

New Jersey Department of Community Affairs

SUPERSTORM SANDY COMMUNITY DEVELOPMENT BLOCK GRANT - DISASTER RECOVERY

Public Law 113-2; January 29, 2013

FR-5696-N-01; March 5, 2013

FR-5696-N-06; November 18, 2013

FR-5696-N-11; October 16, 2014



ACTION PLAN AMENDMENT NUMBER 20 - SUBSTANTIAL AMENDMENT FOR THE FINAL DESIGN OF REBUILD BY DESIGN HUDSON RIVER PROJECT

- **Final Design of Rebuild by Design Hudson River Project for Release of Project Construction Funds**

PUBLIC COMMENT PERIOD: April 1, 2017 to April 30, 2017

DATE SUBMITTED TO HUD: June 1, 2017

DATE APPROVED BY HUD: August 30, 2017

Chris Christie
Governor

Kim Guadagno
Lt. Governor

Charles A. Richman
Commissioner



101 South Broad Street, P.O. Box 800
Trenton, NJ 08625-0800



This Substantial Amendment to the Action Plan (as proposed) will be available for public review at www.state.nj.us/dca/. It will be made available in English and Spanish.

For those who otherwise cannot obtain a copy of this Substantial Amendment to the Action Plan, the Department of Community Affairs will make copies available upon request. Requests for copies should be directed to the following address:

New Jersey Department of Community Affairs
1st Floor Information Desk
101 South Broad Street
Trenton, New Jersey 08625

The State will consider comments received in writing or via email on the proposed Substantial Amendment to the Action Plan. Comments on the proposed Plan will be accepted through **April 30, 2017** Eastern Standard Time. Written comments can be submitted to the Department of Community Affairs via email at sandy.publiccomment@dca.state.nj.us, or to the attention of Lisa Ryan, NJ Department of Community Affairs, 101 South Broad Street, Post Office Box 800, Trenton, New Jersey 08625-0800. A summary of all comments received and written responses will be included in the final version of this Substantial Amendment submitted to HUD for approval.

HUD requires the State to hold a public hearing on the proposed Action Plan Amendment. The date, location and time of the hearing is:

- April 24, 2017; Wallace Elementary School, Cafeteria, 1100 Willow Ave, Hoboken, NJ 07030; 5-8 pm.

Once the comment period closes, the State will synthesize and respond to the comments it received in the final version of this Action Plan Amendment to be submitted to HUD for approval.

TABLE OF CONTENTS

SECTION 1: BACKGROUND.....	1-2
SECTION 2: RBD HUDSON PROJECT: “RESIST, DELAY, STORE, DISCHARGE”.....	1-1
2.1 PURPOSE AND NEED.....	2-1
2.2 RBD HUDSON PROJECT DESCRIPTION.....	2-4
2.3 MANAGING STATE AGENCY AND PARTNER ENTITIES	2-14
SECTION 3: RBD HUDSON PERFORMANCE SCHEDULE.....	1-1
3.1 PLANNING AND FEASIBILITY.....	3-1
3.2 DESIGN AND PREDEVELOPMENT.....	3-2
3.3 SITE DEVELOPMENT AND CONSTRUCTION.....	3-2
3.4 POST CONSTRUCTION.....	3-3
SECTION 4: OUTREACH AND PUBLIC COMMENT FOR RBD HUDSON RIVER PROJECT.....	1-2
4.1 CITIZEN OUTREACH PLAN (COP).....	4-1
4.2 OUTREACH ACCOMPLISHMENT TO DATE.....	4-3
4.3 PUBLIC COMMENTS.....	4-6
SECTION 5: RBD HUDSON BENEFIT COST ANALYSIS.....	1-1
5.1 BCA PROCESS DESCRIPTION	5-4
5.2 DESCRIPTION OF PROPOSED, FUNDED PROJECT.....	5-4
5.3 FULL PROJECT COST.....	5-5
5.4 DESCRIPTION OF EXISTING PROBLEM.....	5-6
5.5 RISKS IF RBD HUDSON IS NOT IMPLEMENTED.....	5-7
5.6 LIST OF BENEFITS AND COSTS OF THE RBD HUDSON PROJECT	5-7
5.7 DESCRIPTION OF RISKS TO ONGOING BENEFITS FROM PROPOSED PROJECT.....	5-29
5.8 ASSESSMENT OF PROJECT CHALLENGES.....	5-33
Appendix A: RBD Hudson Operations and Maintenance Certification.....	A-1
Appendix B: RBD Hudson River Operations and Maintenance Plan Framework Development.....	B-1
Appendix C: RBD Hudson River Project Benefit Cost Analysis.....	C-1

SECTION 1: BACKGROUND

Procedural History

The Superstorm Sandy Rebuilding Task Force created the Rebuild by Design (RBD) competition in the summer of 2013 to develop ideas to improve physical, ecological and economic resilience in regions affected by Superstorm Sandy. The competition had two goals: to promote innovation by developing flexible solutions that would increase regional resilience and to implement proposals with both public and private funding dedicated to the RBD effort. To realize the RBD initiative, HUD set aside Community Development Block Grant – Disaster Recovery (CDBG-DR) funds allocated through the federal Sandy Supplemental legislation to develop and incentivize implementation of RBD projects.

HUD engaged multi-disciplinary teams made up of architects, designers, planners and engineers and charged them with proposing regional and community-based projects that would promote resilience in various Sandy-affected areas. The teams included experts from around the world. The teams' proposals, developed with and by the communities where projects were focused, were submitted to HUD, and HUD ultimately selected six "winning" projects. Two of those projects were in New Jersey: one focused in the Hudson River region (RBD Hudson) and the other in the Meadowlands region (RBD Meadowlands).

On October 16, 2014, HUD issued Federal Register Notice FR-5696-N-11 (effective October 21, 2014) which allocated \$881,909,000 of third round CDBG-DR funds to New Jersey. Of that total, \$380 million is for the two RBD projects: RBD Hudson (allocated \$230 million by HUD) and RBD Meadowlands (allocated \$150 million by HUD). Comprehensive information about the RBD process and the winning projects also is available on the RBD website (www.rebuildbydesign.org).

Pursuant to FR-5696-N-11, the State prepared Substantial Amendment 12 to its CDBG-DR Action Plan, which was required to generally set forth:

- RBD Project Descriptions;
- Implementation Partnerships;
- Identification of Leveraged or Reasonably Anticipated Funds for RBD Projects;
- Project Timelines; and
- Citizen Participation Plans.

At the time of the submission of Substantial Amendment 12 in February 2015, providing specific project descriptions beyond the RBD proposals, identifying other funding sources, and estimating project timelines and the roles of partners in the project was premature. Thus, FR-5696-N-11 required that each of the above elements be updated with a more detailed description for each RBD project in a subsequent RBD Substantial Action Plan Amendment in order to release funds for construction. Along with the subsequent Substantial Action Plan Amendment, FR-5696-N-11 requires the State to certify that it will adequately fund the long-term

operation and maintenance of the RBD project from reasonably anticipated revenue, recognizing that operation and maintenance costs must be provided from sources other than CDBG and CDBG-DR funds.

FR-5696-N-11 and its clarifying guidance also required that the subsequent Substantial Action Plan Amendment include an examination of the RBD project through a HUD-approved benefit-cost analysis (BCA).

HUD approved Substantial Amendment 12 on April 20, 2015.

Substantial Amendment 20 to the Action Plan

Pursuant to FR-5696-N-11, the State is required to submit a Substantial Action Plan Amendment that reflects the updated RBD project overview as a condition for release of funds for project construction.

The RBD Hudson project recently finalized a proposed design, and, in accordance with FR-5696-N-11, this Substantial Amendment submits the following updates to Substantial Action Plan Amendment 12 with regard to RBD Hudson:

- Specific Project Description;
- Updated Implementation Partnerships;
- Identification of Leveraged or Reasonably Anticipated Funds;
- Updated Project Timeline;
- Specific Citizen Participation Plan;
- Benefit Cost Analysis Description and Narrative; and
- Certification Regarding Operation and Maintenance Costs (*see* Appendix A).

The RBD Meadowlands project is also required to submit a Substantial Amendment. The RBD Meadowlands project will submit a separate Substantial Action Plan Amendment identifying potential Build Alternatives and other updated project information.

Finally, to the extent required in order to ensure that RBD funding is used in compliance with applicable federal and State laws and regulations, the State incorporates here all applicable provisions of its CDBG-DR Action Plan, including provisions of Section 6 of the Action Plan applicable to RBD initiatives, as modified by Amendments 1 – 19.

SECTION 2: RBD HUDSON PROJECT: “RESIST, DELAY, STORE, DISCHARGE”

2.1 Purpose and Need

The purpose and need statement for the RBD Hudson River Project: “Resist, Delay, Store, Discharge” (referred to herein as “the Project”) was developed through a comprehensive process that began with the development of the original proposal submitted to HUD for funding, continued through the scoping process and concept and alternative development for the Draft Environmental Impact Statement (DEIS).

Purpose

The Study Area, comprising the entire City of Hoboken, and adjacent areas of Weehawken and Jersey City, is vulnerable to flooding from both coastal storm surge and inland rainfall events. The purpose of the Project is to reduce the flood risk to flood prone areas within the Study Area, which comprises the entire City of Hoboken, and adjacent areas of Weehawken and Jersey City. The Project intends to minimize the impacts from surge and rainfall flood events on the community, including adverse impacts to public health, while providing benefits that will enhance the urban condition, recognizing the unique challenges that exist within a highly developed urban area.

Need

Flooding has the potential to impact much of the Study Area's critical infrastructure located in these low-lying areas, including fire stations, hospitals, community centers, transit centers (rail, light rail and ferry), and a waste water treatment plant.

The Study Area is a very dense urban area of Hudson County that is situated along the Hudson River directly west of Manhattan, New York. The Study Area is vulnerable to two interconnected types of flooding: coastal flooding from storm surge and high tide, as well as systemic inland (rainfall) flooding from medium (generally a 5-year, 24-hour) to high (generally over 10-year, 24 hour) rainfall events.

- Coastal flooding happens with much less frequency, but can devastate widespread areas of the Study Area and cause significant economic damage and safety concerns.
- Rainfall-induced flooding occurs with significantly greater frequency than coastal flooding, and is caused in large part by the characteristics of the Study Area's topography and land use patterns as well as the physical constraints of the existing sewer infrastructure.

The flooding problems for both coastal flooding and rainfall-induced flooding can be attributed to several factors, including naturally low topography and proximity to waterways; impervious ground coverage and surface runoff; existing sewer

infrastructure, sewershed interconnections, and insufficient discharge capability, particularly during high tide.

The topography of the Study Area is highest along the east-central portion abutting the coastline of the Hudson River at Castle Point. From here, the land slopes gently downward to the north (toward Weehawken Cove), south (toward the Hoboken Terminal and Jersey City) and to the west (toward the foot of the Palisades). This topography reflects the Study Area's history; when originally settled, Castle Point was an island surrounded to the north, south and west by wetlands. These wetlands were gradually filled as the area grew. Today, these areas – in particular those to the southwest – are still extremely low-lying, in some places no more than 3 feet above sea level.

The City of Hoboken's exposure to flood hazard risks is evident by the number of properties included in the FEMA National Flood Insurance Program (NFIP). The NFIP is intended to reduce the impact of flooding on private and public structures by providing affordable insurance to property owners and encouraging adoption of floodplain management regulations. Mortgage lenders for properties within the Special Flood Hazard Area (SFHA) (areas with a 1 percent annual chance of flooding, also referred to as the base floodplain or the 100-year floodplain) require owners to obtain flood insurance from the NFIP. In addition, property owners receiving awards following presidentially-declared disasters (such as Superstorm Sandy) are often required to obtain NFIP insurance. According to NFIP statistics, as of June 30, 2015, the City of Hoboken had 9,269 NFIP policies in place (the highest in Hudson County), with premiums totaling \$6,734,044 (the highest in Hudson County and fifth highest in New Jersey). In addition, the overall liability to the NFIP from property owners in Hoboken was over \$2 billion (third highest in New Jersey), with an average claim amount of \$26,243.

The interrelationship between coastal flooding and rainfall events contributes to the recurring flooding conditions throughout the Study Area. Each flooding component represents challenges and will need to be addressed comprehensively to reduce the flood risk within the Study Area.

Key Goals and Objectives

A resilient community is able to resist and rapidly recover from disasters or other shocks with minimal outside assistance. The Project is a comprehensive urban water strategy whose overall purpose is to reduce flood hazard risks and which seeks to leverage resiliency investment to enhance the urban condition. The ability to meet this purpose will be measured in terms of Goals and Objectives. Goals are overarching principles that guide decision-making. Goals are measured in terms of Objectives, which are measurable steps to meet the Goal. The Goals and Objectives for the Project are:

- Goal: Contribute to Community Resiliency
- Objective: The Project will seek to integrate flood hazard risk reduction strategies with emergency management and response, civic, and cultural assets (such as Hoboken's fire stations, hospitals, community centers, and transit centers). The Project will reduce flood risks within the Study Area, leading to improved resiliency and the protection of accessibility and on-going operations of services

(including protecting physical infrastructure such as hospitals, fire stations and police department buildings as well as roadways and transit resources). This would allow these key assets to support emergency preparedness and community resiliency during and after flood events.

- Goal: Reduce Risks to Public Health
- Objective: In addition to providing protection to critical healthcare infrastructure (such as local hospitals and emergency preparedness services), the Project will aim to reduce the adverse health impacts that result from combined sewage backups onto streets, and within businesses and residences, through a reduction in storm water infiltration into the existing combined sewer collection system.
- Goal: Contribute to On-going Community Efforts to Reduce FEMA Flood Insurance Rates
- Objective: The City of Hoboken's exposure to flood risks has resulted in some of the highest insurance premiums in the state. The City has long had a goal of reducing those rates through a number of comprehensive flood risk reduction programs, such as those identified in the City's Green Infrastructure Plan. The NFIP's Community Rating System (CRS) allows municipalities to reduce their flood insurance rates through implementation of comprehensive floodplain management. The Project will propose concepts and alternatives that are consistent with Hoboken's overall effort of reducing FEMA Flood Insurance Rates.
- Goal: Delivery of Co-Benefits
- Objective: Where possible, the Project will seek to integrate the flood hazard risk reduction strategy with civic, cultural and recreational values. The Project will look to incorporate active and passive recreational uses, multi-use facilities, and other design elements that integrate the Project into the fabric of the community. In this way, the Project will complement local strategies for future growth.
- Goal: Connectivity to the Waterfront
- Objective: The Study Area's waterfront is currently the location of a vast length of interconnected parks and public walkways which contribute to the vibrancy of the community. The Project will aim to incorporate features that do not restrict access to the waterfront. Where feasible, the Project will build upon, and enhance, existing waterfront access points while providing flood risk reduction.
- Goal: Activation of Public Space
- Objective: The Project will develop concepts that reduce risks to private and public property from flood impacts while also incorporating design elements that activate public and recreational spaces, thereby enhancing quality of life for the community.
- Goal: Consider Impacts from Climate Change

- Objective: The Project will take into account the projected impacts from climate change, particularly as it relates to sea-level rise and its impacts on the frequency and degree of flooding.

2.2 RBD Hudson Project Description

The Rebuild By Design Hudson River Project, known as the “Resist, Delay, Store, Discharge” or “the Project”, is a comprehensive urban stormwater management strategy intended to address impacts from coastal storm surge flooding as well as systemic inland rainfall flooding seen in low-lying areas of Hoboken and parts of Weehawken and Jersey City during Superstorm Sandy. This comprehensive urban water strategy is designed to deploy programmed hard infrastructure and soft landscape for coastal defense (Resist); generate policy recommendations, guidelines and urban infrastructure to slow rainwater runoff (Delay); develop a circuit of interconnected green infrastructure to store and direct excess rainwater (Store); and deploy water pumps and alternative routes to support drainage (Discharge).

This phase of the Project includes the design and environmental impact analysis of the overall comprehensive master plan of the entire project (including the Resist and Delay, Store, Discharge components), funding for the construction of the Resist components (the catalytic coastal defense projects) and a pilot study of a DSD component if funding is available. A DEIS was prepared to evaluate environmental impacts, including indirect and cumulative environmental impacts, associated with three Build Alternatives (Alternatives 1, 2 and 3) as well as a No Action Alternative.

On September 8, 2016, during a public meeting at Stevens Institute of Technology in Hoboken, New Jersey, the State of New Jersey recommended the selection of Alternative 3 at that time as the Preferred Alternative for the RBD Hudson project. A Preferred Alternative is the alternative of a project that best meets the purpose and need of that project while avoiding, minimizing or mitigating impacts to the natural and human environment. The recommendation of the Preferred Alternative as presented in the DEIS resulted from a thorough evaluation process of the three Build Alternatives (i.e., Alternatives 1, 2 and 3) and a No Action Alternative that engaged local officials and residents. . The Preferred Alternative was revised from the earlier “Concept A” and reflected public input to relocate portions of the Resist alignment to areas that would minimize impacts on the community. The Preferred Alternative is described in this document and in the DEIS. Descriptions of Alternative 1 and Alternative 2 are available on the RBD Hudson website: <http://www.nj.gov/dep/floodresilience/rbd-hudsonriver.htm>.

The flood-resistance structure selected for construction as part of the Preferred Alternative (hereafter referred to as the Project) will provide flood risk reduction for the City of Hoboken, parts of Jersey City and Weehawken and for critical infrastructure located in those communities, such as three fire stations, one hospital and the North Hudson Sewerage Authority (NHSA) wastewater treatment plant. This alternative provides coastal flood risk reduction to approximately 85 percent of the population residing within the Study Area 100-year floodplain.

Key characteristics of the Project include the following:

- Provides a high degree of flood risk reduction while integrating the flood risk reduction strategy with community values by considering public input, cost and urban amenities;
- Incorporates a Resist structure that can be constructed with available funds;
- Has the least impact to the built environment of the three Build Alternatives;
- Results in the lowest annual maintenance cost of the three Build Alternatives;
- Requires the fewest number of movable gates, which results in the lowest operation and maintenance costs and the highest level of reliability among the Build Alternatives; and,
- Is most effective in minimizing impact to waterfront access and views of the three Build Alternatives.

The following is a detailed description of the Project:

Resist Alignment

The Project's Resist alignment travels primarily within inland areas minimizing impacts to waterfront open spaces and provides enhancements to approximately 2.55 acres of open space or parks. The Resist structure will be designed to blend in seamlessly with the urban streetscape and enhance the quality of life in the area. The system will also utilize natural higher ground to maximize protection.

The Projects' Resist structure locates portions of the alignment to areas that would minimize impacts on the community. Specifically, utilizing a private alleyway that parallels 14th Street to extend to Washington Street. Washington Street was chosen due to the width of the street to accommodate the necessary structure and potential to blend structural amenities into the commercial nature of the area.

