RÍO PUERTO NUEVO
FLOOD CONTROL PROJECT
PUERTO RICO

Continuing Construction Validation Report

March 2020

US Army Corps
of Engineers ®
Jacksonville District

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EXECUTIVE SUMMARY

The Bipartisan Budget Act of 2018 (P.L. 115-123) (BBA) provides an opportunity to continue construction of the remaining features of the Río Puerto Nuevo Flood Control Project, Puerto Rico (authorized in 1986). The U.S. Army Corps of Engineers (USACE), Jacksonville District (SAJ), has prepared this Validation Report for the Río Puerto Nuevo, Flood Control Project, Puerto Rico (project) to verify that the remaining features of the authorized project are environmentally acceptable, economically justified, and feasible from an engineering and design standpoint. This report recommends a re-scoped strategy for implementing the project that reflects changed conditions and cost increases that have ensued since original project authorization and optimizes the economic efficiency of the project. This recommendation reflects project changes that are within the discretionary authority of the Chief of Engineers and to complete construction of remaining features of the Río Puerto Nuevo Flood Control Project under provisions of the BBA.

Through Section 401(a) of the Water Resource Development Act (WRDA) of 1986 (P.L. 99-662), Congress authorized the construction of the Río Puerto Nuevo Project consisting of flood control improvements to the Río Puerto Nuevo at a total cost of $234 million dollars (1986 price levels). The USACE and the non-Federal Sponsor, the Puerto Rico Department of Natural and Environmental Resources (DNER), signed a Project Cooperation Agreement (PCA) in 1994 and construction on the project began in 1995.

The project encompasses a densely developed drainage basin with a population of approximately 151,000 residents in the San Juan Metropolitan Area along the north coast of Puerto Rico. The drainage basin of the Río Puerto Nuevo project covers an area of 26 square miles and includes the following project tributaries within: Quebrada Margarita, Bechara Canal, Quebrada Josefina, Quebrada Doña Ana, Quebrada Buena Vista, and Quebrada Guaracanal. The Río Piedras and Rio Puerto Nuevo are generally used interchangeably, however, Río Puerto Nuevo is considered the network of rivers and creeks within the basin. Flooding is a serious threat to a significant portion of the population and economic activity in the San Juan Metropolitan Area. The Río Puerto Nuevo basin and tributaries are subject to severe flash flooding that can be attributed to inadequate channel capacity, flow limitations at numerous bridges, increased stormwater runoff from impervious surfaces and flood storage losses due to intense urbanization encroachments into the flood plain.

The authorized plan from the 1986 Survey Report details the recommended plan as concrete sheet pilings, planted mangroves, trapezoidal earth channel lined with rip rap and mangroves, concrete rectangular channel improvements, stilling and debris basins, all bridge relocations

along the main river (except for the Constitution and De Diego Bridges), and the relocation of approximately 18 structures. The plan also authorized channel improvements and bridge relocations to the main tributaries: Quebrada Margarita, Quebrada Josefina, Quebrada Doña Ana, Quebrada Buena Vista, and Quebrada Guarancanal. The authorized plan also included recreation improvements as well as mitigation in the form of mangrove planting. Reference Figure ES-1 for the authorized project features.

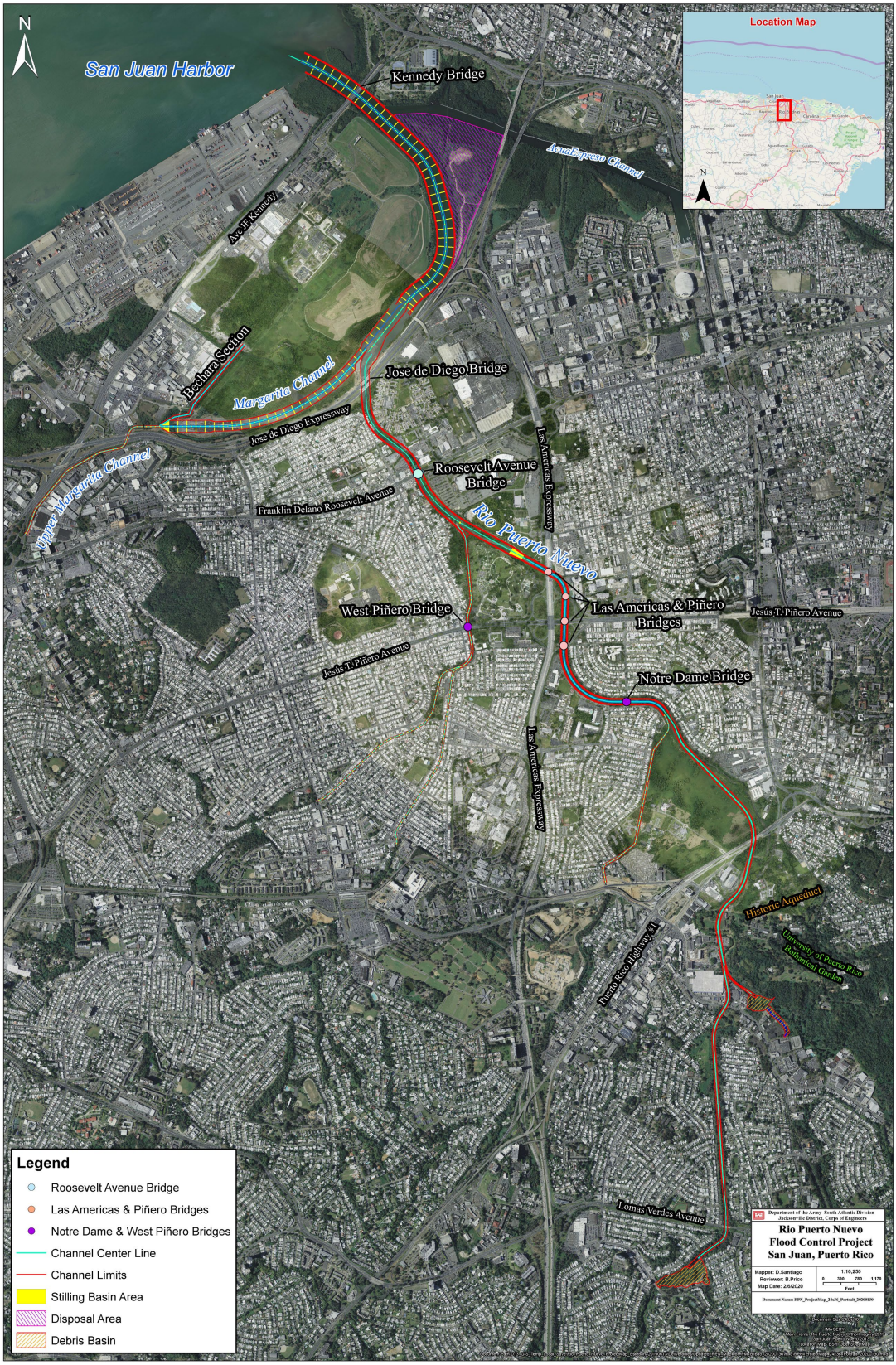

Figure ES-1 – Authorized project features and landmarks

According to the National Hurricane Center, Hurricane Maria made landfall on 20 September 2017 as a Category 4 storm near Yabucoa, Puerto Rico with sustained winds of 155 mph, resulting in catastrophic damage to the island. It has been designated as the tenth most intense Atlantic hurricane on record and is the strongest to make landfall in Puerto Rico since 1928. At the time that Hurricane Maria made landfall, Puerto Rico was still recovering from the impacts of Hurricane Irma that caused significant flooding less than two weeks prior. Hurricane Maria's rainfall caused record flows through Río Puerto Nuevo and its tributaries, resulting in an increase of sediment transported to the San Juan Harbor. Sediment deposition within the project area was a significant concern immediately following the storm event. Record breaking flooding far exceeded the capacity of United States Geological Survey (USGS) Stream Gaging Station 50049100 located at Piñero Avenue Bridge. The USGS Caribbean Water Science Center recovered several high water marks in the area and has not computed the estimated peak flow at this station as of yet. High Water Marks (HWM) reached 3.31 feet above ground just south of F.D. Roosevelt Avenue Bridge, 3.51 feet above ground at Calle Alsacia of Puerto Nuevo, and 2.26 feet above ground just upstream of the confluence of Doña Ana and Josefina Tributaries.

Due to the project's large scope and real estate requirements, segmentation of project construction allowed for incremental fiscal appropriations and real estate certifications. There are two completed contracts under Contract 1 (Contracts 1 and 1A) that started construction of the Lower Río Puerto Nuevo Channel features at the downstream end of the basin where it discharges into San Juan Bay in 1995 which were completed in 2005, using Construction General funds. There are multiple contracts within what is referred to as Contract 2: 2A, 2AR, 2AA, 2B, 2C1, 2C2, 2C3, 2D, 2D1, and 2E. Of these contracts: four have construction funded using Construction General funds and are completed (2A, 2AR, 2AA, 2D1), two are currently funded using Construction General funds and are in progress (2C1 and 2D) and four have not yet been initiated and pending commencement of construction and are included in the Supplemental Contracts (2B, 2C2, 2C3, 2E). The remaining contracts of the authorized project, Supplemental Contracts 3-8 have yet to be awarded. Table ES- 1: Status of Construction Contracts for Río Puerto Nuevo Project provides information on the status of the construction contracts associated with the project organized by Supplemental Contract numbers.

Table ES- 1: Status of Construction Contracts for Río Puerto Nuevo Project

Supplemental Contract Number	Contract	Description	Construction Status as of 2018
N/A	1	Lower Río Puerto Nuevo channel (mouth of river)	Complete
N/A	1A	Kennedy Bridge modifications	Complete
N/A	2A	Lower Margarita Channel	Complete
N/A	2AR	Completion of 2A work including channel excavation, Confluence Wall	Complete
N/A	2AA	Bechara Industrial Area and Bechara Mid-Section	Complete
N/A	2D1	DeDiego Bridge Seismic Retrofit	Complete
N/A	2C1	Lower Margarita Channel and Stilling Basin	In-Progress
N/A	2D Walls	Lower Río Puerto Nuevo Subcritical Channel walls	In-Progress
1	2C2	Upper Margarita Channel including sewer line relocation	Not Initiated
1	2C3	Upper Margarita Channel completion including U-Frame channel ties to 2C1	Not Initiated
2	2B	Roosevelt Bridge	Not Initiated
3	2D	RPN Channel Walls	Not-Initiated
3	2E	Lower Río Puerto Nuevo Subcritical Channel bottom	Not Initiated
4	4A	Bridge Modifications (Las Americas PR-18 bridge, Piñero Ave bridge, NE Access ramp bridge, SE Access ramp bridge)	Not Initiated
5	3AA	Bridge replacement – Piñero Avenue West	Not Initiated
5	4B	Bridge replacement – Notre Dame Street bridge	Not Initiated
6	4	Middle Main Channel – Sta 147+40 to Sta 206+50	Not Initiated
6	4D-1	Buena Vista Bridges – 2 bridge replacements	Not Initiated
6	4D-2	Buena Vista Diversion Channel	Not Initiated
6	5B-1	Middle Puerto Nuevo Channel (Sta 206+50 to PR HWY 1) and Debris basin	Not Initiated
7	3A	Bridge replacement of 10 bridges	Not Initiated
7	3B-1	Quebrada Josefina Channel	Not Initiated
7	3B-2	Quebrada Dona Ana Channel	Not Initiated
8	5A	New PR 1 Highway Bridge	Not Initiated
8	5B-2	Middle Main Channel – PR Highway 1 to Sta 271+50	Not Initiated
8	6	Upper Reach 1 Bridge replacement and 1 bridge foundation modification	Not Initiated

Photograph 1 – Flooding at Upper Reach of Quebrada Josefina

The unconstructed features of the authorized project includes the following contracts: 2B, 2C2, 2C3, 2D, 2E, 3A, 3AA, 3B-1, 3B-2, 4A, 4B, 4, 4D-1, 4D-2 5A, 5B-1, 5B-2, and 6 (see table ES-1). A Cost Agency Technical Review (Cost ATR) of the remaining costs was performed by the Walla Walla District Cost Engineering Mandatory Center of Expertise (Cost MCX) and a Cost Certification was obtained on November 27, 2018. The remaining cost (without sunk cost) to complete full construction of the authorized project in FY19 dollars is approximately $1.864 B (or, $2.217 B fully funded). Given the changed conditions over the years, and recognition that the certified cost exceeded BBA funding allocated to this project, a review was made to identify a re-scoped plan consistent with project authorization and Chief of Engineers discretionary authority. This validation report presents three possible strategies for moving forward with implementation of the Río Puerto Nuevo project.

Strategy 1 evaluates construction of the entire project over 10+ years using the optimal design, engineering, construction and real estate strategy. Under Strategy 1 the project would be deemed complete and it is economically justified, technically feasible and environmentally acceptable. The fully funded cost for Strategy 1 is approximately $2.217B (without sunk cost) with a construction completion date of 2031. Strategy 1 is economically justified with a BCR of 1.12. The average annual NED cost (October 2015 price level) is $105M and the total average annual benefits at October 2015 price levels are $125M.

Strategy 2 evaluates expedited construction of the entire authorized project with a completion date within four years. This strategy would require the setup of Civil Works Construction Camps on site in order to execute and complete the project. Civil Works Construction Camps are dedicated areas that are usually located outside of the populated area specifically for construction contractors and their crews to live and work in the most expedited manner for the four year construction period. These are used due to the lack of construction workforce in the project area. This strategy would realize all intended project benefits. However, there are several implementation risks with attempting to complete the project within a four year timeframe; these are due to: a) the construction sequence of the channel with little to no additional area for diversion of bypass flows, b) the bridge relocations (replacement or retrofitting) with construction of concrete-lined channels, c) utilities relocation within a densely populated urban area e) real estate acquisition f) limited resources (material and contractors) and g) past contractor's performance. All of these risks should be identified and managed prior to the award of any construction contract. This strategy is also not economically justified, as it would significantly increase the total cost of the project by an order of magnitude while generating the same benefits as the authorized project.

Strategy 3 was developed as a result of changed conditions that have occurred since project authorization, and since the BBA funds received for the Río Puerto Nuevo flood control project are less than the amount needed to fully construct all elements of the project. Sufficient analyses have been performed to support a determination that a re-scoped Río Puerto Nuevo project can achieve 97% of the authorized project benefits. This Strategy is within the Chief of Engineers discretionary authority and meets the project authorization. This strategy recommends complete construction of Supplemental Contracts 1 through 7 (see Table ES-1) fully funded with the use of BBA funds. Features related to Supplemental contract 8 appear not to be economically justified nor technically feasible with respect to expected performance. Under Strategy 3 the re-scoped project would be deemed complete as the functional elements identified for construction are economically justified, technically feasible and environmentally acceptable. The fully funded cost for Strategy 3 is approximately $1,579,254,000 (without sunk costs) and would obligate the supplemental funds by year 2025 with construction completion by late 2032. Strategy 3 is economically justified with a BCR of 1.53. The average annual NED cost (October 2015 price level) is $74M and the total average annual benefits at October 2015 price levels are $120M. Table ES-3 provides a summary of the economics for Strategies 1 and 3.

Table ES-2 presents a cost summary for all Strategies 1 and 3. A cost was not developed for Strategy 2 because the Strategy was expected to have a much greater cost overall, was not

economical, has very high risk with regards to the construction sequencing and therefore it is not feasible.

Table ES-2: Fully Funded Cost Summary for all three strategies

Strategy 1 Construction of the entire original authorized project (12+ years to complete construction)		**Strategy 2** Construction of the entire authorized project with a completion date of 4 yrs post receipt of BBA funding.		**Strategy 3** Construction of the features utilizing the allocated BBA funds (construction completion late 2028)	
Supplemental Contract 1	$60.033M	Supplemental Contract 1	-	Supplemental Contract 1	$60.033M
Supplemental Contract 2	$105.939M	Supplemental Contract 2	-	Supplemental Contract 2	$105.939M
Supplemental Contract 3	$491.352M	Supplemental Contract 3	-	Supplemental Contract 3	$491.352M
Supplemental Contract 4	$131.864M	Supplemental Contract 4	-	Supplemental Contract 4	$131.864M
Supplemental Contract 5	$27.600M	Supplemental Contract 5	-	Supplemental Contract 5	$27.600M
Supplemental Contract 6	*$400.721M*	Supplemental Contract 6	-	Supplemental Contract 6	*$400.721M*
Supplemental Contract 7	*$357.371M*	Supplemental Contract 7	-	Supplemental Contract 7	*$357.371M*
Supplemental Contract 8	*$636.330M*	Supplemental Contract 8	-	Recreation features from Supplemental Contract 8	*$4.374M*
Total Cost Strategy 1	**$2.211B**	**Total Cost Strategy 2**	-	**Total Cost Strategy 3**	**$1.579B**

*Figures in table do not include sunk cost ($420M per TPCS)
**No costs were developed for Strategy 2
***Supplemental Contract Costs only

Economic justification of continuing construction of the project has been evaluated by performing a Level 1 economic analysis (for Summary reference Table ES-3). In a Level 1 analysis, the Benefit to Cost Ratio (BCR) is computed by comparing the current annualized costs (deflated to October 2015 price level) to previously estimated benefits, (costs from the 2016 LRR).

Table ES-3: Economic Summary for Strategies 1 and 3.

Equivalent Annual Costs and Benefits		
2.875% Discount Rate, 50-Year Period of Analysis		
	Strategy 1	**Strategy 3**
Total Project First Cost (Oct2018 price level)	**$2,284,583,000**	**$1,796,741,000**
Interest During Construction (IDC)	$451,998,000	$151,579,000
Total Economic NED Cost (Oct2018 price level)	$2,736,581,000	$1,948,320,000
Average Annual NED Cost (Oct2018 price level)	$2,640,996,000	$1,880,268,000
Average Annual NED Cost (Cost deflated to Oct2015 price level)	$105,048,000	$74,068,000
Annual OMRR&R cost (Oct2015 price level)	$6,460,000	$5,080,000
Grand Total AAEQ NED Cost (Oct2015 price level)	**$111,508,000**	**$79,148,000**
	$0	$0
Primary Average Annual Benefits (Flood Risk Management; Oct2015 price level)	$124,153,000	$119,758,000
Incidental Average Annual Recreation Benefits (Oct2015 price level)	$1,089,000	$1,089,000
Average Annual Total Benefits (Oct2015 price level)	**$125,242,000**	**$120,847,000**
	$0	$0
Average Annual Net Benefits (Oct2015 price level)	**$13,734,000**	**$41,699,000**
Benefit-Cost Ratio (computed at 2.875%)	**1.12**	**1.53**

It is important to note that implementation of Strategy 3 (re-scoped project) does have a higher level of residual risk as compared to Strategy 1. Though the vast majority of without-project condition damages (>95%) would be reduced with both implementation strategies, Strategy 3 has fewer damage reduction benefits (~$119.758M vs. ~124.153M in average annual damage reduction benefits or, about 96.5% of primary benefits). These potentially lost benefits are associated with Strategy 3 removing Supplemental Contract 8, which represent a small proportion of the benefits. The few areas expected to benefit from Supplemental Contract 8 are on relatively high ground, unlike the low lying residential and commercial areas closer to the mouth of the channel. The best available information at this time indicates that the costs associated with Supplemental Contract 8 exceed the benefits. Though the entire authorized project (including Contract 8) is economically justified (i.e., per Strategy 1), Contract 8 is not incrementally justified. Therefore, it is not economically viable at this time. Strategy 3 is the

most economically efficient recommendation. An in depth analysis was not developed for Strategy 2 because the Strategy was expected to have a much greater cost overall, was not economical, has very high risk with regards to the construction sequencing and therefore it is not feasible.

