FINAL

Appendix E - Benefits

For the Feasibility Study of Rebuild by Design Meadowlands Flood Protection Project

May 2021

Boroughs of Little Ferry, Moonachie, Carlstadt, and Teterboro and the Township of South Hackensack, Bergen County, New Jersey

REBUILD BY DESIGN
MEADOWLANDS

Prepared by AECOM for the State of New Jersey Department of Environmental Protection

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Table of Contents

List of Tables

Acronyms and Abbreviations

BCA	Benefit-Cost Analysis
BCR	Benefit to Cost Ratio
CDBG-DR	Community Development Block Grant - Disaster Recovery
CDC	Centers for Disease Control and Prevention
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CPI-U	Consumer Price Index for Urban Consumers
CPR	Cardiopulmonary Resuscitation
EIS	Environmental Impact Statement
EMS	Emergency Medical Services
°F	Degrees Fahrenheit
FBI	Federal Bureau of Investigation
FEMA	Federal Emergency Management Agency

GHG	Greenhouse Gas
GIS	Geographic Information Systems
HEC-FDA	Hydrologic Engineering Center - Flood Damage Analysis
HUD	Department of Housing and Urban Development
LiDAR	Light Detection and Ranging
LMI	Low- and Moderate-Income
LOP	Line of Protection
NAAQS	National Ambient Air Quality Standards
NACCS	North Atlantic Coast Comprehensive Study
NFIP	National Flood Insurance Program
NJSEA	New Jersey Sports and Exposition Authority
NJDEP	New Jersey Department of Environmental Protection
NO_2	Nitrogen Dioxide
NOAA	National Oceanic and Atmospheric Administration
NPCC	New York Panel on Climate Change
O_3	Ozone
O&M	Operations and Maintenance
OMB	Office of Management and Budget
PM	Particulate Matter
$PM_{2.5}$	Particulate Matter less than 2.5 micrometers in diameter
PM_{10}	Particulate Matter less than 10 micrometers in diameter
PRB	Passaic River Basin
PTSD	Post-Traumatic Stress Disorder
RBDM	Rebuild by Design Meadowlands
RCEM	Reclamation Consequence Estimating Methodology
SCC	Social Cost of Carbon
SF	Square Feet
SO_2	Sulfur Dioxide
US	United States
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USDOT	United States Department of Transportation
USEPA	United States Environmental Protection Agency

USFWS	United States Fish and Wildlife Service
VOC	Volatile Organic Compounds
VSL	Value of a Statistical Life
WISQARS	Web-based Injury Statistics Query and Reporting System

1.0 Introduction

The Meadowland District is situated in a valley or "bowl" with ridges on its sides that run parallel in a southwest to northeast direction. In some locations, these ridges are over 100 feet above sea level. Comprised of mostly flat terrain, elevations within the Meadowlands District do not exceed 10 feet above sea level (North American Vertical Datum of 1988 [NAVD 88]), with most areas less than 7 feet above sea level (NAVD 88). Flow of water within the Project Area is greatly affected not only by local topography, but also by patterns of urbanization and development. Historic construction of dikes and tide gates in an attempt to control and reduce flooding events has further affected the integrity and spatial configuration of the Project Area and altered its biodiversity. Additionally, existing surface water conveyances within the Project Area are undersized, clogged with sediments, and/or under-utilized. These conditions further compound the drainage challenges within the Project Area.

The Project Area includes the Boroughs of Little Ferry, Moonachie, Carlstadt, and Teterboro, and the Township of South Hackensack, all in Bergen County, New Jersey. The Project Area is 5,405 acres and has the following approximate boundaries: the Hackensack River to the east; Paterson Plank Road to the south; State Route 17 to the west; and Interstate 80 and the northern boundary of the Borough of Little Ferry to the north. The Project Area is vulnerable to flooding from both coastal storm surge and inland rainfall events.

The Proposed Project would include the construction and operation of flood risk reduction measures in the Project Area. These measures are designed to address the impacts of coastal and systemic inland flooding on the quality of the physical, natural, cultural, and socioeconomic environment of the Project Area due to both storm hazards and sea level rise. Therefore, the purpose of the Proposed Project is to reduce flood risk and increase the resiliency of the communities and ecosystems within the Project Area, thereby protecting critical infrastructure, residences, businesses, and ecological resources from the more frequent and intense flood events anticipated in the future.

The benefits evaluated and presented in this appendix are limited to the impacts of tidal storm surge and the potential for storm surges to reduce the discharge from existing and proposed drainage infrastructure. The benefits calculated for the Proposed Project are based on a comparison of future conditions with or without implementation of the Proposed Project.

The benefit analysis has assumed that certain conditions would exist in the future; which include the following:

- Continued flooding from tidal storm surges during severe coastal storm events;
- Continued flooding during heavy rainfall events due to local drainage problems; and
- Increased exposure to the effects of climate change and sea level change, with an anticipated 1.2- to 2.4-foot rise in regional sea level by the year 2075.

Detailed discussion of future conditions can be found in **Section 4** of Feasibility Study Report. Changes in the future condition assumptions from those anticipated in the benefit-cost analysis (BCA) calculations could result in higher or lower benefits than currently estimated.

The interrelationship between coastal flooding and rainfall events contributes to the recurring flooding conditions throughout the Project Area. Each component represents challenges and needs to be addressed within the context of an overall flood reduction strategy for the Project Area. As such, the Project is needed to address: (1) systemic inland flooding from high-intensity rainfall/runoff events; and (2) coastal flooding from storm surges.

This benefits analysis is focused on the evaluation of potential co-benefits for each alternative considered. The co-benefits of the Proposed Project could be described as the added benefits of the Proposed Project that are not the primary purpose of the Proposed Project, but are an indirect result. For example, converting non-permeable areas to green open space can contribute to reduced flooding and stormwater runoff and indirectly improve water quality, air quality, and aesthetics.

Economic impacts, such as job creation from Proposed Project expenditures, are analyzed separately via an economic impact analysis.

1.1 Alternatives

Based on the amount of Community Development Block Grant - Disaster Recovery (CDBG-DR) funding provided by the United States (US) Department of Housing and Urban Development (HUD), the New Jersey Department of Environmental Protection (NJDEP) has determined that the Proposed Project, in application, would focus primarily on reducing flood risk within the Project Area. Early in the planning process, and as codified in the Public Scoping Document for the Environmental Impact Statement (EIS) in August 2016, NJDEP identified three broad Proposed Project alternatives.

Alternative 3 was selected as the preferred alternative because it addresses flooding from both storm surge from major coastal events and localized rain events. However, the cost of Alternative 3 exceeds the available funding; therefore, a modification of Alternative 3 is the *Build Plan* that is recommended for construction with the available Rebuild by Design Meadowlands (RBDM) funds. The remainder of Alternative 3 may be built in the future as funding becomes available, hereafter referenced as the Alternative 3 *Future Plan*.

1.1.1 No Action Alternative

The No Action Alternative assumes that the Proposed Project would not be implemented and current conditions and operations would continue in the Project Area. Under the No Action Alternative, the purpose of and need for the Proposed Project would not be met. Flood protection measures under this alternative would generally be limited to the operation and maintenance of existing infrastructure.

1.1.2 Alternative 1 – Structural Flood Reduction

Alternative 1 would analyze various structural, infrastructure-based solutions that would be constructed to provide protection from coastal storm surges. This alternative would protect the Project Area from coastal flooding; however, chronic inland flooding from heavy or frequent precipitation events would continue to adversely affect the Project Area. This alternative, to the extent practical, would evaluate a Federal Emergency Management Agency (FEMA) certifiable level of flood protection to a portion of the Project Area. Under Alternative 1, a Line of Protection (LOP) would be constructed using of a range of grey infrastructure, including floodwalls, levees, berms, a tide gate and eight closure gates, and a surge barrier and pump station, designed to provide flood protection up to an elevation of 7 feet (NAVD 88). In addition to flood reduction infrastructure, this alternative would integrate open space features and green infrastructure into the design; **Table E-1** presents quantities of the green infrastructure measures for Alternative 1 that were analyzed.

Table E-1: Alternative 1 Inputs

Description	Little Ferry	Other Munici-palities	Total
Number of households within 100' of new tree planting (excluding new parks)	-	-	0
Number of households within 100' of new parks	298	-	298
Number of households within 500' of new parks	667	-	667
Number of new trees planted	222	-	222
Urban vegetation/upland plantings (square feet (SF))	92,171	4,131	96,302
New green open space not included in other categories (SF)	84,478	-	84,478
Population within 1/4 mile of new parks	5,041	3,352	8,393

1.1.3 Alternative 2 – Stormwater Drainage Improvements

Alternative 2 includes various grey and green infrastructure-based solutions, as well as new parks and improved open spaces, intended to improve stormwater management in key locations throughout the Project Area. This alternative would reduce chronic inland flooding from heavy or frequent precipitation events up to approximately the 100-year storm, but coastal flooding would continue to adversely affect the Project Area. Under Alternative 2, stormwater management would be improved through the installation of 41 green infrastructure systems (bioswales, storage/tree trenches, and rain gardens) along roadways, five new parks, improvements to five existing open spaces/public amenities, three new pump stations, two new force mains, and dredging of the lower reach of East Riser Ditch. **Table E-2** presents quantities of the green infrastructure measures for Alternative 2 that were analyzed.

Table E-2: Alternative 2 Inputs

Description	Carlstadt	South Hackensack	Little Ferry	Moonachie	Other Munici-palities	Total
Number of households within 100' of new tree planting (excluding new parks)	-	-	201	14	-	215
Number of households within 100' of new parks	-	-	52	20	-	72
Number of households within 500' of new parks	-	-	297	249	-	546
Number of new trees planted	5	-	893	342	-	1,240
Rain gardens (SF)	-	-	13,102	20,580	-	33,682
Rain garden drainage area (SF)	-	-	140,712	66,414	-	207,126
Urban vegetation/upland plantings (SF)	-	-	467,368	30,951	-	498,319
Bioswales/storage trench (SF)	755	480	18,290	13,681	-	33,206
Bioswales/storage trench drainage area (SF)	8,528	4,546	121,691	86,748	-	221,513
New green open space not	-	-	204,025	78,804	-	282,829

Description	Carlstadt	South Hackensack	Little Ferry	Moonachie	Other Munici-palities	Total
included in other categories (SF)						
Permeable pavement (SF)	-	-	65,712	33,726	-	99,438
Population within 1/4 mile of new parks	-	-	4,204	1,786	1,309	7,299

1.1.4 Alternative 3 – Hybrid of Alternative 1 and 2

Alternative 3 would consist of a hybrid of coastal flood protection and stormwater drainage improvements. To achieve this, the majority of both Alternatives 1 and 2 would be implemented. However, due to funding and construction constraints associated with a project of this magnitude, the Alternative 3 features would be separated into two stages: a *Build Plan*, which includes all features to be constructed as part of the Proposed Project, and a *Future Plan*, which includes the remaining features that could be constructed over time by others as funding sources become available and construction feasibility permits. The Alternative 3 *Build Plan* would consist of all of the Alternative 2 components, with the exceptions of two new parks and a pump station force main in Losen Slote. Additionally, the proposed improvements proposed for one of the parks under Alternative 2 would be altered under the Alternative 3 *Build Plan.* The Alternative 3 *Future Plan* would consist of all of the remaining features from Alternative 2, as well as all of the features from Alternative 1. **Table E-3** presents quantities of the green infrastructure measures for Alternative 3 *Build Plan* that were analyzed.

Table E-3: Alternative 3 *Build Plan* Inputs

Description	Carlstadt	South Hackensack	Little Ferry	Moonachie	Other Munici-palities	Total
Number of households within 100’ of new tree planting (excluding new parks)	-	-	204	14	-	218
Number of households within 100’ of new parks	-	-	14	20	-	34
Number of households within 500’ of new parks	-	-	43	249	-	292
Number of new trees planted	5	-	426	342	-	773
Rain gardens (SF)	-	-	13,236	20,580	-	33,816
Rain garden drainage area (SF)	-	-	110,413	66,414	-	176,826
Urban vegetation/upland plantings (SF)	-	-	200,664	30,951	-	231,615
Bioswales/storage trench (SF)	755	480	14,806	13,681	-	29,722
Bioswales/storage trench drainage area (SF)	8,528	4,546	121,691	86,748	-	221,513
New green open space not included in other categories (SF)	-	-	157,375	78,804	-	236,179
Permeable pavement (SF)	-	-	61,453	33,726	-	95,179
Population within 1/4 mile of new parks	-	-	2,972	1,786	234	4,992

Table E-4 presents quantities of the green infrastructure measures for Alternative 3 *Future Plan* that were analyzed.

Table E-4: Alternative 3 *Future Plan* Inputs

Description	Carlstadt	South Hackensack	Little Ferry	Moonachie	Other Munici-palities	Total
Number of households within 100' of new tree planting (excluding new parks)	-	-	201	15	-	216
Number of households within 100' of new parks	-	-	310	20	-	330
Number of households within 500' of new parks	-	-	692	249	-	941
Number of new trees planted	5	-	951	342	-	1,298
Rain gardens (SF)	-	-	13,236	20,580	-	33,816
Rain garden drainage area (SF)	-	-	117,506	66,414	-	183,920
Urban vegetation/upland plantings (SF)	-	-	427,512	30,951	4,131	462,594
Bioswales/storage trench (SF)	755	480	20,304	13,681	-	35,220
Bioswales/storage trench drainage area (SF)	8,528	4,546	121,691	86,748	-	221,513
New green open space not included in other categories (SF)	-	-	196,658	78,804	-	275,462
Permeable pavement (SF)	-	-	50,952	33,726	-	84,678
Population within 1/4 mile of new parks	-	-	5,041	1,786	3,352	10,179

2.0 Benefit Analysis Framework

The benefits analysis was conducted using the Phase 2 Instructions for CDBG-DR Applicants (**Appendix H**) as a guide for preferred methods and monetized values. The parameters of the benefits analysis follow the protocols set by the Office of Management and Budget (OMB) Circular A-94 (OMB 2003), as well as the recommended benefit quantification methods by the US Department of Transportation (USDOT), the United States Army Corps of Engineers (USACE), FEMA, US Department of Agriculture (USDA) Forest Service. Generally, standard factors and values accepted by federal agencies were used for the benefits calculation except in cases where more Proposed Project-specific values or prices were available. In all such cases, modifications are noted and references are provided for data sources. The analysis follows a conservative estimation of the benefits and assesses some of the benefits qualitatively. By adhering to a strict standard of what could be included in the benefits analysis, actual total benefits may be greater than depicted in the benefits analysis.

The resiliency benefits, economic revitalization, social, and environmental co-benefits of each alternative were evaluated to assist in the selection of the final Proposed Project design. The No Action Alternative assumes that the Proposed Project would not be implemented and current conditions and operations would continue in the Project Area. Under the No Action Alternative, the purpose of and need for the

Proposed Project would not be met. Flood protection measures under this alternative would generally be limited to the operation and maintenance of existing infrastructure. Alternative 1, 2, and 3 were compared to the No Action Alternative to identify benefits.

Hydrologic Engineering Center - Flood Damage Analysis (HEC-FDA), software developed by the USACE, was utilized to analyze the resiliency benefits. HEC-FDA is a well-established flood damage computation model developed by the USACE's Hydrologic Engineering Center. HEC-FDA applies Monte Carlo simulation techniques to compute the expected value of damage while accounting for uncertainty in the value of key parameters such as structure value and elevation, damage as a percent of value at various stages, and hydrologic and hydraulic data such as stage-frequency and stage-discharge relationships. The HEC-FDA program presents results for expected annual damages and equivalent annual damages, where equivalent annual damage is the sum of the discounted value of the expected annual damage, which is then annualized over the period of performance.

HEC-FDA was selected for the flood damage analyses in this study because while it requires the input of significant hydrologic and hydraulic data, it can be applied to study areas of any size, can utilize generic, location specific, and direct damage functions, and provides detailed outputs for individual events and average annual conditions. It is an industry-standard flood damage computation tool for studies of this nature.

A custom Excel-based model was developed to estimate the future co-benefits for each Proposed Project alternative. Benefits were estimated beginning in 2022 (partial year) until 2072. All values were discounted to 2017. It was assumed that 2023 would be the first year that the Proposed Project would be complete and economic, social, and environmental benefits would begin accruing in October 2022.

The benefits are expressed in constant 2017 dollars, which avoids forecasting future inflation and escalating future values for benefits and costs accordingly. The gross domestic product chained price index from the OMB was used to adjust past cost estimates or price values into 2017 dollar terms (OMB 2017).

The use of constant dollar values requires the use of a real discount rate for discounting to the present value. Projects expecting to use federal funding are required to use a 7 percent discount rate. All costs and benefits were discounted to 2017 (base year).

Future condition damages assumed 1.2 feet of sea level rise at Battery Point, in New York, which translates to 0.8 feet of sea level rise across the Project Area. Similar analyses have been conducted to calculate damages and benefits for a higher rate of sea level rise, and the detailed results of these analyses will be included in future versions of this report. The higher rate of sea level rise assumed 2.4 feet of sea level rise at Battery Point, in New York, which translates to 1.6 feet of sea level rise across the Project Area.

3.0 Benefit Analysis

In addition to providing direct benefits by reducing flood damages to homes, businesses, and infrastructure; the alternatives being considered have the potential to generate additional economic revitalization, social, and environmental benefits. Economic revitalization benefits include property value benefits from proximity to new parks and trees, the residential energy savings from new trees, and the residual value. Social benefits considered include new recreational opportunities, avoided stormwater treatment costs, aesthetics, and water retention and flood hazard risk reduction. The alternatives could also generate environmental benefits including improved air quality, reduced nutrient pollution, and increased opportunities for pollination. Additional benefits were assessed qualitatively.

3.1 Resiliency Benefits

The primary resiliency benefits of the Proposed Project are derived from reducing direct damages from flooding to infrastructure, residential, apartment, commercial, industrial, and municipal and utility structures and contents. In addition to structures and contents, damages to motor vehicles associated with residential and apartment structures were also evaluated. Also evaluated during this exercise were benefits derived from reductions in post-flood debris removal and disposal, public emergency services costs, public injury and loss of life, and disruption to critical/first responder facilities within the Project Area and the affected area of the City of Hackensack (known as the "study area" henceforth).

3.1.1 Structures, Contents, and Automobiles

As part of the resiliency damage analysis, data was collected in all five of the Project Area municipalities, as well as in adjacent areas (in the City of Hackensack) into which tie-offs of a comprehensive LOP would need to extend. A database of assets at risk in these six municipalities was developed using a Geographic Information System (GIS) overlay map delineating the FEMA 500-year floodplain and then adding two feet to account for future sea level changes. Current building polygon shapefiles obtained from the New Jersey Sports and Exposition Authority (NJSEA) and building tax data obtained from local municipalities were incorporated into the GIS database and merged with Light Detection and Ranging (LiDAR) data to develop building-specific elevation data. Critical facilities and infrastructure assets were also identified in the database.

To augment the information in the GIS database, a field survey was conducted during the summer of 2016 to collect data about all residential and non-residential structures in the Project Area and associated portions of the City of Hackensack (i.e, the study area). Industrial and commercial land uses are concentrated in the southwestern portion of the Project Area, while residential areas are mostly clustered in the northeast. Teterboro Airport occupies much of the land in the northwest of the Project Area. Land without structures is primarily wetlands in the southern and eastern portions of the Project Area. While GIS and LiDAR were able to provide the ground elevation and footprint area for each potentially flood-vulnerable structure, the field survey captured the usage, stories, foundation height, basement configuration, construction material, and current condition of each structure in the study area. Additionally, a number of large industrial and commercial facilities were directly contacted to participate in detailed interviews regarding past flood experiences and future flood risks, with the aim of refining the database, in particular the value of contents and the elevation at which damages begin.

