FINAL CONTINUING AUTHORITIES PROGRAM (CAP) CONVERSION FEASIBILITY REPORT FOR TURPENTINE RUN, ST. THOMAS, UNITED STATES VIRGIN ISLANDS

March 2020

U.S. Army Corps of Engineers
South Atlantic Division
Jacksonville District

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EXECUTIVE SUMMARY

Background: This report presents the findings of a study to reaffirm, for purposes of specific authorization, the economic justification, environmental acceptability, and engineering feasibility of the plan previously recommended in the Turpentine Run Detailed Project Report and Environmental Assessment prepared in 1990, amended in 1992 and approved in 1994. The recommended plan in the Detailed Project Report was developed to address flooding problems in the Turpentine Run/Nadir area. The plan was approved by U.S. Army Corps of Engineers Headquarters in 1994, however, the project was not constructed because contractor bids exceeded the awardable threshold. The non-Federal sponsor for this project is the Department of Public Works for the United States Virgin Islands (USVI).

Authorization: Turpentine Run was initially authorized under the Continuing Authorities Program (CAP), Section 205 of the Flood Control Act of 1948 (Public Law 80-858) as amended, 33 USC 701s.

The project is now being planned under the Authority of Section 209 of the Flood Control Act of 1966, Public Law 89-789, authorizing studies for flood control in the United States and its territories. Division B, Subdivision 1, Title IV of the Bipartisan Budget Act (BBA) of 2018 (Public Law 115-123), authorizes the Government to conduct the study at full federal expense to the extent that investigations appropriations provided under the BBA of 2018 are available and used for such purpose.

Project Area: The Turpentine Run/Nadir area is located on the southeastern end of the island of St. Thomas, U.S. Virgin Islands, about two miles southeast of the city of Charlotte Amalie. The project area begins at the north end of the Nadir development, with improvements planned for the channel as it flows past the Nadir residential area to Mangrove Lagoon. The capacity of the existing concrete channel is insufficient to carry flood flows thereby causing flooding in the development. In addition to monetary damage, the nature of the flooding creates a substantial and significant threat to the safety of area residents.

The Recommended Plan: As described in the 1994 Detailed Project Report (DPR), the recommended plan involves replacement of the existing concrete channel with a new channel having greater capacity. Improvements would begin at the north end of the Nadir development and include an area to be excavated to transition flow into the new channel. A small levee (260 feet in length) would be constructed along the northern edge of the development. A sheetpile wall (170 feet in length) would run along the development side of the channel and connect the levee to the drop structure, which would be located near the entrance to the existing concrete channel. The drop structure has an overall length of 60 feet.

From the drop structure, the proposed channel would be concrete and U-shaped for a distance of approximately 460 feet. It will then transition to a trapezoidal, earthen channel lined with rip

rap for a distance of 1,385 feet. Where possible, the existing concrete channel wall along the Nadir development will be left intact.

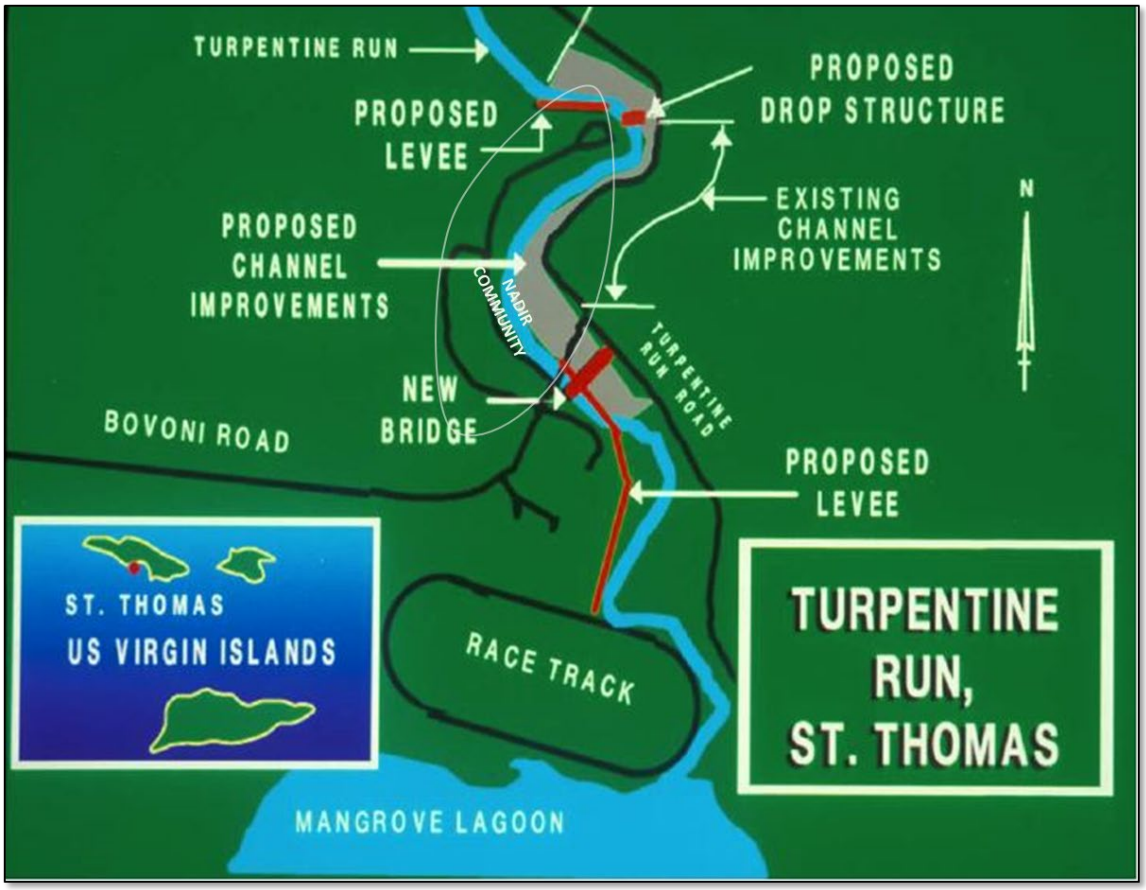

Figure 1: Turpentine Run Project Area

Just south of the new Bovoni Road Bridge, a levee is proposed for the west side of the channel. This levee runs for a distance of approximately 1,300 feet, ending at the Nadir racetrack at the south end of the channel. Rip rap will be placed on the left side of the existing channel as it flows around the corner of the racetrack.

Project Changes: Based on a site visit in November 2018 and September 2019, the conditions on the ground do not require any changes to the previously developed plan.

Project Costs and Benefits: The updated Certified Project First Cost for Turpentine Run is $43,662,000 in FY20 dollars, or $48,142,000 fully funded. Comparing these first costs adjusted to November 1990 (FY 91) price levels to the previously estimated benefits from the approved 1994 DPR, the updated BCR is 1.15, with approximately $114,000 in average annual net benefits. Thus, based on the best available information, the project appears to be remain economically justified.

Project Economics: A Level 1 Reaffirmation Report as defined by Director of Civil Works Policy Memorandum CWPM 12-001, also known as a Level 1 Economic Analysis, was conducted for this study. The objective of the Level 1 Economic Analysis is to confirm the continued existence of the structures that the Federal project was designed to protect, and to confirm that the assumptions made in the original study continue to be realistic. The project scope, area, and purpose remain the same as stated in the 1994 Detailed Project Report. The inventory of property has not changed significantly. Because no major changes have occurred in the study area, it is reasonable to assume that the inventory of property subject to flooding is comparable to the 1994 assessment.

The cost estimate presented in Table 1 represents the current cost to complete the project and presents total project cost, interest and amortization, operation maintenance and replacement cost, total annualized remaining costs, and annualized benefits from the 1994 approved report. Annual benefits and the benefit cost ratio are presented with and without recreation benefits due to issues with implementing the recreation plan (see Section 3.2.2).

Table 1: Economic Costs and Benefits of the Recommended Plan.

	Level 1 BCR Update with Recreation	Level 1 BCR Update Without Recreation
Project First Cost (FY 19 Price Levels)	$43,662,000	$43,237,000
IDC (FY 19 Price Levels)	$1, 630,000	$1,624,000
Total Economic Cost (FY 19 Price Levels)	$45,292,000	$44,860,000
Total Economic Cost (FY 91 Price Levels)[1]	$20,210,000	$20,020,000
Interest and Amortization	$750,000	$740,000
OMRR&R (FY 91 Price Level)	$15,000	$15,000
Average Annual Cost (FY 91 Price Levels)	$765,000	$755,000
Primary Benefits (damage reduction)	$710,660	$710,660
Incidental Recreation Benefits	$168,800	
Total Annual Benefits from 1994 Approved Report (FY 91 Price Levels)	$879,460	$710,660
Benefit to Cost Ratio	**1.15**	**0.94**
Net Benefits (FY 91 Price Levels)	$114,000	($44,340)

1 Costs were adjusted using EM 1110-2-1304, Civil Works Construction Cost Index System (CWCCIS), September 2019, Channels and Canals WBS

Environmental: Pursuant to the National Environmental Policy Act of 1969, as amended, the Corps assessed the effects of the proposed action in the Turpentine Run/Nadir Area, St. Thomas, U.S. Virgin Islands, Detailed Project Report and Environmental Assessment (EA), dated

November 1994. The Corps updated the 1994 EA analysis in the 2019 EA and adopts the 1994 EA, by reference, where the information is valid and applicable (See Attachment D).

Few changes in the environmental conditions of the project area have occurred. The freshwater swamp forest present during the 1994 investigations is no longer intact, possibly due to erosion, pollution, and/or the recently completed construction of the Bovoni Road Bridge by the Federal Highway Administration. Ongoing natural erosion and scouring of the gut bed and banks have continued to degrade the streambank wetlands. Levee construction, channelization, clearing, and grubbing activities would occur in portions of the project located outside of the existing concrete channel. While there appear to be degraded wetlands in the project's vicinity, the project design avoids and minimizes destruction, loss, and/or degradation of wetlands and preserves and enhances the natural and beneficial values of wetlands in adjacent lands. Design work during PED is expected to reduce further potential impacts to areas that might be jurisdictional wetlands, and the clearing and construction actions are not expected to reduce the value or function of the existing degraded wetlands. Upon project completion, impacted areas will be restored to the extent practicable. Within the project footprint, revegetation is expected to occur quickly. Further, best management practices during construction will be employed and the recommended plan will not have more than negligible impacts on ecological resources, including wetlands, and therefore, mitigation is not required as there will be no loss of wetland function. The identification of and impacts to jurisdictional wetlands will be readdressed during PED to ensure restoration is accomplished to the maximum extent practicable and reconfirm the conclusion that mitigation is not required.

Pursuant to the Endangered Species Act of 1983 (16 U.S.C. §1531 *et seq.*), coordination with National Marine Fisheries Service and U.S. Fish and Wildlife Service is complete. Construction activities may affect, but are not likely to adversely affect, the Virgin Island tree boa (*Epicrates monensis granti*). USFWS and USVI standard protection measures for the boa will be implemented to protect any boas that may be in the area.

Compliance with USACE Quality Control Standards: The Turpentine Run project is fully compliant with current USACE Quality Control Standards. This report is prepared in accordance with the Turpentine Run Project Management Plan and ER 1105-2-100, Planning Guidance Notebook, and has been reviewed in accordance with EC 1165-2-217, Review Policy for Civil Works. These reviews include District Quality Control, Agency Technical Review, and Mission Subordinate Command review of the project report and design. Since there are no proposed changes to the project design for this previously developed project, a request for exclusion from completing a Type I Independent External Peer Review was approved by South Atlantic Division (SAD) on March 5, 2019. The review plan can be found at https://usace.contentdm.oclc.org/utils/getfile/collection/p16021coll7/id/10267.

Recommendation: It is recommended that the project presented in the Turpentine Run, St. Thomas, U.S. Virgin Islands, Detailed Project Report and Environmental Assessment dated 22 November 1994, approved previously to be implemented under Section 205 of the 1948 Flood

Control Act, as modified in this Continuing Authorities Program Conversion Report, at an estimated first cost of $42,531,000, be authorized. The updated Conversion Report concludes that the project as previously planned and modified based on current conditions is economically justified, environmentally acceptable, and feasible from an engineering standpoint.

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to Congress as proposals for authorization and implementation funding. However, prior to transmittal to Congress, the sponsor, the States, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

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1 STUDY OVERVIEW

1.1 Introduction

This report presents the findings of a study to reaffirm the economic justification, environmental acceptability, and engineering feasibility of the plan previously recommended in the Turpentine Run Detailed Project Report and Environmental Assessment (DPR and EA) (Attachment A). In 1990, the Turpentine Run DPR and EA reported an estimated cost of $8.7 M to construct the project with a benefit cost ratio of 1.10. The DPR and EA was approved by HQUSACE in December 1994. Construction plans and specifications were also prepared and released for advertisement in 1994. However, bids came in over the awardable range and the project was never constructed. Due to the impact of Hurricanes Irma and Maria in 2017 and at the sponsor's request, the project was selected to receive investigations funding identified in the Bipartisan Budget Act of 2018, (Public Law 115-123), and to be converted to a specifically authorized project. The non-Federal sponsor for this project is the Department of Public Works for the United States Virgin Islands (USVI).