The project is in compliance with all applicable environmental laws, regulations and Executive Orders. Any outstanding commitments made during and after the 1984 Environmental Impact Statement (EIS) and the 1993 Environmental Assessment (EA) and were tracked in the most recent Environmental Assessment, 2002. All identified potential environmental effects were addressed appropriately in these previous NEPA documents and the USACE has determined that no additional NEPA is required at this time. However, if Strategy 3 requires future design refinements such may require supplemental NEPA evaluation. The project has been coordinated with the following agencies: U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), U.S. Environmental Protection Agency (EPA), Puerto Rico Department of Natural and Environmental Resources (DNER), Puerto Rico State Historic Preservation Office (SHPO), and Puerto Rico Planning Board.

This report concludes that completion of the activities identified in Strategy 1 (original authorized project) and Strategy 3 (re-scoped project) both provide an environmentally acceptable, economically justified and feasible project from an engineering and design standpoint.

This Validation Report recommends that USACE proceed with implementation of the Río Puerto Nuevo Flood Control Project under provisions of the BBA of 2018 (P.L 115-123) in accordance with Strategy 3 (re-scoped project) which is within the discretionary authority of the Chief of Engineers and maintains approximately 97% percent of the project benefits.

1 STUDY OVERVIEW

1.1 VALIDATION REPORT PURPOSE

The U.S. Army Corps of Engineers (USACE), has prepared this Validation Report for the Río Puerto Nuevo Flood Control Project, Puerto Rico to verify that the authorized project is still environmentally acceptable, economically justified, and feasible from an engineering and design standpoint. Section 401(a) of the Water Resource Development Act (WRDA) of 1986 (P. L. 99-662) authorized the Río Puerto Nuevo Flood Control Project, based on recommendations made in the Chief of Engineers Report, dated April 25, 1986. Secondly, the validation report provides an opportunity to re-scope the project if necessary, due to changed conditions and/or cost, consistent with the project authorization.

The Bipartisan Budget Act of 2018 (P.L. 115-123) (BBA) provides an opportunity to continue construction of the remaining features of the Río Puerto Nuevo Flood Control Project. The Río Puerto Nuevo Validation Report is intended to document the updated engineering and area conditions, total project costs, and economic analysis in order to support construction of the remaining features of the project. The BBA allocated funds for construction of the remaining unconstructed contracts of the authorized project. The cost certification from the Cost Center of Expertise (MCX) located in the Walla Walla District shows the Total Project First cost to be $2.28 billion (including sunk cost and obligated funds to date) and the total Fully Funded Cost as $2.637 billion. The total first cost to complete the remaining work of the authorized project without sunk cost is estimated to be approximately $1.865 B ($2.217 B fully funded). The validation report explores options for a strategy that is the best course of action to move forward to implement construction of the project within funding constraints while achieving the maximum amount of benefits associated with the project as well as validating that the project is within environmental compliance, is economically justified and still feasible from an engineering and design stand point.

1.2 PROJECT LOCATION

The Río Puerto Nuevo drainage basin is located in the middle of the San Juan Metropolitan Area along the north coast of Puerto Rico. This highly developed basin extends from a three-mile wide lower flood plain, in the southeast side of San Juan Harbor, up to the foothills of the central mountains of Puerto Rico. The river basin includes the main river, Rio Piedras and the following major tributaries: Quebrada Margarita, Bechara Canal, Quebrada Josefina, Quebrada Doña Ana, Quebrada Buena Vista, and Quebrada Guaracanal. See Figure 1.

The Río Puerto Nuevo basin drains an area of 26 square miles and is located mostly within a highly developed urban area that discharges into the San Juan Bay. Presently, the basin is over 80

percent developed. More than 150,000 residents of the San Juan Metropolitan Area live and work within the basin. This basin is characterized by: inadequate channel capacity; rapid stream runoff and flashy storm conditions where runoff surges and recedes on the order of hours; flow constrictions at about 35 highway bridges, increase in impervious surfaces, and elimination of natural water storage in the flood plain caused by intense urbanization. Overbank flooding from the Río Puerto Nuevo presents a life safety and economic threat to a significant portion of the population within the San Juan Metropolitan area, especially during flash flood events.

The primary purpose of the authorized project is to improve human health and safety and to provide additional incidental economic benefits (recreation, redevelopment, etc.) through flood risk management and reduction in damages to structures, contents, and transportation infrastructure within the Río Puerto Nuevo Basin.

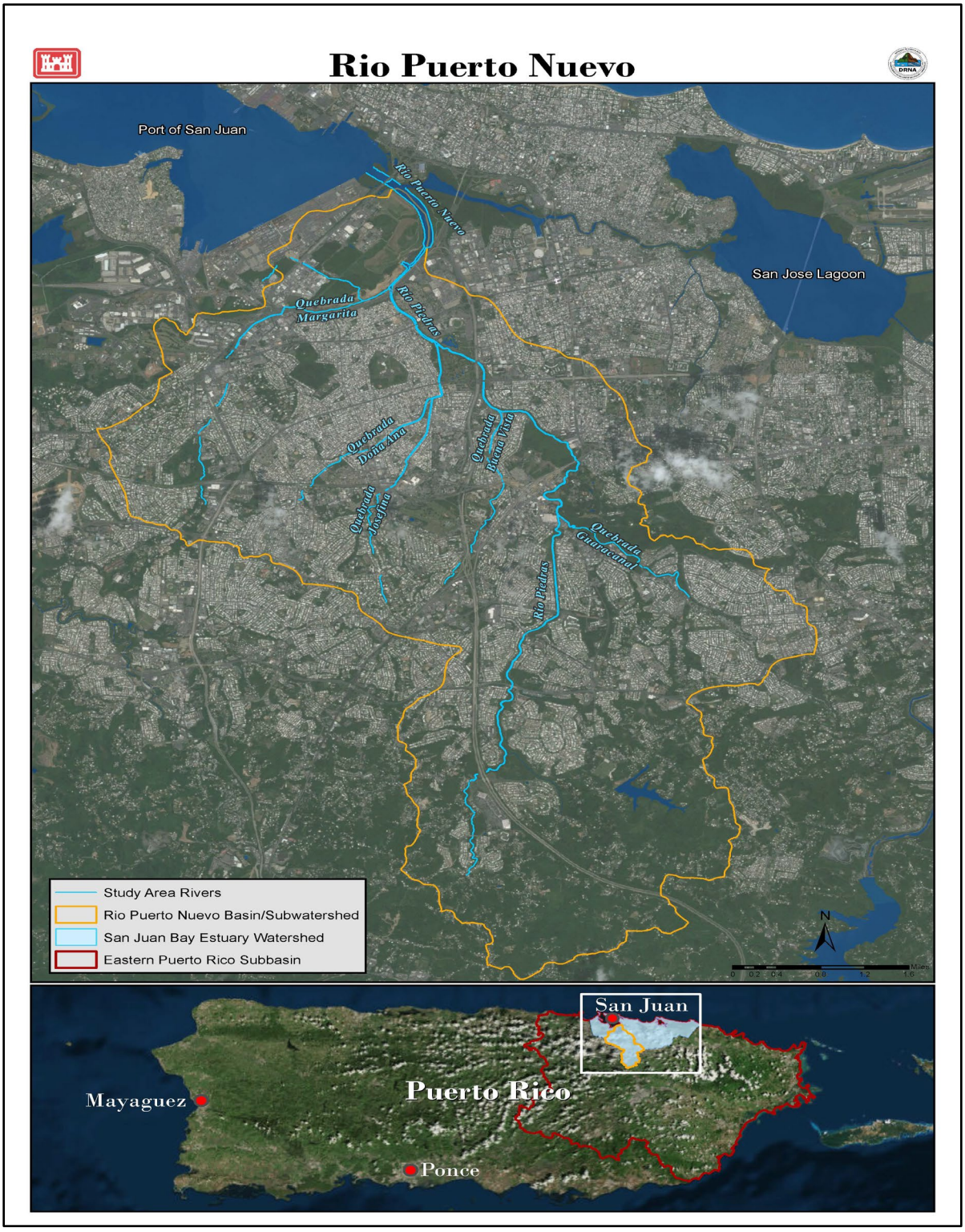

Figure 1 – Río Puerto Nuevo Watershed and Study Area

The authorized project consists of improvements to 11.2 miles of Río Puerto Nuevo and its tributaries (See Figure ES-1) The project includes 1.66 miles of concrete-lined trapezoidal channel, 9.54 miles of concrete-lined rectangular channel, 5.1 miles of which are high velocity (super critical flow), and 2,160 feet of double box culvert(s). Additional features include two baffle pier stilling areas, two high velocity flow confluences with tributary streams Buena Vista Diversion Channel and Guaracanal Channel, two upstream debris basins with side-overflow or lateral spillways, and other project relocations, including bridge replacements and modifications. The authorized project also includes several recreation features (such as a walking trail and a boat ramp).

The project is extremely complex; it includes multiple construction contracts and numerous individual features. Adding to this complexity is the challenge of constructing 11.2 miles of channel improvements in a highly urbanized area. For example, all three of the city's inflows to the regional sewage treatment plant and its outfall lines are impacted by the project. The project also impacts the city's principal power and water supplies, gas lines, sanitary sewer lines, secondary storm sewer lines, highway bridges, telephone, fiber optics, and cable television lines. Soils in the region are mostly alluvial with areas containing artificial fills and swamp deposits. These soils are expected to vary significantly along the project alignment creating additional challenges to the design of the foundations of the proposed project features.

1.3 PROJECT AUTHORIZATION

The original feasibility study, called the Río Puerto Nuevo Survey Investigation, was initiated in 1978 at the request of the Commonwealth of Puerto Rico. It was conducted under the authority of Section 204 of the Flood Control Act of 1970 (P.L. 91-611). The Survey Report was completed in June 1985 and a Chief of Engineers Report was signed April 25, 1986. The final BCR in the Survey Report was 2.6 to 1.

Section 401(a) of WRDA 1986 authorized the construction of the Río Puerto Nuevo Project consisting of flood control improvements to the Río Puerto Nuevo and recreation at a total cost of $234 million dollars (1986 price levels) of which $162.6 million was Federal funded and $71.2 million was non-Federal funded, with the non-federal sponsor being responsible for operating and maintaining the project. Work began on a General Design Memorandum (GDM) in October 1987. The purpose of the GDM was to further refine the design of the project and clarify some implementation details. It was approved December 20, 1991. The GDM included an engineering, environmental, real estate and economic update. The final BCR in the GDM was 2.4 to 1.

During design and construction of the project, two feature design memorandums (FDMs) were completed. Work on the FDM 1 was completed in November 1992 and the FDM 2 was completed in November 1999. These engineering documents did not include any updates to the 1991 economic analysis.

In 2011, a Level 1 Economic Update report was completed for the project. The updated report concluded that, while the project was still economically justified, the total project cost had exceeded the authorized 902 Limit. The 902 Limit is defined by Section 902 of the Water Resources Development Act of 1986 and is the maximum amount that a project may cost. Therefore, the USACE did not have sufficient authority to complete the project. In order to seek additional authority beyond the 902 Limit, a Post-Authorization Change Report (PACR) was developed by SAJ and was submitted to the South Atlantic Division (SAD) office in 2014. SAD did not endorse the PACR, because it was not consistent with 2014 guidance from the USACE Cost Control Board (CCB). The CCB had instructed the district to identify additional cost savings measures and determine which, if any, portions of the project could be completed within the 902 Limit. Based on this feedback, the PACR was revised and modified to a Limited Reevaluation Report (LRR). The LRR included a detailed economic update using the USACE certified model Hydrologic Engineering Center-Flood Damage Assessment (HEC-FDA), as well as limited incremental analysis. The LRR was completed in 2016 and concluded that the project was still economically justified; however the LRR approval was not finalized. Initially, the LRR was not approved by SAD due to cost exceeding the 902 Limit. A revised version of the LRR, which identified a portion of the project that could be completed within the 902 Limit, was drafted and being reviewed when Hurricane Maria hit the island in 2017 (SAD comments on the revised report were in the process of being addressed). At that point, the recommendations in the LRR were overcome by events (ultimately the BBA waived 902 concerns).

1.4 PROJECT SPONSOR

The non-federal sponsor for the construction of the authorized project is the Puerto Rico Department of Natural and Environmental Resources (DNER).

1.5 BRIEF DESCRIPTION OF AUTHORIZED PROJECT

The 1985 Survey Report recommended plan consists of the following:

The Río Puerto Nuevo main channel starts 450 meters (approximately 0.27 miles) into the San Juan Harbor from the Constitution Bridge with a 120 meter (approximately 0.07 miles) bottom width and the banks lined with concrete sheet pilings and mangroves. These sheet pilings

sections extend another 1.5 km (approximately 0.93 miles) upstream of the Constitution Bridge to the vicinity of the San Juan Municipal sanitary of landfill area. The next 580 meters (approximately 0.36 miles) up to the junction with Quebrada Margarita consists of a trapezoidal earth channel lined with riprap and mangrove. Bottom width of the channel in this section is 120 meters (approximately 0.07 miles). From De Diego Expressway Bridge to the extension of the proposed Lomas Verdes Avenue (7.4 km upstream – approximately 4.6 miles) the improvements consist of a high velocity reinforced concrete rectangular channel with bottom width ranging from 55 to 12 meters (approximately 0.03 miles to 0.02 miles).

Two other improvements along the Río Puerto Nuevo main channel consist of a stilling basin at Station 58+03 just upstream of Quebrada Bueno Vista and a debris basin at the uppermost section of the project in the vicinity of Las Lomas Verdes and Winston Churchill Avenues. Total length of the improved channel for the Río Puerto Nuevo main channel would be 10.5 km (approximately 6.5 miles). With the exception of the Constitution and the De Diego Expressway bridges, all bridges along the main river would have to be replaced. In the vicinity of the Norzagaray Bridge the channel would be diverted some 115 meters (approximately 0.07 miles) to the west and a new PR Hwy 1 bridge would be constructed to avoid destroying the historic bridge. The bridges to be replaced are: the Roosevelt Avenue, the Las Americas Expressway and its two eastern ramps, the J.T. Piñero, the Notre Dame and the 176 Hwy bridges. Some 18 structures would have to be relocated.

Improvements for the main tributaries under the authorized plan are as follows:

Quebrada Margarita: From its junction with the main river to 1.6 km (approximately 0.99 miles) upstream it would have an earth trapezoidal channel with riprap and mangrove. The rest of the improvement (some 1.14 km – approximately 0.7 miles) up to the vicinity of the Caparra Interchange calls for a reinforced concrete rectangular channel. Most of the channel has a 25-meter (approximately 0.015 miles) bottom width. Improvements along Quebrada Margarita would require the replacement of the bridge on the De Diego Expressway.

Quebrada Josefina: Improvements under the authorized plan for this stream consist of a 2.3 km (approximately 1.4 miles) reinforced concrete rectangular channel from its junction with the main river to the vicinity of the Veterans Administration Hospital.

Bottom width of the channel ranges from 20 to 10 meters (approximately 0.01 to 0.006 miles). Improvements to Quebrada Josefina would require replacing the bridges on J.T. Piñero and

Americo Mirand Avenues. Three bridges on local streets as well as 46 residential structures would also have to be replaced.

Quebrada Doña Ana: This stream would be channelized for 1.0 km (approximately 0.6 miles) from its junction with Quebrada Josefina to 9 SE Street with a 10-7 meter (approximately 0.006 – 0.004 miles) wide reinforced concrete rectangular channel. The bridge on Americo Miranda Avenue as well as 3 bridges on local streets would have to be replaced in order to convey the 100-year flood. The number of residential structures to be relocated are 35.

Quebrada Buena Vista: This stream would be diverted along a 1.7 km (approximately 1.05 miles) reinforced concrete rectangular channel through currently vacant lands of the University of Puerto Rico's proposed site for the Botanical University Gardens development and end at a new bridge in PR Hwy21. The channel would have a bottom width ranging from 12- 7 (approximately 0.007 – 0.004 miles) meters. Seven residential structures would be displaced.

Quebrada Guarancanal: This stream would have a 290-meter (approximately 0.18 miles) transition section consisting of a 7 meter (approximately 0.004 miles) wide reinforced concrete channel and a small debris basin.

A bicycle corridor is included along the Río Puerto Nuevo Channel right-of-way from Lomas Verdes Avenue to the San Juan Regional Park. Also included are two boat ramps, one near the San Juan Regional Park and the other at the Las Americas Park and a mangrove management plan for the Constitution Bridge area.

Per the 1991 GDM, the authorized plan was modified as follows:

The 6.46-mile long Puerto Nuevo Channel consists of 1.66 miles of trapezoidal channel and 4.80 miles of rectangular channel, all concrete lined. Five tributaries will also be channelized providing an additional 4.74 miles of mostly concrete lined channel. Additional features include two baffle pier stilling areas; two high velocity confluences with the tributary streams Buena Vista Diversion Channel and Guarancanal Channel and two upstream terminus debris basins with side-overflow spillways.

The Margarita Channel is 1.70 miles long, with 0.67 mile of rectangular concrete-lined channel, a baffle pier stilling area, and 1.03 miles of earthen trapezoidal channel. It was determined from physical model tests that the PR-22 (10-lane highway) could pass the 100-year and SPF design flows and, therefore, will not have to be replaced.

The 1.46 mile long Josefina Channel and its 0.62 mile long tributary, Dona Ana Channel, were also included in physical model tests. These two high velocity channels will not require a stilling basin for the subcritical flow regime confluence with the main channel.

The 0.80 mile Buena Vista Diversion Channel is a permanent improvement that eliminated the need for extensive loss of home sites along the existing Quebrada Buena Vista alignment. This new alignment will be excavated through an undeveloped area near the University of Puerto Rico Agricultural Experiment Station and the proposed Botanical Gardens. It has a high velocity confluence with the main channel.

The 0.16 mile Guarancanal Channel has a 6.5-acre debris basin situated near the bottom of a steep draw with a 150-foot long side overflow spillway. The Guarancanal Channel confluence with the Puerto Nuevo Channel is also a high velocity confluence.