In the northern part of the Study Area, the Resist structure begins near the Hudson Bergen Light Rail (HBLR) Lincoln Harbor station at Waterfront Terrace, traveling south along HBLR, then continuing south along Weehawken Cove towards Garden Street. Opportunities for urban enhancement in the northern portion of the Study Area include lighting, murals, and seating. In addition, a bermed and terraced Cove Park will be incorporated into the southwest corner of Weehawken Cove. Potential amenities at this park may include playgrounds, lawn areas, game courts, and a viewing deck overlooking Weehawken Cove.

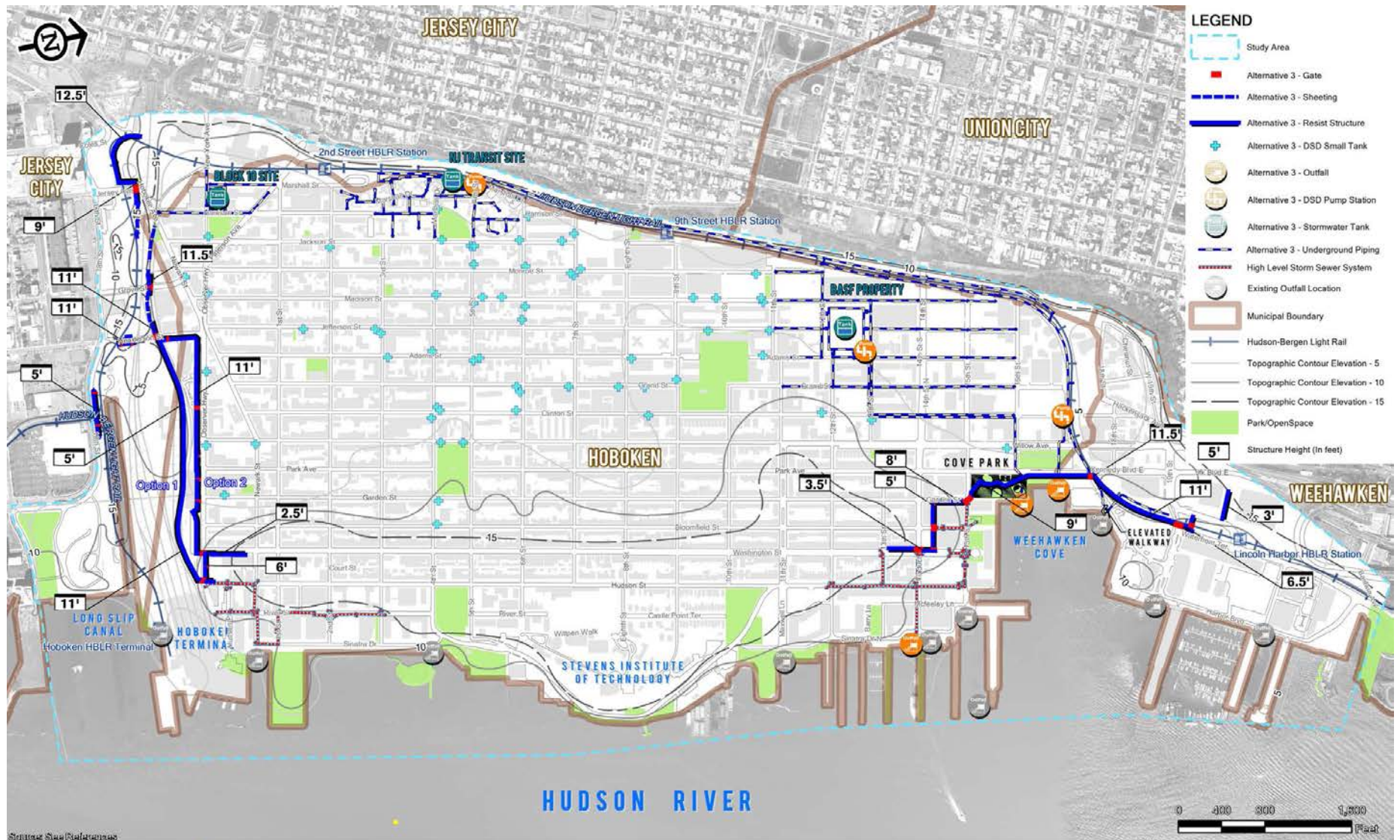


Figure 1: Map of Resist Alignment and DSD locations for the Project.



Figure 2: Project's Resist alignment features at 4 locations along alignment.



Figure 3: Project's Resist alignment features at Cove Park and Alleyway to Washington Street.

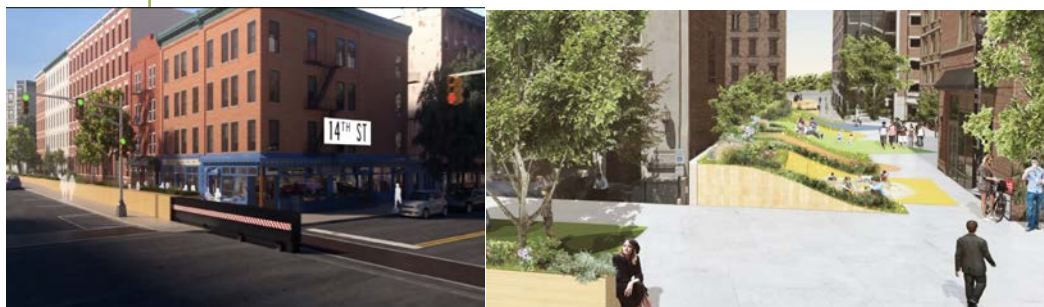


Figure 4: Rendering of gate in open position at 14th Street and Washington Street (left picture) and Rendering of urban amenities within the alleyway (right picture)

A structure would travel down the east side of Garden Street adjacent to the west of the Hudson Tea Parking Garage. The structure would then continue down the alleyway midway between 15th and 14th Streets from Garden to Washington Streets. The structure would then travel south along Washington Street to 13th Street. Street crossings will feature gates to allow for access during non-flood conditions. Consideration will be given to adapting the use of structures in a way to provide urban amenities such as seating and landscape enhancements.

In the southern part of the Study Area, there will then be two options: Option 1 will include an alignment south of Observer Highway within the rail yard (south of the proposed Hoboken Yard Redevelopment Area). Option 2 will feature an alignment along Observer Highway from Washington Street directly to Marin Boulevard. The alignment includes gates for access at various locations including at the Marin Boulevard, Grove Street, and Newark Avenue underpasses beneath the rail lines, as well as protection where HBLR tracks pass below the NJ TRANSIT overpass in the southwest corner of the Study Area. Urban amenities in these areas include lighting, murals, seating, plantings, and wayfinding/signage. Steel sheeting will also be installed along the NJ TRANSIT railroad embankment to support the resist structure. The Option selected for design and construction will be based upon the schedule for the proposed Hoboken Yard Redevelopment Plan

To prevent water intrusion from overtopped bulkheads or through existing inlets and unsealed manholes under the Project, a separation of the sanitary/stormwater collection system is proposed by the construction of a “High Level” storm sewer collection system. In addition to the installation of this new storm sewer system, the existing NHSA combined sewer inlets and manholes would be sealed and lined. This proposed drainage would be designed to prevent additional sewer backflow that could cause major flooding issues within the Preferred Alternative protected areas during a storm surge event. Stormwater collected in this “High Level” storm sewer system would gravity flow into the Hudson River.

Delay, Store, Discharge

The Delay, Store, Discharge (DSD) portion of the Project represents the framework for a future storm water strategy (Master Plan) that will be implemented by the City of Hoboken and other partners, as funding becomes available.

The Project’s DSD features include three large stormwater detention facilities and approximately 61 small tanks (right-of-way [ROW] sites) that will include new and/or improved stormwater management techniques designed to complement other efforts by the City of Hoboken as part of the Green Infrastructure Strategic Plan and multiple redevelopment plans. Details and specific plans on the three-large individual storm water detention sites, known as BASF site or Northwest Resiliency Park, NJ TRANSIT and Block 10, have been developed as part of the feasibility design. The location of these three DSD sites are based on studies of the existing flooding “hotspots” in Hoboken.

Three pump stations will be required as part of the discharge component. One pump station is proposed to discharge the overflow from the proposed NJ TRANSIT site

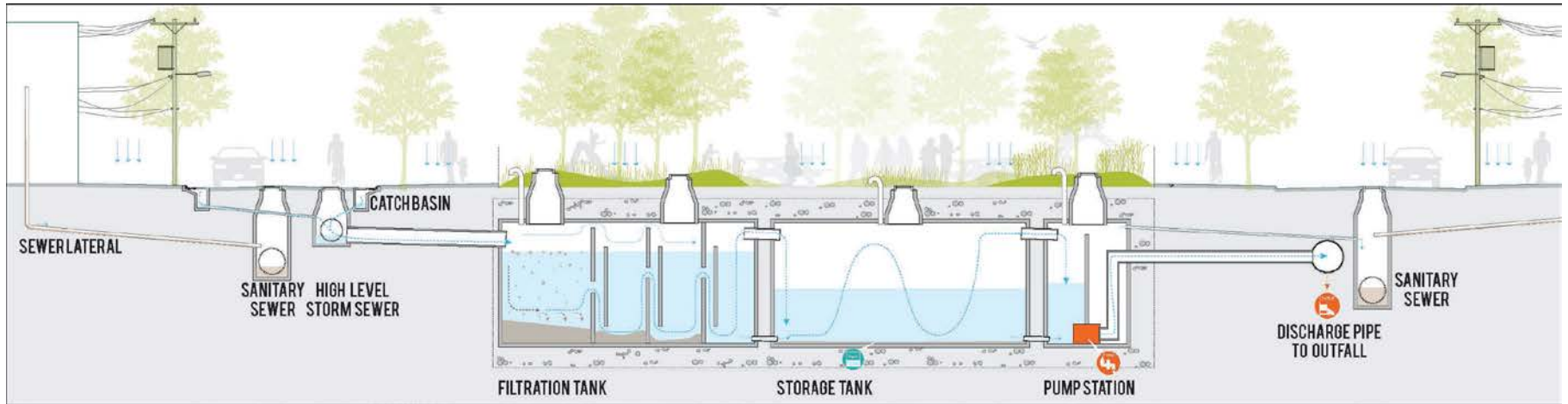


Figure 5: Schematic for typical stormwater retention system depicting tanks and typical “High Level” Storm sewer system for the three (3) DSD sites.

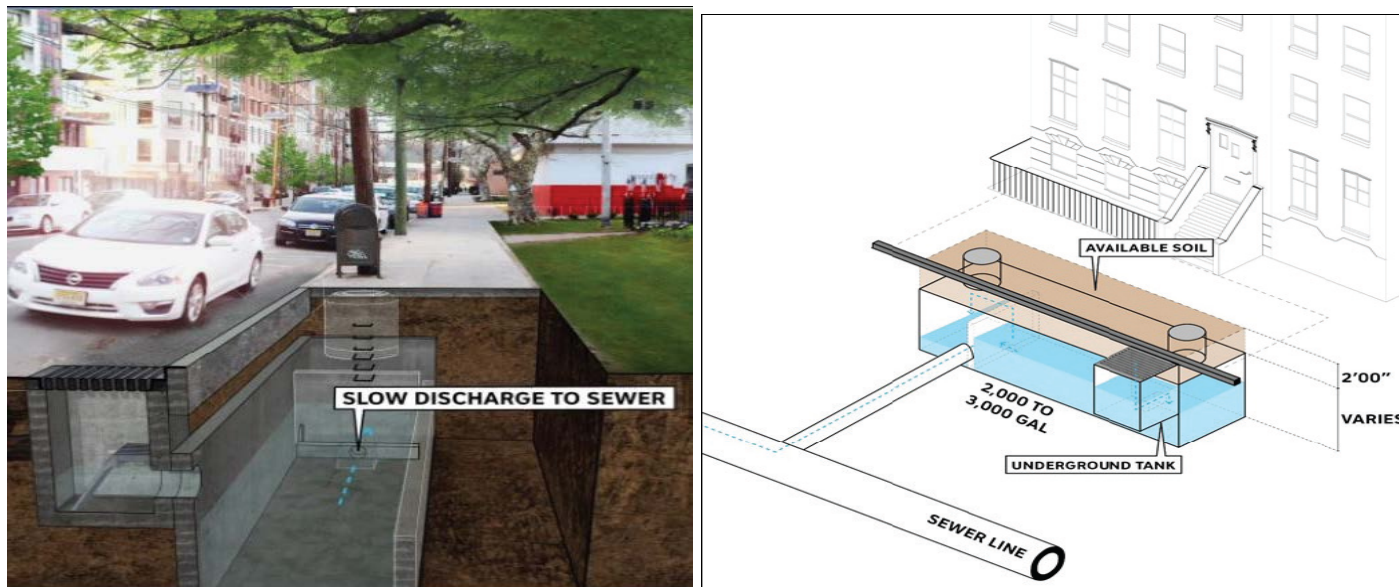


Figure 6: Depiction of typical Right of Way (ROW) site with detention tanks (left picture) and detailed depiction of typical ROW underground tank collection and discharge (right picture)

detention facility. A second pump station is required to discharge overflows from the BASF site detention tank. A third pump is proposed to the north of Clinton Street near the NHSA treatment plant. The purpose of the Clinton Street pump station is to release flows from the ditch to compensate the additional flow discharged from the NJ TRANSIT site and to prevent surcharge of the existing ditch during backflow conditions.

Two new outfall pipes in northern Weehawken Cove are proposed as the discharge component of the Project. One outfall would drain the flow of the existing ditch running along the western side of the HBLR line. This outfall is proposed to be located in the northern part of the Cove near Lincoln Harbor. The second outfall is proposed to be located north of Cove Park to drain the BASF site's catchment area via force main discharge.

As envisioned by the original RBD Hudson award, a pilot study of a DSD component is envisioned as part of this phase (i.e., Phase 1) of the project. Recognizing funding limitations, the DSD portion under the Preferred Alternative is anticipated to be constructed over the next 15 to 20 years. DSD represents the framework for a future storm water strategy that will need to be implemented by the City of Hoboken and other partners, and can be integrated into the city's existing plans. Currently, additional financing, including private financing, to support the DSD components of the project is being explored by the City of Hoboken and other local agencies. The City of Hoboken is pursuing other state loan and grant funding sources for the design and construction of some DSD components of the project. Additional entities, including stakeholder groups or entities that may be able to provide additional private financing to enhance the RBD initiatives, associated with the DSD components.

During this period, adaptive management techniques will be used to provide for effective implementation and allow for improvements and/or modifications based on lessons learned while implementing the DSD components. A completed Resist alignment will be constructed with the HUD grant of \$230 million, and a pilot or demonstration DSD project may be funded if there are available funds. The estimated timeline and budget for the Project are shown in **Table 1**.

Table 1: Hudson River Project
Estimated Timeline and Budget (in \$ millions)

	2015	2016	2017	2018	2019	2020	2021	2022	Total
Planning / Feasibility	\$1	\$7	\$4						\$12
Design / Predevelopment			\$10	\$13	\$7				\$30
Site Development / Construction					\$30	\$62	\$61	\$35	\$188

Allocation for Activity: \$230,000,000 of HUD CDBG-DR funds. Per HUD guidelines, up to 5% of the allocation (\$11.5 million) may be utilized for administrative costs.

Eligibility for CDBG-DR: Notice FR-5696-N-11(VII)(b) (Rebuild by Design)

Final project design, integrating results of ongoing environmental studies that are being conducted by the New Jersey Department of Environmental Protection (NJDEP), is expected to begin in summer 2017. Construction is expected to begin in 2019 and will take about 3.5 years to complete.

Additionally, in the permitting and design phases of the Project, the Project may trigger local zoning and land use regulations that fall within the municipal purview. New Jersey Department of Community Affairs (NJDECA) has certified that the preliminary design considers the appropriate code, industrial design standards and construction standards, and that a registered professional engineer will certify that the final design meets all relevant codes. To date, the known State and Federal permits that will need to be obtained for the Preferred Alternative are as follows:

- Individual Waterfront Development Permit
- Individual Flood Hazard Area Permit
- Freshwater Wetland General Permits 7 and 11
- NJPDES – Discharge to Surface Water (DSW) Permit
- Army Corp of Engineers Nationwide Permit 7
- General Permit (GP-0005A) for emergency generators (DSD pump systems)

The Project is also addressing the long-term efficacy and fiscal sustainability, outlined in Section VI(2)(g)(4) of the November 2013 Federal Register Notice (FR-5696-N-06) by developing the following:

- An Operations and Maintenance (O&M) plan for the Project will be prepared describing the procedures and responsibilities for routine maintenance, communication and timing of activation in the event of an impending storm condition. NJDEP has formed an O&M subcommittee with local and State partners that has helped develop an O&M management strategy framework for the Project. The participants in the O&M planning and development currently include, but are not limited to, entities such as the NJDEP, the cities of Hoboken, Jersey City and Weehawken, NJ TRANSIT, Port Authority of New York & New Jersey (PANYNJ), Hudson County, Jersey City Municipal Utilities Authority, North Hudson Sewerage Authority, and the New Jersey Office of Emergency Management. The O&M Plan management is a critical component of the overall Project and should contain five very distinct functions: Operations, Maintenance, Engineering, Training, and Administration. The detailed O&M framework for the Project is included as Appendix B, which also identifies key stakeholders and metrics for O&M Evaluation.

During the project development, meetings were held with FEMA to review various issues related to FEMA accreditation of the Project including interior drainage, joint probability analysis, freeboard requirements for coastal flood protection structures, and other aspects of design necessary for accreditation in accordance with 44 CFR 65.10. Based on the information provided, FEMA concurred that historically less than 10-year rainfall coincided with one percent and lower coastal storm surge events. Even though it is not currently required by FEMA, it was agreed that sea

level rise should be accounted for, given the life span of the flood reduction system. The accreditation process was reviewed and it was recommended that the Project submit in the design phase a Conditional Letter of Map Revision (CLOMR) to allow early coordination and ensure that map changes will be known prior to Project construction. The Project will need to meet interior drainage analysis 44 CFR 65.10 final O&M, as-builts, certification requirements that includes a Warning and Evacuation Plan and a system exercise schedule. In addition, FEMA will require that a warning system and evacuation system be established for the Project and a certification from a design professional or federal agency is required for accreditation.

The State certifies, after final construction, the State and the municipalities receiving flood protection benefits, such as Hoboken, Jersey City and Weehawken, from the Project will pursue the FEMA LOMR. As part of the FEMA accreditation process, the State and respective municipalities are required to provide the O&M plan that identifies the entities performing routine, on-going maintenance. The State is responsible for ensuring that O&M costs are funded and that entities are in place to own, operate and maintain the levee system associated with the Resist structure before construction begins. The State intends to fulfill fully its obligations under this Certification. Nothing herein shall constitute, nor be deemed to constitute, an obligation of future appropriations by the legislature of the State of New Jersey, where creating such an obligation would be inconsistent with New Jersey Constitution Article 8, Section 2, Paragraphs 2 and 3, N.J.S.A. 59:13-1 et seq., and N.J.S.A. 59:1-1 et seq. of the State of New Jersey.