Utilizing square foot building costs published by RS Means and the survey data, a depreciated replacement value was assigned to each structure and its contents in accordance with current standard flood damage estimation practice. The estimation of flood damages to motor vehicles was conducted using accepted practice for studies of this nature, in that the average number of motor vehicles per housing unit in the study area was taken from US Census Bureau data, and the average value of pre-owned vehicles was obtained from internet sources, adjusted for the probability that owners would be able to move their vehicles to safety in advance of a flood event, following guidance in USACE Economic Guidance Memorandum 09-04, which also provided the reference for automobile damage functions.

The data collected from the structure inventory was input into a flood damage assessment computer program (HEC-FDA v1.4.1) to facilitate the computation of average annual damages with and without the Proposed Project in place, as well as under the existing and assumed future hydrologic conditions.

In addition to the structure inventory and values, other key inputs to the damage estimation model were hydrologic data and depth-damage functions. These inputs enabled the computation of flood damages as a percentage of structure values for a range of flood depths relative to the structure main floor. For this study, the depth-damage functions for structures and associated vehicles were taken from the following sources:

- Generic functions for single-family residences (USACE 2000, USACE 2003);
- Passaic River Basin (PRB) functions for non-residential structures, which were specifically derived in the 1980s for use in a region of northern New Jersey adjacent to the Project Area; and
- Generic functions for motor vehicles (USACE 2009).

For categories not directly related to buildings and vehicles, unique damage functions were developed specifically for use in this analysis, based on established guidance and practice.

Table E-3 presents the number of structures impacted and the damages computed by HEC-FDA for selected frequency storm surge events across the whole Project Area for the No Action Alternative.

Table E-3: Number and Depreciated Replacement Value ($1,000s) of Structures in the Study Area by Type and Tidal Floodplain

Damage Category	10-Year		50-Year		100-Year		500-Year	
	#	Value	#	Value	#	Value	#	Value
Apartment	3	$389,480	35	$4,246,470	55	$9,635,990	80	$42,177,820
Commercial	62	$27,470,520	241	$202,602,030	312	$324,504,430	376	$697,430,440
Industrial	145	$118,606,480	387	$681,701,350	441	$1,005,249,240	484	$1,733,691,880
Municipal	9	$931,610	24	$17,542,470	29	$30,993,860	37	$74,991,420
Residential	751	$7,452,140	2,026	$36,544,900	2,390	$60,057,250	3,003	$158,149,560
Utility	6	$29,760	23	$224,870	37	$1,071,110	47	$4,107,760
Total	**976**	**$154,879,990**	**2,736**	**$942,862,090**	**3,264**	**$1,431,511,880**	**4,027**	**$2,710,548,880**

3.1.2 Public Emergency Costs

Public emergency costs are costs related to efforts made by local communities and other entities to ensure the safety of the public during storm events. For the purposes of this study, public emergency costs were considered to be representative of emergency work that must be performed to reduce or eliminate an immediate threat to life, protect public health and safety, and to protect improved property that is threatened in a significant way as a result of a disaster. Direct damage curves were developed individual drainage areas for input to HEC-FDA, based on historic flood events in the study area. The evaluation of public emergency costs in the study area was derived from the recorded claims under the FEMA's Public Assistance program from 1999 through 2012, matched to water elevation data from local river gages to provide stage-damage relationships for use in the model.

3.1.3 Debris Removal and Disposal

The cost of debris removal and disposal was evaluated based on tools developed as part of the recent North Atlantic Coast Comprehensive Study (NACCS). The analysis utilized a matrix developed by the FEMA Modelling Task Force, debris removal costs from the NACCS Emergency Costs Report, and initial structure damage outputs from the study area HEC-FDA model. The FEMA approach categorizes flood damage into four levels according to water depth: Affected, Minor, Major, and Destroyed. For each level, a matrix is used to assign a debris weight per 1,000 square feet of building area, and structures were further categorized into one of the damage levels according to water depth. Assumed debris weights for each structure were multiplied by an average tipping fee for the Northeast and Mid-Atlantic States, provided by the NACCS Emergency Costs Report and the results were aggregated into reaches to form damage functions for input to HEC-FDA.

3.1.4 Loss of Life and Injuries from Flood Events

Hurricane Sandy caused 109 deaths in the New York City metropolitan area (Daniel, 2012). The majority of deaths occurred as a result of drowning in homes and cars (37 percent), followed by trees falling (19 percent), and falls (11 percent). Deaths attributed to falls occurred mostly to senior citizens and were associated with lack of light due to power outages. Nine deaths were due to carbon monoxide poisoning after people left their generators running indoors (8 percent). The remaining deaths (25 percent) resulted from fire, illness, electrocution, debris crashing into people, and not receiving medical aid fast enough to prevent loss of blood or oxygen. There were at least 12 deaths across Northeast New Jersey and one fatality occurred in the Meadowlands District during Hurricane Sandy (NOAA, 2016).

Data for injuries that are the direct or indirect result of flooding are more difficult to track than fatalities. In addition to injuries that are directly related to a flood event, indirect injuries can occur when the affected population is dealing with the aftermaths of a storm event, such as debris removal, clean up, and repairs.

Although complete data is not available for injuries related to Hurricane Sandy, there were likely numerous non-fatal indirect injuries in categories similar to the causes of fatalities, as well as other indirect injuries associated with cleanup activities (e.g., chainsaw accidents). The Brackbill et al. (2014) survey found that 10.4 percent of respondents who lived in an inundation zone sustained an injury in the first week after Hurricane Sandy. For respondents living in areas that were not inundated, 3.4 percent reported injuries; indicating that 7 percent of injuries may be related to flooding and the other injuries may be related to hurricane winds. These results are similar to reports regarding earlier hurricanes (e.g., Hurricanes Andrew, Katrina, and Irene) which found the most reported injuries occurred after the hurricane passed and were associated with clean-up and repair activities (CDC 2005).

The approach used to estimate injuries from flooding is based on the work of Penning-Rowsell et al. (Penning-Rowsell, et al. 2004). Fatality estimates were based on the Reclamation Consequence Estimating Methodology (RCEM) from the US Department of the Interior Bureau of Reclamation (US Department of the Interior Bureau Of Reclamation 2015). These approaches were used to estimate death and physical injuries as a direct and immediate consequence of flooding combined with an estimate of death and physical injuries associated with the flood event, but occurring in the immediate aftermath. The factors considered in the estimation include the average depth of flooding, flow velocity, and the vulnerability of the population at risk.

A hazard rating was developed using the total population in the flood zone for each depth of flooding from fluvial events, the typical flow velocity, and the debris factor. Depth of flooding is measured from the ground level surrounding structures. Depths of flooding ranged from 1 foot to 8 feet. Due to uncertainty, a triangular distribution was used to define the flow velocity. The average flow velocity was assumed to be 2 feet per second for all depths of flooding, with a minimum of 1.5 feet per second and maximum of 2.5

feet per second. The debris factor ranges from zero to two; zero means that debris would be unlikely; one means that debris would be possible, and two means that debris is likely. The debris factor was set to zero for flood depths ranging from a foot to 3 feet; one for flood depths ranging from 4 feet to 6 feet, and two for flood depths above 6 feet. The hazard rating was calculated using the following formula:

$$HR = d(v + 1.5) + DF$$

Where:

HR = hazard rating

d = depth of flooding in meters

v = velocity of flooding in meters per second

DF = debris factor

The hazard rating associated with each flood depth is presented in **Table E-4**.

Table E-4: Hazard Ratings According to Flood Depth

Average Depth of Flooding (feet)	Hazard Rating
1	0.6
2	1.3
3	1.9
4	3.6
5	4.2
6	4.9
7	6.5
8	7.1

The area vulnerability rating can range from three to nine and is based on the flood warning, speed of onset, and nature of the area. An area can be characterized as a low risk area, medium risk area, or high risk area for flood warning, speed of onset, and nature of the area. For flood warning, an area would be considered low risk if they have an effective flood warning and emergency plans; medium risk if the flood warning system is present, but limited; and high risk if there is no flood warning system. For speed of onset, an area would be considered low risk if the onset of flooding is very gradual (over many hours); medium risk is the onset of flooding is gradual (about an hour or so); or high risk for rapid flooding. The nature of the area would be considered low risk if it is mostly multi-story apartments; medium risk for a typical residential area with low rise commercial and industrial properties; or high risk for mostly mobile homes, busy roads, parks, single story schools, and campsites. For each parameter (i.e., flood warning, speed of onset, and nature of area), one point is scored for each area characterized as low risk, two points for medium risk, and three points for high risk. The area vulnerability rating is the sum of the three factors. For the study area, the flood warning system is considered to be effective (low risk), it is expected that the onset of flooding from fluvial events would be very gradual (low risk), and the area is representative of a typical residential area with low rise commercial and industrial properties (medium risk); the sum of the three factors results in the study area vulnerability rating of four for all types of flood events.

Table E-5 displays the factors used to estimate the number of people exposed to the risk of fatalities and injuries, per residential structure. Fatalities and injuries were estimated per residential structure. This method enables the use of HEC-FDA to model the results for the existing conditions and the conditions with various alternatives using a depth-damage function. The average number of people per housing unit was 2.46, according to the 2010 US Census (US Census Bureau 2014). The population at risk is considered the population with flooding surrounding a residential structure, multiplied by the percentage of people at risk. The percentage of people at risk is calculated by multiplying the hazard rating by the area vulnerability rating (rounded to the nearest hundredth in **Table E-5**). The population at risk was obtained by multiplying the percentage of people at risk by the population in flood zone (average number of people per housing unit). The population at risk is the number of people per household that would be at risk of death or injuries from flooding at each flood depth.

Table E-5: Population at Risk for Fatalities and Injuries per Residential Structure

Average Depth of Flooding (feet)	Hazard Rating	Area Vulnerability Rating	% of People at Risk	Population in Flood Zone	Population at Risk
1	0.64	4	2.57	2.46	0.06
2	1.29	4	5.14	2.46	0.13
3	1.93	4	7.72	2.46	0.19
4	3.57	4	14.29	2.46	0.35
5	4.22	4	16.86	2.46	0.41
6	4.86	4	19.43	2.46	0.48
7	6.50	4	26.00	2.46	0.64
8	7.14	4	28.58	2.46	0.70

The number of injuries is estimated by multiplying the population at risk by the vulnerability rating of the people exposed. The people vulnerability rating is based on the proportion of the population that is considered very old (over age 75) and those that are sick or disabled. If the percentage of people either considered very old or disabled is well below the national average, the parameter would score 10 points. If the percentage of people either considered very old or disabled is around the national average, the parameter would score 25 points. If the percentage of people either considered very old or disabled is well above the national average, the parameter would score 50 points. The sum of the points for both parameters is the people vulnerability rating.

The percentage of people over age 75 or disabled was compared with the national average using US Census Bureau data. Using the American Community Survey US Census Bureau data for 2014, the number of people over 75 years old in the study area (6 percent) was comparable to the national average (6.1 percent); therefore, a score of 25 points was estimated for this parameter. The number of disabled people in the study area (7.9 percent) was well above the national average (6.2 percent); therefore, a score of 50 points was estimated for this parameter (US Census Bureau 2014). The people vulnerability rating is 75 points for the study area.

The people vulnerability rating is the percentage of the population at risk (**Table E-5**) that would incur injuries, including loss of life. The fatality rate is double the hazard rating and is applied to the total number of injuries and fatalities to estimate the number of deaths. The number of injuries is the difference between the number of deaths and the total number of injuries and fatalities (fractions are rounded to the nearest whole number). **Table E-6** displays the estimated number of injuries and fatalities according to flood depth. Although injuries were estimated using these methods, the estimated number of fatalities was estimated using the RCEM approach.

Table E-6: Estimated Number of Injuries and Fatalities

Average Depth of Flooding (feet)	Population in Flood Zone	Population at Risk	People Vulnerability Rating	Number of Fatalities	Number of Injuries
1	2.46	0.06	75	0.000005	0.05
2	2.46	0.13	75	0.000005	0.09
3	2.46	0.19	75	0.000005	0.14
4	2.46	0.25	75	0.0002	0.26
5	2.46	0.37	75	0.0004	0.31
6	2.46	0.43	75	0.0006	0.36
7	2.46	0.49	75	0.0008	0.48
8	2.46	0.55	75	0.0008	0.53

Note: Estimates are rounded. Number of fatalities displayed uses the suggested fatality rate; however, the model incorporated the full spectrum of estimated values from RCEM.

The number of fatalities was estimated based on the RCEM method (DSO-99-06). The Bureau of Reclamation estimates life loss resulting from dam failure based on case histories of dam failures, flash flood, and coastal flooding events (US Department of the Interior Bureau Of Reclamation 2015). **Table E-7** illustrates how flood severity classifications, estimated warning time, and flood severity understanding is used to estimate the fatality rate. Flood severity is a measure of the damage potential or lethality of a flood flow classified as low, medium, or high. Warning time is the amount of time between when the population at risk would receive a warning and the beginning of the threatening flood flows. Flood severity understanding is a measure of how well the population at risk understands the flood warning and is influenced by the quality or forcefulness of the warning. The fatality rate is the fraction of the population at risk that is projected to die.

Table E-7: RCEM Method for Estimating Fatality Rate

Flood Severity	Warning Time (minutes)	Flood Severity Understanding	Suggested Fatality Rate	Suggested Fatality Rate Range	
High	No Warning	N/A	0.75	0.3	1
	15 to 60	Vague	0.75	0.3	1
		Precise	0.75	0.3	1
	> 60	Vague	0.75	0.3	1
		Precise	0.75	0.3	1
Medium	No Warning	N/A	0.15	0.03	0.35
	15 to 60	Vague	0.04	0.01	0.08
		Precise	0.02	0.005	0.04
	> 60	Vague	0.03	0.005	0.06
		Precise	0.01	0.002	0.02
Low	No Warning	N/A	0.01	0	0.02
	15 to 60	Vague	0.007	0	0.015
		Precise	0.002	0	0.004
	> 60	Vague	0.0003	0	0.006
		Precise	0.0002	0	0.0004

Based on RCEM guidance, flood severity, warning time, and flood severity understanding were assessed for the study area for depths of flooding ranging from 1 to 8 feet. **Table E-8** displays the flood severity, warning time, flood severity understanding, and associated fatality rates for each depth of flooding. Fatalities rates for low-med flood severity are interpolations between the low and medium estimates.

Table E-8: Estimated Fatalities by Depth of Flooding

Average Depth of Flooding (feet)	Flood Severity	Warning Time (minutes)	Flood Severity Understanding	Fatality Rate Min	Suggested Fatality Rate	Fatality Rate Max
1	low	>60	precise	0%	0.0002%	0.0004%
2	low	>60	precise	0%	0.0002%	0.0004%
3	low	>60	precise	0%	0.0002%	0.0004%
4	low-med	>60	vague	0.0002%	0.01%	0.02%
5	low-med	>60	vague	0.002%	0.02%	0.03%
6	low-med	>60	vague	0.003%	0.02%	0.05%
7	medium	>60	vague	0.005%	0.03%	0.06%
8	medium	>60	vague	0.005%	0.03%	0.06%

A triangular distribution was used to define the estimated number of fatalities for each depth of flooding using the minimum, maximum, and suggested fatality rates. The estimated numbers of fatalities by flood depth are displayed in **Table E-9**.

Table E-9: Estimated Number of Fatalities by Flood Depth

Average Depth of Flooding (feet)	Life Loss Minimum	Suggested Value for Life Loss	Life Loss Maximum
1	-	0.000005	0.00001
2	-	0.000005	0.00001
3	-	0.000005	0.00001
4	0.0000	0.000192	0.00038
5	0.0000	0.000395	0.00075
6	0.0001	0.000598	0.00112
7	0.0001	0.000738	0.00148
8	0.0001	0.000738	0.00148

The estimated number of fatalities and injuries for the conditions without the Proposed Project were monetized to contribute to estimating the cost of each flood event. The value of a statistical life (VSL) was obtained from the latest Value of a Statistical Life Guidance from the USDOT (US Department of Transportation 2016). The guidance indicates that the VSL for 2015 (base year) was $9.6 million. VSL was updated to $9.7 million for a 2016 base year using the US Bureau of Labor Statistic's Consumer Price Index for Urban Consumers (CPI-U) (US Bureau of Labor Statistics 2017).

The average cost per injury treated at a hospital emergency department was estimated using information from the Centers for Disease Control and Prevention (CDC). The CDC maintains an interactive, online database called WISQARS (CDC 2018). WISQARS provides injury-related data, which includes the average treatment and lost work costs for the injuries. It is conservatively assumed that the majority of injuries are related to cuts and falls; therefore, the average cost of the combined medical and work loss costs are used to value the estimated injuries. The estimates do not evaluate the severity of the injury or include other physical injuries, such as carbon monoxide poisoning or electrocution. Therefore, the findings can be considered a low estimate of the actual injuries that could occur following a flood event.

Table E-10 displays data from WISQARS for non-intentional injuries that received treatment at an emergency department and released (does not include the costs related to hospitalizations and fatal injuries).

Table E-10: Medical and Work Loss Costs for Injuries Common to Flood Events

Injury Mechanism	Cost Category	Average Cost
Cut/Pierce	Medical	$1,700
	Work Loss	$2,100
	Combined	$3,800
Fall	Medical	$2,800
	Work Loss	$4,200
	Combined	$7,000
Average Cost of Injuries Related to Cuts and Falls		**$5,400**

Source: (CDC 2018)
Note: Values were updated to 2016 dollars using the CPI-U. Costs were rounded to the nearest hundred.

The results were calculated as a function of the equations, assumption, and the probability distributions assigned to selected variables. The velocity and number of fatalities were varied within the 90 percent confidence interval to evaluate the probability of the possible results. A Monte Carlo simulation with 10,000 iterations was run to evaluate the likelihood and distribution of the results. The average results are presented in **Table E-11**. Costs were estimated per household according to depth of flooding for the No Action Alternative and each of the Proposed Project alternatives.

Table E-11: Loss of Life and Injuries Results per Household

Average Depth of Flooding (feet)	Cost of Injuries	Cost of Fatalities	Total Cost Per Household
1	$250	$50	$300
2	$500	$50	$550
3	$800	$50	$850
4	$1,400	$1,900	$3,300
5	$1,700	$3,800	$5,500
6	$1,900	$5,800	$7,700
7	$2,600	$7,600	$10,200
8	$2,800	$7,600	$10,400

Note: Costs were rounded to the nearest ten or hundred.

3.1.5 Indirect Loss of Life from Loss of Service at Critical Facilities

When a life-threatening situation occurs, timely emergency care is a key factor that affects the chances of survival. When critical facilities such as fire departments and other emergency medical services providers are delayed, there may be a cost in lives. Flooding may increase the response time of critical services or cause a critical facility to temporarily shut down.

The approach used to estimate the social cost of an indirect loss of life from loss of emergency medical services (EMS) is based on guidance from FEMA (FEMA 2011). The shorter the response time for emergency service professionals, the better chance of a successful outcome. Response time is related to the distance between the EMS facility and the location of the emergency. When a critical facility in the study area that provides EMS is temporarily closed, the nearest available EMS facility would serve a larger geographical area and the average response time will increase. When flooding causes a fire station or an EMS provider to temporarily shut down, increased response time can cost lives. Although fire stations offer many services to communities, this approach is focused on the EMS provided by fire stations.