The project is designed to provide 0.01 exceedence probability (100-year) flood protection for the areas adjacent to the Puerto Nuevo and its tributaries.

The bike path and linear park will incorporate similar design features being planned for the non-cost shared portion of the path in order to achieve maximum compatibility. These design features include planters, rest stops, benches and the path surface itself. A variety of native plant species will be used, in planters where necessary, in order to shade the path and make it visually pleasing. Screening the channel through the use of berms, fencing materials and plants will be done where possible to reduce its visibility and increase its "acceptability" to the local population. The addition of colors and or pebble surfaces to the concrete used in the channel walls will increase its "blending in" where it cannot be successfully screened otherwise.

1.5.1 ITEMS OF LOCAL COOPERATION

Per the 1991 GDM the Flood Control local cooperation requirements were as follows, it is important to note that the Items of local cooperation were updated in accordance with the February 20, 2019 Project Cooperation Agreement Amendment 1:

(1) Provide a cash contribution equal to five percent of the total project costs;
(2) Provide all lands, easements, rights-of-way, relocations (except railroad bridge alterations), and dredged material disposal areas (referred to as LERRD);
(3) Provide an additional cash payment when the sum of items (1) and (2) are less than 25 percent of total project costs;
(4) Operate and maintain the project after completion, including accomplishment of any needed replacement or rehabilitations of any of its components (referred to as OMR&R);

(5) Hold and save the United States free from damages due to the construction or subsequent maintenance of the project, expect damages due to the fault or negligence of the United States or its contractors;
(6) Prevent future encroachments which might interfere with proper functioning of the project;
(7) Participate in and comply with applicable Federal flood plain management and flood insurance programs (i.e., the National Flood Insurance Program), pursuant to Section 402, Public Law 99-662; and,
(8)Provide guidance and leadership to prevent unwise future development in the flood plain.

Per the 1991 GDM the Recreation local cooperation requirements were as follows:
(1) Provide one-half of the separable first cost of post authorization planning and construction of recreation facilities, including project land acquired specifically for recreation; and,
(2) All costs and full responsibility for the operation, maintenance, replacement, and management of recreation lands and facilities.

1.5.2 COST APPORTIONMENT OF THE AUTHORIZED PROJECT

Per the 1991 GDM, the non-federal costs required from the local sponsor are those associated with lands, easements, rights-of way, relocations, and dredge material disposal areas (LERRD). The total LERRD costs are $36,610,000 for the overall plan and represent 12 percent of the total flood control cost of the project. As required by law, the non-Federal sponsor would have to contribute the minimum five percent in cash of the total flood control cost of the project which is $15,164,200 in addition to the entire cost for LERRD plus a share of the cost for recreation cost, which is $232,000. The Federal contribution would therefore be $227,318,000 and the non-Federal contribution would be $75,966,000. Table 1 shows the cost share from the 1991 GDM project's first cost as established in the WRDA 86.

Table 1: Cost Sharing of Total First Cost, 1991 GDM

1. Total Project Cost:
   a. Flood Control…… $302,820,000
   b. Recreation…… $464,000
   TOTAL…… $303,284,000
2. Participation:

	Non-Federal	Federal
a. Lands and Damages…….	$15,967,000	$0
b. Bridges and Roads……	$ 5,484,000	$0

c.	Utilities……	$15,159,000	$0
d.	Cash Contribution	$39,124,000	$227,086,000
e.	Recreation……	$ 232,000	$ 232,000
	TOTAL…….	**$75,966,000**	**$227,318,000**

1.6 CONSTRUCTION STATUS

Due to the complex nature of the project (dozens of individual contracts, large scale land acquisition, relocation, etc.) and its location in a highly urbanized area, the construction schedule was divided into multiple contracts. A graphical summary of the individual contracts is provided in Figure 2.

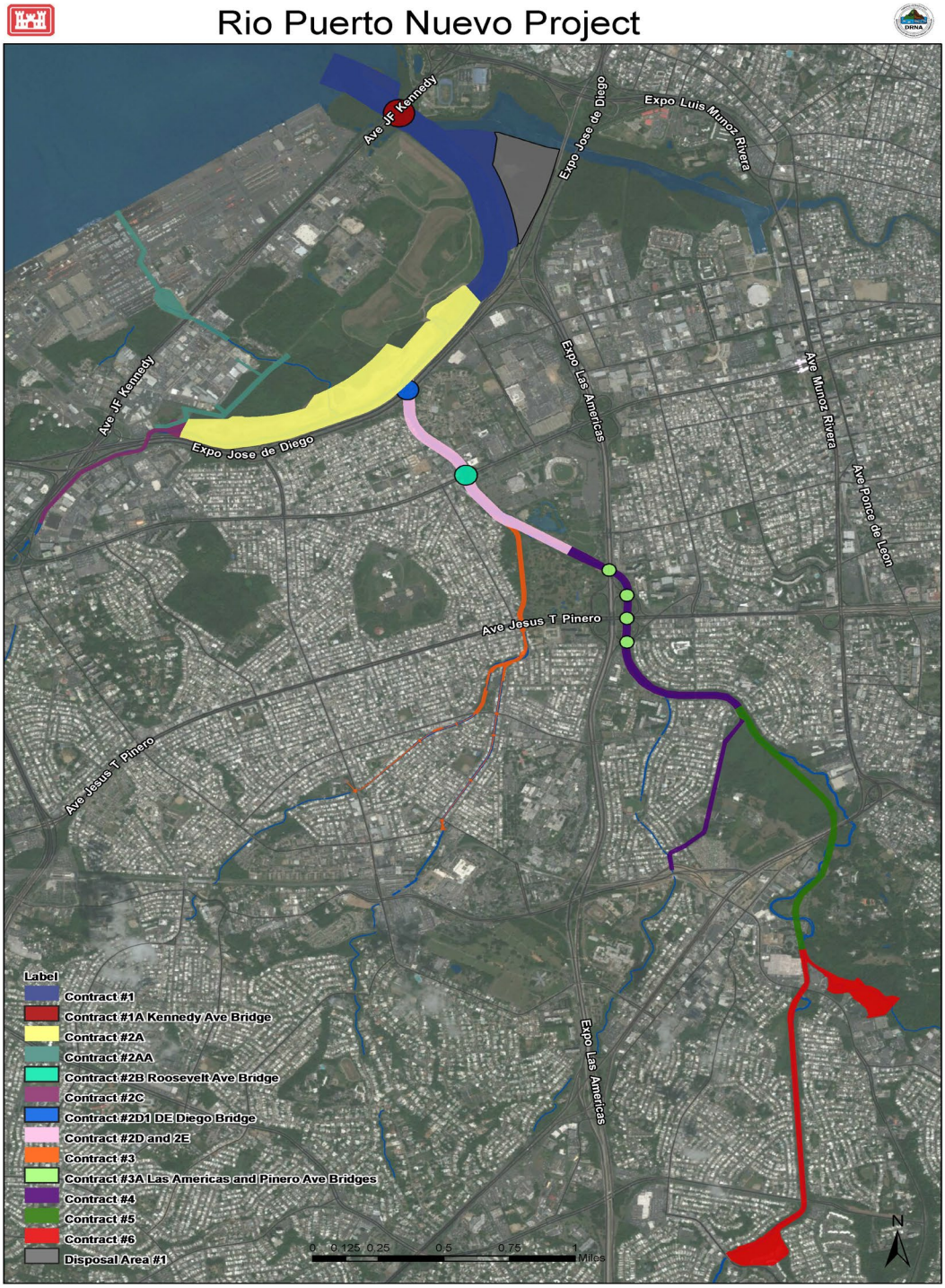

Figure 2 – Río Puerto Nuevo Construction Contracts

Construction on the project began in 1995 and is ongoing. As noted in Figure 2, Contract 1, which significantly widened and armored the mouth area of the RPN channel, and Contract 1A, which relocated the Kennedy Avenue Bridge, were completed in 2005. A picture of the improved, widened channel mouth is provided in Photo 1. Contract 2A, is complete which widened and armored a slightly more upstream section of the main RPN channel. Table 2 shows the remaining project construction contracts (which have been sorted and placed under numbered Supplemental Contracts) with expected construction completion dates and Table 3 shows the completed construction contracts which are not part of the Supplemental Contracts.

Table 2 - Authorized Project Remaining Contracts

Supplemental Contract 1 – expected completion December 2025
Contract 2C2 & 2C3
Sewer Line Relocation & Remaining Upper Margarita Channel (Sta 66+29 to Sta 89+60)
Supplemental Contract 2 – expected completion July 2025
Contract 2B
Bridge Replacement - Roosevelt Bridge
Supplemental Contract 3 – expected completion July 2025
Contract 2D & 2E
Channel Walls and Main Channel Bottom (Sta 88+33 to Sta 147+40)
Supplemental Contract 4 – expected completion February 2027
Contract 4A
Bridge Modifications of 4 Major Existing Bridges - 4A-1) Las Americas Expressway Bridge 4A-2) Piñero Avenue Bridge East 4A-3) NE Access Ramp Bridge 4A-4) SE Access Ramp Bridge
Supplemental Contract 5 – expected completion April 2025
Contract 4B
Bridge Replacement - Notre Dame Street Bridge
Contract 3AA
Bridge Replacement - Piñero Avenue West Quebrada Josefina
Supplemental Contract 6 – expected completion March 2032
Contract 4C
Middle Main Channel - Sta. 147+40 to Sta 206+50
Contract 4D-1
Buena Vista Bridges - 2 New Bridges 2 Replacement Bridges
Contract 4D-2
Buena Vista Diversion Channel
Contract 5B-1

Middle Puerto Nuevo Channel (Sta. 206+50 to PR HWY 1) and Debris Basin
Supplemental Contract 7 – expected completion October 2030
Contract 3A
Bridge Replacement of 10 Bridges -
Contract 3B-1
Q. Josefina (Piñero Avenue West Bridge South) Channel and Stilling Basins
Contract 3B-2
Q. Doña Ana Channel & Stilling Basins
Supplemental Contract 8
Contract 5B-2
Middle Main Channel - PR HWY 1 to Sta 271+50
Contract 5A
New PR 1 HWY Bridge
Contract 6
Upper Reach 1 Bridge Replacement and 1 Bridge Foundation Modification

Table 3 - Authorized Project Completed Contracts (not included in the Supplemental Contracts)

Contract 1 (Sept 1995 – Jun 2003)
Lower Puerto Nuevo Channel Station 0+90 to 64+00
Miramar Trunk Sewer Siphon
Kennedy Ave Bridge Modifications
Contract 1A (Apr 2002 – Oct 2005)
Kennedy Avenue Bridge Seismic Retrofitting & Misc.
Contract 2A (Oct 1998 – May 2001
Lower Puerto Nuevo Channel 64+00 to 88+33
Margarita Earth Channel 0+00 to 54+10
San Jose Sewer Siphon
Contract 2AR (Jun 2010 – May 2014)
Remaining work from Contract 2A
Connection of the new San Jose Sewer Siphon
1.5 million cy of upstream channel excavation
200k cy of shoal material removal
Contract 2AA (Nov 2002 – Jan 2010)
Bechara Industrial Area, Secant Pile Wall Box Culvert, Option B, which was last 300' of culvert near ports
Facility bulkhead and SSP wall channel upstream of Kennedy Avenue
Contract 2AA (Bechara Middle Section, Aug 2011 – Mar 2015)
Construction of 720' earth channel between existing box culvert and Kennedy Avenue Bridge.
Deep Soil Mixing
Relocation of existing 90" sanitary line
Contract 2C1 (Aug 2014 – Dec 2018)[1]

Upper Margarita Channel Station 46+10 to 56+60 and stilling basin
Construction of concrete U-Framed channel
Stilling basin and channel transition into contract 2AR
Contract 2D1 (Apr 2003 – Jul 2014)
De Diego Bridge Seismic Retrofit

1 contract closeout anticipated in early FY20

As noted in Table 2, construction has not yet begun on Supplemental Contracts 1-7. So far (as of October 2019), the total sunk cost (obligated funds) is approximately $420 million. This includes: Preconstruction, Engineering and Design (PED), construction, LERRDs, and other associated costs.

Photograph 1 – Mouth of RPN Channel

1.7 FUNDING SINCE AUTHORIZATION

Table 4: Federal Funding Since Authorization

FY	Investigations (PED 3121)	CG (3122 Regular)	ARRA (3134)	HIMSUP (3122 BBA P.L. 115-123)	**Total**
1987	$ 775,000				$ 775,000
1988	$ 1,400,000				$ 1,400,000
1989	$ 1,850,000				$ 1,850,000
1990	$ 1,300,000				$ 1,300,000
1991	$ 825,000				$ 825,000
1992	$ 1,025,000				$ 1,025,000
1993	$ 365,000				$ 365,000
1994	$ (50,000)	$ 1,292,000			$ 1,242,000
1995	$ (804)	$ 1,747,900			$ 1,747,096
1996		$ 8,170,000			$ 8,170,000
1997		$ 11,173,000			$ 11,173,000
1998		$ 14,146,000			$ 14,146,000
1999		$ 11,157,000			$ 11,157,000
2000		$ 10,524,000			$ 10,524,000
2001		$ 11,914,000			$ 11,914,000
2002		$ 5,201,400			$ 5,201,400
2003		$ 14,135,263			$ 14,135,263
2004		$ 22,717,300			$ 22,717,300
2005		$ 15,450,000			$ 15,450,000
2006		$ 18,800,000			$ 18,800,000
2007		$ 20,000,000			$ 20,000,000
2008		$ 10,724,000			$ 10,724,000
2009		$ 11,171,000			$ 11,171,000
2010		$ 4,239,000			$ 4,239,000
2011		$ 25,779,456			$ 25,779,456
2012		$ 6,860,000			$ 6,860,000
2013		$ 14,171,600			$ 14,171,600
2014		$ 17,250,000			$ 17,250,000
2015		$ 3,000,000	$ (95,510)		$ 2,904,490
2016		$ 19,750,000			$ 19,750,000
2017		$ 2,001,000			$ 2,001,000
2018		$ -		$ 2,100,000	$ 2,100,000
2019		$ -		$ 37,500,000	$ 37,500,000
2020				$ -	$ -
2021				$ -	$ -
2022				$ -	$ -
2023				$ -	$ -
Total	$ 7,489,196	$ 281,373,919	$ (95,510)	$ 39,600,000	$ 328,367,605

2 OVERVIEW OF CHANGED CONDITIONS SINCE AUTHORIZATION

2.1 INTRODUCTION

As noted in Section 1, the project was authorized in WRDA 1986. Since 1986, some new development has occurred in the floodplain, and several hurricanes and tropical storms have impacted Puerto Rico including the powerful Hurricane Hugo in 1989, Hurricane Georges in 1998 and Hurricane Maria in 2017.

The design of the project (as refined in the 1991 GDM and subsequent FDMs) remains reasonable and appropriate for addressing the flooding issues in the study area. The most recent economic and abbreviated hydraulic analyses of the authorized project (completed as part of 2016 LRR and documented in subsequent sections of this report), concluded that the project generates significant benefits (more than $80 million in average annual benefits) by reducing various Annual Chance Exceedance (ACE) event flood stages for thousands of residential and commercial properties. The project area remains the same. The purpose of the project remains the same. In order to validate the decision to proceed with construction of the remaining features of the project, Supplemental Contracts 1-8, economic, engineering and environmental changed conditions for the entire project have been acknowledged and addressed in this section. This section does not address the re-scoping of the project that was assessed as a result of changed conditions, significant increase in the project cost and BBA implementation funding guidance. Re-scoping is discussed in Section 7 of this report.

2.2 SOCIOECONOMIC CONDITIONS

Since project authorization in 1986, there have been notable changes in the overall socioeconomic conditions of the study area. The 2008 economic recession caused a population decline between 2010 and 2018 in the San Juan metropolitan area and the island as a whole; however, since project authorization in 1986, there has been net population and economic growth in the study area. Between 1986 and 2018, the total population of Puerto Rico increased from to 3.00 M to 3.66 M people (an increase of approximately 7.6%), and the population of San Juan increased from 319,068 to 347,052 people (an increase of approximately 8.8%). Since project authorization, economic development in the floodplain has changed and increased significantly. Dozens of new commercial properties, hundreds of new residential properties, and a number of unique structures have been constructed, including: the Plaza las Americas (the

largest shopping mall in the Caribbean) and the San Juan Natatorium (a state of the art competitive swimming facility).

According to the HAZUS Building Stock database, a FEMA disaster analysis tool, Version 2.2 released 12 January 2015 there are approximately 55,000 structures with a total depreciated exposure value of $14.6 billion located within the Rio Puerto Nuevo (RPN) study area. Approximately 90 percent of the structures, or $13.2 billion, were classified as residential, nine percent, or $1.32 billion, was classified as commercial, and one percent, or $84 million, was classified as non-profit (public buildings). The residential information is based on the 2010 Census and the HAZUS database for the non-residential structures. The average value for the single-family residential structures was $194,000, the average value for the multi-family residential structures was $386,000, the average value for the commercial structures was $356,000, and the average value for the non-profit structures was $177,000. The overall average structure value for the study area equals $238,000. Contents and vehicle values were also included in the analysis; the average value for contents and vehicles varies considerably depending on the size, type, and location of the associated property.

Approximately 50 percent of the population in the project area, or slightly over 70,000 people, reside in residential structures with first floor elevations equal to or lower than the stages associated with the 0.01 (100-year) ACE event. For structures with elevation equal or lower than the stages associated with the 0.004 (250-Year) ACE event, the population is approximately 80,000. These estimates are based on the number of single-family or multi-family residential structures that could receive flood damage by the 0.01 ACE interior stage event (see Table 5) and an average of 2.68 persons per household from the 2010 Census. Each multi-family residential structure was estimated to contain an average of 30 units.

Because the study area is exposed to frequent flood events, there is some life safety risk from flooding in the existing condition. In most locations, the risk is relatively low because the depths of flooding above the first floor elevation of residential structures are not high enough to cause life loss. The average depth of flooding above the first floor elevation is equal to 1.78 feet; 935 structures have flood depths of greater than three feet. It should be noted though that some categories of population at risk (PAR) have not been captured or quantified in this analysis, including workers in low-lying areas, travelers on roadways, and others who might be exposed to unexpected flooding could be put at risk by high rainfall events. The certified planning model for FRM studies (HEC-FDA) does not calculate PAR or life loss, because the benefits of the project are economic (rather than improved safety). The life safety risk in the study area is reduced

considerably by the project; in the with-project condition average flood stages through the 100 year ACE event decrease in numerous dense residential neighborhoods. However, neither the purpose nor the primary benefits of the project are associated with reducing life loss. Economic Justification for the project is based on reduced damages, not reduced life safety risk.

