Volume I: Resilience Plan

FOR WATER, WASTEWATER, CHILLED WATER, AND RECLAIMED WATER SYSTEMS

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JEA Resilience Plan for Water, Wastewater, Chilled Water, and Reclaimed Water Systems

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This plan was produced as the final deliverable of the JEA Resiliency Program focused on evaluating flood risk and developing adaptation strategies to mitigate the identified flood risk for JEA's water, wastewater, chilled water, and reclaimed water systems.

This study included a regional analysis of the entire 900-square-mile JEA service area for the purposes of identifying facility vulnerability to future flood events and is not intended to be a site-level analysis for design purposes. However, the results are helpful in prioritizing improvement projects for critical and vulnerable facilities.

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Acronyms and Abbreviations

AACEI	Association for the Advancement of Cost Engineering International
B/C	benefit/cost ratio
BFE	base flood elevation (defined by FEMA as flood elevation associated with the 1% annual chance flood)
CIP	capital improvement plan
CWP	chilled water plant
eAM	enterprise asset management
FBC	Florida Building Code
FDEP	Florida Department of Environmental Protection
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Maps (these delineate special hazard flood zones and state base flood elevations)
GCM	general circulation model
GHG	greenhouse gas
I&C	instrumentation and controls
LOS	level of service
LS	lift station
MHHW	mean higher high water
mph	miles per hour
NAVD88	North American Vertical Datum of 1988
NCA	National Climate Assessment
NHC	National Hurricane Center
NOAA	National Oceanic and Atmospheric Administration
NPV	net present value
O&M	operations and maintenance
PM	project manager
RCP	representative concentration pathway
ROI	return on investment
SLR	sea level rise
SSO	sanitary sewer overflow
TM	technical memorandum
TO	task order
U.S.	United States
USACE	U.S. Army Corps of Engineers

WRF	water reclamation facility
WTP	water treatment plant
WWTP	wastewater treatment plant

Definitions

100-year Flood: This flood event is used as the basis for the Federal Emergency Management Agency's base flood elevation and is generally used to describe a storm with a 100-year return frequency; however, it is more accurately represented as an area having a 1-percent chance of flooding in any given year.

500-year Flood: This flood event exceeds the 100-year event and is generally used to describe a storm with a 500-year return frequency; however, it is more accurately represented as an area having a 0.2-percent chance of flooding in any given year.

Adaptive Capacity: Ability of an asset to relatively easily, or at low cost, adjust to or be modified to accommodate changing conditions to minimize related impacts.

Assets: Individual system components at a facility, such as a motor, pump, electrical panel, transformer, or building.

Benefit/Cost Ratio: Total discounted benefits divided by total discounted costs for a quick determination on economic efficiency.

Booster Lift Station: A wastewater pump station strategically located to decrease pressures at upstream pump stations for long-distance force mains.

Calibrated Flow Model: Tool used to assess capacity and flow in distribution or collection system piping.

Criticality: An asset's importance to maintain primary system function in terms of the system's operational capacity to avoid a loss of service. Critical buildings served by an asset or facility also contribute to its criticality, such as hospitals, or evacuation shelters.

Consequence: Impacts to services, including interruptions in service delivery based on failure of assets or facilities to perform intended function.

Benefit/Cost Analysis: Total discounted benefits divided by total discounted costs for a quick determination on economic efficiency.

Design Flood Elevation: This is a term used by the American Society of Civil Engineers and Federal Emergency Management Agency (FEMA) to describe locally adopted base flood elevations that exceed the FEMA base flood elevation. This term is not used in this guide to avoid confusion with modeled flood elevation and minimum design elevation.

Dry Floodproofing: A form of asset hardening that prevents exposure to flood inundation through the use of flood barriers, sealed building envelopes, and water-tight cabinets or enclosures. This strategy is applied to assets or facilities up to the minimum design elevation when not elevated.

Elevating: A flood mitigation strategy to elevate sensitive equipment and buildings above the anticipated flood elevation to the recommended minimum design elevation to avoid possible impacts from flood inundation.

Exposure (Flood): The proximity of a given asset or facility to the extents of a specific flood event.

Facility: A single site location containing multiple infrastructure assets supporting a single facility type.

Facility Criticality: The degree to which JEA facilities serve critical and priority customers, maintain high flows, and are depended upon by other JEA systems to meet the intended level of service.

Facility Type: Category of facilities in JEA's water, wastewater, chilled, and reclaimed water systems, such as lift station, repump station, booster station, etc.

Flood Barriers: Devices that provide a physical, water-tight barrier used to hold back flood water and protect entire facilities, buildings, or other assets. These can be operable or fixed.

Flood Exposure: The proximity of a given asset or facility to the extents of a specific flood event.

Floodproofing: A flood mitigation strategy to protect sensitive assets against damage resulting from flood inundation, including the use of both wet and dry floodproofing.

Flood Risk: Measure of impact of flooding on a facility, calculated based on a facility's likelihood and criticality score.

Flood Sensitivity: The degree to which an asset or facility may be impacted or damaged by temporary flood inundation, resulting from asset composition and materials.

Freeboard: The distance (in feet) above a stated flood level that an asset is elevated to provide additional level or protection.

Hardening: A flood mitigation strategy that includes wet and dry floodproofing intended to protect sensitive assets from flood damage when elevating cannot be used.

High Emission Scenario: A global climate projection for greenhouse gas emissions, referred to by many scientists as a high probability future scenario, corresponding to a continued increase in concentrations of greenhouse gases and atmospheric warming that will result in increased water temperatures and elevated sea levels.

Likelihood: Probability of an identified threat impacting JEA assets.

Minimum Design Elevation: Comprised of the *anticipated future flood elevation + freeboard*, this is the minimum elevation established to protect a facility or asset from flood damage through either elevating or hardening strategies.

Mitigation: The act of reducing high-risk situations.

Net Present Value: Present value benefits minus present value costs.

Planning Horizons: The 2040, 2070, and 2100 scenarios for which the future conditions flood models could be run to evaluate flood risk at JEA facilities.

Potable Water Booster Station: Pump station strategically located to increase pressure in the potable water distribution system.

Potable Water Repump Station: A pump station strategically located in the potable water distribution system containing water storage to inject into the system to maintain system pressure and flow.

Prioritization: Identification of facilities based on their highest priority to maintain system operation and service reliability, considering multiple performance metrics including regulatory compliance, health and safety, and flood risk.

Reclaimed Booster Station: Pump station strategically located to increase pressure in the reclaimed water distribution system.

Redundancy: Having a secondary or backup system in place to prevent single point of failure of a given system to improve system reliability.

Relative Sea Level Change: Changes in the ocean's surface elevation relative to local factors such as subsidence, upstream flood control, erosion, regional ocean currents, variations in land height, and whether the land is still rebounding from the compressive weight of Ice Age glaciers.

Resilience: The capacity of individuals, communities, or systems to survive, recover, adapt, and thrive in the face of chronic stresses and acute shocks.

Return on Investment: $ Net Return/$ Cost = Net Present Value/$ Cost, based on the dollars netted for each dollar invested.

Return Period: A recurrence interval between specific severe weather events, such as flooding, often stated in terms of 2-, 5-, 10-, 25-, 50-, 100-, and 500-year intervals; typically used to determine flood probability and design criteria.

Sensitivity (Flood): The degree to which an asset or facility may be impacted or damaged by temporary flood inundation, resulting from asset composition and materials.

Service Life: The life of a system based on its type: 25 years for mechanical and electrical systems and 50 or more years for structures/buildings.

Vacuum Station: Small pump station, typically located on private property, that is used when a gravity system is not practical.

Vulnerability: A state of exposure and sensitivity to identified hazards, which can be partially mitigated through adaptive capacity and redundancy. Represented by the following equation: (Exposure + Sensitivity) / (Adaptive Capacity + Redundancy).

Wet Floodproofing: A form of asset hardening that uses non-sensitive materials to prevent damage to an asset or facility. This strategy is applied to assets or facilities up to the minimum design elevation when assets cannot be elevated or where dry floodproofing is cost prohibitive.

Executive Summary

ES.1 Introduction

Located in Jacksonville, Florida, JEA is the seventh largest community-owned electric utility company in the United States and the largest in Florida. On the water and wastewater side of the utility, JEA owns and operates more than 1,400 wastewater lift stations, 11 water reclamation facilities, 134 wells, 37 water treatment plants, and 4 chilled water plants, which collectively serve nearly 420,000 customer accounts and over 1.5 million people across a 900-square-mile service area spanning four counties.

Severe weather impacts and storms since 2016 have caused electrical power disruptions and equipment failures resulting in service interruptions and sewer overflows. These events prompted JEA to develop this comprehensive and forward-looking infrastructure investment plan to reduce system risk and increase reliability and resilience against severe weather events.

ES.2 Background

In the summer of 2018, Jacobs began developing the Resilience Plan Framework for JEA's water, wastewater, chilled water, and reclaimed water systems, which guided the activities under the JEA Resiliency Program, encompassing multiple activities, including the following:

- System Resilience Plan (Task Order [TO] No. 3): Comprehensive assessment of flood vulnerability and risk associated with current and future flood scenarios and the development of adaptation strategies to mitigate the flood risk.
- Electrical, Instrumentation and Controls (I&C) System Assessment (TO 4): Review of electrical and I&C equipment to identify assets that may pose a risk to the reliability of the water, wastewater, and chilled water systems.
- Water Reclamation Facility and Conveyance System Hydraulic Capacity Assessment (TO 5): Hydraulic modeling of wastewater collection system/water reclamation facility (WRF) capacity to convey peak flows and meet the intended level of service today and in the future, under various flood conditions.

In addition to the activities above, which were the primary focus of the Flood Risk Assessment, focused condition assessments or project reviews were also performed at various JEA facilities. These assessments also contributed to the broader JEA facility assessment performed under TO 3 and included the tasks at the following facilities:

- TO 10 Cedar Bay Wastewater Treatment Plant (WWTP) electrical
- TO 12 Buckman WRF Outfall
- TO 15 Monterey WRF
- TO 16 Arlington East WRF effluent pump station
- TO 3 Flood exposure reviews and resilience guidance for ongoing capital projects including:
  - Talleyrand Lift Station Rehabilitation
  - 118th Street Lift Station Rehabilitation
  - Wilson Street Lift Station Rehabilitation
  - Buckman WRF Site Expansion

Within this Resiliency Program, each of the above activities were coordinated to identify system weaknesses that could result in service interruptions or system failures. JEA recognized the importance of this comprehensive system assessment approach to ensure continued service reliability and to protect the health and safety of its customers.

ES.3 Purpose

This Resilience Plan serves as an action-oriented guide to position JEA for long-term reliability and resilience for potable water, wastewater, chilled water, and reclaimed water systems through identification of flood risk, development and prioritization of mitigation strategies, and the incorporation of aggressive design standards for future capital projects.

The vulnerabilities identified during the system assessments are combined to collectively inform capital investment priorities to maintain safe and reliable services and avoid future system interruptions or sanitary sewer overflows during severe weather, flood events, and other common system hazards. The analysis of flood risk is aimed to evaluate asset level vulnerabilities to multiple flood mechanisms including rainfall, extreme tides, storm surge, and sea level rise. This analysis focuses on current and future risk over the service life of assets.

Through a variety of adaptation strategies, capital projects are recommended to mitigate the identified flood risk using cost-effective strategies focused on the right investment at the right time. The vulnerabilities and mitigation strategies are evaluated at the asset level, which is then summarized at the facility level to guide the prioritization of capital investment through rehabilitation projects. The term “assets” is used to represent individual electrical/mechanical components such as motors, electrical panels, and transformers, as opposed to “facilities,” which represent all JEA infrastructure assets at one location.

Although this plan is focused on enhancing the reliability and resilience of infrastructure equipment, a review of water supply, staffing, vendor reliability, and other aspects of JEA system operations should also be considered to identify any potential threats and ensure operational continuity.

ES.4 Methodology

A total of 1,664 JEA facilities were initially reviewed and prioritized based on highest vulnerability and criticality. Of the 1,664 JEA facilities, 176 were identified as having high criticality and/or high flood exposure. Flood modeling was conducted under a range of future climate scenarios representing projections of future changes in rainfall and sea level rise to 2040 and 2070 (Section 3). An example of the flood modelling results for downtown Jacksonville is shown on Figure ES-1.

A vulnerability assessment was conducted for these facilities, which included an in-depth analysis of individual assets at each facility that might result in failure of the overall facility’s ability to provide service to JEA customers and protect JEA staff. The vulnerability assessment reviewed each asset’s function, systems, and site characteristics to identify facility vulnerability (Section 5). Facilities were scored based on flood exposure, sensitivity, adaptive capacity, and redundancy, using the equation:

Vulnerability = (Exposure + Sensitivity) / (Adaptive Capacity + Redundancy)

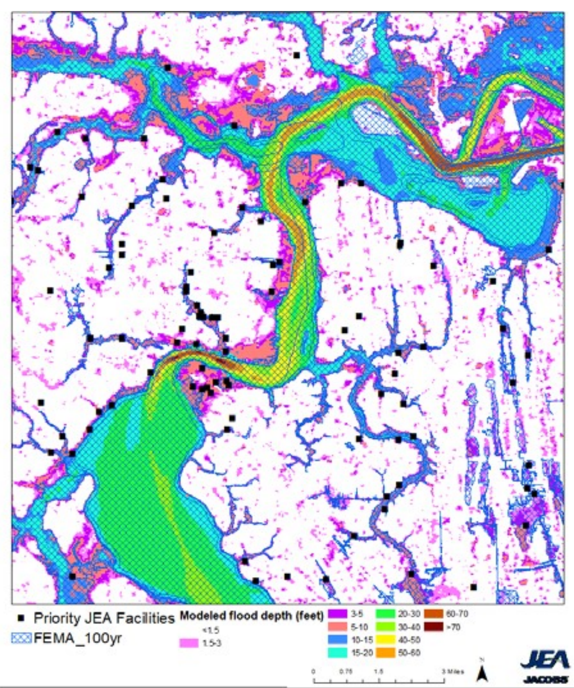


Figure ES-1. Sample Flood Map, 100-year Storm in 2070

Exposure (Flood): *The proximity of a given asset (or facility) to the extents of a flood.*

Sensitivity (Flood): *The degree to which an asset may be impacted/damaged by flooding.*

Adaptive Capacity: *Ability of an asset to accommodate changing conditions.*

Redundancy: *Having a backup system to prevent single point of failure.*

This analysis, along with additional input from JEA, ultimately reduced the previously identified 176 facilities down to 150 priority facilities, which were then included in a risk analysis. The risk analysis was quantified as the product of consequences times the probability of flooding, where the consequences were monetized using both the direct JEA facility impacts based on asset replacement cost and indirect impacts to JEA customers served by each facility (Sections 8.1 and 8.2, respectively). This assessment was used to identify a subset comprised of 40 facilities with the highest risk across all facility types for which site-specific adaptation strategies and cost estimates were developed. This subset of 40 critical and vulnerable facilities served as representative samples of each facility type for use in developing and applying cost curves across all 150 vulnerable JEA facilities (Section 6.2).

Results of the risk analysis were combined with the vulnerability assessment results to provide a risk and vulnerability profile for each asset or asset group, which was then used to inform mitigation strategies based on immediate opportunities, mid-range actions, and long-term design changes. The number of vulnerable facilities by facility type are shown on Figure ES-2.

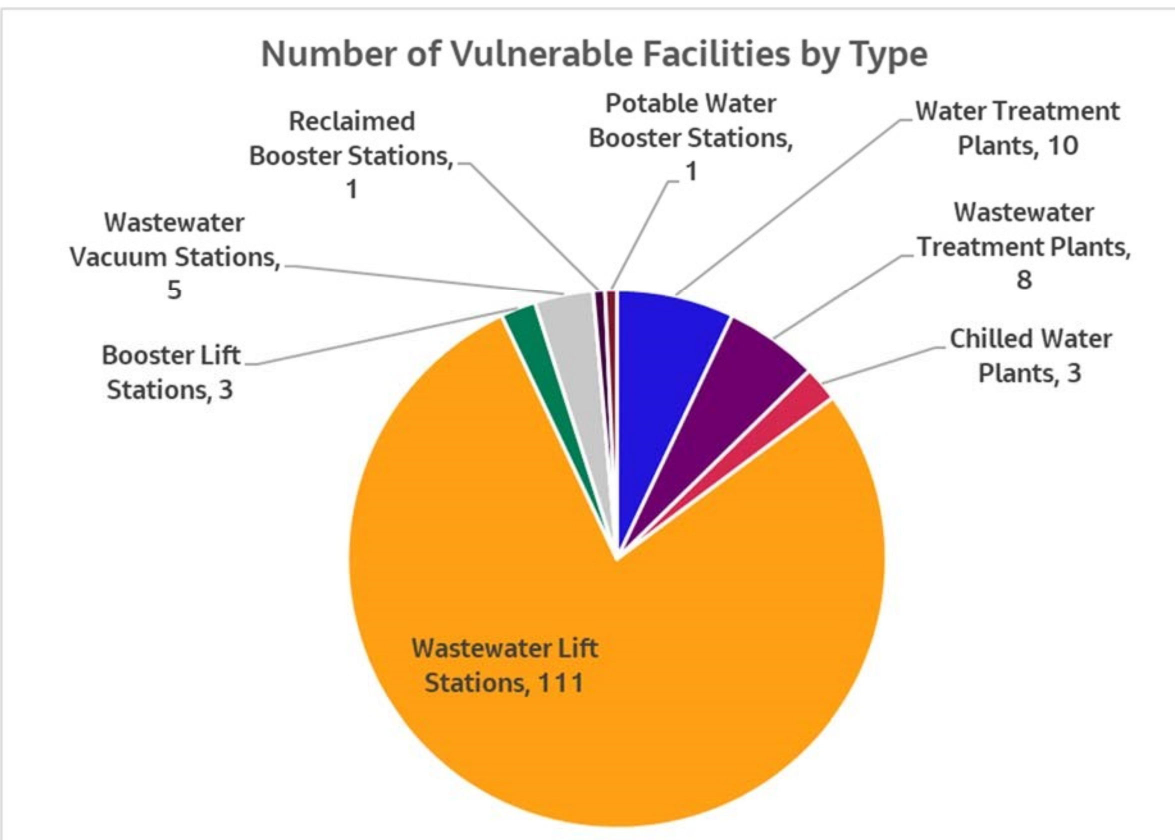


Figure ES-2. Number of Vulnerable Facilities by Type

The Jacobs team then developed applicable strategies that provide varying levels of protection to JEA's assets based on asset criticality and anticipated service life. These strategies were developed using the team's operational knowledge of JEA's water, wastewater, reclaimed water, and chilled water systems and supporting communications, electric supply, and instrumentation and controls (I&C) systems to ensure the strategies are practicable and cost effective to enhance each asset type. The adaptation strategies developed fall into three categories:

1) Elevation
2) Hardening
3) Flood walls/barriers

Example adaptation strategies are illustrated on Figure ES-3.

Cost estimates for each strategy and asset type were then developed. The recommended flood mitigation strategies are categorized as asset-based and facility-based. The hybrid category is comprised of a combination of the elevate and harden categories, using the most cost-effective strategy between them to form a complete solution to protect the vulnerable assets at each facility.

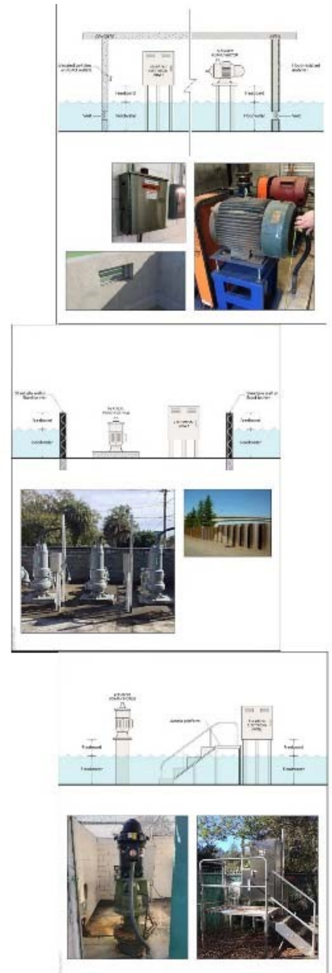


Figure ES-3. Adaptation Strategies

ES.5 Results

The following results provide a clear understanding of facility priorities related to flood risk to inform capital expenditure sequencing and phasing. The ultimate decision on capital project sequencing should also consider available funding, new development capacity needs, health and safety of customers, and other JEA priorities to ensure appropriate alignment with JEA's broader mission while continuing to reduce flood risk and enhance service reliability against the evolving flood threat.

The results of the facility vulnerability and risk analysis allow for facilities to be prioritized based on one of three perspectives:

- Risk (damage avoided)
- Return on investment (ROI) ($ net present valuate of benefits, i.e. risk minus cost, per $ invested in resilience)
- Capital Improvement Plan (CIP) prioritization metric, which includes three different metrics, including risk and ROI

The results based on each of these three perspectives are summarized below.

ES.5.1 Risk-Based Results

The combined risk quantified in dollars includes both direct impacts to JEA assets and business economic losses resulting from a loss of services. The risk was quantified for Flood Scenario 2 (100-year event in 2040), Flood Scenario 4 (100-year event in 2070), and Flood Scenario 7 (500-year event in 2070). The JEA facilities were grouped based on cumulative risk values according to ranges of avoided damages as depicted in Figure ES-4, which resulted in the facilities with the highest risk shown in Table ES-1 for Flood Scenario 4. The risk rankings for all vulnerable facilities are shown in the map on Figure ES-5. The percentage breakdown of monetized risk by facility type is shown on Figure ES-6. Section 6 provides a full list of facility risk ranking.