Critical facilities in the study area that provide EMS were identified using the vulnerability rankings from the Bergen County Multi-Jurisdictional All-Hazards Mitigation Plan (US Department of the Interior Bureau Of Reclamation 2015). **Table E-12** displays the critical facilities in the study area that were analyzed and the respective flooding and storm-surge vulnerability rankings.

Table E-12: Critical Facilities and Vulnerability Ratings

Critical Facility	Flooding Vulnerability Rating	Storm-surge Vulnerability Rating
Little Ferry Hose Co. #1 Fire Department	2	2
Little Ferry Public Safety Building	3	2
Little Ferry Hook and Ladder Fire Department	3	1
Moonachie Fire Department	3	1
Moonachie First Aid Squad	3	1
South Hackensack Fire Department	1	0

A flooding vulnerability rating of one indicates that the structure is in floodplain/flood prone area, but has no prior history of flood damage; two indicates that the structure is in floodplain/flood prone area and has experienced some limited flood damage in the past; and three indicates that the structure is in floodplain/flood prone area and has experienced significant flood damage or is an National Flood Insurance Program (NFIP) repetitive loss property. A storm-surge vulnerability rating of zero indicates that the structure is not located in a storm surge or tsunami inundation area; one indicates that the structure is located in a storm-surge area for a category 4 or 5 hurricane, or is located at the edge of a designated tsunami risk zone; and two indicates that the structure is located in a storm-surge area for a category 3 hurricane, or is located just inside a designated tsunami risk zone but has no prior damage.

A link has been established between mortality and EMS response time. Cardiac arrests calls are of the highest priority and have been used as a measure of emergency medical performance because they are considered to be victims that have the highest chance of being saved using cardiopulmonary resuscitation (CPR) and defibrillation. The approach is based on a study (Valenzula, et al. 1997) that estimated survival function as the following:

$$Survival\ probability = \left(1 + e^{-0.260+0.0106 I_{CPR}+0.139 I_{Defib}}\right)^{-1}$$

Where:

Survival probability = survival probability after out-of-hospital cardiac arrest due to ventricular fibrillation

I_{CPR} = time interval from collapse to CPR

I_{Defib} = time interval from collapse to defibrillation

Information for each facility was gathered including the population served and the distance to the nearest alternative EMS facility that could temporarily provide service in case of shut down of the primary facility. The number of cardiac arrests treated by each EMS provider was estimated based on information from the American Heart Association, which estimates out-of-hospital cardiac arrests to be 36 to 81 per 100,000 people for the population greater than or equal to 20 years old (American Heart Association 2008). The midpoint (58.5 per 100,000 people) was used in the following equation to estimate the number of cardiac arrests per year treated by each EMS facility:

$$Number\ of\ cardiac\ arrest\ per\ year\ treated\ by\ EMS = \frac{population\ served_{EMS\ Facility}\ x\ 58.5}{100{,}000}$$

The average EMS response time was estimated before and after a possible temporary closure. For existing conditions, it is assumed that the response time is equal to the national average. According to the National EMS Information System (NEMSIS, 2008), the national median response time for cardiac arrest calls is 7 minutes for urban areas, such as the Meadowlands District. The additional response time needed when an EMS facility is temporarily closed is estimated using the following equation developed by the New York City Rand Institute (Chaiken et al., 1975):

$$RT_{After} = 7 + (0.65 + 1.70D)$$

Where:

RT_{After} = the response time after the EMS provider shutdown (in minutes)

D = distance in miles to the nearest facility that would provide services in place of the closed EMS facility

For urban areas (such as Meadowlands District), the survival probability for victims suffering from cardiac arrest before and after facility shut down are estimated using the following equations:

$$Survival\ probability_{Before} = \left(1 + e^{-0.260+0.0106*(7+1)+0.139*(7+2)}\right)^{-1} = 0.2543$$

$$Survival\ probability_{After} = \left(1 + e^{-0.260+0.0106*(RT_{After}+1)+0.139*(RT_{After}+2)}\right)^{-1}$$

The increase in the number of deaths from cardiac arrests due to the increased EMS response time was calculated as the difference between the number of deaths per years due to cardiac arrest before and after facility shut down. Then the cost of lives per day due to the increased EMS response time is valued using the VSL introduced in section 1.1.1 ($9.7 million for a 2016 base year) and the following formula:

$$Cost\ per\ day = \frac{(Increase\ in\ the\ number\ of\ deaths\ per\ year\ due\ to\ cardiac\ arrest)}{365}\ x\ \$9{,}700{,}000$$

The costs of lost EMS were estimated per day for each fire department and EMS facility in the study area. The results are presented in **Table E-13**.

Table E-13: Cost per Day for Loss of EMS Providers

EMS Provider	Estimated Population Served	Nearest EMS Substitution (miles)	Cost per day of lost EMS
Little Ferry Hose Co. Fire Department	5,400	3.5	$11,900
Little Ferry Hook and Ladder Fire Department	5,400	3.1	$11,000
Moonachie Fire Department	2,700	2.7	$3,600
Moonachie First Aid Squad	800	1.1	$800
South Hackensack Fire Headquarters	3,100	2.4	$5,400

Note: Values were rounded to the nearest hundred.

Emergency service professionals at the identified critical facilities were contacted and requested to answer questions about how flooding could impact operations. During the interview process, emergency service professionals were sometimes unwilling or unable to provide information. Questionnaire data for all of the identified critical facilities were not obtained from the emergency service professionals that were contacted. Since information specific to how each EMS provider would be impacted by different flood conditions was not available, it was assumed that the following flood depths (above first floor elevation) would cause the respective number of days of diminished or unavailable service as presented in **Table E-14**.

Table E-14: Estimated Number of Days of Diminished/Unavailable EMS

Depth of Flooding	Days
0 to 2 feet	5
2 to 4 feet	7
4 to 6 feet	14
6 to 8 feet	21

Using the assumptions in **Table E-14** and the total cost per day of lost EMS from **Table E-13**, the costs for each depth of flooding above first floor elevation were estimated and are presented in **Table E-15**. This depth-damage function was imported into HEC-FDA and used to compare the No Action Alternative to each Proposed Project alternative.

Table E-15: Cost for Loss of EMS by Depth of Flooding

Depth of Flooding Above FFE	1 Foot	2 Feet	3 Feet	4 Feet	5 Feet	6 Feet	7 Feet	8 Feet
Days of diminished or unavailable service	5	7	7	14	14	21	21	21
The Little Ferry Hose Co. #1 Fire Department	$59,000	$83,000	$83,000	$166,000	$166,000	$250,000	$250,000	$250,000
Little Ferry Hook and Ladder Fire Department	$55,000	$77,000	$77,000	$154,000	$154,000	$231,000	$231,000	$231,000
Moonachie Fire Department	$18,000	$25,000	$25,000	$50,000	$50,000	$75,000	$75,000	$75,000
Moonachie First Aid Squad	$4,000	$6,000	$6,000	$12,000	$12,000	$17,000	$17,000	$17,000
South Hackensack Fire Department	$27,000	$38,000	$38,000	$75,000	$75,000	$113,000	$113,000	$113,000

Note: Costs were rounded to the nearest thousand. FFE = first floor elevation

3.1.6 Mental Health

Decreased mental health may be a result of mental stress and post-traumatic stress disorder (PTSD) associated with exposure to the disaster, including stress associated with evacuations, losing a home and possessions, physical injuries, and illnesses of family and friends. Mental stress can also be a secondary response to other direct impacts, such as being displaced from home and community, loss of electricity and heat in the home for extended periods of time, inability to receive regular counseling or treatment as a result of closure or lack of transportation, or inability to obtain needed medication. Mental health issues can lead to sleep disorders, drug/alcohol abuse, and inability to work and can last for months or years following a flood event. Productivity losses can occur from lost labor and production due to flood-related mental health issues and lost labor and production by those who provide care to affected family members.

The approach used to estimate the treatment costs and cost of lost productivity from the onset of mental illness caused by a flood event follows the guidance provided by FEMA (FEMA 2012). **Table E-16** displays the total treatment costs per person. Values were updated to 2016 dollars using the CPI-U (US Bureau of Labor Statistics 2017). The total treatment cost per person was multiplied by the total number of people in each household that would be affected by each flood event.

Table E-16: Mental Health Treatment Costs

Time after Disaster	Severe	Mild/Moderate	Total per Person
12 Months	$200	$700	$900
18 Months	$200	$500	$700
24 Months	$300	$400	$600
30 Months	$200	$200	$400
Total Treatment Costs			**$2,600**

Note: Costs were rounded to the nearest hundred.
Source: (FEMA 2012)

The cost of lost productivity is estimated only for severe mental illness since no reliable sources were found to document an economic value for mild or moderate mental illness. **Table E-17** displays the total productivity loss due to severe mental illness. The lost productivity value was multiplied by the number of people employed in each household that would be affected by each flood event.

Table E-17: Productivity Loss due to Severe Mental Illness

Time after Disaster	Productivity Loss	Prevalence Rate	Productivity Loss per Worker
12 Months	$20,100	6%	$1,200
18 Months	$30,200	7%	$2,100
24 Months	$40,200	7%	$2,800
30 Months	$50,300	6%	$3,000
Total Productivity Loss			**$9,100**

Note: Costs were rounded to the nearest hundred.
Source: (FEMA 2012)

The mental health costs and productivity loss were estimated per household. According to the 2010 Census, on average there are 2.46 people per housing unit in the study area and 53 percent are employed (1.3 per household). The mental health costs associated with a household that experiences a flood event are estimated to be nearly $6,300 and the productivity loss is estimated to be about $11,900, for a total cost of $18,200 per household (US Census Bureau 2014).

3.1.7 Resiliency Results by Alternative

Results from the HEC-FDA analysis for each of the alternatives is displayed in the following sections.

3.1.7.1 No Action Alternative Results

The baseline conditions (i.e., conditions without the Proposed Project) were modeled in HEC-FDA and results are displayed in **Table E-18** through **Table E-20**. The No Action Alternative assumes that the Proposed Project would not be implemented and current conditions and operations would continue in the Project Area. Under the No Action Alternative, the purpose of and need for the Proposed Project would not be met. Flood protection measures under this alternative would generally be limited to the operation and maintenance of existing infrastructure. The No Action tables below represent the damages from tidal/storm surge flooding (associated with Alternative 1). No Action damages for fluvial and interior drainage impacts are tabulated in later sections covering results of analyses for Alternative 2 and 3.

3.1.7.2 Alternative 1 Resiliency Results

Table E-21 through **Table E-23** present the damages computed in HEC-FDA for the Proposed Project, Alternative 1. The Proposed Project includes a LOP with a 7.0 feet NAVD 88 still water design elevation. For more details of the formulation and evaluation of Alternative 1, see the Feasibility Study Report.

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Table E-18: Annual Average Damage: No Action, Baseline Condition

Stream	Basins Covered	Benefit Category										
		Structures						Other				
		Residential	Apartment	Commercial	Industrial	Municipal	Utility	Motor Vehicles	Debris Disposal	Death/Injury	Public Emergency	Critical Facility Disruption
Berry's Creek	Dell Rd, Eight Day Swamp, Peach Island Creek S, E Riser Ditch S	$216,140	$0	$3,795,100	$12,268,420	$60,400	$720	$74,910	$63,500	$380,620	$86,750	$0
	Paterson Plank Rd	$5,150	$0	$307,740	$1,994,710	$0	$0	$1,000	$7,030	$6,020	$5,130	$0
	West Riser Ditch – Grand St	$3,780	$0	$207,220	$1,014,730	$0	$0	$780	$4,090	$4,050	$5,250	$0
	Anderson Avenue	$38,570	$0	$96,400	$125,840	$5,380	$0	$5,100	$710	$27,580	$1,200	$0
	East Riser Ditch N, Peach Island Creek N	$207,740	$0	$216,490	$556,450	$0	$110	$22,010	$2,870	$122,070	$7,120	$0
	West Riser Ditch S, West Riser Ditch PS	$20,690	$0	$102,230	$1,264,210	$186,680	$650	$1,970	$5,100	$10,670	$5,010	$0
	East Riser Ditch – Main St	$19,140	$0	$1,938,950	$953,960	$350,580	$70	$2,620	$10,960	$15,650	$8,600	$0
	West Riser Ditch – Main St	$0	$0	$524,220	$4,855,570	$181,870	$510	$0	$22,730	$0	$23,810	$0
Subtotal		***$511,210***	***$0***	***$7,188,350***	***$23,033,890***	***$784,910***	***$2,060***	***$108,390***	***$116,990***	***$566,660***	***$142,870***	***$0***
Berry's Creek Total		***$32,455,330***										
Hackensack River	Washington Ave	$10	$0	$665,050	$1,987,230	$0	$400	$20	$16,630	$140	$36,140	$0
	Moonachie Creek S	$0	$0	$278,890	$4,044,600	$0	$870	$0	$29,370	$0	$48,520	$0
	Moonachie Creek N, Carol Place Ditch	$42,740	$0	$2,179,460	$17,237,950	$0	$7,140	$4,220	$123,710	$23,270	$200,670	$0
	Losen Slote South	$1,798,210	$195,390	$2,934,150	$3,552,000	$463,270	$2,220	$284,990	$41,400	$1,714,710	$95,950	$3,730
	Wastewater Treatment Plant	$0	$0	$115,630	$5,170	$0	$0	$0	$0	$0	$0	$0
	A Self Storage	$0	$0	$0	$0	$0	$49,510	$0	$720	$0	$1,360	$0
	DePeyster Creek, Gates Rd, Losen Slote Cntr, Main St Ditch, Mehrhof Rd	$1,212,400	$216,840	$903,660	$1,245,700	$132,230	$2,810	$195,070	$17,200	$1,153,840	$49,610	$9,620
	Waterside Dr	$0	$156,890	$73,130	$0	$0	$0	$19,180	$840	$104,640	$2,740	$0
	Indian Lake Rd, Losen Slote Main St	$112,360	$0	$358,210	$200,630	$6,310	$0	$18,030	$8,450	$100,440	$4,010	$700
	South River St	$0	$0	$150,300	$0	$0	$0	$0	$770	$0	$2,730	$0
	Pulaski Park	$35,010	$21,640	$15,120	$8,920	$56,020	$0	$8,230	$550	$45,560	$1,020	$0
Subtotal		***$3,200,730***	***$590,760***	***$7,673,600***	***$28,282,200***	***$657,830***	***$62,950***	***$529,740***	***$239,640***	***$3,142,600***	***$442,750***	***$14,050***
Hackensack River Total		***$44,836,850***										
Overall Totals		***$3,711,590***	***$590,760***	***$14,861,950***	***$51,316,090***	***$1,442,740***	***$65,010***	***$638,130***	***$356,630***	***$3,709,260***	***$585,620***	***$14,050***
Grand Total		**$77,292,810**										
Total Present Value		**$1,066,690,000**										

Table E-19: Annual Average Damage: No Action, Future Condition

Stream	Basins Covered	Benefit Category										
		Structures						Other				
		Residential	Apartment	Commercial	Industrial	Municipal	Utility	Motor Vehicles	Debris Disposal	Death/Injury	Public Emergency	Critical Facility Disruption
Berry's Creek	Dell Rd, Eight Day Swamp, Peach Island Creek S, E Riser Ditch S	$353,720	$0	$14,135,250	$40,634,230	$159,130	$1,240	$317,890	$236,830	$2,061,870	$511,760	$0
	Paterson Plank Rd	$8,720	$0	$632,760	$6,320,130	$0	$0	$1,620	$21,220	$9,510	$20,090	$0
	West Riser Ditch – Grand St	$11,630	$0	$468,750	$2,585,240	$0	$0	$3,030	$13,560	$20,700	$28,920	$0
	Anderson Avenue	$91,720	$0	$232,790	$515,960	$12,460	$0	$12,270	$2,060	$70,390	$4,540	$0
	East Riser Ditch N, Peach Island Creek N	$400,980	$0	$356,400	$995,540	$0	$190	$46,350	$4,980	$246,760	$19,250	$0
	West Riser Ditch S, West Riser Ditch PS	$45,630	$0	$166,720	$3,315,520	$419,820	$1,270	$3,950	$13,570	$18,770	$20,040	$0
	East Riser Ditch – Main St	$32,300	$0	$4,629,960	$1,473,370	$643,660	$100	$4,440	$27,550	$25,320	$21,370	$0
	West Riser Ditch – Main St	$0	$0	$931,900	$17,228,760	$288,320	$1,920	$0	$84,240	$0	$100,050	$0
Subtotal		***$944,700***	***$0***	***$21,554,530***	***$73,068,750***	***$1,523,390***	***$4,720***	***$389,550***	***$404,010***	***$2,453,320***	***$726,020***	***$0***
Berry's Creek Total		***$101,068,990***										
Hackensack River	Washington Ave	$30	$0	$1,296,980	$3,346,390	$0	$720	$40	$37,980	$230	$52,480	$0
	Moonachie Creek S	$0	$0	$583,770	$7,767,080	$0	$1,750	$0	$65,180	$0	$76,410	$0
	Moonachie Creek N, Carol Place Ditch	$79,810	$0	$3,950,870	$34,039,390	$0	$12,440	$8,170	$311,900	$43,930	$434,500	$0
	Losen Slote South	$3,335,690	$338,360	$5,318,520	$6,670,620	$839,160	$3,650	$531,610	$81,170	$3,265,830	$189,470	$7,160
	Wastewater Treatment Plant	$0	$0	$186,790	$9,410	$0	$0	$0	$0	$0	$0	$0
	A Self Storage	$0	$0	$0	$0	$0	$76,440	$0	$1,610	$0	$1,900	$0
	DePeyster Creek, Gates Rd, Losen Slote Cntr, Main St Ditch, Mehrhof Rd	$2,132,730	$369,260	$1,545,970	$2,168,470	$230,710	$4,540	$346,510	$31,630	$2,101,990	$92,940	$17,030
	Waterside Dr	$0	$237,280	$110,030	$0	$0	$0	$30,030	$1,240	$160,650	$4,500	$0
	Indian Lake Rd, Losen Slote Main St	$182,350	$0	$588,560	$321,500	$9,350	$0	$29,480	$12,800	$167,970	$7,110	$1,080
	South River St	$0	$0	$239,990	$0	$0	$0	$0	$1,300	$0	$8,020	$0
	Pulaski Park	$54,530	$37,690	$25,170	$14,570	$89,230	$0	$13,060	$930	$72,960	$1,740	$0
Subtotal		***$5,785,140***	***$982,590***	***$13,846,650***	***$54,337,430***	***$1,168,450***	***$99,540***	***$958,900***	***$545,740***	***$5,813,560***	***$869,070***	***$25,270***
Hackensack River Total		***$84,432,340***										
Overall Totals		***$6,729,840***	***$982,590***	***$35,401,180***	***$127,406,180***	***$2,691,840***	***$104,260***	***$1,348,450***	***$949,750***	***$8,266,880***	***$1,595,090***	***$25,270***
Grand Total		**$185,501,330**										
Total Present Value		**$2,560,057,000**										

Note: Future condition assumes 1.2 feet of sea level rise at Battery Point, NY by 2073, translating to 0.8 feet of sea level rise across the Project Area.

