacts of any undiscovered artifacts during construction, but also allowing their detection and salvage.

4.16.3 Alternative 1

Impacts to cultural resources are not anticipated under Alternative 1. The 75-foot-wide channel would require dredging a narrower channel cross section, reducing the possibility of impacts on any undiscovered artifacts during construction, when compared to the Recommended Plan and Alternative 3. However, dredging a narrower channel would also reduce the possibilities of finding any unknown cultural resources, and thus, their salvage.

In addition, Alternative 1 would require the Project Channel bottom to be paved with articulated concrete mats, significantly limiting the possibility to conduct future studies of the Eastern CMP in search of any buried cultural resources.

4.16.4 Alternative 3

Impacts to cultural resources are not anticipated under Alternative 3. The 125-foot-wide channel for this alternative, however, would require dredging a wider channel cross section, thus increasing the possibility of impacts on any undiscovered artifacts during construction, when compared to the

Recommended Plan and Alternative 1. On the other hand, dredging a wider channel would also increase the possibilities of finding any unknown cultural resources, and thus, their salvage.

4.17 AESTHETIC RESOURCES

Impacts to aesthetic resources entail visual impairment of the local landscape as a result of the proposed project. All the CMP-ERP alternatives are expected to improve aesthetic resources in the CMP and San José Lagoon.

The improved landscape and water quality in the CMP and San José Lagoon would offer a scenic oasis within the urban landscape. The increased mangrove acreage fringing the lagoons, as well as the additional open water habitat, would offer a pleasant contrast against the urban backdrop of the densely populated SJMA.

The CMP-ERP would greatly enhance the visual quality of the CMP for the entire community. Major vistas from the four bridges would be restored and improved under this project. The proposed project would create access to the water, providing users with long views of the CMP and its surroundings. When completed the visual quality for the user, both waterside and landside would be greatly improved. Walking or driving along the Paseo, the user would enjoy the newly established mangroves that would serve as shelter habitat for birds, fish and other species.

4.17.1 No Action

Current visual impairment would continue in the CMP and the San José Lagoon. The limited access to the CMP would continue to favor its use for illegal dumping, which coupled with decades of filling with various vegetative and non-vegetative materials, would continue to negatively affect the view to the CMP. The views into the existing mangroves would further be adversely impacted by abandoned structures, garbage, and general debris. The quality of the views from within the CMP would be progressively compromised by the lack of definition of the channel and debris that has collected under the mangroves and upland areas.

4.17.2 Recommended Plan

The Recommended Plan's improvements to the CMP, including its recreational features, would positively alter the visual quality of the CMP. The proposed actions offer the community new open spaces suitable for the appreciation of an enhanced ecological scene. Projected improvements to the CMP and the adjacent community projects would restore the mangroves, remove debris from illegal dumping, and connects the CMP to the community trough the Paseo, street improvements, and activity nodes.

Careful placement of recreational features not only would contribute to the protection of the restored ecosystem, but also would provide access to panoramic views, transforming the actual scenery. The removal of the 393 structures within the CMP would eliminate visual obstructions directly adjacent to the Project Area. This would provide a public corridor parallel to the CMP, creating a buffer or separation from private property. The CMP is naturally located at the lowest point within the community; this creates long uninterrupted views of the facility from the local streets as they transverse the topography down towards the CMP.

4.17.3 Alternative 1

Visual and aesthetic benefits would be similar to those achieved by the Recommended Plan.

4.17.4 Alternative 3

Like Alternative 1, visual and aesthetic benefits would also be similar to those achieved by the Recommended Plan.

4.18 CUMULATIVE IMPACTS

The Council on Environmental Quality (CEQ) defines a cumulative impact as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor, but collectively significant actions taking place over a period of time" (40 CFR §1508.7). Therefore, individual actions can produce interrelated, compounded effects that can lead to significant benefits or impacts on single or various resources if carried out within a relatively short time frame and/or when developed over a related and clearly defined environmental setting.

The proposed analysis seeks to determine the cumulative effects or impacts from the CMP-ERP, in combination with past, present, and other reasonably foreseeable future projects within the SJBE.

4.18.1 Cumulative Impact Assessment Methods

The cumulative impact assessment for the CMP-ERP was conducted for the Study Area (the waters within the SJBE, their associated wetlands, and immediately adjoining communities, unless otherwise noticed). This area is anticipated to experience most of the significant effects and impacts dealing with the proposed tidal, water flow, and habitat restoration actions.

There are eight (8) plans/projects that have been completed, are underway, or have been proposed by Commonwealth or Federal agencies that could have a significant effect over parts of the SJBE and its immediate uplands. These have been selected in order to evaluate their cumulative effects or impacts and are briefly discussed in the following section, including:

- Foreseeable actions, such as, the CMP Special District Plan (CMP District Plan) and the SJBEP-CCMP.

- Past and Present Actions, which include: San Juan Harbor Project, the Comprehensive Development Plan for the Cantera Península (Cantera Plan), Río Puerto Nuevo Flood Control Project, Agua-Guagua (AcuaExpreso) Project, and the Juan Méndez Creek Flood Control Project.

Many aspects of the reasonably foreseeable plans/projects are planned, but do not have definitive implementation schedules due to a variety of factors, including funding constraints. The cumulative impact assessment was conducted based on the general assumption that these plans/projects would move forward over the next 1 to 3 years. Best professional judgment was relied upon for cumulative impact assessment to a greater extent than the impact analyses for the CMP-ERP, because information on other projects was based entirely on the limited information available in the public domain, and the inherent uncertainty of estimating the possible combined, future effects of projects conceptually, temporally, and spatially dissimilar. No attempt was made to verify or update documents available on the reviewed projects and no field data were collected to verify the impacts described in the available documents.

Table 4.12 summarizes the potential cumulative effects and impacts that would be anticipated from the CMP-ERP and from the other eight plans/projects identified for the Study Area. These were first evaluated for their individual effect on each of the topics or resources used to compare the environmental effects (e.g., climate, water, and sediment quality, etc.) of the four project alternatives analyzed for the CMP-ERP. Based on the expected environmental consequence or response, a grade was allocated to each plan/project [beneficial or positive (+); adverse or negative (-) or negligible (N)]. A qualitative assessment was then provided on the cumulative effects or impacts that all of the plans/projects are estimated to cause on these topics or resources. It should be noted that all three evaluated plans (CMP District Plan, Cantera Plan, and the SJBE-CCMP) include the CMP-ERP as a proposed action, as well as similar infrastructure improvements commitments to control of untreated sewage discharges under the Consent Decree signed by PRASA and the USEPA. The CMP-ERP and those infrastructure improvements related to the Consent Decree were excluded as if these were not proposed under the CMP District Plan, the Cantera Plan, and the SJBE CCMP to avoid "double counting" their anticipated cumulative effects or impacts to the Study Area.

The following section includes a brief presentation on the eight plans/projects identified and selected for the cumulative impact assessment, in addition to a description on the most notable anticipated effects or impacts resulting from their implementation and how these compare or interrelate with those from the CMP-ERP.

4.18.2 Past, Present, and Reasonably Foreseeable Future Actions

4.18.2.1 CMP Special District Plan

In 2001, the Puerto Rico Department of Transportation and Public Works (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 Puerto Rico Planning Board (PRPB) designated the CMP Special 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).

The CMP's dredging, channelization, and ecosystem restoration is one of the principal elements of the District Plan. It also integrates the design and implementation of strategies before, during, and after the channel's dredging and restoration phase in areas such as the environment, infrastructure, housing development, family relocation, urban revitalization, land tenure, and socioeconomic development.

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 would 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 Rexach sewer trunk, 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.

The following initiatives are or have been implemented by ENLACE itself or by other entities or Commonwealth agencies, most under the coordination of ENLACE:

- 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% of the total remaining relocations are expected to be mandatory, with the remaining relocations to be voluntary. Real estate acquisitions 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.
- 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 was 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.
- 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. Improvements to the San José Trunk in the segment within the Israel-Bitumul communities. The project was completed by y PRASA on December 2014.
- Construction, by PRASA, of the Barrio Obrero Marina vacuum sewer system, north of the CMP.
- Design for a sewer system in northern Israel-Bitumul (PRASA). It is at a 100% design stage.
- Sanitary Sewer and Potable Water System for the South Section of the Israel and Bitumul Communities (100% designed);
- Potable Water System for the North Section of the Israel and Bitumul Communities (100% designed);
- Relocation of the Potable Water Line in Borinquen Avenue (100% designed);

- New Rexach Trunk Sewer Siphon (100% designed);
- Sanitary Sewer and Potable Water System for Buena Vista and San Ciprián Communities (Preliminary Engineering Report completed).
- 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. Is important to continue with the public outreach campaign 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.

The strategies and actions proposed under the CMP Special District Plan, besides those already included under the CMP-ERP, would help improve the natural environmental quality in the Eastern CMP and that of its adjacent, built-up lands. Reconstruction and upgrades proposed for the area's infrastructure (i.e., storm and sewage system) would help further maintain those improvements expected from the CMP-ERP (e.g., water quality) into the future. 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.

4.18.2.2 San Juan Bay Estuary CCMP

As discussed in Section 1.5, the SJBE Program completed a Comprehensive Conservation and Management Plan (CCMP) for the SJBE system on August 2000. The 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. Nine actions dealing with 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 0-5 years after CCMP approval" (SJBEP, 2000). Three of these actions are directly related to the CMP-ERP and include:

- 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

The SJBE Program is one of the main partners of the ENLACE Project Corporation and is part of the Technical Committee for the CMP-ERP. The CCMP, besides proposing the restoration of the CMP includes other actions that would help further and maintain those benefits expected from the CMP-ERP. Both initiatives would help support each other environmental restoration and enhancement efforts.

4.18.2.3 PRASA-USEPA Consent Decree

On September 15, 2015, under a settlement with the U.S. Department of Justice (USDOJ) and the USEPA, PRASA entered into a consent decree (Civil Action No. 3:15-cv-02283) that will require major upgrades, improved inspections, and cleaning of existing facilities within the Puerto Nuevo system and continued 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 area are part of the SJBE 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 CMP. These projects are contingent upon the completion of related prerequisite projects to be developed by parties not affiliated with PRASA, such as ENLACE.

These works, which are also related to similar infrastructure improvements proposed as part of the CMP Special District Plan and the CCMP, would take place prior or concurrently with the CMP-ERP and would be completed prior to finalizing the ERP. Once these and other discharges are addressed, water and sediment quality impairments would be reduced, helping to enhance water quality within the CMP. Further improvements, however, would still be dependent on the CMP-ERP.

