



A Risk-based Approach to Prepare Utility Infrastructure for Storms Ahead

Considerations of a Proactive Utility in Coastal Virginia

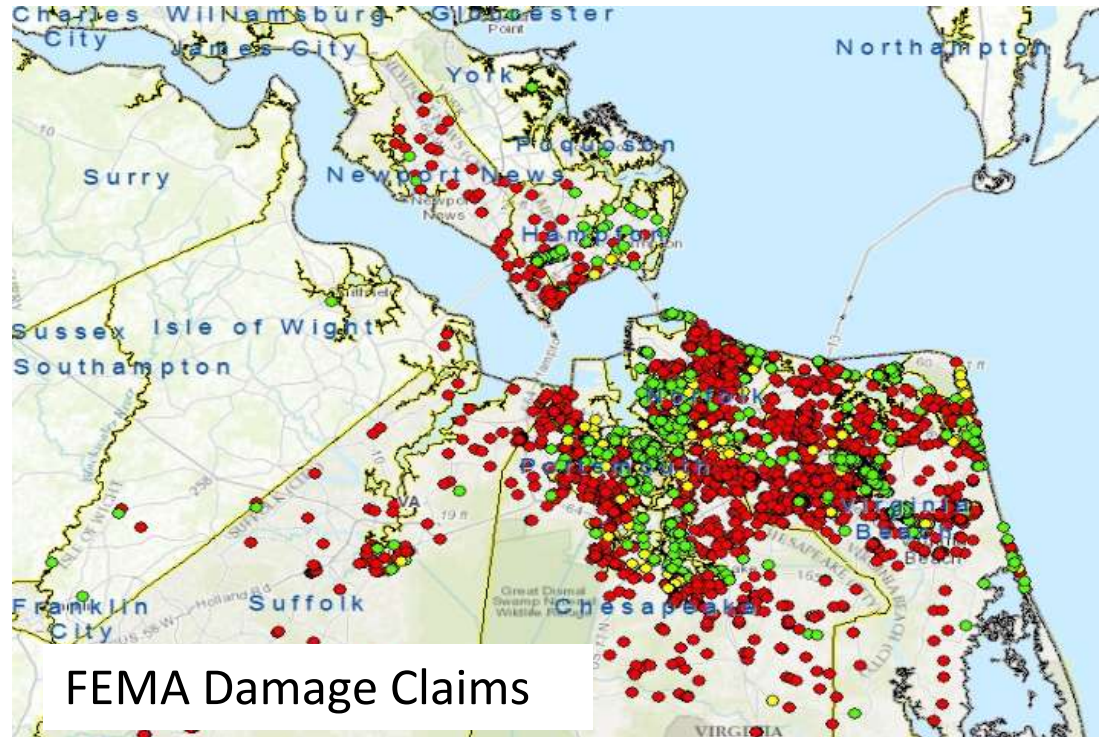
NEWEA
January 26, 2022

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Irvington, NJ near Newark



FEMA Damage Claims

Tropical Storm Ida:
6.4" of rain in 3 hours (a 2000-
year event)
8.4" total

Hurricane Matthew:
12 inches of rain, and
12 inches of rain 16 days
prior to the event



Climate Change Planning is Long Range

- Climate Change Plan will address the next 80 years of climate change impacts
- This 1st version of the plan will be developed to provide a foundation for future updates and utilize varying levels of detail based on the timeframe and magnitude of facility vulnerability
- Focused on climate change related flooding impacts

Climate Change Plan

Key Data Inputs

- Flood elevations database
- Vulnerability cost and losses database
- Mitigation costs, benefits, Benefit Cost Ratio (BCR) values

Decision Support Tools

- Visualization dashboard
- Aggregated view of vulnerability and mitigation
- Ability to modify the implementation schedule

Project Documentation

- Highly visual executive summary
- Technical report and appendices
- Product examples to support future implementation

Vulnerability Assessment and Flood Mitigation Analysis Approach

Characterize Critical Equipment: Core Functions / Assets and Costs

Conduct Site Visits & Inspect Plans:
Elevation of Lowest Point of Entry of Water and Core Function Assets

Flood Elevation & Hazard Determination

Establish Site-Specific Flood Mitigation Measures and Costs

Calculate Flood Risk: Annualized Losses Over Time / Benefit-Cost Ratio

Fact Sheets & Dashboard Visualization for HRSD Stakeholders

Core Functions and Critical Assets



Technical Memorandum

To: Anas Malkawi and Robert J. Martz
 From: Kraig R. Schenkelberg
 Date: August 13, 2020

Subject: HRSD Climate Change Planning Study [240796]
 Work Order 2, Task 2.5 – Initial Identification of Core Functions and Critical Assets
Core Functions and Field Visit Summary Technical Memorandum

1.0 Purpose

This technical memorandum (TM) summarizes the proposed identification and ranking of core functions for assets at Hampton Roads Sanitation District (HRSD) pump stations (PSs, including Pressure Reducing Stations) and treatment plants (TPs) in the HRSD Climate Change Planning Study. This TM also summarizes the findings of initial facility visits conducted on January 22 and 23, 2020 with a follow-up visit on February 27, 2020.