Table E-20: Equivalent Annual Damage: No Action

Stream	Basins Covered	Benefit Category										
		Structures						Other				
		Residential	Apartment	Commercial	Industrial	Municipal	Utility	Motor Vehicles	Debris Disposal	Death/Injury	Public Emergency	Critical Facility Disruption
Berry's Creek	Dell Rd, Eight Day Swamp, Peach Island Creek S, E Riser Ditch S	$250,620	$0	$6,386,070	$19,376,150	$85,140	$850	$135,800	$106,930	$801,900	$193,250	$0
	Paterson Plank Rd	$6,040	$0	$389,180	$3,078,540	$0	$0	$1,150	$10,590	$6,900	$8,880	$0
	West Riser Ditch – Grand St	$5,750	$0	$272,750	$1,408,250	$0	$0	$1,340	$6,460	$8,230	$11,180	$0
	Anderson Avenue	$51,890	$0	$130,580	$223,590	$7,150	$0	$6,900	$1,050	$38,300	$2,040	$0
	East Riser Ditch N, Peach Island Creek N	$256,160	$0	$251,550	$666,480	$0	$130	$28,110	$3,400	$153,310	$10,160	$0
	West Riser Ditch S, West Riser Ditch PS	$26,940	$0	$118,390	$1,778,210	$245,100	$800	$2,460	$7,220	$12,700	$8,770	$0
	East Riser Ditch – Main St	$22,440	$0	$2,613,250	$1,084,110	$424,020	$80	$3,070	$15,120	$18,070	$11,800	$0
	West Riser Ditch – Main St	$0	$0	$626,370	$7,955,970	$208,540	$860	$0	$38,140	$0	$42,910	$0
Subtotal		***$619,840***	***$0***	***$10,788,140***	***$35,571,300***	***$969,950***	***$2,720***	***$178,830***	***$188,910***	***$1,039,410***	***$288,990***	***$0***
Berry's Creek Total		***$49,648,090***										
Hackensack River	Washington Ave	$20	$0	$823,400	$2,327,800	$0	$480	$30	$21,980	$160	$40,230	$0
	Moonachie Creek S	$0	$0	$355,280	$4,977,360	$0	$1,090	$0	$38,340	$0	$55,510	$0
	Moonachie Creek N, Carol Place Ditch	$52,030	$0	$2,623,330	$21,447,950	$0	$8,470	$5,210	$170,870	$28,450	$259,260	$0
	Losen Slote South	$2,183,460	$231,210	$3,531,610	$4,333,440	$557,460	$2,580	$346,780	$51,360	$2,103,380	$119,380	$4,590
	Wastewater Treatment Plant	$0	$0	$133,460	$6,230	$0	$0	$0	$0	$0	$0	$0
	A Self Storage	$0	$0	$0	$0	$0	$56,250	$0	$950	$0	$1,490	$0
	DePeyster Creek, Gates Rd, Losen Slote Cntr, Main St Ditch, Mehrhof Rd	$1,443,010	$255,030	$1,064,610	$1,476,920	$156,910	$3,240	$233,010	$20,820	$1,391,420	$60,470	$11,480
	Waterside Dr	$0	$177,030	$82,380	$0	$0	$0	$21,900	$940	$118,670	$3,180	$0
	Indian Lake Rd, Losen Slote Main St	$129,900	$0	$415,930	$230,920	$7,070	$0	$20,900	$9,540	$117,360	$4,790	$800
	South River St	$0	$0	$172,780	$0	$0	$0	$0	$910	$0	$4,060	$0
	Pulaski Park	$39,900	$25,670	$17,640	$10,330	$64,340	$0	$9,440	$640	$52,430	$1,200	$0
Subtotal		***$3,848,320***	***$688,940***	***$9,220,420***	***$34,810,950***	***$785,780***	***$72,110***	***$637,270***	***$316,350***	***$3,811,870***	***$549,570***	***$16,870***
Hackensack River Total		***$54,758,450***										
Overall Totals		***$4,468,160***	***$688,940***	***$20,008,560***	***$70,382,250***	***$1,755,730***	***$74,830***	***$816,100***	***$505,260***	***$4,851,280***	***$838,560***	***$16,870***
Grand Total		**$104,406,540**										
Total Present Value		**$1,440,888,000**										

Note: Future condition assumes 1.2 feet of sea level rise at Battery Point, NY by 2073, translating to 0.8 feet of sea level rise across the Project Area.

Table E-21: Alternative 1: Annual Average Damage: With Proposed Project, Baseline Conditions

Stream	Basins Covered	Benefit Category										
		Structures						Other				
		Residential	Apartment	Commercial	Industrial	Municipal	Utility	Motor Vehicles	Debris Disposal	Death/Injury	Public Emergency	Critical Facility Disruption
Berry's Creek	Dell Rd, Eight Day Swamp, Peach Island Creek S, E Riser Ditch S	$201,910	$0	$2,661,500	$9,053,020	$48,260	$650	$47,890	$44,210	$203,540	$41,390	$0
	Paterson Plank Rd	$4,950	$0	$273,490	$1,525,490	$0	$0	$970	$5,530	$5,880	$3,500	$0
	West Riser Ditch – Grand St	$2,940	$0	$176,610	$829,480	$0	$0	$530	$3,020	$2,300	$2,730	$0
	Anderson Avenue	$33,090	$0	$78,500	$83,260	$4,430	$0	$4,270	$550	$21,810	$810	$0
	East Riser Ditch N, Peach Island Creek N	$187,610	$0	$197,150	$521,620	$0	$110	$19,010	$2,680	$101,700	$5,380	$0
	West Riser Ditch S, West Riser Ditch PS	$17,870	$0	$92,220	$1,015,370	$154,930	$640	$1,710	$4,080	$9,030	$3,310	$0
	East Riser Ditch – Main St	$18,580	$0	$1,641,330	$910,280	$314,890	$70	$2,510	$9,190	$15,090	$7,090	$0
	West Riser Ditch – Main St	$0	$0	$493,920	$3,486,750	$181,870	$350	$0	$16,050	$0	$15,060	$0
Subtotal		***$466,950***	***$0***	***$5,614,720***	***$17,425,270***	***$704,380***	***$1,820***	***$76,890***	***$85,310***	***$359,350***	***$79,270***	***$0***
Berry's Creek Total		***$24,813,960***										
Hackensack River	Washington Ave	$10	$0	$314,180	$622,230	$0	$380	$20	$3,310	$130	$3,590	$0
	Moonachie Creek S	$0	$0	$130,490	$1,261,720	$0	$440	$0	$5,420	$0	$4,040	$0
	Moonachie Creek N, Carol Place Ditch	$30,550	$0	$1,627,160	$7,149,110	$0	$880	$2,490	$32,110	$14,160	$37,130	$0
	Losen Slote South	$949,740	$144,890	$1,727,350	$1,743,410	$275,540	$2,040	$144,930	$16,200	$716,180	$29,090	$1,530
	Wastewater Treatment Plant	$0	$0	$110,770	$3,490	$0	$0	$0	$0	$0	$0	$0
	A Self Storage	$0	$0	$0	$0	$0	$40,020	$0	$440	$0	$490	$0
	DePeyster Creek, Gates Rd, Losen Slote Cntr, Main St Ditch, Mehrhof Rd	$761,950	$161,210	$658,010	$867,610	$91,880	$2,530	$120,240	$8,360	$624,700	$19,780	$5,590
	Waterside Dr	$0	$152,750	$72,350	$0	$0	$0	$17,960	$830	$100,360	$2,430	$0
	Indian Lake Rd, Losen Slote Main St	$94,990	$0	$268,840	$175,720	$6,210	$0	$14,870	$7,570	$82,660	$2,650	$710
	South River St	$0	$0	$140,320	$0	$0	$0	$0	$680	$0	$1,080	$0
	Pulaski Park	$33,420	$12,550	$11,200	$7,320	$50,780	$0	$7,250	$300	$40,510	$720	$0
Subtotal		***$1,870,660***	***$471,400***	***$5,060,670***	***$11,830,610***	***$424,410***	***$46,290***	***$307,760***	***$75,220***	***$1,578,700***	***$101,000***	***$7,830***
Hackensack River Total		***$21,774,550***										
Overall Totals		***$2,337,610***	***$471,400***	***$10,675,390***	***$29,255,880***	***$1,128,790***	***$48,110***	***$384,650***	***$160,530***	***$1,938,050***	***$180,270***	***$7,830***
Grand Total		**$46,588,510**										
Total Present Value		**$642,956,000**										

Table E-22: Alternative 1: Annual Average Damage: With Proposed Project, Future Condition

Stream	Basins Covered	Benefit Category										
		Structures						Other				
		Residential	Apartment	Commercial	Industrial	Municipal	Utility	Motor Vehicles	Debris Disposal	Death/Injury	Public Emergency	Critical Facility Disruption
Berry's Creek	Dell Rd, Eight Day Swamp, Peach Island Creek S, E Riser Ditch S	$282,020	$0	$3,617,660	$12,214,850	$65,390	$900	$63,050	$58,900	$266,570	$53,310	$0
	Paterson Plank Rd	$8,400	$0	$389,670	$2,102,640	$0	$0	$1,580	$7,490	$9,460	$4,520	$0
	West Riser Ditch – Grand St	$4,050	$0	$241,180	$1,128,380	$0	$0	$700	$4,030	$3,010	$3,510	$0
	Anderson Avenue	$46,960	$0	$105,350	$110,300	$5,950	$0	$5,840	$740	$28,930	$1,040	$0
	East Riser Ditch N, Peach Island Creek N	$271,650	$0	$278,900	$755,410	$0	$190	$26,450	$3,730	$136,590	$6,980	$0
	West Riser Ditch S, West Riser Ditch PS	$26,140	$0	$126,220	$1,370,450	$208,360	$1,050	$2,350	$5,410	$11,910	$4,280	$0
	East Riser Ditch – Main St	$31,000	$0	$2,254,660	$1,320,620	$430,790	$100	$4,020	$12,410	$23,590	$9,290	$0
	West Riser Ditch – Main St	$0	$0	$714,820	$4,680,030	$279,980	$460	$0	$21,510	$0	$19,500	$0
Subtotal		***$670,220***	***$0***	***$7,728,460***	***$23,682,680***	***$990,470***	***$2,700***	***$103,990***	***$114,220***	***$480,060***	***$102,430***	***$0***
Berry's Creek Total		***$33,875,230***										
Hackensack River	Washington Ave	$30	$0	$573,860	$1,141,660	$0	$670	$40	$6,150	$220	$6,790	$0
	Moonachie Creek S	$0	$0	$232,100	$2,257,590	$0	$790	$0	$9,740	$0	$7,440	$0
	Moonachie Creek N, Carol Place Ditch	$53,400	$0	$2,874,770	$12,792,660	$0	$1,620	$4,410	$57,890	$25,700	$68,550	$0
	Losen Slote South	$1,607,630	$241,440	$2,939,520	$3,003,300	$467,580	$3,340	$248,770	$27,710	$1,252,100	$51,650	$2,610
	Wastewater Treatment Plant	$0	$0	$176,480	$5,890	$0	$0	$0	$0	$0	$0	$0
	A Self Storage	$0	$0	$0	$0	$0	$62,220	$0	$710	$0	$820	$0
	DePeyster Creek, Gates Rd, Losen Slote Cntr, Main St Ditch, Mehrhof Rd	$1,244,660	$259,570	$1,065,970	$1,429,440	$151,680	$4,020	$198,600	$13,780	$1,057,430	$34,300	$9,220
	Waterside Dr	$0	$227,490	$107,540	$0	$0	$0	$27,060	$1,210	$150,880	$3,830	$0
	Indian Lake Rd, Losen Slote Main St	$148,770	$0	$415,370	$270,920	$9,310	$0	$23,220	$11,100	$131,440	$4,380	$1,070
	South River St	$0	$0	$216,720	$0	$0	$0	$0	$1,080	$0	$1,810	$0
	Pulaski Park	$51,190	$20,640	$17,720	$11,470	$78,720	$0	$11,150	$470	$62,930	$1,170	$0
Subtotal		***$3,105,680***	***$749,140***	***$8,620,050***	***$20,912,930***	***$707,290***	***$72,660***	***$513,250***	***$129,840***	***$2,680,700***	***$180,740***	***$12,900***
Hackensack River Total		***$37,685,180***										
Overall Totals		***$3,775,900***	***$749,140***	***$16,348,510***	***$44,595,610***	***$1,697,760***	***$75,360***	***$617,240***	***$244,060***	***$3,160,760***	***$283,170***	***$12,900***
Grand Total		**$71,560,410**										
Total Present Value		**$987,587,000**										

Note: Future condition assumes 1.2 Ft of sea level rise at Battery Point, NY by 2073, translating to 0.8 Ft of sea level rise across the Project Area.

Table E-23: Alternative 1: Equivalent Annual Damage: With Proposed Project

Stream	Basins Covered	Benefit Category										
		Structures						Other				
		Residential	Apartment	Commercial	Industrial	Municipal	Utility	Motor Vehicles	Debris Disposal	Death/Injury	Public Emergency	Critical Facility Disruption
Berry's Creek	Dell Rd, Eight Day Swamp, Peach Island Creek S, E Riser Ditch S	$221,980	$0	$2,901,090	$9,845,290	$52,550	$710	$51,690	$47,890	$219,340	$44,380	$0
	Paterson Plank Rd	$5,810	$0	$302,600	$1,670,110	$0	$0	$1,120	$6,020	$6,780	$3,760	$0
	West Riser Ditch – Grand St	$3,210	$0	$192,790	$904,370	$0	$0	$570	$3,270	$2,470	$2,920	$0
	Anderson Avenue	$36,570	$0	$85,230	$90,030	$4,810	$0	$4,660	$600	$23,600	$860	$0
	East Riser Ditch N, Peach Island Creek N	$208,670	$0	$217,640	$580,200	$0	$130	$20,870	$2,940	$110,440	$5,780	$0
	West Riser Ditch S, West Riser Ditch PS	$19,940	$0	$100,740	$1,104,340	$168,320	$740	$1,870	$4,420	$9,750	$3,560	$0
	East Riser Ditch – Main St	$21,690	$0	$1,795,010	$1,013,100	$343,940	$80	$2,890	$10,000	$17,220	$7,640	$0
	West Riser Ditch – Main St	$0	$0	$549,270	$3,785,760	$206,450	$380	$0	$17,420	$0	$16,170	$0
Subtotal		***$517,870***	***$0***	***$6,144,370***	***$18,993,200***	***$776,070***	***$2,040***	***$83,670***	***$92,560***	***$389,600***	***$85,070***	***$0***
Berry's Creek Total		***$27,084,450***										
Hackensack River	Washington Ave	$20	$0	$379,250	$752,380	$0	$460	$30	$4,030	$160	$4,390	$0
	Moonachie Creek S	$0	$0	$155,950	$1,511,260	$0	$530	$0	$6,500	$0	$4,890	$0
	Moonachie Creek N, Carol Place Ditch	$36,270	$0	$1,939,780	$8,563,240	$0	$1,070	$2,970	$38,570	$17,050	$45,000	$0
	Losen Slote South	$1,114,590	$169,090	$2,031,080	$2,059,110	$323,660	$2,360	$170,950	$19,080	$850,460	$34,740	$1,800
	Wastewater Treatment Plant	$0	$0	$127,240	$4,090	$0	$0	$0	$0	$0	$0	$0
	A Self Storage	$0	$0	$0	$0	$0	$45,580	$0	$510	$0	$580	$0
	DePeyster Creek, Gates Rd, Losen Slote Cntr, Main St Ditch, Mehrhof Rd	$882,900	$185,860	$760,230	$1,008,390	$106,860	$2,900	$139,870	$9,720	$733,130	$23,420	$6,500
	Waterside Dr	$0	$171,480	$81,170	$0	$0	$0	$20,240	$930	$113,020	$2,780	$0
	Indian Lake Rd, Losen Slote Main St	$108,460	$0	$305,560	$199,580	$6,990	$0	$16,960	$8,450	$94,880	$3,080	$800
	South River St	$0	$0	$159,460	$0	$0	$0	$0	$780	$0	$1,260	$0
	Pulaski Park	$37,870	$14,580	$12,830	$8,360	$57,780	$0	$8,230	$340	$46,120	$830	$0
Subtotal		***$2,180,110***	***$541,010***	***$5,952,550***	***$14,106,410***	***$495,290***	***$52,900***	***$359,250***	***$88,910***	***$1,854,820***	***$120,970***	***$9,100***
Hackensack River Total		***$25,761,320***										
Overall Totals		***$2,697,980***	***$541,010***	***$12,096,920***	***$33,099,610***	***$1,271,360***	***$54,940***	***$442,920***	***$181,470***	***$2,244,420***	***$206,040***	***$9,100***
Grand Total		**$52,845,770**										
Total Present Value		**$729,311,000**										

Note: Future condition assumes 1.2 feet of sea level rise at Battery Point, NY by 2073, translating to 0.8 feet of sea level rise across the Project Area.

Table E-24 presents a summary of all equivalent annual benefits realized by the Proposed Project, based on the National Oceanic and Atmospheric Administration's (NOAA's) Intermediate-Low sea level rise projection, which is a 1.2-feet sea level rise at the year 2075.

Table E-24: Alternative 1: Equivalent Annual Resiliency Benefits

Evaluated Benefit Category	Hackensack River	Berry's Creek
Residential Structures	$1,668,200	$101,960
Apartment Structures	$147,940	$0
Commercial Structures	$3,267,860	$4,643,770
Industrial Structures	$20,740,550	$16,578,090
Municipal Structures	$290,490	$193,880
Utility Structures	$19,210	$690
Motor Vehicles	$278,030	$95,160
Critical Facilities Disruption	$7,770	$0
Injury and Loss of Life	$1,957,040	$649,810
Emergency Services Costs	$428,590	$203,910
Debris Removal and Disposal	$227,430	$96,340
Totals	**$28,997,110**	**$22,563,610**
Study Area Total	**$51,560,720**	
Total Present Value	**$711,576,000**	

Note: Interest rate is 7 percent for a 50-year period of analysis.

3.1.7.3 Alternative 2 Resiliency Results

The Alternative 2 benefit analysis used the same structure inventory that was developed for Alternative 1, but was applied only to the portions of the study area impacted by the Alternative 2 Proposed Project; i.e. the drainage areas associated with East Riser Ditch, West Riser Ditch, and Losen Slote. The inventory for these areas was input to a separate HEC-FDA model, in conjunction with the same depth-damage functions as described above, and fluvial hydrologic/hydraulic data developed specifically for the Alternative 2 analysis. See **Table E-25** through **Table E-31**.

Table E-25: Alternative 2: Number and Values ($,000) of Structures Impacted in the Project Area by Type and Fluvial Floodplain

Damage Category	10-Year		50-Year		100-Year		500-Year	
	#	Value	#	Value	#	Value	#	Value
Apartment	1	$1,400	1	$1,400	1	$1,400	2	$4,018
Commercial	24	$93,498	33	$162,779	37	$173,273	52	$209,512
Industrial	41	$258,325	62	$342,737	67	$375,076	82	$421,726
Municipal	4	$36,697	6	$54,392	6	$54,392	7	$63,844
Residential	115	$15,859	204	$30,997	241	$36,633	329	$49,375
Utility	3	N/A*	3	N/A*	3	N/A*	3	N/A*
Total	**188**	**$405,779**	**309**	**$592,306**	**355**	**$640,776**	**472**	**$748,475**

*PRB damage functions for utility structures are based on square footage of the structure, not dollar values.