Table 4-10. CMP Projects under PRASA-EPA Consent Decree

Name	Start Date	Completion Date	Approximate Investment (in Millions)	Project Description and Conditions
New Rexach Trunk Sewer Siphon	Start of construction is subject to the relocation of 14 families by ENLACE. Construction will start six (6) months after the relocation of families.	Construction Completion is thirty (30) months from the construction start date assuming that there no contaminated soils and/or archeological findings. If contaminated soils and/or archeological findings are found, PRASA may request additional time to complete the project.	$13	The project consists of the construction of a siphon to replace the existing Rexach Trunk Sewer with the goal of preventing it from interfering with the proposed bottom depth of the Caño Martín Peña and to increase its capacity to allow the additional sanitary flow from the communities which are being provided with the new sewer system. Contingent on the relocation of 14 families to be performed by ENLACE. The construction budget and construction schedule is subject to the possibility of finding contaminated soils in the excavation, archeological findings and any other unforeseen condition.
Israel and Bitumul Communities New Sanitary Sewer System North	Construction will start six (6) months after the "Paseo del Caño Sur" project is completed by ENLACE. In addition, it is contingent on the Municipality of San Juan completing the design of the Storm Sewer Project and obtaining the necessary financing.	Construction Completion is thirty (30) months from the construction start date assuming that there are no contaminated soils and/or archeological findings. If contaminated soils and/or archeological findings are found, PRASA may request additional time to complete the project.	$10	Located on the south east of the Caño Martín Peña, near its access to the San José Lagoon. Neither of these communities has a sanitary sewer system.
Israel and Bitumul Communities New Sanitary Sewer SystemSouth	Construction Start: July 30, 2017. This date is contingent on the Muni-cipality of San Juan completing the design of the Storm Sewer Project and obtaining the necessary financing.	July 30, 2019. This date is contingent to unforeseen conditions thatmay occur.	$25	Located on the south east of the Caño Martín Peña, near its access to the San José Lagoon. Neither of these communities has a sanitary sewer system. PRASA's current proposal to provide sewage collection consists of a gravitysewer collection system. The design and financing of the Storm Sewer project by the Municipality of San Juan is a pre-condition and the necessary financing. Construction shall be performed at the same time as the sewer system. The construction budget and construction schedule is subject to the possibility of finding contaminated soils in the excavation and having to dispose excess material as such and any other unforeseen condition.

Table 4-10, cont'd

Name	Start Date	Completion Date	Approximate Investment (in Millions)	Project Description and Conditions
Las Monjas and Buena Vista Hato Rey New Sanitary Sewer System	The design start date is six (6) months after ENLACE's "Plan de Desarrollo Integral" is implemented.	Construction dates to be submitted to EPA after design is completed.	$32	A gravity sanitary sewer collection system is proposed for those parts that currently do not have a sanitary sewer system. The construction budget and construction schedule is subject to the possibility of finding contaminated soils in the excavation and having to dispose excess material as such and any other unforeseen condition. The design is subject to the implementation by Enlace of their "Plan de Desarrollo Integral."
Buena Vista and San Ciprián New Sanitary Sewer System	The design start date is six (6) months after the ENLACE's "Plan de Desarrollo Integral" is implemented. The construction start date is contingent on the completion of the New Rexach Trunk Sewer Syphon project.	Construction dates to be submitted to EPA after design is completed.	$37	A collection system is proposed for both communities. The project cannot be built until the new Rexach Trunk Sewer siphon is completed. The construction budget and construction schedule is subject to the possibility of finding contaminated soils in the excavation and having to dispose excess material as such, and any other unforeseen condition. The design is subject to the implementation by Enlace of their "Plan de Desarrollo Integral."

Source: Appendix O. Description of Caño Martin Peña Projects. Civil Action No. 3:15-cv-02283.

4.18.2.4 Municipality of San Juan-USEPA Consent Decree

On October 25, 2015, under a settlement with the USDOJ and the USEPA, the Municipality of San Juan entered into a consent decree (Civil Action No. 3:14-cv-1476-CCC) that will require 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 Martin Peña Channel. Through this agreement, the Municipality will come into compliance with their storm water permit, develop and implement a stormwater 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 municipality must also implement the plan and complete construction within an USEPA-approved schedule. Additional requirements under the agreement include:

- Development of an asset management program, including protocols and operating procedures for inspection, cleaning and repair of sewer infrastructure; consistently clean the sewer system; and submit a routine cleaning schedule and checklist to the USEPA for review.
- Development and implementation of a spill prevention control and countermeasures plan, as well as a spill control plan. The Municipality will also submit a vacuum truck sludge disposal plan, and submit standard operating procedures for pump stations.
- Sampling and monitoring of water quality, maintainance of an electronic record of information on system outfalls and completion of an inventory of all of its outfalls in the city of San Juan within 3 years.
- Installation of warning signs at discharge points and through a public education program on the dangers of being exposed to these discharges.
- Maintainance of an Urgent Action Registry that will track all complaints by government agencies and individuals of illegal discharges into San Juan's storm sewer systems. San Juan will address these complaints within 1 to 3 years from the date a complaint is made.

In addition, the Municipality will consider Green Infrastructure projects to comply with obligations under the agreement. The Municipality of San Juan shall commence performance of and comply with the plans for Priority Areas 1A through 1E of its Reconnaissance, Investigation, Planning & Design, Implementation, and Construction Work Plan (Stage I Work Plan), as approved by the USEPA no later than the same date of lodging of the Consent Decree. A Stage II Work Plan, shall be submitted to USEPA for review and approval, which shall include schedules for completion of

Phases I through III for each remaining Priority Area in San Juan, no later than 8 years after the date of lodging of the Consent Decree. Prority areas near the CMP under Stage I and II are presented in Table 4-11.

Table 4-11. Stage I Reconnaissance, Investigation, Planning & Design, and Construction Work Plan in the communities surrounding the CMP

Priority Area	Ward	Sub ward[1]	Sector / Urbanization / Community / Street / Road	Reconnaissance Schedule	Investigation Schedule	Planning and Design Schedule	Complete Construction Schedule
Stage I. PRIORITY AREAS 1A TO 1E							
1A	Santurce	Obrero	Barrio Obrero and La Marina communities	Oct 2012–Sep 2013 Completed	December 2021	December 2022	December 2029
		Obrero	Buena Vista Community	December 2015	December 2021	December 2022	December 2029
	Hato Rey Central	Las Monjas	Buena Vista Community	December 2015	December 2021	December 2022	December 2029
	Oriente	Borinquen	Bitumul Community	December 2015	December 2021	December 2022	December 2029
		San José	Israel Community	December 2015	December 2021	December 2022	December 2029
1D	Santurce	Martín Peña	Martín Peña Sector	December 2021	December 2023	December 2025	December 2029
		Las Palmas	Las Palmas Sector and Community, and streets surroun-ding Las Casas Public Housing Project	December 2021	December 2023	December 2025	December 2029
		Merhoff	Streets surrounding Villa Kennedy Public Housing Project	December 2021	December 2023	December 2025	December 2029
		Las Casas	Las Casas Sector; Cantera, Santa Elena, Condadito Final, and Bravos de Boston communi-ties; and the streets surrounding El Mirador and Las Margaritas public housing project	December 2021	December 2023	December 2025	December 2029
1E	Hato Rey Norte	Martín Peña	Martín Peña Sector	December 2022	December 2024	December 2026	December 2029
Stage II. PRIORITY AREA 2							
2C	Hato Rey Central	Las Monjas	-Las Monjas sector -Héctor Piñero urbanization -Parada 27, and Las Monjas communities				

Source: Appendix A to the Consent Decree between the United States and the Municipality of San Juan in U.S. v. Municipality of San Juan, et al., 3:14-CV-1476 (D.P.R.) (CCC).

4.18.2.5 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%) 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 of 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 to 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)

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 over 34 acres of mangrove forests and 25 acres of open waters along the Eastern CMP, and improving overall water quality and benthic habitat conditions within the SJBE.

4.18.2.6 Comprehensive Development Plan for the Cantera Peninsula (Cantera Plan)

The Cantera Península is a low-income community located on approximately 290 acres at the north and eastern boundary of the CMP, in the Municipality of San Juan. It is bordered on the north and east by the San José Lagoon and on the south by the CMP.

This community initiated a comprehensive redevelopment with participation of the private sector and the Consejo Vecinal de la Península de Cantera, a grassroots organization that today is part of the G-8, Inc. These efforts continue and strengthened with the approval of Law 20-1992, as amended, which created the Company for the Comprehensive Development of the Cantera Península (Cantera Company). In 1995, the PRPB adopted the Comprehensive Development Plan for the Cantera Península (Cantera Plan), which includes the following projects, many of which have been implemented:

- Relocation of most of the residents of the Cantera Península living along the public domain lands in the Eastern CMP;
- Development of several housing projects to allow for relocation alternatives within the community;
- Construction of a vacuum sanitary sewer, as well as other vital infrastructure, and the first segment of the Paseo del Caño.

The portion of the CMP south of the Cantera Península and north of the Israel-Bitumul neighborhood is the most affected by accumulation of trash and debris, and encroachment. 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.

East of the Cantera Península is a small haystack hill located north of the eastern end of the CMP, named Guachinanga Islet. It used to be surrounded by waters from the San José Lagoon, but debris and sedimentation closed the small channel that separated it from the Cantera Península. Guachinanga is a roosting site for coastal birds and is home to a very unique biodiversity in the midst of the SJMA, in part because of its isolation. 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 Guachinanga from the Cantera Península.

The strategies and actions proposed under the Cantera Plan, as with the CMP Special District Plan, would help improve the natural environment in the Eastern CMP and that of its adjacent, built-up lands.

4.18.2.7 Puerto Nuevo (Río Piedras) Rivera Flood Control Project

The Puerto Nuevo River Flood Control Project, currently under construction, is located on the north coast of Puerto Rico within the SJMA. The Puerto Nuevo River (Río Piedras) used to flow into the SJB, and now flows into the western end of the CMP. The Survey Report for the flood control project was completed in October 1984 and revised in June 1985. The Chief of Engineers Report is dated April 25, 1986. 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 Puerto Nuevo River basin drains 25 square miles, 75% of which is highly developed with a population of approximately 250,000 inhabitants. Rapid upstream runoff, inadequate channel capacity, constriction at bridges, and elimination of the floodplain by urbanization cause severe flooding to approximately 7,500 residents and 700 commercial and public structures valued at over $3 billion. These include important transportation facilities, as well as major public works complexes and strategic water, sewer, electrical power, and telephone services.

The flood control project, as currently proposed, seeks protection against the 100-year flood (the flood with a 1% 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. The project eliminated 20.5 acres of mature mangrove wetlands and the affected area included the Constitution Bridge mudflat and mangroves, a Commonwealth designated Critical Coastal Wildlife Habitat. The project proposed 30 acres wetland mitigation project (U.S. Department of the Interior, 1994). 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 USEPA-approved ocean disposal site in San Juan, pursuant to Section 103 of the CWA.