2.0 Definitions

The following defines important technical terms that will be used in this TM and throughout the HRSD Climate Change Planning Study:

Asset – HRSD defines an asset through a series of questions and paths, shown in Figure 1, which illustrates steps for the creation of an asset in HRSD's Asset Management System. Questions include, "Is there an EPA or DEQ requirement associated with [the] item?" Or, "If [the] item failed would it be replaced?" In summary assets generally reflect major pieces of equipment or processes.

Core Function – The core function of a facility is the primary purpose it serves. For example, a pump station's core function is to convey wastewater by introducing energy.

Critical Assets – "Assets that are identified as having the greatest potential to impact the achievement of organizational objectives (i.e. assets with the greatest relative consequence of failure)."¹ For the purpose of this study, critical assets are assets that are of great importance to achieving HRSD's core mission – to protect public health and the waters of Hampton Roads by treating wastewater effectively.

Unit Process – A step in the wastewater treatment process that is either physical, chemical, or biological.




Vulnerability – "Inherent state of a[n] asset or] system [of assets] that can be impacted by a natural hazard ..."²

Unit Process	Criticality				
	1	2	3	4	5
Plant Utilities					
Disinfection					
Influent Pumping (if applicable)					
Effluent Pumping					
Administrative Facilities					
Flow Storage/Equalization					
Preliminary Treatment					
Primary Treatment					
Secondary Treatment					
Distributed Control System					
Biosolids Thickening					
Biosolids Storage					
Biosolids Dewatering					
Sidestream Treatment					
Biosolids Anaerobic Digestion					
Biosolids Heat Treatment					
Biosolids Incineration					
Scum Disposal					
Biosolids Composting					
Biosolids Land Application					
Odor Control					
Liquid Industrial Waste					

Figure 2 – Treatment Plant Criticality as Established by HRSD

¹ Hampton Roads Sanitation District, Guidelines, Treatment Plant Asset Risk Assessment (2020 Draft)
² American Water Works Association, J100-10(R1.3) Risk and Resilience Management of Water and Wastewater

