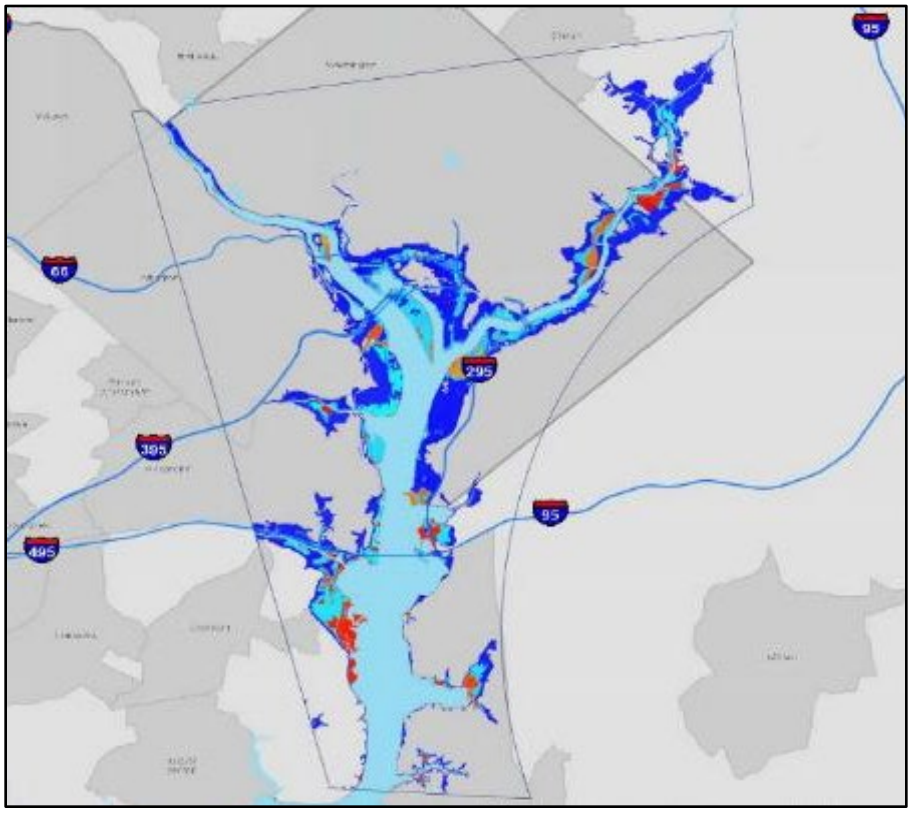
Metropolitan Washington District of Columbia Coastal Storm Risk Management Feasibility Study

Appendix A: Civil Engineering



Northern Virginia

May 2022

US Army Corps of Engineers
Baltimore District

Metropolitan Washington Council of Governments

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APPENDIX A CIVIL ENGINEERING

WASHINGTON D.C. COASTAL FEASIBILITY STUDY

NORTHERN VIRGINIA

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1. INTRODUCTION

1.1 Purpose and Scope of Civil Appendix

The purpose of this appendix is to present the Civil Engineering investigations/studies conducted for the Metropolitan Washington District of Columbia Coastal Storm Risk Management Feasibility Study (DC Coastal) Project. This Appendix investigated and evaluated a holistic way of protecting the study area from inundations associated with storm frequencies ranging from the 100-year to the 500-year. Many flood risk management structures were assessed, evaluated, and ranked as partially and marginally feasible through the project matrix elimination process. Selected structures were elevated roads, earthen levees, floodwalls, and aluminum stop log closures as a flood protection line.

This civil engineering design investigation resulted in the preliminary design of these three structures at strategic locations as a product of Hydrologic and Hydraulic (H&H) studies given water surface elevations at multiple control areas critical to the flood protection of the study area. The designs were sufficient to generate baseline Quantities and Cost Estimates to determine the cost of all the structural alternatives within the project for the feasibility study.

2. EXISTING CONDITIONS

2.1 Study Area

The Middle Potomac River watershed encompasses approximately 11,500 square miles, including a diverse landscape, with urban, rural, and natural areas in six different eco-regions and four states and the District of Columbia. The study area for the DC Coastal Feasibility Study encompasses approximately 76 square miles and includes the Northern Virginia jurisdictions within the Middle Potomac watershed boundary, from Arlington County south to include a portion of Prince William County. Within the study area, the Virginia side of the Potomac River contains approximately 135 miles of Potomac River shoreline. The population within the study area is approximately 155,000). The study area was further reduced to four main sections: Ronald Reagan Washington National Airport, Arlington Water Pollution Control Plant, Four Mile Run, and Belle Haven.