1.2 Authorization and Prior Reports

The Turpentine Run Section 205 Project was initially authorized under the Continuing Authorities Program (CAP), Section 205 of the Flood Control Act of 1948 (Public Law 80-858), as amended. The language in Section 205 reads as follows:

> The Secretary of the Army is authorized to allot from any appropriations heretofore or hereafter made for flood control, not to exceed $68,750,000 for any one fiscal year, for the implementation of small structural and nonstructural projects for flood control and related purposes not specifically authorized by Congress, which come within the provisions of section 701a of this title, when in the opinion of the Chief of Engineers such work is advisable. The amount allotted for a project shall be sufficient to complete Federal participation in the project. Not more than $10,000,000 shall be allotted under this section for a project at any single locality. The provisions of local cooperation specified in section 701c of this title shall apply. The work shall be complete in itself and not commit the United States to any additional improvement to insure its successful operation, except as may result from the normal procedure applying to projects authorized after submission of preliminary examination and survey reports.

The Bipartisan Budget Act (BBA) of 2018 (Public Law 115-123), Division B, Subdivision 1, Title IV; provided appropriations for the project to complete this study. The appropriations language from the BBA of 2018 reads as follows:

> For an additional amount for "investigations" for necessary expenses related to the completion, or initiation and completion, of flood and storm damage reduction, including shore protection, studies which are currently authorized or which are authorized after the date of enactment of this subdivision, to reduce risk from future floods and hurricanes, at full Federal expense, $135,000,000, to

> remain available until expended: *Provided*, That of such amount, not less than $75,000,000 is available for such studies in States and insular areas that were impacted by Hurricanes Harvey, Irma, and Maria: *Provided further*, That funds made available under this heading shall be for high-priority studies of projects in States and insular areas with more than one flood-related major disaster declared pursuant to the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5121 et seq.) in calendar years 2014, 2015, 2016, or 2017: *Provided further*, That such amount is designated by the Congress as being for an emergency requirement pursuant to section 251 (b)(2)(A)(i) of the Balanced Budget and Emergency Deficit Control Act of 1985: *Provided further*, That the Assistant Secretary of the Army for Civil Works shall provide a monthly report to the Committees on Appropriations of the House of Representatives and the Senate detailing the allocation and obligation of these funds, including new studies selected to be initiated using funds provided under this heading, beginning not later than 60 days after the enactment of this subdivision.

The project is now being planned under the authority of Section 209 of the Flood Control Act of 1966 (Public Law 89-789) authorizing studies for flood control in the United States and it territories. The authorizing language reads as follows:

> The Secretary of the Army is hereby authorized and directed to cause surveys for flood control and allied purposes, including channel and major drainage improvements, and floods aggravated by or due to wind or tidal effects, to be made under the direction of the Chief of Engineers, in drainage areas of the United States and its territorial possessions, which include the localities specifically named in this section. After the regular or formal reports made on any survey authorized by this section are submitted to Congress, no supplemental or additional report or estimate shall be made unless authorized by law except that the Secretary of the Army may cause a review of any examination or survey to be made and a report thereon submitted to Congress, if such review is required by the national defense or by changed physical or economic conditions.
>
> Watersheds and streams of Puerto Rico and the Virgin Islands, with respect to a framework plan for developing water resources of the region.

1.3 Planning Considerations of the 1994 Detailed Project Report

The primary purpose of the original study was to investigate flooding and related problems in the Turpentine Run/Nadir area, determine if feasible means for reducing these problems exist, and recommend the most appropriate course for action. The study area was the Nadir development along Turpentine Run, located on the southeastern end of the island of St. Thomas, U.S. Virgin Islands. Turpentine Run drains into Mangrove Lagoon and is the largest watershed on St. Thomas. Nadir is a completely developed urban, principally residential area. Turpentine Run in

Nadir is an existing concrete channel with insufficient capacity to contain flood flows resulting in regular flooding of the developed area. See Figure 2.

Figure 2: Turpentine Run Location

The Detailed Project Report (Attachment A) describes the identification and evaluation of alternative plans to reduce flood damages in the Turpentine Run/Nadir area. Plan 1 was identified as the National Economic Development plan and the plan recommended for implementation. The recommended plan is a twenty-five year flood protection plan involving the construction of a larger channel, incorporating a system of levees and interior drainage improvements. The plan included replacing and relocating the old Bovoni Road Bridge, which has since been completed by the Federal Highways Adminstration.

1.4 Project Design

The recommended plan as described in the 1994 DPR and EA would provide flood damage reduction benefits for a 25 year storm. Per updated guidance in Engineering Regulation 1105-2-101, the 25-year Level of Protection (LOP), which was used within the authorization language as a performance index, is now a legacy term. The term is no longer appropriate and project performance shall be described by Annual Chance Exceedance (ACE) Event. Therefore, the project performance is to protect against the 4% ACE Event. The plan involves replacement of the existing concrete channel with a new channel having greater capacity. Improvements would begin at the north end of the Nadir development where an area would be excavated to transition flow into the new channel. A small levee (260 feet in length) would be constructed along the northern edge of the development. A sheetpile wall (170 feet in length) would run along the development side of the channel between the levee and drop structure, which would be located near the entrance to the existing concrete channel. The drop structure has on overall length of 60 feet.

From the drop structure, the new concrete channel, with a "U" shape (approximately 460 feet in length) then transitions to a trapezoidal, earthen channel lined with rip rap (1,385 feet in length). Where possible, the existing concrete channel wall along the Nadir development will be left intact.

Just south of the new Bovoni Road Bridge, a levee is proposed for the west side of the channel. This levee runs for a distance of approximately 1,300 feet, ending at the Nadir racetrack at the south end of the channel. Rip rap will be placed on the left side of the existing channel as it flows around the corner of the racetrack.

In the 1994 DPR, interior drainage was designed to be conveyed from the small existing concrete channel by a 72-inch underground pipe which runs under the levee footprint. However, two 48-inch pipes were placed in the vicinity of the new Bovoni Bridge when it was constructed by the Federal Highway Administration. The design for the remaining pieces of the interior drainage system, which includes a 1,745 feet of pipe that discharges into Mangrove Lagoon, will be reevaluated during PED. Additionally, potential cost savings were discovered when evaluating potential changes to the interior drainage design during the 2007 Value Engineering study.

The recommended plan also included recreation components. As described in Appendix G of the 1994 Report, the proposed channel alignment would result in the loss of a Nadir neighborhood park located north of Bovoni Road and west of Highway 32. The proposed recreation features include passive recreation facilities such as a nature walk on top of the levee, picnic facilities and parking. These features would be constructed as a new recreational components to take advantage of project-related recreation opportunities.

1.5 Construction Status

The Federal Highway Administration replaced the Bovoni Road Bridge in 2004 and then constructed the bridge approachments in the 2017/2018 timeframe. The old Bovoni Road Bridge is no longer in service and has been removed.