The study area is very large and densely populated, therefore the possibility of loss of life from flooding will always exist. Though the RPN project reduces expected flood stages across a wide area, it is not possible to completely eliminate this risk. The HEC-FDA model results provide detailed information about potential flood damage and expected depth of flooding, but they do not tell a complete story of population at risk.

It is too early to assess the long-term socioeconomic impacts of Hurricane Maria. The 2020 Census (currently in progress) will provide new population data with a high level of detail.

2.3 ENGINEERING CONDITIONS

The authorized features include the replacement, modification, and relocation of multiple bridges, debris basins with side or lateral overflows, multiple miles of channel work, two stilling basin areas, the relocation of a segment of De Diego expressway, and mitigation areas to provide the 100-year flood level of protection for the city of San Juan.

Since 1940 the Río Puerto Nuevo Basin has undergone significant physiographic changes. Natural drainage conditions have been altered as a result of construction of residential, industrial, commercial, public, and transportation facilities. A by-product of this urbanization process has been an acute flooding problem caused by development in the flood plain, inadequate hydraulic capacity of the remaining riverine system including undersized bridge openings, and inadequate local storm sewer capacity. The present flooding problem is compounded by continuing increases in suburban development that reduces rainfall infiltration and increases and accelerates runoff into the existing storm drainage system. Most areas adjoining the Río Puerto Nuevo and its tributaries are subject to frequent flood damage. Development of vacant areas and intensification of existing development will continue to exacerbate the flooding problem.

The project design presented in the survey report was refined as a result of detailed investigations conducted during the preparation of the GDM, FDMs, design modifications required and value-engineering studies performed during construction of Contracts 1 and 2. The GDM produced design revisions that affected most of the project features. Revisions made during the GDM included the deletion of three stilling basins from the smaller tributaries and using extended reaches of high velocity channel and high velocity confluence junctions. Portions

of the Puerto Nuevo and Margarita channels were tested using physical models by the USACE Waterways Experiment Station (WES) in Vicksburg, Mississippi. Replacement of four important bridges was avoided by proposed modifications to the bridge piers as tested in the model.

During the completion of FDM 2, evaluation of additional field data indicated that an extensive culvert drainage system would be required to protect the Bechara Industrial Area (BIA) from overflow from the Quebrada Margarita and Río Puerto Nuevo, and to provide drainage for the portion of the basin within the levee. Other changes to the authorized project are due to: differing site conditions, construction sequences,

value-engineering studies (including value-added designs), upgrading bridge structures to meet the current design criteria of the Puerto Rico Highway and Transportation Authority (PRHTA), design refinements to include seismic analysis of project features (required by current regulations) and funding constraints. Additional information regarding the design changes by contracts are described in the following paragraphs:

Contract 1 (construction contract completed). Contract 1's design changes and construction modifications were performed for the Kennedy Avenue Bridge due to the widening and deepening of the channel, seismic retrofitting of the bridge piers, length of the 48 inch diameter piles (tip elevation from minus 135 feet to 192 feet), different site conditions in the Miramar sewer cofferdam and shift in channel alignment and addition of king pile walls due to the presence of a retired landfill immediately adjacent to the channel.

Contract 1A (construction contract completed). Installation of the seismic isolator bearings for Kennedy Avenue was removed from Contract 1 and advertised separately as Contract 1A. Contract 1A included replacement of the expansion joints and repairs to the flanges of the steel beams of the superstructure (including lead paint abatement) to allow proper seating of the bearings and as well the replacement of joints and bearings.

Contract 2A and Contract 2A Remainder (construction contract completed). Contract 2A features includes the construction of a steel pipe pile wall with sheet pile lagging on the east and west side of the channel, a steel sheet pile wall at the Margarita confluence, relocation of the San Jose Sewer Siphon and a 36-inch waterline, and dredging the trapezoidal earth channel. Access for dredging was impeded by the construction of Contract 1, and environmental issues, which surfaced during final coordination efforts with Puerto Rico Aqueduct and Sewer Authority (PRASA). The issue developed during efforts to divert wastewater to the new San Jose Sewer Siphon of Contract 2A, which delayed removal of the existing siphon. Rather than incur delay

costs while PRASA worked to resolve these issues with the EPA, dredging of approximately 1.7 million cubic yards of material and related work was removed from Contract 2A to be re-advertised at a later date as Contract 2A Remainder. Also included in Contract 2A Remainder was the removal of approximately 250,000 cubic yards of shoal material from the Contract 1 reach.

Contract 2AA (construction contract completed). The Bechara Industrial Area (BIA) is a 465-acre, industrialized sub-basin located between the Margarita Channel and San Juan Harbor. Historically, runoff for the BIA flowed northwesterly into the harbor via the old natural Río Piedras now known as the Bechara Canal. In the early 1960's, this natural floodway was blocked by the construction of the San Juan Harbor port facilities (Puerto Nuevo Terminal). After completion of the GDM, as more detailed topographical, hydrological, and geotechnical data were obtained, it was determined that the GDM plan would require refinement to provide the authorized flood risk management benefits for the BIA. A Value Engineering Study (VES) was implemented to develop the most cost-effective plan of refinement and recommended the following features: relocation of the Margarita Channel levee to the southern edge of the BIA with a new length of about 3,500 feet; 850 feet of rectangular channel along the eastern edge of the BIA; 400 feet of open trapezoidal earth channel; and 2,100 feet of reinforced concrete double-box culvert that will extend under the PR Port Authority's Puerto Nuevo Terminal, exiting into San Juan Harbor.

Contracts 2C and 2D were divided in several construction contracts due to funding constraints.

Contract 2C Upper Margarita Channel was divided into three separate construction contracts; Upper Margarita Channel (Contract 2C1 – construction contract completed) - STA 46+00 to STA 56+00 and Stilling Basin; Upper Margarita Channel (Contract 2C2) - STA 66+29, Sewer Line Relocation; and Upper Margarita Channel (Contract 2C3) - STA 56+00 to STA 89+60.

Contract 2D Walls is a portion of Contract 2D for the channel walls that will be constructed downstream of the De Diego Expressway Bridge over Río Puerto Nuevo. Starting downstream from the De Diego Expressway Bridge abutment the proposed left channel wall will start from the bridge's abutment and extend for about 350 feet. The right channel wall will start from the bridge's abutment and extend for about 700 feet.

Hydraulics and Hydrology

The hydrologic investigations and hydraulic designs were originally completed in the 1984 Río Puerto Nuevo Survey Investigation report. There has been multiple revisits for various reports as needs arose during construction of several contracts (or phases). In 2016, the hydrology and

hydraulics analyses were revisited for the Limited Re-Evaluation Report (LRR). The analyses scope and purpose was to update the hydrology using NOAA Atlas 14 to verify the 1991 GDM Plan's performance with adjusted rainfall values, verify delineation of flooded areas and to update costs (original rainfall distribution was not updated to today's standards). No plan reformulation nor other updating of design criteria and data were made in the abbreviated analyses. The revisited analyses were verified as acceptable for task purpose and resulted in confirmation that the benefits of the project are likely similar to what was originally quantified and communicated in prior reports. The certified cost provided by the Cost MCX on November 28, 2018 are the authorized project current costs and no further cost updates are scheduled until after the new H&H analyses are completed and PED level efforts produce plans at 30% complete level of design.

The PED level hydrology and hydraulic analyses to be performed will include all of the following with the intent of verifying adequacy of original feature designs, and investigating and matching cost efficiencies to the desired level of performance using state-of-the-art computing tools. All USACE Regulations, Policies and Community of Practice (CoP) standards will be adhered to with proper Quality Control reviews accordingly:

(1) Update the project rainfall depths and distribution with NOAA Atlas 14 (based on H&H updates to other Puerto Rico projects, NOAA Atlas 14 rainfall depths are significantly different from previous rainfall calculations) and re-model the drainage basin using CoP approved computing software (HEC-HMS) to determine design flow rates. The period of return frequency floods to be included are the 2-year, 5-year, 10-year, 25-year, 50-year, 100-year and Standard Project Flood (SPF). The 200-year return frequency storm was added since previous study for an additional case study for risk analysis purposes. The different frequencies are used to identify risk and make risk informed decisions with respect to conveyance needs and other features. The SPF is used to identify residual risk as the project is to provide the 100-year flood damage reduction capability. LiDAR data collected to date will be used for the project's basin analysis.

(2) Update the hydraulic routing of flood flows through the riverine/tributary system using Community of Practice (CoP) approved computing software (1D/2D HEC-RAS). The previous model used, 1-dimensional HEC-RAS, encountered instability for the range of mixed regime flows expected (multiple transitions between sub-and super-critical flow) and the large area inundated by flood flow out of bank. Because of instability, residual flood flow out of bank and multiple confluences of super-critical flowing channels, a 2-dimensional routing model will be used where it provides improvement in accuracy, stability and robustness. A new hydrographic survey will be required to account for aggradation and erosion of sediment over the years since last modeled

for design purposes. A scour analysis will be performed for the Roosevelt Bridge and channel surfaces to determine cost efficient armoring needs (other bridges will be lined channel reaches). All hydraulic control and conveyance features will be verified for cost efficiency and performance adequacy or new criteria will be developed to ensure proper hydraulic design of project feature(s).

(3) Sea Level Rise will be investigated through model sensitivity analyses, e.g. varying downstream boundary conditions (sea) to determine potential impacts on design features effectiveness and change in river stages or risks/level of flood damage reduction over time.

(4) Results from hydrology and hydraulic analyses will be used to make NEPA updates if needed. Expected project benefits will be verified and or updated with project costs.

(5) Lastly, new flood maps (residual) will be redrawn for the region for the populace's knowledge and future use.

2.4 SEA LEVEL CHANGE AND CLIMATE CHANGE ANALYSIS

The Río Puerto Nuevo climate change assessments for both sea level change (SLC) and Inland Hydrology will be conducted as part of the PED effort to address the vulnerability, risk, resiliency, and adaptation measures of the project to climate change.

The USACE overarching climate adaptation policy requires consideration of climate change in all current and future studies to reduce vulnerabilities and enhance the resilience of our water resources infrastructure. For the Rio Puerto Nuevo project, both SLC and inland hydrology will be assessed to determine if the project is vulnerable to climate change. The climate assessment will include a discussion on risk associated with climate change (both SLC and Inland Hydrology) and how resiliency or adaptation measures may be incorporated over the project life cycle.

The climate assessment for SLC follows the USACE guidance of Engineer Regulation (ER) 1100-2-8162, Incorporating Sea Level Change in Civil Works Programs and Engineer Technical Letter (ETL) 1100-2-1, Procedures to Evaluate Sea Level Change: Impacts, Responses, and Adaptation. Per the guidance, projected sea level changes will first be calculated using the USACE web-based Sea Level Change Curve Calculator. This statistical tool provides estimates on when sea levels may impact threshold elevations for the critical infrastructure of the project. If the projected sea level elevations indicate that the project may be vulnerable to SLC and that the project may not function (performance and operation) as intended over time, then additional analysis will be conducted by the project team to assess the resiliency and potential adaptation measure needs

for the project. Additional analysis may include performing a model sensitivity analysis and development of inundation maps using future sea level projections to determine potential impacts on project design features and when these impacts may occur. Typically, projects with major infrastructure are evaluated for SLC at the end of the 50-year and 100-year project lifecycles. Project performance and operation could be affected during the project life cycles by SLC associated with tidal backwater effects or directly by flood inundation associated with SLC including high tides and coastal storm surge.

The climate assessment for inland hydrology follows the USACE guidance of Engineering and Construction Bulletin (ECB) 2018-14, Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects. Inland hydrology assessments are currently qualitative. For most USACE projects and studies, a qualitative analysis provides the necessary information to support the assessment of climate change risk and uncertainties to the project design or constructed project. Per the guidance, a vulnerability assessment will be performed to include a literature review and climate tool evaluation of observed and projected climate trends. The Climate Hydrology Assessment Tool (CHAT) evaluation will not be conducted because observed streamflow data is not incorporated into the hydrologic tools in Puerto Rico at this time. In lieu of using CHAT tool, the Nonstationarity Detection Tool (NSD) will be used assess the stationarity of annual peak streamflow for the project. Furthermore, a qualitative analysis on precipitation may be performed, in coordination with the Climate Preparedness and Resilience (CPR) CoP, using the CPR web-based Time-Series Toolbox. This qualitative information will be used to assess the risk of the project to climate change and compared to the findings in the literature review. A synthesis of USACE peer reviewed climate literature (US Climate Change and Hydrology Literature Applicable to US Army Corps of Engineers Missions – Caribbean Region 21) is available for the Caribbean Region and is the primary source of information in this literature review. The literature review shows that there is reasonable consensus that the intensity and frequency of extreme storm events will increase in the future for the Caribbean Region, however there is no quantitative evidence to further support the assessment. Risk and resiliency of the project can however be discussed qualitatively to help inform the decision making process on the project design.

The climate assessment will include a discussion on risk associated with climate change (both SLC and Inland Hydrology) and how resiliency or adaptation measures may be incorporated over the project life cycle. Because the project may be vulnerable to sea level rise, increases in extreme precipitation, and drought, it would be beneficial for the project to account for risk due to climate change by developing a strategy for adaptive management of the project. Adaptive management

could be used as a means of ensuring that the project is resilient to the impact of climate change for the duration of the project life cycle. This includes ensuring that the design of the project and prescribed operations can easily be adapted to handle extreme wet and dry conditions, including floods and droughts. This will ensure that the plan selected is robust enough to accommodate changing climatic conditions.

3 PERFORMANCE OF THE PROJECT AND IMPACTS OF HURRICANE MARIA

According to the National Hurricane Center, Hurricane Maria made landfall on 20 September 2017 as a Category 4 storm near Yabucoa, Puerto Rico with sustained winds of 155 mph, resulting in catastrophic damage to the island. It has been designated as the tenth most intense Atlantic hurricane on record and is the strongest to make landfall in Puerto Rico since 1928. At the time that Hurricane Maria made landfall, Puerto Rico was still recovering from the impacts of Hurricane Irma that caused significant flooding less than two weeks prior. Hurricane Maria's rainfall caused record flows through Río Puerto Nuevo and its tributaries, resulting in increased sediment transport rates to the San Juan Harbor. Sediment deposition within the project area was a significant concern immediately following the storm event.

Record breaking flooding far exceeded the capacity of USGS Stream Gaging Station 50049100 located at Piñero Avenue Bridge. The USGS Caribbean Water Science Center recovered several high water marks in the area and has not computed the estimated peak flow at this station to date. Recorded flood levels are much higher than any on record. High Water Marks (HWM) reached 3.31 feet above ground just south of F.D. Roosevelt Avenue Bridge, 3.51 feet above ground at Calle Alsacia of Puerto Nuevo, and 2.26 feet above ground just upstream of the junction of Doña Ana and Josefina tributaries.

According the NOAA National Weather Service in San Juan, portions of the Río Puerto Nuevo upper basin received an estimated amount of rainfall between 10 to 20 inches of rain (see Figure 3).

Many public facilities, streets, roads, and highways in the San Juan Metropolitan Area were flooded causing traffic jams, disrupting rescue efforts and hampering emergency management operations. (See Photographs 2-7).

Flood damage to residential, commercial, industrial, and public property in San Juan Metropolitan Area was extensive and severe. Over 4,000 residential, commercial and public structures were affected. The Municipality of San Juan estimated flood damages at over $200 million.

Hurricane Maria's excessive rainfall caused increased flows in Río Puerto Nuevo, resulting in a large amount of sediment suspension upstream. No damage was noted above the water in the areas of the completed project components, but hydrographic surveys showed that the eroded

sediment suspended in the flow settled out in the channel downstream of the De Diego Bridges, both in the Río Puerto Nuevo and the Margarita Channels. The uncompleted portions of the channel in its current condition would likely fail to provide the authorized level of flood damage reduction benefits as a result of a 100-year return period storm event. In addition, the occurrence of frequent storm events on the urban area are expected to result in continued higher sediment accumulation rates and hydraulic capacity reduction, further reducing the current channel's flood damage reduction benefits. While the design storm is estimated to be the single storm event that would lead to large flood damages, cumulative smaller events will also lead to flooding with more frequent events. The hydrographic survey performed after Hurricane Maria shows approximately 440,000 cubic yards of sedimentation within the completed lower channels. The channel in its current condition presents a blockage from sediment along the completed 2,026-foot reach of Río Puerto Nuevo and Quebrada Margarita, resulting in a conveyance area reduction ranging between 20 and 46% in Río Puerto Nuevo just downstream of the confluence wall. An emergency repair of this part of the project was approved under FCCE authority, so that this 20-46% blockage will be addressed without the project itself incurring additional costs. However, despite the sedimentation and urban flooding, there has not been a significant environmental change or newly listed species which could be affected in the project area that would require an additional evaluation under NEPA at this time. Per Section 4.1 below, the USACE will prepare additional NEPA documentation as appropriate prior to construction of the remainder of the project once lands acquisition and Section 106 consultation have been completed and the designs finalized.

The completed portions of the Río Puerto Nuevo and Quebrada Margarita lower channels contracts performed as designed and provided adequate flood damage reduction to a portion of De Diego Expressway, Plaza Las Americas Mall and over 600 families living in Puerto Nuevo Norte. The completed Bechara Canal performed as designed and provided adequate flood damage reduction to J.F. Kennedy Avenue, Container Port Facilities, San Juan Municipal Public Works facilities, and the Bechara Industrial Area.