Concerns have been expressed over whether the construction of the Puerto Nuevo River Flood Control Project, as currently conceptualized (e.g., construction of enlarged, paved, high velocity channels) might have detrimental effects on the CMP-ERP. It is understood that the Corps 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 comparable configuration as the National Ecosystem Restoration (NER) and Recommended Plan for CMP-ERP, did not point to problems or issues such as backflow into the San José 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 if the simulations accounted for the Eastern CMP's proposed configuration, if 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 or others nearby once it is dredged. Dependent upon the results of the review, further modeling may be warranted.

The 9.5 miles of concrete lined channels (5.1 of which are high velocity) to be built along the Río Piedras River and some of its tributaries, as currently proposed under the Puerto Nuevo Flood Control Project, would eliminate most of the ecological services associated to the habitats on its earthen riverbed and banks. This would greatly diminish the river's capacity to sustain fish and wildlife, substantially affecting its water quality and hydrologic regime, impoverishing those opportunities for the development of outdoor recreational amenities related to these resources, while degrading its aesthetic values (Lugo, Ramos-González, and Rodríguez- Pedraza, 2011). The project could also cause significant impacts to cultural resources. [24]

The CMP-ERP could help offset some of the impacts associated to a reduction in forest cover (i.e., riparian corridors) and the degradation of water quality; the latest at their common outlet towards the SJB. These benefits, however, would be minimal since the ecosystems affected by the CMP-ERP and the Puerto Nuevo Flood Control Project differ substantially, especially when considering those present and that would be impacted by the latest in upper reaches of the Río Piedras River.

4.18.2.8 AguaGuagua Project (AcuaExpreso)

In 1982, the DTPW requested the USACE to conduct engineering and design studies for a waterway along the western half of the CMP, from the SJB 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.

Construction began in 1984 and was completed in 1988 at a cost of $20 million. Work consisted of dredging the Western CMP to a dimension of 200 feet wide and 10 feet deep, ocean disposal of over 1.3 mcy 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 of Puerto Rico. 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 Lineal 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 the CMP, 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 wastewater 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

[24] Concerns regarding the project's impacts on structures of cultural or historic value include those associated to the nineteenth century Río Piedras Old Aqueduct's low-water dam and valve house, its gravity-operated sedimentation/filtration tanks or ponds, and the site's historical integrity consisting of maintenance, storage and administrative buildings. The Río Piedras Old Aqueduct is believed to be the only known Spanish-period aqueduct in existence in all of the United States and its territories. The Department of the Interior's National Park Service has included this site in the National Register of Historic Places since 2007. It was designated by the National Trust for Historic Preservation as a National Treasure in 2014. Retrieved online from http://www.paralanaturaleza.org/antiguo-acueducto-eng/

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.

The CMP-ERP would further those benefits that resulted from the Agua-Guagua (AcuaExpreso) Project in terms of tidal flow and water quality improvements, and mangrove habitat restoration, finally reconnecting the SJB and the San José Lagoon. Navigation by small vessels would be possible across the CMP, and as a result, through most of the SJBE, once the CMP-ERP is completed.

4.18.2.9 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 lying 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 upstream 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. Now, the creek runs 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. Flood waters discharged by the Juan Méndez Creek, however, would be able to exit the San José Lagoon more easily through the SJB by means of the restored CMP.

Table 4-12. Cumulative Impacts Summary (N: negligible)

TOPIC / RESOURCE	PLANS/PROJECTS IN THE STUDY AREA										Qualitative Summary of Cumulative Effects or Impacts
	CMP ERP	CMP Special District Plan	SJBE CCMP	San Juan Harbor Project	Cantera Península Plan	Puerto Nuevo Flood Control Project	Aqua-Expreso Project	Juan Méndez Creek Flood Control Project	PRASA USEPA Consent Decree	Mun. of San Juan USEPA Consent Decree	
Climate	+	N	+	N	N	-	+	N	N	+	Temporary fossil fuel emissions generated by construction equipment (e.g., machinery). Otherwise, most of these projects would improve or maintain adequate ambient temperatures due to an expected net increase in forest cover and/or green spaces, or from the designation of natural protected areas. Resulting vegetated areas would help remove and sequestered greenhouse gases such as carbon dioxide (CO_2). Infrastructure improvements built to collect and treat sewage discharges would also help ameliorate localized hydrogen sulfide (H_2S) and methane (CH_4) emissions.
Geology	N	N	N	N	N	N	N	N	N	N	Mining and extraction of aggregates (e.g., rock, sand) and other minerals from the Earth's crust for the production of materials to be used in the development of these projects. Digging or blasting of rock is required in some of the projects involving dredging works. However, the underlying geology in the Study Area is not expected to be significantly altered by the collective impacts of these plans/projects.
Soils	+	N	+	N	N	-	+	+	+	+	A cumulative beneficial effect is expected. A positive effect would be derived from those plans/projects that require the removal of soils formed through the deposition of unsuitable fill, construction debris, and/or domestic trash. Soils would also be maintained, enhanced or protected by those plans/projects that entail the designation of natural protected areas or the creation of green spaces, as well as those that would include infrastructure upgrades to control the discharge of pollutants. Impacts are expected from those plans/projects involving concrete, flood control channels. The latest would require the excavation of potentially fertile soils in areas within and adjacent to stream and river channels, paving and isolating those that would remain underneath by the construction of a concrete channel.

Table 4-12, cont'd

TOPIC / RESOURCE	PLANS/PROJECTS IN THE STUDY AREA										Qualitative Summary of Cumulative Effects or Impacts
	CMP ERP	CMP Special District Plan	SJBE CCMP	San Juan Harbor Project	Cantera Península Plan	Puerto Nuevo Flood Control Project	Aqua-Expreso Project	Juan Méndez Creek Flood Control Project	PRASA USEPA Consent Decree	Mun. of San Juan USEPA Consent Decree	
Hydrology	+	N	+	-	+	-	+	+	N	+	An overall beneficial effect is estimated. Most of the plans/projects include actions towards restoring water conveyance capacity within or from discharges into the Study Area through the removal of severe artificial flow constrictions. Storm water sewer infrastructure upgrades can alleviate localized ponding or drainage problems, but by exacting further demands on the hydraulic capacity of receiving waterbodies. Vegetated areas created or protected by some of the plans/projects, especially those adjacent to surface waterbodies intercept and store storm water runoff. Excess waters are then gradually release down gradient, thus helping to maintain natural water flows within surface waterbodies. This function is eliminated when soils and surface waterbodies, such as streams and rivers, are paved or confined with concrete channels, respectively, thus impacting hydrologic regimes.
Water & Sediment Quality	+	+	+	-	+	-	+	+	+	+	Temporary impacts are expected from all plans/projects during construction activities associated to dredging and infrastructure improvements due to the resuspension of sediments and soil erosion. Temporary short term adverse impacts would occur to water quality as a result of dredging and elimination of discharges of untreated wastewater from residential and commercial units not connected to the PRASA's collection system. However, 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. A permanent beneficial effect has been determined for the Study Area's water and sediment quality condition. Those plans/projects that include dredging works would involve the removal of trash and debris that have been deposited and mixed with sediments, thus reducing possible leaching of contaminants into waters and sediments. The creation of vegetated buffers or greenways, and the designation of natural protected areas are predicted to facilitate the concomitant function as filters, transformers, and sinks for nutrients, sediments, organic materials, pesticides, and other detrimental substances normally carried by runoff into surface waters.

Table 4-12, cont'd

TOPIC / RESOURCE	PLANS/PROJECTS IN THE STUDY AREA										Qualitative Summary of Cumulative Effects or Impacts
	CMP ERP	CMP Special District Plan	SJBE CCMP	San Juan Harbor Project	Cantera Península Plan	Puerto Nuevo Flood Control Project	Aqua-Expreso Project	Juan Méndez Creek Flood Control Project	PRASA USEPA Consent Decree	Mun. of San Juan USEPA Consent Decree	
Air Quality	+	+	+	N	+	-	+	N	+	+	The use of machinery and the demolition of structures are expected to produce fossil fuels emissions and fugitive dust during construction activities. Those plans/projects involving dredging works would also temporarily promote or facilitate the emission of H_2S as sediments are disturbed or removed. However, permanent, net cumulative benefits are anticipated. Restoration of hydraulic capacity would significantly reduce the production of undesirable odors from the decomposition of organic material in stagnant waters. The same would result from those plans/projects that entail infrastructure upgrades to eliminate raw sewage discharges into the Study Area.
Noise	+	N	+	N	+	N	+	N	N	+	Impacts are expected to be short term and temporary, mostly associated to those actions requiring the use of heavy equipment for construction activities. Long term cumulative possitive effects are otherwise forecasted. Vegetated areas to be restored, planted, or protected in or close to the estuarine portions of the Study Area would help buffer noise pollution caused by nearby urban activities.
Solid Waste	+	+	+	N	+	N	+	N	+	N	Overall, improvements in solid waste management or disposal practices is expected due to an increase in public awareness, the implementation of community-based programs involving recycling and periodic aquatic clean-up events. In addition, infrastructure works that have been planned or constructed in those communities fringing the CMP (e.g., realignment or expansion of streets) would facilitate access of municipal trucks, and thus, the collection of household refuse. No determination has ever been made regarding the detection of hazardous, toxic, radioactive wastes (HTRWs) involving those plans/projects that have been partially performed or completed in the Study Area. HTRWs are not forecasted for those plans/projects that still have not been implemented. In the event that these need to be handled in order to perform any of the latest, compliance with the corresponding regulatory measures would have to be guaranteed. Those plans/projects that have as an objective the enhancement or restoration of natural features and functions, or the reduction of pollutant loadings, would help prevent the accumulation of contaminants at specific sites and in such concentrations that could result harmful to fish and wildlife and human health.

Table 4-12, cont'd

TOPIC / RESOURCE	PLANS/PROJECTS IN THE STUDY AREA										Qualitative Summary of Cumulative Effects or Impacts
	CMP ERP	CMP Special District Plan	SJBE CCMP	San Juan Harbor Project	Cantera Península Plan	Puerto Nuevo Flood Control Project	Aqua-Expreso Project	Juan Méndez Creek Flood Control Project	PRASA USEPA Consent Decree	Mun. of San Juan USEPA Consent Decree	
Habitats	+	N	+	-	+	-	+	N	N	+	Temporary, short term impacts related to the degradation or elimination of forested or vegetated areas, among other biological communities, are anticipated from the implementation of those actions that require construction. However, permanent, significant beneficial cumulative effects are expected to predominate since many of the actions entailed in these plans/projects have been propose with the main purpose of restoring or protecting many of the Study Area's habitats, leading to an increase in the acreage occupied by these natural communities. Habitat fragmentation is to be reduced. Improved conditions would strengthen habitat resiliency against the anticipated impacts of climate change.
Flora & Fauna Resources	+	N	+	-	+	-	+	N	+	+	Short term disturbance and displacement of fish and wildlife species and the unavoidable elimination of some animals (e.g., crabs, reptiles, amphibians) and plants are expected from those actions that would entail construction. Animal species, such as birds, would be able to cope better with these temporary impacts by moving into other natural sites within the Study Area. Permanent, significant beneficial cumulative effects are otherwise predicted for flora and fauna resources. Expected increases in acreage and habitat quality improvements would provide new feeding, roosting and nesting grounds for many species of fauna, with concomitant increases in their populations. The same applies to fisheries. This would strengthen flora and fauna resiliency capabilities against climate change and other impacts related to invasive species.