2.2 Site Description

1. Ronald Reagan Washington National Airport also known as National Airport, Washington National, Reagan National Airport, DCA, Reagan, or simply National, is a national airport in Arlington, Virginia, across the Potomac River from Washington, D.C. The airport is operated by the Metropolitan Washington Airports Authority that serve the National Capital Region (NCR). The airport is 5 miles (8.0 km) from downtown Washington D.C. National Airport cover approximately 1.34 square miles The airport is bounded to the east and south by the Potomac River. The airport has approximately 2.84 miles (15,000 feet) of shore along the Potomac River. It is bounded on the West by the George Washington Parkway. See Figure A-1. The airport is critical infrastructure for transportation.

2. Arlington Water Pollution Control Plant (WPCP) is located in south Arlington, Virginia at 3402 South Glebe Road. The plant is bounded to the south along the bank of the stream called Four Mile Run. A local bike trail also, runs along the north bank of the stream and the WPCP. The plant treats 23 million gallons of wastewater each day from local residences and businesses and is critical infrastructure to the northern Virginia area. See Figure A-2

3. Four Mile Run Project is located Alexandria, Virginia just south of WPCP along the stream Four Mile Run. The project starts just west of the bridge at Mt. Vernon Avenue and travels east thru Four Mile Run Park. Park offer cover about 5 acres along the south bank of Four Mile Run. The Park is dotted with trails, sport fields, and wetland habitat. See Figure A-2

4. Belle Haven is mostly residential single-family housing area located south of Alexandria, Virginia. Project is bounded to the north by Golf Course and the east side by George Washington Parkway owned by National Park Service on the west-bank of the Potomac River. The west is bordered by Fort Hunt Road. See Figure A-4.

2.3 Level of Protection

1. Ronald Reagan Washington National Airport
    - Flooding Level of Protection for National Airport was for a 500-year coastal storm with Moderate Sea Level Change (2080) + 3 ft Free Board at elevation **14.3** NAVD 88 (The North American Vertical Datum of 1988 is the vertical control datum).
2. Arlington Water Pollution Control Plant
    - 500-year coastal storm with Moderate Sea Level Change (2080) + 3 ft Free Board at elevation **14.3** NAVD 88
3. Four Mile Run
    - 100-year coastal storm with Moderate Sea Level Change (2080) + 3 ft Free Board at elevation **13.9** NAVD 88
4. Belle Haven
    - 100-year coastal storm with Moderate Sea Level Change (2080) + 3 ft Free Board at elevation **13.0** NAVD 88

See Hydrology Hydraulic Appendix B for additional information.

2.4 Proposed Structural Alignment

1. Ronald Reagan Washington National Airport: The proposed airport alternative includes 16,606 Linear feet of a Raised Perimeter Roads, Concrete Floodwalls and Aluminum Stop log closures. The alignment follows the perimeter road located on the outside of the Airport. The perimeter road will be removed and replaced with an earthen levee. The levee will be designed with heavy duty asphalt on top of the levee. The asphalt will be design so that it can support large maintenance vehicles. However, the perimeter road could not be raised at the end of the runways. Therefore, Stop-log closures were needed at the end of the runways. The length of

closures around the airports equal to 6,313 feet. The amount and length of closures are necessary for the airport to remain operational until flooding event occurs. The closures will add to the cost estimate and will take many man-hours to install. An un-manned computerize alternative will be research in the future as the study progresses. We will also be working with the sponsor to help reduce the linear feet of closures around the airport. Because of the drainage patterns around the airport, pump stations were deemed unnecessary at this point of the study.

2. Arlington Water Pollution Control Plant: The proposed alternative includes 1,160 Linear feet of proposed I-Wall (See Figure A-2) and 1,300 feet of elevated curb. The proposed floodwall will be located along the existing fence located around the plant along the bike path along Four Mile Run (See Figure A-3) along with a power line seen on (Figure A-5). A closure will be placed at the end of the alignment located across South Eads Street. The I-wall will be installed near large transmission poles that run East -West along Four Mile Run. The floodwall will need to be installed around the poles and pole's foundations.

3. Four Mile Run: This project starts West of Mount Vernon Avenue with 24 feet of Concrete I wall and 60 feet replacement of an existing 13' high concrete wall. A 70 Linear feet Aluminum Stop-Log closure will be installed across Mount Vernon Road. 190 Linear feet I-wall will travel into the Four Mile Run Park. The existing Trail will be removed and replaced with an earthen levee with asphalt installed over the crown of the levee. The levee will be installed as to not enter the wetland areas that exist in the park. 2 pump stations will be needed on 2 unnamed Tributaries that flow into Four Mile Run. Some wetlands will be disturbed for the installation of culverts and pump stations.