Table E-26: Alternative 2 – Average Annual Damage Without Proposed Project, Baseline Condition

Streams Covered	Flood Damage Benefit Category										
	Structures						Other				
	Residential	Apartment	Commercial	Industrial	Municipal	Utility	Motor Vehicles	Debris Disposal	Death/Injury	Public Emergency	Critical Facility Disruption
East Riser Ditch	$5,170	$0	$8,933,420	$2,667,440	$262,280	$0	$88,940	$2,280	$1,627,700	$10	$0
West Riser Ditch	$12,640	$0	$2,092,400	$58,208,240	$274,450	$7,700	$1,820	$348,410	$13,200	$2,560	$0
Losen Slote	$1,070,470	$20,560	$1,059,170	$157,530	$142,620	$0	$135,460	$7,400	$1,901,610	$40	$50
Category Totals	**$1,088,280**	**$20,560**	**$12,084,990**	**$61,033,210**	**$679,350**	**$7,700**	**$226,220**	**$358,090**	**$3,542,510**	**$2,610**	**$50**
Proposed Project Total	***$79,043,570***										

Table E-27: Alternative 2 – Average Annual Damage Without Proposed Project, Future Condition

Streams Covered	Flood Damage Benefit Category										
	Structures						Other				
	Residential	Apartment	Commercial	Industrial	Municipal	Utility	Motor Vehicles	Debris Disposal	Death/Injury	Public Emergency	Critical Facility Disruption
East Riser Ditch	$17,320	$0	$12,435,450	$6,749,400	$437,150	$10	$171,590	$6,540	$4,026,800	$30	$0
West Riser Ditch	$36,870	$0	$2,918,200	$68,127,110	$463,930	$9,270	$4,750	$398,210	$63,140	$3,010	$0
Losen Slote	$1,256,300	$32,160	$1,245,430	$257,140	$182,660	$0	$161,240	$7,790	$2,435,630	$40	$310
Category Totals	**$1,310,490**	**$32,160**	**$16,599,080**	**$75,133,650**	**$1,083,740**	**$9,280**	**$337,580**	**$412,540**	**$6,525,570**	**$3,080**	**$310**
Proposed Project Total	***$101,447,480***										

Table E-28: Alternative 2 – Equivalent Annual Damage Without Proposed Project

Streams Covered	Flood Damage Benefit Category										
	Structures						Other				
	Residential	Apartment	Commercial	Industrial	Municipal	Utility	Motor Vehicles	Debris Disposal	Death/Injury	Public Emergency	Critical Facility Disruption
East Riser Ditch	$8,220	$0	$9,810,940	$3,690,270	$306,100	$0	$109,650	$3,350	$2,228,850	$20	$0
West Riser Ditch	$18,710	$0	$2,299,320	$60,693,640	$321,930	$8,090	$2,560	$360,890	$25,710	$2,680	$0
Losen Slote	$1,117,040	$23,460	$1,105,830	$182,490	$152,650	$0	$141,920	$7,500	$2,035,420	$40	$110
Category Totals	**$1,143,970**	**$23,460**	**$13,216,090**	**$64,566,400**	**$780,680**	**$8,090**	**$254,130**	**$371,740**	**$4,289,980**	**$2,740**	**$110**
Proposed Project Total	***$84,657,390***										

Table E-29: Alternative 2 – Average Annual Damage With Proposed Project, Baseline Condition

Streams Covered	Flood Damage Benefit Category										
	Structures						Other				
	Residential	Apartment	Commercial	Industrial	Municipal	Utility	Motor Vehicles	Debris Disposal	Death/Injury	Public Emergency	Critical Facility Disruption
East Riser Ditch	$3,210	$0	$7,028,740	$1,219,400	$188,720	$0	$2,640	$800	$15,220	$0	$0
West Riser Ditch	$12,540	$0	$2,057,000	$57,506,820	$271,260	$7,600	$1,810	$343,920	$13,100	$2,530	$0
Losen Slote	$813,740	$18,950	$794,380	$131,860	$54,810	$0	$106,850	$7,890	$1,300,030	$40	$0
Category Totals	**$829,490**	**$18,950**	**$9,880,120**	**$58,858,080**	**$514,790**	**$7,600**	**$111,300**	**$352,610**	**$1,328,350**	**$2,570**	**$0**
Proposed Project Total	***$71,903,860***										

Table E-30: Alternative 2 – Average Annual Damage With Proposed Project, Future Condition

Streams Covered	Flood Damage Benefit Category										
	Structures						Other				
	Residential	Apartment	Commercial	Industrial	Municipal	Utility	Motor Vehicles	Debris Disposal	Death/Injury	Public Emergency	Critical Facility Disruption
East Riser Ditch	$21,580	$0	$8,984,990	$2,736,240	$326,240	$20	$15,610	$2,970	$262,170	$20	$0
West Riser Ditch	$36,620	$0	$2,876,250	$67,576,950	$459,220	$9,240	$4,720	$393,480	$61,900	$2,980	$0
Losen Slote	$937,520	$27,440	$869,210	$192,800	$77,410	$0	$124,840	$7,820	$1,654,470	$50	$190
Category Totals	**$995,720**	**$27,440**	**$12,730,450**	**$70,505,990**	**$862,870**	**$9,260**	**$145,170**	**$404,270**	**$1,978,540**	**$3,050**	**$190**
Proposed Project Total	***$87,662,950***										

Table E-31: Alternative 2 – Equivalent Annual Damage With Proposed Project

Streams Covered	Flood Damage Benefit Category										
	Structures						Other				
	Residential	Apartment	Commercial	Industrial	Municipal	Utility	Motor Vehicles	Debris Disposal	Death/Injury	Public Emergency	Critical Facility Disruption
East Riser Ditch	$7,810	$0	$7,518,920	$1,599,480	$223,180	$0	$5,890	$1,350	$77,100	$10	$0
West Riser Ditch	$18,570	$0	$2,262,280	$60,030,130	$318,360	$8,010	$2,540	$356,340	$25,330	$2,640	$0
Losen Slote	$844,760	$21,080	$813,130	$147,130	$60,480	$0	$111,350	$7,500	$1,388,850	$40	$0
Category Totals	**$871,140**	**$21,080**	**$10,594,330**	**$61,776,740**	**$602,020**	**$8,010**	**$119,780**	**$365,190**	**$1,491,280**	**$2,690**	**$0**
Proposed Project Total	***$75,852,260***										

Table E-32 summarizes expected annual damages with and without the Alternative 2 in place, and the resulting annual benefits by flood damage category. This table includes totals only for those streams for which preliminary Alternative 2 analyses have been completed.

Table E-32: Alternative 2: Equivalent Annual Resiliency Benefits

Evaluated Benefit Category	Without Proposed Project	With Proposed Project	Benefits
Residential Structures	$1,078,010	$871,140	$272,830
Apartment Structures	$218,210	$21,080	$2,380
Commercial Structures	$14,008,380	$10,594,330	$2,621,760
Industrial Structures	$63,506,460	$61,776,740	$2,789,660
Municipal Structures	$1,123,230	$602,020	$178,660
Utility Structures	$8,140	$8,010	$80
Motor Vehicles	$253,130	$119,780	$134,350
Critical Facilities Disruption	$364,950	$365,190	$6,550
Injury and Loss of Life	$4,301,390	$1,491,280	$2,798,700
Emergency Services Costs	$2,660	$2,690	$50
Debris Removal and Disposal	$180	$0	$110
Totals	**$84,864,740**	**$75,852,260**	**$8,805,130**

3.1.7.4 Alternative 3 – *Build Plan*

The Alternative 3 *Build Plan* benefit analysis used the same structure inventory that was developed for Alternative 1, but was applied only to the portions of the study area impacted by the Alternative 3 *Build Plan*; i.e., the drainage areas associated with East Riser Ditch, West Riser Ditch, and Losen Slote. The inventory for these areas was input to a separate HEC-FDA model, in conjunction with the same depth-damage functions as described above, and fluvial hydrologic/hydraulic data developed specifically for the Alternative 3 analysis. See **Table E-33** through **Table E-35**. The No Action Alternative (i.e., the conditions without the Proposed Project) is not repeated here because future and equivalent annual damages are same as for Alternative 2 (see **Table E-26** through **Table E-28**).

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Table E-33: Alternative 3 *Build Plan* Average Annual Benefits With Proposed Project, Baseline Condition

Streams Covered	Flood Damage Benefit Category										
	Structures						Other				
	Residential	Apartment	Commercial	Industrial	Municipal	Utility	Motor Vehicles	Debris Disposal	Death/Injury	Public Emergency	Critical Facility Disruption
East Riser Ditch	$3,210	$0	$7,028,740	$1,219,400	$188,720	$0	$2,640	$800	$15,220	$0	$0
West Riser Ditch	$12,540	$0	$2,057,000	$57,506,820	$271,260	$7,600	$1,810	$343,920	$13,100	$2,530	$0
Losen Slote	$1,018,010	$18,020	$1,052,590	$149,380	$126,620	$0	$123,450	$7,820	$1,706,980	$40	$20
Category Totals	**$1,033,760**	**$18,020**	**$10,138,330**	**$58,875,600**	**$586,600**	**$7,600**	**$127,900**	**$352,540**	**$1,735,300**	**$2,570**	**$20**
Proposed Project Total	***$72,878,240***										

Table E-34: Alternative 3 *Build Plan* Average Annual Benefits With Proposed Project, Future Condition

Streams Covered	Flood Damage Benefit Category										
	Structures						Other				
	Residential	Apartment	Commercial	Industrial	Municipal	Utility	Motor Vehicles	Debris Disposal	Death/Injury	Public Emergency	Critical Facility Disruption
East Riser Ditch	$21,580	$0	$8,984,990	$2,736,240	$326,240	$20	$15,610	$2,970	$262,170	$20	$0
West Riser Ditch	$36,620	$0	$2,876,250	$67,576,950	$459,220	$9,240	$4,720	$393,480	$61,900	$2,980	$0
Losen Slote	$1,120,620	$27,340	$1,137,450	$220,430	$149,280	$0	$140,190	$7,790	$2,033,320	$50	$220
Category Totals	**$1,178,820**	**$27,340**	**$12,998,690**	**$70,533,620**	**$934,740**	**$9,260**	**$160,520**	**$404,240**	**$2,357,390**	**$3,050**	**$220**
Proposed Project Total	***$88,607,890***										

Table E-35: Alternative 3 *Build Plan* Equivalent Annual Benefits With Proposed Project

Streams Covered	Flood Damage Benefit Category										
	Structures						Other				
	Residential	Apartment	Commercial	Industrial	Municipal	Utility	Motor Vehicles	Debris Disposal	Death/Injury	Public Emergency	Critical Facility Disruption
East Riser Ditch	$7,810	$0	$7,518,920	$1,599,480	$223,180	$0	$5,890	$1,350	$77,100	$10	$0
West Riser Ditch	$18,570	$0	$2,262,280	$60,030,130	$318,360	$8,010	$2,540	$356,340	$25,330	$2,640	$0
Losen Slote	$1,043,710	$20,350	$1,073,850	$167,180	$132,300	$0	$127,640	$7,810	$1,788,750	$40	$70
Category Totals	**$1,070,090**	**$20,350**	**$10,855,050**	**$61,796,790**	**$673,840**	**$8,010**	**$136,070**	**$365,500**	**$1,891,180**	**$2,690**	**$70**
Proposed Project Total	***$76,819,640***										

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Table E-36 summarizes expected annual damages with and without the Alternative 3 *Build Plan* in place, and the resulting annual benefits by flood damage category. This table includes totals only for those streams for which preliminary Alternative 3 *Build Plan* analyses have been completed.

Table E-36: Alternative 3 *Build Plan*: Equivalent Annual Resiliency Benefits

Evaluated Benefit Category	Without Proposed Project	With Proposed Project	Benefits
Residential Structures	$1,143,970	$1,070,090	$73,880
Apartment Structures	$23,460	$20,350	$3,110
Commercial Structures	$13,216,090	$10,855,050	$2,361,040
Industrial Structures	$64,566,400	$61,796,790	$2,769,610
Municipal Structures	$780,680	$673,840	$106,840
Utility Structures	$8,090	$8,010	$80
Motor Vehicles	$254,130	$136,070	$118,060
Critical Facilities Disruption	$371,740	$365,500	$6,240
Injury and Loss of Life	$4,289,980	$1,891,180	$2,398,800
Emergency Services Costs	$2,740	$2,690	$50
Debris Removal and Disposal	$110	$70	$40
Totals	***$84,657,740***	***$76,819,640***	***$7,837,750***

For the Alternative3 *Build Plan*, the distribution of benefits by affected municipality was also analyzed, as presented in **Table E-37**.

Table E-37: Distribution of Alternative 3 *Build Plan* Equivalent Annual Benefits

Municipality	Annual Benefit	Percentage (%)
Carlstadt	$1,102,000	14%
Little Ferry	$574,000	7%
Moonachie	$4,961,000	63%
South Hackensack	$32,000	0.4%
Teterboro	$1,169,000	15%
Total	**$7,838,000**	**100%**

3.1.7.5 Alternative 3 – *Future Plan*

The benefits associated with the LOP component of the Alternative 3 *Future Plan* are presented in **Section 3.1.7.2**. The fluvial/drainage component of the Alternative 3 *Future Plan* benefit analysis used the same structure inventory that was developed for Alternative 1, but was applied only to the portions of the study area impacted by the fluvial/drainage component of the Alternative 3 *Future Plan*; i.e., the drainage areas associated with East Riser Ditch, West Riser Ditch, and Losen Slote. The inventory for these areas was input to a separate HEC-FDA model, in conjunction with the same depth-damage functions as described above, and fluvial hydrologic/hydraulic data developed specifically for the

Alternative 3 analysis. See **Table E-38** through **Table E-40**. The No Action Alternative (i.e., the conditions without the Proposed Project) is not repeated here because future and equivalent annual damages are same as for Alternative 2 (see **Table E-26** through **Table E-28**).

Table E-38: Alternative 3 *Future Plan* Average Annual Benefits With Proposed Project, Baseline Condition

Streams Covered	Flood Damage Benefit Category										
	Structures						Other				
	Residential	Apartment	Commercial	Industrial	Municipal	Utility	Motor Vehicles	Debris Disposal	Death/Injury	Public Emergency	Critical Facility Disruption
East Riser Ditch	$2,080	$0	$3,884,610	$708,870	$70,880	$0	$4,170	$350	$48,370	$0	$0
West Riser Ditch	$12,540	$0	$2,057,000	$57,506,820	$271,260	$7,600	$1,810	$343,920	$13,100	$2,530	$0
Losen Slote	$813,740	$18,950	$794,380	$131,860	$54,810	$0	$106,850	$7,890	$1,300,030	$40	$0
Category Totals	**$828,360**	**$18,950**	**$6,735,990**	**$58,347,550**	**$396,950**	**$7,600**	**$112,830**	**$352,160**	**$1,361,500**	**$2,570**	**$0**
Proposed Project Total	***$68,164,460***										

Table E-39: Alternative 3 *Future Plan* Average Annual Benefits with Proposed Project, Future Condition

Streams Covered	Flood Damage Benefit Category										
	Structures						Other				
	Residential	Apartment	Commercial	Industrial	Municipal	Utility	Motor Vehicles	Debris Disposal	Death/Injury	Public Emergency	Critical Facility Disruption
East Riser Ditch	$21,530	$0	$8,640,340	$2,708,150	$316,430	$20	$15,680	$2,960	$261,940	$20	$0
West Riser Ditch	$36,620	$0	$2,876,250	$67,576,950	$459,220	$9,240	$4,720	$393,480	$61,900	$2,980	$0
Losen Slote	$937,520	$27,440	$869,210	$192,800	$77,410	$0	$124,840	$7,820	$1,654,470	$50	$190
Category Totals	**$995,670**	**$27,440**	**$12,385,800**	**$70,477,900**	**$853,060**	**$9,260**	**$145,240**	**$404,260**	**$1,978,310**	**$3,050**	**$190**
Proposed Project Total	***$87,280,180***										

Table E-40: Alternative 3 Future Plan Equivalent Annual Benefits with Proposed Project

Streams Covered	Flood Damage Benefit Category										
	Structures						Other				
	Residential	Apartment	Commercial	Industrial	Municipal	Utility	Motor Vehicles	Debris Disposal	Death/Injury	Public Emergency	Critical Facility Disruption
East Riser Ditch	$6,950	$0	$5,076,270	$1,209,840	$132,410	$0	$7,050	$1,010	$101,890	$10	$0
West Riser Ditch	$18,570	$0	$2,262,280	$60,030,130	$318,360	$8,010	$2,540	$356,340	$25,330	$2,640	$0
Losen Slote	$844,760	$21,080	$813,130	$147,130	$60,480	$0	$111,350	$7,500	$1,388,850	$40	$60
Category Totals	**$870,280**	**$21,080**	**$8,151,680**	**$61,387,100**	**$511,250**	**$8,010**	**$120,940**	**$364,850**	**$1,516,070**	**$2,690**	**$60**
Proposed Project Total	***$72,954,010***										

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Table E-41 summarizes expected annual damages with and without the Alternative 3 *Future Plan* in place, and the resulting annual benefits by flood damage category. This table includes totals only for those streams for which preliminary Alternative 3 *Future Plan* analyses have been completed.

Table E-41: Alternative 3 Future: Equivalent Annual Resiliency Benefits

Evaluated Benefit Category	Without Proposed Project	With Proposed Project	Benefits
Residential Structures	$1,143,970	$870,280	$273,690
Apartment Structures	$23,460	$21,080	$2,380
Commercial Structures	$13,216,090	$8,151,680	$5,064,410
Industrial Structures	$64,566,400	$61,387,100	$3,179,300
Municipal Structures	$780,680	$511,250	$269,430
Utility Structures	$8,090	$8,010	$80
Motor Vehicles	$254,130	$120,940	$133,190
Critical Facilities Disruption	$371,740	$364,850	$6,890
Injury and Loss of Life	$4,289,980	$1,516,070	$2,773,910
Emergency Services Costs	$2,740	$2,690	$50
Debris Removal and Disposal	$110	$60	$50
Totals	**$84,657,390**	**$72,954,010**	**$11,703,380**

3.2 Economic Revitalization

In Normal, Illinois, a $15.5 million redevelopment project to create a new community space in a traffic circle that incorporated innovative green infrastructure led to $160 million in private business investment in the Uptown District; property values increased 16 percent and retail sales grew 46 percent (EPA, 2016a). Redevelopment of a former industrial brownfield site into the Menomonee Valley Industrial Center located in Milwaukee, WI that incorporated a centralized green infrastructure system that provides the community a new recreational park with access to the Menomonee River led to 1,400 percent increase in property values from 2002 to 2009, adding more than $1 million a year to city property tax revenues (USEPA 2016a). A study published by the New York City Department of Transportation revealed retail sales increased by 49 percent where street landscaping was improved (New York City Department of Transportation 2012). These are a few examples of how green infrastructure projects can increase property values, tax revenues, and business sales.

Residential properties located within 500 feet of new parks or within 100 feet of new tree plantings are expected to appreciate in value. In addition, newly planted trees provide shade to nearby buildings, thereby reducing costs for heating and cooling and saving energy.

3.2.1 Residential Property Values

Many studies have consistently shown that parks and open space have a positive impact on nearby residential property values (Crompton 2005, McConnell and Walls 2005). The value of commercial properties near parks may also appreciate, but there are not sufficient studies available that have quantified this relationship. The property value attributable to the proximity to a park is separate from the direct recreational use value, meaning the property value appreciates even if the resident never visits the park. The magnitude of the increase in the property value is linked to the distance and the quality of the park and open space. While studies have shown increased property values up to 2,000 feet from a large park, most of the value is found within 500 feet of a park (Bolitzer and Netusil 2000, Crompton 2001, National Association of Realtors 2009, Crompton 2004, Crompton and Nicholls 2005). To be conservative, only residential properties within 500 feet of new parks were considered in the analysis.