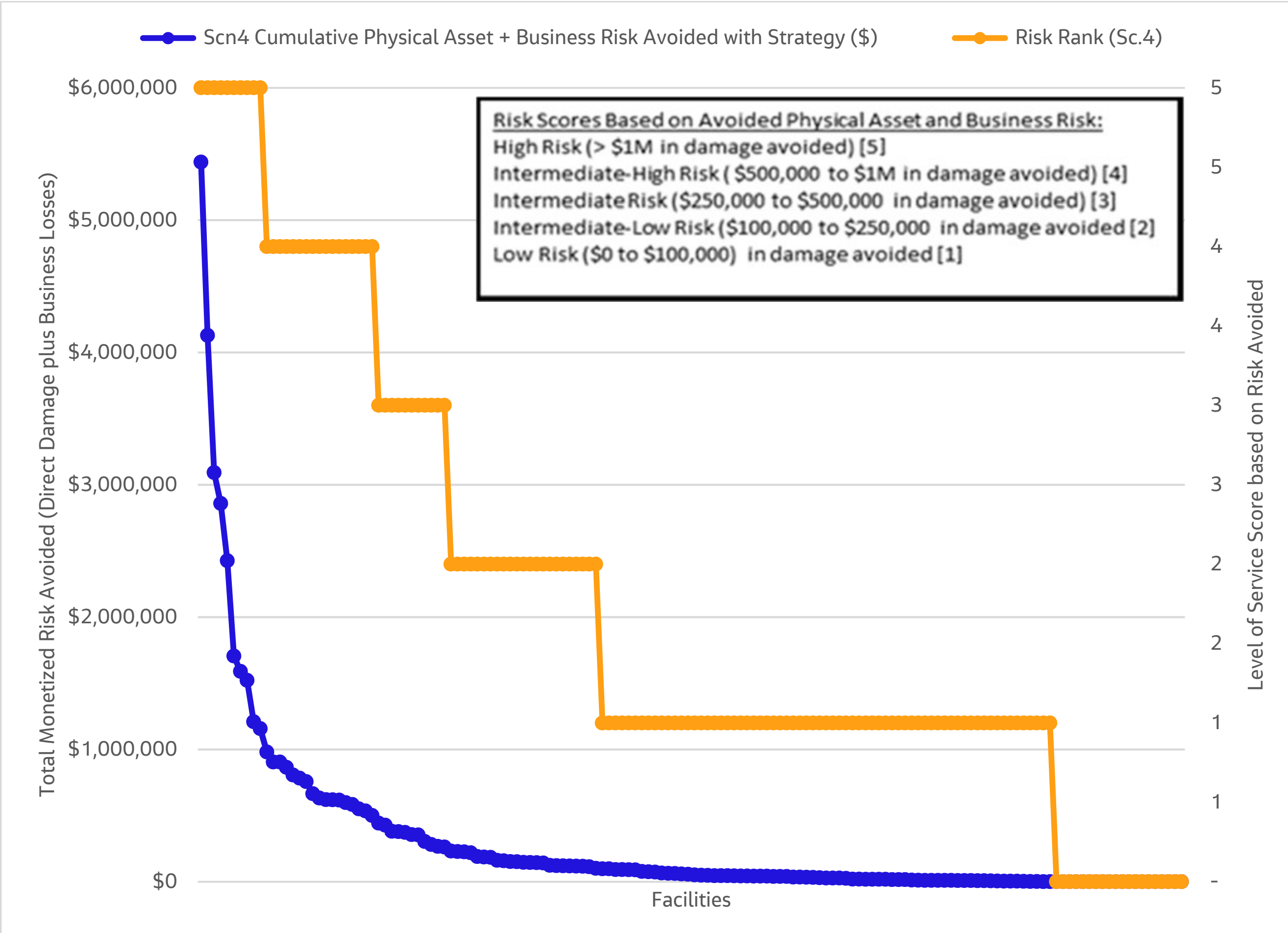


Figure ES-4. Cumulative Risk Scores Based on Avoided Direct and Secondary Impacts and Risk Rank (5,4,3,2,1) used in CIP Prioritization based on Flood Scenario 4.

Table ES-1. JEA Facilities with Highest Monetized Risks in Flood Scenario 4

Facility Name	Risk Avoided (combined direct and indirect)
2045 Utah Avenue Lift Station (LS)	$ 7,320,230
Main Street Water Treatment Plant (WTP)	$ 4,567,610
1202 Bunker Hill Boulevard Vacuum Station	$ 3,091,658
Southwest WRF	$ 3,767,425
Hendricks WTP	$ 2,425,512
7834 Holiday Road South LS	$ 2,148,808
1636 Talleyrand Avenue LS	$ 1,589,362
7200 AC Skinner Parkway LS	$ 2,218,486
Ponce De Leon WRF	$ 1,209,271
1023 Laura Street North LS	$ 1,360,946
Downtown Chilled Water Plant (CWP)	$ 980,358
Mayport WTP	$ 903,971

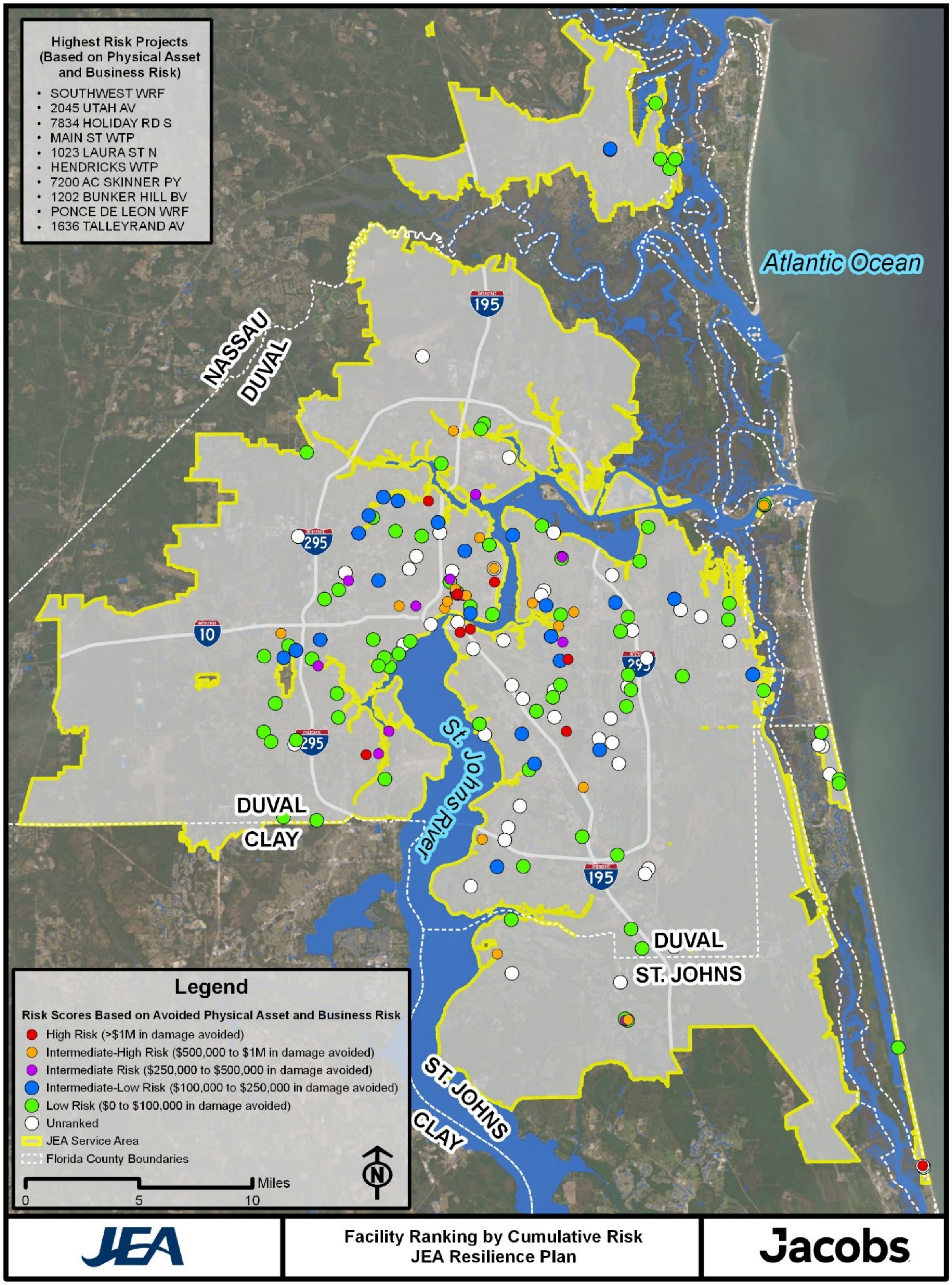


Figure ES-5. Map of Facility Ranking Based on Combined Risk (Physical Asset + Business Impacts) for Flood Scenario 4 (100-year storm in 2070).

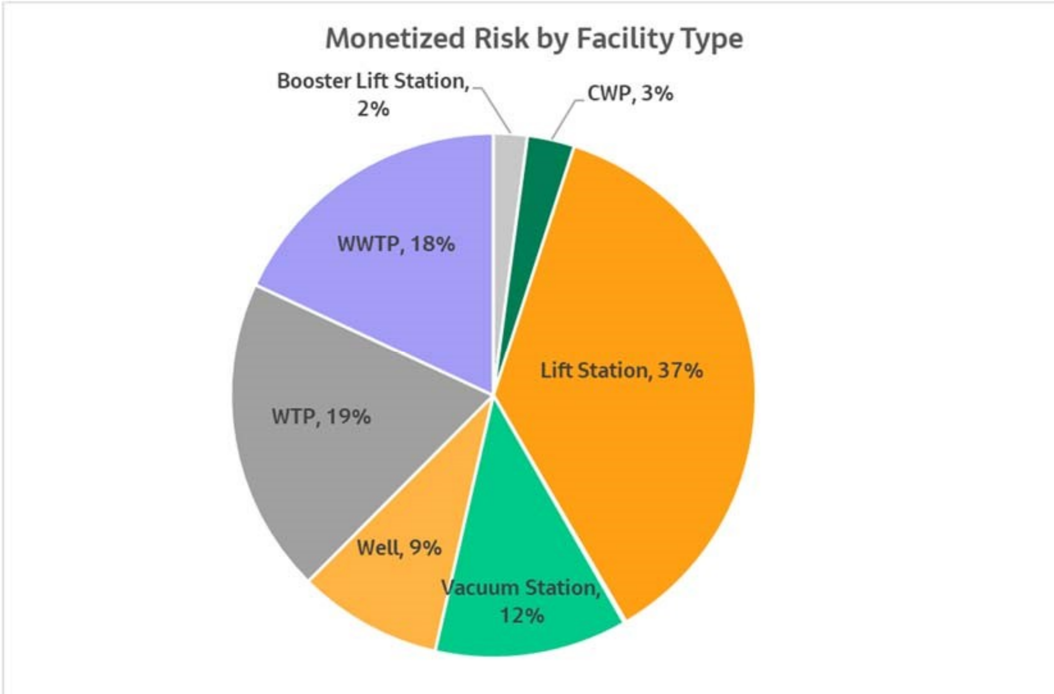


Figure ES-6. Monetized Risk Summarized by Facility Type

ES.5.2 ROI-Based Results

The ROI is used to measure the cost-effectiveness of capital investment in specific facilities to reduce flood risk and is defined as the Net Present Value (NPV) of benefits per dollar invested, that is the net combined benefits minus resilience strategy costs, divided by the strategy costs. Similar to risk ranking, the facilities were categorized into five groups based on their ROI ratio as shown on Figure 8-7 in Section 8. These five groups are shown in the map on Figure ES-7. Table ES-2 depicts the facilities with a high ROI ranking for each flood scenario evaluated as part of the economic assessment. Figure ES-8 illustrates the ROI for Scenario 4 for the top-ranked facilities compared to strategy costs, which shows that cost-effectiveness as measured by ROI does not reflect just total project costs. The full list of facilities and ROI rankings can be found in Section 8 and in Appendix G.

Table ES-2. Facilities with "High" ROI Ranking by Flood Scenario

Scenario 2 ROI Ranking	Scenario 4 ROI Ranking	Scenario 7 ROI Ranking
Southwest WRF	Southwest WRF	Arlington Wellfield Well No. 5
Main Street Wellfield Well No. 1	2045 Utah Avenue LS	2045 Utah Avenue LS
2045 Utah Avenue LS	Main Street Wellfield Well No. 1	Ridenour Wellfield Well No. 7
Ridenour Wellfield Well No. 7	Ridenour Wellfield Well No. 7	Main Street Wellfield Well No. 1
1636 Talleyrand Avenue LS	1636 Talleyrand Avenue LS	Main Street Wellfield Well No. 12
7834 Holiday Road South LS	7834 Holiday Road South LS	6630 Broadway Avenue LS
1706 Boulevard Avenue LS	3300 San Pablo Road South LS	7834 Holiday Road South LS
1023 Laura Street North LS	1706 Boulevard Avenue LS	1636 Talleyrand Avenue LS
1202 Bunker Hill Boulevard Vacuum Station	1023 Laura Street North LS	Brierwood Wellfield Well No. 5
Main Street Wellfield Well No. 3	1202 Bunker Hill Boulevard LS	834 Bay Street East LS
	210 Hollybrook Avenue LS	1023 Laura Street North LS
		Greenland Wellfield Well No. 2
		210 Hollybrook Avenue LS

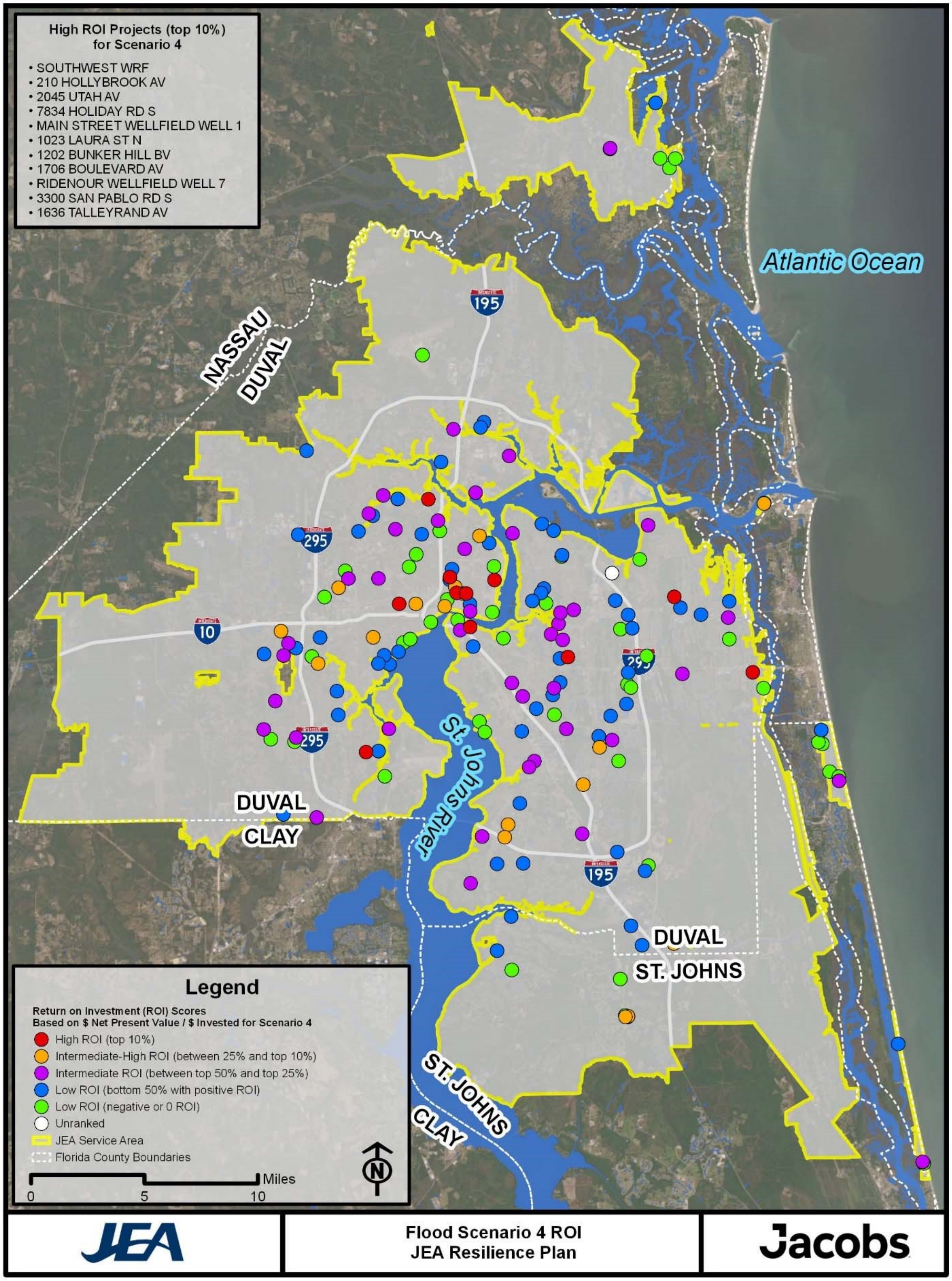


Figure ES-7. Map of Facility Ranking Based on Return on Investment for Scenario 4 (100-year storm in 2070).

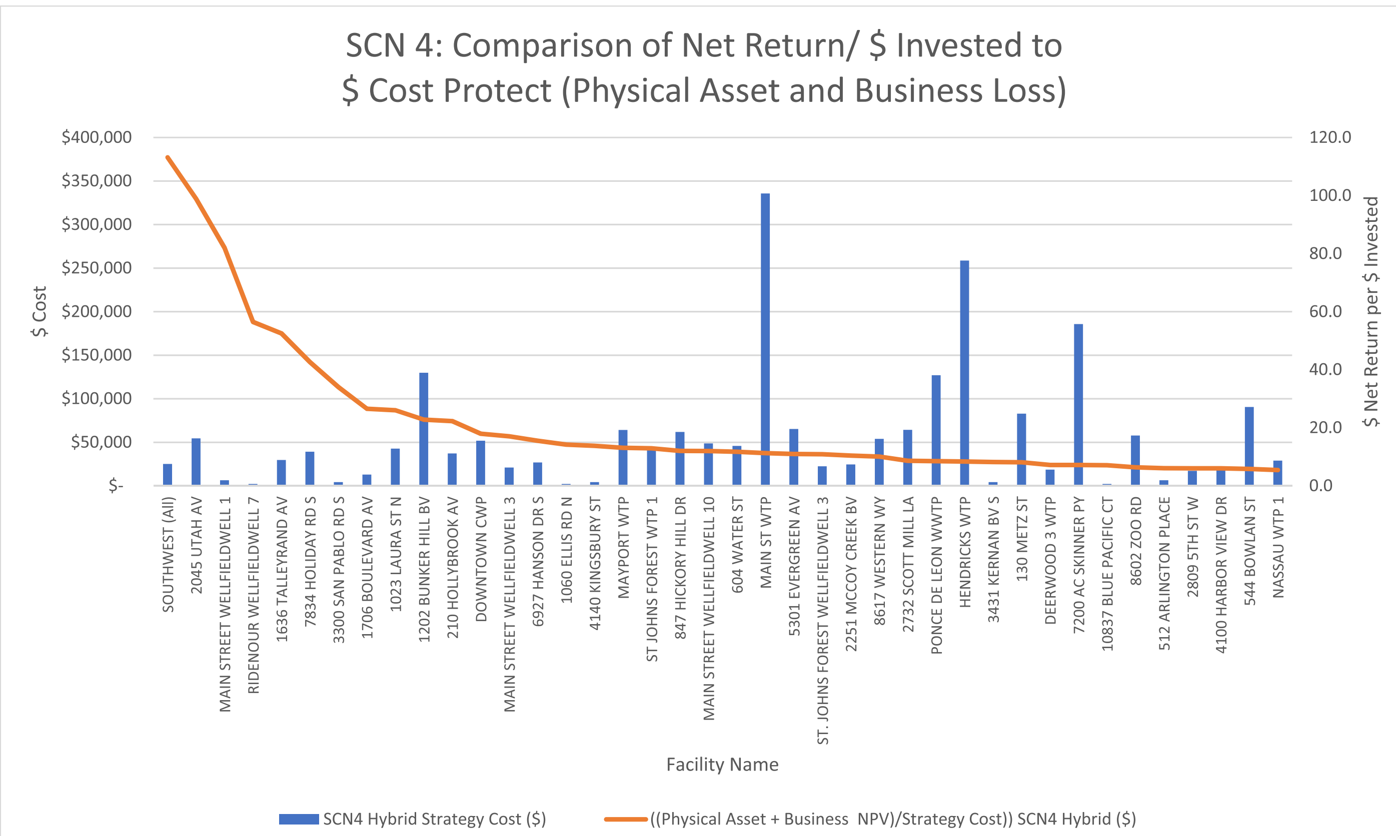


Figure ES-8. Scenario 4 Hybrid Strategy Cost and $ Combined Net Return per $ Invested by Facility

ES.5.3 Capital Improvement Project Prioritization

The capital improvement projects resulting from TOs 3, 4, 5, 10, 12, 15, and 16 were combined to address the broader system vulnerabilities and needs to enhance reliability. These projects encompass the bulk of the facility assessments conducted as part of the JEA Resiliency Program, including flood risk, electrical, I&C, hydraulic capacity of wastewater collection system, and conditions assessments of specific critical facilities. More information on the full list of projects, including prioritization scores, can be found in Section 10 of this plan.

A numerical score was assigned to each project, by facility, based on the following approved JEA prioritization criteria and corresponding evaluation methodology:

- Capacity/System Growth
- Level of Service Improvement
- Redundancy/Operational Flexibility
- Environmental Impact
- Cost Effectiveness

The facilities were then grouped into high, medium high, medium, medium low and low ranking based on their numerical score. The project ranking, by facility, resulted in the following facilities with the highest ranking, in order of priority, as shown in Table ES-3. Figure ES-9 tallies how many facilities are in each ranking category by facility type. Figure ES-10 is a map of all facilities by CIP ranking.