The NJDEP has taken the following steps to meet the resilience performance standards requirements identified in Section VI(2)(e) of the November 2013 Federal Register Notice (FR-5696-N-06). Through the NJDEP Flood Hazard Area Control Act (FHACA) Rules, the State has taken steps to reduce the damage and risks to public safety and health and the environment caused by flooding while assuring the creation of a more resilient coastal community. These steps include incorporating the following amendments to the FHACA Rules into the Project design:

- Amendments issued in 2007 include:
 1. The regulation of all commercial, residential, industrial, and public development within the flood hazard area design flood, which is the 100-year (1 percent) flood plus a 25 percent factor-of-safety to account for potential future increases in flood discharges in fluvial areas
 2. Restricting the loss of any flood storage volume within the flood hazard area of fluvial surface waters, which ensures continued protection from anticipated flood events of increasing intensity
 3. Establishment of protected riparian zones around all surface waters, which limit the removal of vegetation, thereby increasing water quality protection, reducing erosion, and preserving flood storage along these waters, all of which ensures continued protection from anticipated flood events of increasing intensity
 4. Requiring that the lowest floor of buildings and the travel surface of roadways and parking areas be situated at least one foot above the

flood hazard area design flood elevation to account for the possibility of impacts from future flood events that may be greater than the predicted levels

- Emergency amendments in 2013 facilitating rebuilding after Superstorm Sandy in a more resilient manner by:
 1. Ensuring that the best available flood elevation data is used to determine the flood hazard area design flood elevation for a given site, including FEMA's advisory flood maps and subsequently released preliminary maps for New Jersey's coast, which include revised A and V-Zone limits, as well as FEMA mapping issued as final (effective) that is developed in partnership with the NJDEP and depict the NJDEP's flood hazard area design flood elevation and floodway limit
 - The flood mapping used by the State prior to this rulemaking was outdated and generally underestimated the actual 100-year flood elevation by approximately 1 to 4 feet and, in some circumstances, by as much as 8 feet. This was illustrated during Superstorm Sandy, when many people who had constructed a building with its lowest floor at the 100-year flood elevation shown on FEMA's effective Flood Insurance Rate Maps discovered that the portions of their building that lay below the advisory base flood elevation were subjected to severe flood damage. Had the NJDEP not taken steps to allow for the use of the best available flood mapping, and to incorporate future FEMA mapping, residents would have been able to reconstruct their substantially damaged structures using the prior and inaccurate flood elevations, creating a potentially significant detriment to public health, safety and welfare during the next flooding event.
 2. Allowing flood proofing measures to be used instead of elevating buildings in certain, limited situations where elevating is not feasible or cost-effective
 3. Ensuring consistency between the NJDEP's standards for elevating buildings in flood hazard areas with the building standards of the Uniform Construction Code promulgated by the Department of Community Affairs at N.J.A.C. 5:23

The FHACA rules are not the State's sole means of protecting residents and their properties from flooding and severe weather events. Many efforts are ongoing throughout the State and in the various other NJDEPs to assist in the recovery from Superstorm Sandy and Hurricane Irene. For example, the NJDEP's Blue Acres Program was established for the purposes of acquiring flood-damaged or flood-prone properties from willing sellers for conservation and recreation purposes, thus removing families from harm's way while creating natural buffers against future severe weather events and returning flood carrying capacity to vital areas. With respect to tidal areas, since 2011, the New Jersey Coastal Management Program (NJCMP) has developed two assessment tools to ensure that coastal communities have consistent and comprehensive guidance to assess their vulnerability to coastal hazards and capacity for resilience: the Coastal Community Vulnerability

Assessment and Mapping Protocol and the Getting to Resilience questionnaire. Through the NJCMP, the NJDEP has developed the Resilient Coastal Communities Initiative to further develop these tools into a community-based planning program. The NJCMP has also initiated a Sustainable and Resilient Communities Grant Program to fund a comprehensive planning approach at the municipal level. Further, the 2013 amendments to the NJDEP Coastal Zone Management Rules allow for soft buffers through the establishment of living shorelines. Tidal wetlands are a major component of the coastal ecosystem that provide multiple ecosystem services, as well as a first defense against storm surge. Living shorelines are a means to assist in restoring special areas, such as wetlands, that have been lost and can be designed to adapt to changing environmental conditions.

National Objective: FR-5696-N-11 allows the State to “categorize the [RBD] project into multiple activities in order to distinguish and classify expenditures as benefitting [LMI] populations, as a means of meeting the overall benefit requirement.” As described above, the State is currently evaluating the resultant impacts of the RBD Hudson River project’s Preferred Alternative, and therefore, is not positioned to designate what components may potentially be classified as meeting the LMI national objective. As a result, the State avails itself of the option to characterize activities within this project as either meeting the LMI national objective or the Urgent Need national objective (or characterizing an entire project as LMI, if appropriate under HUD regulations), at least so long as funding provided for RBD projects continues to be counted toward the State’s overall LMI benefit requirement.

2.3 Managing State Agency and Partner Entities

The NJDEP is the state agency responsible for overseeing and implementing both RBD initiatives. The NJDCA, as the State’s Grantee for CDBG-DR funds from HUD, transfers CDBG-DR funding for RBD projects to NJDEP under a Memorandum of Understanding, and NJDEP administers those funds.

Over the course of implementing this project, NJDEP has developed a team with expertise needed to meet the challenge. NJDEP has staff experienced in the planning, permitting, design and construction of flood risk reduction projects as well as other large construction projects including wetland enhancement, landfill closure, park development, site remediation, etc. Information about NJDEP’s experience with various types of environmental issues and projects is available on its website at <http://www.state.nj.us/dep/>.

The NJDEP Bureau of Flood Resilience within the Engineering and Construction Program of the NJDEP will be managing the day-to-day implementation of the project. As the design phase of the RBD project continues, and all the way through implementation, NJDEP will routinely assess its own staffing needs and, if additional staffing is required, will use program delivery funds to bring on resources to meet needs (subject to applicable federal laws and regulations on the permissible use of CDBG-DR funds). The NJDEP will be ultimately responsible for monitoring and evaluating the efficacy and sustainability of the Project, as described below, and will add staffing or resources as required in order to perform this function in a manner compliant with Section VII(a)(iv) of FR-5696-N-11.

NJDEP also is working with the Department of Treasury to release Request for Proposal (RFP) to hire a design team to complete engineering and additional design services, construction bid package development, and construction oversight. The NJDEP, in conjunction with the Department of Treasury, has successfully bid and awarded a contract for a Construction Management Firm (CMF). The CMF has been engaged to provide additional engineering support to the NJDEP team. The Department of Treasury will also work cooperatively with NJDEP and its partners to solicit bids for project construction. NJDEP, Treasury and the design contractor will oversee project construction to ensure adherence to plans, specifications, permits and all other State and federal requirements.

While NJDEP will be the primary agency involved in designing and implementing the Project, it will not be the only relevant State agency. Roles of other agencies in this process include:

- **NJ TRANSIT.** NJ TRANSIT received significant funding from the Federal Transit Administration (FTA) to fill Long Slip Canal, which will block some of the storm surge coming from the Hudson River near the south end of the RBD project area. While this project was coordinated with the RBD team, it is funded with FTA funds and is a wholly separate project from RBD Hudson River. Ongoing coordination will be required to ensure that the projects yield an integrated coastal protection system.
- **Department of Treasury/Office of State Comptroller.** NJDEP will continue to work closely with these two agencies in order to procure services and materials needed to realize the project. The State procurement process is a necessary condition of ensuring cost reasonableness and complying with federal and State law, but compliance also may add significant time to the Project.

Coordination and communication with potential partners are also critical in the implementation of this project. Two examples of early coordination of the Hudson River RBD project team (project team) with partners for the Project are the following:

- **Sandy Regional Infrastructure Resilience Coordination (SRIRC) Federal Review and Permitting (FRP) Team** members committee met with the project team on August 18, 2015 at HUD's offices in Manhattan to provide the FRP with an overview of the Project's timeline, discuss the Project's draft Purpose and Need, and discuss the upcoming publication of the draft Scoping Document. The project team provided an overview of initial conceptual Resist and DSD features to provide examples to the regulatory agencies of the various alignments and types of structures that the project team was considering, in an early effort to identify issues that may be associated with particular strategies. The SRIRC FRP Team members are federal officials with responsibility for federal review and permitting of complex Sandy infrastructure projects. The mission of this interagency team is to facilitate expeditious and efficient reviews of the most complex projects funded by the Disaster Relief Appropriations Act of 2013 through early engagement and identification of issues, studies, and overall development needs of the projects.

- Coastal Hudson County Technical Coordination Team (TCT) met with the project team on June 18, 2015 for an initial project kickoff meeting, which included background on the Project, an overview of the proposed project schedule, and review of project milestones. The groups met again on October 8, 2015 to review the project schedule, draft Scoping Document, and discuss the preliminary concept screening criteria and on September 27, 2016 for a review of the project schedule, introduction of the Preferred Alternative, and overview of the project benefits and environmental impacts that had been identified. The TCT is comprised of federal, state, and local officials with subject matter expertise in resilience, planning, environmental review, and permitting in the Study Area. It was formed by the federally convened SRIRC Group and includes members from NJDEP, HUD, U.S. Army Corps of Engineers (USACE), U.S. Environmental Protection Agency (EPA), U.S. Fish and Wildlife Service (USFWS), National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), FEMA, FTA, Federal Highway Administration (FHWA), NHSA, PANYNJ, NJ TRANSIT, and representatives from the local municipalities.

The project also requires ongoing agency outreach including coordination for permits and approvals. The following is a list of ongoing agency coordination needs:

- Section 106 Consultation - Consultation with the NJ Historic Preservation Office (HPO) and identified consulting parties would be undertaken to develop the Project Programmatic Agreement (PA) that would provide a consultation framework to minimize and/or mitigate adverse effects that are expected to result from the Project. The executed PA will be incorporated into the FEIS. The potential effects on those historic properties would be assessed by NJDEP in consultation with the HPO and in accordance with the Section 106 process.
- FEMA and USACE consultation and review has been ongoing and will continue throughout the design and required permitting processes.

As was proposed in APA12, municipal governments and stakeholders in the project area are also playing a critical role in realizing the Project and are being engaged as follows:

- An Executive Steering Committee (ESC) for the Project meets on a monthly basis to share information and provide input throughout all phases of the project, from feasibility through construction. The Commissioner of NJDEP, HUD representatives and the Mayors of Weehawken, Jersey City and Hoboken are members of the ESC. Among other things, this Committee advises on the direction of the project, policy issues that arise in connection with the project, as well as issues raised to the Committee by the NJDEP Project Management Team (PMT). The ESC works in unison with NJDCA as issues arise.
- The PMT works on the day-to-day issues that arise in connection with the project. Any issues that cannot be addressed at this level are synthesized and raised to the Executive Steering Committee for discussion. A number of smaller teams and workgroups support the PMT on issues specific to the project. These working groups evaluate and make recommendations on such

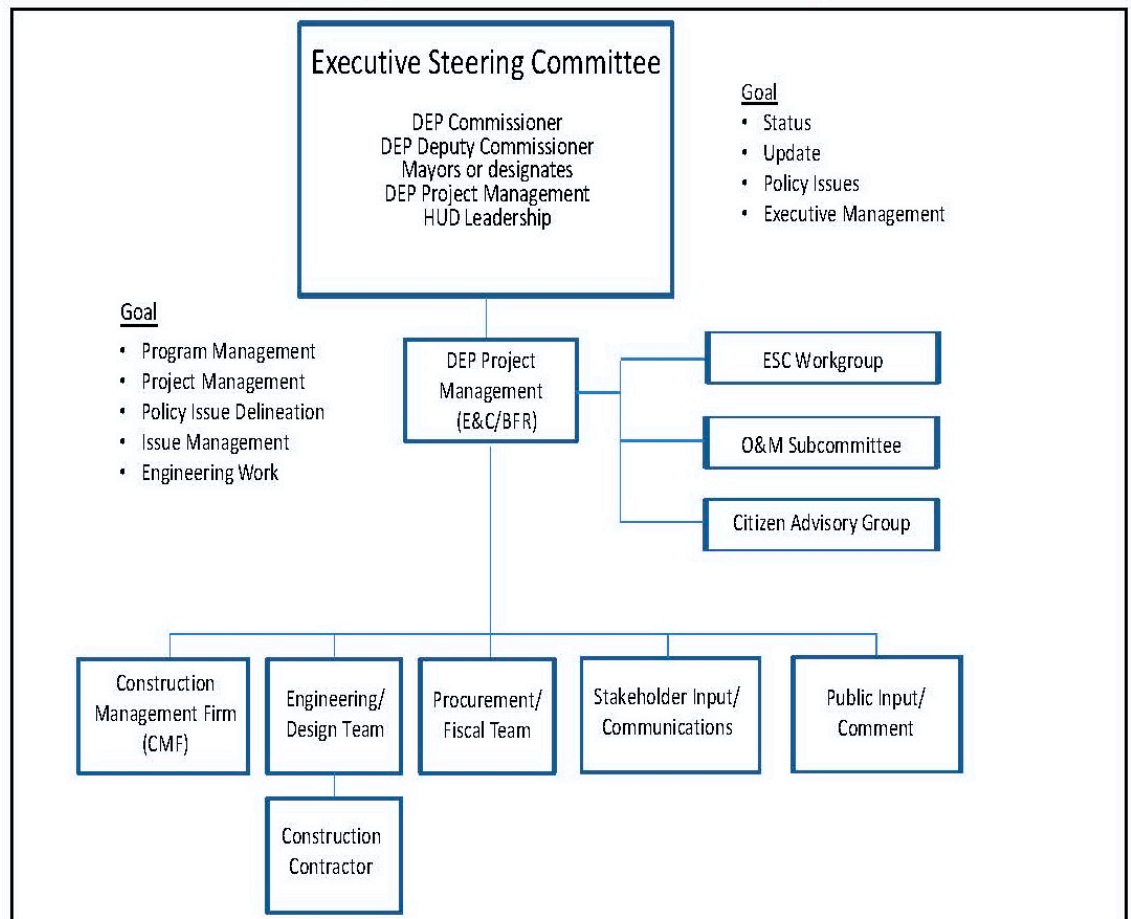
issues as Uniform Relocation Act (URA), permitting, operation and maintenance and public outreach. Examples of these working groups are:

- ESC Working Group (ESCWG): The ESCWG is comprised of key members of each of the municipalities, the engineering/design team, NJDEP, HUD, and Construction Management Firm (CMF). Periodically during critical phases of the Project, such as concept development, urban design, and important document review (Scoping, DEIS, Design Scope of Work), the ESCWG will meet to check on project status and work through project issues. The group will also meet to review draft presentations and run-throughs prior to public meetings and hearings.
- O&M Subcommittee: The O&M Subcommittee is comprised of members of each municipality, NJDEP, CMF, engineering/design team, HUD, and other important stakeholders who may be impacted by the final project. This group includes NJ TRANSIT, North Hudson Sewerage Authority, and Hudson County. The goal of the Subcommittee is to continue the discussion of issues that arise from the Project and how to manage them as issues arise. In the end, this group will make recommendations on how and when the Project is activated in an emergency and how existing services will need to react at that time. The O&M Subcommittee works in unison with NJDCA as issues arise.
- Citizen Advisory Group (CAG): The CAG is a group of key citizens and citizen groups representative of that community interested in the Project. CAG members are responsible for bringing issues and concerns to the table as well as sharing information from the PMT with their constituents, including members of vulnerable populations. CAG members will supplement the knowledge of local government officials or their delegates about the project areas and provide input on ideas, problems, observations and solutions.

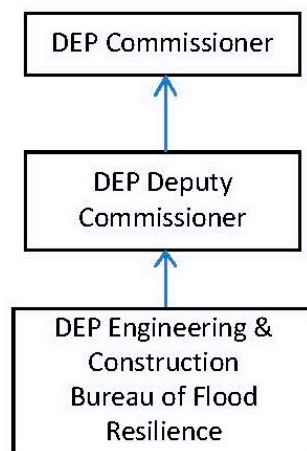
In short, throughout all phases of the project, Executive Steering Committee members have both a voice and input into the process, though to be clear the Executive Steering Committee is advisory, and all final project determinations rest with NJDEP as the agency responsible for implementation of the Project.

The chart below shows the Advisory Structure and the Decision-Making Structure for the Project.

RBD Hudson River Organizational Chart: Advisory Structure



RBD Hudson River Organizational Chart: Decision-Making Structure*



* Advice from the Executive Steering Committees is considered by E&C/BFR and reported up to the Commissioner who has final decision-making authority. The Commissioner also chairs the Executive Steering Committees and is directly informed of the Committee's advice. E&C/BFR's role in the Advisory Structure is primarily a staffing function to facilitate the synthesis and transmission of issues and considerations to the Executive Steering Committee for input. Separate from its role in facilitating the Executive Steering Committee's advisory role, E&C/BFR also is involved in NJDEP's RBD decision-making process, which includes evaluating the input provided through the advisory structure.

SECTION 3: RBD HUDSON PERFORMANCE SCHEDULE

The table below indicates the high-level schedules for the Project. The schedule, along with the attachment of timelines developed by the consultant teams, establishes that this project will require the timeline extension approved by HUD on February 13, 2017 in order to be completed.

Milestone	Time Period by Month/Year
Recommendation of Preferred Alternative	September 2016
DEIS Public Hearing	March 2017
Design Contract Award (Resist)	June 2017
FEIS	June 2017
Record of Decision	July 2017
Design Completion	January 2019 (North) & June 2019 (South)
Construction Contract Award	April 2019 (North) & September 2019 (South)
Design/Build (DSD Pilot)	November 2019 – September 2021
Construction Completion	September 2022

Feasibility and Planning is nearly complete. The next phase, Design and Predevelopment, refers to all design and engineering work required for the Project, culminates with complete construction specifications, and is anticipated to last from 2017 to 2019. Under the proposed schedule, the Project will proceed in a timely manner and is currently on schedule for completion of construction by September 30, 2022.

Given that the Project has not yet entered the construction phase, these budget estimates and timeframes remain preliminary estimates, which are subject to change. These estimates will be refined to be more accurate following completion of the Final Environmental Impact Statement.

This overview of the four project phases includes but is not limited to the following:

3.1 Planning and Feasibility (Planned Completion July 2017)

- **Scope of work:** overall project/sub-component feasibility; identification of available and potential resources; project timeline; begin environmental review process; project scoping; critical issues/obstacles analysis;

alternatives analysis; general cost-benefit analysis; bid packages for design phase; permit identification; EIS and Record of Decision (ROD); begin master planning process and community engagement/outreach; identification of necessary land acquisition and easements

- **Key tasks:** conduct data collection and analysis; evaluate overall project feasibility; assess and confirm feasibility of RBD team's conceptual design; create concept drawings; publish Notice of Intent; develop purpose and need for project; develop scoping document; meet with stakeholders; identify necessary permits; prepare and publish DEIS; receive and respond to public comments; hold public hearing; draft and publish Final EIS (FEIS); draft and publish Record of Decision (ROD); identify environmental consequences, identify resources, identify and analyze critical issues/possible obstacles; identify necessary real estate/easements; develop more detailed timeline and budget estimates; analyze feasibility of sub-components as stand-alone projects; create Master Plan.
- **Key deliverables:** development of concept drawings; DEIS; FEIS; Section 106 project-specific Programmatic Agreement, ROD; list of necessary permits; feasibility report; general timeline and budget for project phases; general cost-benefit analysis; plan for addressing critical issues; development and issuance of bid packages for design and engineering services.