Figure 3: Plans and specifications from the 1994 DPR and EA – Plate 1

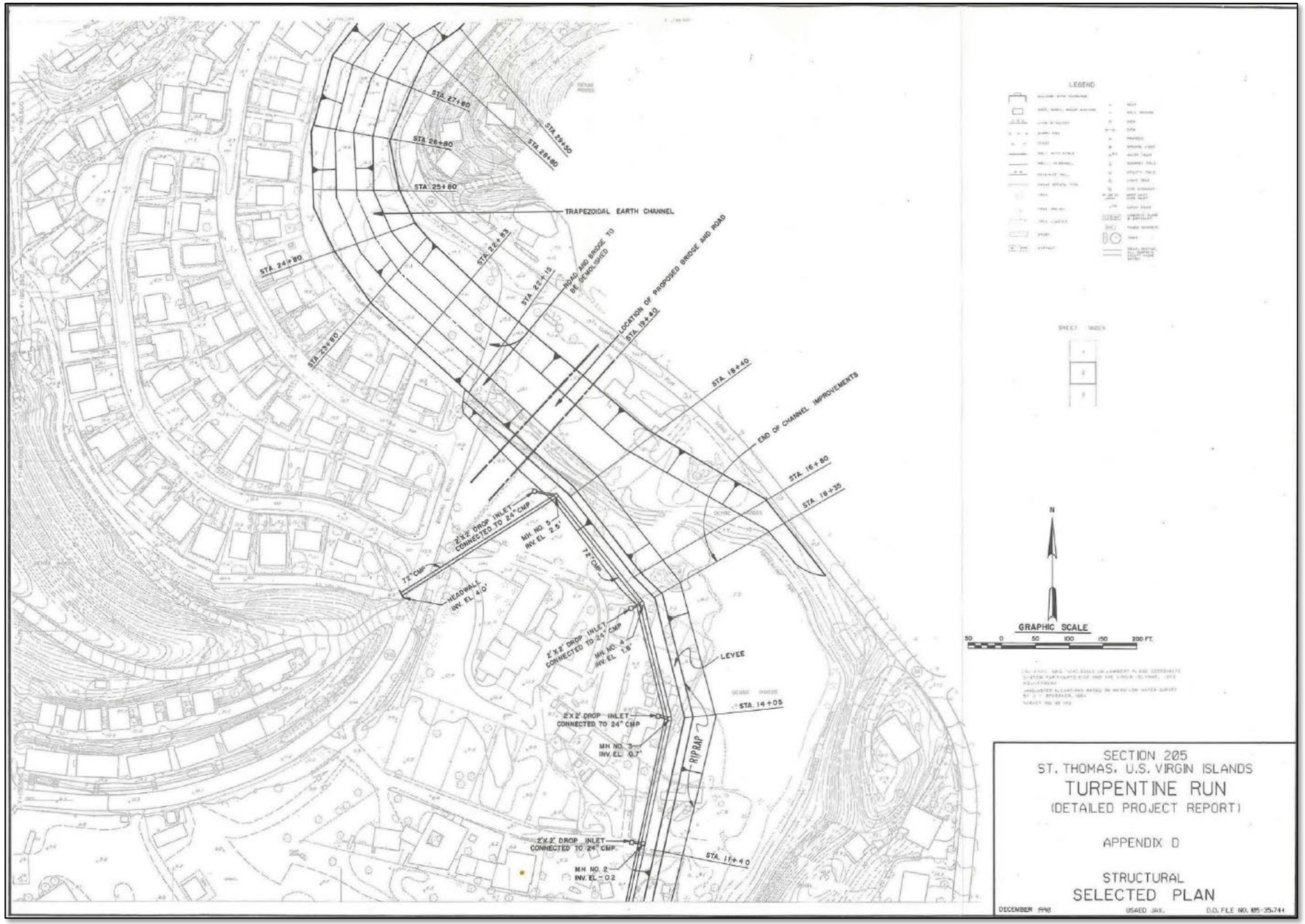

Figure 4: Plans and specifications from the 1994 DPR and EA – Plate 2

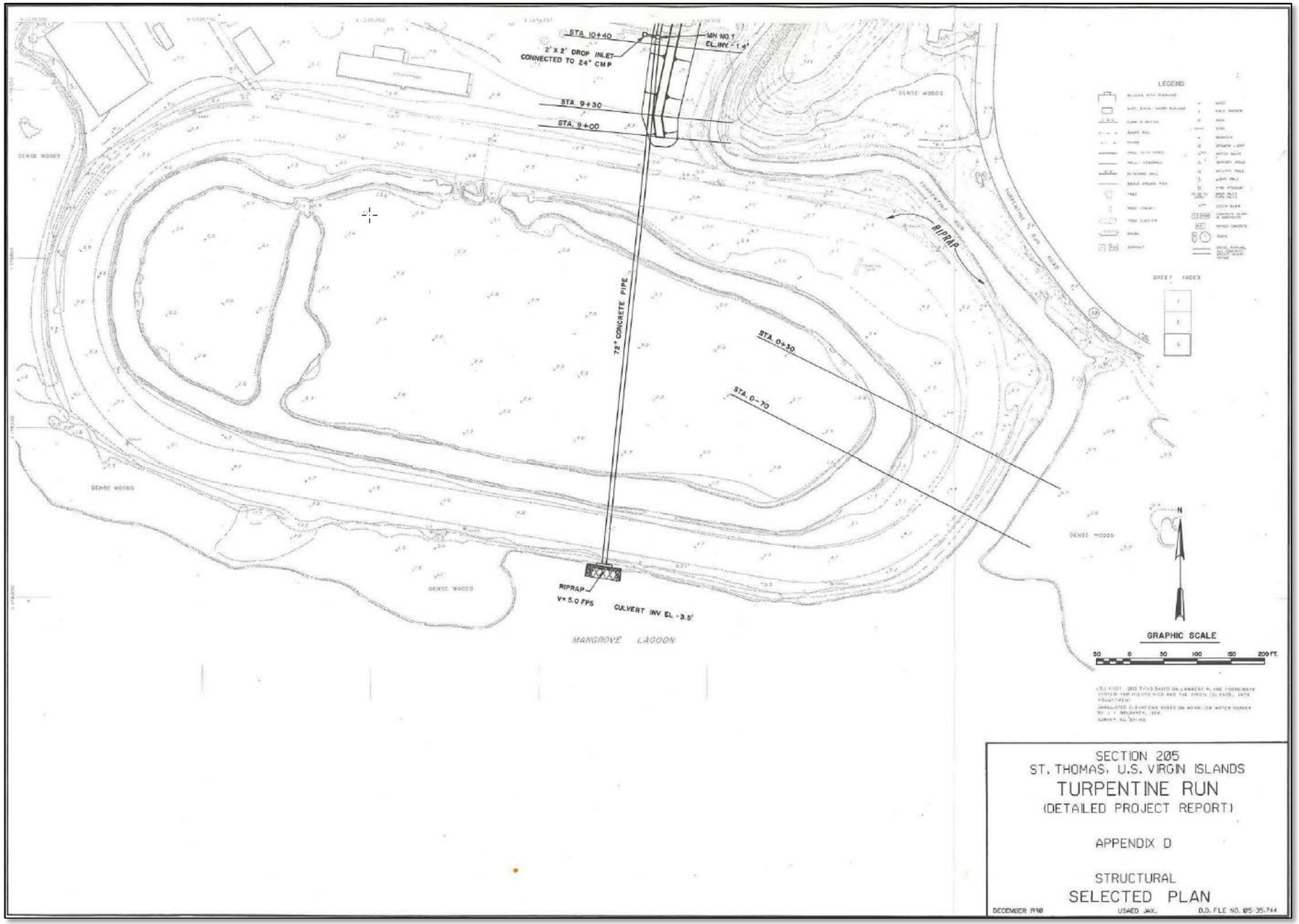

Figure 5: Plans and specifications from the 1994 DPR and EA – Plate 3

2 OVERVIEW OF CHANGED CONDITIONS FROM AUTHORIZATION

2.1 Economic conditions

Population - According to the USVI Bureau of Economic Research, the population of the US Virgin Islands (USVI) had been increasing from 1990 to 2000, with an increase of 6.7 percent for the ten year period. However, from 2007 to 2017 the Territory has experienced a 15.6% decline in population, which could be associated with decrease in development and benefits.

Table 2[1]: Population of US. Virgin Islands and St. Thomas

	1990	2000	2007	2008	2009	2010	2017
US Virgin Islands	101,809	108,612	114,743	115,852	107,343	106,405	96,815
St. Thomas	48,166	51,181	54,070	54,592	50,583	51,634	46,600

2.1.1 Socio-Economic Assessment

The 1994 DPR and EA indicate that at that time the Turpentine Run basin had 13,000 residents, or 13% of the islands' population. Approximately 118 structures, principally single family homes, were identified within the study area subject to flooding impacts and used to calculate potential benefits. Recent site visits indicate the neighborhoods appear to be houses with ground floor elevation equal to adjacent land. The structure inventory does not appear to have changed since the original report. The houses are in various states of disrepair and appear to be the same housing inventory as was previously documented in the 1994 DPR and EA. A majority of the structures appear to be inhabited and all show considerable signs of aging. There are numerous vehicles on every street in the study area, with a mix of operational and abandoned. It appears that numerous residents also operate businesses out of the home. The neighborhoods would not be a destination for tourists, but the adjacent recently renovated horse track (Clinton Phipps Racetrack) likely brings in local and regional Virgin Islands residents for the races. Not far from that area is a Nadir neighborhood park that is open to the public.

Tourism, trade, and other services are the primary economic activities, accounting for nearly 60% of the USVI's gross domestic product (GDP) and about half of total civilian employment[2]. Close to two million tourists per year visit the islands. The government is the single largest employer. In 2016, government spending (both federal and territorial together) accounted for about 27% of GDP while exports of goods and services, including spending by tourists, accounted for nearly 47%. The agriculture sector is small, with most food being imported. The

[1] U.S. Virgin Islands Economic Review, VI Bureau of Economic Research, May 15, 2016.

manufacturing sector consists of rum distilling, electronics, pharmaceuticals, and watch assembly. Rum production is significant. Shipments during a six-month period of fiscal year 2016 totaled 8,136.6 million proof gallons.

2.2 Engineering Conditions

Preliminary review of the current conditions from aerial imagery, an emergency assessment under Public Law 84-99 made on October 31, 2017, following Hurricane Maria, and a more recent site visit on November 9, 2018, suggests that the project features in the original plan of 1994 would be valid as designed. Construction of the new Bovoni Bridge is complete and provides a new traffic pattern so the old culvert crossing bridge can be removed without disruption to the main flow of traffic. It is important to note that the construction of the Bovoni Bridge occurred in the early 2000's, with the bridge approaches being constructed in the 2017/2018 timeframe. The 1994 Detailed Project Report (DPR) states that the Bovoni Road Bridge was hydraulically inadequate for the Recommended Plan and that the proposed hydraulic design data (based on the 100-year storm event) was sent to the U.S. Virgin Islands Public Works Department as it was their responsibility to design and construct a new Bovoni Road Bridge. Construction of the new bridge was completed in 2004, but bridge as-builts were unable to be located at the time of this Validation Report effort. In order to evaluate the new bridge's capability to convey project flows, non-survey field measurements were taken and compared to the Recommended Plan. The existing channel dimensions beneath the bridge have similar bottom widths and side slopes, although the distance from the low cord of the bridge to the channel invert was slightly less (approximately 19 feet vs 20 feet) than what was proposed in the 1994 DPR. This may be a function of sediment and debris accumulation along the channel bottom and side slopes, as 15+ years have passed since construction. Therefore, it appears that the new bridge was constructed to provide adequate capacity to pass the project flows. As-built and design documentation has been requested from the non-federal sponsor. Once these documents are received by SAJ, Engineering personnel will review the documentation to ensure the design is consistent with USACE standards and meets the requirements as outlined in recommended plan, as described in the 1994 DPR and EA. Findings of this analysis will be included during PED.

A Qualitative Hydrologic Assessment is included as an Appendix to this report. The analysis reviewed the original project design hydrology and made comparisons to current rainfall depth, distribution and peak flows. The 1994 hydrologic analysis used a 6-hour design storm for a 25-year (4% ACE) event. The 4% ACE 6-hour design storm selected for Turpentine Run is appropriate for the small size of the project basin. The rainfall total from appendix A of the original 1994 DPR and EA (6.4 in.) is within 4.4% of the updated National Oceanographic & Atmospheric Association (NOAA) Atlas 14 precipitation-frequency rainfall total (6.7 in.). The distribution applied to the 1994 design rainfall is considered a conservative distribution, Soil Conservation Service (SCS) Type II. There is no indication that design flows would appreciably increase if a new hydrologic analysis were performed; this statement is based primarily on comparison of the rainfall / temporal distribution used in the 1994 report with the rainfall /

temporal distribution from NOAA Atlas 1ER4 that would be applied as part of a new analysis. In conclusion, there is no need to perform a new hydrologic analysis for the Turpentine Run study.

The Hydraulic analysis performed for the Turpentine Run/Nadir Area Section 205 Detailed Project Report states that the Hydraulic design criteria and procedures completed for the 1992 report were in accordance with standard engineering practice and applicable provisions of Corps Engineering Manuals and the Corps of Engineers "Hydraulic Design Criteria". Hydraulic modeling was performed for both the existing condition and the selected plan using the HEC-2 computer program, which at the time was an appropriate and approved modeling tool of relatively high quality. The hydraulic model was run for the 2-, 5-, 10-, 25-, 50-, 100-year and Standard Project Flood. Accuracy of the HEC-2 runs were checked using equations found in HEC publication "Accuracy of Computed Water Surface Profiles". Hydraulic design conditions, including the roughness coefficient, channel alignment, and freeboard from superelevation was calculated using Engineer Manual 1110-2-1601 dated 1 July 1991, which is compliant with current standards. Additionally, the top of levee was set to 3 feet above the 4% ACE design event which, according to the HEC-2 results, would also correspond to levee top elevations at or above the 100-year flood profile. This freeboard design was recommended both based on benefits and potential uncertainty in the modeling. The concrete drop structure was designed in accordance with the Corps of Engineers Hydraulic Design Criteria, hydraulic design chart 623, which although has been replaced with updated EM's, is still approved for publication and likely an appropriate design for the structure.

The hydraulic model used in the past design is superseded by the Hydrologic Engineering Center – River Analysis System (HEC-RAS) model. A preliminary two dimensional (2D) HEC-RAS model of the project has been developed during this study process. During PED, the model will be used to support design refinements and Value Engineering proposals. The validity of the channel design has been confirmed by the preliminary 2D HEC-RAS model of the project. In addition, a comparison of the without project condition to the with-project condition without including the sheet pile wall downstream of station 16+00 does not worsen conditions beyond station 16+00. There is a high potential that this feature will be eliminated during PED analysis, resulting in a cost savings to the project.

Since the project levees were conceptually designed, there has been updated guidance and policies governing the design of levees, including ER 1105-2-101, ECB 2019-15, and EM 1110-2-1619. As a result, design changes regarding the levee heights may occur to incorporate this updated guidance.

2.3 Sea Level Change (SLC) Due to Climate Change

The climate assessment for sea level change 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. ER 1100-2-8162 and ETL 1100-2-1 provide guidance for incorporating the direct and indirect physical effects of projected future sea level change across the project life

cycle in managing, planning, engineering, designing, constructing, operating, and maintaining USACE projects and systems of projects. However, it is important to note that the climate change analysis included within this Validation report is limited in scope and therefore the climate assessment is scaled based on project purpose and complexity.

Turpentine Run is divided into three sections: the uppermost section is a natural channel with a mud bottom and a high west bank and low east bank. The middle section is a 1,300 foot long unvegetated concrete channel along the eastern side of the Nadir development. The lowermost section has an almost flat grade and water movement is in response to tides as much as stream flow. The bottom of this section is mud and the stream banks are heavily vegetated.

Figure 6 shows the channel alignment of the Turpentine Run Project on the terrain model. The channel invert and ground elevation profile of the alignment is also shown with the headwater elevations starting at approximately 22 feet Virgin Islands Vertical Datum of 2009 (ft-VIVD09) and the lowest channel invert at the end of the project construction at approximately 4.48 ft-VIVD09. Figure 7 shows the terrain at the project construction end point. Figure 8 and Figure 9 shows the estimated Relative Sea Level Change (RSLC) Low, Intermediate and High prediction curves from the USACE Sea-Level Change Curve Calculators for the 100-year lifecycle previously mentioned. The Charlotte Amalie tide gauge is located 3.8 miles to the northwest. The critical elevation line shown in Figure 8 at 4.48 ft-VIVD02 corresponds to the lowest channel invert elevation. Figure 8 also shows the NOAA Tides and Currents Relative Sea Level Trend at the same tide gauge location. The relative sea level trend is 0.0068 ft/year with a 95% confidence interval of +/- 0.0021 ft/yr based on monthly mean sea level data from 1975 to 2018 which is equivalent to a change of 0.68 feet in 100 years. Using the USACE Sea-Level Change Curves, the relative sea level trend would lie close to the Low Curve and below the Intermediate Curve. Figure 9 shows the different datums at the gauge location, which illustrates that the VIVD09 is 0 ft relative to MSL. It is important to note that within the Sea Level Change Curve Calculator tool, the datum values relative to Local Mean Sea Level (LMSL) are the same as to MSL, as illustrated in Figure 13 through Figure 15. Therefore the Local MSL reported along the y-axis in the RSLC graphic is being used interchangeably as MSL, which is the same value as VIVD09.

This analysis of the predicted Sea Level Change curves show that the improved channel invert elevation will begin to experience increased tidal influence (from Mean sea levels) in 2097 if the High curve was to occur and well past 2100 if the Intermediate curve occurs. The hydraulic design of the project channel will not affect the water stage levels at the outlet during the design flowrate due to sea level change. Additionally, the Sea Level Curve Calculator tool was utilized to determine when the sea level change and other components of the total water level could potentially reach the critical elevation. Figure 13 through Figure 15 illustrate various combinations of water levels and sea level curves to gain a better understanding. The 10% extreme water level (EWL) and the high sea level curve may impact the project features beginning in 2075. The intermediate + 10% EWL would potentially see impacts to the project features past 2100. No impacts to the project features would be experienced due to the 10% EWL and the low curve. Similarly with the tides, MHHW and the high curve will not impact the

project until 2091. No impacts to the project would be experienced due to MHHW and the low curve.