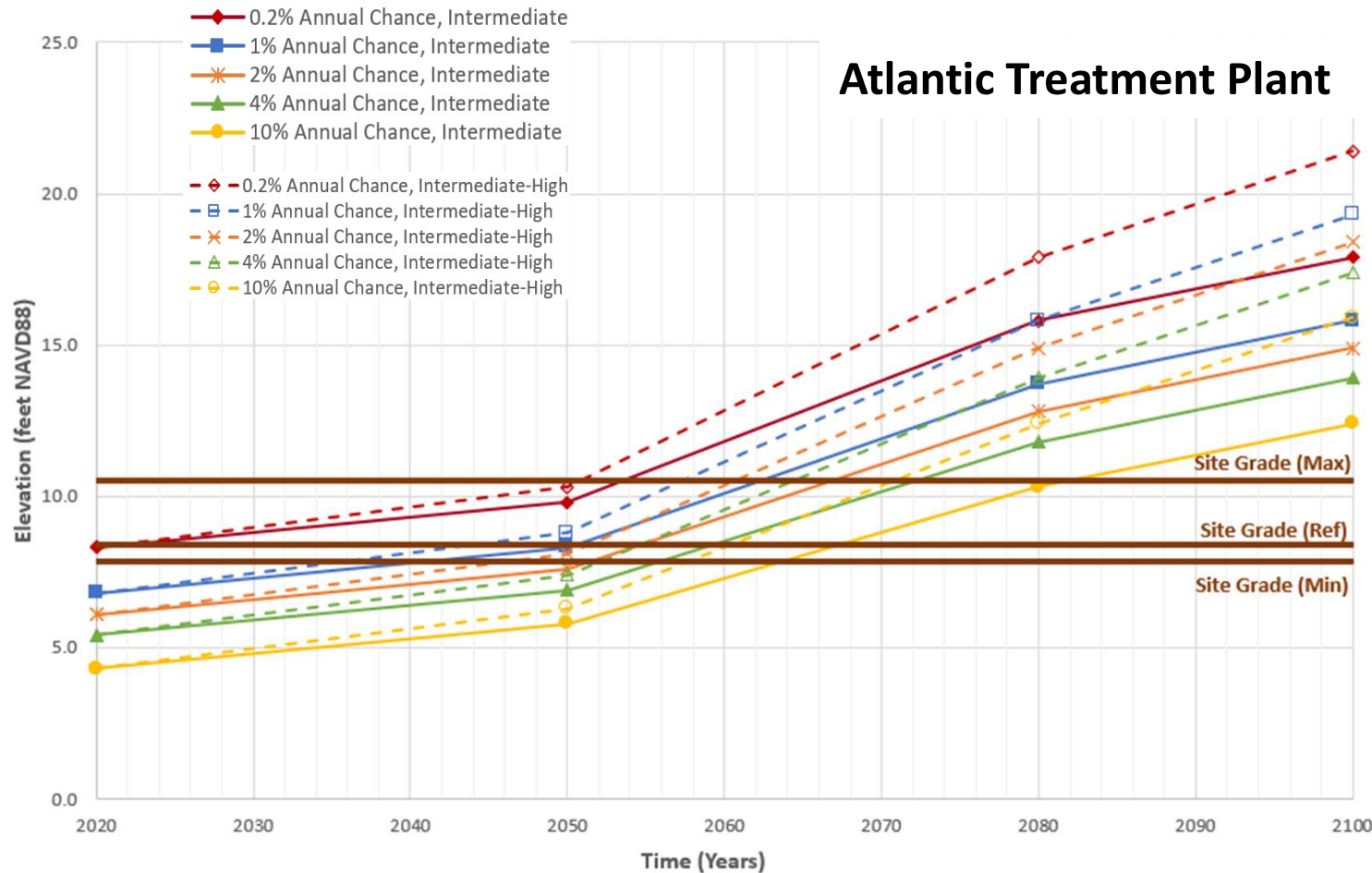
Flood Elevation & Hazard Determination

Flood Sources		Description
Coastal (storm surge)		Elevation estimated based on North Atlantic Coast Comprehensive Study (NACCS) modeling completed by USACE, includes sea level rise estimates (NOAA 2017).
Fluvial (riverine)		Elevation estimated based on FEMA Flood Insurance Study riverine profiles including sea level rise estimates (NOAA 2017).
Pluvial (rainfall)		Changes in future rainfall conditions based on Global Climate Models + local hydrology and conveyance capacity local drainage features, such as topography, pipes, ditches and culverts