3.2 Design and Predevelopment

- **Scope of work:** development of engineering and design documents; real estate/easement acquisition; development of construction bid package; completion of environmental review process; issuance/approval of all necessary permits
- **Key tasks:** pursuit of identified financing/funding opportunities; draft engineering and design documents; develop construction bid packages; obtain necessary permits; obtain real estate/easements; identify and secure funding source and partners for operations and maintenance; identify long-term ownership entity/structure
- **Key deliverables:** concept drawings; completed engineering and design documents; filing and approval of all necessary permits; complete necessary easements and land acquisition, development and issuance of construction bid packages; complete procurement of construction services contract; detailed construction timeline and cost estimate; comprehensive cost-benefit analysis.

3.3 Site Development and Construction

- **Scope of Work:** begin and complete site development and construction

- **Key Tasks:** prepare identified areas of site for construction phase on time and on budget, in accordance with plans and specifications. Build, on time and on budget, in accordance with plans and specifications.
- **Key Deliverables:** completed site development in areas required in order to begin construction; complete construction.

3.4 Post Construction

- **Scope of work:** all ongoing operations, maintenance to ensure continued effectiveness of project components.
- **Key tasks:** create maintenance agreements
- **Key deliverables:** well-maintained project components; funding in place to ensure continued effectiveness of the project.

SECTION 4: OUTREACH AND PUBLIC COMMENT FOR RBD HUDSON RIVER PROJECT

4.1 Citizen Outreach Plan (COP)

NJDEP has committed to a robust community and stakeholder outreach process throughout the course of what will be a multi-year effort to realize the Hudson River RBD project. The primary goal of NJDCA's Citizen Participation Plan (CPP) is to provide all New Jersey citizens with an opportunity to participate in the planning, implementation, and assessment of the State's CDBG-DR Sandy recovery program(s). The CPP required that a Citizen Outreach Plan (COP) specific to the Project be developed to serve as a supplement to NJDCA's existing CPP. The Project: Resist, Delay, Store, Discharge COP provides a transparent and inclusive community outreach and public participation plan allowing all citizens and stakeholders in the Project's Study Area and adjoining areas to participate in the planning, design, and implementation of the Project. The COP provided the framework for public outreach for the entire Project, including the NEPA phase and future phases, as it moves through final design into construction.

The project-specific COP establishes the framework for the interaction between the primary public and agency coordination groups that will meet throughout the Project. These include the CAG, the TCT, and the ESC. The CAG was established to be the primary link between the project team and the overall community. The TCT was established by HUD's Sandy Recovery Task Force to support regional resilience across federal infrastructure investments in the region impacted by Superstorm Sandy and to facilitate planning, development, and implementation of infrastructure projects funded through the Disaster Relief Appropriations Act of 2013. The ESC was established as a project advisory committee. The coordination groups interacted with the project team throughout the project schedule to develop a project that met the overarching resiliency needs, while considering community and regulatory requirements.

In developing the COP, the State complied with all HUD citizen participation plan requirements described in Section VI of Federal Register Notice FR-5696-N-11 and with the public involvement requirements of the National Environmental Policy Act (NEPA), 40 CFR Sec. 1506.6 Public Involvement, as well as the State's Language Access Plan (LAP), which is available online at

http://www.renewjerseystronger.org/wp-content/uploads/2016/05/nj_vca_hud_approved_language_access_plan_051616-FINAL-.pdf.

The goal of the COP is to engage and collaborate with the public, including vulnerable and underserved populations, racial and ethnic minorities, persons with disabilities, and persons with limited English proficiency, as well as municipal officials, community organizations and the academic community, in the RBD planning, design and implementation processes. The purpose is to solicit relevant input and provide timely information throughout the environmental review. Community stakeholders have been continuously engaged throughout the feasibility/environmental review (planning), and will continue to be actively engaged in the design, and implementation phases of the project.

Periodically during critical phases of the Project, such as concept development, urban design, etc., a subset of the ESC met in person or via online web conferencing to check on project status and project issues. This was known as the ESCWG and consisted of task and discipline leads with the planning team, as well as representatives from NJDEP, HUD, mayors' offices, and other members of the ESC.

Environmental Impact Statement Outreach

The extensive consultation and coordination that was undertaken as part of the Project began with the initiation of the National Environmental Policy Act (NEPA) process in June of 2015. The publication of the DEIS on February 24, 2017 represents a significant public outreach effort, with a 45-day public comment period and a public hearing held on March 16, 2017. To date, the Project has involved significant local, State, and federal coordination, as well as collaboration with the public, to build an understanding among stakeholders in the Study Area. This coordination has taken place to satisfy NEPA and agency regulatory requirements, as well as to make sure that the public remains well informed and engaged throughout the Project. Public involvement occurred throughout the Project and focused on major milestones, which were:

- Purpose and Need
- Scoping
- Concept development
- Concept screening
- Introduction of the Build Alternatives
- Urban design
- Coastal storm surge modeling

- Rainfall modeling and alternatives analysis
- Selection of the Preferred Alternative

Public feedback during key project milestones was critical in developing a Project that provides flood risk reduction and community amenities, while respecting the existing urban environment. This section describes the plans that established the Project's public and agency outreach; the groups that were developed to help foster communication between the community, agencies, and the Project team (which includes the NJDEP and the Consultant team); and a summary of the meetings held for the Project.

4.2 Outreach Accomplishments to Date

NJDEP and its partners held initial community meetings in each of the RBD project regions, where the projects were discussed. The first Project meeting was held on January 20, 2015, after the first ESC meeting. Information on these meetings and documents presented to the public at each meeting is available on the RBD HUDSON website located online at <http://www.nj.gov/dep/floodresilience/rbd-hudsonriver.htm>

The public has consistently been engaged throughout the process through the following events at various locations in the impacted area:

- Citizen Advisory Group Meetings on:
 - July 28, 2016 - Alternative Analysis Workshop;
 - July 12, 2016 - Coastal Storm Surge Flood Model Presentation;
 - June 16, 2016 – Community Workshop;
 - April 7, 2016 – Community Workshop;
 - December 3, 2015 – Concept Screening Workshop;
 - November 23, 2015 – Concept Review Workshop;
 - October 29, 2015 – Draft Concept Screening Workshop;
 - October 8, 2015 – Project Update and Concept Screening Presentation;
 - September 10, 2015 – Overview of RBD Scoping Process and Workstation Breakout; and
 - August 6, 2015 – RBD Overview, Background and Status.

- Community Meetings on:
 - June 16 , 2016 - Urban Design and Amenities preliminary findings;
 - April 28, 2016 - Community Workshop/Drop-in Session;
 - April 14, 2016 - Community Workshop/Drop-in Session;
 - April 12, 2016 - Community Workshop/Drop-in Session;
 - February 18, 2016 - Project Alternative Update; and
 - December 7, 2015 - Drop-in Session follow up to Public Meeting on December 10.
- General Public Meetings on:
 - September 13, 2016 - Jersey City Community Update;
 - September 8, 2016 - Preferred Alternative Public Meeting;
 - December 10, 2015 - Concept Screening Public Meeting;
 - November 24, 2015 – Public Walking Tour Discussion;
 - November 23, 2015 – Public Walking Tour Discussion;
 - September 24, 2015 – Environmental Impact Statement Public Scoping Meeting;
 - June 23, 2015 – RBD Overview, Background and Process; and
 - December 10, 2015 – Concept Screening Public Meeting.

Community involvement has been an integral part of the entire Project process. In order to facilitate communication with the community, NJDEP made extensive use of the Project website to upload materials presented at meetings such as presentations, handouts, video recordings, and meeting summaries. NJDEP also utilized an electronic mailing list (listserv) to facilitate ongoing contact with the community, transfer information, and invite people to public meetings. The database contained the names and addresses of Study Area representatives, media organizations, and representatives from the business community, as well as other interested stakeholders who signed up to receive updates via the website. At meetings, members of the public were encouraged to add their email address to the listserv so that they could be notified of Project updates and schedules for upcoming meetings. In addition to participation at public meetings public participation was encouraged and facilitated by:

Project Website: The Project website (www.rbdhudsonriver.nj.gov) is an important tool used to communicate with the public by serving as a repository for documentation and information related to the Project. The website features

resources such as presentations, videos, public notices, and documents for public review, which were made available for download within a few days following public meetings. The website also features a link allowing individuals to subscribe to the Project's listserv. The website will continue to function as a valuable resource for the community as the Project moves forward through the design and construction phases

Fact Sheets and FAQs: The project team has recognized that as the Project progresses, people that may not have been involved in earlier phases may become aware of the project and want to get involved. To bring people up to speed, as well as answer questions that had been raised by members of the public at previous meetings or through email, Fact Sheets and FAQ documents were developed at project milestones, such as during scoping and the introduction of the three Build Alternatives

Drop-In Sessions: NJDEP and its partners provided additional opportunities for input, comment, and participation at key project milestones such as concept screening, urban design, or at the request of Executive Steering Committee members. These drop-in sessions were not formal public hearings, but rather forums for an exchange of information between the public and the project team. Subject matter experts were available to field specific questions or provide additional explanations related to their technical expertise. Project team members provided status updates and presentations and the public was given an opportunity to ask questions and voice concerns.

Spanish Language Translation: All notifications published to inform the public of an upcoming public meeting were published in both English and Spanish. In addition, at public meetings (scoping, concept screening, and DEIS public hearing), a Spanish translator was available to help Spanish speaking individuals.

Stakeholders will continue to be engaged during the design and construction project phases. As shown in the organizational chart in Section 2.1, a group reporting up to the PMT has been specifically focused on outreach. Moreover, for the environmental review component in particular, NJDEP has synchronized its outreach approach specifically to the public engagement requirements attendant to environmental impact studies. The full RBD HUDSON Outreach Plan with specific community goals, contacts and specific community outreach actions is available online at <http://www.nj.gov/dep/floodresilience/docs/rdb-hudson-coplan-final.pdf>

The next phase of the Project will be final design. During final design, the Project team will work with the communities to finalize the urban design considerations and amenities to be incorporated into the Project's Resist component. This coordination will emphasize the usage of context sensitive designs that will be

mindful of the existing urban fabric to help mitigate impacts of the structures on the community. During construction, the Project will also involve outreach and coordination with communities to help mitigate construction-related impacts.

4.3 Public Comments

Consistent with HUD requirements, this proposed Substantial Amendment will be made available for public comment over a period of at least thirty days. Also per HUD requirements, the State will hold a public hearing to solicit comments in connection with this proposed amendment. The date and location of the public hearing are:

- April 24, 2017; Wallace Elementary School, Cafeteria, 1100 Willow Ave, Hoboken, NJ 07030; 5-8 pm.

Commenters may submit comments to this proposed amendment (i) via email to sandy.publiccomment@dca.nj.gov (Subject: APA 20); (ii) via U.S. mail; or (iii) via oral or written comments at the public hearing. All comments are given the same amount of consideration regardless of the method of submission.

After the public comment period closes, the State will synthesize the comments submitted on this proposed amendment and include responses to those comments received as part of the final amendment submitted to HUD for review and approval.

SECTION 5: RBD HUDSON BENEFIT COST ANALYSIS

Pursuant to FR-5696-N-11 and its implementation guidance, the State is required to submit with its Substantial Action Plan Amendment a Benefit Cost Analysis (BCA), as well as a clear and concise narrative description of the BCA. The full narrative of the BCA is attached hereto as Appendix C. The narrative description below describes the RBD Project and expected costs and benefits, according to the categories outlined in HUD Notice CPD-16-06, issued on April 20, 2016. The BCA was prepared in accordance with HUD BCA Guidance for APA for RBD Projects outlined in HUD CPD-16-06. The analysis used generally accepted economic and financial principles for BCA as articulated in OMB Circular A-94.

The Project consists of the following elements:

- (1) Preferred Alternative (Alternative 3) will provide flood risk reduction benefits to the community by placing the “Resist” barrier structures primarily inland and along a privately owned alleyway between Garden Street and Washington Street in northern Hoboken. The Preferred Alternative (also referred to as the “Alleyway” alternative) provides the most balanced approach to delivering significant coastal flood risk reduction benefits to the community within the available budget of \$230 million and with project completion to be September 2022. This alternative provides coastal flood risk reduction to approximately 85 percent of the population residing within the Study Area 100-year floodplain. The Preferred Alternative creates the opportunity for beneficial activation of certain resist features including enhanced public park space while minimizing perceived negative impacts to the community.
- (2) Preferred Alternative: Option 1 will include an alignment south of Observer Highway, within the rail yard (south of the proposed Hoboken Yard Redevelopment Area). Option 2 will feature an alignment along Observer Highway from Washington Street directly to Marin Boulevard. The alignment includes gates for access at various locations including at the Marin Boulevard, Grove Street and Newark Avenue underpasses beneath the rail lines, as well as protection where HBLR tracks pass below the NJ TRANSIT overpass in the southwest corner of the study area. Urban amenities in these areas include lighting, murals, seating, plantings, and wayfinding/signage.

The Project Resist Preferred Alternative is designed to:

- 1) Contribute to Community Resiliency
- 2) Reduce Risks to Public Health

- 3) Contribute to On-going Community Efforts to Reduce FEMA Flood Insurance Rates
- 4) Deliver Co-Benefits
 - a. Integrate civic, cultural and recreational values
- 5) Enhance Connectivity to the Waterfront
- 6) Activate Public Space
 - a. Public and recreational spaces
- 7) Consider Impacts from Climate Change

- The BCA demonstrates that the Preferred Alternative project will generate substantial net benefits (i.e., the benefits exceed the lifecycle costs of the Project over its useful life, by a factor of five (Benefit Cost Ratio = 5.61). The benefits to the host community and region would be substantial and justify the costs of implementation and operations. The Preferred Alternative assets will create large resiliency values, social values, environmental values and economic revitalization benefits to the Hudson River communities of the City of Hoboken, Jersey City and Weehawken, as well as other beneficiaries from the New York/New Jersey metropolitan region¹.

Table 2 shows the monetized costs and benefits of the Project for Resist Alternative 3. The largest group of benefits consists of resiliency values related to flood risk protection provided by the Project's assets. In summary, the lifecycle costs to build and operate the proposed Resist Preferred Alternative Project (amounting to \$213.4 million in constant 2017 present value dollars) would generate the following benefits:

- Total benefits of \$1.2 billion, of which:
 - Resiliency Values are: \$1.05 billion
 - Environmental Values are: \$65.3 million
 - Social Values are: \$47 million
 - Economic Revitalization Benefits are: \$33.9 million

The Project's cumulative present value of net benefits (benefits minus costs) is \$ 982.6 million, and the Benefit Cost Ratio (BCR) (Benefits divided by Costs) is 5.61. These net benefits demonstrate that the Project has substantial merit and would add value to the community and region. The Resist Alternative 3 Project would benefit other coastal areas that are susceptible to the three different annual chance coastal storm events: 10% (10-year), 2% (50-year), and 1% (100-year). These areas are located outside of the Project area but are within these vulnerable flood hazard zones.

¹ See Social Value and Economic Revitalization sections.

Table 2: RBD Hudson Project – Resist Alternative 3: Benefit Cost Analysis Summary Cumulative Present Values (2017-2067) Constant 2017 US Dollars	
	Cumulative Present Values [Discount Rate = 7%]
LIFECYCLE COSTS	
Project Investment Costs \a	\$194,934,026
Operations & Maintenance (O&M)	\$18,431,043
Total Costs	\$213,365,069
BENEFITS	
Resiliency Values	\$1,049,805,724
Avoided Flood Risk Damages:	
Structures	\$404,538,532
Contents	\$240,785,789
Displacement / Loss of Function	\$282,824,194
Avoided Mental Stress & Lost Productivity	\$95,535,861
Avoided Cost of Power Outages	\$10,523,966
Avoided Costs to Critical Infrastructure (HSRA)	\$1,232,070
Avoided Casualties (Mortality & Injuries)	\$14,365,313
Environmental Values (water quality improvements)	\$65,264,648
Social Values	\$46,991,423
Avoided Medical Costs from Sewer Backup Events	\$25,032,451
Recreation Value of Added Park Space	\$21,824,398
Stormwater Retention Value of Added Park Space	\$134,574
Economic Revitalization Benefits	
Property Value Impacts	\$33,924,000
Total Benefits	\$1,195,985,795
Benefits less Costs (Net Present Value)	\$982,620,726
Benefit Cost Ratio (BCR)	5.61
Notes:	
\a Note that because Project construction is anticipated to occur start in Feb. 2019 and last 44 months, the present value calculation of costs (as of 2017) will appear to be lower than the nominal project investment costs shown in the cost estimates and Feasibility Study due to the application of the 7% HUD recommended discount rate	

The Project's future annual benefit and cost streams, projected over the 50-year planning horizon, were subjected to a sensitivity analysis. The sensitivity analysis tested how key variables and parameters, if changed, would alter the economic feasibility of the Project, measured by the BCR and the net present value. The sensitivity analysis examined potential construction cost overruns, construction schedule delays, and O&M increases as well as substantial reductions in the largest benefit categories. The results showed that the Project's net present value of benefits is robust and can withstand these standard stress factors given the uncertainties that may arise, and remain economically viable over this period.

5.1 BCA Process Description

The BCA narrative was prepared by Louis Berger U.S, Inc. (Louis Berger), using inputs provided by the flood risk reduction BCA completed by Dewberry. The full BCA narrative is included in Appendix C. In addition, the BCA incorporates information and inputs from the various contributors to the Feasibility Study (FS) including costing experts (Dewberry, Hill International Inc.), team members working on the EIS review, the Draft Environmental Impact Statement and the City of Hoboken, New Jersey Proposed Stormwater Management Plan, Health Impact Assessment (HIA) Final Report. Louis Berger provided value added expertise relevant to the BCA in terms of resilience, landscape design, coastal and environmental engineering, ecology, economic analysis, geographic information systems, project evaluation, engineering economics and socio-economics. In addition, Louis Berger applied its own research findings, collective multidisciplinary expertise, experience, and professional judgment in completing the BCA on behalf of the State of New Jersey.

5.2 Description of Proposed, Funded Project

The Project's Preferred Alternative includes two options. Option 1 will include an alignment south of Observer Highway, within the rail yard (south of the proposed Hoboken Yard Redevelopment Area). Option 2, which is slightly more expensive, will feature an alignment along Observer Highway from Washington Street directly to Marin Boulevard. The Project's main elements include the flood gates and superstructure and substructure infrastructure necessary to achieve the resiliency goals and objectives. Among these elements are inlets and pipes for stormwater drainage to the NHSA system. In addition, the Project elements also consist of environmental remediation costs, utilities, urban design features (including landscaping), engineering, FS/EIS, inflation escalation and contingencies.