A 2009 report from the National Association of Realtors found the premium for homes near parks can extend three blocks and start at 20 percent for those homes directly adjacent (declining as distance from the park increases) (National Association of Realtors 2009). An empirical review of 30 studies validated a 20 percent appreciation for properties abutting or fronting a passive park area and a 10 percent appreciation for properties two or three blocks away (Crompton 2001). A 20 percent property value increase was applied to residential properties within 100 feet of new parks and a 10 percent property value increase was applied to residential properties between 100 and 500 feet of new parks.

In various studies, improved landscaping and new tree plantings have also been associated with overall increases in house values varying on average from 7 to 30 percent (Des Rosiers, et al. 2002, Donovan and Butry 2010, USEPA 2016a, Kusnierz and et al. 2010, Watcher and Gillen 2006). For purposes of this analysis, it is assumed that properties within 100 feet of new tree plantings would appreciate in value by 7 percent.

In 2015, the median home value was higher in Bergen County ($441,400) in comparison to the five municipalities, which ranged from $269,500 in the Township of South Hackensack to $389,800 in Carlstadt (US Census Bureau 2016). The 2015 median value of housing units for each borough are displayed in **Table E-42**. The median housing value for each municipality from the US Census was used to help mitigate sensitivity to extremely high selling prices and the type of properties sold each year (e.g., condominiums versus single family homes).

Table E-42: 2015 Median Housing Value by Municipality

Carlstadt	Little Ferry	Moonachie	South Hackensack	Teterboro
$389,800	$319,000	$346,100	$269,500	$386,700

Due to the uncertainty of whether the appreciation rate of homes would be higher or lower than the general rate of inflation, the property value benefit is conservatively estimated based on the 2015 housing value. It is assumed that the property value benefit would occur in the first year after the Proposed Project is completed.

The property value premium for each alternative is displayed in **Table E-43**. The total property premium includes residential properties within 100 feet of new parks (20 percent property value increase), residential properties within 100 feet of new tree plantings (7 percent property value increase), and residential properties between 100 and 500 feet of new parks (10 percent property value increase).

Table E-43: Residential Property Value Premium by Municipality

ALTERNATIVE PLAN 1	Little Ferry	Moonachie	Total
Number of Residential Properties with 20% Premium	298	0	298
Number of Residential Properties with 10% Premium	369	0	369
Number of Residential Properties with 7% Premium	0	0	0
One-Time Property Value Premium	**$30,783,500**	**$0**	**$30,783,500**
ALTERNATIVE 2	**Little Ferry**	**Moonachie**	**Total**
Number of Residential Properties with 20% Premium	52	20	72
Number of Residential Properties with 10% Premium	245	229	474
Number of Residential Properties with 7% Premium	201	14	215
One-Time Property Value Premium	**$15,621,400**	**$9,649,300**	**$25,270,700**
ALTERNATIVE 3 BUILD PLAN	**Little Ferry**	**Moonachie**	**Total**
Number of Residential Properties with 20% Premium	14	20	34
Number of Residential Properties with 10% Premium	29	229	258
Number of Residential Properties with 7% Premium	204	14	218
One-Time Property Value Premium	**$6,373,600**	**$9,649,300**	**$16,022,900**
ALTERNATIVE 3 FUTURE PLAN	**Little Ferry**	**Moonachie**	**Total**
Number of Residential Properties with 20% Premium	310	20	330
Number of Residential Properties with 10% Premium	382	229	611
Number of Residential Properties with 7% Premium	201	15	216
One-Time Property Value Premium	**$36,452,100**	**$9,673,500**	**$46,125,600**

Note: Dollar values rounded to the nearest hundred.

Table E-44 displays the residential property value premium, present value, and equivalent annual value by alternative.

Table E-44: Residential Property Value Premium by Alternative

Property Premium	Total Value	Present Value	Equivalent Annual Value
Alternative 1	$30,783,500	$20,512,300	$1,486,300
Alternative 2	$25,270,700	$16,838,900	$1,220,100
Alternative 3 *Build Plan*	$16,022,900	$10,677,000	$773,600
Alternative 3 *Future Plan*	$46,125,600	$30,735,500	$2,227,100

Note: Values were rounded to the nearest hundred.

3.2.2 Energy Conservation

Natural gas and electricity savings were provided by the i-Tree Tool, a peer-reviewed software from the USDA Forest Service (USDA Forest Service 2017). In addition to the kilowatt-hours of electricity savings, therms of natural gas savings, and monetized energy conservation benefit, the i-Tree Tool provides the number of gallons of reduced stormwater runoff, estimated stormwater savings benefit, air emission reductions (in pounds), and the associated value.

For calculation purposes, it was assumed that all trees planted would be Red Maples (a common tree in the study area) and would be 3 diameters when planted; diameter growth was extrapolated to the end of the period of analysis. This assumption was used in the i-Tree Tool to estimate the value of energy conservation, stormwater savings, and air quality improvements from trees; however, a more diverse assortment of trees would likely be planted. The average annual diameter growth was obtained from the USDA Forest Service Growth Model for the Northeastern United States (USDA Forest Service 1991). When more specific values for the study area were available, these were used in place of the estimates from i-Tree. The i-Tree Tool was used to calculate the average annual electricity benefit of $6.36 per tree and average annual natural gas benefit of $26.04 per tree. **Table E-45** displays the annual energy conservation benefit according to alternative.

Table E-45: Annual Energy Conservation Benefit by Alternative

Calendar Year	Alternative 1	Alternative 2	Alternative 3 *Build Plan*	Alternative 3 *Future Plan*
2022	$400	$2,100	$1,300	$2,200
2023	$1,500	$8,400	$5,200	$8,800
2024	$1,700	$9,700	$6,000	$10,200
2025	$2,000	$11,000	$6,800	$11,500
2026	$2,200	$12,300	$7,600	$12,800
2027	$2,400	$13,500	$8,400	$14,200
2028	$2,700	$14,800	$9,200	$15,500
2029	$2,900	$16,100	$10,000	$16,800
2030	$3,100	$17,400	$10,800	$18,200
2031	$3,300	$18,600	$11,600	$19,500
2032	$3,600	$19,900	$12,400	$20,900
2033	$3,800	$21,200	$13,200	$22,200
2034	$4,000	$22,500	$14,000	$23,500
2035	$4,300	$23,800	$14,800	$24,900
2036	$4,500	$25,000	$15,600	$26,200
2037	$4,700	$26,300	$16,400	$27,500
2038	$4,900	$27,600	$17,200	$28,900
2039	$5,200	$28,900	$18,000	$30,200
2040	$5,400	$30,200	$18,800	$31,600
2041	$5,600	$31,400	$19,600	$32,900
2042	$5,900	$32,700	$20,400	$34,200
2043	$6,100	$34,000	$21,200	$35,600
2044	$6,300	$35,300	$22,000	$36,900
2045	$6,500	$36,500	$22,800	$38,300
2046	$6,800	$37,800	$23,600	$39,600
2047	$7,000	$39,100	$24,400	$40,900
2048	$7,200	$40,400	$25,200	$42,300
2049	$7,500	$41,800	$26,100	$43,700
2050	$7,700	$43,100	$26,900	$45,200
2051	$8,000	$44,500	$27,700	$46,600
2052	$8,200	$45,800	$28,600	$48,000
2053	$8,400	$47,200	$29,400	$49,400
2054	$8,700	$48,500	$30,200	$50,800

Calendar Year	Alternative 1	Alternative 2	Alternative 3 *Build Plan*	Alternative 3 *Future Plan*
2055	$8,900	$49,900	$31,100	$52,200
2056	$9,200	$51,200	$31,900	$53,600
2057	$9,400	$52,500	$32,800	$55,000
2058	$9,600	$53,900	$33,600	$56,400
2059	$9,900	$55,200	$34,400	$57,800
2060	$10,100	$56,600	$35,300	$59,200
2061	$10,400	$57,900	$36,100	$60,600
2062	$10,600	$59,300	$37,000	$62,000
2063	$10,900	$60,600	$37,800	$63,500
2064	$11,100	$62,000	$38,600	$64,900
2065	$11,300	$63,300	$39,500	$66,300
2066	$11,600	$64,700	$40,300	$67,700
2067	$11,800	$66,000	$41,100	$69,100
2068	$12,100	$67,300	$42,000	$70,500
2069	$12,300	$68,700	$42,800	$71,900
2070	$12,500	$70,000	$43,700	$73,300
2071	$12,800	$71,400	$44,500	$74,700
2072	$13,000	$72,700	$45,300	$76,100
TOTAL	**$360,000**	**$2,010,700**	**$1,253,400**	**$2,104,700**

Note: Values rounded to the nearest hundred.

Table E-46 displays the total energy conservation benefit, present value, and equivalent annual value by alternative.

Table E-46: Energy Conservation Benefit by Alternative

Energy Conservation	Total Value	Present Value	Equivalent Annual Value
Alternative 1	$360,000	$43,500	$3,200
Alternative 2	$2,010,700	$242,900	$17,600
Alternative 3 *Build Plan*	$1,253,400	$151,400	$11,000
Alternative 3 *Future Plan*	$2,104,700	$254,300	$18,400

Note: Values were rounded to the nearest hundred.

3.2.3 Residual Value

Construction of each alternative would have residual value after the end of the analysis period, because the useful life of these elements is longer than 50 years. Yet, many of the facilities would require substantial refurbishing and maintenance after 50 years and these costs are expected to offset any negligible residual benefits.

Land would need to be purchased for construction of an alternative and land is not expected to depreciate over time. Therefore, the value of the purchased land is considered a residual benefit in year 50 of the benefits analysis period. The present value of the land was added as a residual benefit.

Table E-47 displays the residential property value premium, present value, and equivalent annual value by alternative.

Table E-47: Residual Value by Alternative

Residual Value	Total Value	Present Value	Equivalent Annual Value
Alternative 1	$0	$0	$0
Alternative 2	$10,300,000	$249,300	$18,100
Alternative 3 *Build Plan*	$10,300,000	$249,300	$18,100
Alternative 3 *Future Plan*	$10,300,000	$249,300	$18,100

Note: Values were rounded to the nearest hundred.

3.2.4 Economic Revitalization Benefits Not Included

Creating an inviting and pleasant atmosphere with landscaping and trees can make local businesses more attractive for shopping and increase property values. Anecdotal evidence from a couple of case studies have shown improved street landscaping has increased retail sales around 50 percent. Because no large-scale economic studies have been performed to support a benefits-transfer approach, increased sales and appreciating property values of businesses in the immediate area of the improvements were not monetized.

3.3 Social Value

The proposed alternatives seek to integrate engineering function that is equally rooted in the aesthetics and dynamic usability of flood reduction infrastructure. Through this approach, the flood protection infrastructure can be absorbed as an asset to the community. In this way, structural flood reduction infrastructure can function as an integrated solution situated in the landscape in order to bring added benefits and enjoyment to users on a daily basis. By placing emphasis on both the environment and the community, the Proposed Project can utilize flood reduction and reimagined infrastructure to introduce a new waterfront condition and expand recreation opportunities within the Project Area.

3.3.1 Recreation

The Hackensack River is an important recreational resource in the Project Area and can provide a wide variety of recreational and educational opportunities (Bergen County Department of Planning and Economic Development 2004). Approximately 1,051 total acres of active and passive parkland, wetlands and mitigation banks, open spaces, recreational areas, and boating facilities currently exist within the Project Area. Several private boating facilities are also located in the Boroughs of Carlstadt and Little Ferry, offering varying amounts of boat storage, slips, repair facilities, and public launch areas (Bergen County Department of Planning and Economic Development 2004).

New green space, recreational fields, and wetlands can help balance the intensity of urban life. When the living environment is more aesthetically pleasing and there is more green space, people are enticed to walk more and participate in recreational activities. The proposed alternatives seek to work within new and existing open space to provide more opportunities for the community to be mobile with recreation and leisure activities. New and improved open space can provide opportunities for pedestrians, runners, and cyclists to enjoy benefits associated with engaging nature, exercising, and interacting with the community.

From a former study of public parks conducted by Cohen et al. (Cohen, McKenzie and et al. 2007), it was observed that 43 percent of park users lived within ¼ mile of the park, 21 percent lived between ¼ and ½ of the park, and 23 percent lived between ½ and 1 mile of the park surveyed. Since some of the new proposed parks are located near each other, only the estimated number of users within ¼ mile of the park was used for the analysis as a conservative estimate. The estimated number of users for the new parks was based on a study conducted by Active Living Research (Active Living Research 2011). It was assumed that 10 percent of the population living within ¼ mile of a proposed park would be daily users, 40 percent would use the park once a week, 20 percent would use the park once a month, 10 percent would use the park less than once a month, 10 percent would use the park once, and 10 percent would never use the park.

The recreation benefits from new parks were monetized using the USACE recreational day use value for fiscal year 2017 of $5.94 based on the expected characteristics of the new parks (USACE 2016). The season for the new parks is assumed to be from mid-April to mid-October (26 weeks) and because of inclement weather, it is conservatively assumed that daily users would only use the park 122 days per year. Using these assumptions, it is calculated that for every person living within ¼ mile of a new park, there would be 24 days of park use per year for an estimated annual use value of about $144. The recreational benefits do not include a health benefit.

The estimated annual number of visits and applicable annual recreation value for each alternative is displayed in **Table E-48**.

Table E-48: Annual Recreation Values by Municipality

ALTERNATIVE 1	Little Ferry	Moonachie	Adjacent Municipalities	Total
Number of Annual Visits	121,824	-	81,007	202,831
Annual Value	$723,600	$0	$481,200	$1,204,800
ALTERNATIVE 2	**Little Ferry**	**Moonachie**	**Adjacent Boroughs**	**Total**
Number of Annual Visits	101,597	43,162	31,634	176,393
Annual Value	$603,500	$256,400	$187,900	$1,047,800
ALTERNATIVE 3 – *Build Plan*	**Little Ferry**	**Moonachie**	**Adjacent Boroughs**	**Total**
Number of Annual Visits	71,823	43,162	5,655	120,640
Annual Value	$426,600	$256,400	$33,600	$716,600
ALTERNATIVE 3 – *Future Plan*	**Little Ferry**	**Moonachie**	**Adjacent Boroughs**	**Total**
Number of Annual Visits	121,824	43,162	81,007	245,993
Annual Value	$723,600	$256,400	$481,200	$1,461,200

Note: Dollar values were rounded to the nearest hundred.

Table E-49 displays the total recreation benefit, present value, and equivalent annual value by alternative.

Table E-49: Recreation Benefits by Alternative

Recreation	Total Value	Present Value	Equivalent Annual Value
Alternative 1	$60,542,000	$12,069,800	$874,600
Alternative 2	$52,650,500	$10,496,600	$760,600
Alternative 3 *Build Plan*	$36,009,200	$7,178,900	$520,200
Alternative 3 *Future Plan*	$73,425,100	$14,638,200	$1,060,700

Note: Values were rounded to the nearest hundred.

3.3.2 Stormwater Treatment Costs

Historically, stormwater management has been a significant challenge in the Project Area and the entirety of the Meadowlands District, as the Meadowlands District and the Project Area are less than 10 feet in elevation (NAVD 88) (Rutgers University 2007). This lack of elevation puts a strain on the ability of the municipalities to drain stormwater. Drainage infrastructure is typically powered by gravity, and is slower if the slopes of the infrastructure are shallow (Guo, et al. 2014). Furthermore, much of the Project Area has become impervious due to the high degree of development. This, in conjunction with the significant changes made to the natural hydrology of the Project Area, has severely limited the ability of the land to absorb and store stormwater and discharge it over time. Consequently, most rainfall becomes surface runoff and immediately goes into the drainage infrastructure.

The Project Area is an urbanized watershed that was, and continues to be, impacted by ongoing residential, commercial, and industrial development. Much of this development has taken place in areas within the FEMA-designated 100-year floodplain and along tributaries to the Hackensack River, which has increased the amount of pollutants entering these water resources.

Impervious surface is a material, such as concrete and asphalt that comprise roadways, parking areas, sidewalks, and buildings, that limits infiltration of stormwater into the ground. Impervious surfaces generate rates of runoff faster than grassed or vegetated areas that slow flow, or open spaces and pervious areas that infiltrate stormwater. High peak runoff rates can create capacity issues in downstream drainage systems or erosion problems in stream channels. In addition, runoff from roadways and developed sites with parking lots can collect petroleum products, salts, and other contaminants and transport them to the receiving waterbody. The Project Area contains approximately 2,187 acres (40 percent) of impervious surface and 3,218 acres (60 percent) of pervious surface.

Green infrastructure measures can vary in the level of effectiveness. This variability is accounted for in the model using minimum and maximum values for the number of gallons of stormwater that can be reduced. The average value of the low and high estimates was used to estimate the number of gallons of stormwater runoff that would be reduced. The factors used to calculate the minimum and maximum amount of stormwater that would be reduced by each green infrastructure measure (in gallons) were obtained from the Center of Neighborhood Technology (Center of Neighborhood Technology 2010) and adjusted to the average annual rainfall in Teterboro (US Climate Data 2017). The number of gallons of stormwater estimated to be reduced annually by measure and alternative is displayed in **Table E-50** (in thousands of gallons).

Table E-50: Annual Gallons of Stormwater Reduced by Measure (in thousands)

ALTERNATIVE 1	Carlstadt	South Hackensack	Little Ferry	Moonachie	Adjacent Municipalities	Total
Urban Vegetation	-	-	1,474	-	66	1,541
New Green Space	-	-	1,631	-	-	1,631
ALTERNATIVE 2	**Carlstadt**	**South Hackensack**	**Little Ferry**	**Moonachie**	**Adjacent Boroughs**	**Total**
Rain Gardens	-	-	2,970	1,680	-	4,650
Urban Vegetation	-	-	7,476	495	-	7,971
Bioswale/storage trench	179	97	2,703	1,939	-	4,918
New Green Space	-	-	3,939	1,522	-	5,461
Permeable Paving	-	-	1,269	651	-	1,920
Alternative 3 – *Build Plan*	**Carlstadt**	**South Hackensack**	**Little Ferry**	**Moonachie**	**Adjacent Boroughs**	**Total**
Rain Gardens	-	-	2,387	1,680	-	4,067
Urban Vegetation	-	-	3,210	495	-	3,705
Bioswale/storage trench	179	97	2,635	1,939	-	4,851
New Green Space	-	-	3,039	1,522	-	4,560
Permeable Paving	-	-	1,187	651	-	1,838
Alternative 3 – *Future Plan*	**Carlstadt**	**South Hackensack**	**Little Ferry**	**Moonachie**	**Adjacent Boroughs**	**Total**
Rain Gardens	-	-	2,524	1,680	-	4,204
Urban Vegetation	-	-	6,839	495	66	7,400
Bioswale/storage trench	179	97	2,742	1,939	-	4,957
New Green Space	-	-	3,797	1,522	-	5,319
Permeable Paving	-	-	984	651	-	1,635

Note: Drainage areas were included for rain gardens, bioswales, and storage trenches for the Alternative 3 *Build Plan* only. Stormwater reduction from trees was estimated separately.