4. Belle Haven: This project starts along Belle Haven Road on the northside of the project then runs south running parallel to the George Washington Parkway. The alignment then turns west thru high density units and tie-into high ground at Westgrove Dog Park. There are 5 Aluminum stop-log closures will be needed on (2) Bell Haven Road, (1) Belle View Blvd, (2) at River Tower Condominiums. There are 2 proposed pump stations located on the south end of the project area on 2 unnamed tributaries that flow into Dyke Marsh Wildlife Reserve. The proposed alignment length is 6,725 linear feet. 1,900 feet of I-walls, and 3,715 feet T-walls, and 400 feet of earthen levee.

Figure A-1 Ronald Reagan Washington National Airport

Figure A-2 Arlington Water Pollution Control Plant and Four Mile Run

Figure A-3 Arlington Water Pollution Control Plant Fence, Biking Trail, and Transmission Poles

Figure A-4 Belle Haven

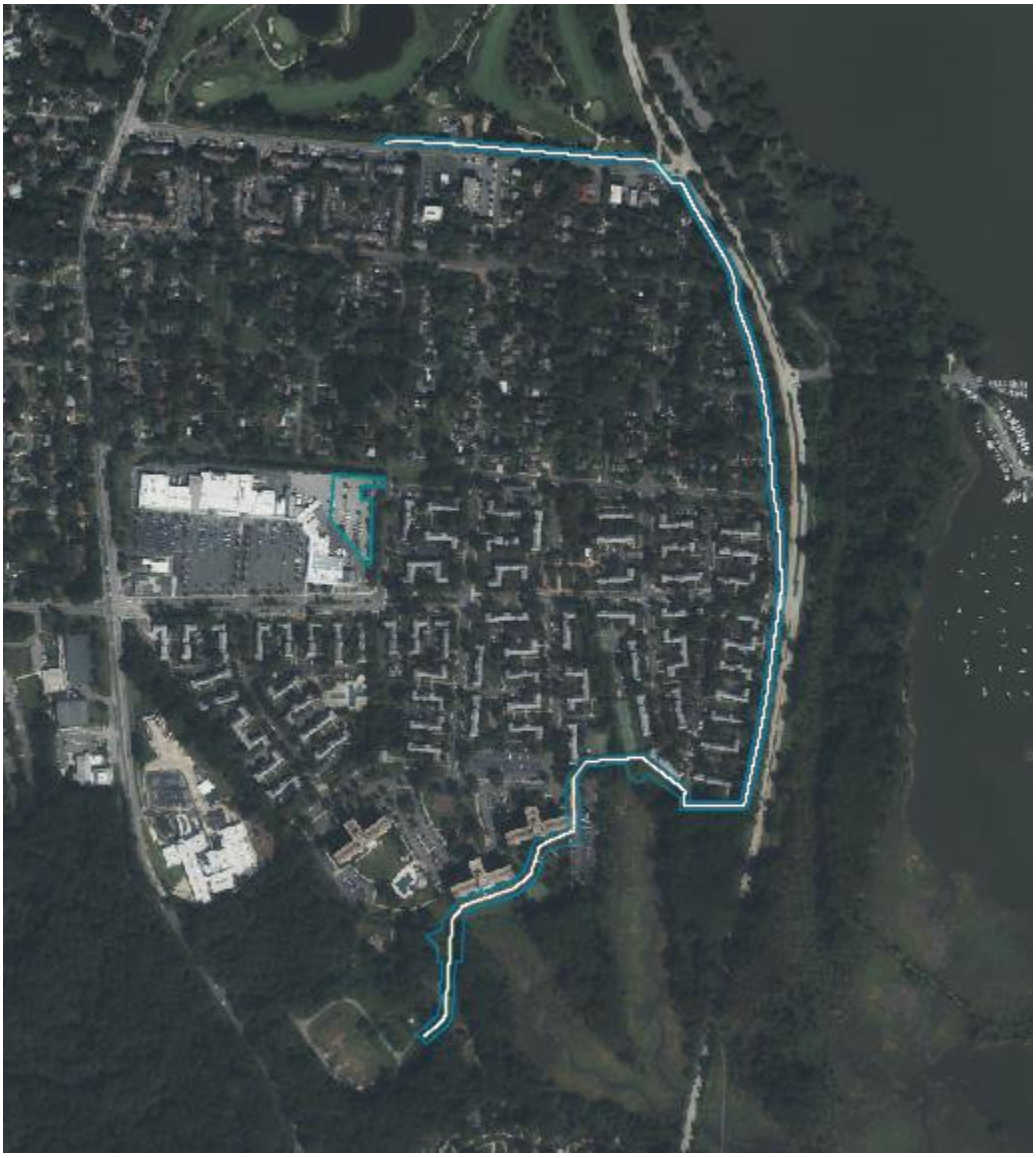


Figure A-5 Transmission power pole located near Arlington WPCP

3. APPLICABLE DESIGN STANDARDS AND CRITERIA

3.1 General

Improvements to site protection form floodwaters are required to follow federal, state, and local standards. This appendix combines all these standards to come up with the most effective safe design. Emphasis is on the use of USACE engineering circulars and manuals. Below are the list of standards referenced.

1. AASHTO 2018. A Policy on Geometric Design of Highway and Streets.197263

2. EM 1110-2-2102, Waterstops and Other Preformed Joint Materials for Civil Works Structures, U.S. Army Corps of Engineers, Washington DC; September 1995.

3. EM 1110-2-2104, Strength Design for Reinforced-Concrete Hydraulic Structures, U.S. Army Corps of Engineers, Washington DC; August 2003.

4. EM 1110-2-2502, Retaining and Flood Walls, U.S. Army Corps of Engineers, Washington DC; 29 September 1989.