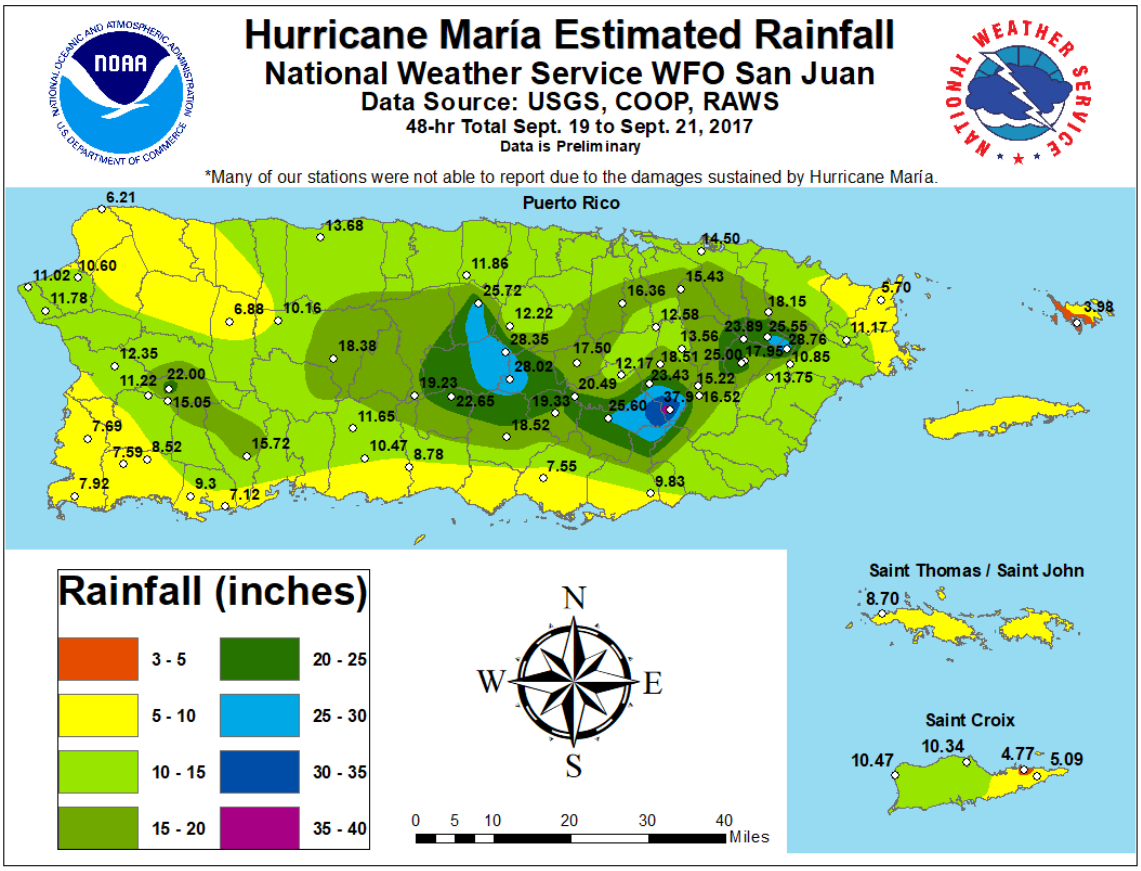

Figure 3 – NOAA NWS San Juan Hurricane Maria Estimated Rainfall

Photograph 2 – Flooding at Upper Reach of Quebrada Josefina

Photograph 3 – Quebrada Josefina Flooding

Photograph 4 – Río Piedras Flooding at Intersection of Piñero Avenue and Cesar Gonzalez Avenue

Photograph 5 – Quebrada Margarita Flooding at San Patricio

Photograph 6 – Quebrada Margarita Flooding at PR-2 and PR-22

Photograph 7 - Quebrada Margarita Flooding at PR-2 and PR-22

4 ENVIRONMENTAL CONDITIONS

4.1 ENVIRONMENTAL CONDITIONS

The USACE prepared an EIS which evaluated construction of the entire project in 1984 and subsequent EAs in 1993 and 2002 concerning some changes in project design, mitigation, and environmental requirements. Based on a thorough review of the project, environmental site information, and prior NEPA documents and studies completed in 1984, 1993, and 2002, we have determined that while the project costs have escalated, the scope of the project remains essentially the same. There is no change in the wetland mitigation requirement which was completed in 2014. The project still would not be likely to adversely affect threatened or endangered species or designated critical habitat.

Solid waste and hazardous substances will be identified, separated, handled, transported and disposed in accordance with all applicable laws and regulations. All hazardous substances and waste(s) such as, tires, asbestos containing materials, lead paint, and petroleum oil and lubricants contaminated materials, will be disposed at 100% Non-federal sponsor cost. Per Article VXII of the RPN Project Cooperation Agreement (PCA), in the event it is discovered through an investigation for hazardous substances or other means that any lands, easements, rights-of-way, borrow or disposal areas to be acquired or provided for the Project contain any hazardous substances regulated under CERCLA, the Local Sponsor and the Government shall provide prompt notice to each other, and the Local Sponsor shall not proceed with the acquisition of lands, easements, rights-of-way, borrow or disposal areas until mutually agreed.

The proposed action remains within the scope of the Water Quality Certification issued by the Puerto Rico Environmental Quality Board on June 1993 and subsequent modifications issued on April 2001 and February 2011. Compensatory wetland mitigation for impacts from construction of the entire project was completed with construction of Contract 2 AR and deemed successful in the third quarterly monitoring report dated April 21, 2015.

The USACE has determined that construction of the entire project may affect, but is not likely to adversely affect, the Puerto Rican boa, Antillean manatee, sea turtles, whales and corals. The USFWS and NMFS concurred with these determinations via letters dated December 18, 2013 and June 10, 2014, respectively, provided the USACE implement conservation measures for these species under Section 7 of the Endangered Species Act. Although five threatened hard corals under the purview of NMFS could occur along the north coast of Puerto Rico and are newly listed since the last consultations were completed in the 2013/2014, the project is anticipated to have

discountable effects to these newly listed species. Updated consultations with USFWS and NMFS would occur during the PED phase. However, SAJ does not expect these species conservation measures will change for the remaining contract phases.

The USACE completed Essential Fish Habitat consultation for construction of the entire project with NMFS on May 29, 2015. At this time no significant design changes are anticipated for Supplemental Contracts 1-5 that would require preparation of supplemental NEPA documentation. However, due to the complex nature of the project and the need to complete additional real estate acquisition and cultural resource surveys; at this time the USACE cannot conclude whether design changes identified in Planning Engineering and Design (PED) for the Supplemental Contracts 6 and 7 will not require completion of supplemental NEPA. As such, the USACE will prepare an additional NEPA documentation as appropriate during the PED phase once lands acquisition and Section 106 consultation have been completed and the Supplemental Contracts 6 and 7 designs are finalized.

4.2 CULTURAL RESOURCES

The identification and evaluation of historic properties for the Río Puerto Nuevo flood risk management project has been conducted in a phased process. Due to the size and scope of the area of potential effects, each Contract has been subject to separate consultation and consideration of project effects to historic properties during PED and based on final designs or modifications of project features. The Puerto Rico State Historic Preservation Office (SHPO) concurred with the USACE's employment of a phased approach to satisfy compliance with Section 106 of the National Historic Preservation Act (NHPA) by letter dated May 19, 1992 and as part of the 1992 Environmental Assessment Finding of No Significant Impact, signed by the USACE Jacksonville District Commander at that time. The USACE has previously coordinated a determination of no effect on historic properties with the Puerto Rico SHPO for the completed construction contracts; however, cultural resources surveys and coordination with the SHPO is required for all remaining contracts to be issued for the remainder of the project due to changes in the built environment and the potential identification of cultural resources that have become eligible for listing in the National Register of Historic Places (NRHP) over the last 27 years. Compliance with Section 106 of the NHPA is ongoing will be complete prior to construction.

A variety of cultural resources are located within or adjacent to the area of potential effects for Supplemental Contracts 2, 3, 4, 5, 6, 7, and 8, including historic-period bridges and structures. These cultural resources will require evaluation of their eligibility for inclusion in the NRHP and an assessment of visual effects that the project may have on the historic landscape. If these sites

are found to be eligible for listing in the NRHP, avoidance, minimization, or mitigation of adverse effects will need to be coordinated with the SHPO and Advisory Council on Historic Preservation (ACHP). Additionally, two historic properties dating from the nineteenth century and listed on the NRHP are also located within or adjacent to the area of potential effects. These historic properties consist of the Río Piedras Bridge #3, located south of Puerto Rico Highway 1, and Antiguo Acueducto del Río Piedras (San Juan Waterworks), located within the botanical gardens at the University of Puerto Rico. The Río Piedras Bridge #3 is not currently located within the APE; however, avoidance of this historic property should be maintained to prevent project delays.

The Antiguo Acueducto del Río Piedras is a historic property listed on the NRHP in 2007 and designated a National Treasure by the National Trust for Historic Preservation (NTHP) in 2014. This mid-nineteenth century waterworks is the only Spanish-period aqueduct known to exist within the United States and its territories. The historic elements of the property include the weir across the Río Piedras, the water inlet structure and piping, the water settling basins and various supporting buildings. Construction of Supplemental Contract 8 would directly impact the settling basins and cause an adverse effect to the historic integrity of the entire property.

The Antiguo Acueducto del Río Piedras is currently managed by Para la Naturaleza, a unit of the Conservation Trust of Puerto Rico (CTPR). These agencies, along with the Puerto Rico Department of Natural and Environmental Resources (DNER), the Puerto Rico Aqueduct and Sewer Authority (PRASA), and the NTHP have partnered to preserve and rehabilitate the site to be used as a center of scientific research and dedicated to ecological, educational, and recreational uses related to water resources. The USACE has received numerous requests from CTPR, DNER, NTHP, the State Historic Preservation Office, and the resident commissioner from Puerto Rico to reconsider the original design that impacts the Antiguo Acueducto del Río Piedras and avoid adverse effects to the historic property. The recommended implementation of Strategy 3 will not construct Supplemental Contract 8 and therefore will avoid impacts to the historic Antiguo Acueducto del Río Piedras.

As part of the USACE compliance with Section 106 of the NHPA, additional cultural resources surveys and coordination with the SHPO to determine effects of Supplemental Contracts 1-7 is currently ongoing. A cultural resources survey of Supplemental Contract 8 will not be undertaken based on the recommended implementation of Strategy 3, which will not construct Supplemental Contract 8. These surveys will identify historic properties, if present, in portions of the area of potential effects that were not previously evaluated for cultural resources. Avoidance of historic properties that may be identified during the current survey effort is recommended; however, if

the project footprint cannot be realigned then minimization or mitigation of adverse effects will need to be coordination with the SHPO and the ACHP. Consultation will be complete prior to construction to ensure compliance with Section 106 of the NHPA.

5 ECONOMIC ANALYSIS FOR THE TOTAL AUTHORIZED PROJECT

5.1 COST UPDATE FOR THE AUTHORIZED PROJECT

The total estimated cost of the authorized project has increased significantly since authorization. The original authorized cost, in FY86 dollars, was $234 million. The current total estimated project first cost (not including sunk costs) in current (FY19) dollars is estimated to be $1,864,859,000. Some of this increase can be explained by inflation over time. The original cost, inflated to current price levels, is $528,593,000. However, the rest of the increase in cost is due to a variety of factors, including weather impacts, construction issues, real estate cost increases, changed design standards, unknown underground utilities, and changed site conditions. The total project first cost of the project (about $2.285 billion) includes approximately $420 million in sunk costs.

5.1.1 COST NARRATIVE

SAJ Cost Engineering expects all projects in Puerto Rico, including Río Puerto Nuevo, to see rising costs due to the effects of Hurricane Maria and the resulting Supplemental funding. The effects to the cost estimate will include but not be limited to the following: 1) rising costs in materials, 2) rising costs in labor rates, 3) availability of skilled labor on the island, 4) availability of local and/or worldwide contractors to perform all the work needed on the island, 5) rising fuel prices, and 6) future funding amounts to execute the project.

5.1.2 COST AND SCHEDULE RISKS

This section provides a summary of significant risk analysis results that were identified in the Cost and Schedule Risk Analysis. The key cost and schedule risk drivers noted below were identified as those risks that are shown to represent the greatest uncertainty by the sensitivity analysis. Risk analysis results are intended to provide project leadership with contingency information for scheduling, budgeting, and project control purposes. Results also provide tools to support decision making and risk management as projects progress through planning and implementation.

Major findings and observations of the risk analysis are listed below.

1. The total contingency was quantified as approximately $418,883,000 at 80% confidence level, or about 30% total contingency for the project. It is important

to note that these results reflect contingencies based on both the cost and schedule risk analyses.

2. The most critical cost risk drivers identified through the sensitivity analysis are the "Design development stage" and "Historic change order or modification growth", which contribute 21.1% and 22.4% of statistical cost estimate variance during Monte Carlo simulation, respectively.

3. The "Design development stage", which contributes 21.1%, reflects that the estimate was developed using a GDM that was developed in 1991, and did not capture the actual condition of the project area. Even if the estimate was adjusted to capture the lessons learned for the design, there are still some unknowns concerning the conditions at the time of final design and construction of the project. The key schedule risk drivers identified through sensitivity analysis are "Acquisition planning to accommodate funding stream" and "Relocations may not happen in time", which contribute 43.7% and 17.1% of statistical cost estimate variance during Monte Carlo simulation, respectively.

5.2 REAL ESTATE COSTS

Real Estate costs include lands, easements, rights-of-way, relocations, and disposal site (LERRDs). The estimated cost of lands, easements, rights-of-way, (LER) included in the gross appraisal (2015) which estimated a total land value of LER of approximately $545 million (not including contingency), with $327 million of the total LER value associated with already completed features. However, the SAJ PB-3 cost for the project showed a different cost. The SAJ PB-3 for the entire project cost at that time was $25.6 million (based on the original estimated real estate cost in the 1991 General Design Memorandum, then escalated to FY15 for inflation). It was agreed to use the gross appraisal for all future construction work, while the original 1991 GDM costs updated for inflation in the PB-3 to be used for estimating LER cost for completed features. The gross appraisal estimated that completed contracts amount to 60% of the entire project LER cost. Therefore, 60% of the total PB-3 real estate cost estimate, $15.4 million will be assumed to be a reasonable estimate of the completed features LER cost. All future LER contracts are estimated to be approximately $217.7 million without contingency. Thus the grand total of LER cost for the entire project including contingency is estimated to be $287.5 million ($217.7 million + 25% contingency + $15.4 million). Utilities, roads, bridges, and facilities relocations costs were estimated. The estimated total project cost is $139.4M for relocations and $178.6M for roads and bridges (total of $318.3M).

5.3 ECONOMIC UPDATE FOR THE AUTHORIZED PROJECT

The most recent benefit analysis was completed in FY16. According to CWPM 12-001, *Methodology for Updating Benefit Cost Ratios*, a Level One Economic Update verifies economic justification by taking the current estimated cost and deflating it to the price level of the benefits. This is the approach taken in the Validation Report.

Though there have been some changed conditions since 2016 (most notably the effects of Hurricane Maria in 2017), SAJ has concluded that a Level 1 analysis represents a conservative and defensible approach for verifying economic justification for the project. The scope of the Validation Report is limited and is intended to be completed in an expedited manner. A higher level of effort (Level 2, 3 or 4) is not warranted, as the action is to implement an already congressional authorized project, subject to changes warranted based on changed conditions, if any. Based on the information available at this time, a Level 1 Update seems appropriate. Also, according to CWPM 12-001 and EC 11-2-200, economic evaluations are valid for up to five years on continuing construction projects.

The remainder of this section describes the methods and conclusions of the 2016 economic analysis that was developed for the 2016 LRR.

5.3.1 ECONOMIC MODEL AND APPROACH

The Hydrologic Engineering Center Flood Damage Analysis (HEC-FDA) Version 1.2.5a USACE-certified model was used to calculate expected annual damages and benefits over the 50-year period of analysis. The economic inputs for the model included the structure and vehicle inventory, content-to-structure value ratios, first-floor elevations, and depth-damage relationships. The engineering inputs for the model included ground elevations, and stage-probability relationships.

The uncertainty surrounding each of the economic and engineering variables was also entered into the model. Either a normal probability distribution, with a mean value and a standard deviation, or a triangular probability distribution, with a most likely, a maximum and a minimum value, was used to quantify the uncertainty associated with the key economic variables. A normal probability distribution was used to quantify the uncertainty surrounding the ground elevations. The number of years that stages were recorded at a given gauge was entered for each study area reach to quantify the hydrologic uncertainty surrounding the stage-probability relationships. The general building stock portion of the Hazard-U.S.-Multihazard (HAZUS-MH) application, HAZUS-MH Version 2.2 Release 12 January 2015, a GIS-based multi-hazard loss estimation tool

developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS) was used to develop the structure inventory. The HAZUS total depreciated replacement or exposure value is given by various residential and non-residential structure categories for each census block.

In order to run HEC-FDA, the hydrology and hydraulics were updated as well. The entire study area was divided up into 24 sub-basins, depicted in Figure 4. The 2016 H&H model (which was developed for the LRR) allowed flood stages to be developed across the study area for eight ACE events in both the with-and-without project condition. The new H&H model included updated topography data (from recent LiDAR surveys) and incorporated Atlas 14 rainfall data.

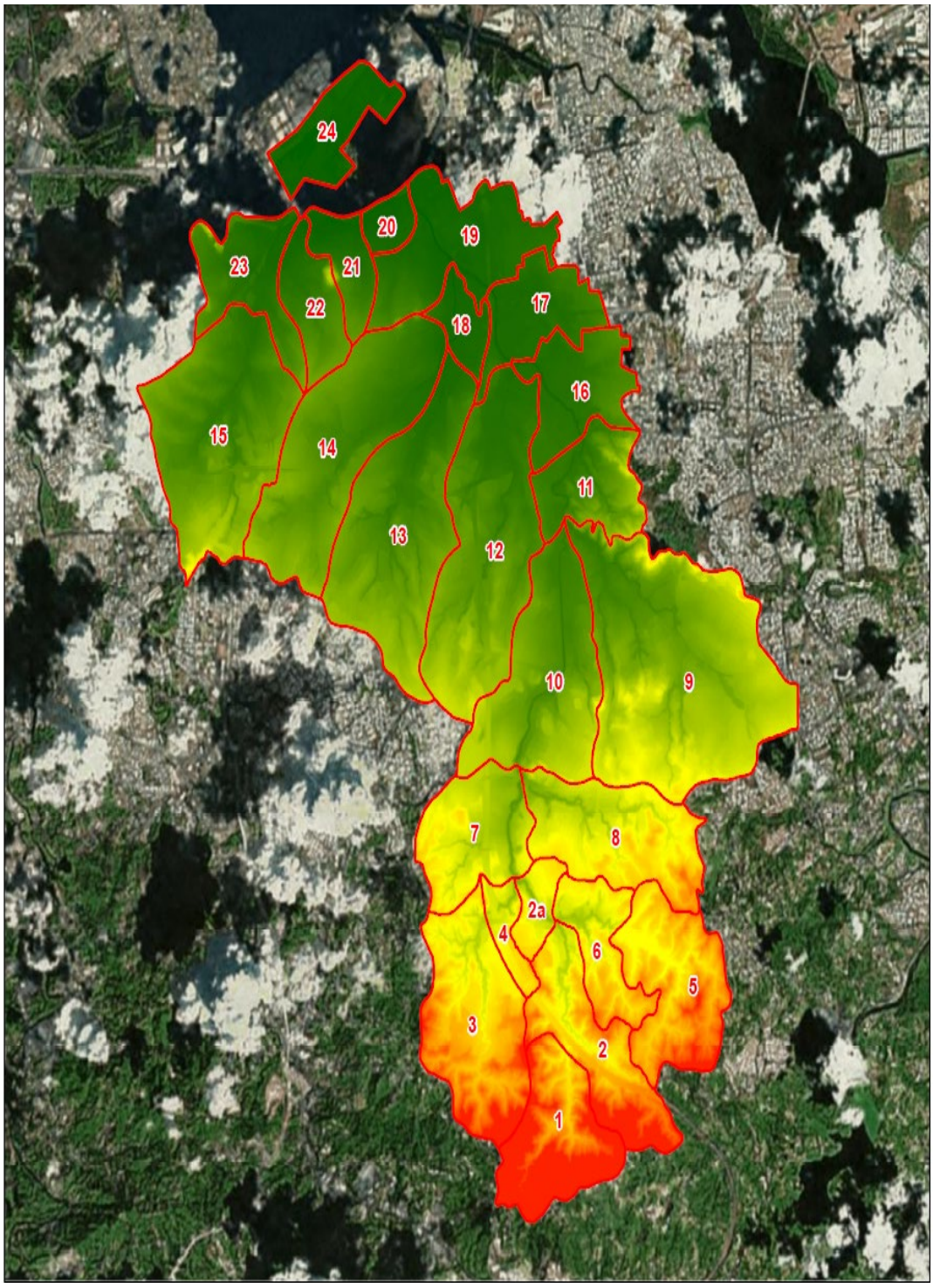

Figure 4 – RPN Hydrologic Sub-Basins

5.3.2 WITH AND WITHOUT PROJECT ESTIMATED DAMAGES

The 2016 HEC-FDA model was utilized to evaluate flood damages using risk-based analysis. Damages were reported at the index location for each of the 24 basins for which engineering data was available and a structure inventory had been developed. A range of possible values, with a maximum and a minimum value for each economic variable (first-floor elevation, structure and content values, and depth-damage relationships), was entered into the HEC-FDA model to calculate the uncertainty or error surrounding the elevation-damage, or stage-damage, relationships. The model also used the number of years that stages were recorded at a given gage to determine the hydrologic uncertainty surrounding the stage-probability relationships.