Table 4-12, cont'd

TOPIC / RESOURCE	PLANS/PROJECTS IN THE STUDY AREA										Qualitative Summary of Cumulative Effects or Impacts
	CMP ERP	CMP Special District Plan	SJBE CCMP	San Juan Harbor Project	Cantera Península Plan	Puerto Nuevo Flood Control Project	Aqua-Expreso Project	Juan Méndez Creek Flood Control Project	PRASA USEPA Consent Decree	Mun. of San Juan USEPA Consent Decree	
Species of Special Concern	+	N	+	N	+	N	+	N	N	+	No significant impacts are anticipated for Federal and/or Commonwealth listed species reported in the Study Area. Listed species are predicted to benefit in the same way as determined for other flora and fauna resources due to an increase in habitat area and quality, the protection of those listed species found within proposed or designated natural protected areas, and the introduction of listed plant individuals into newly restored sites. These benefits are significant, since the status of most of the listed species is due to the degradation or destruction of habitat.
Land use & Infrastructure	+	+	+	+	+	+	+	+	+	+	Short term impacts due to the temporary interruption of utility services (e.g., electricity, water supply, roads, etc.) are expected as part of the construction works related to infrastructure upgrades. Overall environmental and infrastructure improvements can "reenergized" and lead to the renewal of underutilized areas, promoting a more efficient use of limited land space, and strengthening communities to become more resilient to some of the impacts resulting from climate change (e.g., flooding). However, if not properly handled or regulated, land use pressures could jeopardize gained environmental benefits.
Socioeconomics	+	+	+	+	+	+	+	+	+	+	The majority of the plans/projects considered involve, to some degree, the relocation of households and other structures, and the temporary displacement of businesses during construction. This impact can be lessened through proper compensation and diligent response coordination. No significant disproportionate impacts have been determined for disadvantage or environmental justice communities. These plans/projects are driven with the purpose of improving citizens living standards irrespective of any social characteristics. The overall economic impact of all the plans/projects evaluated is very significant in terms of the investment of public funds and the new development opportunities that can be created. A reduction in flood damage related costs is expected due to storm and sewage infrastructure upgrades and the enhancement or conservation of green areas that can help manage flood waters and mitigate their impact.

Table 4-12, cont'd

TOPIC / RESOURCE	PLANS/PROJECTS IN THE STUDY AREA										Qualitative Summary of Cumulative Effects or Impacts
	CMP ERP	CMP Special District Plan	SJBE CCMP	San Juan Harbor Project	Cantera Península Plan	Puerto Nuevo Flood Control Project	Aqua-Expreso Project	Juan Méndez Creek Flood Control Project	PRASA USEPA Consent Decree	Mun. of San Juan USEPA Consent Decree	
Human Health & Safety	+	+	+	+	+	+	+	+	+	+	The use of heavy machinery and other construction related activities are inherently dangerous even when performed during a short period of time, thus posing a risk to human health and safety. However, this potential impact is not expected to be significant since it would be very limited to site specific areas, and proper safety measures would be adopted to guarantee the health of workers and nearby residents (e.g., fencing, controlling pests or vectors, etc.). Cumulative beneficial effects are anticipated from all plans/projects. These would be a direct consequence of improvements in environmental or ambient conditions related to the restoration and protection of natural areas and infrastructure upgrades. Most notably, restoring the water conveyance capacity of the SJBE, in addition to the construction of storm sewers and other flood control works would reduce frequent damages to life and property. The construction of sanitary sewers and the removal of trash and other wastes improperly disposed of would significantly reduce the risk of contracting water borne diseases, the reproduction of pests and vectors, and other health ailments. This would enhance communities resiliency against these health related issues due to the compounding impacts of climate change. Those works that would entail upgrading access routes would also bring safety improvements to land and water transportation.
Cultural Resources	N	N	+	+	N	-	N	N	N	N	No cumulative significant impacts within the Study Area limits in the SJBE are expected to occur. Reconnaissance studies commissioned for these plans/projects can provide a better historical picture of land use change and the cultural value of archeological remains, buildings and other structures. Documentation, salvage, and/or preservation of unknown historic or cultural remains would be performed in the event these are encountered during construction activities.

Table 4-12, cont'd

TOPIC / RESOURCE	PLANS/PROJECTS IN THE STUDY AREA										Qualitative Summary of Cumulative Effects or Impacts
	CMP ERP	CMP Special District Plan	SJBE CCMP	San Juan Harbor Project	Cantera Península Plan	Puerto Nuevo Flood Control Project	Aqua-Expreso Project	Juan Méndez Creek Flood Control Project	PRASA USEPA Consent Decree	Mun. of San Juan USEPA Consent Decree	
Recreation	+	+	+	+	+	-	+	N	N	N	No significant cumulative impacts over recreational facilities or structures are anticipated within the SJBE Study Area. Temporary, short term impacts could result, mostly by limiting or closing access to some recreational areas while construction activities are been completed; nevertheless, other areas would still be accessible or able to serve those needs. Long term, cumulative beneficial effects are anticipated due to the construction or upgrades of facilities, especially those associated to outdoor recreation. Improvements to the overall environmental quality of the SJBE, including reestablishing its connection through the CMP, would provide extraordinary new opportunities for the development and enjoyment of aquatic (e.g., kayaking, sport fishing, paddle boarding) and nature-based (e.g., bid washing) recreational amenities within a densely populated, urban landscape. Some of the plans/projects entail infrastructure improvements that include access upgrades to the estuary's waterways.
Aesthetic Resources	+	+	+	N	+	-	+	N	N	+	No significant cumulative impacts over aesthetic resources within the SJBE Study Area limits are expected, other than those which would be temporary, such as demolition and deforestation, increase turbidity of surface waters, and others related to construction activities. Significant, long term or permanent cumulative, beneficial effects are anticipated due to the removal of improperly disposed trash and debris, the renewal of depauperate communities, and enhancement of overall natural features (e.g., mangrove forests and other green areas, surface waterbodies, water quality); the latest within a densely urbanized setting.

4.19 UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

Unavoidable adverse environmental effects include temporary project construction losses of wetlands and upland vegetation, whose functions and values are presently impaired, and do not provide significant habitat for many species. Temporary project construction losses under Recommended Plan include the 34.46 acres of wetlands and the replacement of 24.19 acre of upland vegetation within the Project Area, a condition that would be significantly improved with the CMP-ERP. These would be replaced with 34.48 acre of mangroves and 25.57 of open water. In the CDRC staging area, 1 acre of vegetated wetland would be temporarily impacted for construction of the staging pier. In addition, approximately 5 acres of secondary upland forest would be temporarily impacted in the CDRC staging area, but restored with native vegetation.

Related unavoidable adverse impacts due to the temporary elimination of wetlands and upland vegetation also include disturbance to fish and wildlife species still present in the Project Area during contruction. Many of these species, especially those that are highly mobile such as birds and fish, would be able to move into other areas of the SJBE while project construction is completed. Unavoidable temporary impacts to water quality are expected, since dredging projects cause turbidity, affect water quality, and cause sedimentation. These impacts are expected to occur in those areas proposed for dredging, as well as those where the dredeged sediments would be placed. Contaminants found in the sediments may also become dissolved in the surrounding waters and get dispersed. As previously discussed, the CMP sediments are contaminated with various substances, including pesticides, other organic compounds, and metals. These are presently trapped in the CMP, but may get diluted to some extent and travel as do sediments and turbidity. The proposed measures to control these contaminants are the same methods to control turbidity.

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 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, blankets, matting, vegetative filter strips, and berms. These BMP would include turbidity controls such as the placement of turbidity curtains, the use of a clamshell bucket, encapsulation of dredged sediments into geotextile tubes or bags, and burying geotextile tubes with a sand layer into the SJ1/SJ2 pits.

In addition, to prevent sediment dispersion during construction, the channel flow would be plugged increasing the potential of flooding in structures adjacent to the Eastern CMP. Proper coordination with residents will be carried out by ENLACE.

Once the CMP-ERP is constructed and its unconsolidated bottom is exposed to the intended tidal exchange, there would be a period of time that the flowing water would stir bottom sediments, and carry them to San Juan Bay. This transition period is anticipated to last less than one month.

Other unavoidable temporary impacts that would result from the implementation of the CMP-ERP, include noise from construction activities, however, the heavier activities would take place during daytime and would be at levels that would not cause hearing impairment. Monitoring and mitigation measures would be enforced to guarantee that noise levels would not cause hearing impairment. Other impacts include emission of air pollutants associated with heavy equipment, hydrogen sulfide from the sediment and particulates from demolition. The use of non-renewable energy resources (fuel for the heavy equipment) is also unavoidable.

4.20 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

An irreversible commitment of resources is one in which the ability to use and/or enjoy the resource is lost forever. An irretrievable commitment of resources is one in which, due to decisions to manage the resource for another purpose, opportunities to use or enjoy the resources, as they presently exist are lost for a period of time. An analysis of irreversible and irretrievable commitment of resources is listed in Table 4-13.

Table 4-13. Irreversible and Irretrievable Commitment of Resources by the CMP-ERP

Resource	Irreversible Commitment	Irretrievable Commitment	Description
Soils	Yes	Yes	Landfill space or capacity needed to discard, approximately, 76,200 cy of trash to be dredged and removed from the Eastern CMP.
Water Quality	No	Yes	Temporary impacts to water quality due to sediment resuspension cause by dredging and dredged material disposal during a period extending almost 27 months, and at a limited area, as part of project construction.
Vegetation	Yes	Yes	An irretrievable commitment would have to be made due to the elimination of wetland and upland vegetation at the Eastern CMP during the project's construction and afterwards, until it is restored and reaches maturity. However, the 34.46 acres of wetlands that would be impacted in the Project Area would be improved and increase with 35.48 acres of mangroves. In addition, approximately 5 acres of secondary forest would be temporarily impacted in the CDRC staging area, but later restored with native vegetation. An irreversible commitment would occur with the elimination of 24.19 acres of upland vegetation that would be converted or restored into wetlands and open water areas within the Eastern CMP. Notwithstanding, additional areas would be available for reforestation with upland vegetation along the mangrove fringe that would be restored within the Eastern CMP.
Fish & Wildlife	No	Yes	An irretrievable commitment would have to be made with any benthic fauna that may exist in the Eastern CMP due to the project's construction. The same applies to those wildlife species that would be temporarily displaced during construction activities. However, once flow is restored through the CMP, fish and wildlife species populations would be able to expand into this area and others in the Study Area.