Construction for Resist infrastructure in the Preferred Alternative would begin in February 2019 and last 44 months. The construction would occur concurrently for the northern and southern resist features. Equipment required for this project includes dump trucks, backhoes, pile drivers, concrete trucks, and other assorted delivery trucks. Some street closures will be required, particularly for gate construction. Pile driving will be required over nine work months. A total of 6,000 crew days will be required to complete this construction. (Draft EIS, 2017).

Project Schedule, Useful Life and Discount Rate:

Project construction is anticipated to start in February of 2019 and last 44 months. For the purposes of this BCA, the capital construction costs (Project Investment

Costs) are phased in ratably over this time period. The BCA also assumes a 50-year project evaluation time horizon. A discount rate of 7 percent, recommended by HUD and per OMB Guidelines, has been applied.

5.3 Full Project Cost

The total nominal construction cost of the Preferred Alternative - Option 1 is estimated to cost between \$224.4 million and \$249.9 million. The total construction cost for Preferred Alternative - Option 2 is estimated to cost between \$238.1 million and \$268.5 million. For the purposes of the BCA, the midpoint of each option was applied and averaged. This convention is acceptable practice for the BCA. For the purposes of the BCA the sensitivity analysis addresses the range of estimated capital investment costs, per each option, and the potential impacts to the BCR from potential cost overruns and uncertainties.

Since the BCA depicts each future year over the fifty year project evaluation period, the total construction cost was phased in over the multi-year construction period per information received from Hill International Inc. Hill provided shares of the total costs that would be implemented over the years 2019 through 2022 and these ranges were used to create the BCA's capital investment phase-in assumptions (Hill International, 2017). The cumulative present value of the cost, in current 2017 terms, falls within the budget of \$230 million. **Table 3** shows the summary nominal (undiscounted) capital investments costs for the Preferred Alternative, Options 1 and 2. Table 4 compares the projected nominal future costs and the discounted annual costs applying the capital investment phase-in assumption shares.

Table 3: Summary of Cost Estimates for the Preferred Alternative (Alternative 3)			
Alternative No. 3 (Option 1)	Low Range Estimate	Midpoint of Range	High Range Estimate
Construction Costs	\$132,134,421	\$142,293,755	\$152,453,089
Design, Engineering & Program Management Costs	\$53,241,893	\$53,241,893	\$53,241,893
PROJECT COSTS (Inflation Included) Without Contingencies	\$185,376,314	\$195,535,648	\$205,694,982
Contingency	\$39,085,885	\$41,625,719	\$44,165,552
Total Estimated Project Costs	\$224,462,199	\$237,161,367	\$249,860,534
Alternative No. 3 (Option 2)	Low Range Estimate	Midpoint of Range	High Range Estimate
Construction Costs	\$140,758,854	\$152,915,810	\$165,072,766
Design, Engineering & Program Management Costs	\$55,492,396	\$55,492,396	\$55,492,396
PROJECT COSTS (Inflation Included) Without Contingencies	\$196,251,249	\$208,408,205	\$220,565,161
Contingency	\$41,804,619	\$44,843,858	\$47,883,097
Total Estimated Project Costs	\$238,055,868	\$253,252,063	\$268,448,258

Table 3: Summary of Cost Estimates for the Preferred Alternative (Alternative 3)

Midpoint Nominal Capital Cost Applied in CBA \a		\$245,206,715	
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Source; Dewberry, Hill International Inc.

Notes: \a The nominal capital investment cost is phased in over the years 2019 – 2022. The cumulative present value of this cost, in 2017\$ is less than \$230 million.

Table 4: Alternative 3: Nominal and Discounted Capital Investment Costs by Construction Year

	Total/Cumulative Present Value	2019	2020	2021	2022
Capital Cost Phase-in Shares, %	100%	18.0%	34.5%	35.0%	12.5%
Nominal Capital Costs (Mils. \$)	\$245.2	\$44.1	\$84.6	\$85.8	\$30.7
Discount Factor (i = 7.0%)		0.8734	0.8163	0.7629	0.7130
Discounted Capital Costs (Mils. \$)	\$194.9	\$38.6	\$69.1	\$65.5	\$21.9

Source; Dewberry, Hill International Inc.

Table ES-1, located in Appendix C: Full BCA Narrative, shows the cumulative present value of the total construction and operational and maintenance costs. Because the 7% discount rate is applied to future years when these costs would be incurred (construction implementation years) the cumulative discounted costs will appear lower than the nominal costs of the alternatives provided in the capital cost estimates.

5.4 Description of Existing Problem

The Study Area, comprising the entire City of Hoboken and adjacent areas of Weehawken and Jersey City, is vulnerable to flooding from both coastal storm surge and inland rainfall events. The purpose of the Project is to reduce the flood risk within the Study Area. The Project intends to minimize the impacts from surge and rainfall flood events on the community including adverse impacts to public health and safety, as well as economic vitality, while providing benefits that will enhance the urban condition, recognizing the unique challenges that exist within a highly developed urban area.

The Study Area is a densely populated urban area of Hudson County with very little impervious surface situated along the Hudson River directly west of Manhattan, New York. The Study Area is vulnerable to two interconnected types of flooding:

- coastal flooding from storm surge and high tide, and
- systemic inland (rainfall) flooding from medium (generally a 5-year, 24-hour) to high (generally over 10-year, 24 hour) rainfall events.

Coastal flooding happens with much less frequency than rainfall flooding events, but can devastate widespread areas of the Study Area and cause significant economic damage and safety concerns. Rainfall induced flooding occurs with substantially greater frequency than coastal flooding, but causes less severe economic damage and safety concerns. The flooding problems for both coastal flooding and rainfall-induced flooding can be attributed to several factors including naturally low topography and proximity to waterways; significant areas impervious ground coverage which causes surface runoff; existing combined storm sewer infrastructure that cannot handle the volume of water during significant rainfall events; and insufficient storm sewer discharge capability, particularly during high tide.

The Project would minimize the likely future impacts from coastal and rainfall flooding and would provide protection for public health and safety, and the economic vitality of the community of Hoboken and its beneficiary neighbors in Weehawken and Jersey City.

5.5 Risks If RBD Hudson is Not Implemented

The devastating impacts to the City of Hoboken, New Jersey and the adjacent river communities in Jersey City and Weehawken from Superstorm Sandy have been widely documented. The City of Hoboken's exposure to flood hazard risks is evident by the number of properties included in the FEMA NFIP. According to NFIP statistics (<https://www.fema.gov/policy-claim-statistics-flood-insurance>), as of August 31, 2016, the City of Hoboken had 9,446 NFIP policies in place (the highest in Hudson County), with premiums totaling \$7,213,754 (the highest in Hudson County and fifth highest in New Jersey). In addition, the overall liability to the NFIP from property owners in Hoboken was over \$2 billion (third highest in New Jersey) with an average claim amount of \$26,733 (FS, 2016).

5.6 List of Benefits and Costs of the RBD Hudson Project

Lifecycle Costs

The lifecycle costs of the intervention over the Project's lifetime are necessary for the BCA and to determine economic feasibility (i.e., whether the cumulative present value of the Project benefits exceed the cumulative present value of costs over this period). The Project's lifecycle costs consist of both project investment costs (upfront capital construction costs) and long-term annually recurring operations and maintenance costs.

Project investment costs were obtained from the Draft Privileged and Confidential cost estimates prepared and reviewed by Hill International and reflect the midpoint of the low and high ranges. Similarly, the annual operational and maintenance costs projected within the BCA's Project Resource Statement reflect the midpoint of a low and high annual O&M cost. The annual midpoint applied was \$1.9 million per year, (calculated as the midpoint of the estimated annual O&M range, \$1.4 million - \$2.4 million).

Resiliency Values

I. Avoided flood risk damages:

Dewberry estimated the avoided flood risk damages to building structures, their contents, and the avoided costs of displacement and loss of function (LOF) for vulnerable properties and residents. Dewberry also estimated the avoided costs of mental stress and lost productivity that would be experienced by the impacted populations. The benefits were estimated as the difference between the future without project situation (the No Action Alternative or NAA) and the residual expected damages that would occur "with" the Resist Preferred Alternative being implemented. The benefits for each of the three proposed "Resist" alternatives were estimated under three different annual chance coastal storm events: 10% (10-year), 2% (50-year), and 1% (100-year). The net benefits from the Resist Preferred Alternative option were applied in the BCA contained in this analysis. The benefits can be applied or offset to either option 1 or 2, in terms of cost. In the BCA, the midpoint of the Option 1 and 2 Cost was applied. The sensitivity analysis accounts for the higher cost option and goes above this amount to test the impact on the Benefit Cost Ratio in terms of higher cost tolerance. The expected annual damages (avoided flood risk costs) were the sum of the three annual chance storm events by severity type.

Dewberry followed a five-step process to estimate the net benefits of Resist Preferred Alternative. The first step was to estimate the flood depths that would be experienced under each annual chance storm / inundation event. The MIKE 21 coastal model was applied to property parcels under this step using GIS analysis. The second step was to gather and analyze parcel level data by type and size of the structures. Parcel data was obtained from the State of New Jersey's MOD IV database. The MOD IV database is maintained by the New Jersey Department of the Treasury and is used by county tax assessors to compile parcel-level data on individual properties that comprise the tax base.

The third step was to assemble and apply appropriate depth damages functions (DDFs) to the property/asset data base that was assembled. The depth-damage functions (DDFs) depict the relationships between the depth of flooding on a property and the amount of monetary damage that can be attributed to the flooding (measured as a percent of building replacement value).

The selected residential DDFs applied were based on the USACE generic DDFs for the residential building types located within the study area. This application of the DDFs step was applied to estimate the physical damages that would occur under each storm event return period both under the NAA and after the construction of the alternatives. Select DDFs were applied to estimate damages for (i) Structures, (ii) Building Contents and (iii) Displacement/loss of function. Since the Project area has a number of mid- and high-rise residential structures, Dewberry made adjustments to the USACE generic DDFs (which were originally developed for low-rise residential buildings with and without basements) to apply them to the mid- and high-rise buildings.

Displacement and LOF damages are the costs associated with not being able to use the structure. For residential structures, these damages are based on the number of days that the structure cannot be occupied, and for non-residential structures, it is based on the number of days that the structure cannot provide service. The non-residential loss of service consists of two components, a one-time disruption cost and a recurring monthly cost for the duration of the displacement. Both costs are measured in dollars per square foot. Data on the recovery time, onetime, and monthly loss of service costs were obtained from the FEMA Benefit Cost Analysis Re-Engineering (BCAR) guide to estimate the non-residential loss of service (FEMA BCAR, 2011).

The fourth step was to estimate the Project benefits associated with the avoided damages. The structure and contents damages were estimated by applying the DDFs to the Building Replacement Values (BRV) estimated for each parcel. BRVs were estimated by multiplying the size of the building structure (in square feet) by the construction costs (\$/square foot) based on data adapted from RS Means®. The construction costs differed based on the type of building and were adjusted to reflect the local market conditions within the study area. The DDFs for structure and contents estimate the damage as a percentage of the BRV. The percentage increases as the flooding depth increases.

The residential displacement damages were based on the number of days that the displaced residents were removed from their properties due to flood related damage, and the number of residents per unit. The General Services Administration (GSA) per-diem rates for the study area, amounting to \$234/person/day were applied in the analysis. The number of days of displacement was determined by the DDFs applied. To estimate the number of residents in each type of unit, the data from the U.S. Census Bureau's American Community Survey Public Use Micro Data (PUMS) dataset specific for the study area was used.

Under the with and without Resist Project framework, for each storm frequency, the damages that would occur under the NAA (without Project) and the damages that would occur after the Resist Project is implemented were estimated. The difference between the “without Project” and the “with Project” event damages represents the amount of damages that would be avoided (the net benefit) if the Preferred Alternative Project was constructed. The avoided damages across all parcels in the study area were summed to arrive at the aggregate Project benefits (Dewberry, 2016).

II. Avoided Mental Stress & Lost Productivity Damages

Dewberry also estimated the public health related social benefits (avoided damages) associated with the mental stress and anxiety suffered by residents and the loss of productivity to wage earners caused by flood events. Dewberry used the FEMA method to measure these benefits and applied the currently allowed unit values for use in the benefit calculations: (i) \$2,443 per resident for avoided mental stress and anxiety (ii) \$8,736 per resident for avoided loss of productivity. The 2010 US Census and other local resources were used to estimate the residential and wage earning populations within the study area that would be protected by each alternative. The FEMA unit values were then applied to the affected population to estimate the total social benefits for Preferred Alternative (Dewberry, 2016).

The annual expected avoided damages per each of the resiliency categories estimated by Dewberry were then represented within the annual Project Resource Statement used in this BCA, as the main category of Resiliency Value benefits. Figures 2 through 4 are reproduced from the Dewberry BCA and show the relative magnitude of avoided damages per each storm event return period estimated. These figures are included in the main report attached in Appendix C .

III. Avoided Cost of Power Outages

It has been well documented that Superstorm Sandy exposed the vulnerabilities to extreme climatic events facing residents in the Project Area and the risks to critical infrastructure. During Sandy, the coastal storm surge waters flooded electric utility substations and transformers and a significant number of Jersey City and Hoboken residents were without electric power service for nearly two weeks (Draft EIS, 2016). In fact, one fatality in Jersey City was attributed to the lack of lighting due to the loss of power for several weeks (Star-Ledger, 12/2/12). The BCA estimates the avoided cost of power outages to the Project area for a significant climatic event of Sandy’s magnitude and counts this averted loss as a benefit because the risk of these damages would be greatly reduced with Project Alternative 3. **Table 5** shows the key data and parameters applied in the estimate.

Table 5: Parameters and Data Applied in Avoided Cost of Power Outage Estimate		
Parameter / Data / Information	Value	Note / Source
Days without power (Sandy, Jersey City, Hoboken, NJ)	14	page 32, EIS
Estimated Percent without Power (%)	75%	Jersey City recovers after Hurricane Sandy, The Jersey Journal, M. Conte, Oct. 30, 2012. http://www.nj.com/hudson/index.ssf/2012/10/jersey_city_recovers_after_hur.html
Projected Project Area Population (2023)	71,726	New York Metropolitan Transportation Council
75% of Projected Area Population	53,795	
Discount Rate	7%	HUD BCA Guidance
100 Year Event Annual Chance Factor	1%	= 1/ 100
FEMA - Economic Impacts of Loss of Electric Power Per Capita Per Day \a		
Category	Value (2017)	
Impact on Economic Activity	\$117.0	Calculated from 2010 value
Impact on Residential Customers	\$27.1	Calculated from 2010 value
Total Economic Impact	\$144.1	Calculated from 2010 value
GDP Implicit Price Deflator Escalator \b	1.1009	GDP Deflator _{2016: Q4} /GDP Deflator _{2010: Q4}
Projected cost of power outage (14 days):	\$108,488,352	
Projected annual cost of power outage (expected annual damage)	\$1,084,884	Adjusts total projected loss over 14 days by annual chance factor (1%)
Source/Notes: \a FEMA BCAR 2011 \b Gross Domestic Product: Implicit Price Deflator, Index 2009=100, Quarterly, Seasonally Adjusted, FRED		

To estimate the loss of electric power services that would be experienced by the Project Area's estimated vulnerable population during a comparable Sandy type storm event, the FEMA methodology was applied (FEMA BCAR, 2011). The FEMA method applies the following steps: 1) Estimate the physical damages to the electric power system in dollars, 2) Estimate the functional downtime (system days of lost service), 3) Obtain the number of people served by the electric power utility, and 4) Calculate the economic impacts of lost electric power service using the per capita economic impacts and the affected population.

Table 5 shows that the Project area vicinity lost power for 14 days and approximately 75% of the population were impacted over that time period. The projected Project Area population (starting in the year 2023, the first year of Resist operations) was obtained from the New York Metropolitan Transportation Council (NYMTC). The bottom portion of **Table 5** shows the FEMA per capita per day economic impact estimate values. The original values (in 2010 US\$) have been updated to 2017 US dollars by applying the GDP Implicit Price Deflator index. Using the combined data, it is estimated that the impact to the Project Area of a 14-day power outage was \$108.5 million. Adjusting this total loss by the annual 1% chance factor results in a projected expected annual damages amount that would be averted of approximately \$1.1 million, on average. The cumulative present value of

the expected annual damages amounts totals \$10.5 million over the 50-year project evaluation period.

IV. Avoided Costs to Critical Infrastructure (NHSA)

During Sandy, numerous types of critical infrastructure were impacted within the Project Area. The infrastructure included hospital services, police and fire services and emergency response assistance. The BCA did not quantify and monetize the benefits that the Resist Alternative 3 would have on the avoided costs of interruptions to all critical infrastructure services. However the benefits to these services is qualitatively acknowledged and would be assigned (++ = expected strong positive impact) under HUD's qualitative assignment system (HUD CPD-16-06).

The BCA was able to quantify and monetize the service impacts to the North Hudson Sewerage Authority (NHSA, the "Authority"). The Authority serves an estimated population of approximately 185,000 (Fitch, 2016). The Study Area's population represents approximately 39% of the Authority's population. The daily average treatment flow is 21.95 mgd and the NHSA has a maximum treatment plant capacity of 30.8 mgd. The City of Hoboken's share of flows is approximately 29-30% of the average daily total amount (HSRA, 2016). Superstorm Sandy had a large impact on the Authority and its customers within the Study Area. The treatment plant was down for 24 hours, while full treatment was restored within 36 hours (HSRA, 2016). In October of 2012, the Authority incurred expenditures for emergency repairs as a result of Sandy. The total cost of the repairs is estimated to be approximately \$12.6 million (NHSA, 2016).

The above information was applied to estimate the benefits of the Project in terms of resilience protection it would offer to the wastewater treatment plant (WWTP) critical infrastructure and the service population within the Study Area. The historic event of Sandy is applied as a "one percent annual chance" event in terms of expected annual damages that would be mitigated by the Preferred Alternative Project. **Table 6** shows key data applied in the calculations of the mitigated damages to the Authority's critical infrastructure and customer service base. The avoided costs to critical infrastructure were estimated as the combined averted costs of emergency repairs that would be incurred for an event of Sandy's magnitude and the loss of sewage treatment service experienced by NHSA customers within the Study Area.

Table 6: Parameters and Data Applied in Avoided Costs to Critical Infrastructure NHSA Estimate

Parameter/Data	Value	Source
HSRA Estimated total cost of emergency repairs, Superstorm Sandy	\$12,600,000	NHSA, 2016
Annual chance factor, 100 yr. event	1.0%	=1/100
Effective annual avoided costs	\$126,000	
Discount Rate:	7.0%	
Downtime Loss of Service to Customers (36 hours):	1.5 days	NHSA, 2016
Total User Fees and Charges plus Connection Fees	\$55,944,969	NHSA, 2016
Average daily charge per capita	\$0.83	
Study Area Population (Est. 2017)	71,976	NYMTC
Estimated averted cost of lost service (1.5 days downtime)	\$89,449	

The cumulative present value of the combined averted damages would total \$1,232,070 over the projected 50-year period.