Treatment of runoff is one way of complying with Federal Clean Water Act regulations by preventing contaminated stormwater from entering local waterways. To estimate the value of rainfall intercepted and potential cost reductions in stormwater-management control, a value that includes the cost of collection, conveyance, and treatment, a stormwater treatment cost of $0.008 per gallon was applied to the estimated gallons of stormwater that would be reduced annually (USDA Forest Service 2017). The stormwater benefits for the newly planted trees were calculated separately using the USDA i-Tree Tool. A summary of the stormwater benefit (without trees included) is displayed in **Table E-51**.

Table E-51: Annual Stormwater Benefit for Selected Measures by Municipality

Stormwater Benefit	Carlstadt	South Hackensack	Little Ferry	Moonachie	Other Municipalities	Annual Total

Stormwater Benefit	Carlstadt	South Hackensack	Little Ferry	Moonachie	Other Municipalities	Annual Total
Alternative 1	$0	$0	$24,800	$0	$500	$25,400
Alternative 2	$1,400	$800	$146,900	$50,300	$0	$199,400
Alternative 3 *Build Plan*	$1,400	$800	$99,700	$50,300	$0	$152,200
Alternative 3 *Future Plan*	$1,400	$800	$135,000	$50,300	$500	$188,100

Note: Values were rounded to the nearest hundred.

The annual stormwater benefits for the newly planted trees that were estimated using the USDA i-Tree Tool are displayed in **Table E-52**.

Table E-52: Annual Stormwater Benefit for Newly Planted Trees by Alternative

Calendar Year	Alternative 1	Alternative 2	Alternative 3 *Build Plan*	Alternative 3 *Future Plan*
2022	$90	$500	$300	$500
2023	$400	$2,000	$1,300	$2,100
2024	$400	$2,300	$1,400	$2,400
2025	$500	$2,600	$1,600	$2,700
2026	$500	$2,900	$1,800	$3,000
2027	$600	$3,200	$2,000	$3,300
2028	$600	$3,400	$2,100	$3,600
2029	$700	$3,700	$2,300	$3,900
2030	$700	$4,000	$2,500	$4,200
2031	$800	$4,300	$2,700	$4,500
2032	$800	$4,600	$2,800	$4,800
2033	$900	$4,800	$3,000	$5,100
2034	$900	$5,100	$3,200	$5,400
2035	$1,000	$5,400	$3,400	$5,700
2036	$1,000	$5,700	$3,500	$6,000
2037	$1,100	$6,000	$3,700	$6,200
2038	$1,100	$6,200	$3,900	$6,500
2039	$1,200	$6,500	$4,100	$6,800
2040	$1,200	$6,800	$4,200	$7,100
2041	$1,300	$7,100	$4,400	$7,400
2042	$1,300	$7,400	$4,600	$7,700
2043	$1,400	$7,700	$4,800	$8,000
2044	$1,400	$7,900	$4,900	$8,300
2045	$1,500	$8,200	$5,100	$8,600
2046	$1,500	$8,500	$5,300	$8,900
2047	$1,600	$8,800	$5,500	$9,200
2048	$1,600	$9,100	$5,700	$9,500

Calendar Year	Alternative 1	Alternative 2	Alternative 3 *Build Plan*	Alternative 3 *Future Plan*
2049	$1,700	$9,400	$5,800	$9,800
2050	$1,700	$9,700	$6,000	$10,100
2051	$1,800	$10,000	$6,200	$10,400
2052	$1,800	$10,200	$6,400	$10,700
2053	$1,900	$10,500	$6,600	$11,000
2054	$1,900	$10,800	$6,800	$11,300
2055	$2,000	$11,100	$6,900	$11,600
2056	$2,000	$11,400	$7,100	$12,000
2057	$2,100	$11,700	$7,300	$12,300
2058	$2,100	$12,000	$7,500	$12,600
2059	$2,200	$12,300	$7,700	$12,900
2060	$2,300	$12,600	$7,800	$13,200
2061	$2,300	$12,900	$8,000	$13,500
2062	$2,400	$13,200	$8,200	$13,800
2063	$2,400	$13,500	$8,400	$14,100
2064	$2,500	$13,800	$8,600	$14,400
2065	$2,500	$14,100	$8,800	$14,700
2066	$2,600	$14,300	$8,900	$15,000
2067	$2,600	$14,600	$9,100	$15,300
2068	$2,700	$14,900	$9,300	$15,600
2069	$2,700	$15,200	$9,500	$15,900
2070	$2,800	$15,500	$9,700	$16,200
2071	$2,800	$15,800	$9,900	$16,600
2072	$2,900	$16,100	$10,000	$16,900
TOTAL	**$80,600**	**$450,400**	**$280,800**	**$471,500**

Note: Values rounded to the nearest hundred.

Table E-53 displays the total stormwater benefit, present value, and equivalent annual value by alternative.

Table E-53: Stormwater Benefits by Alternative

Stormwater	Total Value	Present Value	Equivalent Annual Value
Alternative 1	$1,355,600	$264,100	$19,100
Alternative 2	$10,468,200	$2,052,400	$148,700
Alternative 3 *Build Plan*	$7,927,100	$1,558,800	$113,000
Alternative 3 *Future Plan*	$9,924,300	$1,942,300	$140,700

Note: Values were rounded to the nearest hundred.

3.3.3 Aesthetics

Redesigned parks, an activated waterfront, and other landscape-based interventions create a more visually appealing system of open spaces throughout the site. Green infrastructure implementations within streetscapes establish more attractive conditions along transportation corridors. Existing ditches that are improved and re-landscaped to function more efficiently in conveying stormwater can also become a unique and attractive feature in the local landscape.

Green infrastructure interventions can not only prevent debris from being carried with runoff throughout the streets in higher-volume storms, but can also include plantings that create pockets of color and texture throughout the landscape. The aesthetic value from green open space is $1,787 per acre of new green open space per year, as established by FEMA and updated to 2017 dollars (FEMA 2012). **Table E-54** displays the annual aesthetic value from new green open space by municipality.

Table E-54: Annual Aesthetic Value by Municipality

Aesthetic Value	Little Ferry	Moonachie	Other Municipalities	Annual Value
Alternative 1	$7,200	$0	$200	$7,400
Alternative 2	$28,000	$5,300	$0	$33,400
Alternative 3 *Build Plan*	$15,200	$5,300	$0	$20,500
Alternative 3 *Future Plan*	$26,100	$5,300	$200	$31,600

Note: Values were rounded to the nearest hundred.

Table E-55 displays the total aesthetic benefit, present value, and equivalent annual value by alternative.

Table E-55: Aesthetic Benefits by Alternative

Aesthetic Value	Total Value	Present Value	Equivalent Annual Value
Alternative 1	$372,000	$74,200	$5,400
Alternative 2	$1,676,500	$334,200	$24,200
Alternative 3 *Build Plan*	$1,032,100	$205,800	$14,900
Alternative 3 *Future Plan*	$1,588,200	$316,600	$22,900

Note: Values were rounded to the nearest hundred.

3.3.4 Water Retention and Flood Hazard Risk Reduction

Green open space is a provisioning area for stormwater retention and floodwater storage and conveyance. To measure the benefit of water retention and flood hazard risk reduction from new green open spaces, the national FEMA value of $322 per acre (updated to 2017 dollars) was applied to new green open spaces that were previously impervious (FEMA 2012). **Table E-56** displays the annual water retention and flood hazard risk reduction from new green open spaces by municipality.

Table E-56: Annual Water Retention/Flood Hazard Risk Reduction by Borough

Water retention/flood hazard risk reduction	Carlstadt	South Hackensack	Little Ferry	Moonachie	Other Municipalities	Annual Total
Alternative 1	$0	$0	$1,300	$0	nil	$1,300
Alternative 2	nil	$0	$5,700	$1,300	$0	$7,000
Alternative 3 *Build Plan*	nil	$0	$3,300	$1,300	$0	$4,600
Alternative 3 *Future Plan*	nil	$0	$5,200	$1,300	nil	$6,600

Note: Values were rounded to the nearest hundred.

Table E-57 displays the total water retention and flood hazard risk reduction benefit, present value, and equivalent annual value by alternative.

Table E-57: Water Retention/Flood Hazard Risk Reduction Benefit by Alternative

Water retention/flood hazard risk reduction	Total Value	Present Value	Equivalent Annual Value
Alternative 1	$67,200	$13,400	$1,000
Alternative 2	$352,100	$70,200	$5,100
Alternative 3 *Build Plan*	$232,800	$46,400	$3,400
Alternative 3 *Future Plan*	$331,400	$66,100	$4,800

Note: Values were rounded to the nearest hundred.

3.3.5 Social Benefits Not Included

The Proposed Project is expected to produce additional benefits that could not be adequately quantified for inclusion in the benefits analysis. The benefits analysis excludes a number of societal or user benefits because they are difficult to measure given the currently available information. Inclusion of these additional benefits would increase the overall benefits of the selected alternative.

3.3.5.1 Wetlands and Riparian Areas

Wetlands are valued for their aesthetic properties and provide active and passive recreational opportunities in urban settings. Passive recreational activities include bird watching. Over 330 bird species have been identified in the Meadowlands District (USFWS 2007). The Meadowlands District serves as a key stopover point for many migratory birds using the North Atlantic Flyway, and has been designated as an area of special concern under the North American Waterfowl Management Plan (Day, et al. 1999). Approximately 80 species (summer or permanent residents) have been documented breeding and/or nesting in the Meadowlands District. However, limited areas of swamp and upland forest restrict the potential breeding habitat for many sensitive bird species. By providing additional habitat for birds and more access to the waterfront, recreational birdwatching opportunities are expected to increase.

Wetlands store floodwaters and maintain surface water flow during dry periods which contributes to the amount of water available for use by people. Wetlands help maintain a higher level of groundwater in the surrounding area because they absorb and hold vast quantities of water which are released slowly over time. Wetlands can serve as both discharge and recharge areas for the groundwater reservoir. The effect of wetlands on the level of groundwater can help ensure a constant supply of water to people that depend on shallow private wells.

3.3.5.2 Urban Heat-Island Effect

Bergen County is within the central climate zone of the State of New Jersey. The central zone generally has a large number of flat, urban areas with high volumes of vehicles and industries that emit pollutants and a concentration of built and paved surfaces that trap heat. Because of this, the central zone typically has more pollutants in the atmosphere and temperatures are typically warmer (an average mean temperature of around 53 degrees Fahrenheit [°F]) than in surrounding zones that are suburban or rural. By converting previously paved surfaces to green open space, the proposed alternatives may contribute to reducing the urban heat-island effect.

The increased temperature in urban heat-islands causes an increase in demand for air conditioning, leading to increased peak energy demand in the summer and greater electricity costs. The increased use of electricity causes more air pollutants from fossil fuel power plants to meet the demand. The primary pollutants from fossil fuel power plants include carbon dioxide, sulfur dioxide, nitrogen oxides, particulate matter, carbon monoxide, and mercury. These pollutants are harmful to human health and contribute to ground-level ozone, fine particulate matter, and acid rain (USEPA 2016b).

Increased temperatures can also contribute to heat-related illness and mortality, especially for sensitive populations; for example, respiratory problems, heat exhaustion, and heat stroke. The CDC estimates that from 1979 to 2003, excessive heat exposure contributed to more than 8,000 premature deaths in the United States (CDC 2006). Climate change is expected to increase the frequency of high temperature events in the future.

Green infrastructure measures can make a small improvement in the urban heat-island effect by creating shade, reducing the amount of heat absorbing pavement, and by emitting water vapor. These cooling effects can contribute to reducing the number of heat stress-related fatalities during extreme heat wave events. Trees and other vegetation in urban settings have been shown to reduce temperatures by about 5°F to 9°F when compared to non-pervious areas (Center of Neighborhood Technology 2010).

The extent to which urban areas can mitigate the urban heat-island effect depends on numerous factors, including meteorology and climate, geography, scale, topography, basin morphology, proximity to water bodies, land-use patters, precursor emission rates and mix, baseline albedo (reflectivity) and vegetative fraction distributions, and potential for modification (Taha, Chang and Akbari. 2000).

Because little research exists to support the monetization of the benefits of tree and vegetation plantings on reducing the urban heat-island effect in terms of health care savings and potential decreases in mortality, these benefits were not monetized.

3.3.5.3 Mobility

The proposed alternatives can improve circulation and safety for pedestrians and cyclists along roadways. Streets can host a variety of interventions rooted in green infrastructure and stormwater management efforts that can also serve as traffic-calming measures aimed at improving pedestrian circulation and safety. Road-side bioswales, planted medians, and sidewalk improvements allow local roads to be more enjoyable and navigable for pedestrians and cyclists, streamline the flow of traffic to result in traffic calming, make drivers more aware, and bring a more clearly defined structure to multimodal circulation in key intersections.

3.3.5.4 Improved Physical Health from New Parks

Parks and open spaces that feature new and improved paths and updated recreational fields bring a range of health benefits to the community, including reduced stress, lower obesity rates, and less disease. The incidences of depression and anxiety, asthma and chronic obstructive pulmonary disease, diabetes, and coronary heart disease have been found to be significantly reduced for people living with more green space (defined as 10 percent or more than the average) within a 0.6 mile radius, according to a study published by the Harvard School of Public Health (Harvard School of Public Health 2014). A 20 percent increase in greenery results in about 1.1 percent reduction of Type 2 Diabetes and the average annual cost of treatment is about $14,000.

People diagnosed with diabetes, on average, have medical expenditures about 2.3 times higher that people without diabetes (American Diabetes Association 2013). Considering the HUD income threshold for poverty is about $32,000 a year and $51,000 a year for low and moderate income (LMI) households, the treatment cost for diabetes is nearly 50 percent of the poverty income threshold and about 30 percent of LMI threshold. According to New Jersey Department of Health, over 8 percent of the population in the State of New Jersey has asthma and approximately 8 percent of the population of Bergen County has been diagnosed with diabetes (New Jersey Department of Health 2014). According to the most recent data, over 25 percent of the Bergen County population is considered obese (The State of Obesity 2016).

3.3.5.5 Mental Health Improvements from Green Open Space

Overall, approximately 16 percent of the population of New Jersey has had a diagnosable mental, behavioral, or emotional disorder, other than a developmental or substance use disorder (Mental Health America 2016). Dutch researchers have shown that residents with only 10 percent green space within 0.6 miles of the residence had a 25 percent greater risk of depression and a 30 percent greater risk of anxiety disorders in contrast to residents in the highest (90 percent) residential green space bracket.

3.3.5.6 Reduced Crime

The overall crime rate for most of the Project Area is lower than the national average, with the exception of the Borough of Teterboro. Reviewing crime statistics from the Federal Bureau of Investigation (FBI) Uniform Crime Reports, the Borough of Teterboro generally had a higher incidence of assaults, burglaries, thefts, and vehicle thefts per 100,000 people than both the State of New Jersey and the nation.

According to several recent peer-reviewed studies, urban nature and green infrastructure is associated with reduced crime. Philadelphia's green infrastructure program has had an effect on safety in nearby areas. The models found significant reductions in certain crimes over an average four year follow-up period, indicating that a relatively long-term impact might be expected (Wolfe and Mennis 2012). In Baltimore, Troy et al (Troy, Grove and O'Neil-Dunne 2012) found that a 10 percent increase in tree canopy was associated with a roughly 12 percent decrease in crime; the magnitude was 40 percent greater for public than for private-owned lands.

3.3.5.7 Cultural Services

Wetlands provide tangible and intangible ecosystem services including provisioning, regulating, cultural, and supporting services that generate economic value from their direct, indirect, and potential use. Cultural services include educational opportunities and spiritual and religious values related to aspects of wetland ecosystems.

3.4 Environmental Value

The creation of new green space and other green infrastructure measures is expected to improve water quality, air quality, and increase opportunities for pollination.

3.4.1 Air Quality

Air pollution can have both chronic and acute effects on human health, ranging from minor upper respiratory irritation to chronic respiratory and heart disease, lung cancer, acute respiratory infections in children and chronic bronchitis in adults, aggravating pre-existing heart and lung disease, or asthmatic attacks (Kampa and Castanas 2008). In addition, short- and long-term exposures have been linked with premature mortality and reduced life expectancy ((Kampa and Castanas 2008). The amount of pollution removed by urban vegetation and trees is directly related to the amount of pollution in the atmosphere, the length of the in-leaf season, precipitation, and other meteorological variables (Nowak and Heisler 2010).

The National Ambient Air Quality Standards (NAAQS) for six of the most common air pollutants – namely ground-level ozone (O_3), particulate matter (PM), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), and lead – are not set at a zero risk level, but at a level that reduces risk to human health with an adequate margin of safety (USEPA 2015). Bergen County is designated by the US Environmental Protection Agency (USEPA) as a moderate nonattainment area for 8-hour ozone and a maintenance area for carbon monoxide (USEPA 2017). Improvements in air quality can assist in meeting NAAQS requirements and reducing health implications.

Air pollution can have both chronic and acute effects on human health, ranging from minor upper respiratory irritation to chronic respiratory and heart disease, lung cancer, acute respiratory infections in children and chronic bronchitis in adults, aggravating pre-existing heart and lung disease, or asthmatic attacks (Kampa and Castanas 2008). In addition, short- and long-term exposures have been linked with premature mortality and reduced life expectancy (Kampa and Castanas 2008). The amount of pollution removed by urban vegetation and trees is directly related to the amount of pollution in the atmosphere, the length of the in-leaf season, precipitation, and other meteorological variables (Nowak and Heisler 2010).

Short-term exposure to ground-level ozone can cause a variety of respiratory health effects; decrease the capacity to perform exercise, increase susceptibility to respiratory infection, and premature mortality (USEPA 2015). Long-term exposure to ozone can permanently damage lung tissue and may contribute to the development of asthma, especially among children (USEPA 2015). Ozone and other pollutants can also damage plants and trees.

Particulate matter classified as PM_{10} and $PM_{2.5}$ can cause premature mortality, aggravation of respiratory and cardiovascular disease, and changes in sub-clinical indicators of respiratory and cardiac function (USEPA 2015). More studies are showing associations between long-term $PM_{2.5}$ exposure and developmental effects such as low birth weight and infant mortality due to respiratory causes (USEPA 2009). Particles in the air can also reduce visibility (i.e. haze).

Short-term exposure to SO_2 and NO_2 is associated with increased respiratory symptoms in children and older adults, and people with asthma are especially susceptible to the effects of SO_2 and NO_2 (USEPA 2015). Sulfur dioxide can lead to acid rain, which harms structures and vegetation.

Carbon monoxide exposure reduces the capacity of blood to carry oxygen, thereby decreasing the supply of oxygen to tissues and organs such as the heart (USEPA 2015). People with angina or heart disease are at the greatest risk from ambient CO (USEPA 2015). Other populations at risk include those with chronic obstructive pulmonary disease, anemia, diabetes, and those in prenatal or elderly life stages (USEPA 2010).

Trees and urban vegetation can remove ozone, particulates, nitrogen dioxide, sulfur dioxide, and carbon monoxide from the air (Nowak and Heisler 2010). Trees also emit volatile organic compounds (VOC) emissions that contribute to ozone but the net effect is a reduction in overall VOC emissions and, consequently, ozone levels in urban areas (Nowak and Heisler 2010).

Additionally, trees and urban vegetation can sequester carbon dioxide (CO_2) by directly removing and storing CO_2 and indirectly by reducing air temperature (and consequential building energy use for cooling). Conversely, trees and urban vegetation can also release CO_2 via decomposition or indirectly through emissions from vegetation maintenance practices; however, the net effect is a reduction in CO_2 (Nowak and Heisler 2010).