The possible occurrences of each variable were derived through the use of Monte Carlo simulation, which used randomly selected numbers to simulate the values of the selected variables from within the established ranges and distributions. For each variable, a sampling technique was used to select from within the range of possible values. With each sample, or iteration, a different value was selected. The number of iterations performed affects the simulation execution time and the quality and accuracy of the results. This process was conducted simultaneously for each economic and hydrologic variable. The resulting mean value and probability distributions formed a comprehensive picture of all possible outcomes.

The model used Monte Carlo simulation to sample from the stage-probability curve with uncertainty. For each of the iterations within the simulation, stages were simultaneously selected for the entire range of probability events. The sum of all damage values divided by the number of iterations run by the model yielded the expected value, or mean damage value, with confidence bands for each probability event. The probability-damage relationships are integrated by weighting the damages corresponding to each magnitude of flooding (stage) by the percentage chance of exceedance (probability). From these weighted damages, the model determined the expected annual damages (EAD) with confidence bands (uncertainty). Tables 5 and 6 show the number of structures and vehicles damaged by structure category for each of the eight probability events under without-project and with-project conditions. Tables 7 and 8 show the dollar damages by structure category for each of the eight probability events under without-project and with-project conditions. Table 9 shows the expected annual without-project damages, with-project damages, and expected annual benefits in for the project alternative by study area basin. It should be noted that the benefits associated with the Bechara Industrial Area (Basin 24) at the mouth of the RPN channel have already been realized due to the completion of Contracts 1, 1A, 2AA. Though part of the total project BCR, these benefits are not included in the remaining benefit remaining cost ratio (RBRCR).

Table 5 - Number of Structures Damaged under Without Project Conditions by Probability Event

Annual Chance Exceedance Event (ACE)	Single-Family Residential	Multi-Family Residential	Non-Residential	Non-Profit	Vehicle	Total
0.50 (2 yr.)	1,232	227	65		593	2,117
0.20 (5 yr.)	2,080	380	129	2	1,398	3,989
0.10 (10 yr.)	2,542	493	176	2	1,930	5,143
0.04 (25 yr.)	3,039	612	228	3	2,657	6,539
0.02 (50 yr.)	3,262	647	251	5	2,980	7,145
0.01 (100 yr.)	3,669	762	286	6	3,597	8,320
0.005 (200 yr.)	3,915	822	305	6	4,036	9,084
0.004 (250 yr.)	4,058	850	330	6	4,345	9,589

Table 6 - Number of Structures Damaged under With Project Conditions by Probability Event

Annual Chance Exceedance Event (ACE)	Single-Family Residential	Multi-Family Residential	Non-Residential	Non-Profit	Vehicle	Total
0.50 (2 yr.)	1	0	0	0	1	2
0.20 (5 yr.)	2	0	0	0	2	4
0.10 (10 yr.)	7	0	0	0	7	14
0.04 (25 yr.)	26	4	0	0	22	52
0.02 (50 yr.)	37	7	0	0	36	80
0.01 (100 yr.)	64	9	0	0	60	133
0.005 (200 yr.)	104	24	1	0	119	248
0.004 (250 yr.)	124	25	1	0	143	293

Table 7 - Without Project Damages by Probability Event (FY16 Price Level, $1,000s)

Annual Chance Exceedance Event (ACE)	Single-Family Residential	Multi-Family Residential	Non-Residential	Non-Profit	Vehicle	Total
0.50 (2 yr.)	23,175	10,583	5,564	0	1,723	41,045
0.20 (5 yr.)	63,030	21,116	12,505	15	5,914	102,580
0.10 (10 yr.)	93,865	30,979	19,181	49	9,291	153,364
0.04 (25 yr.)	135,499	44,289	27,536	60	14,246	221,629
0.02 (50 yr.)	157,724	51,056	31,018	74	17,128	256,999
0.01 (100 yr.)	205,831	5,142	41,422	260	22,849	334,591
0.005 (200 yr.)	245,062	73,763	47,409	398	27,632	394,263
0.004 (250 yr.)	278,716	82,956	51,503	464	31,971	445,610

Table 8 - With Project Damages by Probability Event (FY16 Price Level; $1,000s)

Annual Chance Exceedance Event (ACE)	Single-Family Residential	Multi-Family Residential	Non-Residential	Non-Profit	Vehicle	Total
0.50 (2 yr.)	29	0	0		0	30
0.20 (5 yr.)	56				1	57
0.10 (10 yr.)	207				4	211
0.04 (25 yr.)	678	508			36	1223
0.02 (50 yr.)	1375	1103			100	2578
0.01 (100 yr.)	2779	1791			261	4831
0.005 (200 yr.)	6177	6932	66	26	1160	14359
0.004 (250 yr.)	8917	7669	67	58	1488	18200

Source: Values are based on output provided by HEC-FDA model.

Table 9- Summary of Without and With-Project Expected Annual Damages and Benefits by Basin ($1,000s; FY16 Price Level)

Basin Number	Without Project Damages	With Project Damages	Benefits
Basin 9	0	0	0
Basin 10	944	0	944
Basin 11	140	0	140
Basin 12	8870	26	8844
Basin 13	9017	115	8901
Basin 14	4626	94	4531
Basin 15	0	0	0
Basin 16	1911	0	1911
Basin 17	3806	14	3792
Basin 18	10025	18	10007
Basin 19	27259	44	27216
Basin 20	5857	0	5857
Basin 21	2788	36	2752
Basin 22	192	0	192
Basin 23	140	0	140
Basin 24	9377	0	9377
Total	**84,951**	**347**	**84,604**

Note: Does not include partial benefits achieved during construction prior to the Base Year.

5.3.3 BENEFITS DURING CONSTRUCTION

Though the authorized project is designed to be constructed and operated as one integrated whole, each of the individual Contracts of the project are capable of generating benefits on their own. Throughout the entire construction process, the total annual benefits during construction were estimated to be $40.8 million.

5.3.4 INCIDENTAL RECREATION BENEFITS

The authorized project also has several recreation features (a walking trail and a boat ramp) which generated incidental recreation benefits. A unit day value (UDV) recreation analysis was completed as part of the 1992 General Design Memorandum (GDM). At that time, the recreation benefits of the project were estimated to be $831,000 (Oct 1990 price level). Using updated unit day values (per EGM 16-03), the recreation benefits of the project are estimated to be $1,089,000 in FY 2016 dollars (Oct 2015 price level). The recreation benefits have been updated to Oct 2015 price level in order to be consistent with the primary flood risk management benefits of the project.

5.3.5 TOTAL INVESTMENT COST AND INTEREST DURING CONSTRUCTION

Just as the project generates benefits during construction, the interest during construction (IDC) is quite significant. This is due to the large overall cost and extremely long duration of construction. Based on the most recent cost estimate, the average annual interest during construction was estimated to be $796,950 M, including $344.95 M in sunk IDC. This a very large IDC figure compared to most other projects; it has such a large magnitude because RPN is a multi-billion dollar project spread out over several decades (1995 to 2032). In order to accurately calculate a BCR, the total average annual investment cost must include the IDC. However, USACE CECW-P memorandum dated March 8, 2012, subject: Methodology for Updating Benefit-to-Cost Ratios (BCR) for Budget Development, Attachment, Item 3 states, "Interest during construction will only be calculated based on remaining construction costs and a schedule to complete that assumes adequate funding." Therefore, in this document IDC has only been computed for remaining construction activities, rather than all construction activities since 1995. In accordance with the memorandum, sunk IDC is not included in the updated BCR.

5.3.6 UPDATED BCR AND NET BENEFITS

Though the costs are reported in current (FY19) dollars, in order to compute a BCR they must be deflated to the price level of the benefits (FY16) and annualized. The below reflects the costs, benefits, BCR, and net benefits all calculated at October 2015 price levels, after the costs have

been deflated to the price level of the benefits. . The table indicates that the project continues to be economically justified.

Table 10 – Updated Benefit to Cost Ratio of the Authorized Project

Remaining Project Cost **(Oct2018 price level)**	**$1,864,858,000**
Sunk Cost	$419,725,000
Total Project First Cost	$2,284,583,000
Remaining IDC	$451,998,000
NED Economic Cost (Oct2018 price level)	$2,736,581,000
NED Economic Cost (deflated to Oct2015 price level)	$2,640,996,000
AAEQ NED Economic Cost (deflated to Oct2015 price level)	$105,048,000
Annual OMRR&R cost (Oct2015 price level)	**$6,460,000**
Grand total AAEQ NED Economic Cost (Oct2015 price level)	**$111,508,000**
AAEQ FRM Benefits	$124,153,000
AAEQ Recreation Benefits	$1,089,000
AAEQ Total Benefits (Oct2015 price level)	$125,242,000
Net Benefits: Total Project	**$13,734,481**
BCR: Total Project	**1.12**

Notes:

1. RPN Costs reflect estimate dated 10/29/18 (FY19 Price Level)
2. Benefits reflect 2016 LRR
3. Costs and benefits have been amortized at the FY19 discount rate: 2.875%
4. Per CECW-P memorandum dated March 8, 2012, interest during construction will only be calculated based on remaining construction costs.
5. OMRR&R costs taken from 2016 LRR

Table 11 – Updated Remaining Benefit Remaining Cost Ratio (RBRBCR) of the Authorized Project

Remaining Project Cost (Oct2018 price level)	**$1,864,858,000**
Sunk Cost	$0
Total Remaining Project First Cost	$1,864,858,000
Remaining IDC	$451,998,000
NED Remaining Economic Cost (Oct2018 price level)	$2,316,856,000
NED Remaining Economic Cost (deflated to Oct2015 price level)	$2,235,932,000
AAEQ NED Remaining Economic Cost (deflated to Oct2015 price level)	$87,920,000
Annual Remaining OMRR&R cost (Oct2015 price level)	$4,600,000
Grand total remaining AAEQ NED Economic Cost (Oct2015 price level)	**$92,520,000**
AAEQ Remaining FRM Benefits	$112,077,000
AAEQ Remaining Recreation Benefits	$1,089,000
AAEQ Total Benefits (Oct2015 price level)	**$113,166,000**
	$0
Remaining Net Benefits: Total Project	**$20,646,000**
RBRCR: Total Project	**1.22**

Notes:

1. RPN Costs reflect estimate dated 10/29/18 (FY19 Price Level)
2. Benefits reflect 2016 LRR
3. Costs and benefits have been amortized at the FY19 discount rate: 2.875%
4. Per CECW-P memorandum dated March 8, 2012, interest during construction will only be calculated based on remaining construction costs.
5. Remaining OMRR&R costs taken from 2016 LRR

6 RISK AND UNCERTAINTY

In accordance with the principles of risk informed planning and decision making, it is important to acknowledge all relevant sources of risk and uncertainty associated with the project. These sources are described in the following sections.

6.1 STUDY RISKS

This Validation Report is developed for internal purposes only. The project is authorized and construction is ongoing. The study is not analyzing different alternatives and no reformulation is being conducted. Therefore, there are no study risks associated with this effort.

6.2 UNCERTAINTIES IN THE ECONOMIC ANALYSIS

STRUCTURE VALUE UNCERTAINTY. The uncertainty surrounding the HAZUS general building stock exposure values for the structures and contents in each census block was estimated by comparing the HAZUS exposure values to values obtained using the Marshall and Swift Cost Estimator Program for residential and non-residential structures. The total HAZUS exposure value was divided by the total square footage of the three structure categories in the 24-basin study area to derive the HAZUS depreciated price per square foot for each of the structure categories. The depreciated cost per square foot using the Marshall and Swift program was calculated for a prototypical structure in each of the structure categories within a zip code located within the study area. The HAZUS depreciated price per square foot was then compared to the Marshall and Swift depreciated cost per square foot for each of the three categories. Based on this comparison, a mean value and a standard deviation were calculated for each structure category. The uncertainty surrounding the total structure value is represented by the standard deviation divided by the mean value for each of the categories. The structure value uncertainty was determined to be 12 percent for both single-family and multi-family residential structures, 12.6 percent for commercial structures, and 67 percent (due to much smaller sample size) for non-profit structures. These percentages were entered into the HEC-FDA model to represent the structure uncertainty for each of the structure categories.

GROUND AND FIRST FLOOR ELEVATION UNCERTAINTY. The error implicit in the LIDAR data used to estimate the ground elevation is normally distributed with a mean value of zero. It was estimated to be plus or minus 0.475 feet at the 90 percent level of confidence. Based on this error, the standard deviation was calculated to be 0.29 feet. The error surrounding the foundation heights is also normally distributed with a mean value of zero. It is estimated to be plus or minus 1.0 feet at the 90 percent level of confidence. Based on this error, the standard

deviation was calculated to be 0.61 feet. The squares of the two standard deviations were added together, and the square root of this sum was used to derive the uncertainty surrounding the first floor elevation. A value of 0.67 feet was entered into the HEC-FDA model to represent the uncertainty surrounding the first floor elevation for all structures in the study area. A value of 0.29 feet was entered into the HEC-FDA model to represent the uncertainty surrounding the ground elevation for all vehicles in the study area.

As noted above, a normal distribution (rather than a triangular distribution) was used to represent the uncertainty surrounding first floor elevations. This is appropriate because it more realistically represents the continuous variability in ground elevation (including fill material). With regard to foundation heights, a normal distribution was also deemed the most appropriate. And any potential distortion that might be created by using a normal distribution should be minor, because the ground elevation was incorporated with the foundation height in the analysis.

CONTENT-TO-STRUCTURE VALUE RATIO UNCERTAINTY. Based on EGM, 01-03, dated 4 December 2000, no uncertainty was assigned to the content-to-structure value ratios (CSVRs) for residential structures. The uncertainty surrounding the non-residential and non-profit CSVRs was determined by comparing the CSVRs based on HAZUS data for the two structure categories to the CSVRs based on surveys conducted in coastal Louisiana by New Orleans District for similar structure categories (commercial retail buildings and public buildings). A mean CSVR and a standard deviation were calculated for each structure category. The uncertainty surrounding the CSVRs is represented by the standard deviation divided by the mean value for each of the two categories. The CSVR uncertainty was determined to be 19.6 percent for commercial structures and 46.0 percent for non-profit structures. These percentages were entered into the HEC-FDA model to represent the CSVR.

STRUCTURE AND VEHICLE DEPTH-DAMAGE RELATIONSHIP UNCERTAINTY. The uncertainty surrounding the generic residential depth-damage relationships was taken from EGM, 01-03. The uncertainty is represented by a normal distribution with a mean damage percentage and a standard deviation for each one-foot increment of flooding. The uncertainty surrounding the non-residential and non-profit structure category is based on the depth-damage relationships used for other Puerto Rico projects. The uncertainty surrounding the damage percentages associated with various depths of flooding for non-residential and non-profit structures was represented by a triangular probability distribution. For each depth of flooding, the damage percentage associated with the previous, or lower, increment of flooding was used as the minimum value, and the damage percentage associated with the next, or higher, depth of

flooding was used as the maximum value. The uncertainty surrounding the vehicle depth-damage function was represented by a normal distribution with a mean damage percentage and standard deviation for each increment of flooding given by the EGM, 09-04.

6.3 IMPLEMENTATION RISKS

6.3.1 UNCERTAINTIES IN THE ENGINEERING ANALYSIS

The uncertainties in the Engineering Analysis are proportional to the total construction time and include:

- Retrofitting existing bridges to meet current seismic design criteria and other requirements from the Puerto Rico Highway and Transit Authority (PRHTA) and design codes
- Insufficient information on the Cultural Resources located within APE. Cultural resources surveys will be completed to determine measures required to avoid, minimize, or mitigate impacts to historic properties.
- Cost of avoiding/minimize potential damage to existing or newer structures during construction.
- Larger lead times due to limited transportation to the island and timely supply of construction materials.
- Changes in updated hydraulic and structural design criteria may result in design and construction cost increases (USACE regulations and policies, as well as changes in site conditions over time).
- Deterioration of new and existing structures.
- Limited construction space, including for bypass storm flows and maintenance of traffic.
- As-built plan and specs of the existing structures might require modifications to fit current conditions.
- Un-accounted for HTRW that may be found within project with more detail investigations.
- Risk due to climate change including sea level rise, and extreme wet and dry precipitation conditions, including floods and droughts. It would be beneficial for the project to account for risk due to climate change by developing a strategy for adaptive management of the project. Adaptive management could be used as a

means of ensuring that the project is resilient to the impact of climate change for the duration of the project life cycle.

The above identified risks are low and will be addressed in the PED phases with expected minor impacts to cost and schedule.

6.3.2 ADDITIONAL SOURCES OF UNCERTAINTY

UNCERTAINTIES IN THE ECONOMIC ANALYSIS

Because a significant period of time has passed since the last full economic analysis, there is some uncertainty about the estimated project benefits. A Level 1 Economic Update was completed in 2011, which documented some changes to the property subject to flooding, as of that time. As described in Section 5.3, the 2016 LRR included a detailed benefit update and concluded that the project was still economically justified. According to CWPM 12-001 and EC 11-2-200, economic evaluations are valid for up to five years on continuing construction projects. Therefore, the 2016 benefits are still considered valid. The various uncertainties in the 2016 Economic Analysis are described in Section 6.2. Risks associated with these uncertainties are considered low, and consist of study risks rather than project implementation risks (i.e., risk that the benefits of the project could be overstated or understated).