Projected sea level change during the 25-yr rainfall runoff event in the Turpentine Run project channel will not affect peak flows or stages until much later in the project lifecycle (likely after 2075). There is a greater possibility of sea level change affecting the downstream portions of the Turpentine Run, which are located outside of the project area. This includes portions of the Turpentine Run natural channel, which contain lower channel invert and floodplain elevations than the project. Within these areas, adaptation measures may be required in the future to ensure that the downstream reach of Turpentine Run is resilient to the impact of climate change, but this will likely be the responsibility of the non-federal sponsor and is outside the scope of this project. Potential adaptation measures could include installation of a water control structure with backflow prevention (such as a flap gate) to limit the potential for salt water to propagate upstream. In conclusion, sea levels relative to the Turpentine Run outlet are projected to rise, although at a rate that will not impact the project features or benefits for over 50-years or more.

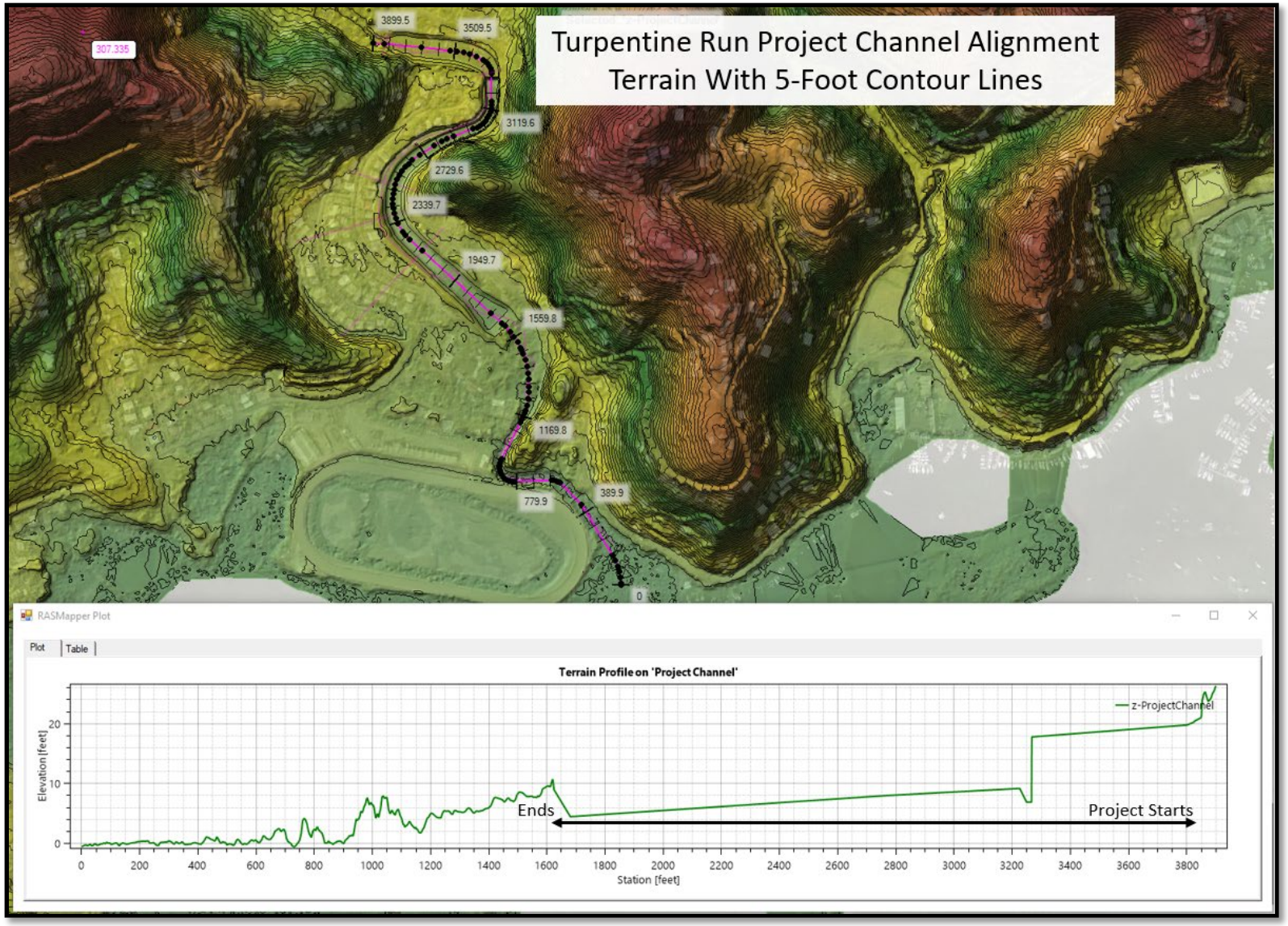

Figure 6: Turpentine Run Channel Alignment Terrain Profile

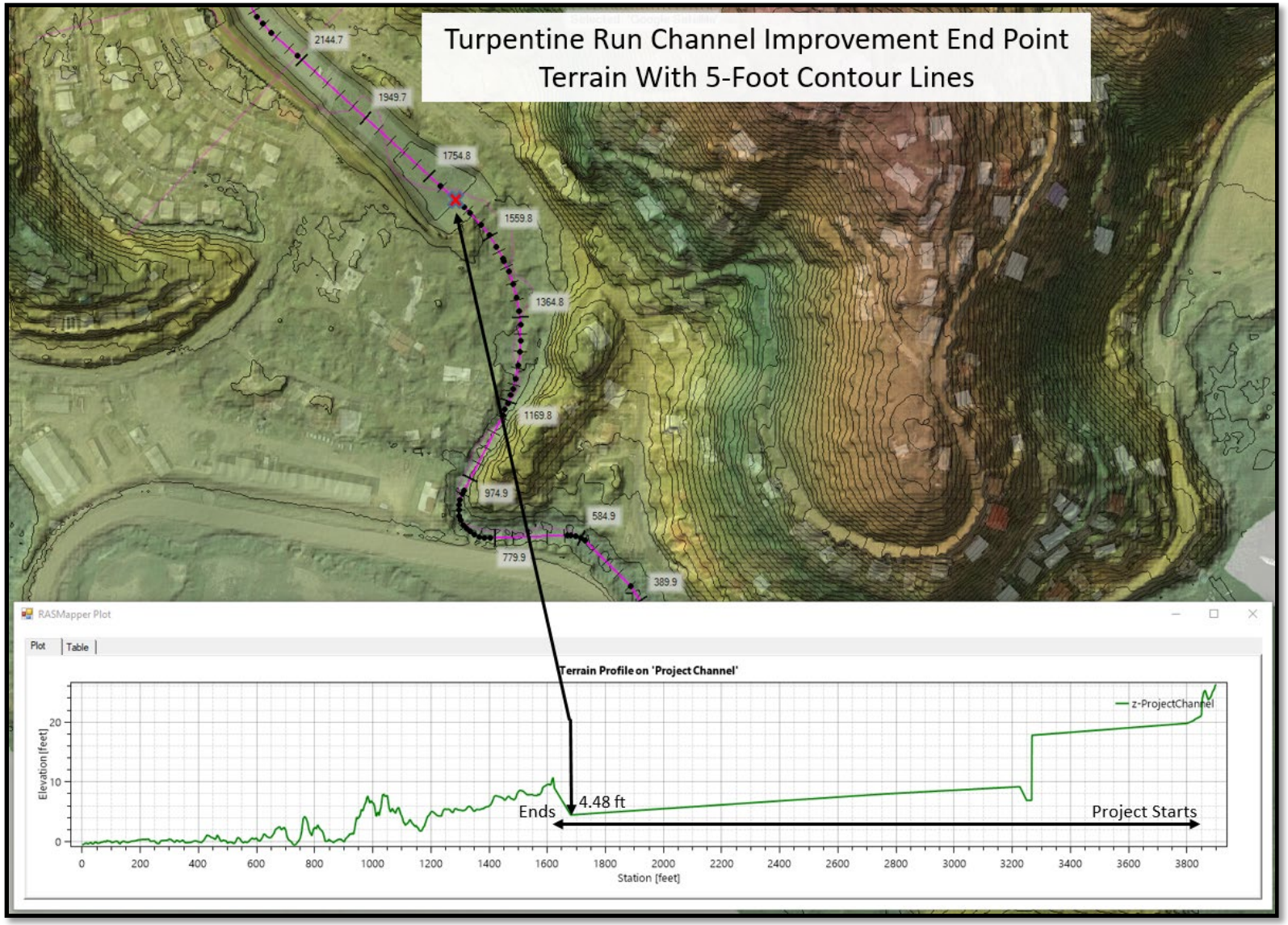

Figure 7: Terrain Elevation at Project Construction End

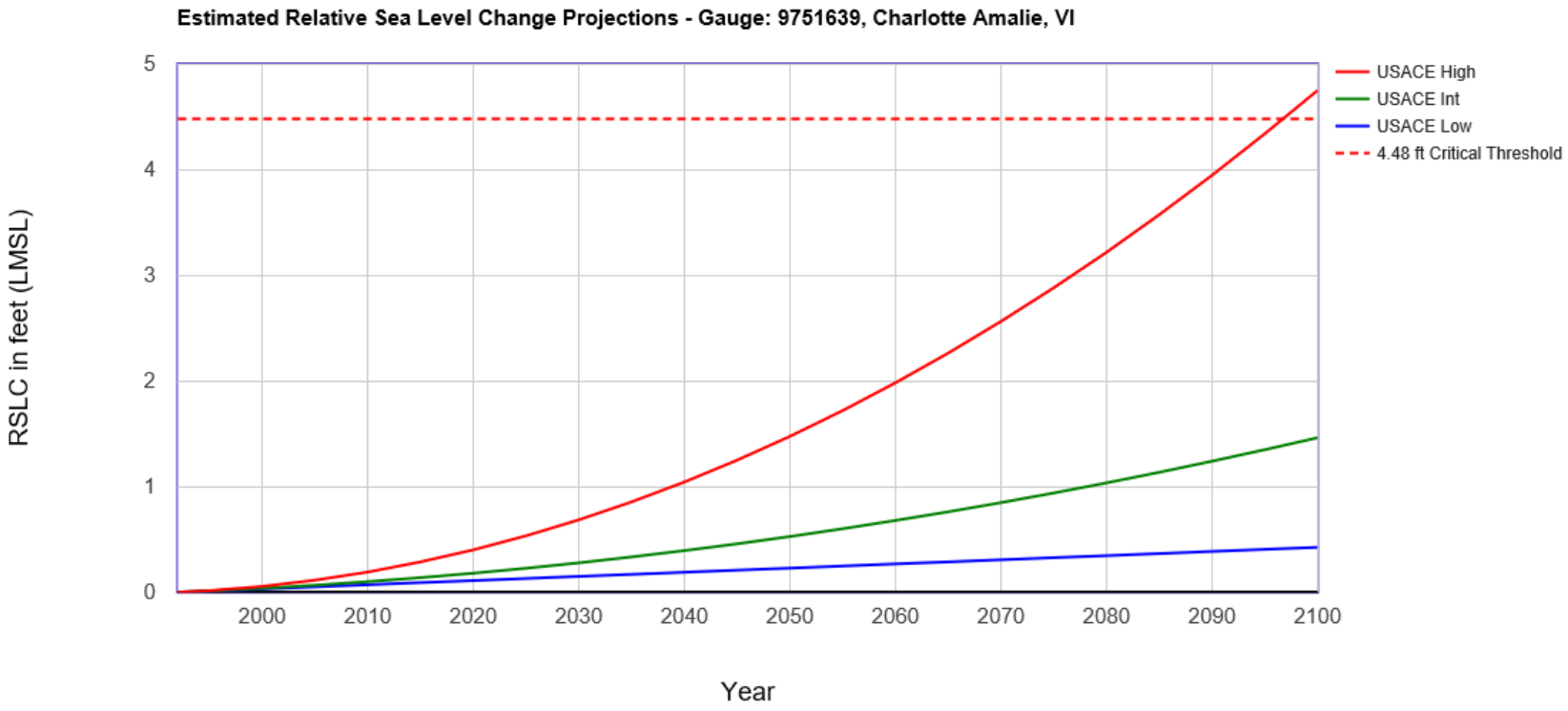

Figure 8: Tidal Prediction Curves at Charlotte Amalie, VI

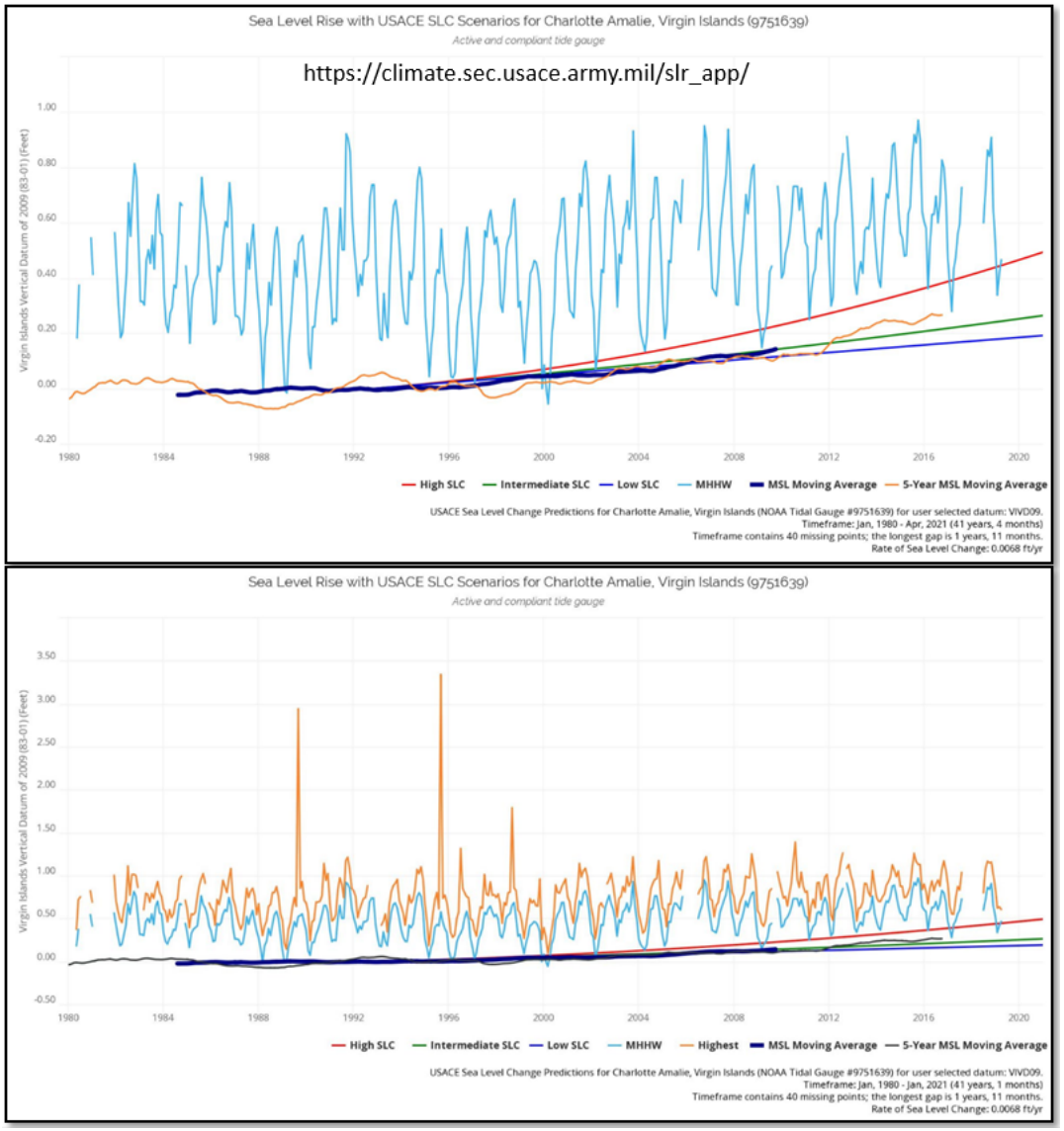