CO_2 is the primary greenhouse gas (GHG) produced by human activities. Climate change can cause the sea level to rise, more extreme weather events, changes to agricultural productivity, increased spreading of diseases, and ecosystem changes. There is only an impact on human health at very high concentrations of CO_2 (approximately 15,000 ppm), which is over 37 times greater than its current concentration ((Luft, Finkelstein and Elliot 1974, Schaefer 1982).

The monetary values for the reduced emissions used in the benefits analysis are based on USDOT guidance and adjusted to 2017 dollars (US Department of Transportation 2016). The GHG emission values are based on the Social Cost of Carbon (SCC) developed by the Federal Interagency Working

Group on Social Cost of Carbon and suggested by TIGER guidance (US Department of Transportation 2016). SCC values were inflated to 2017 dollars.

Federal SCC guidance recommends that GHG emissions are valued with a lower discount rate than other benefits because CO_2 emissions are long-lived and subsequent damages persist over many years. A 3 percent discount rate was selected as a central value that reflects the after-tax riskless interest rate and is consistent with OMB's Circular A-4 guidance for the consumptive rate of interest (OMB 2003). However, all air quality benefits including GHG emissions were discounted using a 7 percent discount rate for this analysis. The GHG emissions value was calculated by multiplying the quantity in metric tons of carbon dioxide by the appropriate SCC value in that same year. Carbon sequestration of green infrastructure was monetized using the climate regulation annual values from FEMA of $15 per acre of new green open space (FEMA 2012). **Table E-58** displays the annual air quality benefits by alternative.

Table E-58: Annual Air Quality Benefits by Alternative

Calendar Year	Alternative 1	Alternative 2	Alternative 3 *Build Plan*	Alternative 3 *Future Plan*
2022	$1,100	$5,300	$3,000	$5,300
2023	$4,200	$21,300	$11,900	$21,200
2024	$4,300	$21,600	$12,000	$21,400
2025	$4,300	$21,800	$12,200	$21,700
2026	$4,400	$22,100	$12,400	$22,000
2027	$4,400	$22,300	$12,500	$22,200
2028	$4,500	$22,600	$12,700	$22,500
2029	$4,500	$22,800	$12,800	$22,700
2030	$4,600	$23,100	$13,000	$23,000
2031	$4,600	$23,400	$13,100	$23,300
2032	$4,700	$23,600	$13,300	$23,600
2033	$4,700	$23,900	$13,500	$23,800
2034	$4,700	$24,100	$13,600	$24,100
2035	$4,800	$24,400	$13,800	$24,400
2036	$4,800	$24,600	$13,900	$24,600
2037	$4,900	$24,900	$14,100	$24,900
2038	$4,900	$25,200	$14,200	$25,200
2039	$5,000	$25,500	$14,400	$25,400
2040	$5,000	$25,700	$14,600	$25,700
2041	$5,100	$26,000	$14,700	$26,000
2042	$5,100	$26,200	$14,900	$26,200
2043	$5,200	$26,500	$15,000	$26,500
2044	$5,200	$26,700	$15,200	$26,800
2045	$5,300	$27,000	$15,300	$27,000
2046	$5,300	$27,200	$15,500	$27,300
2047	$5,400	$27,500	$15,700	$27,600
2048	$5,400	$27,800	$15,900	$27,900
2049	$5,500	$28,100	$16,100	$28,200
2050	$5,500	$28,500	$16,200	$28,600

Calendar Year	Alternative 1	Alternative 2	Alternative 3 *Build Plan*	Alternative 3 *Future Plan*
2051	$5,600	$28,700	$16,400	$28,900
2052	$5,600	$29,000	$16,600	$29,100
2053	$5,700	$29,300	$16,800	$29,400
2054	$5,700	$29,600	$17,000	$29,700
2055	$5,800	$29,900	$17,100	$30,000
2056	$5,800	$30,200	$17,300	$30,300
2057	$5,900	$30,400	$17,500	$30,600
2058	$5,900	$30,700	$17,700	$30,900
2059	$6,000	$31,000	$17,800	$31,200
2060	$6,000	$31,300	$18,000	$31,500
2061	$6,100	$31,600	$18,200	$31,800
2062	$6,100	$31,900	$18,400	$32,100
2063	$6,200	$32,100	$18,500	$32,400
2064	$6,200	$32,400	$18,700	$32,700
2065	$6,300	$32,700	$18,900	$33,000
2066	$6,300	$33,000	$19,100	$33,300
2067	$6,400	$33,300	$19,300	$33,600
2068	$6,400	$33,600	$19,400	$33,900
2069	$6,500	$33,800	$19,600	$34,200
2070	$6,500	$34,100	$19,800	$34,500
2071	$6,600	$34,400	$20,000	$34,800
2072	$6,600	$34,700	$20,100	$35,100
TOTAL	**$271,700**	**$1,397,300**	**$797,600**	**$1,402,000**

Note: Values rounded to the nearest hundred.

Table E-59 displays the total air quality benefit, present value, and equivalent annual value by alternative.

Table E-59: Air Quality Benefits by Alternative

Air Quality	Total Value	Present Value	Equivalent Annual Value
Alternative 1	$271,700	$48,300	$3,500
Alternative 2	$1,397,300	$245,700	$17,800
Alternative 3 *Build Plan*	$797,600	$138,800	$10,100
Alternative 3 *Future Plan*	$1,402,000	$245,300	$17,800

Note: Values were rounded to the nearest hundred.

3.4.2 Pollination

Creation of additional green space, including rain gardens and urban vegetation, provides opportunities for native bees, butterflies, flies, and beetles to move pollen among flowers so that plants can form seeds and fruit. The pollination value is $319 per acre of new green open space per year as established by FEMA and updated to 2017 dollars (FEMA 2012). **Table E-60** displays the pollination benefits by municipality.

Table E-60: Annual Pollination Benefits by Municipality

Pollination	Little Ferry	Moonachie	Other Municipalities	Annual Value
Alternative 1	$1,300	$0	nil	$1,300
Alternative 2	$5,000	$1,000	$0	$6,000
Alternative 3 *Build Plan*	$2,700	$1,000	$0	$3,700
Alternative 3 *Future Plan*	$4,700	$1,000	nil	$5,700

Note: Values rounded to the nearest hundred.

Table E-61displays the total pollination benefit, present value, and equivalent annual value by alternative.

Table E-61: Pollination Benefits by Alternative

Pollination	Total Value	Present Value	Equivalent Annual Value
Alternative 1	$66,500	$13,300	$1,000
Alternative 2	$299,800	$59,800	$4,300
Alternative 3 *Build Plan*	$184,500	$36,800	$2,700
Alternative 3 *Future Plan*	$284,000	$56,600	$4,100

Note: Values were rounded to the nearest hundred.

3.4.3 Water Quality

Managing stormwater to complement drainage improvements for more frequent rainfall events would improve the quantity and quality of runoff throughout the drainage areas of the Hackensack River and reduce nutrient pollution from excess nitrogen and phosphorus.

Bioswales can reduce nutrient pollution from excess nitrogen and phosphorus. The factors used to determine the number of pounds of nitrogen and phosphorus reduced was obtained from the Watershed Protection Techniques Journal (Schueler 1997). The monetized value per pound of the reduced nitrogen ($3.83) and phosphorus ($40.20) (come from multiple research journals (Shaik, Helmers and Langemeier 2002, Birch and et al. 2011, Ancev, et al. 2006). **Table E-62** displays the annual water quality benefits by municipality.

Table E-62: Annual Water Quality Benefits by Municipality

Water Quality	Carlstadt	South Hackensack	Little Ferry	Moonachie	Annual Value
Alternative 1	$0	$0	$0	$0	$0
Alternative 2	nil	nil	$300	$200	$500
Alternative 3 *Build Plan*	nil	nil	$200	$200	$400
Alternative 3 *Future Plan*	nil	nil	$300	$200	$500

Note: Values rounded to the nearest hundred.

Table E-63 displays the total water quality benefit, present value, and equivalent annual value by alternative.

Table E-63: Water Quality Benefits by Alternative

Water Quality	Total Value	Present Value	Equivalent Annual Value
Alternative 1	$0	$0	$0
Alternative 2	$23,300	$4,600	$300
Alternative 3 *Build Plan*	$20,900	$4,200	$300
Alternative 3 *Future Plan*	$24,700	$4,900	$400

Note: Values were rounded to the nearest hundred.

3.4.4 Environmental Benefits Not Included

The benefits analysis excludes environmental benefits primarily associated with new riparian and wetland areas. Inclusion of these additional benefits would increase the overall benefits of the selected alternative.

3.4.4.1 Wetlands and Riparian Areas

Habitat degradation, habitat loss, species invasions, habitat fragmentation, contaminant uptake and sequestration, and loss of biodiversity are the primary threats to aquatic habitats and resources in the Meadowlands District. Invasive plants are an important concern in the Meadowlands District. Invasive plants are often effective colonizers in disturbed habitats, out-competing native flora under stressed conditions. This threat is potentially exacerbated within the Project Area by extensive habitat fragmentation and loss associated with residential, commercial, industrial development, and transportation infrastructure.

The Meadowlands District has lost large expanses of salt meadow, Atlantic white cedar swamp, and natural upland habitat since the 17th century. Losses were caused by conversion of wetlands to farmland by Colonial-era settlers and, more recently over the past 100 years, expanses of the Meadowlands District have been drained and/or filled in attempts to control mosquitoes, for industrial and commercial uses, and for the creation of landfills (Kiviat and MacDonald 2002).

Terrestrial communities within the Project Area provide habitat for a number of wildlife species, including migratory birds. These habitats also provide important ecosystem services to the surrounding area, such as providing aquifer recharge and supporting nutrient cycling. Many terrestrial communities or habitat types within the Project Area include the juxtaposition of natural settings and the “built environment,” and are characterized by floristic and faunal assemblages adapted to urban landscapes.

Ecological uplift and ecosystem services are provided by green and natural spaces, including new habitat. The proposed alternatives create new habitat by adding wetland and riparian areas. Additionally, new wetland and riparian areas can contribute to nutrient cycling, biological control, erosion control, and support biodiversity.

3.4.4.2 Aquatic Species Impacts

When surface temperatures rise, heated stormwater is not as easily absorbed and generally becomes runoff. Tests have shown that pavements that are 100ºF can elevate initial rainwater temperature from roughly 70ºF to over 95ºF (James 2002). Rapid temperature changes in aquatic ecosystems from warm stormwater runoff affects the metabolism and reproduction of many aquatic species and can be particularly stressful or even fatal to aquatic life (USEPA 2016b).

4.0 Results

Monetizing the benefits of each alternative assists in evaluating a Proposed Project’s expected future economic performance. The benefits were monetized using established and substantiated economic methods, as discussed in **Section 3.0**. The resiliency benefits include reduced damages to structures, contents, and automobiles; avoided public emergency costs; avoided debris removal and disposal; loss of life and injuries from flood events; indirect loss of life from loss of service from critical facilities; and, reduced mental health costs and associated productivity losses. The economic revitalization benefits include the residential property value premium, energy savings from planting trees, and the residual value of the Proposed Project after the period of analysis. The social benefits include the recreation value from new parks, avoided stormwater treatment costs, the aesthetic value of new green open space, and water retention and flood hazard risk reduction. The quantified environmental benefit is limited to air quality improvements from added vegetation, the pollination value from the creation of new green space, and improved water quality. All results assume a future condition featuring 1.2 feet of sea level rise at Battery Point, in New York, which translates to 0.8 feet of sea level rise across the Project Area. All benefits were discounted to 2017 using a 7 percent discount rate over the period of analysis.

4.1 Alternative 1 Summary

The present value of the total benefits of Alternative 1 is over $746 million. **Table E-64** shows the total benefits of Alternative 1 that are expected to exceed costs by a factor of 5.99 to1 (the benefit-to-cost ratio (BCR)).

Table E-64: Summary of Alternative 1 Results

Alternative 1	Total Value	Present Value	Equivalent Annual Value
Resiliency	**$4,663,582,100**	**$713,157,300**	**$51,675,300**
Berry's Creek Resilience	$2,908,658,400	$418,181,100	$30,301,300
Hackensack River Resilience	$1,754,923,800	$294,976,200	$21,373,900
Economic	**$31,143,500**	**$20,555,800**	**$1,489,500**
Property Value	$30,783,500	$20,512,300	$1,486,300
Energy Conservation	$360,000	$43,500	$3,200
Residual Value	$0	$0	$0
Social	**$62,336,700**	**$12,421,400**	**$900,100**
Recreation	$60,542,000	$12,069,800	$874,600
Avoided Stormwater Treatment	$1,355,600	$264,100	$19,100
Aesthetic Value	$372,000	$74,200	$5,400
Water retention/flood hazard risk reduction	$67,200	$13,400	$1,000
Environmental	**$338,200**	**$61,500**	**$4,500**
Air Quality	$271,700	$48,300	$3,500
Pollination	$66,500	$13,300	$1,000
Nutrient Pollution	$0	$0	$0
TOTAL BENEFITS	**$4,757,400,500**	**$746,196,000**	**$54,069,300**
Capital Investment Costs (2)	$142,284,000	$111,250,000	$8,060,900
Operations and Maintenance (O&M)	$67,500,000	$13,280,000	$962,500
TOTAL COSTS	**$213,590,000**	**$127,506,000**	**$9,239,000**
Benefit Cost Ratio		**5.99**	**5.99**

Note: Sub-category values are rounded to the nearest hundred and total costs and benefits are rounded to the nearest thousand.

4.2 Alternative 2 Summary

The present value of the total benefits of Alternative 2 is over $146 million. **Table E-65** displays a BCR of 1.14.

Table E-65: Summary of Alternative 2 Results

Alternative 2	Total Value	Present Value	Equivalent Annual Value
Resiliency	**$653,292,700**	**$115,904,700**	**$8,398,400**
East Riser Ditch Resilience	$537,431,000	$92,958,600	$6,735,800
West Riser Ditch Resilience	$32,941,500	$7,384,400	$535,100
Losen Slote Resilience	$82,920,200	$15,561,700	$1,127,600
Economic	**$37,581,400**	**$17,331,200**	**$1,255,800**
Property Value	$25,270,700	$16,838,900	$1,220,100
Energy Conservation	$2,010,700	$242,900	$17,600
Residual Value	$10,300,000	$249,300	$18,100
Social	**$65,147,400**	**$12,953,400**	**$938,600**
Recreation	$52,650,500	$10,496,600	$760,600
Avoided Stormwater Treatment	$10,468,200	$2,052,400	$148,700
Aesthetic Value	$1,676,500	$334,200	$24,200
Water retention/flood hazard risk reduction	$352,100	$70,200	$5,100
Environmental	**$1,720,400**	**$310,100**	**$22,500**
Air Quality	$1,397,300	$245,700	$17,800
Pollination	$299,800	$59,800	$4,300
Nutrient Pollution	$23,300	$4,600	$300
TOTAL BENEFITS	**$757,742,000**	**$146,499,000**	**$10,615,000**
Capital Investment Costs (2)	$144,715,000	$113,148,000	$8,198,700
O&M	$75,950,000	$15,456,000	$1,119,900
TOTAL COSTS	**$220,665,000**	**$128,604,000**	**$9,318,600**
Benefit Cost Ratio		**1.14**	**1.14**

Note: Sub-category values are rounded to the nearest hundred and total costs and benefits are rounded to the nearest thousand.

4.3 Alternative 3 *Build Plan* Summary

The present value of the total benefits of the Alternative 3 *Build Plan* is over $105 million. **Table E-66** displays a BCR of 1.15.

Table E-66: Summary of Alternative 3 *Build Plan* Results

Alternative 3 Build Plan	Total Value	Present Value	Equivalent Annual Value
Resiliency	**$491,970,700**	**$84,770,700**	**$6,142,500**
East Riser Ditch Resilience	$430,167,400	$72,751,600	$5,271,600
West Riser Ditch Resilience	$35,329,300	$7,834,200	$567,700
Losen Slote Resilience	$26,474,000	$4,184,900	$303,200

Alternative 3 Build Plan	Total Value	Present Value	Equivalent Annual Value
Economic	**$27,576,300**	**$11,077,500**	**$802,700**
Property Value	$16,022,900	$10,676,700	$773,600
Energy Conservation	$1,253,400	$151,400	$11,000
Residual Value	$10,300,000	$249,300	$18,100
Social	**$45,201,300**	**$8,989,900**	**$651,400**
Recreation	$36,009,200	$7,178,900	$520,200
Avoided Stormwater Treatment	$7,927,100	$1,558,800	$113,000
Aesthetic Value	$1,032,100	$205,800	$14,900
Water retention/flood hazard risk reduction	$232,800	$46,400	$3,400
Environmental	**$1,003,000**	**$179,800**	**$13,000**
Air Quality	$797,600	$138,800	$10,100
Pollination	$184,500	$36,800	$2,700
Nutrient Pollution	$20,900	$4,200	$300
TOTAL BENEFITS	**$565,751,300**	**$105,017,800**	**$7,609,600**
Capital Investment Costs (2)	$101,680,000	$79,500,000	$5,760,600
O&M	$55,950,000	$11,520,000	$834,800
TOTAL COSTS	**$157,630,000**	**$91,020,000**	**$6,595,300**
Benefit Cost Ratio		**1.15**	**1.15**

Note: Sub-category values are rounded to the nearest hundred and total costs and benefits are rounded to the nearest thousand.

4.4 Alternative 3 *Future Plan* Summary

The present value of the total benefits of the Alternative 3 *Future Plan* is over $899 million. **Table E-67** displays a BCR of 3.33.

Table E-67: Summary of Alternative 3 *Future Plan* Results

Alternative 3 Future Plan	Total Value	Present Value	Equivalent Annual Value
Resiliency	**$5,370,340,200**	**$850,960,900**	**$61,660,500**
East Riser Ditch Resilience	$590,896,400	$114,857,600	$8,322,600
West Riser Ditch Resilience	$32,941,500	$7,384,400	$535,100
Losen Slote Resilience	$82,920,200	$15,561,700	$1,127,600
Berry's Creek Resilience	$2,908,658,400	$418,181,100	$30,301,300
Hackensack River Resilience	$1,754,923,800	$294,976,200	$21,373,900
Economic	**$58,530,300**	**$31,239,000**	**$2,263,600**
Property Value	$46,125,600	$30,735,500	$2,227,100
Energy Conservation	$2,104,700	$254,300	$18,400

Alternative 3 Future Plan	Total Value	Present Value	Equivalent Annual Value
Residual Value	$10,300,000	$249,300	$18,100
Social	**$85,269,000**	**$16,963,300**	**$1,229,200**
Recreation	$73,425,100	$14,638,200	$1,060,700
Avoided Stormwater Treatment	$9,924,300	$1,942,300	$140,700
Aesthetic Value	$1,588,200	$316,600	$22,900
Water retention/flood hazard risk reduction	$331,400	$66,100	$4,800
Environmental	**$1,710,700**	**$306,900**	**$22,200**
Air Quality	$1,402,000	$245,300	$17,800
Pollination	$284,000	$56,600	$4,100
Nutrient Pollution	$24,700	$4,900	$400
TOTAL BENEFITS	**$5,515,850,200**	**$899,470,100**	**$65,175,500**
Capital Investment Costs (2)	$314,217,000	$245,698,700	$17,803,300
O&M	$120,950,000	$24,311,800	$1,761,600
TOTAL COSTS	**$435,197,000**	**$270,010,500**	**$19,564,900**
Benefit Cost Ratio		**3.33**	**3.33**

Note: Sub-category values are rounded to the nearest hundred and total costs and benefits are rounded to the nearest thousand.

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