REAL ESTATE RISKS

Per the Implementation Guidance signed by the ASA (CW) dated Aug 9, 2018, the provision of lands, easements, rights-of-way, relocations and disposal areas (LERRDs) are the responsibility of the non-Federal sponsors (NFS). However, the NFS may elect to request real estate acquisition assistance through the USACE. Any such request is subject to approval by HQ USACE.

Risks associated with acquisition of LER by the NFS for this project include:

- The NFS is currently in bankruptcy with limited funding available for LERRDs acquisitions, which is comprised of a revolving account of $15M for all projects under BBA-2018. With this lack of funding, the likelihood that the NFS requests USACE acquisition assistance increases. To mitigate this risk, SAJ is providing clear reimbursement procedures to the NFS with the goal of providing a streamlined reimbursement to the NFS to replenish its revolving account. SAJ has had a Real Estate Workshop with the NFS to go over the reimbursement process in great detail to ensure they are familiar with their responsibilities to assist in timely reimbursements. As initial NFS reimbursement

packages are reviewed, additional coordination workshop meetings may be required to adjust or improve the heretofore unprecedented streamlined process.

- There are approximately 520 impacted parcels, including approximately 305 residential and/or commercial property Uniform Act relocations. This is a high number of acquisitions/relocations requiring specialized experience. The NFS plans to contract the land acquisitions/relocations to a professional firm with appropriate resources to manage the extensive acquisition program. Additionally, SAJ Real Estate (SAJ-RE) would work continuously, through Mobile District Real Estate (SAM-RE), with the NFS throughout the process to provide review and approval of specific tasks to ensure compliance with Federal laws and Army regulations.
- The 2014 Gross Appraisal estimate for Lands, Easements and Rights of Way (LER) current estimated value of is in excess of $229M for this project under PL 115-123 funding. As stated above, the NFS has limited funding to acquire properties. Being that Federal funds cannot be advanced to the NFS, it is paramount that USACE and the NFS adhere to reimbursement procedures in order for timely reimbursements to occur and keep the NFS in the lead position for land acquisitions/relocations.

Risks associated with acquisition of LERRDs by USACE include:

- Current staffing shortfalls to support timely acquisition of LERRDs. In order to support the Supplemental program, SAJ-RE plans to hire up to additional temp/term positions if USACE is to acquire and somewhat less temp/term positions if the NFS is to acquire. Current labor market conditions for realty specialists with Federal ROW acquisitions experience are extremely tight. Federal employee PCS relocation benefits recently became taxable, diminishing ability to recruit from the current Federal workforce.
- Lack of familiarity with real estate market in Puerto Rico. This fact will be mitigated by contracting with local firms for allowable services, such as boundary surveys, title evidence, appraisals and closing services.
- Potential schedule delays due to lengthy condemnation procedures. USACE should work with the Department of Justice to discuss concerns related to potential condemnation actions for the Project.

Additional risks applicable to either the NFS or USACE acquiring LERRDs include:

- Concurrent real estate acquisition schedules for Río Puerto Nuevo, Río Grande de Arecibo and Río de la Plata. SAJ-RE plans to increase staff accordingly to properly support its

requested and approved level of acquisition assistance. SAJ would also contract for those services discussed above to help streamline the acquisition process. If the NFS is to acquire, they will rely on contracted professional land acquisition firms with resources available to work projects concurrently.

- Locating displaced owners who have left the islands since Hurricanes Irma and Maria, potentially requiring numerous condemnation actions. USACE and the NFS will work this issue together, leveraging available public information along with making contact with friends, family and/or neighbors of impacted owners.
- Extensive number of residential/commercial relocations. Again, whether USACE or the NFS take lead on the land acquisition processes, each entity is planning to staff accordingly to execute the workload.
- Real estate title records in Puerto Rico are not centrally controlled. Local survey contractors have not succeeded in providing sufficient title evidence in recent boundary survey work. Delays due to inefficient title evidence research and validation are expected.

OTHER POTENTIAL IMPLEMENTATION RISKS

Other potential implementation risks are thoroughly documented in the Cost Schedule Risk Assessment (CSRA), which describes known sources of risk that could affect the project cost or schedule. Some of the key implementation risks potentially affecting cost and schedule are:

- Weather**:** Unpredictable weather, because of the site's latitude where tropical storm events pass by between June and November can present challenges to project implementation.

- Underground Utilities**:** Incomplete surveys of underground utilities have been one of the reasons that project cost has increased so significantly since authorization. Potentially, this issue could arise again in future contracts however, the team will be coordinating with the appropriate entities during the PED and construction phases of the project.

- Sponsor cooperation: It is imperative that the Non-Federal Sponsor be available and willing to provide any and all information (i.e. utilities, Real Estate, etc.) that is required in order to keep the construction of the contracts moving forward.

- Contracting: One risk noted in the CSRA is limited availability of qualified contractors in the post-Maria environment. This may be significant if multiple projects in Puerto Rico are being constructed simultaneously due to Supplemental Bill funding and other governmental restorative programs.

- Cultural Resources: Construction of Supplemental Contract 8 as currently designed would have an adverse effect on the Antiguo Acueducto del Río Piedras, a historic property listed on the NRHP and designated a National Treasure. Impact to the historic property would cause major project delays, increased cost, and loss of public support. Cultural resource surveys and additional design work are needed for Supplemental Contract 8 to determine if avoidance is feasible or if additional mitigation will be required. This risk is only applicable if the entirety of Contract 8 is constructed, however; as if only the Contract 8 recreation features are recommended this risk is no longer applicable.

- Construction sequencing of the project:
  1. Construction sequence of the channel (Contracts 2D/E, Supplemental Contracts: 3, 4 5, and 6): The construction of the reinforced concrete channel (excavation, material disposal, U-frames, drilled shafts, sheet piles with concrete facing, or others) should start from downstream (Confluence wall of Margarita Channel) to upstream (Supplemental Contract 6), in order to improve the hydraulic capacity of the channel as the construction progress. Otherwise, there is an increased probability of flood damages downstream as runoff is channeled faster than unimproved channels can convey it into the original Contract 1 completed channel reach. For example, channel work of contract 2D/E should be completed prior to rest of the Supplemental Contracts (3, 4, 5, etc.).

  2. Construction sequence- Retrofitting and replacement of the bridge relocations. Currently the plan includes the replacement of 15 bridges and the modification of the foundation/retrofitting of five bridges. No channel work can be done under bridges until these bridges are replaced or retrofitting is complete. The retrofitting of the bridges is complex work: the bridge needs to be upgraded for new seismic loads, new codes and standards. The foundation work and bridge retrofitting, may require new foundation system (piles, drilled shafts, cap beams, etc.). The new foundation system or bridge retrofitting work should be completed keeping the superstructure of the bridges open to the traffic. As a result, the Contractor will be working under the bridge with limited room, and specialized equipment (low clearance), which may reduce the production and increase the risk to weather/overtopping delays (all the work will be in the existing channel and will be susceptible to flood overtopping during storm events). For the bridge relocations, there will be a need to construct temporary bridges to minimize the traffic impact in the area, though coordination with local agencies may reduce the need for an optimal solution. For instance, a bridge structure that includes 6-lanes on two independent structures may allow one bridge to be replaced at a time utilizing the other to maintain 2-way traffic flow or 1-way during commuting hours.

3. Real Estate- The channel and bridge works will be constructed in urbanized areas, adjacent to existing structures, commercial and residential buildings, close to gas stations, Police Headquarter-Building, local government's lands, historic aqueduct and private university lands. The relocation and the impact to those lands needs to be coordinated with the owner and local agencies prior to the award of each construction contract.

4. Utilities relocations and demolition of existing structures- Río Puerto Nuevo requires demolition of existing structures and extensive utilities relocations, among them: poles, power lines, water/sewer pipe lines, siphons, culverts, cable, telecommunications, gas, etc. For a few contracts, temporary and permanent relocations will be needed. All the utilities relocations will require relocation agreements, coordination and approval of the utility/facility owners or any other approval authorities. Coordination has been initiated in order to mitigate the risk to the schedule.

5. Resources (Materials and Local contractors) - Puerto Rico is an island. There likely will be an on-hand limitation of construction materials (cement, sand, steel, sheet piles, etc.) as well as a limitation on the number of contractors and skilled work crews. These factors may affect the construction schedule.

6. Past contractor's performance- Typical construction period of past construction contracts (Portugues Dam, Río Puerto Nuevo -Becharra, Río Puerto Nuevo- Contract 2AR, San Geronimo, Río Puerto Nuevo- Margarita Channel-2C1-current construction contract, RPN-2D Walls-current construction contract) took between three to five years/per contract due to past contractor performance taking longer than the anticipated construction schedule, weather delays and complicated project features.

6.4 OUTCOME RISKS

Generally, Flood Risk Management (FRM) projects have at least two broad outcome risks: increased flood hazards associated with bridge or bulkhead failures and increased development in the floodplain. The team is not aware of any other outcome risks specific to this project.

Increased Flood Hazard: If, at some point after construction, higher water velocities undermine a bridge or retaining wall foundation leading structural failure and channel obstruction during an extreme rainfall event, the subsequent flooding would be sudden and worse than it would have been in the without project condition. Though this outcome is highly unlikely (very low probability), the consequences of this outcome could be large and adverse. Therefore, it is a risk that should be acknowledged.

Increased Development in the Floodplain: According to Executive Order 11988, the Federal government should not take any action that induces economic development in a floodplain. While this is certainly not the intent of the Río Puerto Nuevo Flood Control Project, it is always a risk of any FRM project. It is not really possible for the project to induce development, because there are no large benefitting areas that are not already developed. The only possible exception is the low lying area near the mouth of the channel. But, these lands are public lands with no plans for future development. Also, the project would significantly reduce the consequences associated with the flooding (and therefore the risk of flooding) because it reduces the stages at nearly every ACE event. Therefore, the channelization will fundamentally change the nature of flood risk in this area.

6.5 RESIDUAL RISK OF THE AUTHORIZED PROJECT

The complete "with-project" condition reduces approximately 99% of without project damages. This includes flood protection up through the 100 year ACE and damage reduction in less frequent events as well (due to improved conveyance throughout the floodplain). Without the construction of the features in Supplemental Contracts 2, 3, 4, 5, 6, and 7 (as described in the recommended strategy 3 below) this project will likely only prevent about 11% of the damages and approximately $112.5 million dollars in expected annual damages will remain. Additionally, the total population at risk in the without project condition is about 70,000 people. Completed as authorized, the vast majority of these people will no longer be at risk from flood events as infrequent as the 0.004 exceedance (250 year) event.

7 IMPLEMENTATION STRATEGIES

The BBA of 2018 (P.L. 115-123) provides an opportunity to continue/complete construction of the remaining features of the Río Puerto Nuevo Flood Control Project, Puerto Rico (authorized in 1991). The USACE Jacksonville District (SAJ), has prepared this Validation Report for the Río Puerto Nuevo Flood Control Project, to verify that the remaining features of the authorized project are environmentally acceptable, economically justified, and feasible from an engineering and design standpoint, and to recommend a strategy for implementation of the project. This Validation Report presents three possible strategies for moving forward with implementation of the Río Puerto Nuevo Project.

Strategy 1 evaluates construction of the entire authorized project "over 10+ years" using the optimal design, engineering, construction and real estate strategy. Under Strategy 1 the project would be deemed complete and it is economically justified, technically feasible and environmentally acceptable. The fully funded cost for Strategy 1 is approximately $2.217B (without sunk cost) with a construction completion date of 2031. Strategy 1 is economically justified with a BCR of 1.12. The average annual NED cost (October 2015 price level) is $105M and the total average annual benefits at October 2015 price levels are $125M.

Strategy 2 evaluates expedited construction of the entire authorized project with a completion date "within four years". This strategy would require the setup of Civil Works Construction Camps on site in order to execute and complete the project. Civil Works Construction Camps are dedicated areas that are usually located outside of the populated area specifically for construction contractors and their crews to live and work in the most expedited manner for the four year construction period. These are used due to the lack of construction workforce in the project area. This strategy would realize all intended project benefits. However, there are several implementation risks with attempting to complete the project within a four year timeframe; these are due to: a) the construction sequence of the channel with little to no additional area for diversion of bypass flows, b) the bridge relocations (replacement or retrofitting) with construction of concrete-lined channels, c) utilities relocation within a densely populated urban area d) real estate acquisition e) limited resources (material and contractors) and f) past contractor's performance. All of these risks should be identified and managed prior to the award of any construction contract. This strategy is also not economically justified, as it would significantly increase the total cost of the project by an order of magnitude while generating the same benefits as the authorized project.

Strategy 3 was developed due to significant cost increases in project construction, changed conditions since project authorization, and since the BBA funds received for the Río Puerto Nuevo flood control project are less than the amount to complete the project as authorized., A review of the benefits and costs in Supplemental Contract 8 reveal that only 3% of the overall annual project benefits would be achieved in implementing measures within this reach. The cost for those features were estimated to be over $636M. Therefore, Strategy 3 resulted in a re-scoping of the project in accordance with Engineering Regulation (ER) 1105-2-100, Appendix G and the Memorandum for Commander, Subject: Re-scoping of Supplemental Projects dated 20 June 2019. This strategy recommends only constructing the remaining features of Supplemental Contracts 1-7 and the recreation features from Supplemental Contract 8. This strategy maximizes the economic efficiency of the project and would allow the project to realize the majority of damage reduction benefits (approximately 97%) at a significantly reduced cost. All of the features (listed below) are necessary to achieve those benefits and can be implemented independently from Supplemental Contract 8. Flood risk management features related to Supplemental Contract 8 would not be constructed and therefore will avoid impacts to the historic Antiguo Acueducto del Río Piedras as well.

- Contracts 2C2 & 2C3 – sewer line relocation and remaining upper margarita channel
- Contract 2B – Bridge Replacement – Roosevelt Bridge
- Contracts 2D & 2E – Channel Walls and Main Channel Bottom
- Contract 4A – Bridge modifications of 4 Major Existing Bridges
    - 4A1 – Las Americas Expressway Bridge
    - 4A2 – Piñera Avenue Bridge East
    - 4A3 – NE Access Ramp Bridge
    - 4A4 – SE Access Ramp Bridge
- Contract 4B – Bridge Replacement – Notre Dame Street Bridge
- Contract 3AA – Bridge Replacement – Piñero Avenue West
- Contracts 4C – Middle Main Channel
- Contract 4D-1 – Buena Vista Bridges – 2 new bridge replacements
- Contract 4D-2 – Buena Vista Diversion Channel
- Contract 5B-1 – Middle Puerto Nuevo Channel
- Contract 3A – Bridge replacement of 10 Bridges
- Contract 3B-1 – Q. Doña Ana Channel & Stilling Basins
- Contract 3B-2 – Q. Josefina Channel and Stilling Basins

The total fully funded cost of Strategy 3, including $420M in sunk costs, is $1.999B, and without sunk cost is approximately $1.579B. This strategy obligates these supplemental funds by year 2025 with construction completion of Supplemental Contracts 1-7 and the recreation features from Supplemental Contract 8. This strategy has obligation of the allocated BBA funds by year 2025 with construction completion by 2032 and is economically justified, retains the majority of the project benefits, is environmentally compliant and feasible from an engineering standpoint.

The breakdown of benefits described above is based on the hydraulic and economic analyses developed for the 2016 LRR. Based on the spatial distribution of damages and benefits, the 2016 analysis indicates that the vast majority of benefits can be achieved through Supplemental Contracts 1-7. Figure 5 below shows a side-by-side comparison of the hydraulic sub-basins (previously described in Figure 4) and map of authorized contracts (previously described in Figure 2). Table 11 describes the breakdown of benefits by sub-basin. It should be noted that Supplemental Contracts 1-7 will not affect the area of Supplemental Contract 8. The design for Supplemental Contract 6 now includes the debris basin which was originally intended to be a feature of Supplemental Contract 8. This is an important component from Supplemental Contract 8 that is maintained within the currently designed project. The NFS has recommended not to construct the channel improvements in Supplemental Contract 8, due to concerns of impacting a Cultural Resource, the Antiguo Acueducto del Río Piedras as the channel would change from a meandering river around the Antiguo Acueducto del Río Piedras to a linear river to successfully transport flow at the intended hydraulic design.