Figure 9: Tidal Prediction Curves at Charlotte Amalie, VI with Extreme Water Levels (EWL)

Elevations on Mean Sea Level

Station: 9751639, Charlotte Amalie, VI
Status: Accepted (Sep 7 2017)
Units: Feet
Control Station:

T.M.: 0
Epoch: 1983-2001
Datum: MSL

Datum	Value	Description
MHHW	0.41	Mean Higher-High Water
MHW	0.37	Mean High Water
MTL	0.02	Mean Tide Level
MSL	0.00	Mean Sea Level
DTL	0.02	Mean Diurnal Tide Level
MLW	-0.33	Mean Low Water
MLLW	-0.38	Mean Lower-Low Water
VIVD09	0.00	Virgin Islands Vertical Datum of 2009
STND	-5.63	Station Datum
GT	0.79	Great Diurnal Range
MN	0.70	Mean Range of Tide
DHQ	0.04	Mean Diurnal High Water Inequality
DLQ	0.05	Mean Diurnal Low Water Inequality
HWI		Greenwich High Water Interval (in hours)
LWI		Greenwich Low Water Interval (in hours)
Max Tide	3.34	Highest Observed Tide
Max Tide Date & Time	09/16/1995 05:00	Highest Observed Tide Date & Time
Min Tide	-1.85	Lowest Observed Tide
Min Tide Date & Time	02/06/1985 02:00	Lowest Observed Tide Date & Time
HAT	0.82	Highest Astronomical Tide
HAT Date & Time	10/17/1989 15:36	HAT Date and Time
LAT	-0.88	Lowest Astronomical Tide
LAT Date & Time	01/28/1987 04:06	LAT Date and Time

Figure 10: Station 9751639 Datum Values

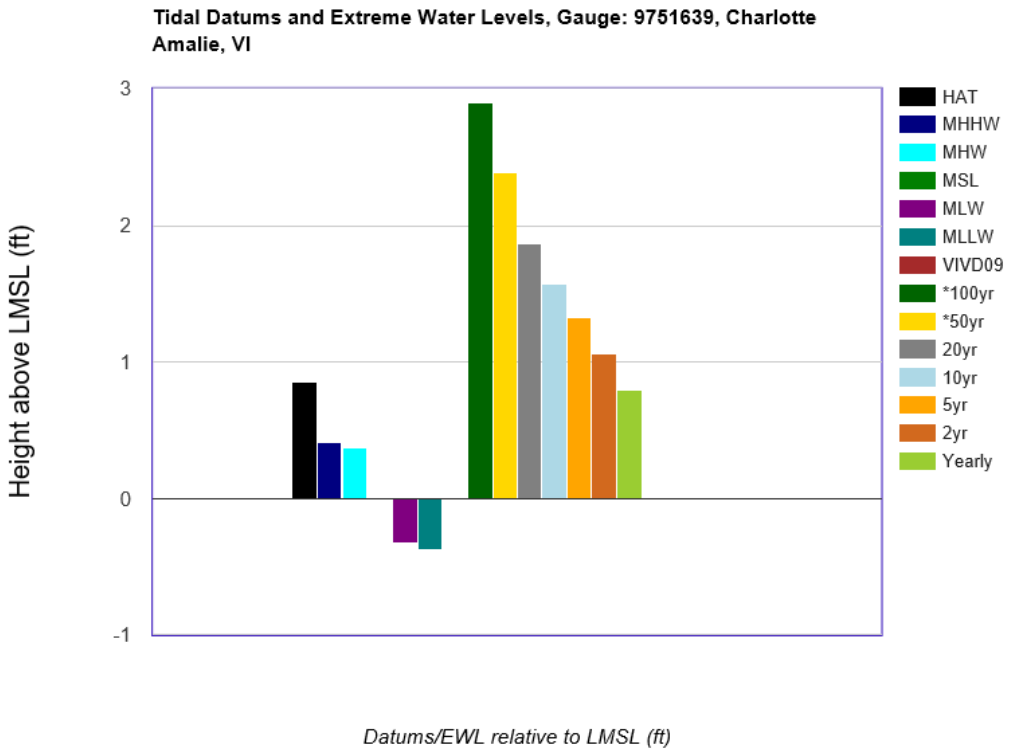

Figure 11: Tidal Datums and Extreme Water Levels, Gauge 9751639

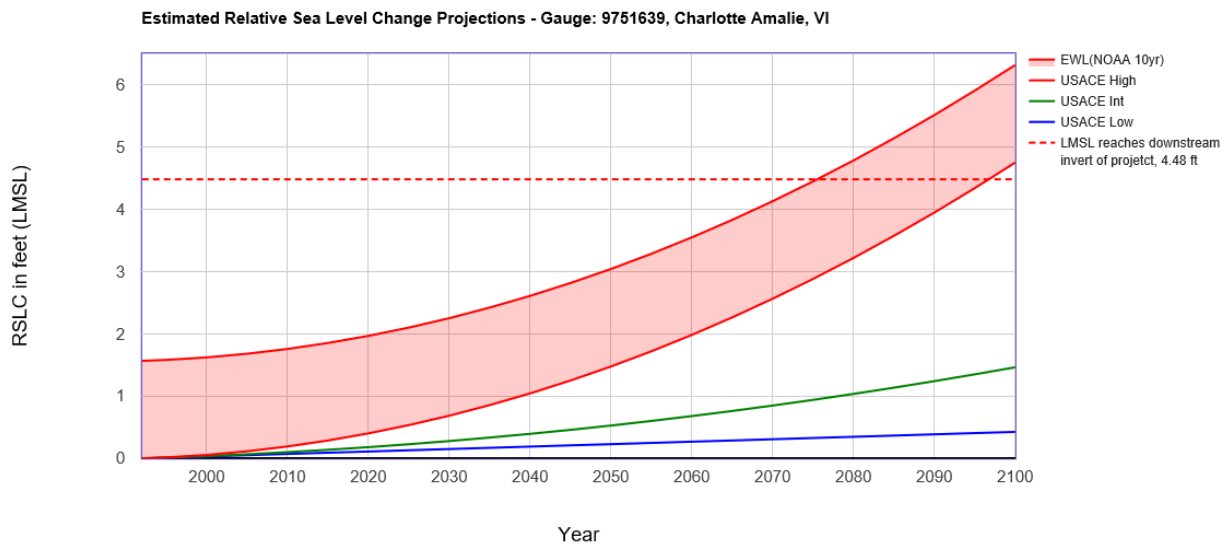

Figure 12: 10-year EWL with High Sea Level Curve Versus Critical Threshold for Gauge 9751639

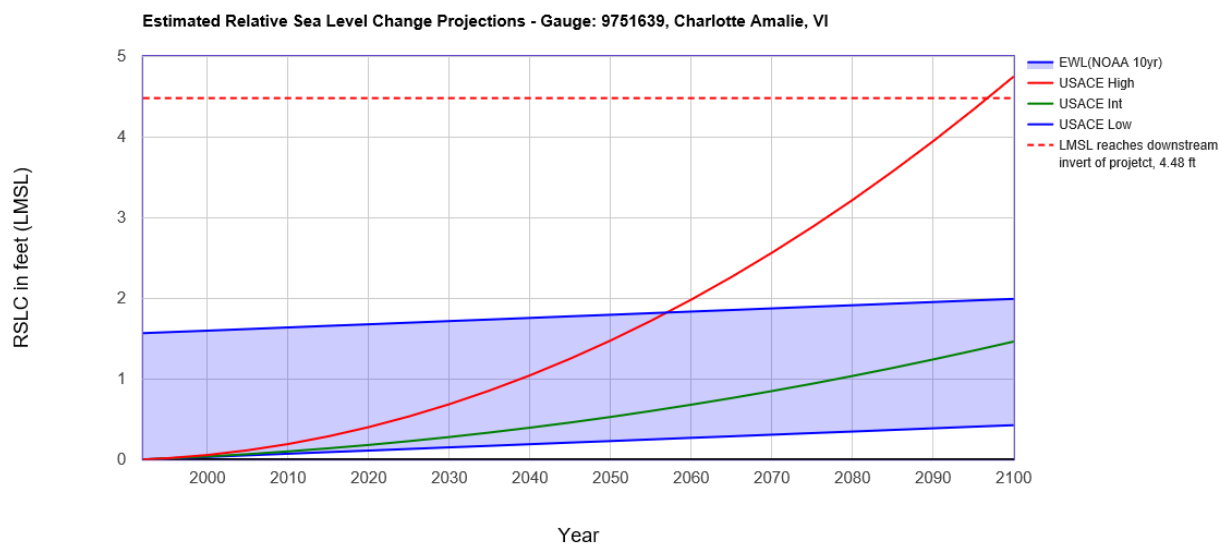

Figure 13: 10-year EWL with Low Sea Level Curve Versus Critical Threshold for Gauge 9751639