Table ES-3. Facility Capital Improvement Project Prioritization

Facility	CIP Ranking (High/Medium/Low)
Arlington East WRF	High
Buckman WRF	High
Southwest WRF	Medium High
210 Hollybrook Avenue LS	Medium High
2045 Utah Avenue LS	Medium High
7834 Holiday Road South LS	Medium High
Buckman WRF Outfall	Medium High
Nassau Regional WRF	Medium High
River Oaks Potable Repump Station	Medium High
10477 Bradley Road LS	Medium High
2304 McMillan Street LS	Medium High
Main Street WTP	Medium High
Main Street Wellfield Well No. 1	Medium High
1023 Laura Street North LS	Medium High
604 Water Street LS	Medium High
Monterey WRF	Medium High
Hendricks WTP	Medium
Main Street Wellfield Well No. 10	Medium
5301 Evergreen Avenue LS	Medium
Mayport WTP	Medium

Table ES-3. Facility Capital Improvement Project Prioritization

Facility	CIP Ranking (High/Medium/Low)
8617 Western Way Booster LS	Medium
Deerwood III WTP	Medium
Arlington Booster Pump Station	Medium

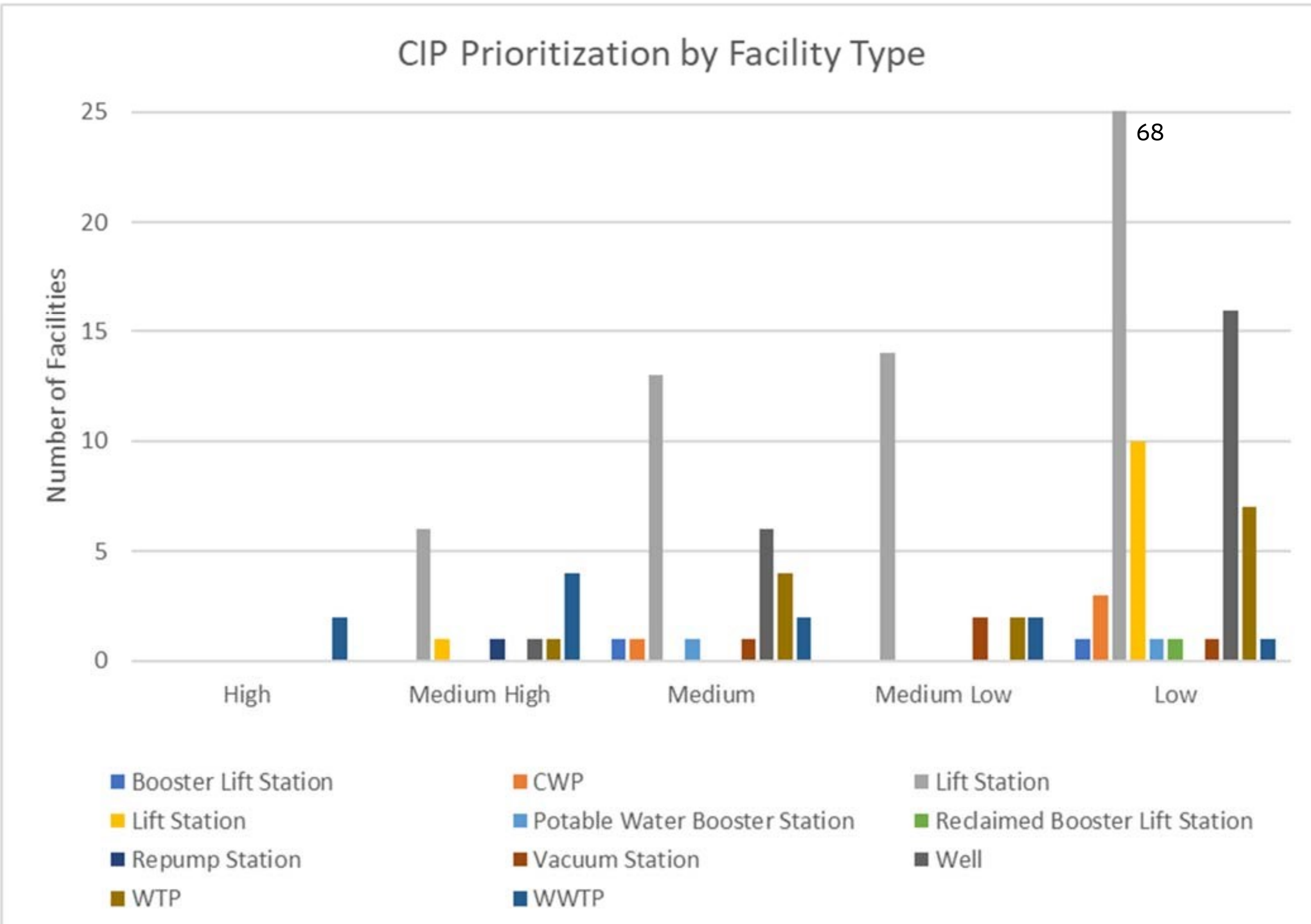


Figure ES-9. Chart of CIP Scores and Ranking (H, M, L) for all 173 facilities, including TOs 3, 4, and 5

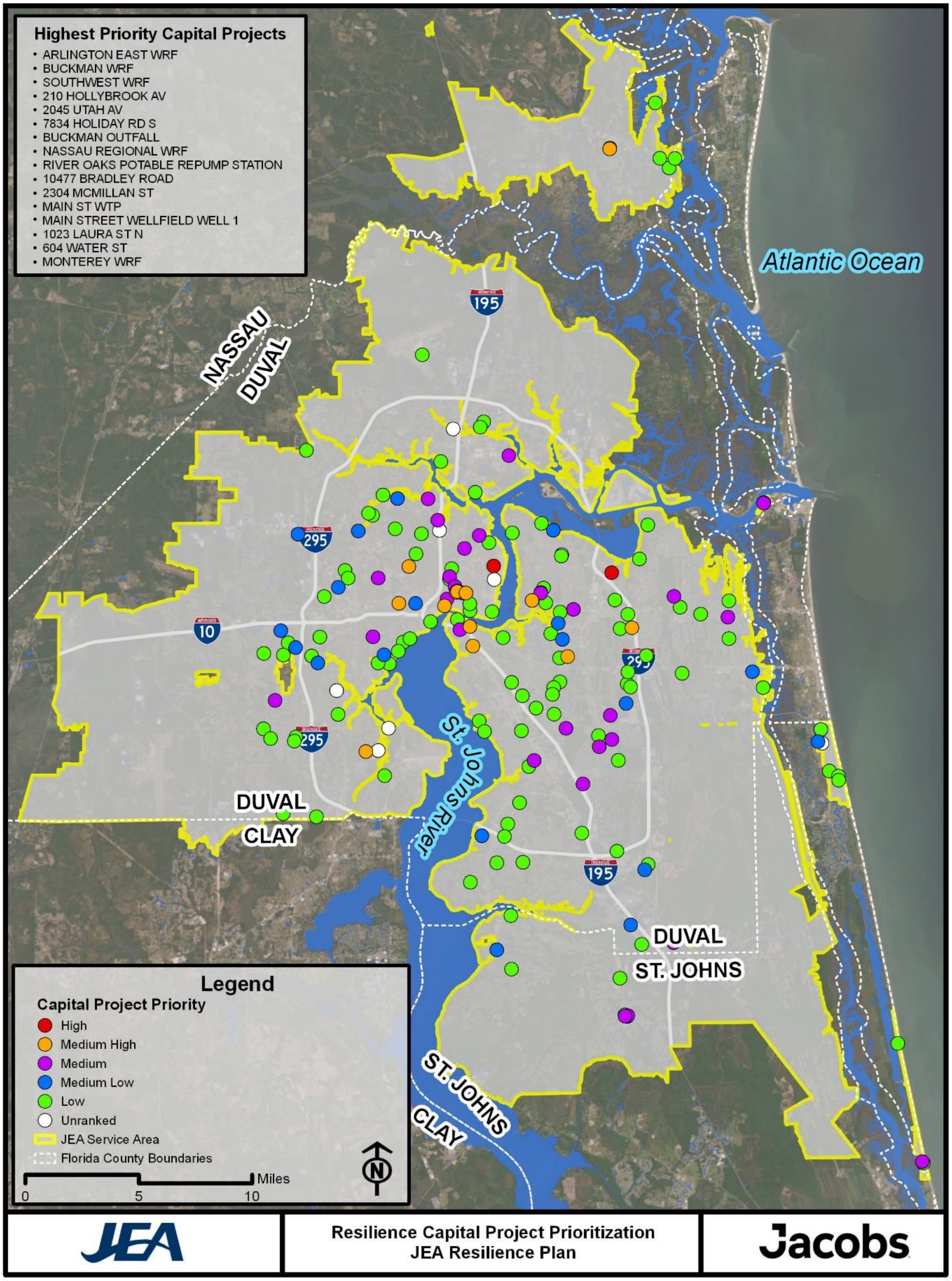


Figure ES-10. Map of Overall CIP Prioritization Results

ES.6 Recommendations and Next Steps

The following actions are recommended for implementation to reduce flood risk, improve system reliability, and enhance resilience of JEA's water, wastewater, reclaimed water, and chilled water systems. These recommendations include both physical improvements to facilities and recommendations to standards to ensure all future capital projects are designed and constructed to meet the same level of service.

ES.6.1 Design Standards and Guidelines

Concurrent with the asset vulnerability and risk assessment and mitigation strategy development, JEA's water, wastewater, chilled water, and reclaimed water design standards and design details were reviewed to identify opportunities for enhancement to system reliability, severe weather risk reduction, and future-looking design approaches. Recommendations were made to the existing standards, including non-corrosive material selection, electric power and communications redundancy, general equipment hardening, and the application of freeboard, in addition to adopting some standards as JEA-wide policy rather than including duplicate standards in multiple documents (Section 9).

In addition, a new Flood Risk Reduction Implementation Guide was developed for consistent application across all of JEA's projects. This single source of all information related to flood risk mitigation can be referenced across JEA's other design documents.

The planning process produced several recommendations, including new flood mitigation guidance to enhance JEA's existing design standards for adoption by JEA and for application on new project designs, including for ongoing CIP and operations and maintenance projects.

ES.6.2 Prioritized Capital Improvements for Flood Risk Mitigation

Additionally, this plan identifies capital project phasing focused on avoiding sanitary sewer overflows (SSOs) and service disruptions, with the following project phasing based on the prioritized CIP list presented in Section 10, and summarized as:

- Immediate projects (eight ongoing projects, estimated at $500,000 to $700,000)
  - Defined as improvements to ongoing or planned projects.
- Near-term (16 projects/facilities, estimated at $1.5 million to $2.5 million)
  - Defined as Projects/Facilities designated as High and Med-High priority per prioritized CIP list.
  - Critical facilities at risk of flooding today (within the current 100-year and 500-year flood zones)
- Mid-term (49 projects/facilities, estimated at $2.0 million to $4.0 million)
  - Defined as Projects/Facilities designated as Medium and Med-Low priority per prioritized CIP list.
- Long term (109 projects/facilities, estimated at $1.5 million to $3.0 million)
  - Defined as Projects/Facilities designated as Low priority per prioritized CIP list.
  - General enhancements to system reliability and redundancy for lower criticality facilities with lower vulnerabilities.

The costs range presented here represents the difference between building to Flood Scenario 2 versus Flood Scenario 7. While these costs do not include equipment replacement or specialty repairs, they summarize the probable construction cost additions to facility rehabilitation projects to incorporate flood risk reduction, hardening, and system redundancy to improve overall reliability and resilience.

ES.6.3 Next Steps

The following actions are recommended:

- Incorporate recommendations to design standards into current and new JEA design standards, details, and guidance documents, including the JEA Project Management Handbook.

- Adopt new standards as a unified policy applicable to all JEA capital projects and related operations.
- Review all ongoing and planned capital projects for opportunities to influence new facility siting and enhance designs to incorporate flood risk reduction.
- Evaluate recommended capital projects against ongoing and planned projects for improved alignment and to shift high-priority projects forward.
- Evaluate recommended capital projects against capital budget to inform project sequencing and timing.
- Evaluate water supply reliability and future resilience against severe weather influence, including drought conditions or water quality impacts.
- Provide staff training around new standards, policies, and the operationalization of resilience to promote its integration across all JEA activities.
- Review vendor contracts and supply chain redundancies to ensure backup systems are in place for emergency response.
- Review and update response plan agreements with neighboring utilities with respect to sharing resources and staff, when needed.

Moving forward, stakeholder engagement and staff capacity-building will be critical to the success of this program and approach. Finally, resilience planning is an ongoing process, requiring continuous evaluation and improvements, and should be updated regularly as new weather data and climate projections become available. Jacobs recommends periodic reviews and updates to the data inputs and subsequent realignment of projects as required.

1. Resilience Plan Framework

1.1 Plan Goals and Objectives

The goal of this Resilience Plan is to provide a comprehensive flood vulnerability and risk assessment of JEA facilities and assets based on severe weather today and future climate projections, including rainfall, sea level rise (SLR) and storm surge, as well as potential costs and suggested measures to reduce risk and enhance system reliability.

This Resilience Plan provides an understanding of current and future severe weather-related flood risks to JEA's water, wastewater, chilled water, and reclaimed water systems, which are expected to be exacerbated by SLR, increased precipitation, and increasing storm severity. This Resilience Plan outlines system vulnerabilities to these threats and presents appropriate mitigation actions to protect existing infrastructure, including mitigation measures to reduce risk today and adaptative strategies to prepare for future uncertainty. This plan will also guide the development of enhanced design criteria and forward-looking standards for current and future projects to prepare JEA today for a more resilient tomorrow.

As a valued asset and vital community partner, JEA strives to maintain its position as an industry leader through its excellent customer service and through the quality and reliability of its water, wastewater, and energy services. This reliability of high-quality services attracts private sector investment in the market, promoting both regional growth and competitiveness for Jacksonville and northeast Florida.

1.2 Plan Participants

During the Resiliency Program, the Jacobs team worked closely with JEA leadership, grid managers, facility managers, department heads and other key staff, with close coordination through over 10 facilitated workshops and over 25 submittals of technical memoranda (TMs), maps, datasets, and other related information to support the continued knowledge sharing and advancing awareness of incorporating resilience into ongoing and planned JEA capital projects. JEA has provided review comments and guidance at each step of the process leading up to this plan and the recommendations presented herein.

During the data collection phase, the emergency response leaders for each of the four counties across the service area. Duval, St. Johns, Clay, and Nassau Counties were contacted to obtain a list of critical facilities in support of the JEA facility prioritization. They each expressed interest to learn of the findings and outcome of this study as they relate to protecting the critical infrastructure of the four counties.

The JEA program leadership has presented information regarding the flood risk modeling results, and plans to mitigate the risk, to the City of Jacksonville Adaptation Action Area Working Group on multiple occasions as a means of sharing knowledge with the region to promote collaboration and advance the region's efforts to build a resilient community.

2. Background and Project Understanding

JEA is the seventh largest community-owned electric utility company in the United States and the largest in Florida. JEA owns and operates over 1,400 wastewater lift stations, 11 water reclamation facilities (WRFs), 134 wells, 37 water treatment plants (WTPs), and four chilled water plants (CWPs), which serve nearly 420,000 customer accounts serving over 1.5 million people across a 900-square-mile service area spanning four counties and six regional service grids (Figure 2-1).

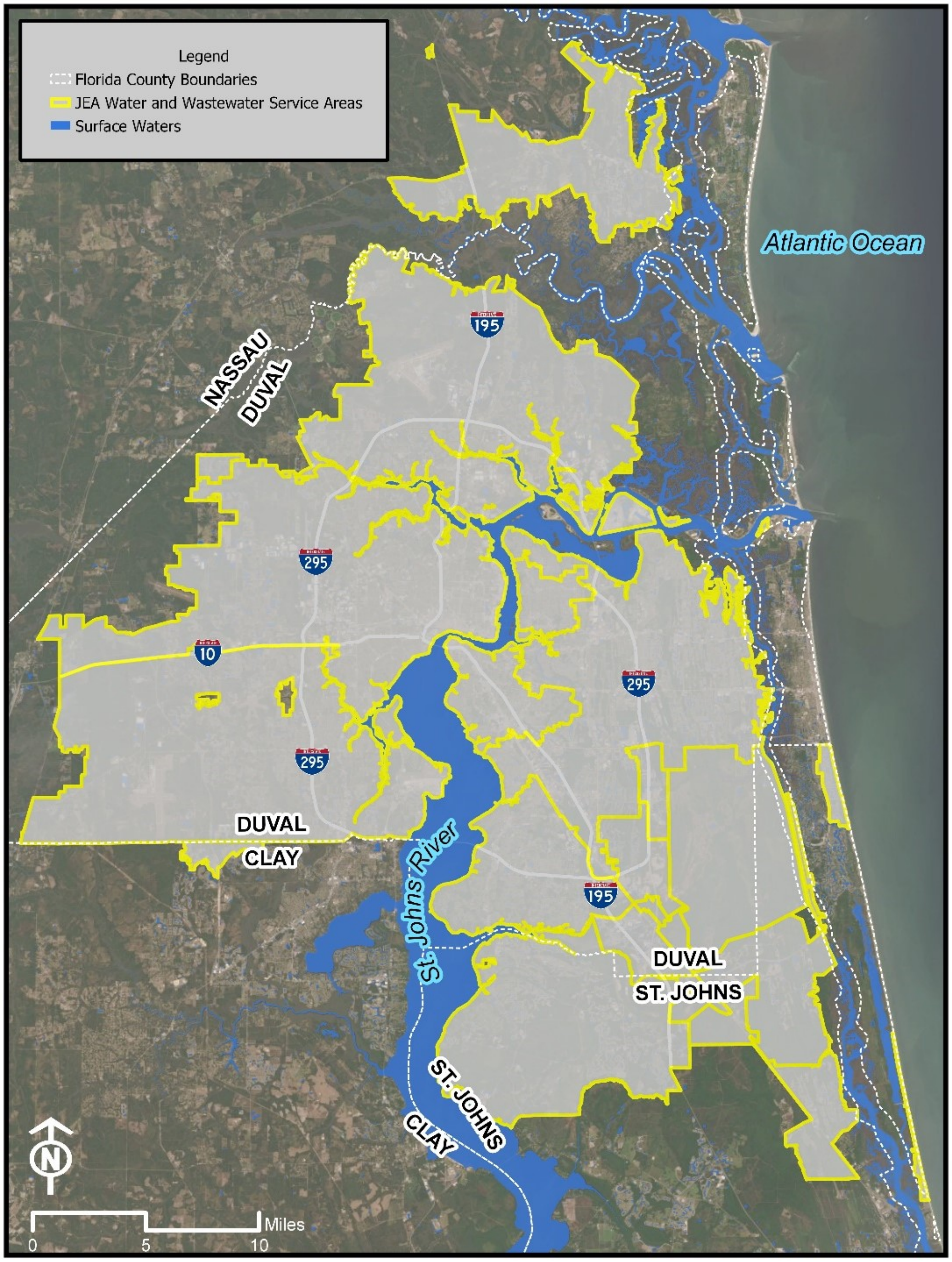


Figure 2-1. JEA Service Area Map Across the Four-County Region

Management of the expansive water, wastewater, chilled water, and reclaimed water system network across a large service area has been an ongoing challenge that takes a large number of operators and maintenance staff. The size of the JEA service area and the coastal nature of these systems coupled with more frequent and severe weather events in recent years, has required an increasing amount of resources to maintain a safe and reliable water system and prevent wastewater collection overflows. The extent and complexity of inland and coastal flood exposure across the JEA service area adds to this challenge and is depicted on Figure 2-2.

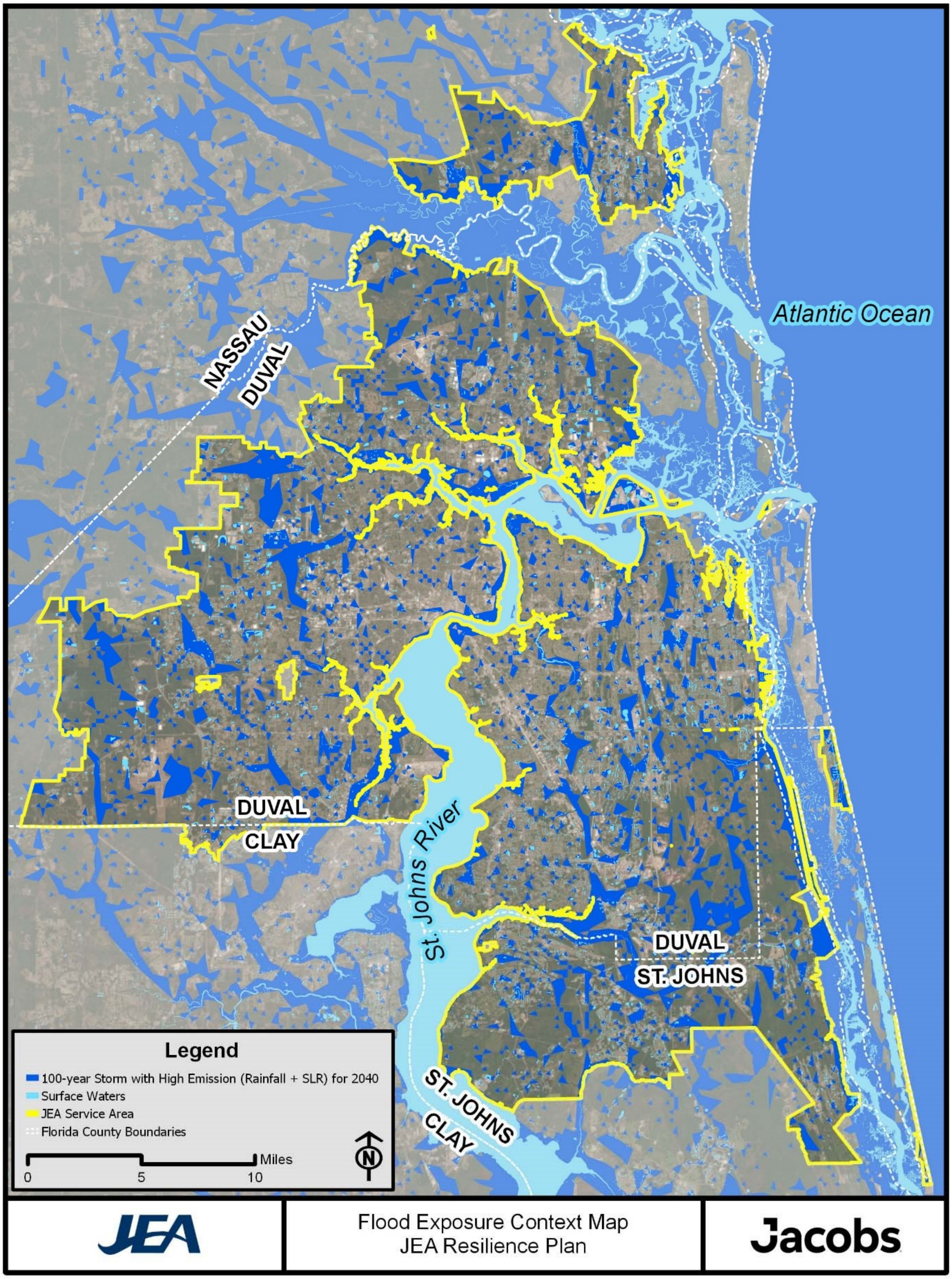


Figure 2-2. Flood Exposure Context Map (Scenario 2, 100-year event in 2040) for JEA Service Area

2.1 Historical Severe Weather Events

The Jacksonville area has experienced numerous extreme weather-related events in recent years that have resulted in damage to JEA equipment and/or caused service interruptions or sanitary sewer overflows (SSOs). These events have elevated the need for action, garnering support for significant investment by JEA, including a series of projects to harden equipment and communications and improve system redundancy and reliability. Some of these severe weather events are described in the following sections.

2.1.1 Hurricane Matthew, October 2016

Hurricane Matthew was the first major hurricane to adversely affect Jacksonville in over a century. The hurricane passed Jacksonville approximately 50 miles to the east (offshore) as a Category 3 storm with winds of 60 miles per hour (mph) and isolated rainfall totals exceeding 10 inches in less than 72 hours. The National Hurricane Center (NHC) reported storm surge of 5 to 7 feet above ground level along the coasts of St. Johns and Duval counties (Figure 2-3). The St. Johns River observed water levels of 4 to 6 feet above normal, with flood inundation of 2 to 4 feet above ground level along the river banks.

Overall storm surge and rainfall induced flooding impacted nearly 500 homes and interrupted power for over 250,000 customers and led to power failures at 785 JEA facilities, leading to SSOs at 54 of these facilities.