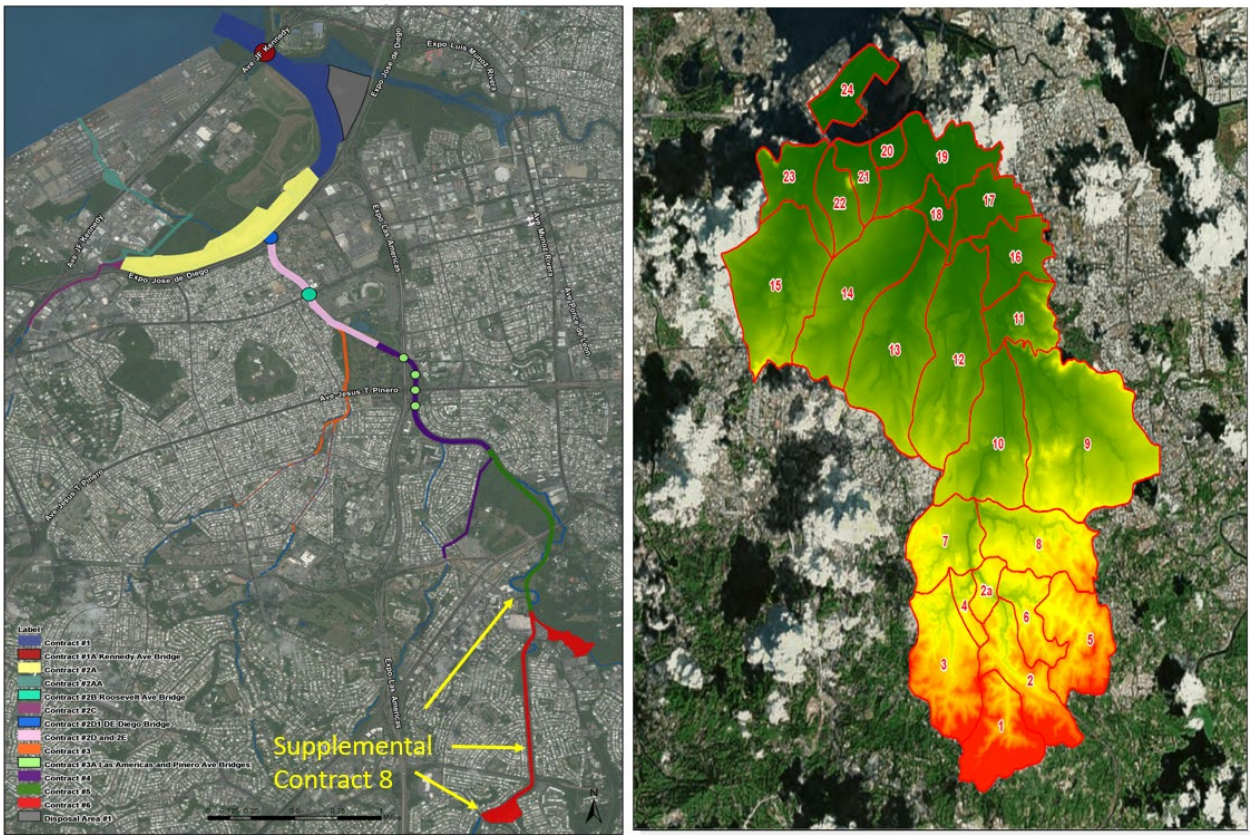

Figure 5 –Comparison of RPN Hydrologic Sub-Basins and Authorized Contract Map

Table 12 – Damages and benefits by Sub-Basin ($1,000)

Basin Number	Without Project Damages	With Project Damages	Benefits	% Benefits
Basin 9	0	0	0	0.00%
Basin 10	944	0	944	1.12%
Basin 11	140	0	140	0.17%
Basin 12	8870	26	8844	10.45%
Basin 13	9017	115	8901	10.52%
Basin 14	4626	94	4531	5.36%
Basin 15	0	0	0	0.00%
Basin 16	1911	0	1911	2.26%
Basin 17	3806	14	3792	4.48%
Basin 18	10025	18	10007	11.83%
Basin 19	27259	44	27216	32.17%
Basin 20	5857	0	5857	6.92%
Basin 21	2788	36	2752	3.25%

Basin 22	192	0	192	0.23%
Basin 23	140	0	140	0.17%
Basin 24	9377	0	9377	11.08%
Total	**84,951**	**347**	**84,604**	**100.00%**

As seen in Figure 4 and Table 12, the only benefits that would be lost by forgoing Supplemental Contract 8 are associated with sub-basins 9, 10, 11, and 16. These benefits represent approximately 3% of the total annual authorized project benefits. The potentially benefitting properties in those basins are primarily residential in nature, though there of a number of commercial and public properties in Basins 11 and 16 that could benefit. Existing condition damages in those basins (10, 11, and 16) are associated with relatively small magnitudes of flooding (< 3 feet above the first floor elevations) in very large, infrequent rainfall events (1/50 year ACE and less frequent events). This is due to the topography and spatial distribution of structures in those basins. In general, the vast majority of RPN project benefits are in low lying areas closer to the San Juan Harbor which will benefit from Supplemental Contracts 1-7. It should be noted that the 2016 modeling indicated no without-project damages (or benefits) in the far upstream portions of the original RPN study area (sub-basins 1-8) due to significantly higher topography in the developed portions of those areas.

Under Strategy 3, the re-scoped project would be deemed complete as the functional elements identified for construction are economically justified, technically feasible and environmentally acceptable. Sufficient analysis has been performed to support a determination that the re-scoped Río Puerto Nuevo project can be completed with the BBA funds, meets the authorized intent from Congress and still provides approximately 97% percent of the authorized project benefits. A summary of the BCR and Remaining Benefit Remaining Cost Ratio (RBRCR) of Strategy 3 is provided in tables 13 and 14 below. It should be noted that Strategy 3 does not include the Contract 2C1 and 2D Walls modifications, as described in the TPCS (approximately $5.7M) this work is not funded through the BBA but rather is utilizing regular appropriations to complete construction. But it does include the authorized recreation features (approximately $4.4M – fully funded) from Supplemental Contract 8.

Table 13. Río Puerto Nuevo: Total Project BCR Summary Table for Supplemental Contracts

Remaining Project Cost (Oct2018 price level)	**$1,377,016,000**
Sunk Cost	$419,725,000
Total Project First Cost	$1,796,741,000
Remaining IDC	$151,579,000
NED Economic Cost (Oct2018 price level)	$1,948,320,000
NED Economic Cost (deflated to Oct2015 price level)	$1,880,268,000
AAEQ NED Economic Cost (deflated to Oct2015 price level)	$74,068,000
Annual OMRR&R cost (Oct2015 price level)	$5,080,000
Grand total AAEQ NED Economic Cost (Oct2015 price level)	$79,148,000
AAEQ FRM Benefits	$110,993,000
AAEQ Recreation Benefits	$1,089,000
AAEQ Total Benefits (Oct2015 price level)	$112,082,000
Net Benefits: Total Project	**$41,699,000**
BCR: Total Project	**1.53**

Notes:

1. RPN Costs reflect estimate dated 10/29/18 (FY19 Price Level)
2. Benefits reflect 2016 LRR
3. Costs and benefits have been amortized at the FY19 discount rate: 2.875%
4. Supplemental Construction Reflects Supplemental Contract 1-7 (does not include contract 8, other than the recreation features)

5. Per CECW-P memorandum dated March 8, 2012, interest during construction will only be calculated based on remaining construction costs.

6. OMRR&R costs taken from 2016 LRR

Table 14. Río Puerto Nuevo: RBRCR Summary Table for Supplemental Contracts

Remaining Project Cost (Oct2018 price level)	**$1,377,016,000**
Sunk Cost	$0
Total Remaining Project First Cost	$1,377,016,000
Remaining IDC	$151,579,000
NED Remaining Economic Cost (Oct2018 price level)	$1,528,595,000
NED Remaining Economic Cost (deflated to Oct2015 price level)	$1,475,204,000
AAEQ NED Remaining Economic Cost (deflated to Oct2015 price level)	$58,007,000
Annual Remaining OMRR&R cost (Oct2015 price level)	$3,618,000
Grand total remaining AAEQ NED Economic Cost (Oct2015 price level)	$61,625,000
AAEQ Remaining FRM Benefits	$110,993,000
AAEQ Remaining Recreation Benefits	$1,089,000
AAEQ Total Benefits (Oct2015 price level)	$112,082,000
Remaining Net Benefits: Total Project	**$50,457,000**
RBRCR: Total Project	**1.82**

Notes:

1. RPN Costs reflect estimate dated 10/29/18 (FY19 Price Level)
2. Benefits reflect 2016 LRR
3. Costs and benefits have been amortized at the FY19 discount rate: 2.875%
4. Supplemental Construction Reflects Supplemental Contract 1-7 (does not include contract 8, other than the recreation features)

5. Per CECW-P memorandum dated March 8, 2012, interest during construction will only be calculated based on remaining construction costs.
6. Remaining OMRR&R costs taken from 2016 LRR

7.1 RESIDUAL AND TRANSFERRED RISK OF IMPLEMENTATION OF THE RE-SCOPED PROJECT

It is important to note that implementation of the re-scoped project (Strategy 3) does have a slightly higher level of residual risk compared to Strategy 1. Though the vast majority of without-project condition damages would be reduced in all three implementation strategies, Strategy 3 does have fewer damage reduction benefits (~ $120 million vs. ~$124 million. or, about 3% of

total annual benefits). These potentially lost benefits are associated with hydrologic basins 9, 10, 11 and 16 (see **Figure 4**), which represent a small proportion of the benefits. No benefits were expected within basins 9 and 15, because the project is not expected to produce measurable stage reductions on those areas. Because the costs of those final contracts (beyond Supplemental Contract 7) are higher than their respective benefits, the BCR of Implementation Strategy 3 is higher than it is for the entire authorized project.

Because the project has been constructed downstream first (with contracts moving gradually upstream over time), there is no expectation of transferred risk during construction or after project completion. The sequence of construction was designed in part to avoid induced flooding or other adverse impacts. Also, this project primarily consists of channelization, rather than large scale levees. There is no chance or risk transfer associated with levee failure. Finally, the mouth of the channel (already constructed) flows directly into San Juan Harbor. No additional flow or velocities are being introduced into other riverine settings or populated areas.

7.2 ITEMS OF LOCAL COOPERATION AMENDMENT

The Items of Local Cooperation per the 1991 GDM were updated in the executed February 2019 Project Cooperation Agreement (PCA) Amendment due to the implementation of the BBA of 2018 (P.L. 115-123). The Rio Puerto Nuevo project is currently in the design phase for several of the Supplemental Contracts and upon approval of this validation report the project will begin construction of the Supplemental Contracts.

Per the February 20, 2019 Project Cooperation Agreement Amendment 1, the BBA of 2018 (P.L. 115-123) changed the local items of cooperation by adjusting the following:

(a) As of the effective date of Amendment Number 1 to this Agreement, the amount of available BBA 2018 funds is estimated at $1,552,453,000. Any costs funded with BBA 2018 funds shall not be included in the calculation of total project costs for cost-sharing purposes.
(b) The Local Sponsor remains responsible for providing the lands, easements, and rights-of-way, and performing all relocations, and making improvements to lands, easements, and rights-of-way to enable the disposal of dredged or excavated material required to complete construction of the Project.
    1. For lands, easements, and rights-of-way acquired from private owners after the effective date of Amendment Number 1 to this Agreement, the Government shall reimburse the Local Sponsor, subject to the availability of BBA 2018 funds, for costs it incurs in acquiring such lands, easements, and rights-of-way, except as provided in Article XXI.h. The crediting procedures in Article IV.a. will be used to determine the costs, documented to the satisfaction of the Government, that are eligible for

reimbursement. If requested by the Local Sponsor, the Government, in its sole discretion, may agree to acquire any lands, easements, or rights-of-way on the Local Sponsor's behalf, using BBA 2018 funds.

2. Any publicly owned lands, easements, and rights-of-way required for completing construction of the Project will be provided by the Local Sponsor at no cost to the Government and without credit or reimbursement, except as provided in Article XXI.h.
3. For relocations performed after the effective date of Amendment Number 1 to this Agreement, the Government shall reimburse the Local Sponsor, subject to the availability of BBA 2018 funds, for costs it incurs in performing such relocations, except as provided in Article XXI.h. The crediting procedures in Article IV.b. will be used to determine the costs, documented to the satisfaction of to the Government, that are eligible for reimbursement. If requested by the Local Sponsor, the Government, in its sole discretion, may agree to perform any relocations on the Local Sponsor's behalf, using BBA 2018 funds.
4. For improvements to lands, easements, and rights-of-way to enable the disposal of dredged or excavated material made after the effect date of Amendment Number 1 to this Agreement, the Government shall reimburse the Local Sponsor, subject to the availability of BBA 2018 funds, for costs it incurs in making such improvements, documented to the satisfaction of the Government, except as provided in Article XXI.h. If requested by the Local Sponsor, the Government, in its sole discretion, may agree to make any improvements on the Local Sponsor's behalf, using BBA 2018 funds.

(c) Subject to the availability of BBA 2018 funds, the Government shall reimburse the Local Sponsor for costs, documented to the satisfaction of the Government, that the Local Sponsor incurs, after the effective date of Amendment Number 1 to this Agreement, for investigations for hazardous substances conducted pursuant to Article XVII.a.

(d) The provisions of Article XX regarding the Section 902 project cost limits do not apply to the funds provided in BBA 2018 that are used for completing construction of the Project.

(e) In the event that there are insufficient BBA 2018 funds to complete construction of the Project, such completion shall be subject to cost-sharing as otherwise provided for in this Agreement.

(f) Nothing in this Article affects the responsibility of the Local Sponsor for operation, maintenance, repair, replacement, and rehabilitation of the Project as provided in Article VIII and for indemnification as provided in Article IX.

(g) Except as provided in Article XXI.c., nothing in this Article affects the responsibilities of the parties regarding hazardous substances as provided in Article XVII.

(h) As soon as practicable, the Government shall perform an interim accounting of work that has or will be completed with other than BBA 2018 funds on a cost-shared basis and furnish the Local Sponsor with the results of such interim accounting.

1. If the Government determines that the Local Sponsor has not met its minimum required cash contribution for the cost-shared work, the Local Sponsor shall provide funds in the amount necessary to meet the required minimum cash contribution.
2. If the Government determines that the Local Sponsor owes an additional amount to meet the required minimum non-Federal share of the cost-shared work, the amount owed by the Local Sponsor may be reduced by the estimated value of publicly owned lands, easements, and rights-of-way that the Local Sponsor must provide after the date of Amendment Number 1 to this Agreement.
3. If the Government determines the estimated value of publicly owned lands, easements, and rights-of-way that the Local Sponsor must provide after the date of Amendment Number 1 to this Agreement is less than the additional amount necessary to meet the required minimum non-Federal share of the cost-shared work, the Local Sponsor shall either provide the required amount in cash or elect to waive reimbursement of the required amount for privately owned lands, easements, and rights-of-way, relocations, and improvements to enable the disposal of dredged or excavated material to be acquired, provided, or made after the date of Amendment Number 1 to this Agreement.
4. The determinations made as a result of the interim accounting shall be verified during the final accounting. The crediting procedures in Article IV.a. shall be used to verify the value of any publicly owned lands, easements, and rights-of-way used to reduce the amount owed by the Local Sponsor for the cost-shared work."

3. All other terms and conditions of this Agreement remain unchanged.

8 RECOMMENDATION

This report validates that the authorized project remains justified. The project is economically justified, environmentally acceptable and continues to be feasible from an engineering standpoint. Hurricane Maria produced significant amounts of damage to the residential, commercial and public property in the Río Puerto Nuevo flood control area where construction has not been initiated while minimal damage was incurred in areas where construction has been completed. The best available information at this time suggest that the Río Puerto Nuevo flood control project, if completed, significantly reduces urban flood damages. This report confirms that the remaining features of the authorized project considered under Strategy 1 remain environmentally acceptable, economically justified, and feasible from an engineering and design standpoint.

In addition, this report presents a viable alternate implementation strategy and concludes that completion of the work activities identified in Strategy 3 (re-scoped project) provide a more cost effective plan that is also environmentally acceptable, economically justified and feasible project from an engineering and design standpoint. This strategy avoids impacting significant historic structures, which have been major concerns of the SHPO and other interested parties. Sufficient analyses have been performed to support a determination that the re-scoped Río Puerto Nuevo project maximizes the economic efficiency of the project and provides the majority of the benefits of the project authorized by Congress (approximately 97% of flood damage reduction benefits) at a substantial reduction in cost (approximately $636M). The proposed work under Strategy 3 includes construction of the Supplemental Contracts 1-7 and the recreation features from Supplemental Contract 8. Strategy 3 would result in constructing a complete functional project that is economically justified with a benefit to cost ratio of 1.53. The remaining construction contracts included in Strategy 3 have a fully funded cost estimate of $1,579,254,000 and a total fully funded cost of $1,999,019,000 (including $420M in sunk costs). The re-scoped project design and implementation are to be conducted at 100% federal expense per the BBA of 2018 (P.L. 115-123).

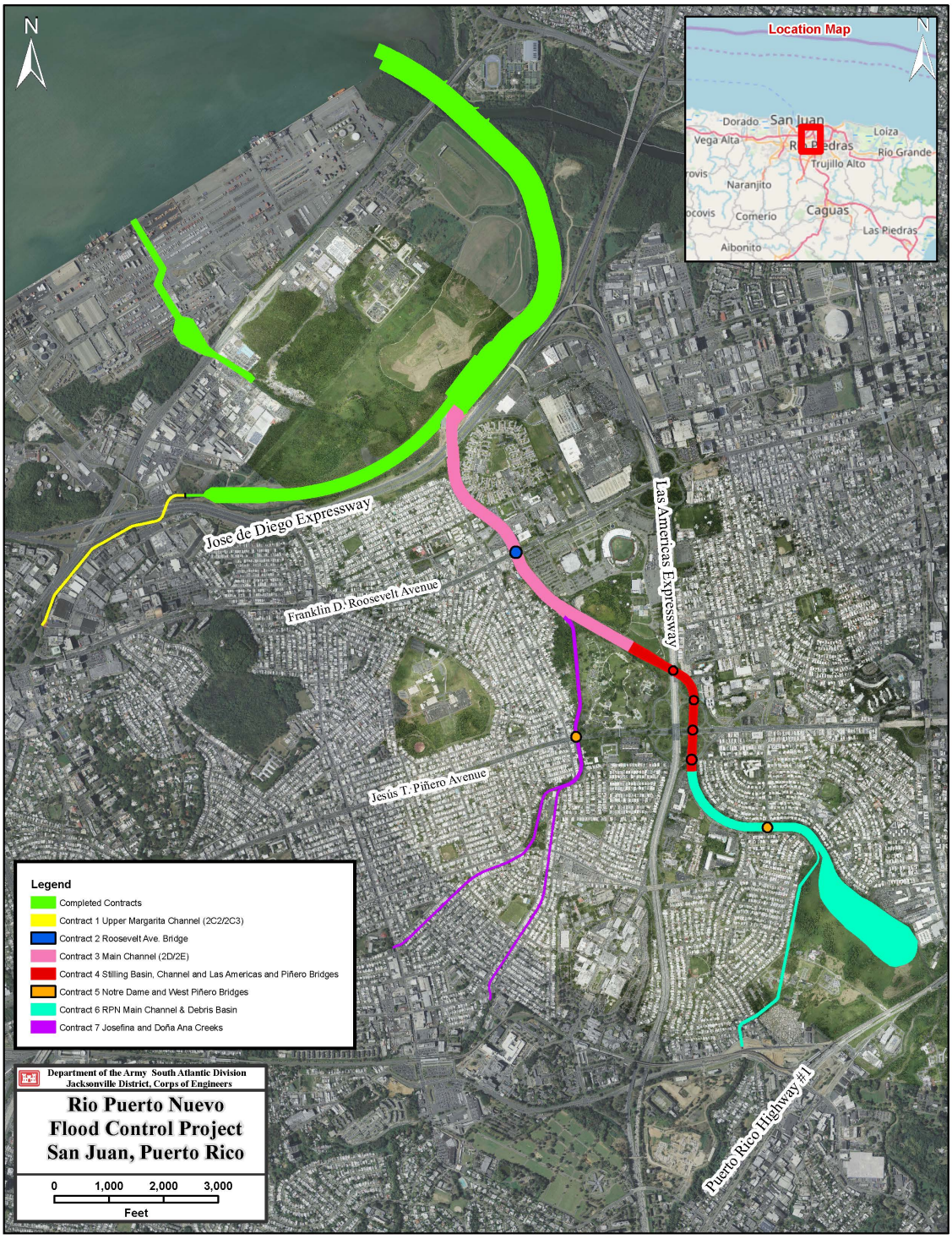

Figure 5 – Río Puerto Nuevo Recommended Strategy 3

The recommendation is for USACE to proceed with implementation of the Río Puerto Nuevo Flood Control Project under the provisions of the 2018 BBA in accordance with Strategy 3 (re-scoped project). Under Strategy 3 the re-scoped project would be deemed complete as the functional elements identified for construction are economically justified, technically feasible and environmentally acceptable and are within the discretion of the Chief's authority.

ANDREW D. KELLY JR.
Colonel, EN
Commanding