5. EM 1110-2-2705 - Structural Design of Closure Structures for Local Flood Protection Projects

6. ENGINEERING PRINCIPLES AND PRACTICES Chapter 5-Design of Floodwalls and Levees, FEMA (44 CFR60.3(c)(2))

7. Standard Specifications for Municipal Roadway and County Roadway in New Jersey

3.2 Design Criteria

The floodwalls for Airport and Arlington WPCP were designed to the maximum water surface elevation inundation for the 500-year Coastal Flood Event Sea Level Rise (2080) and three feet freeboard. The Four Mile Run and Belle Haven were designed for 100-year Coastal Storm Event, Sea Level Rise (2080) and three feet freeboard. The foundation of the selected T-wall was designed to have the lightest possible footing base and the smallest possible width given the restrictions associated with the uncertain soil conditions. Flow rate for the maximum cubic footage of water passing into the bypass culvert was supplied by the H&H Engineer. The roadway elevation design incorporated the existing road undergoing reclamation and the proposed elevated portion used the new materials.

3.2.1 Civil

AutoCAD Civil 3D will be used to create the alignments, profiles, cross sections and layouts for the floodwalls, road elevations with design guidance from EM 1110-2-2502, Retaining and Flood Walls and ENGINEERING PRINCIPLES AND PRACTICES Chapter 5-Design of Floodwalls and Levees, FEMA (44 CFR60.3(c)(2)).Specifications, base design and preliminary estimates from the Sponsor and flow rates from the H&H engineer enable the complete design of the bypass culvert. thickness set, and foundation dimensions.

3.2.2 Structural and Geotechnical

No Structural analysis has been completed at the time. Typical detail for T-Walls and I-walls are provided for refence to cost and impact to the project. See Appendix D for Geotechnical analysis