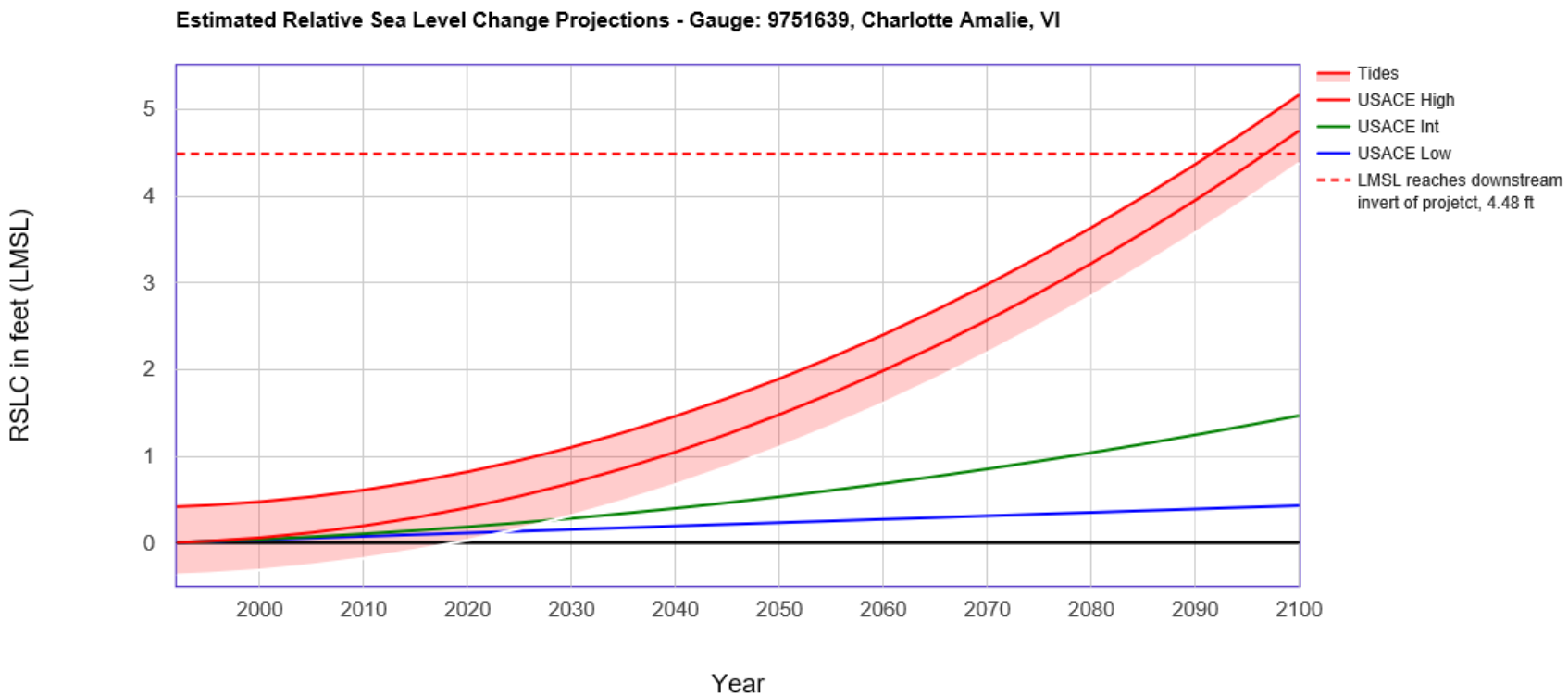

Figure 14: Tidal Signal with High Sea Level Curve Versus Critical Threshold for Gauge 9751639

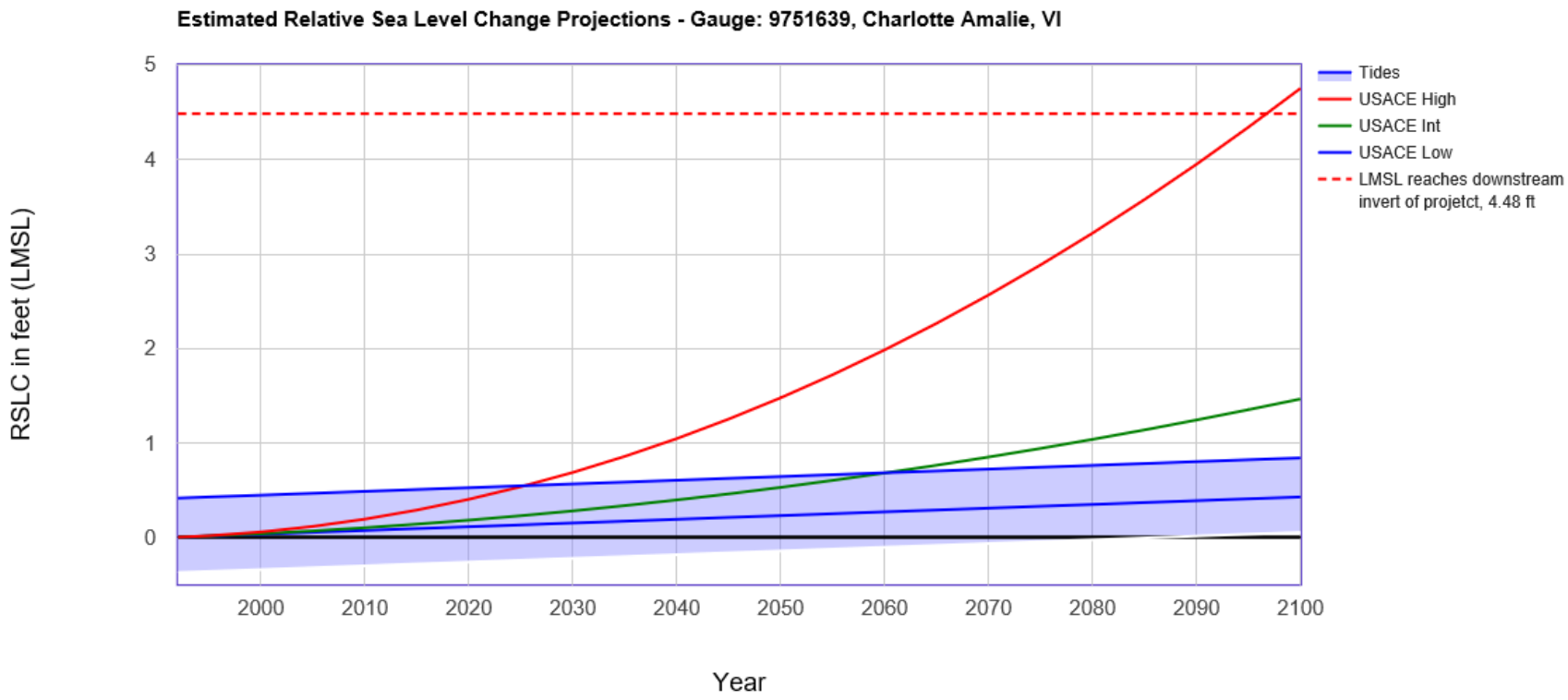

Figure 15: Tidal Signal with Low Sea Level Curve Versus Critical Threshold for Gauge 9751639

2.4 Inland Hydrology Project Vulnerabilities Due to Climate Change

In some geographic locations and for some impacts relevant to USACE operations, the climatological baseline and the range of natural climate variability is shifting. More extreme seasonal conditions of rainfall and runoff (flooding or drought) and altered snow volume and melt have been observed in some regions. As a result, the assumptions of stationary climatic baselines and a fixed range of natural variability as captured in the historical hydrologic record are no longer appropriate for long-term project planning in some locations. Because projections of specific climatic changes and their associated impacts to local-scale project hydrology that may occur in the future can be highly uncertain, USACE guidance supports a qualitative assessment of potential climate change threats and impacts to the hydrologic analysis of a project.

The following climate assessment for inland hydrology was prepared in accordance with Engineering and Construction Bulletin (ECB) 2018-14, Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects. ECB 2018-14 provides guidance for incorporating climate change information in the hydrologic analyses in accordance with the USACE climate preparedness and resilience policy and ER 1105-2-101, Risk Assessment for Flood Risk Management Studies. A full hydrologic assessment of the project using ECB 2018-14 was not performed because the USACE hydrologic climate tools are not available in the project area. A hydrologic literature review was conducted on observed climate trends and projected climate trends in the project area. 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 observed precipitation trends are unclear in the Caribbean Region and that there is little evidence that indicates change in the observed average streamflow. The literature review also shows that there is reasonable consensus that the intensity and frequency of extreme storm events will increase in the future for the Caribbean Region. There is however no clear consensus that projected streamflow will change in the future.

It is determined that the project is not vulnerable to inland hydrology variations due to climate change. The project was analyzed and designed for the 25-year (4% ACE) event. The small size of the runoff basin and short time of concentration for the basin would not be as sensitive to increased frequency of storms as compared to large watersheds.

If sea level rise trends increase significantly or if an increase in the frequency of extreme storm events increases the design event, then a future resiliency and adaptation measure to the area served by the project would be to raise the berms in the low lying areas.

2.5 Environmental Conditions

Pursuant to the National Environmental Policy Act of 1969, as amended, the Corps assessed the effects of the proposed action in the Turpentine Run/Nadir Area, St. Thomas, U.S. Virgin Islands, Detailed Project Report and Environmental Assessment (EA), dated November 1994. The 2019 draft EA updates the 1994 EA analysis and adopts the 1994 EA, by reference, where the information is valid and applicable (See Attachment E).

Few changes in the environmental conditions of the project area have occurred. The freshwater swamp forest present during the 1994 investigations is no longer intact, possibly due to erosion, pollution, and/or the recently completed construction of the Bovoni Road Bridge by the Federal Highway Administration. Ongoing natural erosion and scouring of the gut bed and banks have continued to degrade the streambank wetlands. Levee construction, channelization, clearing, and grubbing activities would occur in portions of the project located outside of the existing concrete channel. While there appear to be degraded wetlands in the project's vicinity, the project design avoids and minimizes destruction, loss, and/or degradation of wetlands and preserves and enhances the natural and beneficial values of wetlands in adjacent lands. Design work during PED is expected to reduce further potential impacts to areas that might be jurisdictional wetlands, and the clearing and construction actions are not expected to reduce the value or function of the existing degraded wetlands. Upon project completion, impacted areas will be restored to the extent practicable. Within the project footprint, revegetation is expected to occur quickly. Further, best management practices during construction will be employed and the recommended plan will not have more than negligible impacts on ecological resources, including wetlands, and therefore, mitigation is not required as there will be no loss of wetland function. The identification of and impacts to jurisdictional wetlands will be readdressed during PED to ensure restoration is accomplished to the maximum extent practicable and reconfirm the conclusion that mitigation is not required.

Pursuant to the Endangered Species Act of 1983 (16 U.S.C. §1531 *et seq.*), coordination with National Marine Fisheries Service and U.S. Fish and Wildlife Service is ongoing. Construction activities may affect, but are not likely to adversely affect, the Virgin Island tree boa (*Epicrates monensis granti*). USFWS and USVI standard protection measures for the boa will be implemented to protect any boas that may be in the area.

2.6 Cultural Resources

In 1988, the Corps identified no cultural resources eligible or potentially eligible for listing in the National Register of Historic Places (NRHP) within the project footprint; however, the project design subsequently changed after the cultural resources surveys were completed. Appendix G of the 1994 DPR and EA recommends additional Phase I cultural resources survey to include a 1,200-foot corridor at the southern end of the project where a levee would be constructed and riprap emplaced; a 900-foot corridor spanning the Bovoni Road Bridge; and a 1,745-foot corridor for a 72-inch diameter pipeline during PED.

Heavy ground disturbance within the project footprint since the initial study may have impacted cultural resources. A phase I cultural resources field study is needed to identify cultural resources within the project footprint to determine NRHP eligibility and make a determination of effects on historic properties. The Jacksonville District coordinated a programmatic agreement with U.S. Virgin Islands SHPO to conduct a phased identification and evaluation of historic properties in PED. The programmatic agreement was executed on January 13, 2020.

2.7 Impacts of Maria

Imagery prior to Hurricane Maria shows evidence that there was a home adjacent to the channel wall that was washed into and caused the wall to collapse into the channel. In addition, 640 feet downstream of the collapsed wall at the Bovoni Road bridge culvert crossing, the flood flows went over the channel wall and scoured a hole and undermined a house foundation. Remaining features of the channel in this area were in good condition. See Figure 16 through Figure 18 from the October 2017 timeframe. The collapsed wall section had already been repaired when a site visit was conducted in November 2018.

Figure 16: Collapsed section of channel wall, house missing

Figure 17: Home no longer present at collapsed wall section

Figure 18: Erosion on back side of channel wall

3 VALIDATION OF AUTHORIZED/MODIFIED PROJECT

3.1 Project Design Components

Construction of the Turpentine Run channel improvements will be carried out in three main phases.