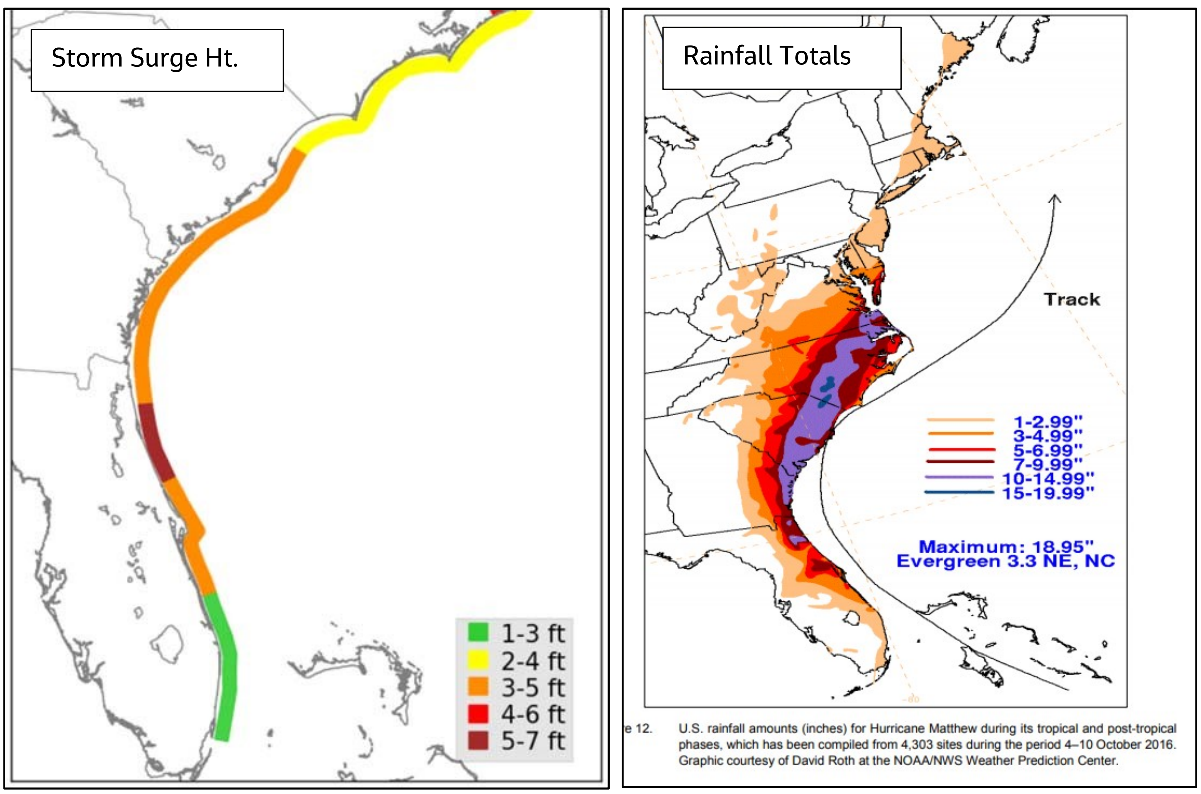


Figure 2-3. Observed Surge and Rainfall Totals from Hurricane Matthew (Source: NHC)

2.1.2 Nor'easter Storm, July 2017

This unusual, off-season cold front brought heavy winds and rain to the Jacksonville area. During the event, the slow-moving weather system dropped over 4 inches of rainfall in less than 1 hour in parts of JEA's service area, resulting in flooding of numerous JEA facilities and disruption of services. While this event was not considered devastating and did not cause the same level of damage seen during a hurricane, for example, it demonstrated the vulnerability of JEA's system to flooding caused by intense rain events.

2.1.3 Hurricane Irma, September 2017

During the week of September 10, 2017, Hurricane Irma made landfall in southwest Florida as a Category 4 storm with sustained winds over 130 mph. As Hurricane Irma moved north through the interior of western Florida, it continued weakening and was a Category 1 storm as it crossed north Florida and entered Georgia. This weakening reduced the impacts observed in north Florida but still resulted in major impacts to JEA's systems. According to the NHC, Hurricane Irma is responsible for one of the worst flooding events in the City of Jacksonville's more than 225-year history, with hundreds of people needing to be rescued.

The storm created a storm surge along the St. Johns River that peaked at an elevation of approximately 5 feet mean higher high water (MHHW) (6.1 feet North American Vertical Datum of 1988 [NAVD88]), flooding 33 of JEA's facilities and causing power failures at 730 facilities (Figure 2-4). There was a total of 59 SSO incidents, with approximately 2.3 million gallons discharged. The Hendricks wellfield also saw a loss of power, which nearly resulted in a boil-water notice. Unsafe weather conditions and lack of accessibility greatly contributed to the number of overflows due to delayed response times in addition to the direct equipment impacts.

The events resulting from Hurricanes Matthew and Irma led to the State Governor's 90-Day Emergency Rule: *Public Notice of Pollution*. This statute requires an operator of an installation at which a reportable pollution release occurred to provide a report to the Florida Department of Environmental Protection (FDEP) within 24 hours after its discovery.

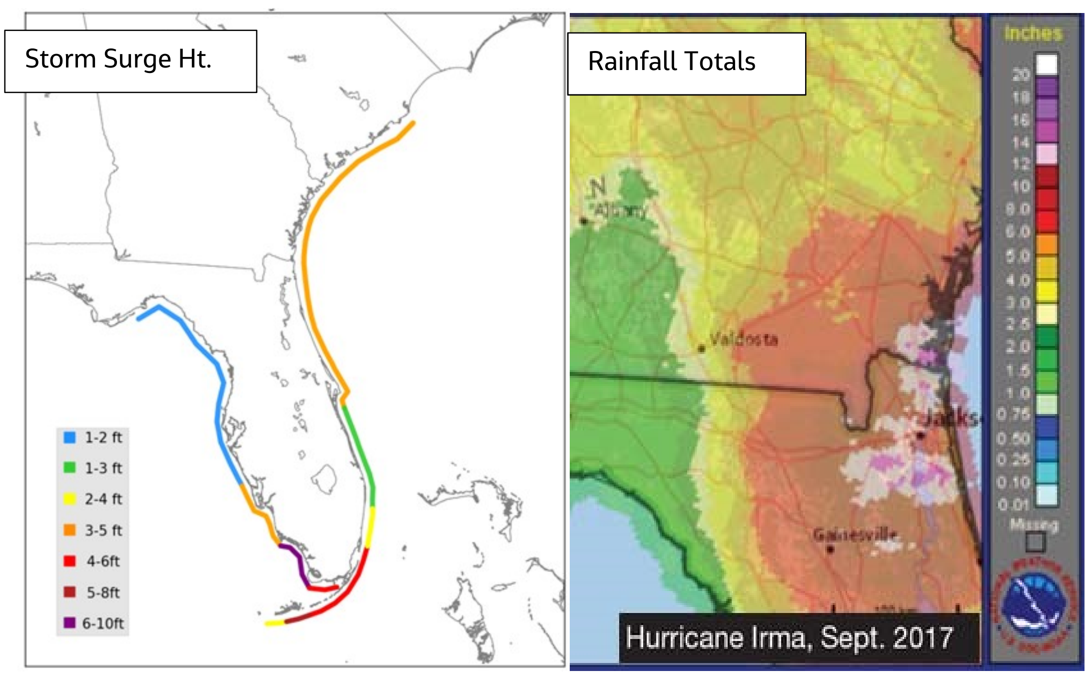


Figure 2-4. Observed Surge and Rainfall Totals from Hurricane Irma (Source: NHC)

2.1.4 Hurricane Dorian, September 2019

Hurricane Dorian was a Category 5 hurricane when it reached Great Abaco and Grand Bahama islands on September 3, 2019, with a forecasted path taking it directly toward Jacksonville, Florida. JEA asked Jacobs to provide estimates of potential flood levels to inform storm preparations. While not being able to know the full extent of possible flooding due to the uncertainty of hurricane track forecasts, Jacobs provided guidance consisting of probable flood impacts from surge and rainfall if the storm followed the forecasted path.

Fortunately, the storm turned north and stayed 90 miles offshore in the Atlantic Ocean and continued weakening to a Category 2 hurricane, sparing Jacksonville from major damage like previous hurricanes. The storm produced tropical storm force winds and isolated areas of 5 inches of rainfall locally (Figure 2-5). Some coastal areas were wave-battered and flooded, but most of Jacksonville only experienced weak winds and short-lived power outages to 32,000 JEA customers that were quickly restored by nightfall.

JEA's water, wastewater, and chilled water systems did not encounter any service interruptions, demonstrating how the system redundancy and hardening activities, in conjunction with JEA's emergency management protocols, were working to maintain safe and reliable service.

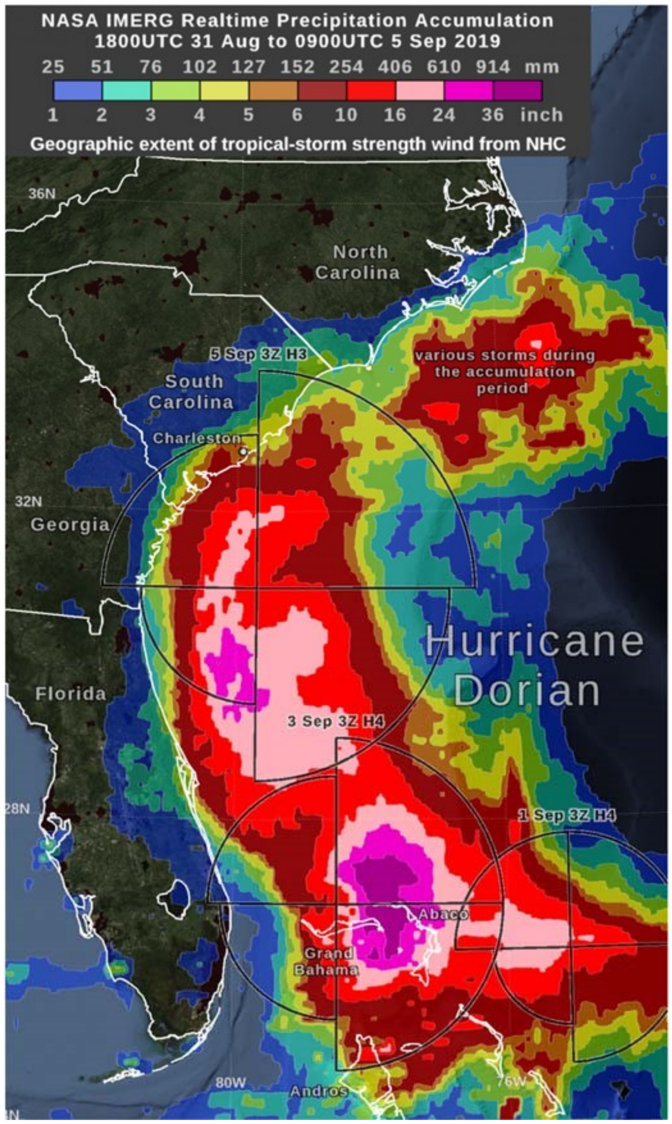


Figure 2-5. Observed Rainfall Totals from 2019 Hurricane Dorian (Source: NASA)

2.2 JEA Directives and Commitments

JEA has continued to be committed to continuing to provide reliable water, wastewater, chilled water, and reclaimed water services to customers across its service area while protecting public health and the environment. However, storm impacts from the recent storm events brought to light some vulnerabilities of JEA's facilities and systems. These events triggered loss of power and system failures, resulting in loss of pressure, loss of service, and/or SSOs. As a result, JEA has committed to investing in developing and implementing a Resilience Plan, including system upgrades, equipment hardening, elevating, and electrical power redundancy to reduce these risks and maintain system reliability. JEA has also established a directive committing to "Zero Overflows" for the wastewater system to uphold protection of public health and the environment.

2.3 Previous and Ongoing Resilience Efforts

JEA has undertaken numerous initiatives to avoid adverse impacts to its various utility systems resulting from extreme weather events including upgrades to communications and monitoring systems; application of redundant electrical power systems, including backup generators and pony pumps at nearly 300 lift stations with remote start and automatic transfer switches; and elevating sensitive equipment above flood stages to avoid service interruptions and maintain operation continuity.

The JEA “Zero Overflows” directive strives to eliminate single points of failure, specifying resilience requirements and developing adaptation strategies for prevention of system interruptions and failures.

JEA has also initiated the creation of the Resilience Plan, led by Jacobs, to perform a comprehensive analysis of flood risk and to develop mitigation measures and adaptation strategies to further enhance JEA system resilience.

To support the implementation of this initiative, JEA has allocated $100 million in direct resilience-related activities in the five-year capital plan. This plan prioritizes the most at-risk facilities as a crucial way to combat the devasting impacts from severe weather events. With 11 WTPs/WRFs and 1,400 wastewater pumping stations, this plan includes an extensive and in-depth assessment of the height of critical assets in relation to projected flood heights. In determining the benefits of resilience measures and the level of acceptable costs, JEA considered not only the value of wastewater assets but also the population and critical facilities in the service areas and potential impacts to beaches.

3. Climate Projections and Flood Scenarios

An evaluation of flood exposure and risk was performed for JEA's water, wastewater, chilled water, and reclaimed water facilities. This exposure review considered multiple flood mechanisms, including tidal flooding, rainfall-induced flooding, and storm surge flooding, and included scenarios featuring future rain events and elevated sea levels. More information on climate projections and flood scenarios can be found in Appendix A, *Activity 3: Sea Level Rise, Precipitation Projections, and Climate Scenarios Technical Memorandum* and in Appendix B, *Activity 3: Activity 3: Flood Modeling Surge and Inland Flood Modeling Technical Memorandum*.

3.1 Climate Projections

Projections of future sea levels and rainfall were developed for inclusion in the flood scenarios based on the most recent peer-reviewed climate science, as further described following sections. More information on climate projections can be found in Appendix A, *Activity 3: Sea Level Rise, Precipitation Projections, and Climate Scenarios Technical Memorandum*.

3.1.1 Projected Sea Levels

Future conditions of relative SLR for the Jacksonville area were based on the published 2017 projections from the National Oceanographic and Atmospheric Administration (NOAA) using the Mayport, Jacksonville tide gauge. These projections consist of seven different climate scenarios, representing various global greenhouse gas emission projections, ranging from low to extreme (Figure 3-1). Three of these climate scenarios were chosen for use in developing the flood scenarios for JEA, including the Intermediate, Intermediate-High, and High SLR curves. They were chosen for their high probability of occurrence, recognizing that the extreme and lower curves contain a higher amount of uncertainty, especially for the longer planning horizons.

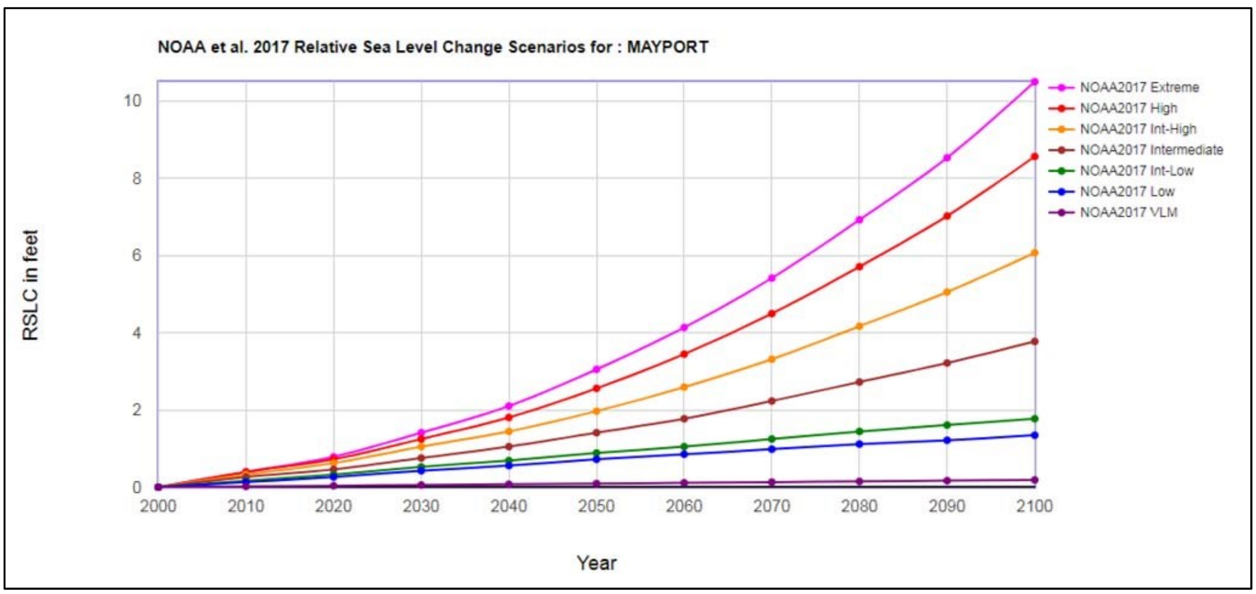


Figure 3-1. Relative Sea Level Rise Projections for Mayport Tide Gauge (NOAA, 2017)

Existing and future mean higher high water (MHHW) elevations from the Mayport, Jacksonville for the 2040, 2070, and 2100 timeframes are listed in Table 3-1. Projected increases in MHHW elevations were included in each climate scenario, which are greatest for the NOAA High climate scenario.

Table 3-1. Existing and Future Mean Higher High Water Elevations at Mayport, Jacksonville, Florida

Year	Intermediate (feet, NAVD88)	Intermediate-High (feet, NAVD88)	NOAA High (feet, NAVD88)
2000	1.96	1.96	1.96
2040	3.01	3.40	3.76
2070	4.19	5.27	6.45
2100	5.73	8.03	10.52

3.1.2 Projected Rainfall

Projected changes in 24-hour precipitation were derived using results from 30 general circulation models (GCMs) with daily time steps for the years 2040, 2070, and 2100 using medium and high greenhouse gas (GHG) emission scenarios, referred to as representative concentration pathways (RCPs) 6.0 (medium emissions) and 8.5 (high emissions). Projected changes in precipitation depths are shown in Figure 3-2 for the 24-hour duration and multiple return periods.

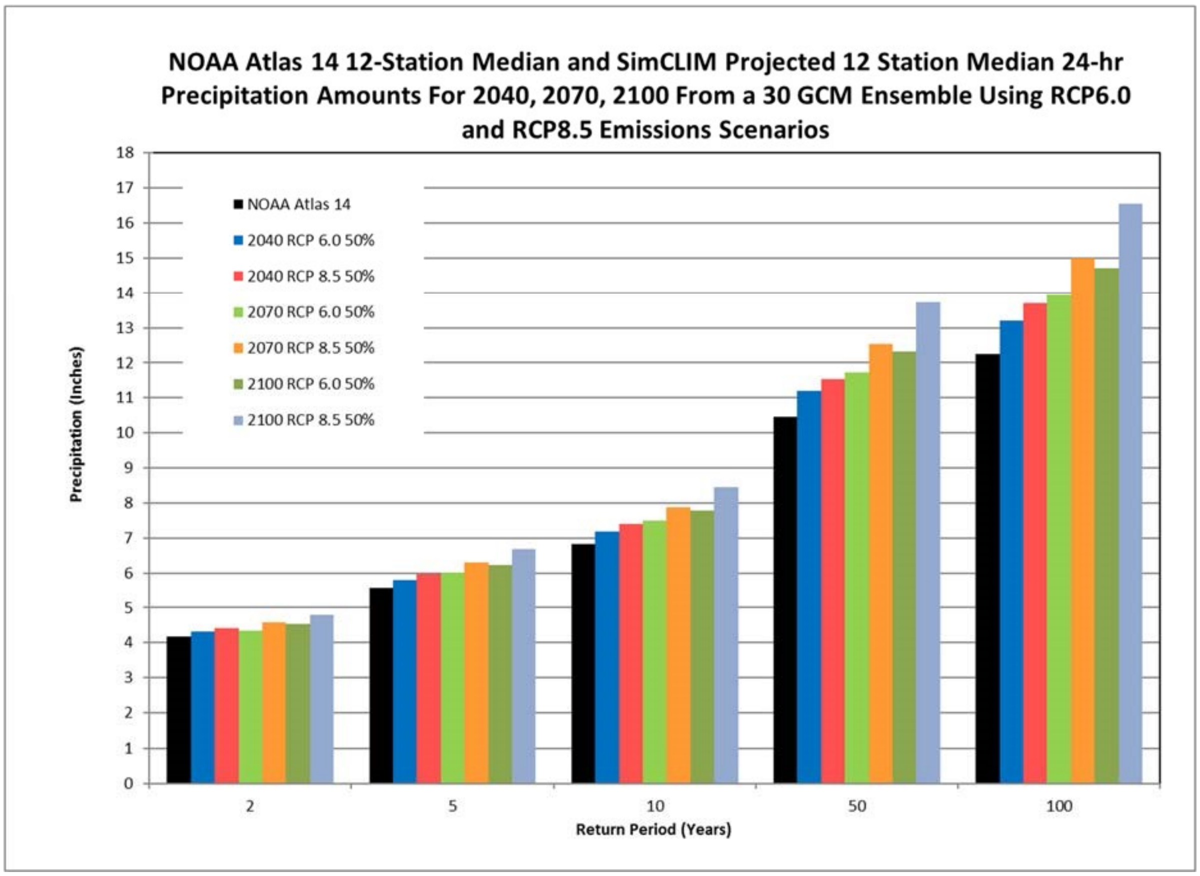


Figure 3-2. Projected 24-hour Rainfall for Select Return Periods, Future Years, and Greenhouse Gas Emissions

3.2 Flood Scenario Development

Previous severe weather impacts have prompted JEA to assess flood risk from both current and future conditions related to climate-induced flood hazards, which include SLR, increased rainfall intensity and frequency, and storm surge. Projections of these future flood hazards helps to ensure the proper level of flood protection across JEA's service area over the service life of assets.

A total of 11 flood scenarios were analyzed: three current conditions and eight projected future climate scenarios. The three current condition scenarios reflect different storm magnitude, as given by the storm probability, 4-, 1-, and 0.2-percent annual probability of occurrence, which correspond to recurrence intervals of 25-year, 100-year, and 500-year, respectively.

To assess future risk to JEA assets, eight climate scenarios were selected with JEA that bracket the range of potential climate projections (RCP6.0 and RCP8.5), storm probability or frequency (25-, 100-, and 500-year storms), and planning horizon. Planning horizon timeframes of 2040, 2070, and 2100 were chosen that best align with expected asset service life. The service life of mechanical and electrical systems is assumed to be 20 years, with structures assumed to have a service life of 50 years. The 2100 time horizon is meant primarily to provide a bookend for the most critical facilities that are not likely to move in the next 80 years and is also a convenient long-term planning horizon because most climate projection data are available through 2100.

More information on flood scenarios can be found in Appendix A, *Activity 3: Sea Level Rise, Precipitation Projections, and Climate Scenarios Technical Memorandum*.

Figure 3-3 shows the eight future climate scenarios that were used to analyze flood risk and the associated values for each climate variable.

Scenario Description		Scenarios (R/S = Rain/Surge, with SLR; R = Rain only, with SLR)							
		1	2	3	4	5	6	7	8
Rainfall	SLR Projections	Rainfall and/or SLR, with Storm Surge (R/S = Rain/Surge, with SLR; R = Rain only, without storm surge or SLR)							
RCP6.0 50% non-exceedance	NOAA 2017: Intermediate	R/S		R/S		R/S			
RCP8.5 50% non-exceedance	NOAA 2017: High		R/S		R/S		R/S	R/S	R/Astronomical Tide
Target Year									
2040		✓	✓			✓			
2070				✓	✓		✓	✓	✓
Return Period of Surge Event (year)									
25-year (current rain: 8.8”)						✓	✓		
100-year (current rain: 12.3”)		✓	✓	✓	✓				✓
500-year (current rain: 16.6”)								✓	
Scenario Summary									
Rainfall 24-hour Total (inches)		13.21	13.69	13.94	14.99	9.34	10.36	21.54	14.99
MHHW (2000: 1.96 feet NAVD88)		3.01	3.76	4.19	6.45	3.01	6.45	6.45	N/A
SLR (feet)		1.05	1.8	2.23	4.49	1.05	4.49	4.49	4.49

Figure 3-3. Table of Modeled Flood Scenarios

3.3 Flood Modeling

The coastal surge and inland flood modeling analysis has assessed JEA facility flood risk from current and future climate scenarios using a calibrated flow model developed during this study. The model represents the coastal area along the shoreline and the St. Johns River across the four-county JEA service area. The MIKE 21 Flow Flexible Mesh (FM) module flood modeling software was applied for this analysis because it incorporates the coastal storm surge, sea level rise, and rainfall-driven flood processes to be simulated simultaneously, thus allowing the complex flood processes in the St. Johns River estuary to be evaluated. The model was calibrated based on measured U.S. Geological Survey (USGS) water level data from Hurricane Matthew and validated using data from Hurricane Irma.