3.3 Design Considerations

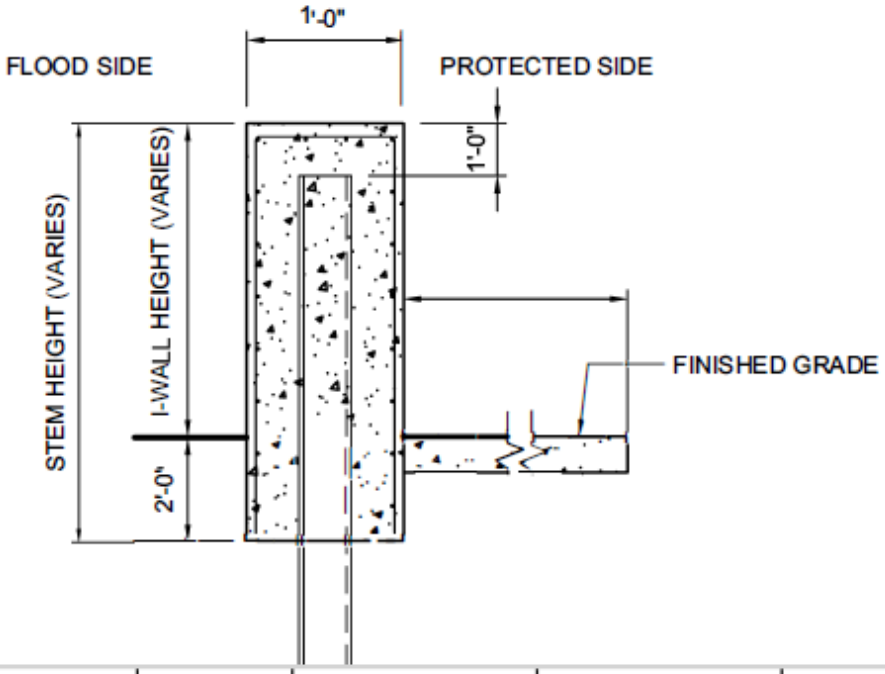
3.3.1 Interior Drainage

Interior drainage always forms a part of the FRM structure. Interior drainage represents all water runoff, seepage (water going under or thorough the levee), and water collection on the landward side of the levee system. The analysis for interior must identify and demonstrate the potential runoff paths from the impacted drainage area. Since the design was on the feasibility level, 4 culvert and 4 pump stations were assigned to the various floodwall systems. See appendix for additional H&H analysis.

3.3.2 Utility Incorporation into the Design:

No underground utility analysis has been completed at the time.

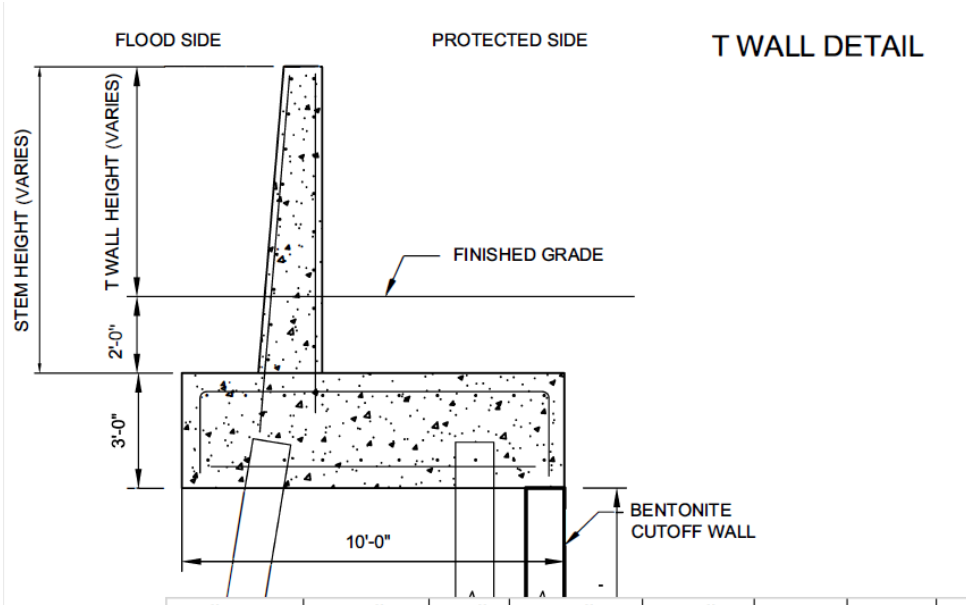
I-Wall Detail



I-Wall				
Length	Height	Stem Height	Width	Conc. Vol
FT	FT	FT	FT	CY/LF
960	3	5	1	0.19
2415	4	6	1	0.22
908	6	8	1	0.30

NOTES:

1. ALL CONCRETE SHALL HAVE A 28 DAY STRENGTH OF 4000 PSI.
2. ALL REINFORCEMENT SHALL HAVE AN FY=60 KSI
3. BENTONITE SLURRY WALL SHALL BE BY EXCAVATION AND PUMPING.
4. ALL SHEETPILE SHALL BE ASTM A 572 PZ 35 SHEETPILE. UNO AS ON THE COMBO WALL.
5. "I-WALL HEIGHT" AND "T-WALL HEIGHT" REFER TO THE EXPOSED HEIGHT OF THE WALL ABOVE GROUND
6. PIPE PILE (PP) SHALL BE ASTM A 500 GRADE B.



T-Wall Length	Wall Height	Wall Width	Wall Stem height	Wall Vol	Basse Width	Base Height	Base Vol	Total Conc Vol
LF	FT	ft	FT	cy/ft	FT	FT	cy/ft	CY/LF
3448	7	1	9	0.46	10	3	1.11	1.57
1300	9	1	11	0.59	10	3	1.11	1.70
60	5	1	13	0.74	10	3	1.11	1.85