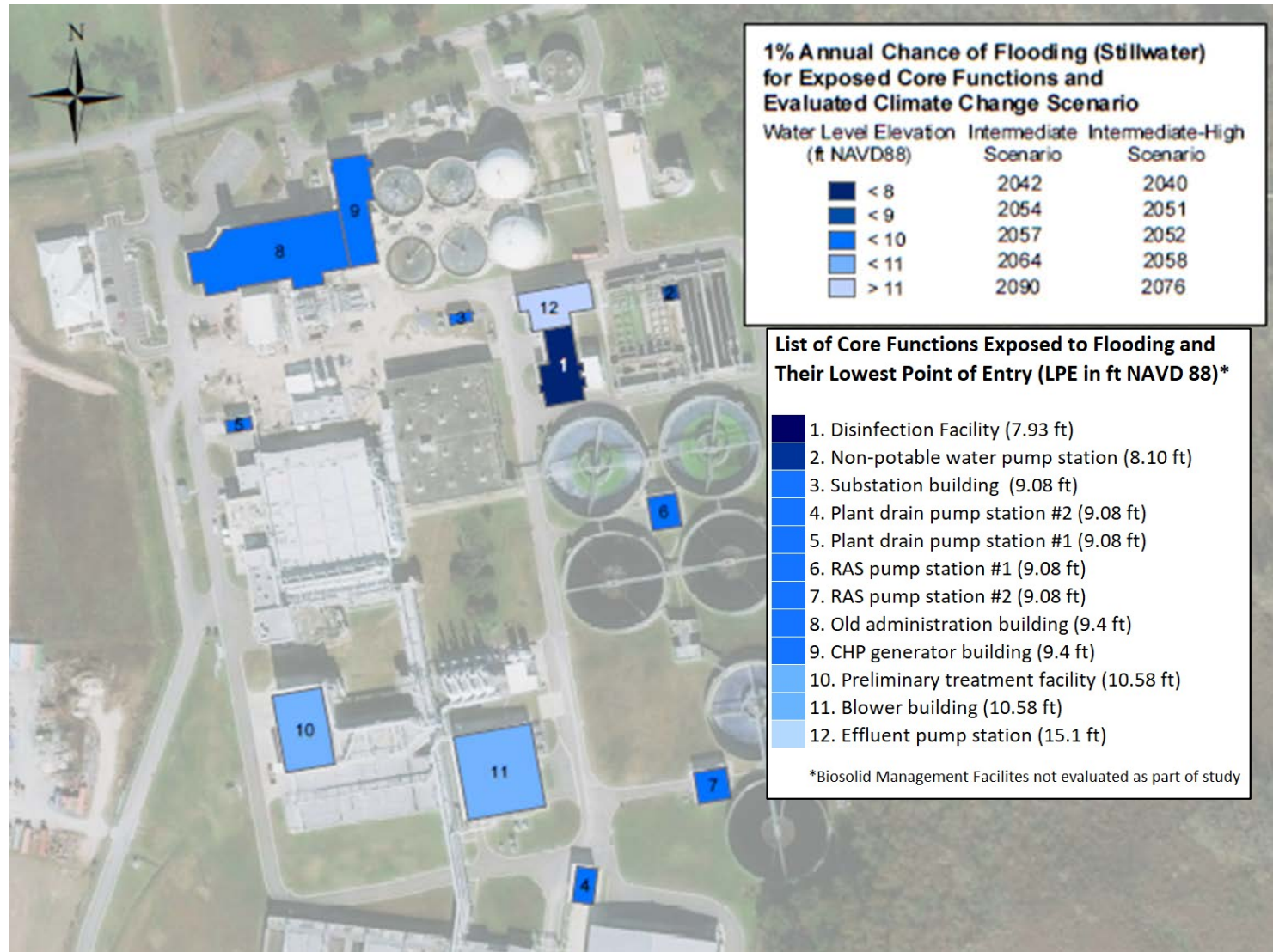
Flood Frequency Graph Example

- 5 Recurrence Intervals
- 1 Existing Condition
- 3 Planning Horizons (near term, medium term, long term) with 2 sea level rise conditions (intermediate and intermediate-high)
- 35 elevations

Atlantic Treatment Plant



Core Function Stillwater Flooding Exposure to the 1% Annual Chance Events



Determine Site-Specific Flood Mitigation Measures



Considerations:

- Understand site features (e.g. outside generator or bypass pump)
- Review site layout and physical constraints
- Consider site aesthetics and community acceptability

Considered Two Mitigation Measure Alternatives

Building Level/Process Level Mitigation Measures (\$20M)

- Dry floodproofing of buildings (e.g., stop logs)
- Raise outdoor equipment
- Floodwalls that surround each building (includes stormwater pumps)
- Protects critical assets only

Sitewide Flood Mitigation Measure (\$25M)*

- Berm
- Wall
- Stormwater Pump Stations
- Protects all assets, including biosolids processing and non-critical assets

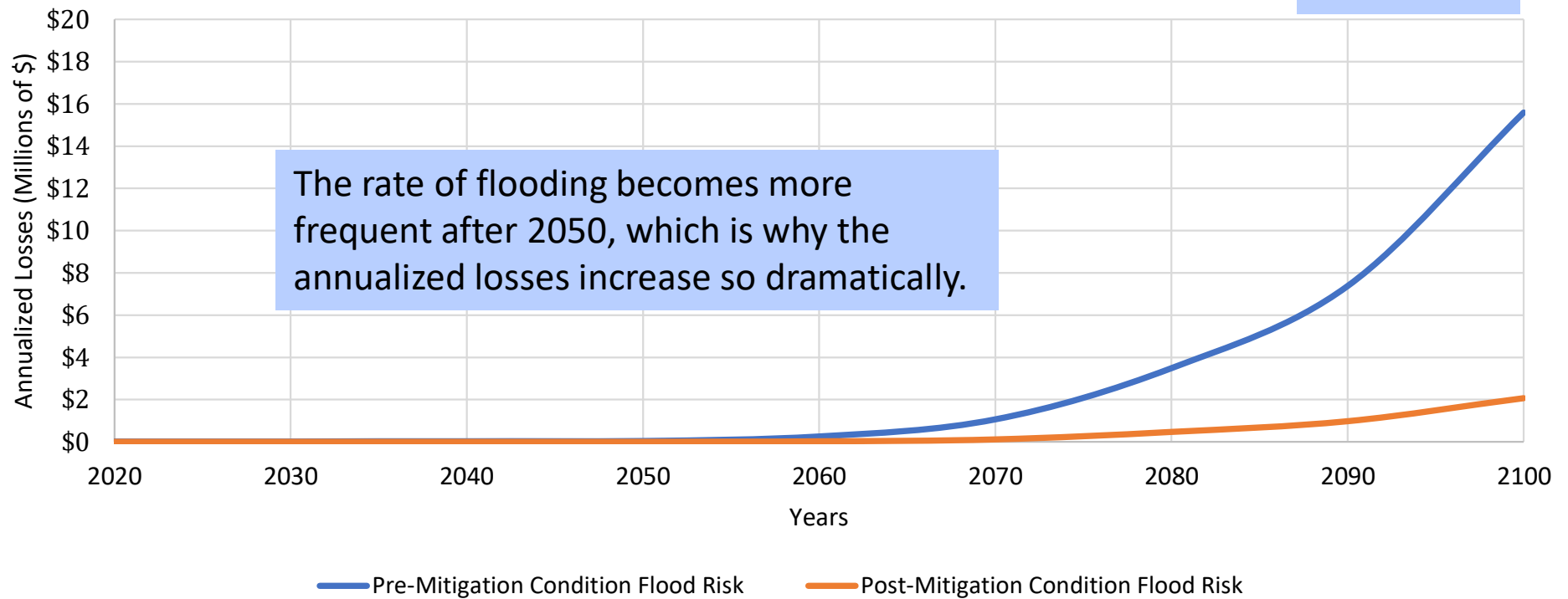
**Selected mitigation measure for the Atlantic Treatment Plant. Feedback from HRSD was that the building level mitigation measure may significantly pose daily operational challenges for staff and disrupt subsurface utilities during construction activities.*