The potential flood extents are generated by the change in future rainfall and SLR, which were evaluated using the eight climate scenarios described in the previous section. The resulting flood extents and depths were evaluated at prioritized JEA facilities to support the detailed vulnerability assessment (Figures 3-4 and 3-5). The surge and inland flood model domain incorporates the entire JEA service area, including the adjacent catchment area of the St. Johns River and a portion of the Atlantic Ocean abutting the shoreline. Figures 3-6, 3-7, and 3-8 show examples of the flood extent from the modeled future 100-year and 500-year storm events compared to the current Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) special hazard flood areas (SHFA) for a portion of the St. Johns River basin centered on the JEA service area and model domain.

More information on flood modeling can be found in Appendix B, *Activity 3: Flood Modeling Surge and Inland Flood Modeling Technical Memorandum*.

To further validate the flood model, a review of the technical paper describing the U.S. Army Corps of Engineers (USACE) St. Johns River Channel Dredging Project was performed to identify possible changes to flood water levels associated with a deeper channel. This review determined that dredging the St. Johns River will not have an appreciable impact on water levels in the river associated with storm surge events. More information on the St. Johns River dredging analysis can be found in the *St. Johns River Dredging Impact Assessment Technical Memorandum* in Appendix B.

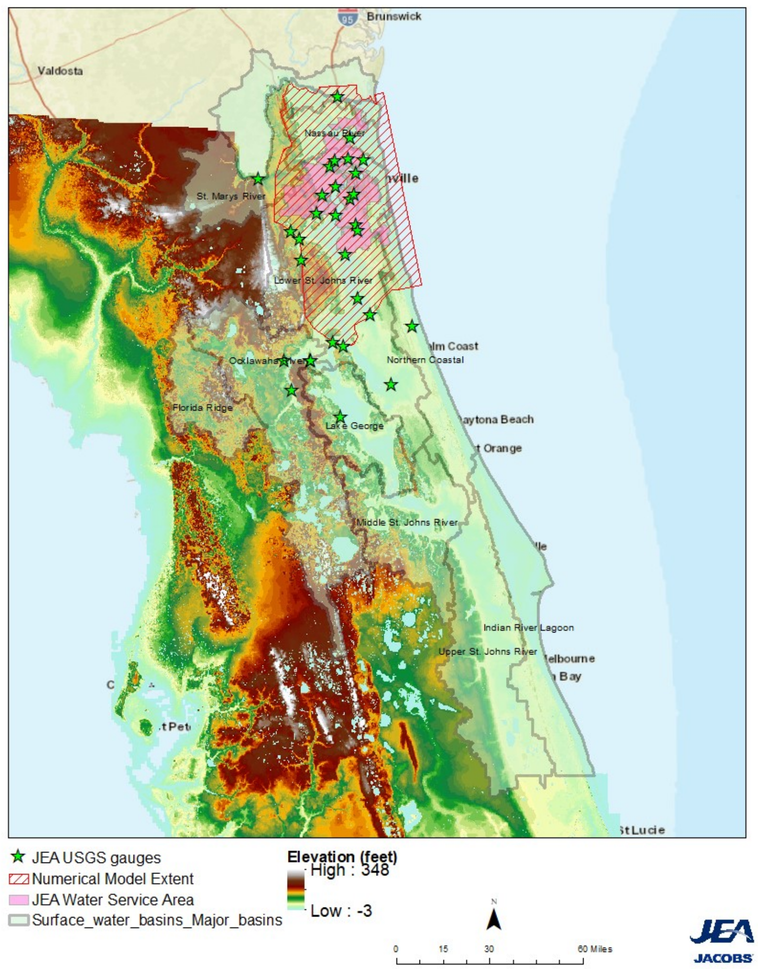


Figure 3-4. Flood Model Grid Extents

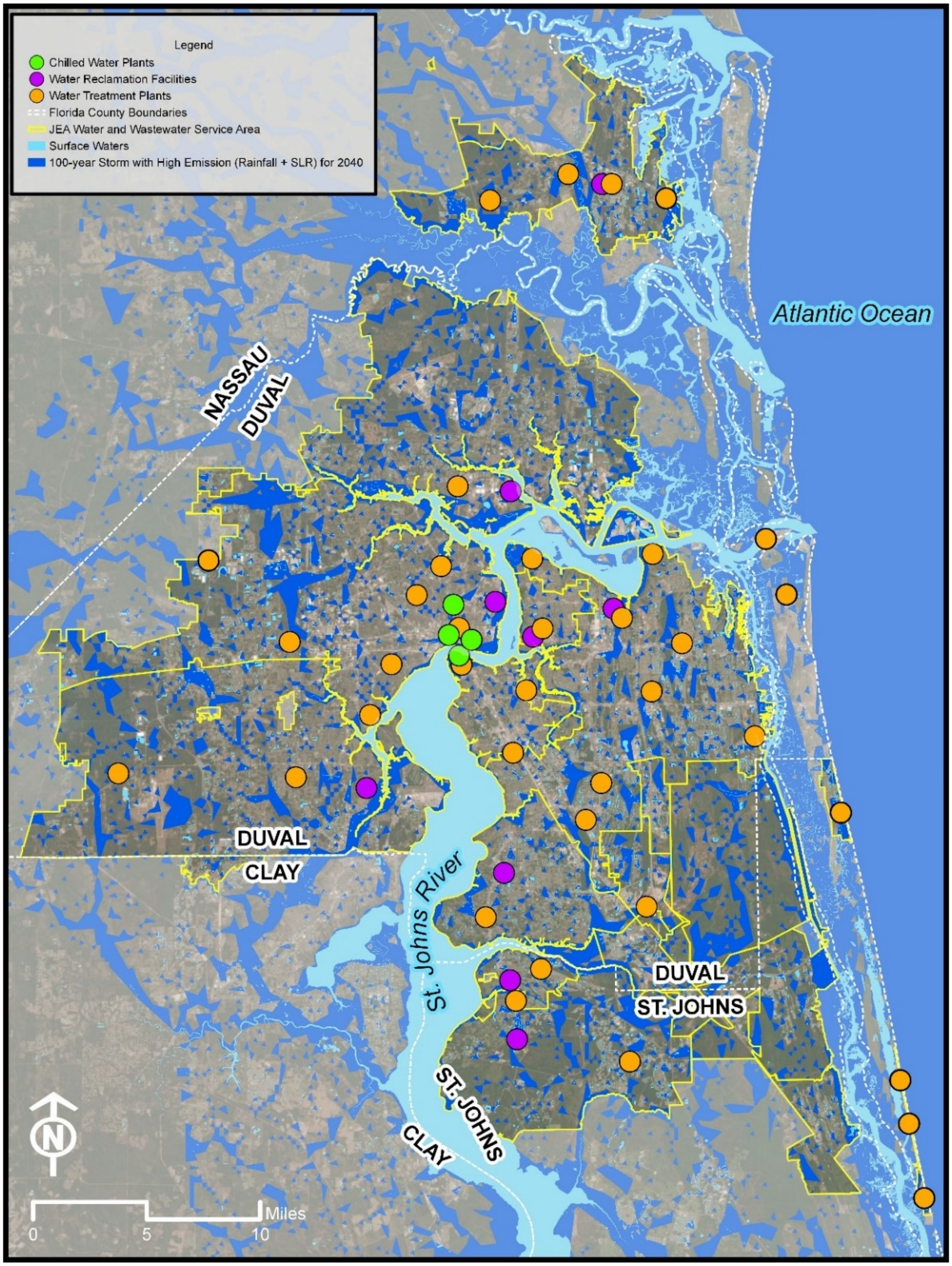


Figure 3-5. JEA Water, Wastewater, and Chilled Water Plants – Map of Flood Extents across JEA Service Area for Flood Scenario 2: 100-year Storm in 2040 with High Projection for Rainfall (RCP8.5) and SLR (NOAA High)

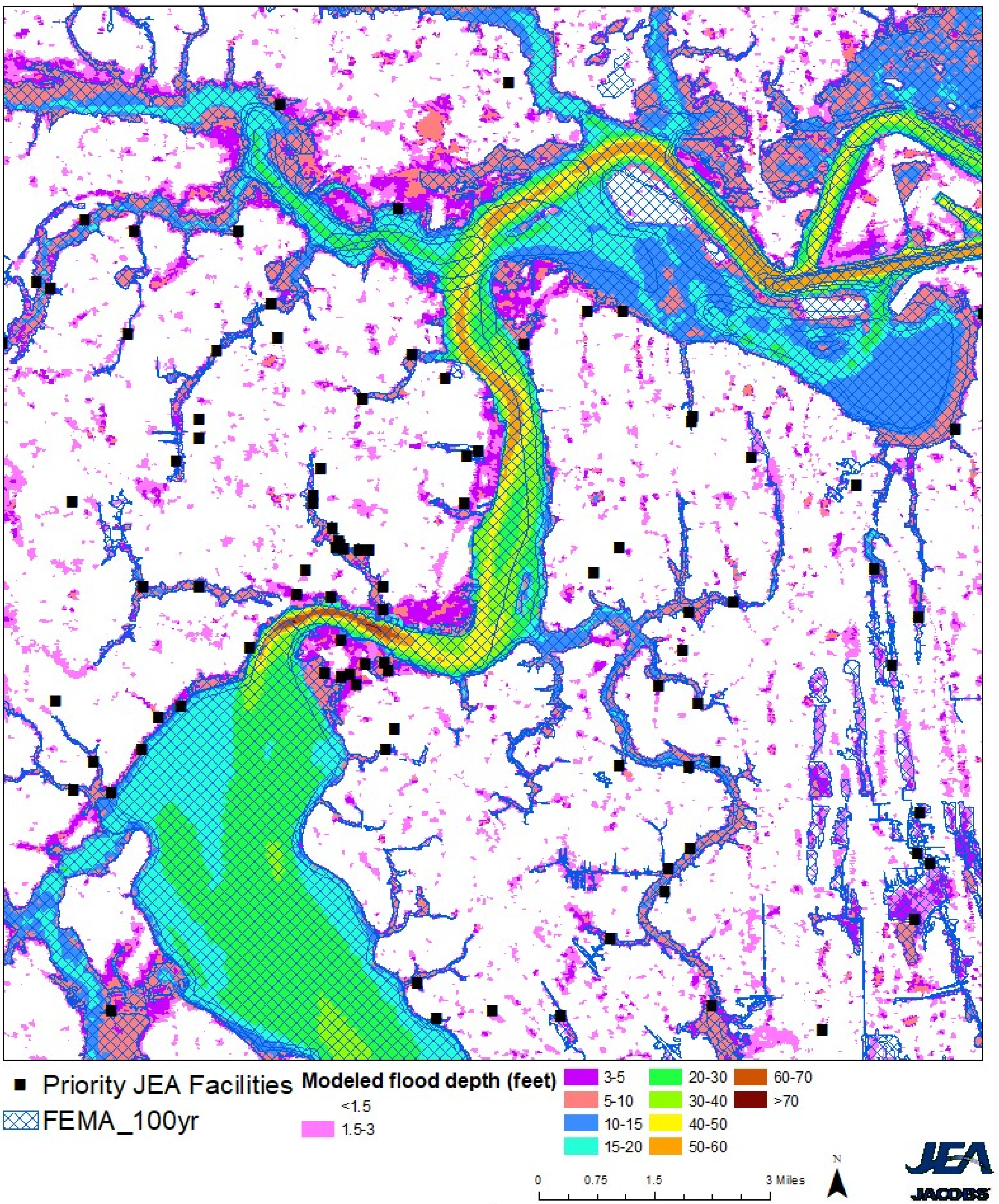


Figure 3-6. Flood Depths and Extents for Flood Scenario 2: 100-year Storm in 2040 with High Projection for Rainfall (RCP8.5) and SLR (NOAA High)

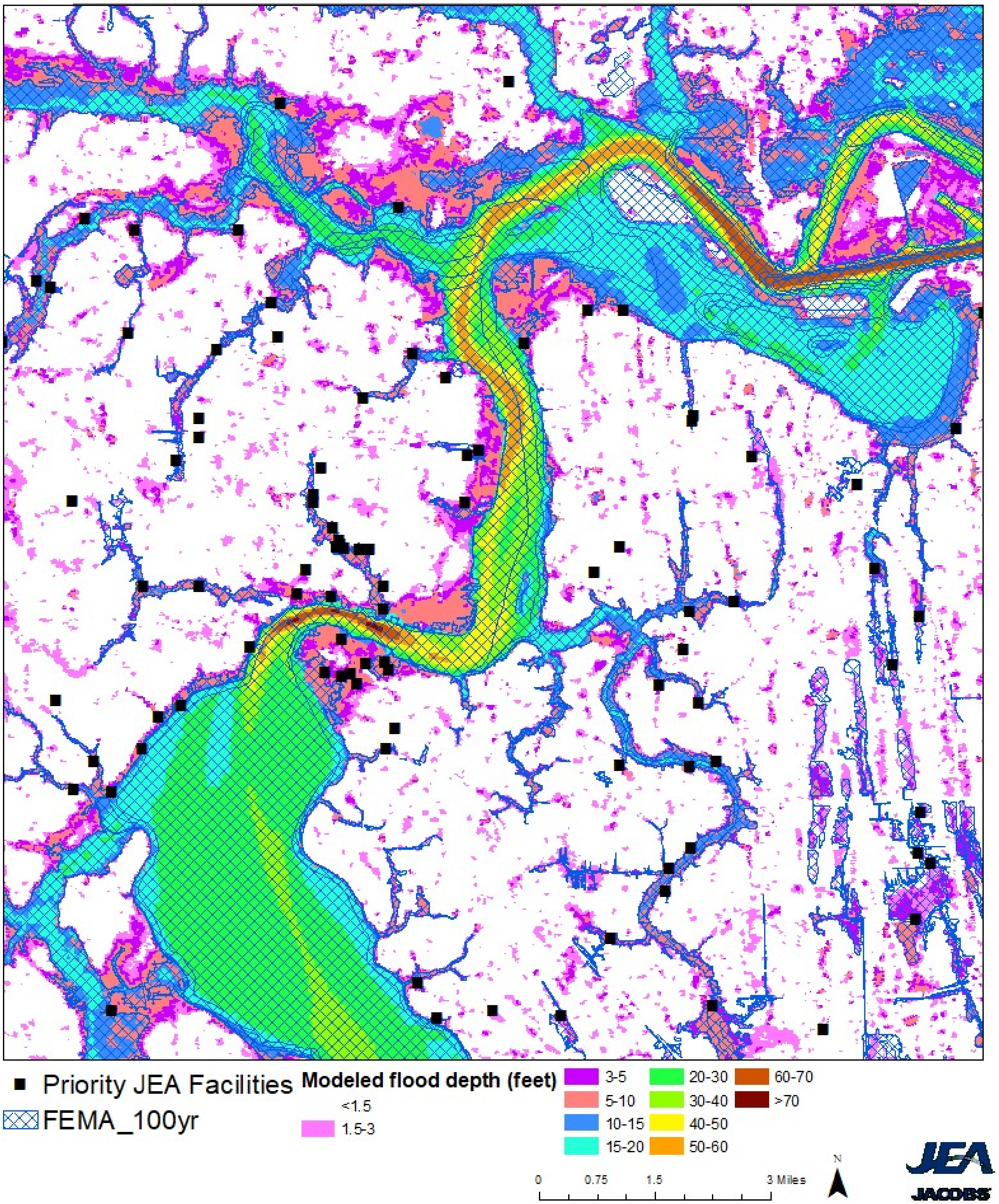


Figure 3-7. Flood Depths and Extents for Flood Scenario 4: 100-year Storm in 2070 with High Projection for Rainfall (RCP8.5) and SLR (NOAA High)

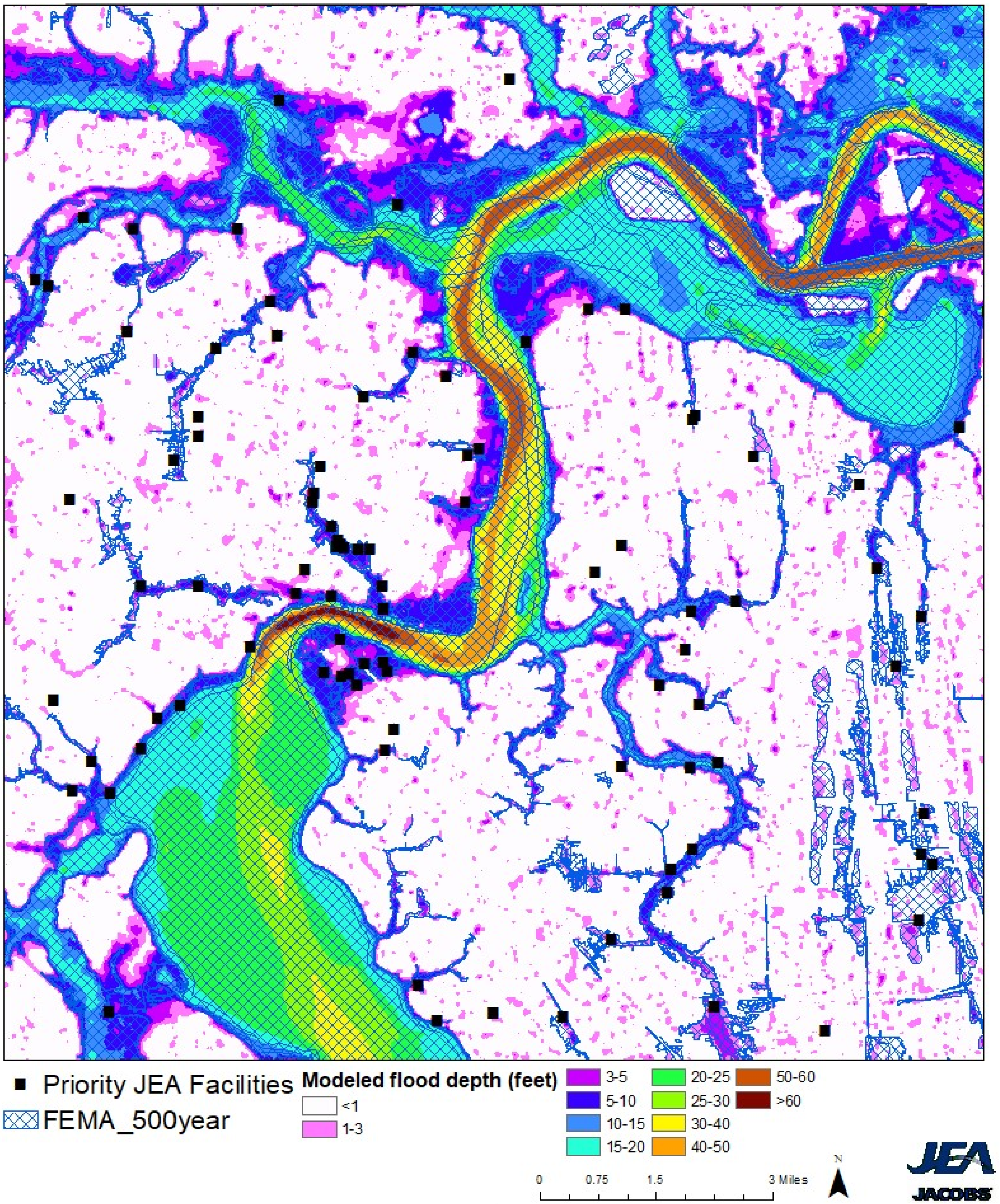


Figure 3-8. Flood Depths and Extents for Flood Scenario 7: 500-year Storm in 2070 with High Projection for Rainfall (RCP8.5) and SLR (NOAA High)

4. Facility Prioritization

Prior to performing the vulnerability and risk assessments, an initial facility prioritization was performed of the 1,664 JEA facilities to identify those facilities with the highest vulnerability and criticality for inclusion in field assessments and further analysis. Recognizing the large number of facilities managed by JEA, there was a need to focus the flood risk analysis on those facilities with the highest priority and need. The prioritization activity involved the first two steps in a multi-step process to identify those facilities to be included in the vulnerability assessment. Figure 4-1 depicts this multi-step process to narrow down to the highest priority JEA facilities. Further details of the entire process can be found in Appendix C, *Activity 4, Facility Criticality and Prioritization for Site Visits Technical Memorandum*.

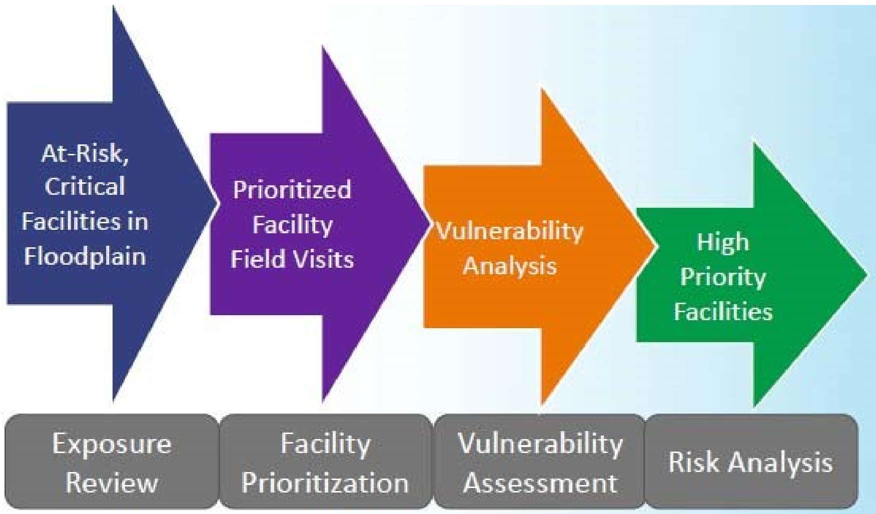


Figure 4-1. Facility Vulnerability and Prioritization Process

4.1 Facility Criticality and Current Flood Exposure Review

The criticality assessment and initial review of current flood exposure was performed for 1,664 JEA facilities, resulting in facilities that were included in the vulnerability assessment. The criteria used to in this analysis are listed in Table 4-1.

Table 4-1. Evaluation Criteria

	Facility Criticality	Current Flood Exposure
Criteria	Critical and priority facilities served	Current flood exposure
	Enterprise asset management (eAM) system (Tier 1)	JEA staff survey
		Previous flood impacts
		eAM System (Tier 2)
		eAM System (Tier 3)

Each of these criteria was translated into a normalized numerical value to quantify the flood risk associated with severe weather impacts for each facility, providing the basis for facility priority.

4.1.1 Facility Criticality

A review of critical facilities served by each of JEA's water, wastewater, and chilled water systems was performed to support the identification of critical JEA facilities. Critical facilities served include hospitals, emergency operations centers, airports, first responders, evacuation shelters, and other critical public service buildings and facilities across the four-county JEA service area.