V. Reduction in Expected Casualties (Mortality and Injuries)

Since the BCA is forward looking, event based mortality estimates were developed assuming impacts would be comparable to those for a Superstorm Sandy type event and a 100-year storm return period extrapolated over the 50-year project evaluation period (planning horizon). The historical record was examined and two individual deaths were reported within Jersey City, New Jersey. These deaths were attributable to forces and impacts from severe flooding and inundation that would be avoidable or mitigated with Project infrastructure in place. Therefore, the BCA includes likely avoided mortality benefits and associated avoided injuries within the Project area.

The Expected Annual Damages calculation applied for this BCA over the 50-year project evaluation horizon is based on the 1% annual chance event. The adjustment factor calculation adjusts the total Value of Statistical Lives (VSL) monetary estimate for two expected deaths by a 1% factor (return period reciprocal: 1/100) each and every year over the projection period. The VSL estimate is the HUD suggested value assigned to value the benefits from an avoided fatality. The 1% factor is also applied to the estimated projected number of non-fatal injuries. **Table 7** shows key parameters and assumptions applied in the mortality and injury estimates.

Table 7: Parameters and Assumptions Applied in Mortality and Injury Estimates

	Parameters	Value	Note
	Discount Rate	0.07	
	Expected Fatalities avoided:	2	Star-Ledger, 12/2012, reflects Jersey City, NJ
	Storm event return period	100	
	Annual 1% chance storm	0.01	

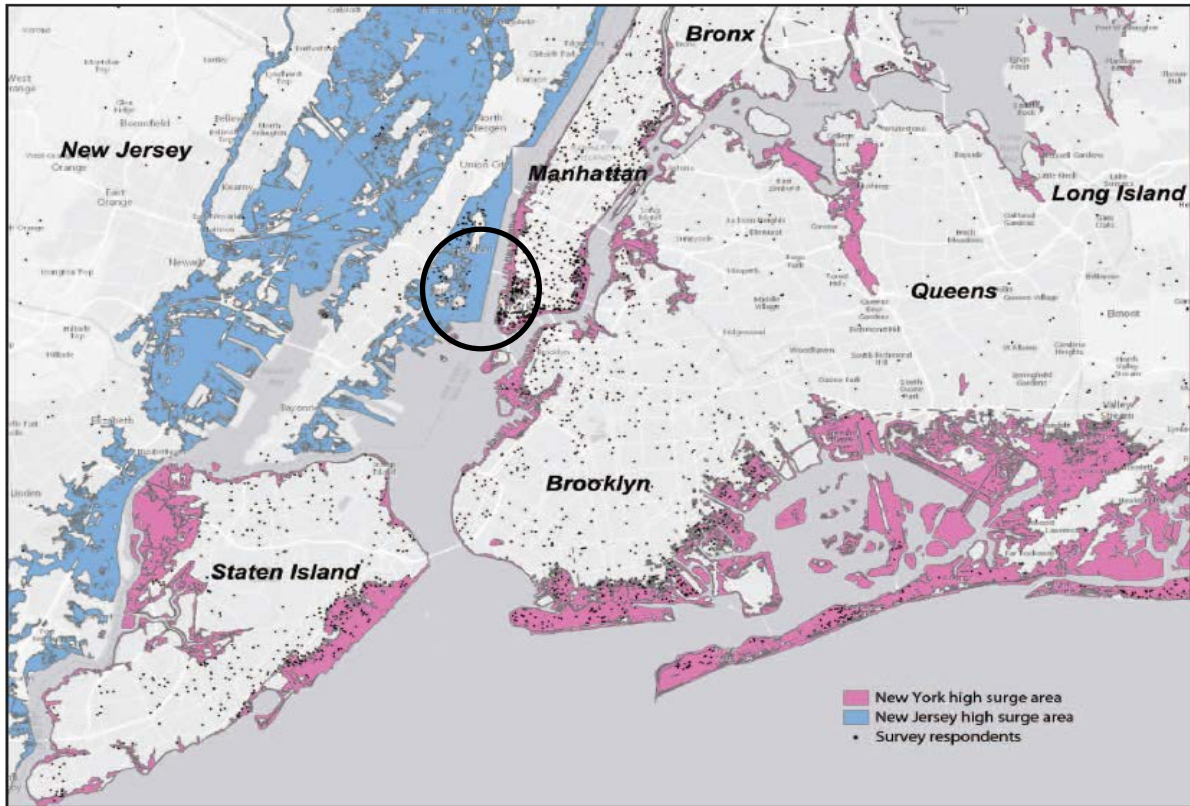
Table 7: Parameters and Assumptions Applied in Mortality and Injury Estimates			
	Fatality Rate (% of base population at risk)	2.78%	per 1,000 population
	Injury Rate:	10.4%	CDC. MMWR / October 24, 2014 / No. 42
	Percent of population impacted:	50.00%	

The population growth rates applied to the base population at risk in the projections were sourced from New York Metropolitan Transportation Council's (NYMTC) population projections for the Project area (NYMTC, 2016).

The injury rate was sourced from a Centers for Disease Control (CDC) report released post-Superstorm Sandy. This study, entitled "Nonfatal Injuries 1 Week after Hurricane Sandy — New York City Metropolitan Area, October 2012" examined reported injuries one week after Sandy, by area (CDC, 2014). The study found that of the at-risk population, 10.4% sustained an injury in the first week after Sandy. The Study Area, including Hoboken, was within this study's sampled and respondent population. In fact, most of the populations that were impacted sustained more than one injury (CDC, 2014).

Figure 7 below shows a map of the sampled respondent points within the inundation zones that was used in the referenced study. A circle has been superimposed over the Hoboken vicinity.

FIGURE. Hurricane Sandy inundation zones — New York City metropolitan area, October 2012*



Source: New York City Department of Health and Mental Hygiene, World Trade Center Health Registry.

* Map depicts 80% (n = 1,970) of respondents in the inundation zone sample and 47% (n = 991) of respondents in the sample of persons not in an inundation zone.

Figure 7: Map of Surveyed Respondents falling within CDC's Study by Superstorm Sandy Inundation Zone

The injury rate was applied to the projected population at risk over the project evaluation period to calculate the expected number of non-fatal injuries. From the CDC Study, the severity of injuries reported were mostly arm cuts, leg cuts, hand cuts and back, leg and foot strains. These types of injuries were cross-referenced to the most likely Abbreviated Injury Scale (AIS) suggested for use under the HUD Guidance for Benefit Cost Analysis (HUD CDP 16-06). **Table 8** reproduces the AIS table.

Table 8: Selected Sample of Injuries by the Abbreviated Injury Scale (AIS)		
AIS	Injury Severity	Selected Injuries
1	Minor	Superficial abrasion or laceration of skin; digit sprain; first-degree burn; head trauma with headache or dizziness (no other neurological signs).
2	Moderate	Major abrasion or laceration of skin; cerebral concussion (unconscious less than 15 minutes); finger or toe crush/amputation; closed pelvic fracture with or without dislocation.
3	Serious	Major nerve laceration; multiple rib fracture (but without flail chest); abdominal organ contusion; hand, foot, or arm crush/amputation.

Table 8: Selected Sample of Injuries by the Abbreviated Injury Scale (AIS)		
AIS	Injury Severity	Selected Injuries
4	Severe	Spleen rupture; leg crush; chest-wall perforation; cerebral concussion with other neurological signs (unconscious less than 24 hours).
5	Critical	Spinal cord injury (with cord transection); extensive second-or third degree burns; cerebral concussion with severe neurological signs (unconscious more than 24 hours).
6	Unsurvivable	Injuries, which although not fatal within the first 30 days after an accident ultimately result in death.
Source: HUD CPD-16-06		

The estimated injuries were therefore assigned as AIS 1 Minor given that they corresponded to AIS 1.

To estimate the avoided monetary cost of projected deaths and injuries, the HUD Guidance Source, *Table 2-2: Relative Disutility Factors by Injury Severity Level, (for Use with 3% or 7% Discount Rates)* (HUD CPD-16-06) was applied. The cumulative number of deaths and injuries were valued by applying the updated 2017 Dollar values to these injury estimates by year. The updated 2017 dollar values were escalated based upon applying the CPI cost escalation factor (2017 CPI / 2015 CPI) of 1.030. **Table 9** shows the values below.

Table 9: Relative Disutility Factors by Injury Severity Level, (for Use with 3% or 7% Discount Rates)				
AIS Code	Description of Injury	Fraction of VSL	2015 Dollar Value	2017 Dollar Value
AIS 1	Minor	0.003	\$28,800	\$29,671
AIS 2	Moderate	0.047	\$451,200	\$464,852
AIS 3	Serious	0.105	\$1,008,000	\$1,038,500
AIS 4	Severe	0.266	\$2,553,600	\$2,630,867
AIS 5	Critical	0.593	\$5,692,800	\$5,865,052
AIS 6	Unsurvivable/Fatal	1	\$9,600,000	\$10,028,943
Sources: See HUD CPD-16-06, page 9. Note that the original table found within the HUD Guidance was updated per the table called "Relative Disutility Factors by Injury Severity Level, (for use with 3% or 7% Discount Rates) sourced from the FAA document, <<econ-value-section-2-tx-values.pdf>> https://www.faa.gov/regulations_policies/policy_guidance/benefit_cost/media/econ-value-section-2-tx-values.pdf U.S. Department of Labor, Bureau of Labor Statistics, CPI				

Combined annual values for both the projected avoided costs of mortality and the avoided cost of injuries were calculated in the final step of the valuation procedure. The projected annual values were then discounted to present values by applying the HUD BCA Guidance 7% discount rate (HUD CPD-16-06). The cumulative present value of the combined averted casualty damages would total \$14,365,313 over the projected 50-year period.

Social Value

I. Avoided Medical Treatment Costs from Sewer Backup Events

A main goal of the RBD Hudson River project is to reduce the risks to public health. One of the Project's objectives is to reduce the adverse health consequences resulting from combined sewage backup into residential areas that exposes vulnerable populations to health risks posed from contact with contaminated flood waters and sewage residues containing harmful contaminants and constituents. Stormwater infiltration into the existing combined sewer collection systems has resulted in recurrent frequent exposures to residents. Under the BCA framework, Project infrastructure and elements that would prevent and reduce the frequency of such backup events from occurring results in ongoing annual benefits that are measured by avoided public health impacts and medical costs that are no longer incurred by residents.

Using data obtained from the City of Hoboken, *New Jersey Proposed Stormwater Management Plan Health Impact Assessment* (HIA-2016), the estimated exposures that would occur under the "without project" situation were estimated for a portion of the Study Area's population. Sixty percent of the survey respondents from the City of Hoboken's Stormwater Management Plan Health Impact Assessment survey reported that sewer backup is a problem when it floods. The survey reported that one third of the respondents (28 percent) reported experiencing one or more of the following symptoms: headaches; vomiting; abdominal cramping, nausea, or diarrhea; muscle aches; eye irritation/infection; asthma or other respiratory condition; or skin rash. Twenty-three percent of respondents reporting seeking medical attention as a result of experiencing one or more of the symptoms. Approximately 3% reported an injury requiring medical attention due to regular persistent flooding. In addition, 2% reported seeking counseling and mental health services to cope with the adverse consequences of regular flooding.

To calculate a measure of the avoided cost associated with the reduction in human suffering caused by exposure to contaminated flood waters, the following procedures were applied. The projected population for the City of Hoboken was obtained from the New York Metropolitan Transportation Council (NYMTC, 2016). An estimate of flood frequency per year, where sewer backup would be involved under the "without project" situation was obtained from the EIS. The EIS documented that, "rainfall events of greater than two inches, combined with a high tide of four feet or greater, occurred 26 times in Hoboken from 2002 to 2012." (Draft EIS, 2016 p. 35). The rate of frequency of events that would involve backup was 2.6 times/year, on average. The percentage of the population requiring medical treatment from a contaminated flood incident (3%) was applied to the City's

projected population as a conservative estimate of the population at risk of exposure who would seek medical treatment, per event.

The medical costs of visiting a physician and for an emergency room visit for a minor health incident were sourced from the Healthcare Bluebook cost estimator for the area of Hoboken, New Jersey. The Healthcare Bluebook Fair Price is the reasonable estimated price that a consumer should pay for a service in a given geographic location. The Fair Price is calculated from a nationwide database of medical payment data, sorted by your geographic area (zip code) (Healthcare Bluebook, 2016). **Table 10** shows the parameters that were applied in the avoided cost calculation.

Table 10: Parameters and Data Applied in Avoided Medical Treatment Cost Calculation from Sewer Backup Events			
	Calculation Element	Value	Note
\a	Frequency of flood events causing sewer backup	2.6	Estimated average per year
\b	Percentage of Hoboken Residents reporting from HIA Survey that injury from exposure event required medical attention	3%	Does not include percentage that sought mental health treatment or counseling
\c	Estimated Number of Hoboken Residents sustaining sewerage backup related illness injuries requiring medical attention (per backup event)	1,618	Per event per year
\c	Estimated total number of people injured per year, assuming average event frequency	4,208	2.6 x / yr.
\d	Estimated Healthcare costs from Healthcare Bluebook (for City of Hoboken, NJ, Zip Code, 07030, (02/08/17)		
	Office Visit, Established Patient (≈ 40 min.)	\$306	Per visit / current dollars, 02/08/17
	Emergency Room Visit, Minor Problem	\$780	Per visit / current dollars, 02/08/17
	Average:	\$543	Average of office and ER visits
	Estimated Annual Avoided Cost of Medical Treatment	\$2.3	US\$ Million per year
Sources \ Notes: \a EIS page 35 \b HIA 2016 \c NYMTC 2016 and HIA 2016. Per the EIS 2016, page 35, “rainfall events of greater than two inches, combined with a high tide of four feet or greater, occurred 26 times in Hoboken from 2002 to 2012 and is expected to increase in frequency over time based on projections of sea levels rising.”. So the frequency was calculated as 26/(2012-2002) = 2.6x/yr. \d Healthcare Bluebook, accessed 2/8/2016			

The above conservative calculation does not include the cost of avoided counseling and mental health treatment services. In addition, the avoided cost of medical services does not include the associated cost of lost productivity that the region would incur from residents who miss work due to the exposure to health incidents.

The benefit cost analysis credits these benefits after the Hudson River project infrastructure is implemented. These benefits would start to accrue in the year 2023, during the Project's operational phase (post commissioning). The BCA project evaluation is for a fifty year period spanning from 2017 to 2067. The cumulative present value of the avoided medical treatments costs over this time horizon amounts to **\$25,032,451**, using a 7% discount rate.

II. Recreation Value of Added Park Space

Under the Preferred Alternative for Resist only, area residents would gain 2.55 acres of open space for parks. Contemplated improvements may include installation of recreation facilities including playgrounds, picnic areas, trails, signage, viewing decks and gathering spaces. These amenities would be available to residents in a densely populated area, and consequently would benefit a large number of potential users.

Open land and additional park space is highly valued in densely populated urban communities. Economists have obtained willingness to pay (WTP) value estimates through surveys that reflect the amounts households are willing to pay for park space that provides for numerous social value benefits such as recreation area venues, public health benefits and community gathering/meeting areas offered by parks. Open spaces and their landscaping breaks up the monotony of the built city landscape with large amounts of impervious surface, and can function as an oasis to area residents.

Studies have also valued preservation and conservation values for residents who may never actually use the park amenities themselves, but may value the option to use them, or the park's value to subsequent generations of users. These are "non-use" values that have also been elicited through various stated preference surveys. Numerous studies have also quantified the property value premium impacts from homes that are located in close proximity to parks. Traditionally, recreational valuations have focused on applying a utility value per day (or a WTP value per person per visit) to a park for a type of recreational visit. These values are then applied to the estimated number of park visits per day to arrive a measure of annual value.

Since the Resist portion of the Preferred Alternative would add to currently designated park space areas, and offer park enhancements, the value of this additional space was quantified by taking an average value obtained from a national survey and applying this value to the estimated population within a one square mile area. According to the National Recreation and Park Association Americans

currently pay an average of \$70 per person per year in local taxes to support park and recreation activities. In fact, two in five Americans are willing to pay even more than the 2015 U.S. average of \$70 per person in local taxes to support their local and regional park systems (NRPA 2016). The \$70 per person value, taken as a conservative lower bound estimate of WTP for incremental park/open space, was updated and applied to an estimate of potential users within the Study area vicinity to arrive at the annual value of recreation from Alternative 3. **Table 11** shows the data that was applied in the estimate.

Table 11: Parameters and Data Applied in Recreation Value Estimate		
Calculation Element	Value	Note
Population Density Hoboken, NJ	39,212	Population per sq. mile
Percent of Americans who say that their local parks are well worth average spending of \$70/person/yr.	80%	4 out of 5, NRPA, 2016
Percent applied to pop/sq. mile	31,370	
Updated 2016 Value per person	\$71.72	CPI adjustment to original 2015 value
Annual Value of Park Benefit to Users	\$2,249,811	(w/in 1 sq. mile)

The cumulative present value of the annual incremental recreational value to users over this time horizon amounts to \$21,824,398 using a 7% discount rate.

III. Stormwater Retention Value of Added Park Space

To acknowledge the stormwater retention value that the Preferred Alternative's open land and incremental park space would provide, the estimated annual value of stormwater that would be retained on 2.55 acres of park space over the life of the Project. This value was based on the estimated gallons of water that would be retained and the avoided cost of treating this annual volume of water that would be incurred by NHSA's, grey infrastructure treatment works. This water volume would be intercepted and would not burden the collection, conveyance and treatment/processing works for the Authority. **Table 12** shows the data and information that was applied in the estimate. The calculation of the annual gallons of stormwater runoff reduced by the Preferred Alternative number of park acres of 2.55 is based upon the following equation (CNT, 2010):

$$\text{runoff reduction (gal)} = [\text{Annual Precipitation, inches}] \times \left[2.55 \text{ ac} \times 43,650 \frac{\text{sf}}{\text{ac}} \right] \times [\% \text{ retained}] \times \left[144 \frac{\text{sq inches}}{\text{sf}} \right] \times \left[0.00433 \frac{\text{gal}}{\text{cubic inch}} \right]$$

Table 12: Parameters and Data Applied in Stormwater Retention Value Estimate		
Calculation Element	Value	Unit
Preferred Alternative Resist open space	2.55	Acres

Table 12: Parameters and Data Applied in Stormwater Retention Value Estimate		
Calculation Element	Value	Unit
Preferred Alternative Resist open space	111,078	sf
1 acre =	43,560	sf
Annual precipitation inches	49.94	https://rainfall.weatherdb.com/l/12058/Hoboken-New-Jersey
Percent of rainfall retained	0.8	%, CNT 2010
Sq. inches / sf	144	CNT 2010
gal / cubic inch	0.00433	CNT 2010
Total runoff reduction (gals)	2,767,050	Estimated gallons
Annual cost of providing treatment services (2016)	\$40,167,566.51	NHSA, 2016, page 94
Daily Average Treatment, mgd	21.95	Mgd, Fitch, 2016
Annual average treatment (gal)	8,011,750,000	
Est. treatment cost per gallon	\$0.0050	Annual Cost / Annual Treatment gallons
Annual cost averted	\$13,872.83	Total runoff reduction x Cost per gal

The cumulative present value of the annual reduction in stormwater runoff that is attributable to the addition of 2.55 acres of parks/open space designed to manage stormwater amounts to **\$134,574** using a 7% discount rate.