Risk Results: Annualized Losses and BCR Atlantic Treatment Plant

Intermediate Climate Change Scenario

Flood Risk Over Time
(Intermediate Climate Change Scenario)

BCR = 0.91



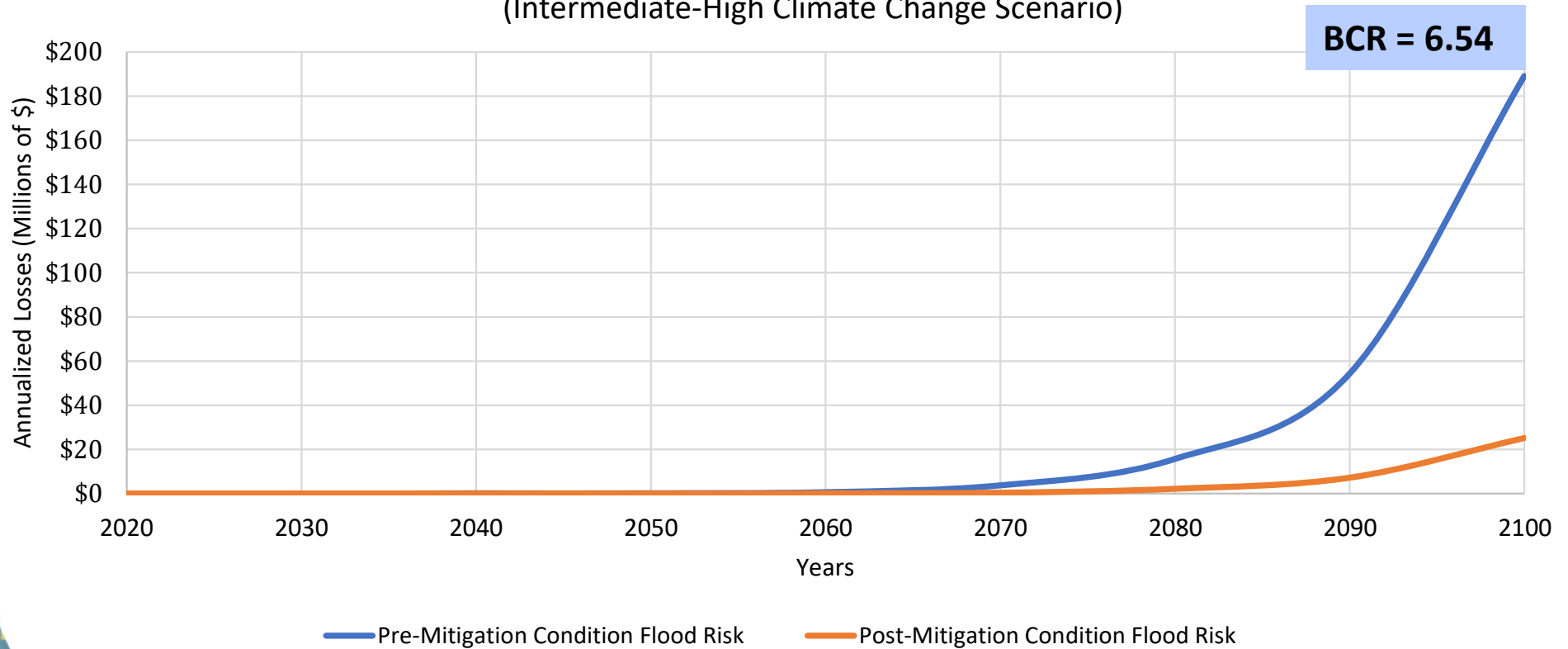
The rate of flooding becomes more frequent after 2050, which is why the annualized losses increase so dramatically.

Note: Risk results include the annualized losses and BCR for ~\$50M of critical assets at ATP (only). The flood risk would increase if all assets at ATP were included in this study (additional ~\$114M in non-critical asset value).