Table 4-13, cont'd

Resource	Irreversible Commitment	Irretrievable Commitment	Description
Cultural	No	No	No irretrievable or irreversible commitments are anticipated for cultural resources.
Air Quality	No	Yes	During construction, a localized temporary deterioration of air quality may occur due to hydrogen sulfide emissions from the dredged material, from heavy-equipment emissions, and particulates from demolition activities.
Land use and Recreation	No	No	An irreversible commitment would result due to the relocation of existing settelments within Public Domain Lands to allow restoration; residents would be moved into safer areas. Recreational opportunities would increased.
Social and Economic Values	No	Yes	An irretrievable commitment would have to be made with those tarpon fishing charters that would have used the San José Lagoon dreged pits during the project's construction. However, once the ecosystem is restored, revenue opportunities from tourism and sport fishing activities would increase. During construction, an irretrievable commitment would be made associated to the daily livelihoods of low income communities next to the construction site. However, ENLACE would maintain close coordination with these communities during construction to guarantee that no disproportionate adverse effects area caused by the proposed project.
Transportation	No	No	No irretrievable or irreversible impacts are anticipated to transportation resources.
Noise	No	Yes	An irretrievable commitment may occur during construction from the use of heavy-equipment, and from demolition and pile-driving activities.
Visual	No	Yes	An irretrievable commitment would have to be made associated to the scenery of the San José Lagoon during construction and while the dredged sediments are deposited in its artificial dredged pits. This, from the presence of barges and dredging equipment. Removal of vegetation, including trees, would occur during the initial period of construction within the Project Area.
Solid Waste	No	No	No irretrievable or irreversible impacts are anticipated.
Public Health	No	Yes	During construction, the air quality and noise impacts may temporarily impact the health of sensitive populations, such as asthmatics, young children and the elderly. However, there would be close on-site monitoring and community coordination during construction, in order to address these effects.

4.21 ENERGY REQUIREMENTS AND CONSERVATION POTENTIAL

Energy requirements associated with the ERP alternatives would be similar to, and involve, consumption of various fuels for construction equipment used for the dredging operations, as well as for the transportation and sorting of the dredged material, and the installation of bulkheads. The contractors would try to make efficient use of vehicles and equipment and minimize energy consumption whenever possible and would keep vehicles and equipment in good working condition.

4.22 COMPLIANCE WITH FEDERAL STATUTES

Table 4-14. Compliance with Federal Statutes

Statute	Description
Clean Water Act (CWA)	This activity would involve dredging of wetlands and surface water a the CMP, the construction of a temporary dock for the barges at the CDRC staging and dredged material management site, and the disposal of dredged sediments in the SJ Lagoon pits. Therefore a Section 401 Water Quality Certificate from the EQB would be obtained and a Section 404(b) evaluation has been conducted. A public notice would be issued and a public hearing would be held, if required, to comply with the requirements of Section 404 of the CWA. A water quality monitoring and management plan would be implemented during construction activities to ensure that, if water quality indicators are non-compliant with corresponding standards, appropriate actions are taken. The process leading to the 401 Water Quality Certification (WQC) for the CMP-ERP will be initiated and completed prior to project construction.
Clean Air Act (CAA)	The project is in compliance with the CAA and no air quality permits are required, as there would be no permanent sources of air emissions. This Final EIS would be submitted to the USEPA for review and comments, in order to comply with Section 309 of the Clean Air Act, which requires USEPA to review and publicly comment on the environmental impacts of major Federal actions including actions which are the subject of Final EIS. The Project Area is not located in any designated “non-attainment” or “maintenance” area under the CAA, nor would any works pertaining to the CMP-ERP. Therefore, the CMP-ERP satisfies the requirements set in the CAA Section 176 (c) (known as “the conformity rule”).
Coastal Barrier Resources Act (CBRA) and Coastal Barrier Improvement Act (CBIA)	The CMP is located within the SJBE, which is an "otherwise protected area" (OPA) a new category of coastal barriers, as defined by the CBIA. OPAs are undeveloped coastal barriers that are within the boundaries of an area established under federal, state, or local law, or held by a qualified organization, primarily for wildlife refuge, sanctuary, recreational, or natural resource conservation purposes. The CMP-ERP proposes the restoration of the historic tidal flow to portions of this OPA. The predicted outcome is a healthier and more resilient coastal barrier. Therefore, the ERP would be in compliance with both, CBRA and CBIA.
Coastal Zone Management Act (CZMA)	A draft Application for a Certification of Consistency with the Puerto Rico Coastal Zone Management Program (PRCZMP) for the CMP-ERP has been prepared in accordance with the provisions of 15 CFR 930. The CMP-ERP would be undertaken in a manner consistent to the Maximum Extent Practicable with the enforceable policies of the PRCZMP. Its effects on coastal uses and resources are all consistent with the enforceable policies of the CZMP. Therefore, the ERP would be in compliance with this Act. The process leading to a CZMP consistency certification for the CMP-ERP will be completed prior to project construction.

Table 4.14, cont'd

Statute	Description
Endangered Species Act (ESA)	The USFWS and the NMFS were officially informed of this effort on September 30, 2010, when the non-Federal sponsor, ENLACE, called for participation in the CMP-ERP's Technical Committee (TC) meeting. A biological assessment under Section 7 of the ESA has been drafted. On December 10, 2015, the USACE sent a letter to the USFWS and the NOAA-NMFS initiating consultation under ESA. On December 14, 2015, the USFWS sent a letter indicating that the agency concurr with the determination that the proposed action may affect but is not likely to adversely affect federally listed species under its jurisdiction. The ERP has been and would continue to be coordinated under ESA. Therefore, the proposed ERP is in the process to be in compliance with the ESA. The process leading to an ESA compliance determination for the CMP-ERP will be completed prior to project construction.
Estuary Protection Act	The CMP-ERP is in compliance with the Estuary Protection Act. The CMP-ERP is essential for the restoration of the SJBE resources and is part of the goals and objectives of the CCMP for the SJBE. The Final-EIS has given full consideration of the SJBE and its natural resources. In fact, the SJBEP is represented in the ERP's TC.
Federal Water Project Recreation Act (FWPRA)	Outdoor recreation opportunities were considered in this Final-EIS. A Recreation Plan was prepared consistent with USACE regulations. Also, the effects of the proposed action on outdoor recreation have been discussed in this document. Therefore, the Final EIS is in compliance with the FWPRA.
Fish and Wildlife Coordination Act	The USFWS, DNER, and NMFS are a part of the ERP's Technical Committee, which has met several times since September 2010. Comments from these agencies have been incorporated in the preparation of this FEIS. A NEPA Scoping Letter was prepared and circulated on February 2013 and comments received during the scoping process were also addressed and included in Appendix H-7. Comments received during the public comment process were addressed and included in Appendix H-8. On December 10, 2015, the USACE sent a letter to the USFWS initiating consultation under ESA and responded to comments by the USFWS issued under the Fish and Wildlife Conservation Act. This letter stated that the project will develop and implement standard manatee protection measures, a spotter during construction to look for manatees, and a protocol to identify and remove the Puerto Rican Boa. On December 14, 2015, the USFWS sent a letter expressiing that the agency concurred with the determination that the proposed action may affect but is not likely to adversely affect federally listed species under its jurisdiction.
Farmland Protection Policy Act	This Act is intended to reduce the unnecessary and irreversible conversion of farmland to nonagricultural uses through Federal projects. No prime or unique farmland would be impacted by the implementation of the CMP-ERP. Therefore, this Act is not applicable.

Table 4.14, cont'd

Statute	Description
Magnuson-Stevens Fishery Conservation & Management Act	An Essential Fish Habitat (EFH) Assessment was conducted that determined the proposed action would not have a significant adverse impact on EFH or federally managed fishery species in the CMP and surrounding waters. Impacts would only be unavoidable and short term while construction takes place. Once completed, the proposed project would result in greater connectivity and accessibility of species to EFH throughout the SJBE system and near offshore reef habitat. On December 10, 2015, the USACE sent a letter to the NMFS initiating consultation under the ESA and Magnuson-Stevens Fishery Conservation and Management Act. On January 21, 2016, the NMFS replied offering two recommendations: 1) Modify the design of the project to bring residence time down to 1 day or less, and 2) Ensure that sanitary sewer lines are available for all structures within the project watershed and that they do not drain into the storm sewer lines. A main project constraint for the proposed project is that the plan should not damage the shoreline and sheet pile structures in the downstream Western CMP area. 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. Thus the project is constrained in the flow that can be exchanged through the CMP channel and the resulting residence time. Infrastructure improvements related to the construction of a sanitary and sewer system for dwellings and other structures draining into the Eastern CMP are outside of the Project Area and the responsibility of entities other than the USACE. However, several projects, including two consent decrees, are planned or being developed to address improper sanitary discharges taking place in those lands within the Project Area's watershed.
Marine Mammal Protection Act	Management measures have been proposed as part of the CMP-ERP. The USFWS concurred with the USACE in the determination that the proposed action may affect, but is not likely to adversely affect federally listed species, including the Antillean manatee.
Marine Protection, Research and Sanctuaries Act (MPRSA)	Ocean disposal is not the preferred disposal option for dredged material under this ERP. Therefore, this Act is not applicable.
Anadromous Fish Conservation Act	Benefits associated with the CMP-ERP include a healthier habitat for fish and wildlife. Therefore, the ERP should bring widespread benefits to anadromous fish that may be present in the SJBE. This project is in compliance with this Act.
Migratory Bird Treaty Act and Migratory Bird Conservation Act	The proposed ERP consists of restoring the ecosystem of the SJBE from its existing impaired condition. Benefits associated with the ERP include a healthier habitat for fish and wildlife. Therefore, the ERP is in compliance with this Act and should bring widespread benefits to migratory birds that use the SJBE.
National Environmental Policy Act	On November 16, 2012, a NOI to prepare an EIS was published in the Federal Register. On February 22, 2013, a scoping letter was sent out to all stakeholders for comments on the ERP. Comments of the scoping process are included on Appendix H-7. The public comment period was provided following 40 CFR 1503. The Draft EIS was available for public comment and two public meetings were conducted. Comment period was provided from October 16, 2015 through November 9, 2015. Comments were addressed and included in Appendix H-8 of this FEIS. Upon public and agency review and comment on this document and the subsequent Final EIS, and the signing of the ROD, this project would be in full compliance with this Act. The non-Federal sponsor, ENLACE, has promoted meaningful public participation as part of the ERP consultation process with the neighboring communities and the general public, since 2002.