Environmental Value

I. Improved Water Quality

The Preferred Alternative would reduce frequent occurrence of combined sewer overflows (CSOs) and improve water quality and ultimately the quality of water entering the Hudson River. As documented within the Draft EIS, the Lower Hudson River Estuary is an urban estuary that has been impacted by runoff from development and stormwater/combined sewer discharges into the waters. These events have resulted in degraded water quality and sediment contamination (Draft EIS 2017, Page 4-13).

Stated preference survey studies have been performed to elicit the values individuals place on water quality associated with improvements made to urban drainage infrastructure that reduces the risks from combined sewer overflows (CSOs). The Seattle Public Utilities conducted a willingness to pay survey of customers in their rate base. Respondents were willing to pay an additional \$0.35 per month (or an additional \$4.2 2005 \$/year) to achieve a minimum sewer backup level of service (Seattle Public Utilities, 2014). A Swiss study investigated the willingness to pay to reduce the ecological and health risks associated with three events: (i) wastewater overflowing in rivers and lakes; (ii) wastewater flooding of streets; and (iii) of cellars. The study results showed that there was a very high WTP to reduce the frequency of CSOs in rivers and lakes compared to the elicited values for the willingness to pay to reduce the risks of wastewater flows in streets

and cellars. The results showed that the highest elicited marginal willingness to pay, expressed as CHF 1,200 higher in annual local taxes was equivalent to 1% of the annual household income. The 2010 US\$ equivalent annual amount of increase in taxes that the survey respondents were willing to pay to reduce the frequency of CSOs in rivers and lakes was equivalent to US \$1,294 (Veronesi et al, 2014).

The Water Environment Federation commissioned a stated preference survey experiment as part of a Handbook developed for utilities. The project also estimated willingness-to-pay to avoid a substantial reduction in service levels due to water-pipe failures. Estimated willingness to pay was \$10.70 [95% CI: \$9.34–\$12.547] per month (\$128/yr. using the Full CE survey instrument (WEF, 2011). Hensher et al. in an Australian study, attempted to establish how much customers are willing to pay for specific levels of utility service by applying a series of stated choice experiments and mixed logit models to establish the willingness to pay to avoid interruptions in water service and overflows of wastewater, differentiated by the frequency, timing and duration of these events. The results showed that the average WTP to reduce the number of overflows is \$77.85 when customers face two wastewater overflows per year (Hensher et. al., 2005). This amount converts to US \$56.8 at the end of 2005.

Table 13: Summaries of Stated Preference Studies Measuring the Willingness to Pay for Water Quality Improvements

Study \a	Water Quality Preference/Change Valued	Willingness to Pay (WTP) per Household	Study Value Date	CPI Escalator	Current Value (2017 US\$)	Country/Region of Study
Seattle Public Utilities	achieve minimum sewer backup level of service	\$4.20	2005	1.243	\$5.2	US/NW
Veronesi et al, 2014 (SUI)	reduce the frequency of CSOs in rivers and lakes	\$1,294.00	2010	1.114	\$1,441.1	Switzerland
WEF 2011	avoid a substantial reduction in service levels due to water-pipe failures	\$128.00	2011	1.080	\$138.2	US / SW
Hensher et. al., 2005 (AU)	avoid overflows of wastewater	\$56.80	2005	1.243	\$70.6	Australia
Carson and Mitchell (1993)	For rivers and lakes (a) Avoid reduction to below-boatable levels, (b) improve from boatable to fishable, and (c) improve from fishable to swimmable	\$168.00	2000	1.410	\$236.9	US/Nationwide
Croke et al. (1986)	For a River system, improve to allow for: (a) outings along the banks of a river, (b) boating and	\$88.00	2000	1.410	\$124.1	US/Chicago

	outings, and (c) fishing, boating, and outings					
Gramlich (1977)	Improve from 1973 status quo to a level of “clean enough for swimming and wildlife” for: (a) rivers nationwide and (b) Charles River	\$167.00	2000	1.410	\$235.5	US/Boston, MA
Cronin (1982)	For Potomac River. Improvement on 5-level index describing 6 water quality attributes (suitability for swimming, suitability for boating, fish habitat, odor, appearance, ecology)	\$41.00	2000	1.410	\$57.8	US/DC
De Zoysa (1995) \b	For a major river basin in Ohio that drains into Lake Erie, reduce algae, turbidity and increase sport fisheries	\$157.00	2011	1.080	\$169.5	US/Ohio
Summary Distribution of WTP for Sample of Water Quality Studies						
Minimum					\$5.2	
Average					\$275.4	
Maximum					\$1,441.1	
Std. Dev.					\$444.00	
Source/Notes:						
\a Van Houtven et. al., 2007						
\b Young and Loomis, 2014.						

These above studies show that researchers have constructed analyses that address how households perceive interventions that can improve water quality and how the willingness to pay for water quality improvements is measured. **Table 13** compiles and contrasts the above noted studies and adds some other study results reflecting valuation of water quality in urban river and watershed systems and lakes. The willingness to pay values have all been updated to 2017 dollar values for comparison.

The bottom portion of **Table 13** shows the range, average and standard deviation of WTP values from the profiled studies. The average WTP value from the sample of studies was \$275.4 per household. This value is in line with a broad comparison of WTP values across many studies. In a comparison of annual WTP for use and non-use values of surface water quality improvements by geographic region (in 2011 dollars) Young and Loomis compiled the results from twelve studies that showed an average willingness to pay of \$258 per household. In 2017 US dollars, this amount would be \$278.5 (Young and Loomis, 2014).

Comparing WTP values to an income distribution reflecting the Project Area for Preferred Alternative can provide more information on the relative percent of

income, across ranges that the average WTP for water quality would account for. **Table 14** shows the average WTP value of \$275.4 as a percent of the midpoint of the median income range, for Hoboken, as a representative comparison for the majority of the Study Area. For fifty-nine percent of the Hoboken population, the average WTP for water quality would represent between 0.1% and 0.2% of the income midpoint for the class range.

Table 14: Hoboken, New Jersey: Distribution of Income and Willingness to Pay for Water Quality Median Income by Percent of Population			
Percent of Population	Income Range	Midpoint	WTP/Income Midpoint
21%	< \$50,000	\$25,000	1.1%
20%	\$50,000 - \$100,000	\$75,000	0.4%
35%	\$100,000 - \$200,000	\$150,000	0.2%
24%	> \$200,000	\$200,000	0.1%
Source: Censusreporter.org (2/22/2017)			

From the City's Health Impact Assessment, it was revealed that sixty percent of survey respondents listed sewer backups as a problem when it floods (HIA, 2016). Undoubtedly, a large share of households place a value on water quality improvements as the literature search revealed. The HIA survey percentage (60%) was applied to the Project Area's households that would most likely be willing to pay the representative average amount for water quality improvements (\$275.4) that would result from the implementation of the infrastructure for the Preferred Alternative.

The annual valuation of water quality benefits was based on multiplying the average WTP for water quality by sixty percent of the projected number of households within the Study area. The cumulative present value of these annual amounts over a 50- year period amounts to \$65,264,648.

Economic Revitalization

The economic livelihood and vitality of the Project Area community is adversely affected by the business disruptions, and social dislocations caused by flooding and the ongoing costs to repair and restore homes and businesses. The potential for future flooding in the Study Area is significant based on Hoboken's topography. Therefore, the need for a project that minimizes flooding is critical to the health, safety, and economic vitality of Hoboken and its affected neighbors in Jersey City and Weehawken (Draft EIS, 2017).

The Project's features and functions would serve to revitalize the community by reducing the disruptions to economic activity and the quality of life of residents who

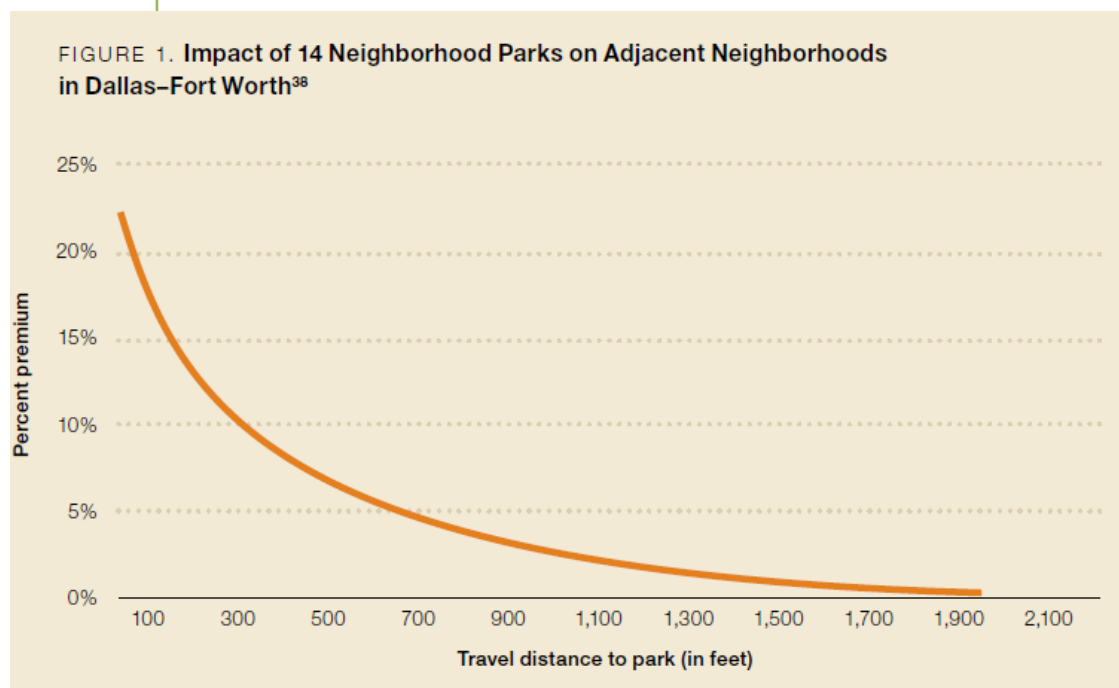
have experienced recurrent flooding and sewer backups. In addition, the additional park land and greenway connectivity would provide more and improved recreational experiences for both permanent residents and tourist visitors. These complementary features will rejuvenate the community and enhance its value and quality of life for all residents.

I. Enhanced Property Values

There is an established body of research that shows that homes adjacent to parks benefit from this close proximity and this is realized as a market price premium. Residents are willing to pay more for a home near a park or open green space and the real estate market confirms this behavior (TPL, 2006). The hedonic price economic studies have assessed the variation in home values based on a basket of factors that determine a home's value. The distance to an adjacent park can be added as an explanatory variable, and the relative contribution of the park to the total home value can then be determined.

One study found that the positive relationship between park proximity and property value holds true in neighborhoods where the residents are mostly immigrants and poor. In a dense urban neighborhood, the value effect of nearby green space can be stronger than lot size itself. The study found that an 11 percent increase in the amount of green space within a radius of 200 to 500 feet from a house leads to an approximate increase of 1.5 percent in the expected sales price of the house (Pincetl et. al., 2003).

Figure 8 shows the results of a property value study completed in Dallas Texas.



Source: Active Living Research, 2010, Miller 2001.

Figure 8: Property Value Premiums and Travel Distance to Adjacent Parks

Figure 8 shows how the market value premium tapers off with increased distance from the neighborhood park site. In addition, researchers have found that in urban areas, a small park located close to residential areas may have a larger impact on home prices compared to a large park located at a greater distance (Active Living Research, 2010).

Figure 9 shows a map segment capture of Project vicinity adjacent to, and surrounding Cove Park.



Source: EIS, 2016

Figure 9: Census Tract 184 and Cove Park Vicinity

The Preferred Alternative will enhance Weehawken Cove Park (Cove Park) and property owners can be expected to benefit from this expanded and enhanced amenity. **Table 15** compiles data on Census Tract 184. The analysis is based on Census Tract 184, which is adjacent to and surrounds Cove Park in the Project Area. The analysis shows how valuable park space and open green areas are to communities in densely populated areas like the Project Area's Census Tract 184.

Table 15: Census Tract 184: Median Value of Owner Occupied Housing Units								
	Median Value Range	Low	Mid	High	Percent of Occupied Units	Housing Units	Property Base Value, Midpoint Est.	Market Premium from Park Proximity (1.5%)
1	< \$100,000	\$0	\$50,000	\$100,000	1.3%	32	\$1,583,400	\$23,751
2	\$ 100,000 - \$200,000	\$100,000	\$150,000	\$200,000	1.0%	24	\$3,654,000	\$54,810
4	\$ 200,000 - \$300,000	\$200,000	\$250,000	\$300,000	1.7%	41	\$10,353,000	\$155,295
5	\$ 300,000 - \$400,000	\$300,000	\$350,000	\$400,000	9.1%	222	\$77,586,600	\$1,163,799
6	\$ 400,000 - \$500,000	\$400,000	\$450,000	\$500,000	30.1%	733	\$329,956,200	\$4,949,343
7	\$ 500,000 - \$1,000,000	\$500,000	\$750,000	\$1,000,000	29.2%	711	\$533,484,000	\$8,002,260
8	\$1,000,000 - \$1,500,000	\$1,000,000	\$1,250,000	\$1,499,999	10.6%	258	\$322,769,871	\$4,841,548
9	\$1,500,000 - \$2,000,000	\$1,500,000	\$1,750,000	\$1,999,999	12.0%	292	\$511,559,854	\$7,673,398
10	\$2,000,000	\$2,000,000	\$2,000,000		5.0%	122	\$243,600,000	\$3,654,000
	Census Tract Sum				100.0%	2436	\$2,034,546,925	\$30,518,204
Source: U.S. Census Bureau (American Community Survey) ACS 2015 5-year, Table universe: Owner-Occupied Housing Units, Value of owner-occupied housing units (Table B25075) https://censusreporter.org/profiles/14000US34017018400-census-tract-184-hudson-nj/								

Table 15 shows the distribution of housing units by median value for Census Tract 184 and midpoint values calculated for ranges provided by the American Community Survey. Applying a 1.5% market value premium to the estimated property value base amounts to \$30.5 million. The 1.5% premium is based on moving out a travel distance of approximately 1,300 feet from the Cove Park vicinity, and represents a conservative estimate of the premium applied in percentage terms. Because of the range of values at varying distances, many benefit transfer studies apply an estimate of 5.0% (Harnik & Crompton, 2014).

The Draft EIS provided a time series of average sales prices for homes in the Project Area from 2012 to 2016. The data shows that Hoboken area home sales prices appreciated at a compound average annual rate of 7.6% from 2012 to 2016 (Draft EIS 2017, Page 4-174). This average sales price appreciation rate was applied to the property value base shown in Table 13 to provide an estimate of the projected property base value for 2023. It was assumed that by this year of Project operations, the park enhancements for Preferred Alternative would be completed. The present value of the projected market value premium that would arise in the year 2023 for Census Tract 184 homes was based on the following formula.

$$\begin{aligned} \text{Present Value of Market Premium}_{CT\ 184,\ 2017} &= \\ &= \frac{\$2,034,546,925 \times (1.076)^7 \times (0.015)}{(1 + 0.07)^{2023-2017}} \end{aligned}$$

This computed value was applied in the benefit cost analysis as an estimate of the property value enhancements that would arise from park and open space enhancements attributable to Alternative 3. The cumulative present value of the market premium from park enhancement is equal to \$33,924,000.

II. Economic Impacts

The Project's construction phase, anticipated to last for several years, will have a substantial positive economic impact on the Project Area and region. Construction for Resist infrastructure in Preferred Alternative would begin in February 2019 and last 44 months. The construction would occur concurrently for the northern and southern resist features. Equipment required for this project includes dump trucks, backhoes, pile drivers, concrete trucks, and other assorted delivery trucks. Some street closures will be required, particularly for gate construction. Pile driving will be required over nine work months. A total of 6,000 crew days will be required to complete this construction (Draft EIS, 2017).

The direct expenditures associated with spending on construction payrolls and contractors, suppliers and vendors will generate an indirect and induced positive impact both locally, and throughout the region. Multi-million dollar direct spending from construction packages by phase would stimulate the economy and employment in the region. The direct multi-year construction spending would have an indirect positive impact on suppliers and vendors linked to the Project's resource and materials/supply chain. These economic gains would be realized in additional jobs, economic output, labor income and tax receipts accruing to local jurisdictions, the State of New Jersey and the federal government. Wage income generated from direct and indirect spending would also have an induced positive impact on the region as wages are spent, and re-spent on local and regional goods and services.

The economic impact benefits from the Project would consist of jobs, labor income, industrial output and value added and associated tax receipts.

Post construction, the Project will also generate incremental tourist spending and revenue from visitors who come to the area from outside the region. These visitors will be attracted by an enhanced connected waterfront that complements the Project area's existing cultural and park assets as well as the unique resilience features of the Project that show innovative adaptation to climate change within a densely populated coastal/estuarine environment. As the Project's assets are tested over time under extreme climatic conditions, the uncertainty associated with living in a flood-prone area will be lessened. This impact can also be positive for the economy in terms of attracting future residents and investments. In addition, the operational phase will generate spending associated with the maintenance and up-keep of the flood protection infrastructure.

5.7 Description of Risks to Ongoing Benefits from Proposed Project

Description of Project Risks

Project risks generally relate to issues that could influence the projected size and timing of lifecycle costs, and the scale and timing of anticipated benefits over the useful life of the Project.

The risks that have been identified relate to factors that could potentially influence future capital costs. It is possible that additional projects being implemented concurrently within the Project area may have an impact on the available supply of labor and materials and resources needed to implement the Preferred Alternative. Heightened demand and limited supply for these resources may influence the commodity and labor prices and render certain construction costs relatively more expensive compared to the projected base case assumption estimates. To account for this possibility, in terms of impacts to the economic feasibility of Alternative 3, the sensitivity analysis below factors in potential cost overruns during the Project's implementation phase.

In addition, it is also possible that some risks may result in delays in construction that could add time to and extend original schedules. For the BCA, this kind of risk would also result in deferred benefits. As benefits would start to accrue farther out in time, the BCR could be lower than originally anticipated.

Sensitivity Analysis

A sensitivity analysis was completed that assessed the impacts of the Project's

cumulative present value of net benefits and BCRs based on potential increases in lifecycle costs, reductions in anticipated benefits for the categories providing the most value, and construction delays. **Table 16** shows the results of the sensitivity analysis.