Risk Results: Annualized Losses and BCR Atlantic Treatment Plant

Intermediate-High Climate Change Scenario

Flood Risk Over Time
(Intermediate-High Climate Change Scenario)



Note: Risk results include the annualized losses and BCR for ~\$50M of critical assets at ATP (only). The flood risk would increase if all assets at ATP were included in this study (additional ~\$114M in non-critical asset value).

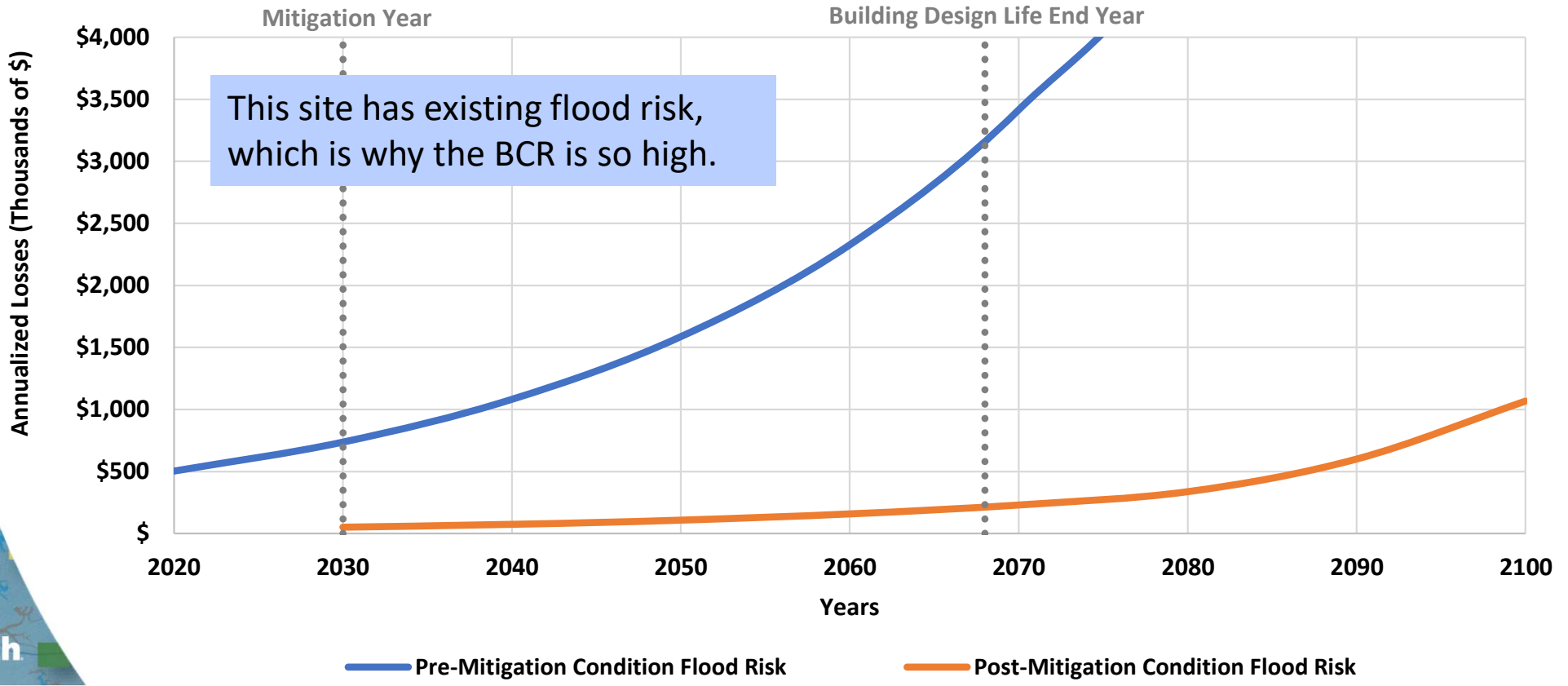
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Risk Results: Annualized Losses and BCR

Arctic Avenue
Pump Station Building

Intermediate Climate Change Scenario

BCR = 518.8



Communication Tools

Project Name: Arctic Ave PS
Mitigation Measure: Dry Floodproofing / Flood Wall / Flood Gate
Mitigation Year: 2030
Capital Cost (\$2020): \$644,000
Annual Maintenance (\$2020): \$500

Capital and Maintenance Costs (Future Value)

Flood Risk Over Time

Annualized Losses

Scenario: Intermediate

Project Description	Count	Cost
Wet Floodproofing	72	\$20,779,429
Dry Floodproofing	61	\$4,711,576
Elevate	16	\$46,265,250
Flood Gate	9	\$11,224,750
Flood Wall	5	\$20,912,500
Relocate	1	\$20,718,750
Total	166	\$133,612,255