Phase I - The first order of work will be the installation of all interior drainage items. Then the protective steel sheet piling for the overflow channel and along the Turpentine Run Road shall be placed, the channel excavated from the project south end to Station 26+86, and the embankment along the west side of the overflow channel wall constructed.

Phase II - Work in phase II consists of construction of the concrete channel in two parts (including its steel sheet pile wing-walls) and drop structure.

Phase II (a) - Stormwater Bypass Channel. Construction of the concrete channel and drop structure begins with the driving of the permanent and temporary steel sheet piling along the length of the concrete channel. Four stages of excavation are then performed with soil anchors and internal bracing being installed. After the excavation is completed, the east side channel bottom and wall foundation concrete is placed and water is diverted through the completed bypass channel.

Phase II (b) - Channel Construction. With the bypass channel in place, the remainder of the channel and drop structure can be completed. The west side excavation is performed by driving steel sheet piling and placing internal bracing. The retaining wall and channel bottom concrete is then placed up to the bypass channel. Next, the bypass wall is removed and the unfinished bottom slab is isolated using sandbags. The bottom slab concrete and remaining east wall concrete is then placed and the sandbags removed to finish the channel.

Phase III - The permanent steel sheet pile upper east and west walls are placed and the channel excavated from Station 32+69 to the north end of the project.

3.2 Real Estate

The non-Federal sponsor is required to perform and pay for facility and utility relocations as part of the Non-Federal Sponsor’s responsibility to acquire Lands, Easements, Rights-of-Way, Relocations, including suitable borrow and dredged or excavated material disposal areas (LERRD) for the project. Any conclusions contained in this report that an item is a utility or facility relocation to be performed by the non-Federal sponsor as part of its LERRD responsibilities is preliminary only. The government will make a final determination of the relocations necessary for the construction, operation, or maintenance of the project after further analysis and completion and approval of final attorney's opinions of compensability for each of the impacted utilities and facilities.

3.2.1 Facility and Utility Relocation

The plan included replacing and relocating the old Bovoni Road Bridge, which has since been completed. Federal Highway Administration has constructed a new bridge that will serve the purpose of the old Bovoni Road Bridge. The old Bovoni Bridge is no longer in service and has been removed. Utility relocations (water and electric) along the channel are expected to be performed concurrently with each phase of construction. These utility relocations would be the responsibility of the non-federal sponsor as part of their LERRDs responsibilities.

The 1994 Detailed Project Report (DPR) states that the Bovoni Road Bridge was hydraulically inadequate for the Recommended Plan and that the proposed hydraulic design data (based on the 100-year storm event) was sent to the U.S. Virgin Islands Public Works Department as it was their responsibility to design and construct a new Bovoni Road Bridge. Construction of the new bridge was completed in 2004, but bridge as-builts were unable to be located at the time of this Study Report effort. In order to determine the new bridge's capability to convey project flows, field measurements were taken (non-survey) and the net cross sectional area available for flow was computed. This value was then compared to the required net area and cross sectional properties, as proposed in the 1994 DPR, to determine if the new bridge could accommodate the proposed project channel. The Recommended Plan and existing channel dimensions beneath the bridge have similar bottom widths and side slopes, although the existing-condition channel has a slightly higher channel invert elevation (approximately 1-2 foot) than what was proposed in the 1994 DPR. Assuming the design water surface is 1 ft below the low chord elevation, as specified in the DPR for the 100-year event, the existing channel is slightly less than (approximately 190 ft^2) the Recommended Plan cross sectional area for flow. This may be a function of sediment and debris accumulation along the channel bottom and side slopes, as 15+ years have passed since construction. During future construction of the project, minor modifications of the channel geometry beneath the bridge may be necessary once the hydrologic and hydraulic models for the 100-year event have been updated. At this time it is anticipated that additional bridge retrofitting or replacement will not be necessary, but confirmation of this assumption will occur once bridge design and as-built data is obtained from the non-federal sponsor during PED.

Per Appendix G of the 1994 report, the proposed channel alignment in the recommended plan would result in the loss of a Nadir neighborhood park located north of Bovoni Road and west of Highway 32. The existing park is owned by the local government. It will be determined during PED if the impacted recreation area will be acquired or relocated. Figure 19 through Figure 21 show the existing recreation facilities that will be subject to acquisition or relocation. They are currently located to the East of Turpentine Run (see Figure 22). These photos were taken at a site visit in September 2019.

3.2.2 Proposed Recreation Features

Authority to consider Federal development of project-related recreational resources is contained in Section 4 of the Flood Control Act of 1944, as amended. Additional authorities

containing recreation considerations are the Land and Water Conservation Fund Act of 1965 (Public Law 88-578), the Federal Water Project Recreation Act of 1965 (Public Law 89-72), and the Water Resource Development Act of 1986 (Public Law 99-662) (WRDA of 1986). The Corps' objective in terms of recreation development is to "fully consider the recreation potential that may be applied at Corps Civil Works Projects" (ER 1165-2-400, Recreational Planning, Development, and Management Policies, CH 1).

Per Appendix G of the 1994 report, the proposed recreation features for the project include passive recreation facilities such as a nature walk on top of the levee, picnic facilities, and parking. Walkways, benches, and interpretive signage for the nature trail would be incorporated on the earthen levee. Smooth even grades would ensure the safe access of visitors.

While the 1994 DPR did include the replacement of existing park features that will be disturbed as a result of implementation of the project, the report considered that replacement to be a real estate relocation, not as recreational project features. This validation report recommends those existing features be examined during PED as discussed above in Section 3.2.1. The park will only be replaced in kind in the event it is determined to be a real estate relocation. There is insufficient information at this time to draw a conclusion.

In accordance with Engineer Regulation 1105-2-100, agreements to participate with a non-Federal entity in the development of basic recreational facilities will require the non-Federal entity to:

(1) Acquire in its name in fee title, and dedicate to public outdoor recreation use, lands on which cost shared recreation facilities and improvements for access, parking, potable water, sanitary facilities and related developments for health and safety are provided, with credit as specified below;
(2) Make an additional contribution sufficient to raise the non-Federal share to at least 50 percent of the total first cost of adding recreation to the project if the appraised value of the creditable lands amount to less than that percentage; and
(3) Operate, maintain and replace without cost to the Federal Government, for the economic life of the project, the recreation areas and all facilities installed pursuant to the agreement.

Figure 19: Existing bleachers that were damaged during Hurricane Maria

Figure 20: Existing Basketball Goal and Picnic Pavilion (picture taken looking upstream)

Figure 21: Existing Basketball Court (picture taken looking downstream)

Figure 22: Overview of Existing Recreational Features in Relation to Turpentine Run, the Bovoni Road Bridge and the Nadir Neighborhood. –

3.3 Cost Update

The total estimated cost of the authorized project has increased significantly since the project was authorized in December 1994. The main factors contributing to the cost increase include but are not limited to the following: 1) rising costs in materials, 2) rising costs in labor rates, and 3) changes in design criteria. Design changes could be related to seismic criteria for the steel sheet pile and concrete designs. The seismic conditions in St Thomas will have to be re-examined during the PED phase to see if seismic conditions warrant increases to the seismic acceleration coefficients. Design changes would also be related to updating the concrete designs to conform to the latest USACE Engineering Manual (EM 1110-2-2104 dated 30 November 2016). Recently, the island was devastated by hurricane(s) and is undergoing reconstruction with substantial government investment on the island. Therefore, it is anticipated that there will be other risk factors that affect the cost of the project such as: 1) availability of skilled labor on the island, 2) availability of local and/or worldwide contractors to perform all the work needed on the island, 3) availability of material, 4) future funding stream, and 5) acquisition strategy. The current fully funded cost of the project is $48,142,000 as reflected in the certified cost estimate.

Development of the project's current cost estimate is in accordance with the current Corps guidance. The total cost estimate in FY20 dollars (including all contingencies) is $48,142,000. The major construction features in this cost estimate includes the demolition of the current concrete canal, construction of levees on both sides of the Turpentine Run, construction of a drainage culverts structures to be placed to help reduce flooding in the canal, the construction of a new wider concrete channel, and the addition of sheet pile walls throughout the canal in order to provide stability to both the road and housing areas.

The estimate was developed using the information available in the feasibility report prepared in 1994. This estimate assumed no change to the current scope of work. Features in this estimate were updated based on new Corps guidance. This cost estimate was based on the 1994 completed plans and specifications. The cost estimate was originally priced out in 1994 dollars and then brought up to FY20 price levels. The updated cost estimate assumes site access from existing town streets, state highways and agricultural roads in the vicinity of the project which would provide adequate access for construction, future maintenance, and to the borrow and disposal areas. No detour road would be used for construction but there will need to be Maintenance of Traffic "MOT" for the construction due to Turpentine Road being the main road way around the construction area. The bridges located within the Turpentine Run project area need to be evaluated for adequate hydraulic capability. Work will be performed in a flood area and the weather can impact the productivity and the duration of the project. Productivity rates in the cost estimate were adjusted to reflect potential delays due to weather.

In addition, in order to secure the cost certification for this project, a mitigation plan had to be in place. This mitigation plan had the following items which could be removed: Eliminate interior drainage system, eliminate recreation areas, replacing PZ-22 sheet pile with PZC-13

sheet pile, eliminate the sheet pile wall at lower reach of project, and stop channel improvements downstream of Bovoni Bridge.

3.3.1 Cost Risk Analysis

The cost risk analysis is the process of identifying and measuring the cost impact of project uncertainties on the estimated total project cost. This risk analysis was accomplished as a joint analysis between the cost engineer and the appropriate project delivery team (PDT) members. This section provides a summary of significant risk analysis results that were identified in the Abbreviated Risk Analysis (ARA). 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.

In order to establish a contingency for the project cost estimate, the contingencies were removed from the estimate prior to running the analysis. The total estimated Construction cost of the remaining project excluding contingency was established at approximately $21,536,000. Land Cost remaining for the project is approximately $2,300,000. Planning, Engineering & Design plus Supervision & Administration cost is $7,839,000. This yields a total ARA base cost of approximately $42,531,000. The total contingency was quantified as approximately $10,856,000, or about 35% total contingency for the project. The cost risk elements that were evaluated through the risk analysis consist of the following: project growth; acquisition strategy; construction elements; quantities for current scope; cost estimate assumptions; and external project risks. Each of these elements were given a risk level based on each feature of work for the project. The key cost risk elements identified through the risk analysis were “construction elements” and “quantities for current scope” since the drawings were produced in 1994, there could be a risk of the landscape not being the exact same which could cause a redesign. Also a major risk is the construction due to the method of construction being very complex.

This project is identified as a Class 3 estimate as defined in ER 1110-2-1302, Civil Works Cost Engineering, with technical information approaching 10-60% of project design. A contingency of 35% generated from the ARA is reasonable for this stage of the project development per ER 1110-2-1302.

3.4 Economic Update

In accordance with the BBA of 2018 the recommended plan has been evaluated to reaffirm the economic justification. Per ER 1105-2-100, economic justification is presumed to be realized when the expected benefits of the recommend plan exceed the expected costs. Reformulation of project alternatives has not been conducted; consequently, the economic update examines the National Economic Development (NED) Plan identified and approved in the 1994 Detailed Project Report and Environmental Assessment. Economic justification can be evaluated by comparing the updated cost estimate to the approved project benefits.

The appropriate type of Economic Update for a Corps project is defined by Director of Civil Works Policy Memorandum, CWPM 12-001, Methodology for Updating Benefit-Cost-Ratios (BCR) for Budget Development. CWPM defines four levels of economic update. A Level 1 Update involves deflating a new cost estimate to the price level of the previously estimated benefits in order to verify economic justification. A Level 2 Update involves using the previous benefit model with some updated input data (where applicable). A Level 3 Update involves developing a new benefit model with entirely new data (comparable to an LRR level of effort), and a Level 4 is essentially a feasibility level of effort (new modeling, new plan formulation, potential for new NED plan identification).

The Headquarters memorandum dated April 7, 2019, dictating the scope of this report, determined that a Level 1 analysis represents a conservative and defensible approach for verifying economic justification. The scope of this report is limited and is intended to be completed in an expedited manner. Also, a level 2 Update is not a practical option because the original benefit model does not exist. And, an even higher level of effort (Level 3 or 4) is inconsistent with the intent of the Supplemental Bill as outlined by, among other documents, Director's Policy Memorandum Civil Works, DPM CW 2018-09, Principles of Delivery for the 2018 Emergency Supplemental. Within the context of Supplemental funding, the agency has been directed to adopt an expeditionary mindset and a commitment to aggressive Civil Works delivery, particularly for already authorized projects.