Table 4.14, cont'd

Statute	Description
National Historic Preservation Act of 1966	The Martín Peña Bridge is in the NRHP. Section 106 Review Process and its implementing regulations were considered in the EIS. Standards found in 800.8, Coordination with the National Environmental Policy Act were met. Consulting parties were identified through the NEPA scoping process. A letter was sent to SHPO, the ICP, the Municipalities and other agencies and interested parties. Comments received from SHPO were addressed in this FEIS. (See Appendix H-7). Historic properties were identified and assessed. A "Cultural and Historic Resources Study" for the CMP-ERP was prepared by ENLACE in 2011. Findings are discussed in Sections 3.16 and 4.16 of this EIS. There is one historic property present, listed in the NRHP, the Martin Peña Bridge. However, the undertaking will have no effect upon it. The CMP-ERP does not meet the Criteria of Adverse effect as stated in 800.5 (a)(1). The CMP-ERP would not alter, directly or indirectly, any of the characteristics of this historic property that qualifies it for inclusion in the NRHP in a manner that would diminish its integrity in terms of location, design, setting, materials, workmanship, feeling, or association.
Resources Conservation and Recovery Act (as amended by the Hazardous and Solid Waste Amendments of 1984, the Comprehensive Environmental Response, the Compensation and Liability Act, the Superfund Amendments and Reauthorization Act of 1996, the Toxic Substances Control Act of 1976)	There are no hazardous, toxic, or radioactive waste substances in the Project Area. The ERP is in compliance with these Acts.
Rivers and Harbors Act of 1899 (RHA)	The proposed ERP would not cause permanent obstructions in navigable waters of the United States. On the contrary, the ERP consists of opening the CMP where it presently is unusable for navigation or even tidal connection. Proper coordination with the U.S. Coast Guard and other Federal, State, and local agencies would be ensure to comply with Section 10 of the RHA.
Submerged Lands Act	The ERP's purpose is to return formerly submerged lands to their original condition. Therefore, the proposed ERP aims to bring to compliance the Submerged Lands Act where these formerly submerged lands are presently filled.
Wild and Scenic River Act	No designated Wild and Scenic River would be affected by ERP related activities. Therefore, this Act is not applicable.

Table 4.14, cont'd

EXECUTIVE ORDERS AND MEMORANDUMS OF UNDERSTANDING OR AGREEMENT	
EO	**DESCRIPTION**
Executive Order 11514, Protection of the Environment	Executive Order (EO) 11514 requires Federal agencies to "initiate measures needed to direct their policies, plans and programs to meet national environmental goals." This Final EIS supports this initiative, and therefore is in compliance with the goals of this EO.
Executive Order 11593, Protection and enhancement of the cultural environment	Requires Federal agencies to initiate measures necessary to direct their policies, plans and programs in such a way that federally owned sites, structures, and objects of historical, architectural or archaeological significance are preserved, restored, and maintained for the inspiration and benefit of the people, and, in consultation with the Advisory Council on Historic Preservation (16 U.S.C. 470i), institute procedures to assure that Federal plans and programs contribute to the preservation and enhancement of non-federally owned sites, structures and objects of historical, architectural or archaeological significance. There is the potential to encounter cultural items during the dredging/construction that would be have to be addressed. A cultural resources monitor (a professional archeologist) would be present during construction to inspect sediments and the site for remains of any archeological material. If archeological material, or any other cultural resource, is found on site, construction works would be temporarily halted until these materials are properly removed, protected, and transported.

Table 4.14, cont'd

EXECUTIVE ORDERS AND MEMORANDUMS OF UNDERSTANDING OR AGREEMENT	
EO	**DESCRIPTION**
Executive Order 11988, Flood Plain Management	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. The CMP-ERP complies with this new policy by restoring the CMP's flow conveyance capacity, and thus, helping to preserve the SJBE's floodplain natural values, increasing community resilience against flooding. EO 11988 (Floodplain Management; May 24, 1977) requires a Federal agency, when taking an action, to avoid short- and long-term adverse effects associated with the occupancy and the modification of a floodplain. The agency must avoid direct and indirect support of floodplain development whenever floodplain siting is involved. In addition, the agency must minimize potential harm to or in the floodplain and explain why the action is proposed. Additional floodplain management guidelines for EO 11988 were provided in 1978 by the Water Resources Council and these have recently been revised (October 2015) as part of EO 13690, signed on January 30, 2015, which amends EO 11988. An eight-step process is used to ensure compliance with EO 11988; this process involves public review, consideration of practicable alternatives, identification of impacts and measures to minimize those impacts, and presentation of the findings. The NEPA compliance process involves essentially the same basic decision-making process to meet its objectives. Therefore, the eight-step decision-making process has been integrated into the analysis in this FR/EIS, as listed below. • Step 1: Determine whether the proposed action is in the base floodplain. *As described throughout this document, the proposed project is located within the base floodplain associated with the CMP and the San José Lagoon, as discussed in Chapter 1 (Background) and sections 3.4 – Hydrology, 3.4.1 – Runoff & Floods and 3.14 – Human Health & Safety of this FEIS.* • Step 2: Provide early public review of any plans or proposals for action in the base floodplain. *Multiple opportunities have been provided for public and agency review of the CMP-ERP, as described in Chapter 6 of this FEIS.* • Step 3: If the action is in the base floodplain, determine whether there is a practicable alternative to the action. *The NER plan seeks to restore water flow across the Eastern CMP with the goal of improving its wetlands and submerged habitats, as well as those in the San José Lagoon, and their connectivity with the rest of the SJBE, including its associated marine ecosystems. Thus, the project alternatives were developed following a nature-based approach, to the maximum extent practicable, in order to take advantage of the Project Area's and Study Area's natural systems and facilitate the regenerative capacity driven by ecosystem processes.* *As the NER plan is intended to restore these natural features found within the base floodplain, there is no practicable alternative to siting the proposed project features in any other area. Chapter 2 of this FEIS provides a detailed discussion of the project alternatives evaluated. The NER plan would have ancillary flood protection benefits through the relocation of structures found within the project footprint to make way for the proposed restoration project. Once completed, it would also provide ancillary benefits for those other structures that would remain adjacent to the Eastern CMP. As such, there is no practicable alternative to siting the project features out of the base floodplain since the NER plan seeks to restore many of its functions and values.* • Step 4: Identify beneficial and adverse impacts caused by the proposed action and any expected losses of natural and beneficial floodplain values. *The SJBE watershed is already highly developed, especially those lands adjacent to the Eastern CMP. Besides water access plazas proposed as part of the NER plan (see Section 2.3.3 - Recreational Features in this FEIS), it is not expected that the proposed project will induce any other direct or indirect land use development on the lands immediately adjacent to the open waters of the Eastern CMP. These would be mostly planted with mangroves as proposed by the NER plan. Beneficial and adverse impacts associated with the NER plan are identified in Chapter 4 – Environmental Consequences, of this FEIS.*

Table 4.14, cont'd

EXECUTIVE ORDERS AND MEMORANDUMS OF UNDERSTANDING OR AGREEMENT	
EO	**DESCRIPTION**
Executive Order 11988, Flood Plain Management (cont'd)	• Step 5: Determine viable methods to minimize any adverse impacts of the action and methods to restore and preserve the natural and beneficial values. *Potentially adverse impacts are expected to be temporary and limited to project construction, as discussed in Section 4.4 – Hydrology and Section 4.14 – Human Health and Safety of this FEIS. Potentially adverse impacts would be avoided, minimized or mitigated through implementation of appropriate management measures, as described in Chapter 2, and sections 4.4 and 4.14 of this FEIS, and in the Engineering Appendix.* • Step 6: Reevaluate the proposed action based on the information generated in Steps 4 and 5. *A plan formulation process was completed, as described throughout Chapter 2 - Alternatives.* • Step 7: Prepare a Statement of Findings and advise the general public if the proposed action will be located in the floodplain. *Multiple opportunities have been provided for public and agency review of the proposed project, as described in Chapter 6 – Public Involvement, as well as in Appendix H8-a of the Final FR/EIS. In addition, this Final FR/EIS is being published for public review.* • Step 8: Implement the action after completing the seven evaluation steps. *The project will be implemented after a number of further required steps are completed, such as Pre-construction Engineering Design (PED), and once all construction permits are obtained in compliance with Federal and local statutes.* USACE guidance requires the non-Federal sponsors to prepare a Floodplain Management Plan (FPMP) designed to reduce the impacts of future flooding in the Project Area. The primary focus of the FPMP is to address the potential measures, practices, and policies that will reduce impacts of future residual flooding, help preserve levels of protection provided by the USACE project, preserve and enhance natural floodplain values, and reduce the risk of future flood damages to structures and internal drainage issues within the post-project floodplain. To fulfill this requirement for the CMP-ERP, elements of the District Plan, the PRPB's Special Flood Hazard Areas Regulation (2010) and information from this Final FR/EIS would need to be used to create the FPMP.
Executive Order 13690, Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input	Adopts a new Federal Flood Risk Management Standard, as an ammendment to the process established under Executive Order 11988 for evaluating the impacts of Federal actions in or affecting floodplains. This Standard ensure that agencies expand management from the current base flood level to a higher vertical elevation and corresponding horizontal floodplain to address current and future flood risk and ensure that federally funded projects last as long as intended.
Executive Order 11990, Protection of Wetlands	A Wetlands Assessment has been prepared for this ERP. The creation of a wetland conservation fringe along the canal is part of the ecosystem habitat uplift and restoration goals. Wetlands in the CMP and the SJBE would be increased in area and functional value would be improved. Therefore, this project is in compliance with the goals of this EO.
Executive Order 12962, Recreational Fisheries	The ERP would temporarily impact recreational fisheries. However, it would enhance the CMP and associated resources productivity and, improve conditions for recreational fisheries. Therefore, the ERP complies with the goals of this EO.
Executive Order 12898, Environmental Justice	The ERP would improve the environment, health, housing, and infrastructure conditions within the CMP adjacent communities. While some temporary adverse effects would be felt by low income and minority communities during the construction phase, final actions would have a significant positive outcome, improving their living conditions and their quality of life. Also, there has been fair treatment and meaningful public participation of the communities through the non-Federal sponsors coordination process. Therefore, the CMP-ERP would not cause disproportionately high and adverse effects on any minority or low-income populations in accordance with the provisions of E.O. 12898.