Facility Type	Year	Cost
PRs	2031	\$82,256,750
North Shore	2031	\$26,867,000
Elevate	2031	\$14,772,000
WB-NS-PRS-LE-1	2092	\$2,300,000
WB-NS-PRS-215-1	2091	\$1,829,750
WB-NS-PRS-239-Interceptor	2035	\$2,812,500
WB-NS-PRS-LNG-1	2075	\$2,500,000
WB-NS-PRS-WC-1	2031	\$2,500,000
WB-NS-PRS-205-1	2037	\$2,329,750
Flood Gate	2050	\$687,500
Flood Wall	2050	\$10,937,500
Wet Floodproofing	2082	\$470,000
South Shore	2033	\$55,389,750
Elevate	2037	\$15,568,750
Flood Gate	2038	\$8,017,250
Flood Wall	2033	\$7,475,000
Relocate	2055	\$19,718,750
Wet Floodproofing	2015	\$4,610,000
PS	2030	\$39,830,505
North Shore	2034	\$6,081,517
Small Communities	2032	\$16,673,736
Dry Floodproofing	2033	\$1,692,215
Elevate	2033	\$1,692,215
Total	2030	\$133,612,255

Climate Change Planning Study Fact Sheet on Climate Change Flood Risk and Planning-Level Mitigation Measures

The purpose of this fact sheet is to summarize the current and future climate change related flood risk of an HRSD facility and present practical flood mitigation measures that HRSD could implement to reduce that risk.

Arctic Avenue Pump Station (SS-PS-101)

- Built: 1968
- Renovated: 2013
- Capacity: 10 MGD
- Public Service Areas: 1
- Private Service Areas: 0
- 2030 Population Estimate: 3,275

Figure 1: Flood and Infrastructure Elevations

Building Elevation: 10.6 ft (10.6 M) Mitigation Measures

7.3 Meter control center, meter and controller, electrical equipment, habbo panel, transfer switch

7.1 Building Lowest Point of Entry

3.0 Emergency Bypass Pump Lowest Point

1.5 Ground Level

-11.1 Pump

Not center (Oct. 2009)

Hurricane Sandy (Oct. 2012)

Hurricane Matthew (Oct. 2016)

Figure 2: Intermediate Climate Change Scenario Flood Risk as Annualized Losses Over Time

Annualized Losses (\$)

Year

Pre Mitigation Condition Flood Risk

Building Emergency Bypass Pump

Post Mitigation Condition Flood Risk

Project Description/Justification

- The Arctic Avenue Pump Station is at risk for flooding under current (Year 2020) conditions. This flood risk is exacerbated by climate change as shown in Figure 1 and 4.
- Coastal flooding** is the dominant flooding source as the site is at risk from storm surge for current and future sea level conditions. Proximity to the coast, local topography, and the storm return period are contributing factors.
- Dry Floodproofing with stop logs and a partial floodwall with a floodgate to an elevation of 10.6 ft NAVD88 are the preferred planning-level mitigation measures. The measures are expected to deliver a positive net value to HRSD (see BCR).
- 3.5 ft of flood protection (from the lowest points of entry) reduce the risk of flooding by agency bypass pump (from the lowest points of entry) reduce the risk of flooding by 34% over an assumed 48-year lifetime as illustrated in Figure 2.

Key Terms

- Intermediate Climate Change Scenario** shown in this fact sheet incorporates climate change flood projections through 2100 including from sea level rise (RCP4.5 2017 Intermediate Curve), storm surge, riverine, and surface water flooding from sources.
- Benefit Cost Ratio (BCR)** is the ratio of the monetized benefits (i.e. avoided losses) of the mitigation measure relative to the cost of constructing and maintaining the measure to deliver a positive net value. The greater the value above 1 the greater the expected net value.
- Annualized Losses** are a yearly measured flood risk based on the equipment repair cost for a facility that may be damaged during an extreme weather event.

Arctic Avenue Pump Station Planning-Level Flood Mitigation Measures

Hybrid Approach of the following:

- Dry Floodproofing** – Waterproofs a building by covering building openings, sealing walls and smaller openings prior to flooding events and removing covers afterwards.
- Floodwalls and Levees** – Protect a building from water and allow for continued operation of that building. They can also protect adjacent structures and infrastructure or include a floodgate as part of the floodwall or levee system that controls water flow.

Detailed Project Description and Technical and Operational Feasibility

Dry Floodproofing – removable stop logs on the east entrance and two south facing doors plus covers for two north facing weirs (6 inches in height) were assumed to be necessary to maintain access and airflow to all operations.

Building Mitigation – 7 ft long and 7 ft high (protection) partial floodwall surrounding the emergency bypass pump and leveraging an existing wall was assumed to be necessary and maintains the general aesthetics of the site.

Floodgate – a floodgate was assumed to be necessary on the western side of the emergency pump to permit access.