Table 16: Benefit Cost Analysis Sensitivity Analysis (Resist Alternative 3)				
Test	Baseline Project / Net Present Value / BCR	Project Net Present Value with Change	BCR with Test Change	Switching Value \c
[1]	[2]	[3]	[4]	[5]
Increase in Capital Costs (30%)	\$982,620,726 / 5.61	\$924,140,519	4.40	504.1%
Increase in Annual O&M (50%) \a	\$982,620,726 / 5.61	\$973,405,205	5.37	5331%
Construction Delays \b				
+ 1 Year	\$982,620,726 / 5.61	\$905,227,442	5.34	
+ 2 Years	\$982,620,726 / 5.61	\$833,644,351	5.10	
Decrease in Resiliency Benefits (Percent of Baseline Estimates):				6.40%
75% of Baseline	\$982,620,726 / 5.61	\$720,169,295	4.38	
50% of Baseline	\$982,620,726 / 5.61	\$457,717,864	3.15	
25% of Baseline	\$982,620,726 / 5.61	\$195,266,433	1.92	
Notes: \a A fifty percent increase in annual O&M costs from the baseline midpoint value of \$1.9 M/yr. works out to be \$2.85 M/yr. \b the construction delay scenarios also defer the start of benefits \c the switching value is the percentage change in the variable of interest that renders the cumulative net present value of the Project (benefits – costs) equal to zero (BCR = 1.0), holding all of the other variables constant.				

Column [1] shows the type of stress test that the net present value amount (benefits less costs, or net benefits) and the BCR were subjected to a 30% increase in capital costs would the lower the BCR from 5.61 to 4.40, and lower the cumulative net present value of the Project (net benefits) by \$58.5 million. The switching value shows the increase in capital construction costs that would render the net present value of the Project equal to zero. A 50% increase in annual O&M costs would result in the baseline BCR declining to 5.37 from 5.61. The annual value of the 50% increase in O&M is equal to \$2.85 million per year, compared to the midpoint of the O&M range of \$1.9 million per year applied in the baseline analysis.

Resiliency values (the cumulative sum of all flood risk reduction benefits) represent the largest category of values (88%). The sensitivity analysis starts by reducing the combined value of resiliency benefits to a percentage of the baseline total value for this category. The Project's total net present value would still be positive even if resiliency benefits fell by 75%, to a level representing 25% of the baseline total amount.

The sensitivity analysis also includes the results of extending the construction schedule by one and two years, respectively. This analysis was applied by extending the capital phase-in schedule as shown below in Figure 10. The original capital phase in schedule (the baseline) was provided by Hill International Inc.

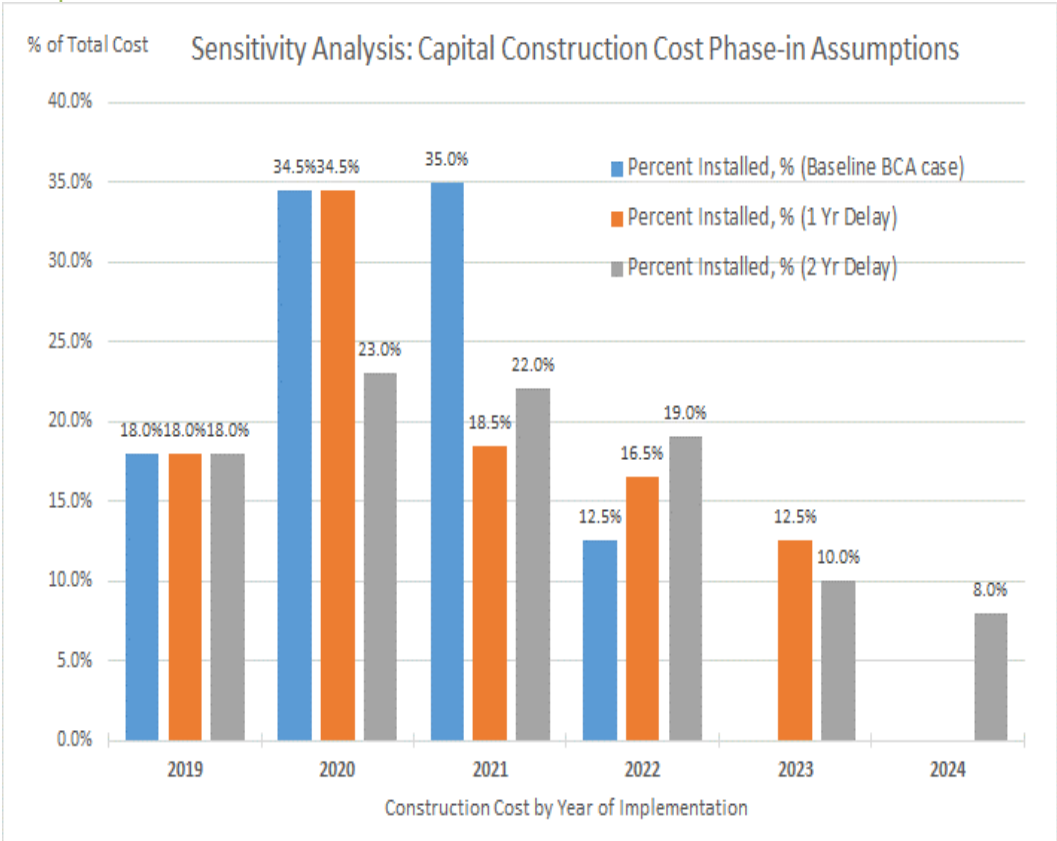


Figure 10

Table 16 shows that the Preferred Alternative favorable benefit cost ratio would still be over 5.0, even with factoring in delays and extensions of the construction period. The Preferred Alternative’s economic feasibility was also assessed for changes in the discount rate. **Table 17** show the Project’s cumulative present value of net benefits and BCRs at various discount rates.

Table 17: Preferred Alternative Cumulative Net Present Value of Benefits (NPV) & Benefit Cost Ratios (BCR) at Varying Discount Rates		
Discount Rate	NPV	BCR
3.0%	\$2,323,812,752	9.87
4.0%	\$1,838,975,516	8.45
5.0%	\$1,475,017,514	7.30
6.0%	\$1,197,475,402	6.37
7.0%	\$982,620,726	5.61
8.0%	\$813,905,457	4.98
9.0%	\$679,638,743	4.46
10.0%	\$571,453,097	4.02
11.0%	\$483,281,396	3.65
12.0%	\$410,667,479	3.33
13.0%	\$350,296,657	3.06
14.0%	\$299,672,597	2.82
15.0%	\$256,892,538	2.61
16.0%	\$220,489,257	2.43

Figure 11 plots the results of the sensitivity analysis of the Project's cumulative net present value of benefits at varying discount rates.

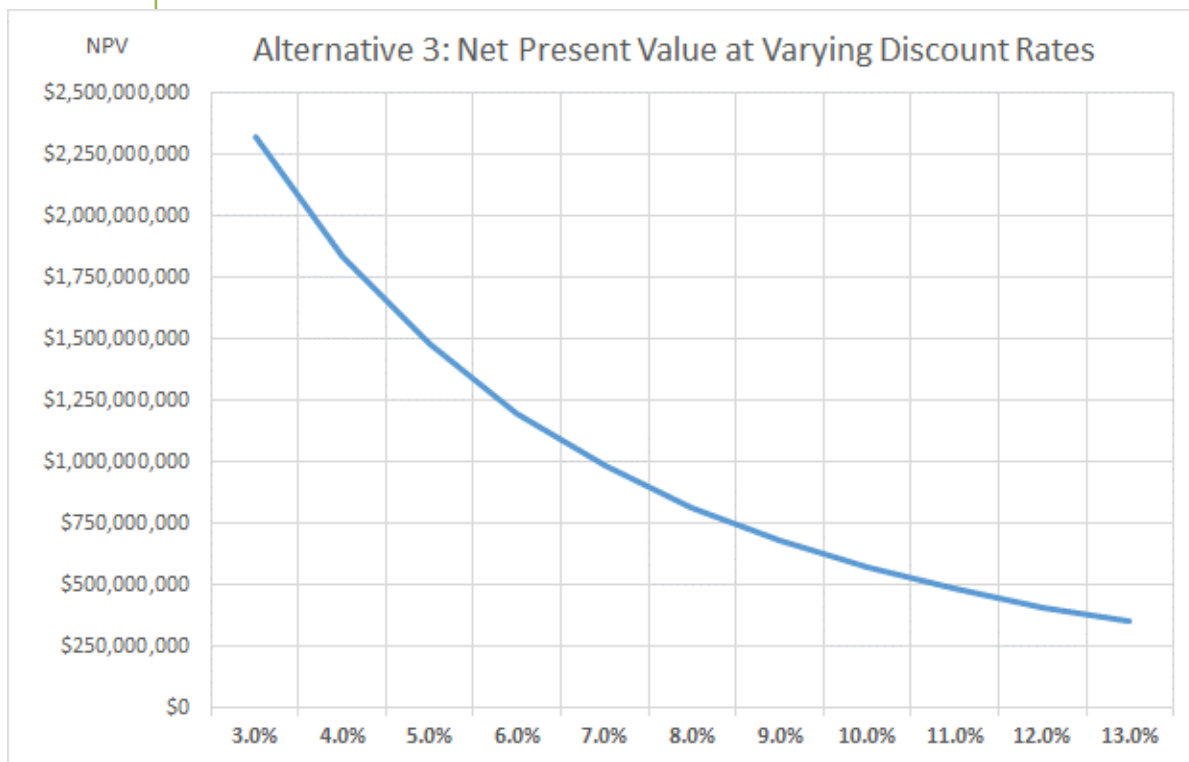


Figure 11

5.8 Assessment of Project Challenges

Implementing a large project in a densely populated area can present challenges during the various project stages: design, construction and operations. During the construction phase, there are challenges likely to be encountered with area traffic management and parking within a location characterized by narrow streets. In addition, there are logistical challenges associated with finding adequate space for laydown and staging areas, to store equipment and materials in tight spaces.

There are many other Projects that may be implemented concurrently with the RBD Hudson River Project Resist Preferred Alternative within the Project Area. This heightened level of construction and development activity may present increased demands on scarce resources such as skilled labor and craft workers, select materials and equipment and contractors available for work on specific project elements and contract packages. These kinds of market demands can be reflected in higher costs for both labor and materials, and potentially result in scheduling delays.

Given the large number of public agencies, and other stakeholders (both public and private) involved in the Project, there may be some challenges encountered related to coordination, communication and scheduling/sequencing of events, and timing. These coordination issues are likely to arise during the design, construction/implementation and operational stages of the Project.

Appendix A: RBD Hudson Operations and Maintenance Certification

REBUILD BY DESIGN - HUDSON RIVER PROJECT

CERTIFICATION FOR OPERATIONS & MAINTENANCE

The purpose of this Certification is to provide the US Department of Housing and Urban Development (HUD) assurance that there will be a means of operating and maintaining the Rebuild by Design Hudson River Project (RBD Hudson) resist structure as a complete system envisioned by the Preferred Alternative identified in the Environmental Impact Statement (EIS) The Notice of Availability of the Final Environmental Impact Statement (NOA) will be published in the Federal Register.

The New Jersey Department of Community Affairs (DCA), as HUD's CDBG-DR Grantee, hereby certifies in accordance with Federal Register FR-5696-N-11 VI.6.b that the RBD Hudson project's long term operations and maintenance (O&M) costs will be adequately funded from reasonably anticipated revenue provided by the State and by local partners. During the design phase of the project, the State will identify the local partners (i.e., sub-recipients) that will own, operate and maintain the Project. Specific obligations of each local partner will be fully detailed and agreed upon during the RBD Hudson Project design phase. The State is responsible for ensuring that O&M costs are funded and that entities are in place to own, operate and maintain the levee system associated with the Resist structure before construction begins. The State intends to fulfill fully its obligations under this Certification. Nothing herein shall constitute, nor be deemed to constitute, an obligation of future appropriations by the legislature of the State of New Jersey, where creating such an obligation would be inconsistent with New Jersey Constitution Article 8, Section 2, Paragraphs 2 and 3, N.J.S.A. 59:13-1 et seq., and N.J.S.A. 59:1-1 et seq. of the State of New Jersey. The O&M Subcommittee comprised of, but not limited to, Department of Environmental Protection, City of Hoboken, City of Jersey City, City of Weehawken, County of Hudson, North Hudson Sewerage Authority and NJ TRANSIT will continue to work toward a complete O&M plan. The O&M Subcommittee works in unison with NJDCA as issues arise. An agreement that will detail the specific responsibilities of each individual party will be executed under a separate agreement.

Appendix B: RBD Hudson River Operations and Maintenance Plan Framework Development

I. Considerations in Development of Operation & Maintenance (O&M) Plan

O&M management is a critical component of the overall RBD – Hudson River program. The management function should bind the distinct parts of the program into a cohesive entity. The overall program should contain five very distinct functions making up the organization: Operations, Maintenance, Engineering, Training, and Administration. A subset of the roles and responsibilities for each of the elements is presented below.

a. Operation

- i. Administration – To ensure effective implementation and control of operation activities.
- ii. Conduct of Operations – To ensure efficient, safe, and reliable operations.
 1. System Testing
 2. Communications
 3. Chain of Command
- iii. Equipment Status Control – To be cognizant of status of all equipment and facilities.
- iv. Operator Knowledge and Performance – To ensure that operator knowledge and performance will support safe and reliable facility/equipment operation.
 1. Urban environment considerations

b. Maintenance

- i. Administration – To ensure effective implementation and control of maintenance activities.
- ii. Work Control System – To control the performance of maintenance in an efficient and safe manner such that economical, safe, and reliable equipment/facility operation is optimized.
- iii. Conduct of Maintenance – To conduct maintenance in a safe and efficient manner.
- iv. Preventive Maintenance – To contribute to optimum performance and reliability of facility systems and equipment.
- v. Maintenance Procedures and Documentation – To provide directions, when appropriate, for the performance of work and to ensure that maintenance is performed safely and efficiently.
- vi. Routine maintenance is maintenance that is anticipated to be performed annually, or more frequently, i.e.:
 1. Landscape contractor – mowing, trimming, pruning, etc.
 2. Street sweeping (especially for porous pavements).

3. Catch Basin pumping
 4. Fence maintenance and repair.
 5. Inlet/outlet protection refurbishment (riprap installation, fix erosion problems)
 6. Swale/ditch maintenance (seeding, sodding, fix erosion problems)
 7. Removal of trash and debris – include cost of disposal
 8. Removal of invasive plants.
 9. Proprietary device maintenance contract costs.
 - vii. Identify and estimate the cost and time associated with inspections and maintenance that will be performed.
 1. List estimated annual hours for inspections and administration
 2. Cost of complying with reporting requirements
 3. Apply appropriate labor rate to estimate.
 4. Equipment or supplies purchased to support routine maintenance.
 - viii. Identify major maintenance items that will be performed infrequently (i.e. greater than annually) and provide an estimate of cost and estimated frequency of occurrence.
- c. Engineering Support
- i. Engineering Support Organization and Administration – To ensure effective implementation and control of technical support.
 - ii. Equipment Modifications – To ensure proper design, review, control, implementation, and documentation of equipment design changes in a timely manner.
 - iii. Offsite storage and inventory of equipment, spare parts and additional operating equipment.
 - iv. Equipment Performance Monitoring – To perform monitoring activities that optimize equipment reliability and efficiency.
 - v. Engineering Support Procedures and Documentation – To ensure that engineer support procedures and documents provide appropriate direction and that they support the efficiency and safe operations of the equipment.
- d. Training
- i. Administration – To ensure effective implementation and control of training activities.
 - ii. General Employee Training – To ensure that personnel have a basic understanding of their responsibilities and safe work practices and have the knowledge and practical abilities necessary to operate safely and reliably.
 - iii. Training Facilities and Equipment – To ensure the training facilities, equipment, and materials effectively support training activities.
 - iv. Operator Training – To develop and improve the knowledge and skills necessary to perform assigned job functions.
 - v. Maintenance Training – To develop and improve the knowledge and skills necessary to perform assigned job functions.

- e. Administrative
 - i. Organization and Administration – To establish and ensure effective implementation of policies and the planning and control of equipment activities.
 - ii. Management Objectives – To formulate and utilize formal management objectives to improve equipment performance.
 - iii. Management Assessment – To monitor and assess station activities to improve all aspects of equipment performance.
 - iv. Personnel Planning and Qualification – To ensure that positions are filled with highly qualified individuals.
 - v. Industrial Safety – To achieve a high degree of personnel and public safety.

II. Identify Additional Potential Stakeholders for O&M Involvement (examples provided below)

- a. State Departments
 - i. NJDEP
 - ii. NJDOT
 - iii. NJDPMC
 - iv. Port Authority
 - v. NJ TRANSIT
- b. Local Stakeholders
 - i. City of Hoboken
 - ii. Jersey City
 - iii. Weehawken
 - iv. Homeowner Associations
 - v. Property Owners
- c. Utilities
 - i. Sewerage Authorities
 - ii. Water Authority
 - iii. PSE&G
 - iv. Others

III. Key O&M Topics

- a. Describe overall responsibility for the operation, maintenance, repair, and replacement at the project level.
- b. Describe responsibility for the operation, maintenance, repair, and replacement of facilities and equipment.
- c. Define different conditions under which Repair and Replacement (R&R) work will be performed
- d. Define reporting requirement for O&M activities and its frequency.

- e. Submission of the O&M checklists.
- f. Provide O&M training & submit the Operations and Maintenance Manual, including:
 - i. New written operations procedures;
 - ii. Preventive maintenance work procedures and checklists.
- g. Periodic reports on maintenance work performed on facilities/equipment
- h. Identification of O&M issues that can adversely affect savings persistence; Steps to be taken to address the issue.

Appendix C: RBD Hudson River Project Benefit Cost Analysis

Metrics for O&M Evaluation

Below are a number of metrics that can be used to evaluate an O&M program. Not all of these metrics can be used in all situations; however, a program should use as many metrics as possible to better define deficiencies and publicize successes.

- i. Capacity factor – Relates actual Resist/Delay/Store/Discharge system or equipment operation to the full-capacity operation of the Resist/Delay/Store/Discharge system or equipment. This is a measure of actual operation compared to full-utilization operation.
- j. Work orders generated/closed out – Tracking of work orders generated and completed (closed out) over time allows the manager to better understand workloads and better schedule staff.
- k. Backlog of corrective maintenance – An indicator of workload issues and effectiveness of preventive/predictive maintenance programs.
- l. Safety record – Commonly tracked either by number of loss-of-time incidents or total number of reportable incidents. Useful in getting an overall safety picture.
- m. Energy use – A key indicator of equipment performance, level of efficiency achieved, and possible degradation.
- n. Inventory control – An accurate accounting of spare parts can be an important element in controlling costs. A monthly reconciliation of inventory “on the books” and “on the shelves” can provide a good measure of your cost control practices.
- o. Overtime worked – Weekly or monthly hours of overtime worked has workload, scheduling, and economic implications.
- p. Environmental record – Tracking of discharge levels (air and water) and non-compliance situations.