3.4.1 Interest during Construction

Interest during construction (IDC) represents an economic cost of building a project that is considered in the selection of the recommended plan, but does not factor in as a paid cost. IDC is the cost of the foregone opportunity to invest the money required to construct a project for another use. The hypothetical return on another investment, measured as IDC, is counted as the National Economic Development (NED) cost. As an economic, rather than a financial cost, IDC is not considered in the determination of cost-sharing responsibilities. But, as part of the economic cost, IDC is an important part of the total investment cost. IDC varies depending on the duration of construction and the interest rate. Longer durations and higher interest rates tend to result in larger IDC figures. In this case, based on the current (FY20) discount rate (2.75%), the estimated IDC is approximately $1,630,000.

3.4.2 Total Investment Cost (NED Costs)

The total investment cost is the sum of the total project cost and the relevant IDC. In order to calculate an updated BCR, the investment cost must be annualized over the period of analysis (50 years). A summary of the investment cost is provided in Table 3.

Table 3: National Economic Development Cost of Project in Annual Terms

	Total BCR Update at FY19
Project First Cost (FY 20 Price Levels)	$43,662,000
IDC (FY 20 Price Levels)	$1, 630,000
Total Economic Cost (FY 20 Price Levels)	$45,292,000
Total Economic Cost (FY 1991 Price Levels)	**$20,210,000**
Interest and Amortization	$750,000
OMRR&R 1990 Price Level	$15,000
Average Annual Cost (1991 Price Levels)	**$765,000**

3.4.3 Previously Approved Benefits

The previously approved benefits are described in Appendix E of the 1994 DPR. These benefits include primary damage reduction benefits as well as incidental recreation benefits. The primary benefits included reduction to damages in structures, contents, and vehicles; annual damage reduction benefits were estimated to be $710,660 in FY 91 price levels. Annual recreation benefits were estimated to be $168,800, and total annual benefits were estimated to be $879,640 in FY91 price levels.

A field survey conducted by SAJ Economists in 2018 concluded that, while some residential structures in the study area were in various states of disrepair, the overall structure inventory has not changed significantly since 1994. Therefore, the previously estimated benefits represent a reasonable basis for updating the BCR.

3.4.4 Updated BCR and Net Benefits

In accordance with CWPM 12-001, a Level 1 Economic Update (called a Reaffirmation Report) requires a qualitative assessment of existing conditions and key benefit assumptions. With verification of conditions and key assumptions, the economics of the project can be updated using the new approved cost estimate and the existing estimated benefits. Using this method the project realizes $879,000 in average annual benefits and $114,000 net benefits (FY 91 price levels) and a total updated BCR at the FY19 water resources discount rate (2.75%) of 1.15. However, because there is significant uncertainty about the incidental recreation benefits, the BCR has also been calculated with inundation reduction benefits only. Without incidental benefits, the BCR is 0.95 at the FY20 discount rate. These calculations confirm that the annual benefits (including incidental benefits) of the project exceed the annual costs. Therefore, the project continues to be economically justified. The BCR and net benefits are summarized in Table 4.

Incidental recreation benefits are approximately $170k annually in FY 91 price levels, as presented in the 1994 DPR. Current recreational components account for $425,000 of the $43,662,000 project first cost in FY 20 price levels. This equates to $190,000 in FY 91 price levels, or $15,000 annually when including $5,000 (FY 91 price level) in OMRR&R costs. When

compared to the recreation benefits as identified in the 1994 DDR, the BCR for incidental recreation components is approximately 11 to 1.

Table 4: Turpentine Run Updated BCR and Net Benefits at FY20 discount rate (2.75%)

	BCR Update (with Recreation)	Without Recreation	Recreation Components
Project First Cost (FY 20 Price Levels)	$43,662,000	$43,237,000	$425,000
IDC (FY 20 Price Levels)	$1, 630,000	$1,624,000	$6,000
Total Economic Cost (FY 20 Price Levels)	$45,292,000	$44,860,000	$430,000
Total Economic Cost (FY 91 Price Levels)	$20,210,000	$20,020,000	$190,000
Interest and Amortization	$750,000	$740,000	$10,000
OMRR&R (FY 91 Price Level)	$15,000	$15,000	$5,000
Average Annual Cost (FY 91 Price Levels)	$765,000	$755,000	$15,000
Primary Benefits (damage reduction)	$710,660	$710,660	
Incidental Recreation Benefits	$168,800		$168,740
Total Annual Benefits from 1994 Approved Report (FY 91 Price Levels)	$879,460	$710,660	$168,740
Benefit to Cost Ratio	**1.15**	**0.94**	**11.25**
Net Benefits (FY 91 Price Levels)	$114,000	($44,340)	$153,750

1.) Total Project First cost based on certified cost, dated 11/8/19
2.) Annual Benefits based on 1994 revised Turpentine Run Detailed Project Report and Environmental Assessment.
3.) Annual Costs deflated to price level of the benefits for purposes of BCR updates
4.) Incidental Benefits include Recreation benefits

4 RISK AND UNCERTAINTY

4.1 Uncertainty in the Engineering and Economic Analyses

As noted in Sections 1 and 2, there are a number of sources of uncertainties associated with the engineering and economic analyses, including potentially changed conditions. These uncertainties will have to be addressed during PED, using (as necessary) new survey data, updated models in accordance with applicable guidance (including new guidance since project approval in 1994).

At this time, moderate risk and uncertainty remains for the Bovoni Bridge replacement and the assumption that no design modifications are required to meet current USACE standards. The current fully funded cost of the project does not include costs associated with retrofitting or replacement of the Bovoni Bridge. If design deficiencies are found, the cost of the project will likely increase, potentially impacting the economic justification of the project.

Site conditions and other characteristics detailed in the original planning report may have changed over the ensuing years. This expedited review of the project suggests that changes in the physical conditions, watershed hydraulics, and design standards and practices that have changed over time are potential risks that can be addressed if this project is moved into the design phase for eventual authorization and construction. See the attached Turpentine Run Risk Register (Attachment F).

4.2 Implementation Risks

Some of the key implementation risks potentially affecting project schedule are:

- **Real Estate Acquisition:** In order to complete the project, additional Lands, Easements, Rights of Way, Relocations, and Disposal Areas (LERRD) - must be acquired. Difficulty in acquiring the relevant LERRD could disrupt the project schedules and increase the cost.
- **Weather:** Unpredictable weather, particularly hurricanes, can present challenges to project implementation.
- **Underground Utilities:** Incomplete surveys of underground utilities have been one of the reasons that the project cost has increased so significantly since authorization. Potentially, this issue could arise again in future contracts.
- **Funding Availability:** The current cost estimate is based on a relatively aggressive construction schedule, which assumes large and consistent funding packages in coming years. Disruptions in the funding stream have caused issues in the past.
- **Contracting:** One risk noted in other Puerto Rico and USVI studies is the limited availability of qualified contractors in the post Hurricane Maria environment. This could be particularly true if many projects in Puerto Rico and the USVI are being constructed simultaneously due to the BBA funding.
- **Cost:** There is a potential risk during PED, if costs increase it could impact the BCR.

4.3 Project Outcome Risks

Generally FRM projects have at least two broad outcome risks: increased flood hazards associated with levee failures and increased development in the floodplain. The team is not aware of any other outcome risks specific to this project.

The channel was designed to handle floods up to the 25 year (4% ACE) event. However, significant flood damages would accrue in the study area from less frequent events, (100 year, Standard Project Flood, etc.). Therefore, there would be residual flood risks even after project implementation.

Increased Flood Hazard: If, at some point after construction, the Bovoni Road levee fails during an extreme rainfall event, the subsequent flooding would likely be much 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. Four criteria were considered in the 1994 DPR to address compliance with E.O. 11988:

- Avoid development in the base floodplain except where it is the only practical alternative
- Reduce the hazard and risk associated with floods
- Minimize the impacts of floods on human safety, health and welfare
- Restore and preserve the natural and beneficial value of the base floodplain.

The floodplain is highly developed and these features will reduce the hazard and risk associated with floods thereby minimizing the effects of floods on life safety, health, and welfare. The Corps concludes that the proposed project is the most practical alternative and will not result in harm to people, property, and floodplain values, will not induce development in the floodplain, and the project is in the public interest. The project will result in a reduction of flood damages.

4.4 Residual Risks

The economic analysis from the 1994 report (as described in Appendix E of the 1994 revised DPR) indicates that the recommended plan would be expected to prevent damages through the 25 year (4% ACE) rainfall event. However, the project only partially prevents damage in the less frequent events, including the 25 year (4% ACE), 100 year (1% ACE), and SPF events. Therefore, there would be residual flood risks even after project implementation. Appendix E estimates that there would be approximately $90,000 in average annual damages in the with-project condition (including freeboard). However, the appendix also suggests that the majority of without project damages would be prevented by the recommended plan. This suggests that the project is effective despite its relatively small scale.

5 IMPLEMENTATION STRATEGY/RECOMMENDATIONS

Hurricanes Irma and Maria in 2017, and previous storm events have caused multiple damaging flooding events in to the Nadir neighborhood on St. Thomas. The island of St. Thomas is densely populated and there are few options for residents seeking alternative housing options due to the island's topography. Approximately 13% of the islands population resides within the project watershed. There have been at least two documented fatalities associated with flooding events in the project area. The original DPR highlights an unfortunate death in 1987 when a car was washed off the nearby roadway and the driver drowned. Sadly, during the recent storm season the occupant of the lost home depicted in Figure 11 drowned as well. This project is important to the residents in this watershed and allowing the project to move into PED will allow a more detailed review of the previously recommended plan to achieve the needed flood risk management benefits to this community.

This review finds the project economically justified, environmentally acceptable, and feasible from an engineering standpoint. It is recommended that the Turpentine Run flood risk management project as described in this report be approved at a Project First Cost of $42,531,000 (FY19 price level).

5.1 Non-Federal Responsibilities

Federal implementation of the recommended plan would be subject to the non-federal sponsor agreeing to comply with applicable federal laws and policies, including but not limited to:

a. Provide a minimum of 35 percent, but not to exceed 50 percent, of the total structural flood damage reduction costs, and 50 percent of total recreation costs, as further specified below:

(1) Provide, during design, 35 percent of design costs allocated to structural flood damage reduction and 50 percent of design costs allocated to recreation in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;

(2) Pay, during construction, a contribution of funds equal to 5 percent of total structural flood damage reduction costs;

(3) Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements, and rights-of-way to enable the disposal of dredged or excavated material as determined by the Federal Government to be required or to be necessary for the construction, operation, and maintenance of the project, all in compliance with applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of

1970, P.L. 91-646, as amended (42 USC 4601--4655) and the Uniform Regulations contained in 49 CFR Part 24; and

(4) Pay, during construction, any additional funds necessary to make its total contribution equal to at least 35 percent of total structural flood damage reduction costs and 50 percent of total recreation costs.

b. Provide, during construction, 100 percent of the total recreation costs that exceed 10 percent of the federal share of total structural flood damage reduction costs;

c. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements and rights-of-way or the addition of facilities that might reduce the outputs produced by the project, hinder operation and maintenance of the project, or interfere with the project's proper function;

d. Inform affected interests, at least yearly, of the extent of protection afforded by the flood risk management features; participate in and comply with applicable federal floodplain management and flood insurance programs; comply with Section 402 of the WRDA 1986, as amended (33 USC 70lb-12); and publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with protection levels provided by the flood risk management features;

e. Operate, maintain, repair, rehabilitate and replace the project at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable federal laws and regulations and any specific directions prescribed by the Federal Government;

f. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating or replacing the project;

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

h. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 USC 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way

that the Federal Government determines to be necessary for the construction or operation and maintenance of the project;

i. Assume, as between the Federal Government and the non-federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way required for construction, operation, maintenance, repair, rehabilitation or replacement of the project;

j. Agree, as between the Federal Government and the non-federal sponsor, that the nonfederal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate and replace the project in a manner that will not cause liability to arise under CERCLA; and

k. Keep the recreation features, and access roads, parking areas, and other associated public use facilities, open and available to all on equal terms.

5.2 Recommendation

The project is in compliance with NEPA and USACE regulation ER-200-2-2 for implementing NEPA on Civil Works actions. Coordination with resource agencies concerning project revisions was conducted and is included in the Finding of No Significant Impact that has been completed for this project.

I recommend authorization of the project presented in the Turpentine Run, St. Thomas, U.S. Virgin Islands, Detailed Project Report and Environmental Assessment dated 22 November 1994, approved previously to be implemented under Section 205 of the 1948 Flood Control Act, as modified in this Continuing Authorities Program Conversion Report, at an estimated first cost of $42,531,000. I concur with the conclusions in this updated Conversion Report that the project as previously planned and modified based on current conditions is economically justified, environmentally acceptable, and feasible from an engineering standpoint.

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to Congress as proposals for authorization and implementation funding. However, prior to transmittal to Congress, the sponsor, the States, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

DAVFOR Date 12 MAR 2020

ANDREW D. KELLY, JR.
COL, EN
Commanding