4.1.2 Facility Flood Exposure

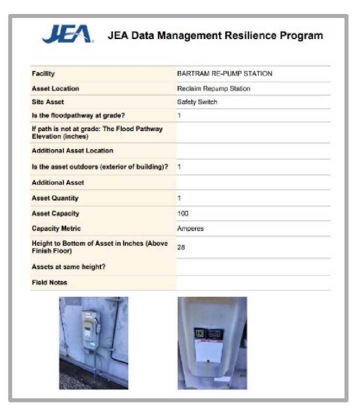
The initial flood exposure review was performed based on the FEMA 100-year and 500-year flood zones and documented previous flooding events at the facilities. This initial review was only a cursory review, based on readily available information, to identify those facilities at the highest risk of flooding today; however, a more extensive flood exposure analysis was performed as part of the vulnerability assessment using the future flood scenarios. This initial assessment identified 176 facilities with high criticality and/or high flood exposure.

4.2 Field Data Collection

The field data collection effort included Jacobs staff visiting and collecting asset-level information for 205 JEA facilities, which included the 176 prioritized facilities as part of the Flood Vulnerability Assessment task (TO 3), additional facilities identified as part of the Electrical and I&C Assessment (TO 4), and the Water Reclamation System Hydraulic Assessment (TO 5), along with additional facilities recommended by JEA. The facilities visited included:

- 117 lift stations (LS)
- 38 wells
- 10 WRFs
- 19 WTPs
- 4 CWPs
- 5 booster lift stations
- 5 vacuum stations
- 3 repump stations
- 1 reclaimed booster station
- 3 potable water booster stations
- Total: 205 facilities

These site visits served to document asset information, including size, age, and condition; capture photos of each asset; and to measure the lowest elevation of each asset from the ground or slab to the bottom of the asset and identify the flood pathways for each asset at each facility (Figure 4-2). This information was compiled into an asset management database to be used in the subsequent exposure, sensitivity, adaptive capacity, and redundancy assessments.



JEA Data Management Resilience Program

Facility	BARTRAM RE-PUMP STATION
Asset Location	Reclaim Repump Station
Site Asset	Safety Switch
Is the floodpathway at grade?	1
If path is not at grade: The Flood Pathway Elevation (inches)	
Additional Asset Location	
Is the asset outdoors (exterior of building)?	1
Additional Asset	
Asset Quantity	1
Asset Capacity	100
Capacity Metric	Amperes
Height to Bottom of Asset in Inches (Above Finish Floor)	28
Assets at same height?	
Field Notes	

Figure 4-2. Field Data Collection Team Photo and Tablet Data Entry Form

5. Vulnerability Assessment

A vulnerability assessment was performed for the assets at each of the 176 priority facilities. Understanding the flood risk at each site/facility, as well as the associated susceptibility for damage of the facility's assets, is essential to conducting a comprehensive vulnerability assessment. An in-depth analysis of each asset's functions, systems, and site characteristics was analyzed to detect and characterize a facility's vulnerability and can be found in Appendix D, *Activity 4, Facility Vulnerability Assessment Technical Memorandum*. A facility vulnerability score was then calculated for each asset using the following equation:

Vulnerability = (Exposure + Sensitivity) / (Adaptive Capacity + Redundancy)

Exposure (Flood): *The proximity of a given asset (or facility) to the extents of a flood.*

Sensitivity (Flood): *The degree to which an asset may be impacted/damaged by flooding.*

Adaptive Capacity: *Ability of an asset to accommodate changing conditions.*

Redundancy: *Having a backup system to prevent single point of failure.*

This assessment helped reduce the previously identified 176 facilities to 142 vulnerable facilities. The vulnerability assessment results and scores for each asset were summed and used to rank the facilities. This assessment helped to categorize and prioritize various facilities/assets for more detailed development of cost of impacts and adaptation strategy development in the next phase of the project. Figure 5-1 shows the breakdown of vulnerability scores for the 142 facilities by facility type.

Facility Type	Total Number of Priority Facilities	Number of Facilities Broken Down by Vulnerability Scores for Flooding				# of Vulnerable Facilities
		Highest Vulnerability (Score greater than or equal 3)	Medium vulnerability (Score from 1.5 to 3)	Low vulnerability (Score less than 1.5)	Not vulnerable (Score of 0)	
Water Treatment Plants	20	5	2	3	10	10
Wastewater Treatment Plants	10	2	2	4	2	8
Chilled Water Plants	4	0	3	0	1	3
Wastewater Lift Station	125	21	62	28	14	111
Booster Lift Stations	5	1	2	0	2	3
Wastewater Vacuum Stations	5	2	1	2	0	5
Repump Stations	3	0	0	0	3	0
Reclaimed Booster Stations	1	0	1	0	0	1
Potable Water Booster Stations	3	0	1	0	2	1
Total	**176**	**31**	**74**	**37**	**34**	**142**

Figure 5-1. Number of Vulnerable Facilities by Facility Type

Vulnerability Assessment Results:

- Of the 1,664 JEA Facilities, 205 were selected for site visits.
- Of those 205 facilities, 176 facilities were found to be vulnerable to flooding.
- Of those 176 facilities, 142 were found to have an elevated vulnerability (Table 5-1).
- These 142 facilities with an elevated vulnerability were advanced into the risk assessment phase.

Note: The initial assessment grouped WTPs with wells that supply them. However, based on direction from JEA, these WTP/well groups were split into separate facilities if the well heads were located separately from the WTPs. This resulted in a total of 150 facilities advancing to the risk assessment phase.

Table 5-1. Facilities with the Highest Flood Vulnerability

Name	Type	Vulnerability Score
MAYPORT WELLFIELD WELL NO. 2	Well	5.0
MAIN STREET WELLFIELD WELL NO. 10	Well	4.9
HENDRICKS WTP	WTP	4.4
6947 NORWOOD AVENUE	LS	4.3
1202 BUNKER HILL BOULEVARD	Vacuum Station	4.3
5104 118TH STREET	LS	4.2
MAIN STREET WTP	WTP	4.1
MAYPORT WTP	WTP	4.1
5730 KINLOCK DRIVE SOUTH	LS	3.9
1023 LAURA STREET NORTH	LS	3.8
MAIN STREET WELLFIELD WELL NO. 6A	Well	3.8
PONCE DE LEON	WWTP	3.7
2251 MCCOY CREEK BOULEVARD	LS	3.6
8460 BRIERWOOD ROAD	LS	3.6
94 32ND STREET EAST	LS	3.4
420 TRESCA ROAD	LS	3.4
8617 WESTERN WAY	Booster Station	3.4
3254 TOWNSEND BOULEVARD	LS	3.4
487 GROVE PARK BOULEVARD	LS	3.4
8602 ZOO ROAD	LS	3.4
MAIN STREET WELLFIELD WELL NO. 1	Well	3.4
130 METZ STREET	Vacuum Station	3.4
ST. JOHNS FOREST WELLFIELD WELL NO. 1	Well	3.4
7834 HOLIDAY ROAD SOUTH	LS	3.3
6267 WHISPERING OAKS DRIVE NORTH	LS	3.3
MAIN STREET WELLFIELD WELL NO. 6	Well	3.3
MAIN STREET WELLFIELD WELL NO. 3	Well	3.3
7211 RHODE ISLAND DRIVE EAST	LS	3.3
6801 RHONE DRIVE	LS	3.3
4881 TIMUQUANA ROAD	LS	3.2
5233 5TH STREET WEST	LS	3.2
ST. JOHNS FOREST WELLFIELD WELL NO. 3	Well	3.1
BRIERWOOD WTP	WTP	3.1
74 BAISDEN ROAD	LS	3.1
11247 BEACON DRIVE	LS	3.1
DEERWOOD III WTP	WTP	3.1

6. Risk Analysis

6.1 Methodology

A risk analysis was performed on the previously selected 151 vulnerable facilities to quantify risk in terms of dollars based on direct damages resulting to JEA's assets for each flood scenario. This assessment was used to identify a representative set of 40 facilities, including those with the highest risk of direct asset damages, that includes representatives from all types of facilities. This list of critical and vulnerable facilities served as representative sample of facilities of each type for use in developing cost curves and extrapolation across all vulnerable facilities within the JEA enterprise.

Adaptation strategies were developed, and strategy costs were compared with cumulative risk avoided to generate facility recommendations. Using the asset elevation data, the benefit of providing flood protection at each facility was calculated as the cumulative risk avoided, which was determined based on each asset's replacement cost times the probability of flooding for each year. This annualized risk is then summed for all years over the asset service life to determine the cumulative risk avoided, which assumes the probability of flooding changes over time based on flood modeling climate scenario results from previous tasks.

Recommended adaptation strategies were identified for three different flood control levels, 100-year in 2040 and 2070 and 500-year in 2070 (Scenarios 2, 4, and 7, respectively); for each flood control level, strategies were selected where costs are less than the cumulative risk avoided for a particular group of assets. This calculation of risk was done separately for direct damages to JEA assets and for indirect economic impacts to JEA customers. See Appendix E, *Activity 5, Facility Risk Assessment Technical Memorandum* for facility-specific analyses and cumulative risk calculations based on direct asset impacts.

6.2 Risk Assessment Results

The results of this risk analysis are summarized by facility type in Figure 6-1. The combined risk of all lift stations with a level of service (LOS) of 1 have the highest monetized risk, followed by WRF facilities and WTPs.

The risk assessment results were used to prioritize the facilities with highest damage assessment costs. The facilities are listed in priority order of decreasing risk, both at a facility level by type of facility and at an asset level at each facility.

The facilities and assets that are generally above the flood scenarios' flood elevations have less risk of damages compared to the facilities and assets that are below the flood elevations. Based on the damage costs, the facilities that are in the top five of highest damages within each facility type are listed in Table 6-1. A full list is provided in Appendix E.

Table 6-1. Prioritization Based on Risk Damage Costs – Up to Top Five of Each Facility Type

Facility	Assets Count	Asset Replacement Cost ($)	Cumulative Risk Without Strategy ($)
Booster Lift Stations			
8617 WESTERN WAY	21	$3,509,600	$861,900
2740 COUNTY ROAD 210	8	$144,500	$28,900
CWP			
DOWNTOWN CWP	8	$5,921,900	$980,400
HOGANS CREEK CWP	4	$2,442,300	$257,500

Table 6-1. Prioritization Based on Risk Damage Costs – Up to Top Five of Each Facility Type

Facility	Assets Count	Asset Replacement Cost ($)	Cumulative Risk Without Strategy ($)
Lift Stations			
5301 EVERGREEN AVENUE	20	$8,974,900	$654,500
7834 HOLIDAY ROAD SOUTH	25	$6,203,200	$1,137,900
834 BAY STREET EAST	18	$5,923,900	$666,700
210 HOLLYBROOK AVENUE	22	$4,521,500	$1,119,000
3806 HERSCHEL STREET	14	$4,091,400	$156,500
Potable Water Booster Station			
1920 BISHOP ESTATES ROAD	1	$1,183,700	$34,800
Reclaim Booster Station			
US-1 RECLAIM PRESSURE BOOSTER STATION	1	$146,800	$21,700
Vacuum Stations			
1202 BUNKER HILL BOULEVARD	41	$5,840,400	$3,184,600
130 METZ STREET	19	$4,599,100	$1,165,600
2732 SCOTT MILL LANE	18	$2,555,400	$589,400
253 STATE ROAD A1A NORTH	15	$1,053,300	$201,300
1108 BARNWELL ROAD	6	$263,800	$16,000
Wells			
MAIN STREET WELLFIELD WELL NO. 10	6	$1,440,600	$793,600
MAIN STREET WELLFIELD WELL NO. 1	4	$1,300,500	$592,200
ST. JOHNS FOREST WELLFIELD WELL NO. 3	7	$1,257,400	$396,400
BRIERWOOD WELLFIELD WELL NO. 5	5	$1,243,100	$353,300
MAIN STREET WELLFIELD WELL NO. 3	2	$1,240,000	$640,700
WTP			
MAIN STREET WTP	154	$14,837,200	$4,143,400
HENDRICKS WTP	41	$6,880,100	$1,906,000
ST. JOHNS FOREST WTP 1	10	$3,169,100	$696,700
MAYPORT WTP	21	$2,513,200	$887,600
NASSAU WTP 1	11	$1,521,800	$261,500
WWTP/WRF			
SOUTHWEST WRF	37	$9,167,000	$839,300
JULINGTON CREEK PLANTATION WRF	37	$8,771,900	$780,600
SOUTHWEST WRF 2	12	$5,586,600	$31,154,700
MONTEREY WRF 1	11	$4,876,000	$1,304,400
PONCE DE LEON WWTP	23	$3,683,800	$1,209,300

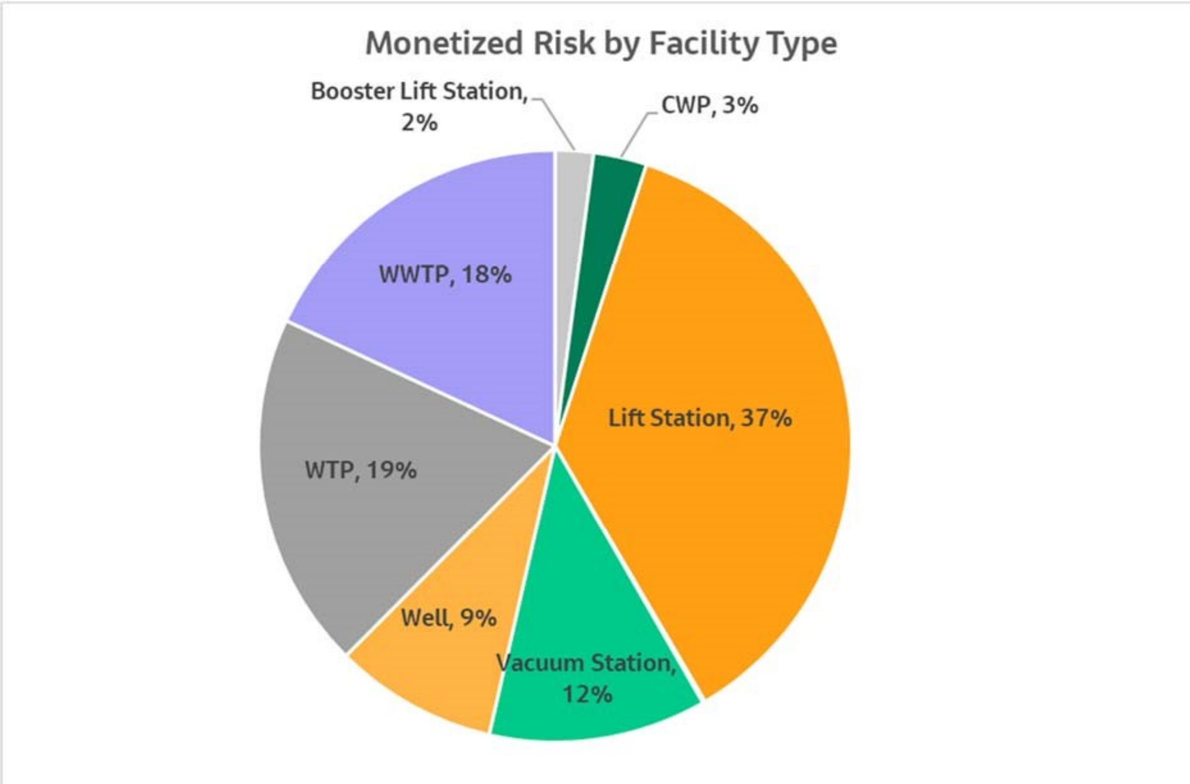


Figure 6-1. Monetized Risk Summarized by Facility Type

7. Adaptation Strategies

7.1 Strategy Development

The purpose of this section is to describe the methodology and assumptions used to develop and apply the most cost-effective adaptation strategies to mitigate flood risk for each asset at each facility. These strategies have been developed using our team's operational knowledge of JEA's water, wastewater, reclaimed water, and chilled water systems and supporting communications, electric supply, and I&C to ensure the strategies are practicable and implementable for each asset type. A full analysis on the development and application of each strategy can be found in Appendix F, *Activity 6, Mitigation and Adaptation Strategy Development Technical Memorandum*.

Adaptation strategies fall into three distinct categories: 1) elevate assets, 2) harden assets, and 3) facility flood walls/barriers. Where the elevate and harden strategies do not work for some asset types, they were combined to form a new category called "Hybrid," which selected the most cost-effective and applicable strategy between the elevate and harden categories to form a complete solution to protect all vulnerable assets at each facility. Examples of these strategies are presented on Figure 7-1.

- **Elevate Flood Strategy**: elevating assets or facilities depending upon cost effectiveness comparison
- **Hardening Strategy**: watertight sealing of windows, vents, and other penetrations using operable barriers
- **Flood Barrier Strategy**: permanent and temporary flood barrier solutions placed around building entrances or gaps in flood walls
- **Hybrid Strategy**: comprised of a collection of the most cost-effective (elevate or harden) strategy from each category to protect a given asset or facility

The determination of applicable flood mitigation strategies for each asset type was based on the assets identified at the 40 high-risk facilities. These 40 facilities include the largest and most critical facilities, with the highest flood risk, with the intent to support development of regression curves by facility type and extrapolation of strategy costs to the remaining vulnerable facilities across the JEA enterprise.

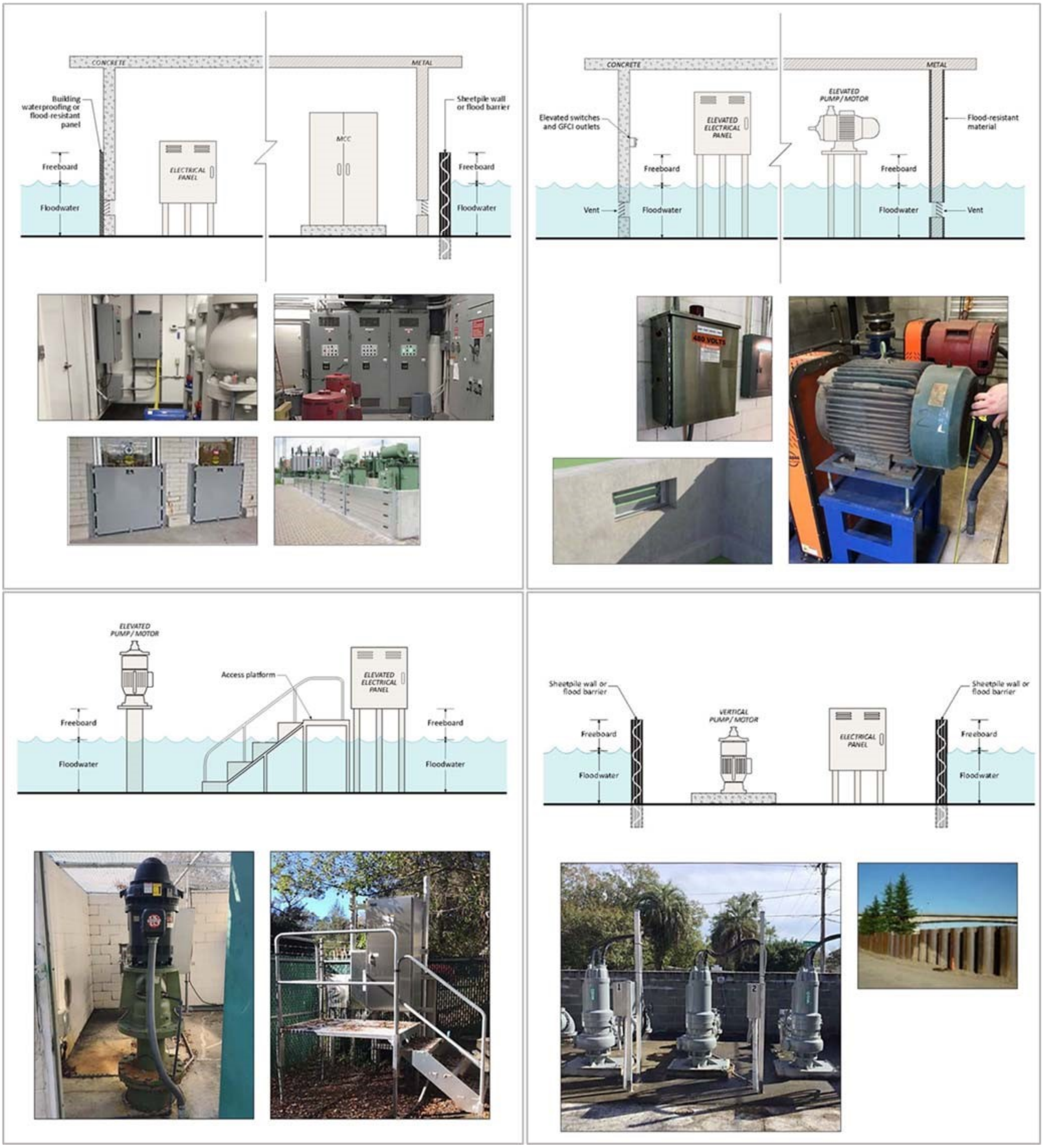


Figure 7-1. Adaptation Strategy Examples

7.2 Strategy Cost Estimates

Flood mitigation strategy costs were developed for each strategy and for each asset type. These estimated construction costs for the recommended strategies represent installed costs, including anticipated soft costs such as design and permitting.

7.2.1 Replacement Costs

Replacement costs were developed for 230 asset categories using over 500 unique asset costs. Jacobs' Timberline cost estimating tool and historical project costs obtained from JEA were used to estimate equipment replacement costs, which were used to support the strategy costs and the benefit/cost analysis. Costs for assets that had accurate capacities/parameters available in the field data collection database were extracted directly from the Timberline software program. Costs were often developed for a range of asset capacities/sizes for ease of application across the asset groups within an asset type. For assets without documented capacities/sizes, reasonable assumptions for capacity ranges were made based on asset functionality.

The project cost estimates are based on 2019 dollars. Table 7-1 provides a summary of replacement costs.

Table 7-1. Monetized Risk Summarized by Facility Type

Facility Type	Assets Impacted	Total Replacement Cost
Booster LS	23	$2,867,900
CWP	3	$1,257,500
LS	633	$54,656,100
Potable Water Booster Station	1	$1,183,700
Reclaim Booster Station	1	$146,800
Vacuum Station	63	$8,362,000
Well	50	$11,845,600
WTP	260	$28,239,400
WWTP/WRF	220	$38,508,400

7.2.2 Soft Costs

The soft costs are calculated for each of the soft costs including tax, mobilization, overhead and profit, and engineering costs, among others, and applied sequentially to the direct construction cost subtotal. Table 7-2 presents the soft costs applied to the cost subtotal (materials only) cost to calculate the total strategy cost for the exposed assets, for each of the strategies, and for each flood scenario (2, 4, and 7). The soft cost percentages were agreed to by JEA at a workshop dated on May 23, 2019.

Table 7-2. Soft Costs Including Permitting, Labor, and Materials

Item	Percentage
Material Sales and Use Tax	7%
General Conditions	10%
Mobilization and Demobilization	5%
Overhead and Profit	15%

Table 7-2. Soft Costs Including Permitting, Labor, and Materials

Item	Percentage
Bonds and Insurance	2%
Contingency	25%
Engineering	10%

7.2.3 Strategy Costs

A Class 5 estimate was prepared for these strategies in accordance with the Association for the Advancement of Cost Engineering International (AACEI) classification system. Based on AACEI guidelines, these estimates are considered to have a level of accuracy between −50 to +100 percent.