Site Pump Mitigation – Flood elevations over time with the current site grade and elevation of the planning-level mitigation measures. In the future, the flood protection provided by the planning-level mitigation measures should be re-evaluated as the station nears its useful life.

For comparison, when evaluating cost effectiveness, a cost estimate provided in Table 7 together with the planning level cost estimate for the 2030 mitigation measures.

Figure 4: Site Estimated Flood and Mitigation Measure Elevations Over Time

Mitigation Start

215 Center Flood Elevation*

215 Climate Flood Elevation**

Building Project Life (ft)

Existing Lowest Point of Entry

Mitigation Measure Lowest Point of Entry

Emergency Bypass Pump Lowest Point

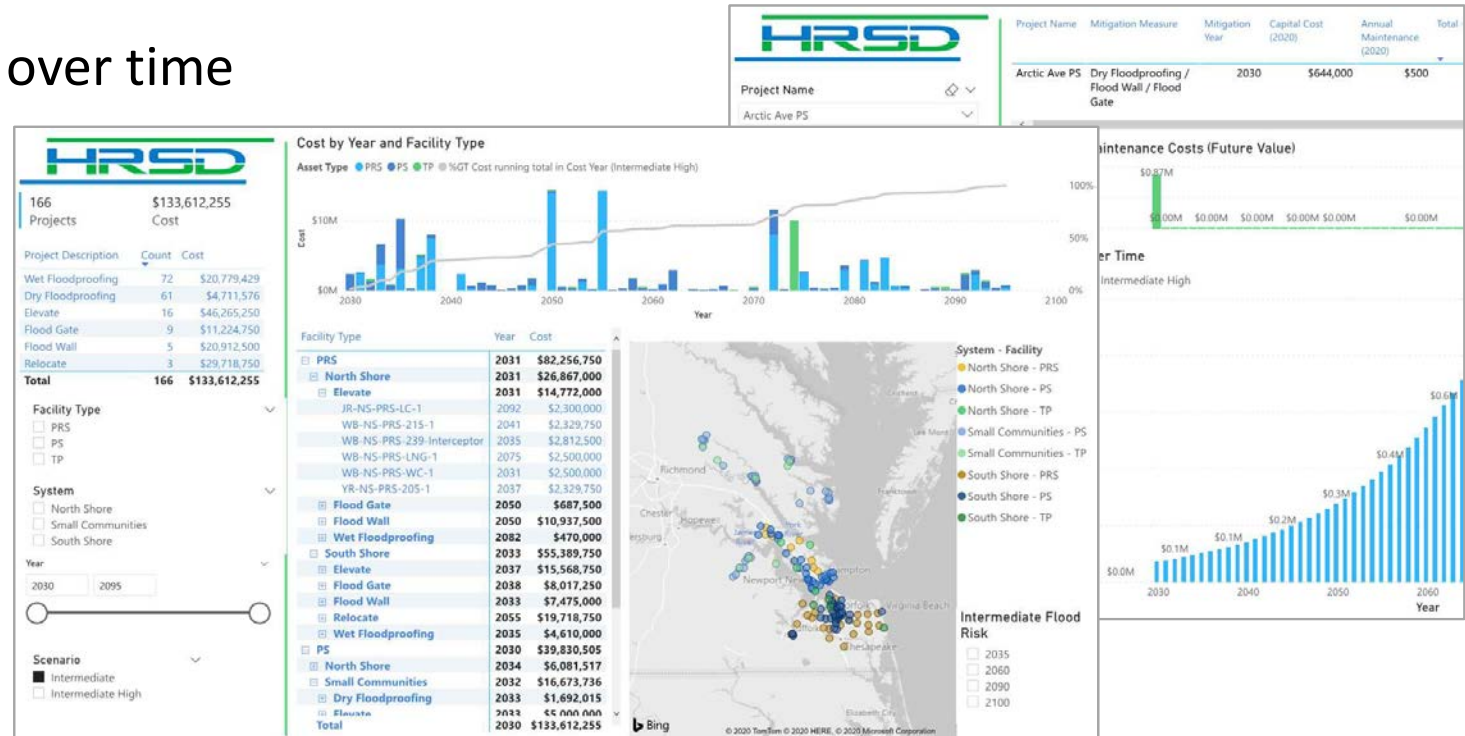
Site Grade

Years in 5-Year Increments

2020 2025 2030 2035 2040 2045 2050 2055 2060 2065 2070 2075 2080 2085 2090 2095 2100

Dashboard using PowerBI will Visualize Results for Decision Makers

- ✓ Visualizes, summarizes, and sorts by geography, system, asset type, or utility-wide: Customizable views for the user's needs
- ✓ Displays flood risk over time
- ✓ Conceptual level cost, schedule, and flood risk for selected flood mitigation measures



Questions | Thoughts | Comments

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