Table 4.14, cont'd

EXECUTIVE ORDERS AND MEMORANDUMS OF UNDERSTANDING OR AGREEMENT	
EO	**DESCRIPTION**
Executive Order 13045, Protection of Children	The environmental risks and safety risks that may disproportionately affect children were identified and assessed in this Final EIS. This project addresses disproportionate risks to children that result from environmental health risks or living with safety risks in the CMP. The ERP would reduce exposure to health risks such as floodings with contaminated waters. Therefore this project is in compliance with this EO.
Executive Order 13089, Coral Reef Protection	The ERP would enhance the conditions of coral reefs in the Study Area. Therefore, the proposed ERP is in compliance with EO 13089.
Executive Order 13112, Invasive Species	This ERP would not exacerbate the status of invasive species in the Study Area. On the contrary, it would provide for restoration of native species and habitat conditions in ecosystems that have been disturbed. Proposed alternatives don't have the potential to disturb previously undisturbed areas. Therefore, this project is in compliance with this EO.
Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds	No effects to migratory birds are anticipated, in contrast, the ERP would improve habitats, and benefits to migratory birds are expected. This project is in compliance with this EO.
Memorandum of Agreement (MOA) between the Federal Aviation Administration, the U.S. Air Force, the U.S. Army, the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, and the U.S. Department of Agriculture to Address Aircraft-Wildlife Strikes	This MOA acknowledges each signatory agency's respective missions. Through this MOA, the agencies establish procedures necessary to coordinate their missions to more effectively address existing and future environmental conditions contributing to aircraft-wildlife strikes throughout the United States. These efforts are intended to minimize wildlife risks to aviation and human safety, while protecting the Nation's valuable environmental resources. This environmental document was distributed to the FAA and the Luis Muñoz Marín International Airport administration (Aerostar Airport Holdings LLC) as part of the public comment review period, and no comments were received. The non-Federal sponsors would consult and seek a sign-off letter from the FAA regarding the proposed project.

4.22.1 Compliance with Local Statutes

The Commonwealth of Puerto Rico's regulations have concurrent jurisdiction with Federal regulation, unless local's regulations become more restrictive or contemplate a specific matter that Federal regulations do not. The CMP-ERP is in compliance with the applicable regulations summarized in Table 4-15.

Table 4-15. Compliance with Local Statues

Statute	Description
Environmental Public Policy Act (Law 416-2004)	The environmental information on the ERP has been compiled in accordance with Federal and Commonwealth's environmental policies. This Final EIS compiles the information that will be disseminated for public participation required by the Federal and Commonwealth's NEPA versions.
Water Quality Standards Regulation of Puerto Rico (2014)	The CMP-ERP would comply with the EQB Water Quality Standards Regulation. A Water Quality Certificate will be obtained from the EQB, according to Section 401(d) of the CWA. The process leading to the 401 Water Quality Certification (WQC) for the CMP-ERP will be initiated and completed prior to project construction.
Puerto Rico Permit Process Reform Act, Law No. 161-2009 as amended and the Joint Permit Regulation for the Evaluation and Issuance of Permits Related to Development and Land Use, Reg. No. 31	To establish the legal and administrative framework that shall govern the application for and the evaluation, granting, and denial of permits by the Government of Puerto Rico; to create the Permit Management Office, define its functions, authorities, and obligations, and to provide for its organization; to create the legal construct of the Authorized Professional, define the composition, functions, authorities, and obligations thereof, and provide for his/her authorizations; to create the constructs of the Permit Manager and the Service Representative, and the construct of the Permit Officer, and provide for their authorities; to create the Office of the Chief Permit Inspector, define its functions, authorities, and obligations, and provide for its organization; to provide for the administrative and judicial review of decisions made pursuant to this Act; to establish penalties; and for other purposes. Any corresponding permit application under this Act is pending until NEPA compliance determination has been granted for this Final FR/EIS.
Atmospheric Pollution Control Regulation (1995)	Emissions during construction would be temporary and limited to the typical emissions of construction and dredging projects: mobile combustion sources, such as trucks and heavy equipment during the construction process; odors from the dredged sediments; and particulates from the structures demolition. There is concern about the emission of hydrogen sulfide as a result of the dredging. As precautionary methods, development and implementation of an H_2S monitoring program during dredging operations would be undertaken to quantify ambient conditions and to manage/mitigate H_2S release.
Noise Control Regulation (1987)	The proposed ERP is not expected to exceed the noise level allowed for residential areas.
Control of Erosion and Prevention of Sedimentation Regulation (1998)	Erosion and sedimentation prevention would be addressed with the best available control technology, which presently consists of turbidity screens, double turbidity screens and fast water turbidity barriers, as applicable. Land-based turbidity controls would be addressed with the Erosion Sedimentation Permit, required by the Commonwealth during the pre-construction phase.
Hazardous Solid Waste Control Regulation (1998)	Following the Federal regulations, the EQB requires a cradle-to-grave tracking format (manifest), and requires testing of the material suspected of being a HW. The Humacao Regional Landfill, for instance, proposed for the disposal of the trash and debris separated from the dredged sediments, would require a manifest demonstrating that the material they would accept is not hazardous. The necessary permits, which include the Solid Waste Generator Permit, would impose the necessary testing conditions for the ERP's solid waste. Preliminary testing along the CMP indicates that the "contaminated" sediments would not be classified as hazardous waste.

Table 4.15, cont'd

Statute	Description
Non-Hazardous Solid Waste Control Regulation (1997)	The proper storage, transportation and disposal of non-hazardous solid wastes are also regulated by the EQB. Solid wastes to be generated by the ERP's dredge works are considered to be of domestic waste origin, should the above-indicated testing demonstrate so. This waste can be deposited in approved landfills. Transporters of the ERP's solid wastes would have to be properly licensed.
Regulation for the Transmittal of General Permits (2007)	Applies to a range of activities regulated by the PREQB, that includes: some erosion and sedimentation control permits; emmissions permits, such as land cover removal among other; permits for activities generating non-hazardous solid wastes; permits for activities that involve mitigation of lead-based paint; and centers for the collection of used oil. Any corresponding permit application under this regulation is pending until NEPA compliance determination has been granted for this FEIS.
Solid Waste Reduction and Recycling Act of Puerto Rico (Law 70-1992)	Established that it would be the public policy of the Government of Puerto Rico to develop and implement economically viable and environmentally safe strategies that would reduce the volume of the solid waste requiring final disposal. Any corresponding permit application under this Act is pending until NEPA compliance determination has been granted for this FEIS.
Caño Martin Peña Special District Act (Law 489-2004) PR Law 104 of 2013, amended Law 489-2004	Gives ENLACE the authority to make the necessary efforts to assure the comprehensive development of the CMP Special District. Through this authority, ENLACE has integrated governmental and community sectors, and elaborated a District Plan in order to guide the processes related to the CMP ecosystem restoration efforts and associated matters. The District Plan was used as a baseline for the ongoing studies to ensure consistency and compatibility with Federal, Commonwealth and local's objectives. ENLACE and DENR are the non-Federal sponsors for the CMP-ERP in order to meet the objective of this law. Law 104 of 2013 ammended the Caño Martín Peña Planning Distric Act of 2004. Section 10 of Law 104 states that the EQB will certify compliance of the CMP District Plan. Once the District Plan's compliance has been certified, said compliance determination shall be extended to any action included in the District's Plan as of its date of approval by the Governor. Thus, the CMP-ERP is in compliance with the Commonwealth environmental review process.
Puerto Rico Wildlife Act (Law 241-1999)	Protects fisheries and wildlife species in the Commonwealth. Its Regulation 6766 includes a number of species not contemplated in the Federal ESA. All of these were considered in this EIS. None of these species would be impacted during the ERP construction or operation, although some individuals of these species may be displaced during the construction period. It should be noted that the DNER, who is the main agency with jurisdiction under this Act, is a local co-sponsor for the CMP-ERP.
To Declare the Public Policy on Wetlands in Puerto Rico (Law 314-1998)	Established the protection of wetlands as a public policy. The proposed ERP would conduct restoration measures upon the SJBE, and restore wetlands from an artificial upland condition. Therefore, the ERP is in accordance with the tenets of this law, which has concurrent jurisdiction with EO 11990, Protection of Wetlands.
Special Flood Hazard Areas Regulation (2010)	The Puerto Rico's Planning Board Special Flood Hazard Areas Regulation (2010) establishes the safety measures for the control of buildings and land developments in areas declared susceptible to floods (e.g., Special Flood Hazard Areas identified in Flood Insurance Rate Map (FIRMs) prepared and approved by FEMA, and the property located thereon; every natural or artificial, public or private person or group thereof; and land that, because of its topographic nature, its location with regard to a body of water, or its flood history, could be flood-prone). The provisions of this regulation have the following purposes: (a) to restrict or prohibit developments that could be hazardous to health, safety, and property, whenever they are prone to increase the flood elevations or water velocity that could increase erosion; (b) to require that all flood-prone developments, including their service facilities, be protected against floods from the moment they are built; (c) to avoid alterations on natural floodplains, water courses, and natural protective barriers that accommodates or channel flood waters or surges; (d). to control the filling, leveling, dredging, obstacles, and other types of development that could increase damages due to floods or surges; (e) to prevent or regulate the erection of barriers that could

Table 4.15, cont'd

Statute	Description
	affect water flow or that could increase the risk of floods in other areas; (f) to discourage new developments, obstacles or substantial improvements, unless it has been shown that alternate locations, have been explored and proved not viable. Land use adjacent to but outside the Project Area, along the Eastern CMP, is determined by the Caño Martín Peña Special District's Land Use and Comprehensive Development Plan (District Plan), which already includes the NER Plan as one of its principal components. Any further improvements to existing structures on areas close to the Eastern CMP and within the base floodplain, but outside the Project Area's footprint, would have to comply with the District Plan and the Puerto Rico's Planning Board Special Flood Hazard Areas Regulation (2010).
DNER Administrative Order 2004-04	This order exempts all actions or projects proposed or performed by the DNER, or those entities authorized to work on its behalf, from requesting those applicable permits under the agency's jurisdiction. These include permits for cutting or removing trees and extracting or dreging materials from the earth's crust. The DNER is a non-Federal sponsor with ENLACE for the CMP-ERP, and they will facilitate corresponding processes and permits and consecuently facilitate the Project's construction. This would advance the latest mission or duties with respect to the conservation and restoration of Puerto Rico's natural resources. It should be noted that the DNER is a local co-sponsor for the CMP-ERP.

5.0 LIST OF PREPARERS

The following tables list the people involved in the preparation (Table 5-1) and review (Table 5-2) of this Final EIS.