The cost estimate for strategies recommended for the 40 facilities was used to develop a regression model for strategy costs by type of facility and level of flood control to extrapolate to the remaining priority facilities identified during the Vulnerability and Risk Assessment.

The calculated hybrid strategy cost for each facility is the function of five main parameters:

1) Flood depth
2) Total number of exposed assets
3) Total number of large exposed assets
4) Total number of penetrations in exposed buildings
5) Total number of assets inside buildings

Costs for the selected (40) facilities are summarized on Figure 7-2 and further described in Section 8 as part of the benefit/cost analysis.

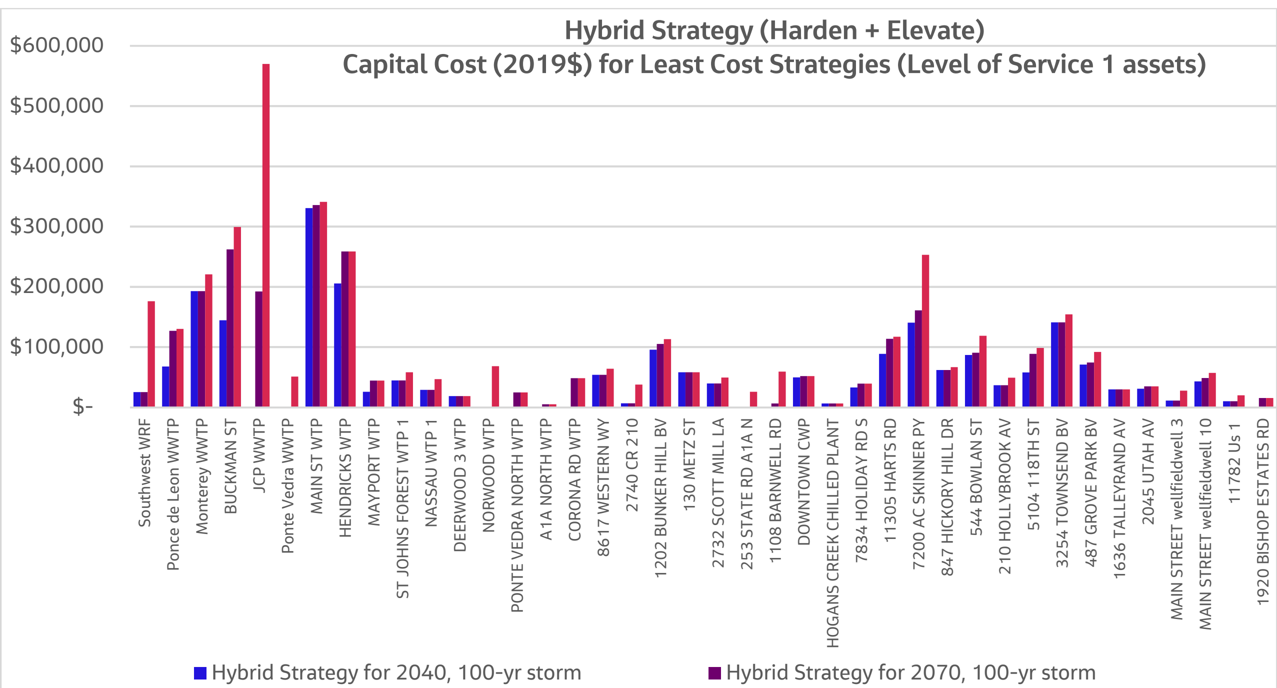


Figure 7-2. Hybrid Strategy (Harden or Elevate) Strategy Costs by Facility (LOS 1 Assets)

7.2.4 Strategy Cost by Flood Scenario

Capital costs for the flood protection strategies for the 40 facilities range from less than $10,000 to $8 million per facility (2019 dollars), not including asset replacement costs. The three planning scenarios evaluated are summarized for the selected 40 facilities as follows:

Flood Scenario 2: Projected 100-year storm in 2040 with 12.3 inches of rainfall, 1.8 feet of SLR, and storm surge with high GHG emissions. Cost range per facility (2019 dollars):

- Hybrid strategy: $5,000 to $330,000 (protecting up to 149 assets at one facility)
- Barrier Wall: $630,000 to $7,000,000

Flood Scenario 4: Projected 100-year storm in 2070 with 12.3 inches of rainfall, 4.5 feet of SLR, and storm surge with high GHG emissions. Cost range per facility (2019 dollars):

- Hybrid: $5,000 to $630,000 (protecting up to 151 assets at one facility)
- Barrier Wall: $640,000 to $7,300,000

Flood Scenario 7: Projected 500-year storm in 2070, with 16.6 inches of rainfall, 4.5 feet of SLR, and storm surge with high GHG emissions. Cost range per facility (2019 dollars):

- Hybrid: $5,000 to $670,000 (protecting up to 151 assets at one facility)
- Barrier Wall: $660,000 to $8,000,000

Figure 7-3 compares the cumulative cost of strategies for 150 facilities by flood scenario, demonstrating the cost effectiveness of the hybrid strategy versus the perimeter wall strategy.

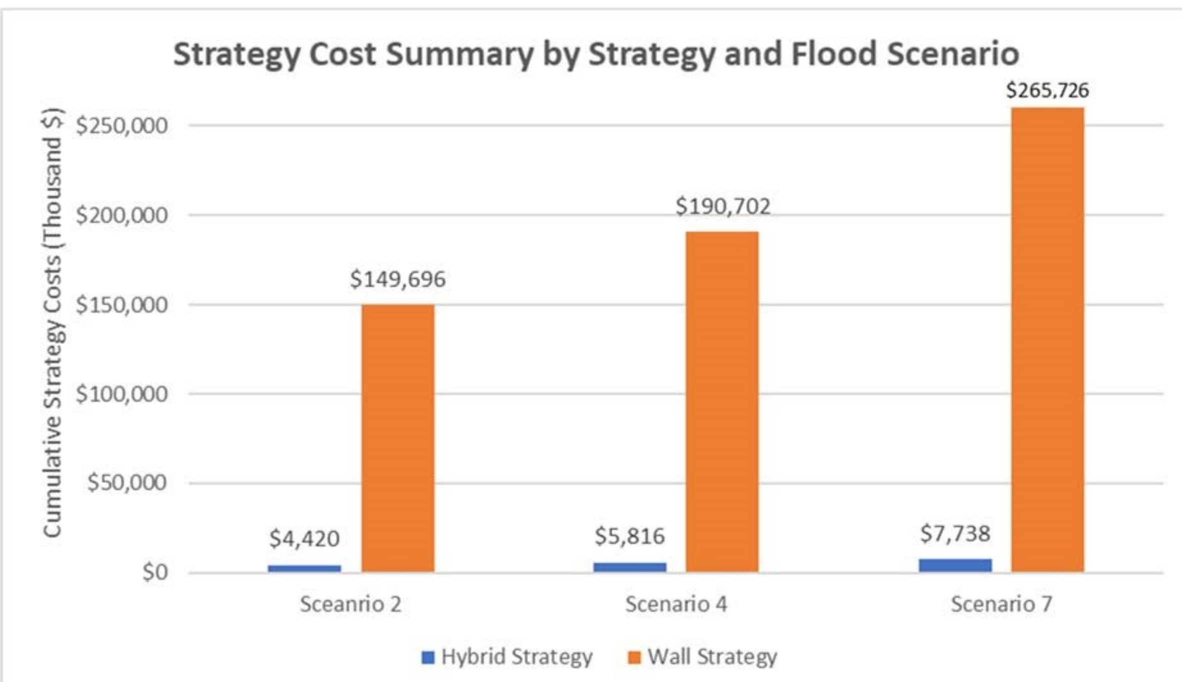


Figure 7-3. Cumulative Strategy Cost for 150 Facilities by Strategy Category and Flood Scenario

8. Economic Impact Assessment and Benefit/Cost Analysis

The primary benefits anticipated from incorporating flood mitigation measures for JEA facilities stem from avoiding damages from flooding. This includes both the direct physical damages to JEA facilities and the indirect damages associated with business interruptions resulting from loss in water service, loss in wastewater service, or sewer overflows. These two types of damages would be avoided by protecting JEA facilities from flooding.

To identify potential flood impacts to assets at selected JEA facilities, three flood model scenarios were used, as listed below, in conjunction with two primary flood protection strategies developed by the Jacobs team, including the hybrid strategy and the perimeter wall strategy.

- Scenario 2: 2040, 100-year storm with storm surge and SLR
- Scenario 4: 2070, 100-year storm with storm surge and SLR
- Scenario 7: 2070, 500-year storm with storm surge and SLR

More information can be found in Appendix G, *Activity 7, Economic Impact and Benefit/Cost Analysis Technical Memorandum*.

8.1 Benefits from Reducing Direct Impacts

As summarized in Section 6, benefits were first determined for reduction in flood risk to JEA's physical assets through the implementation of flood mitigation measures as described in Section 7. The Jacobs team applied the flood mitigation alternatives developed in Section 7, using the modeled flood elevations for the selected facilities. In this step, the benefits from reducing risk of business losses are omitted so that the direct impact to JEA's bottom line can be shown. The benefits from reducing risk to JEA's physical assets are calculated for each asset at each facility per climate scenario, as quantified in Section 6, *Risk Analysis*. These benefits are rolled up to the facility level so that the benefits and costs of maintaining service at the facility level could be evaluated in the benefit cost analysis.

8.2 Benefits from Reducing Secondary Impacts

Benefits associated with reducing interruption in services for JEA business customers as a result of a JEA system failure also support the benefit cost analysis for resilience investment.

The indirect economic impact analysis determines the contribution to the economy of the businesses supported by water distribution or wastewater collection services within the JEA service areas of the priority facilities identified in the vulnerability analysis and subsequently in the risk analysis. The results show the value per day of the business activity in the JEA service areas for each of these facilities. The primary data used for estimating the value of economic activity within the JEA service areas of facilities at risk are embedded in the Impact Analysis for Planning (IMPLAN) model. These data are found in Appendix G, *Activity 7, Economic Impact and Benefit Cost Analysis Technical Memorandum*.

This value per day is multiplied by the duration of the outage (i.e., number of days) to estimate the losses in economic net output from facility failures. The value of preventing the risk of such losses in economic activity due to the loss of water or wastewater service or to SSOs is an economic benefit of resilience measures that protect against flood elevations that force a shutdown of JEA's facilities. Such benefits are separate from and additive to the direct physical damages to JEA facilities.

The combined benefits were then calculated as the sum of direct impacts and indirect business impacts. These can then be sorted to provide a ranking based on the combined benefits. For input to the capital prioritization, the benefits based on combined risk were categorized into a simple 5 to 1 score, as shown on Figure 8-1.

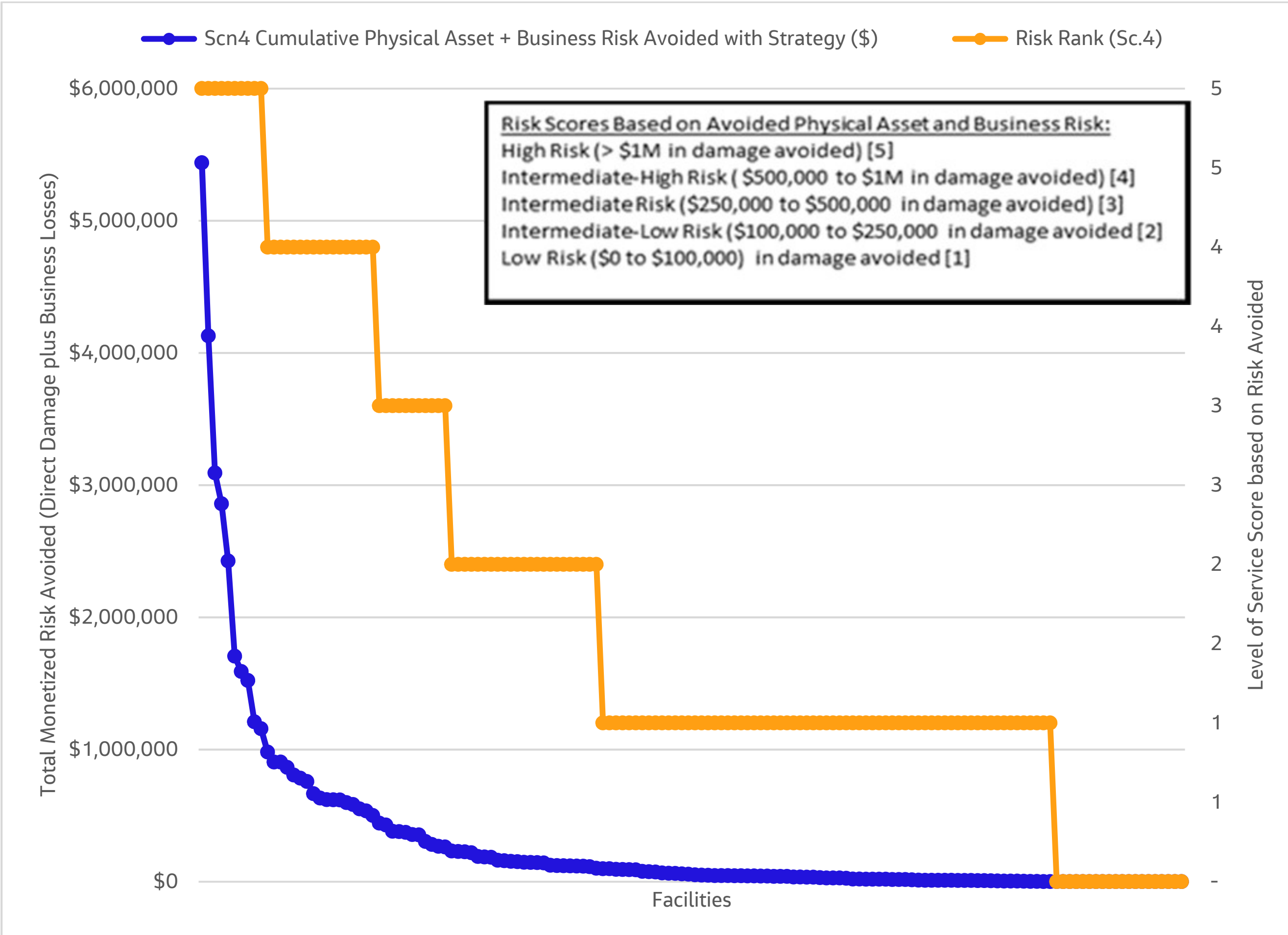


Figure 8-1. Cumulative Risk Scores Based on Avoided Direct and Secondary Impacts

8.3 Benefit/Cost Analysis

The benefit/cost analysis provides the magnitude of the total damages avoided (both direct and indirect) and cost effectiveness of investments in strategies to improve resilience for ranking facilities for investing in strategies to improve resilience. It analyzes the benefits versus costs of JEA making investments to mitigate flood impacts to their facilities and to their customers.

Prior to presenting the results, it is helpful to define the terms used in benefit-cost analysis for evaluating projects based on economic efficiency. These terms and their interpretation are as follows:

- **Benefit/Cost (B/C) Ratio** = Total discounted benefits divided by total discounted costs for a quick determination on economic efficiency.
  - When B/C > 1, the benefits exceed the costs and the project is justified.
  - The larger the B/C ratio, the greater the confidence that the investment is worthwhile.
- **Net Present Value (NPV)** = Present Value Benefits minus Present Value Costs
  - When NPV > 0 project is justified.
  - The larger the NPV the greater the confidence that the investment is worthwhile.
  - When choosing among alternatives, the economic goal is to maximize NPV.

- **$ Net Return/$ Cost** = NPV/$ Cost, which is the return on investment (ROI) based on the dollars netted for each dollar invested
  - Useful metric for ranking projects to achieve the goal of maximizing NPV.
  - Selecting projects according to their $ Net Return/$ Cost rank, gives the most cost-effective portfolio of investments for improving resilience.

For each of these metrics, two sets of benefit-cost results are calculated where the first reflects only the benefits of avoided risk of damages to JEA assets and the second includes the first set plus the avoided risk of loss of business. The detailed results for all 150 facilities are displayed in the Appendix G, *Activity 7, Economic Impact and Cost Benefit Analysis Technical Memorandum*.

Table 8-1 summarizes the results for the combined avoided risks (direct and indirect) for the top 25 facilities in order of cost-effectiveness of the resilience strategy. The facility column identifies the facility. The Net ROI for Maximum Strategy column provides the measure of cost-effectiveness, $NPV for the Combined Benefits column/ $Strategy Cost column. This is also called the net ROI. The selected strategy for each facility is identified in the Max Return Scenario column, and it corresponds to the Hybrid Strategy for the scenario (i.e., 2, 4, or 7) that produced the highest ROI and is thus called the Max Return Scenario.

The Maximum Strategy Cost column provides the strategy cost and the NPV Maximum Strategy column shows the NPV. For the facilities in this list, the NPV far exceeds the strategy costs, resulting in the large ROI in the Net ROI for Maximum Strategy column. For example, for each dollar in strategy cost for improving Arlington Well No. 5, the investment returns a benefit of $136.

Although all the facilities in Table 8-1 pass the benefit/cost test, JEA may have a limited budget for investing in resilience. The Cumulative Cost Maximum Strategy column provides the cumulative cost from investing in multiple resilience projects. Funding all 25 strategies would cost $0.66 million and would generate a net return of $27.12 million. Table 8-2 shows the facilities with “High” ROI ranking by flood scenario.

Table 8-1. Facilities Ranked by Cost-Effectiveness Based on Combined Risk of Direct Impacts and Indirect Cost of Customer Business Interruptions

Facility	Net ROI for Maximum Strategy ($/$)	Max Return Scenario	Maximum Strategy Cost ($)	NPV Maximum Strategy ($)	Cumulative Cost Maximum Strategy	Cumulative NPV
ARLINGTON WELLFIELD WELL NO. 5	135.9	SCN7	$2,149	$292,092	$2,149	$292,092
2045 UTAH AVENUE LS	133.5	SCN7	$54,438	$7,265,793	$56,587	$7,557,885
SOUTHWEST WRF	113.1	SCN4	$25,042	$2,833,447	$81,629	$10,391,332
RIDENOUR WELLFIELD WELL NO. 7	98.9	SCN7	$2,149	$212,514	$83,777	$10,603,846
MAIN STREET WELLFIELD WELL NO. 1	94.9	SCN2	$4,297	$407,972	$88,074	$11,011,818
MAIN STREET WELLFIELD WELL NO. 12	66.3	SCN7	$2,149	$142,438	$90,223	$11,154,256
6630 BROADWAY AVENUE LS	62.1	SCN7	$6,446	$400,247	$96,668	$11,554,503
7834 HOLIDAY ROAD SOUTH LS	54.0	SCN7	$39,096	$2,109,712	$135,765	$13,664,214
1636 TALLEYRAND AVENUE LS	52.5	SCN7	$29,694	$1,559,669	$165,458	$15,223,883

Table 8-1. Facilities Ranked by Cost-Effectiveness Based on Combined Risk of Direct Impacts and Indirect Cost of Customer Business Interruptions

Facility	Net ROI for Maximum Strategy ($/$)	Max Return Scenario	Maximum Strategy Cost ($)	NPV Maximum Strategy ($)	Cumulative Cost Maximum Strategy	Cumulative NPV
BRIERWOOD WELLFIELD WELL NO 5	47.9	SCN7	$6,446	$308,875	$171,904	$15,532,758
834 BAY STREET EAST LS	40.8	SCN7	$38,674	$1,579,803	$210,578	$17,112,561
3300 SAN PABLO ROAD SOUTH LS	34.0	SCN4	$4,297	$146,220	$214,875	$17,258,781
1023 LAURA STREET NORTH LS	30.8	SCN7	$42,743	$1,318,204	$257,618	$18,576,985
GREENLAND WELLFIELD WELL NO. 2	27.3	SCN7	$2,149	$58,616	$259,766	$18,635,601
210 HOLLYBROOK AVENUE LS	27.1	SCN7	$49,489	$1,340,217	$309,255	$19,975,818
1706 BOULEVARD AVENUE LS	26.6	SCN4	$12,891	$342,325	$322,147	$20,318,143
1202 BUNKER HILL BOULEVARD	24.7	SCN2	$120,209	$2,971,450	$442,356	$23,289,593
MAIN STREET WELLFIELD WELL NO. 3	24.7	SCN2	$11,135	$275,122	$453,491	$23,564,715
6927 HANSON DRIVE SOUTH LS	20.0	SCN7	$26,743	$534,164	$480,234	$24,098,879
DOWNTOWN CWP	18.0	SCN7	$51,716	$928,643	$531,950	$25,027,522
MAYPORT WTP	16.5	SCN2	$45,530	$749,965	$577,480	$25,777,487
ST JOHNS FOREST WTP 1	15.7	SCN7	$58,150	$912,802	$635,630	$26,690,288
ST JOHNS FOREST WELLFIELD WELL NO. 3	15.0	SCN7	$22,446	$337,230	$658,075	$27,027,519
1060 ELLIS ROAD NORTH LS	14.2	SCN4	$2,149	$30,563	$660,224	$27,058,082
4140 KINGSBURY STREET LS	13.8	SCN4	$4,297	$59,202	$664,521	$27,117,284

Table 8-2. Facilities with "High" ROI Ranking by Flood Scenario

Scenario 2 ROI Ranking	Scenario 4 ROI Ranking	Scenario 7 ROI Ranking
Southwest WRF	Southwest WRF	Arlington Wellfield Well No. 5
Main Street Wellfield Well No. 1	2045 Utah Avenue LS	2045 Utah Avenue LS
2045 Utah Avenue LS	Main Street Wellfield Well No. 1	Ridenour Wellfield Well No. 7
Ridenour Wellfield Well No. 7	Ridenour Wellfield Well No. 7	Main Street Wellfield Well No. 1
1636 Talleyrand Avenue LS	1636 Talleyrand Avenue LS	Main Street Wellfield Well No. 12
7834 Holiday Road South LS	7834 Holiday Road South Lift Station	6630 Broadway Avenue LS
1706 Boulevard Avenue LS	3300 San Pablo Road South LS	7834 Holiday Road South LS

Table 8-2. Facilities with "High" ROI Ranking by Flood Scenario

Scenario 2 ROI Ranking	Scenario 4 ROI Ranking	Scenario 7 ROI Ranking
1023 Laura Street North LS	1706 Boulevard Avenue LS	1636 Talleyrand Avenue LS
1202 Bunker Hill Boulevard Vacuum Station	1023 Laura Street North LS	Brierwood Wellfield Well No. 5
Main Street Wellfield Well No.3	1202 Bunker Hill Boulevard LS	834 Bay Street East LS
	210 Hollybrook Avenue LS	1023 Laura Street North LS
		Greenland Wellfield Well No. 2
		210 Hollybrook Avenue LS

The results from comparing the combined cumulative cost against the ROI for each flood scenario (2, 4, or 7) for the top ranked facilities from Table 8-2 are shown on Figure 8-2. In general, the ROI increases with higher levels of flood control (i.e., Scenario 7) usually produces the highest ROI, as shown in Table 8-2. As shown on Figure 8-1, Scenario 2 is usually the lowest ROI, followed by Scenario 4 then Scenario 7. However, this is not always the case. For example, for Main Street Well Nos. 1 and 3, Scenario 2 has the highest ROI. In addition, some facilities, such as the Arlington Well No. 5 and the Main Street Well No. 12, Scenario 7 is not only the preferred level of protection, but it is also the only level of protection that is needed or economically viable.