Table 5-1. List of Preparers

ENLACE

NAME	POSITION
Lyvia N. Rodríguez del Valle	Executive Director
Estrella Santiago Pérez	Environmental Affairs Manager

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NAME	POSITION
Wanda I. Crespo Acevedo, PPL	Environmental Scientist, Planner, Project Coordinator at ETI Co-author
Luis Jorge Rivera Herrera, PPL	Environmental Scientist and Planner Consultant, Lead author of the DEIS
Raúl Santiago Bartolomei, PE, MP	Engineer and Planner (former employee)
Héctor Rivera	Economist, Economic Impact
Roberto E. Moyano Flores	GIS
Jorge L. Coll Rivera (Coll Environmental)	Adaptive Management and Monitoring Plan

ATKINS

NAME	POSITION
Webb Smith	Project Manager
Jaime Pabón, J.D., M.S. (former employee)	Project Manager
Francisco Pérez Aguiló, M.S., REM	Lead Author Field Studies Design and Analysis
Steven E. Pophal, R.L.A., C.L.A.	Design Manager, MP
David Tomasko, Ph.D. (former employee)	Hydrodynamic Studies Water Quality Sediment Quality HTRW, Air Quality, Technical Assessment
Adelís Cabán	Deputy Project Manager and Co-author
Anthony Risko, PE (former employee)	Dredged Material Disposal Plan, Alternatives Analysis
Beth Zimmer	Essential Fishery Habitat
David Conrad	P.E. Structures
Donald Ator	Plan Formulation, Economic Studies
Emily Keenan, M.S., (former employee)	CEP Water Quality Fisheries, Technical Support
Donald Deis	CEP Environmental Studies Environmental Benefit Alternatives Analysis

Table 5-1, cont'd

NAME	POSITION
Gabriel Hernández Castro	Field Biologist Photographer
Harley Winer, Ph.D., PE (former employee)	Hydrodynamic Evaluation Hydrologic-Hydraulic Reviewer Design
José Castro-Pavía, PE,	RLA Recreation & Aesthetic Studies
Juan Carlos Moya, Ph.D. (former employee)	Dredged Material Disposal Plan, Alternatives Analysis
Juan Meléndez	PLS Surveyor/imaging
Karla Córdova, RPA	Cultural Resource Study
Ken Jones, PE	Design
Marcia Rivera	Technical coordinator
Nancy Smith (former employee)	Water Quality, Air Quality Studies
Raúl Di Cristina	Environmental specialist
Roberto Mantecón	PSM Surveyor
Julie Morelli	HTRW
Nathan Collier	HTRW
Joseph Banta	CADD and GIS
Desi Maldonado	CADD
David Carter	Cost schedule risk analysis
Monica Rosario	Cost schedule risk analysis
Don Ator (former employee)	Recreation
Bill Stevenson (former employee)	Cost Engineering
Jonathan Porthouse (former employee)	Plan Formulation

Table 5-2. List of Reviewers

ENLACE's Review Team	
Katia R. Avilés Vázquez, MS	Environmental Affairs Manager (Former employee)
Ana Elisa Pérez	Environmental Affairs Coordinator (Former Employee)
Mariano Solorzano Thillet	GIS Analyst
USACE's Review Team	
Jim Suggs	Project Manager
Iván Acosta	Chief Special Projects Section
Javier Cortes	Environmental Engineer
Ken Dugger	Jacksonville District Planning Division-Environmental
Brooks Moore	Office of Legal Counsel
Alfred Walker	Planning Technical Lead

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6.0 PUBLIC INVOLVEMENT

6.1 NON-FEDERAL SPONSOR PREVIOUS COORDINATION

ENLACE's non-Federal coordination process for the CMP-ERP began in 2001, with USACE's 2001 Design Report as a baseline reference. For the past 10 years, ENLACE has carried out multiple stakeholder meetings to address the CMP-ERP. Between 2002 and 2004, ENLACE hosted over 700 community meetings, including round table discussions, public assemblies, workshops, presentations, and educational activities at local schools, in order to select the community alternative for the CMP-ERP, which was incorporated as part of the Comprehensive Development Plan. Topics discussed through these meetings included: the degraded conditions of the CMP and its adjacent waterbodies; alternatives for the relocation of families living within the Project Area; the construction of appropriate infrastructure; its impacts to public health, urban and socioeconomic conditions, including the potential for gentrification; wildlife, and ecosystems, as well potential solutions to these conditions and impacts.

For the discussion of the CMP dredging alternatives, ENLACE developed informational material that was distributed throughout the CMP District and the Península de Cantera neighborhood, and held several community assemblies. Kick-off community assemblies for the preparation of the Draft EIS were held during October 2010 at each community, to inform residents on the status of the ERP and for gathering and documenting their concerns and suggestions. Each of the eight communities selected two representatives to be part of ENLACE's Community Committee (ECC) to review and comment the draft technical documents produced. Other affected stakeholders, such as the sports fisheries and local fishermen, were invited to be part of the ECC. The ECC met monthly or bi-monthly, depending on the amount of technical documents produced and the need for community feedback.

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. During the Community Assemblies, residents voted for their preferred alternative. Through their votes, residents clearly expressed their preference for the 100-foot channel width scenario, with either a rectangular or a hybrid section. Residents considered the 100-foot channel width alternative 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.

A third round of Community Assemblies took place on May 2012 to discuss the Draft EIS and any other relevant issues regarding the implementation of the ERP, such as the expected impacts to the communities during construction of the CMP-ERP and the alternatives for the disposal of the dredged material. ENLACE held informational meetings regarding the Draft EIS with other interested parties, such as the sports fishing business owners, local subsistence fishermen, environmental advocacy organizations, the Autonomous Municipality of Carolina, and the SJBEP Technical Committee (STAC). Also, a web page was created (www.dragadomartinpena.org) to continuously inform the public, provide contact information, and feedback on the CMP-ERP. Additional public input shall also be integrated as part of the public review and comment process regarding this Final EIS. ENLACE and the DNER, as non-Federal sponsors, will continue to incorporate public participation during the NEPA process.

ENLACE, as a non-Federal sponsor, summoned a Technical Committee (TC) in 2009 to help draft the original FR and support the preparation of this Final EIS with their expertise. This Committee is integrated by Federal and Commonwealth's agencies, as well as other stakeholder organizations such as the SJBEP and the Península of Cantera Corporation, among others. The TC's kick-off meeting was held on September 30, 2010, initiating the Draft EIS preparation process. Several meetings have been conducted as part of the coordination process regarding the CMP-ERP.

More recently, on April 1, 2014, the STAC held a meeting for a presentation on the CMP Restoration Project Ecological Uplift Assessment (hereinafter, EUA). All STAC members attending the meeting agreed with the approach followed by the EUA. A technical report, with a detail explanation on the EUA, was later sent to all STAC members for review and endorsement. After reviewing the technical report, the STAC endorsed the approach followed in the EUA, after determining that it was based on acceptable techniques and peer-reviewed processes.

6.2 SCOPING PROCESS

A National Environmental Policy Act (NEPA) scoping letter was sent out on February 22, 2013, to the Federal and Commonwealth's agencies, organizations, and private individuals. A copy of the scoping letter is included within Appendix H7.c.

Previously, a Notice of Intent (NOI) to prepare this Final EIS was published on November 16, 2012, in the Federal Register. Two Federal agencies submitted comments to the NOI during December 2012: the National Parks Service and the Fish and Wildlife Service. A copy of the NOI and the comments received are included within Appendix H-7.

6.2.1 Agency coordination

The various agencies, affected stakeholders, and interested members of the community were allowed opportunities to provide input during NEPA scoping (Appendix H7.d). Opportunities to provide input during the NEPA process will be provided for Federal and Commonwealth's agencies, communities and all interested parties.

6.2.2 Comments received during scoping process and responses

During circulations of scoping letter, the following agencies provided comments:

- Commonwealth Government:
  - Puerto Rico Electric Power Authority (PREPA)
  - State Historic Preservation Office (SHPO)
  - Autonomous Municipality of Carolina
- Federal Government:
  - NOAA's National Marine Fisheries Services
- Community organizations:
  - Asociación Pro-Bienestar Parada 27, Inc.
  - Residentes Unidos de Barrio Obrero Marina, Inc.
  - Junta de Acción Comunitaria Israel & Bitumul, Inc.

Comments received during USACE's scoping, consultation and circulation processes address the following concerns:

- Commonwealth agencies:
  - The need to ensure proper coordination with infrastructure-related agencies if relocations and excavations would take place, and
  - The location of the dredged material disposal site and how it could exacerbate existing vulnerabilities to adjacent communities (if Suarez Canal was selected).
  - The potential to find archeologic material in the Project Area.
- Public:
  - The need to relocate flood-prone households before dredging and to ensure community participation, particularly related to the selection of the dredged material disposal site;
  - Address temporary impacts during construction, such as excessive noise and health impacts, especially respiratory illnesses or conditions; the need to provide controls to reduce pest invasion to adjacent households and the implementation of precautionary measures to avoid exposing children to machinery or dangerous areas.
- Federal agencies:
  - The need of a detailed analysis of alternatives related to the dredging method, including access to the channel and any disposal sites for dredging material in the EIS; and the need of a thorough analysis of the environmental benefits of alternatives.
  - There are concerns regarding some of the dredging material disposal alternatives, in terms of the potential transport of contaminated sediments and potential fish kills from dispersal of anoxic waters if dredged materials are to be disposed in the dredge pits located in the San José Lagoon.
  - Include EFH information on the EIS as well as in project design.

A matrix detailing comments received during USACE's scoping, consultation and circulation processes and USACE's responses is included in Appendix H7.c.

6.3 PUBLIC COMMENTS ON THE DEIS

On Friday, September 11, 2015, The Notice of Availability (NOA) inviting public participation to comment on the CMP-ERP was published in the Federal Register, Volume 80, Number 176, page 54785, according to NEPA. In addition, on Thursday, September 10, 2015, a local NOA was published on a local newspaper, announcing the availability of the DEIS and the dates of the Public Meetings.

On Friday, October 16, 2015, the 45-day comment period for accepting written comments was extended from October 26, 2015, to November 9, 2015. The amended NOA indicating this extension was published in the Federal Register Volume 80, Number 200, page 62526 on Friday, October 16, 2015. Appendix H8-a contains a copy of the Notice of Availability and the Amended Notice.

A copy of the DEIS and a letter inviting to the public meeting was sent to Federal and Commonwealth agencies, Municipalities, NGO, community groups and other interested parties. Hard copies of the FR, the DEIS (English and Spanish) and the Engineering Report were available for revision in ENLACE's Office, G8, Inc. Office, Compañía para el Desarrollo Integral de la Península de Cantera Office, and in the Library of the University of Puerto Rico Planning School. The DEIS was also available online. Details on the process of inviting and respond to comments are discussed in Appendix H-8, Public Participation Report.

Two public meetings were conducted by ENLACE on Wednesday, October 14, 2015, at 9:00 a.m. in the Puerto Rico College of Architects and Landscape Architects and at 6:00 p.m. in the Multiple Uses Center of Buena Vista Santurce. A total of 88 people attended both meetings, in addition to ENLACE's staff and consultants. The attendance lists are included in Appendix H8-b. Both meetings were recorded and transcribed. Written transcripts of each meeting are included in Appendix H8-c. A total of 13 attendees provided oral comments at both public meetings. A total of 23 written comments were received during the comment period. Seven of these were copies of the oral comments provided at public meetings. All written communications are included in Appendix H8-d. Comments and their respective responses are summarized in English and Spanish in Tables 1 and 2 of Appendix H-8.

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