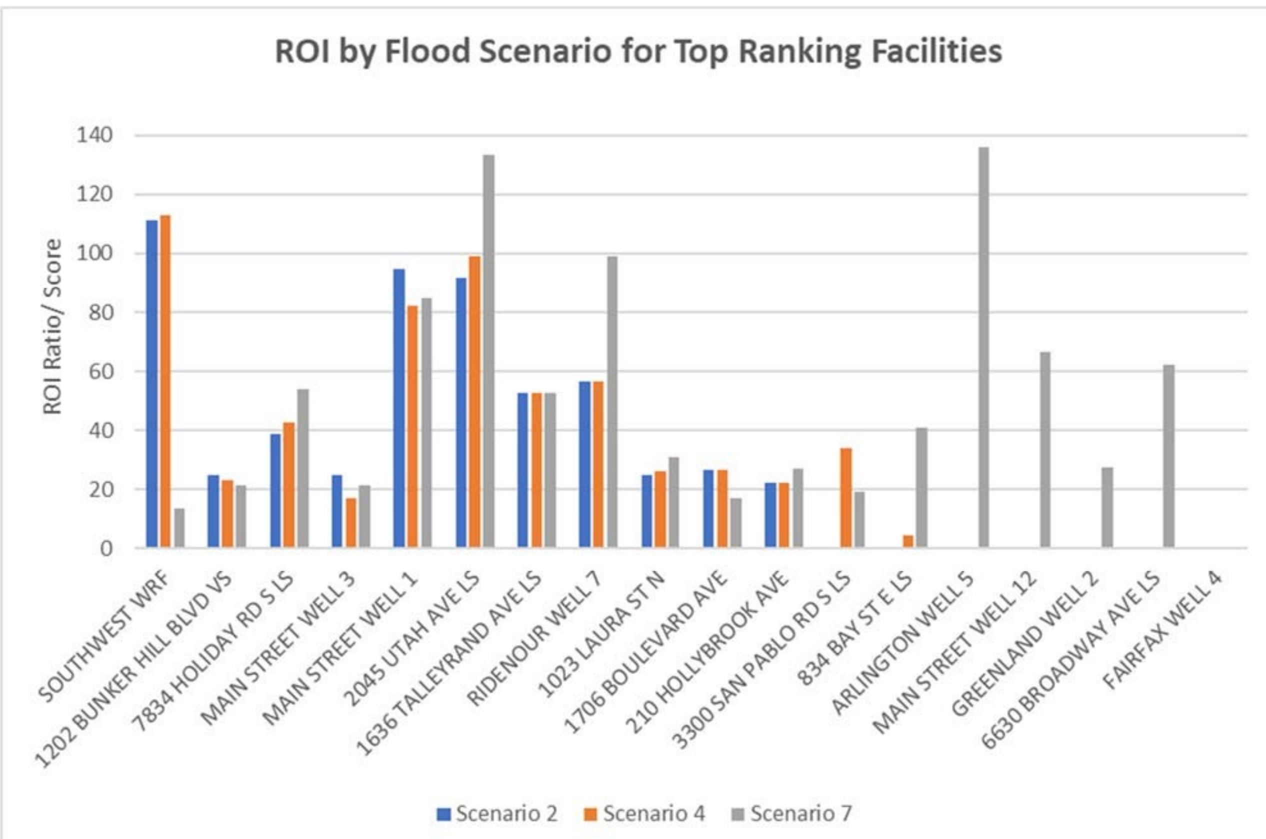


Figure 8-2. Comparison of ROI Across Scenarios 2, 4, and 7 for the facilities with the highest ROI (Combined Physical Asset and Business Loss ROI)

Figure 8-3 compares the ROI to the strategy cost for the 25 top-ranking facilities based on ROI. This shows that ROI declines steeply and then flattens out but remains positive for this short list. It also shows that some strategies are inexpensive and provide a high ROI such that it is easy to recommend them for improvement, but even the relatively expensive strategy costs among these top-ranking facilities are well worth considering if JEA has the funds to invest in improving resilience.

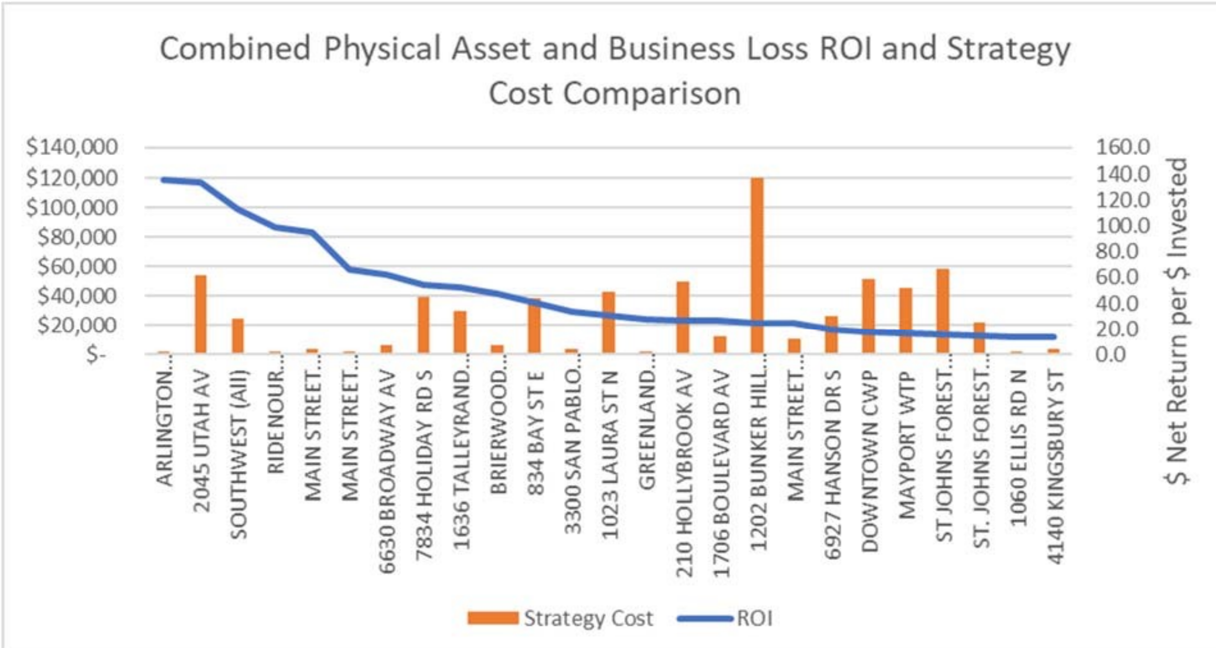


Figure 8-3. Combined Physical Asset and Business Loss ROI and Strategy Cost Comparison

Figure 8-4 is identical to Figure 8-3 except that it includes only the avoided risks to JEA's physical assets in the benefit calculations.

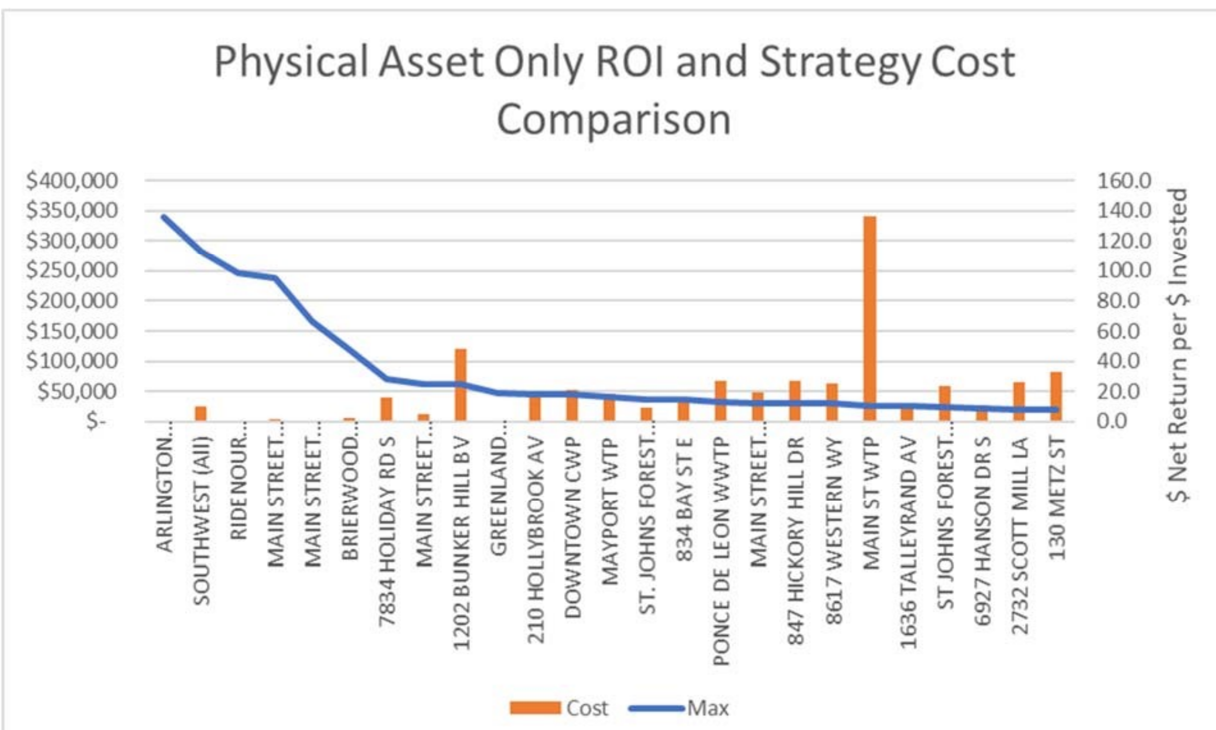


Figure 8-4. Physical Assets ROI and Strategy Cost Comparison.

Another way to illustrate this point is through the comparison of cumulative NPV to cumulative cost in Figure 8-5, which demonstrates that the cumulative NPV far exceeds the cumulative cost.

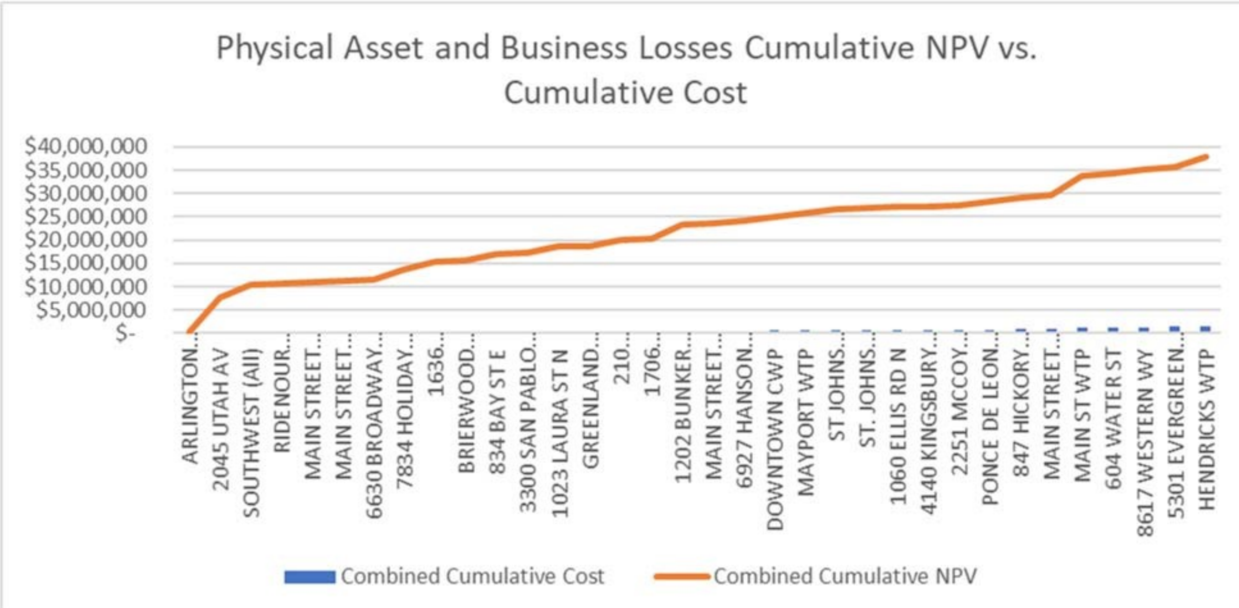


Figure 8-5. Physical Asset and Business Losses Cumulative NPV versus Cumulative Cost

Figure 8-6 shows the Cumulative Strategy Cost for the facilities in order of maximum ROI for the combined physical asset and business loss. This graph is especially useful for illustrating how many facilities can be improved with a given investment if the dollars are allocated in terms of ROI.

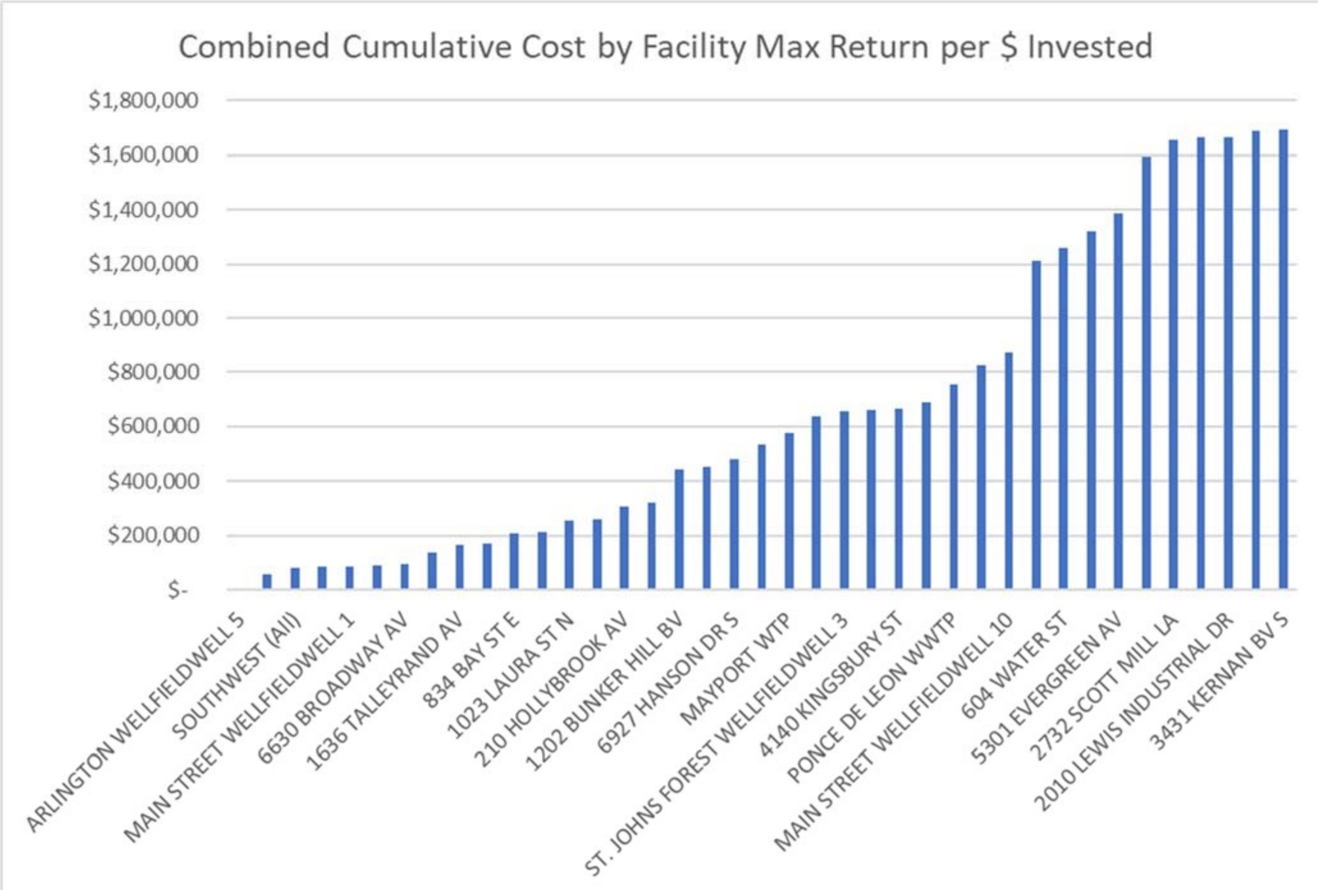


Figure 8-6. Cumulative Costs for Facilities Ranked by Maximum Return on Investment (Combined Benefits of Avoided Physical Assets and Business Losses)

To support the CIP prioritization discussed in Section 9, facilities were categorized into five categories based on ROI from their combined benefits, as shown on Figure 8-9.

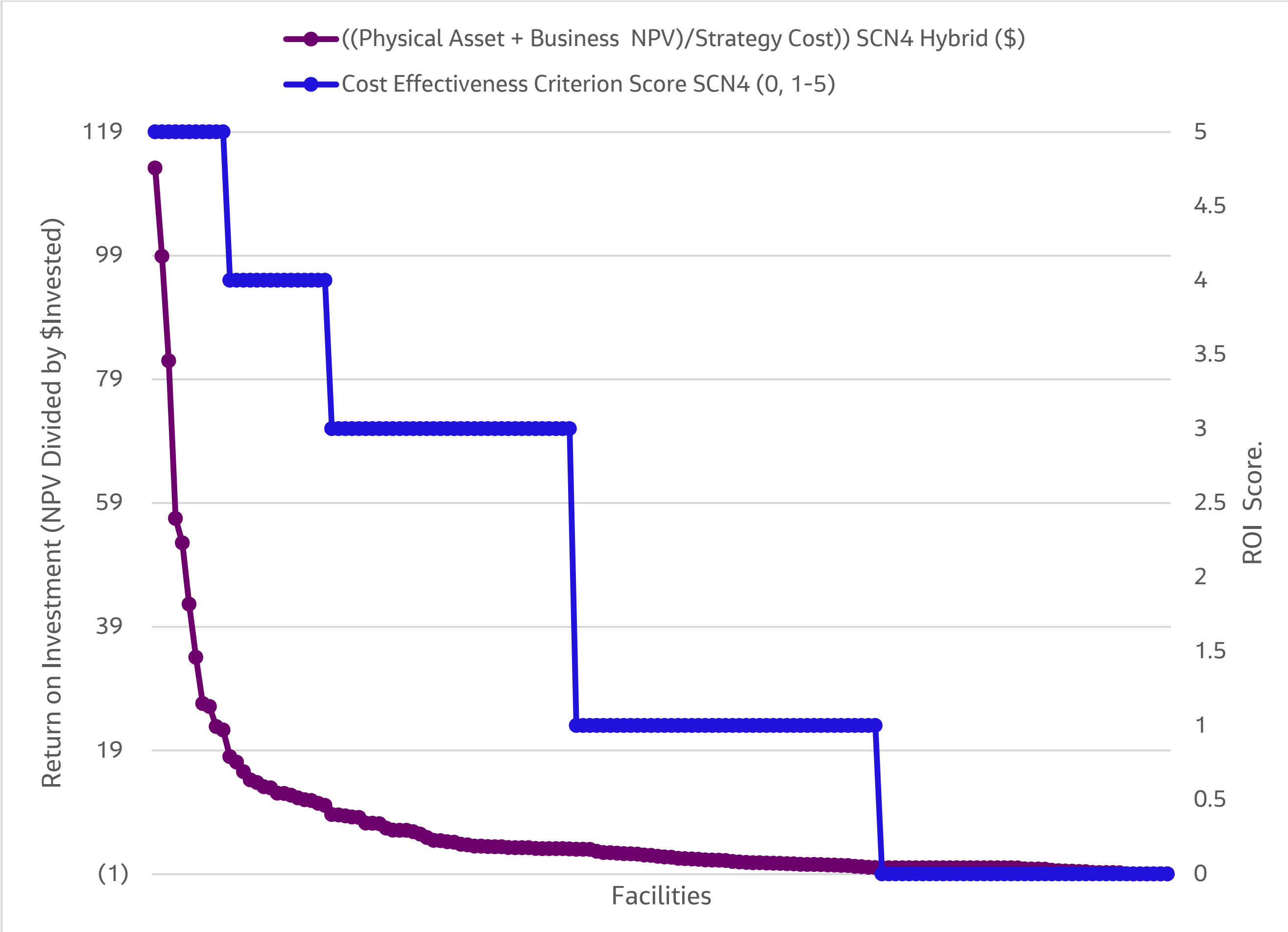


Figure 8-7. Chart Showing Combined Physical Asset and Business Loss ROI and ROI Rank (5,4,3,1,0) used in CIP Prioritization Based on Scenario 4

Several general conclusions can be drawn from the benefit-cost analysis results as follows; refer to Appendix G, *Activity 7, Economic Impact and Benefit Cost Analysis Technical Memorandum* for data tables supporting these conclusions:

- Some facilities should be omitted from investments in measures to improve resilience because they have a B/C ratio less than one and generate a negative return.
- The barrier wall is too expensive and does not generate benefits that justify the costs.
- ROI defined as $NPV/ $Strategy Cost is the best way to rank projects to achieve the greatest amount of protection at least cost.
- Using the combination of business losses and physical assets changes the priority rankings in some cases and should be the basis for setting priorities.
- The hybrid strategy designed for the 500-year flood in 2070 (Scenario 7) is generally, but not always, the best investment, indicating that the decision on level of protection should be made on a facility-by-facility basis
- JEA may not have the funds available to immediately invest in all the facilities that pass the benefit-cost test. To assist in setting priorities, Attachments 18 and 19 from the Activity 7 TM, in Appendix E, shows

which level of protection is most cost-effective for each facility and ranks the facilities by cost-effectiveness from highest ROI to lowest ROI. The top 25 facilities from this list are shown in Table 8-2.

- Some facilities may be at risk sooner rather than later. To further refine priorities the list of such facilities can be cross-referenced against the priority ranking in Table 6-1 and Appendix E, *Activity 5, Facility Risk Assessment Technical Memorandum*.

There are a few caveats in applying these results to investment decisions.

- It might be beneficial to separately rank each type of facility for a fairer comparison.
  - The benefits of the chilled water facilities and the WWTPs are underestimated because, at JEA's request, they do not include any of the avoided risk of business losses.
  - The benefits of the WTP improvements are underestimated because the business losses were limited to a shutdown of 1 day.
- JEA costs of operating and maintaining the improvement measures were not included, thus costs are underestimated.
- Other benefits that were not included in the Benefit/Cost Assessment (BCA) such as JEA emergency response costs, avoided risk of loss of service to residential customers, and avoided costs to JEA to restart facilities after shutdown have the effect of underestimating benefits.

9. Design and Construction Standards

The existing design and construction standards for JEA were reviewed to identify and address any potential resilience-related gaps, conflicts, or opportunities for alignment with JEA's advancing position on flood risk reduction, system reliability, and operational continuity to the increasing flood threat posed by severe weather and climate change. In addition to reviewing the existing standards to enhance water, wastewater, chilled water, and reclaimed water system resilience, new resilience standards and implementation guidance were developed and are recommended for consideration by JEA. Appendix H contains the *Industry Best Practices/Benchmark Assessment Technical Memorandum* submitted to JEA.

The standards reviewed included:

- Water and Wastewater Standards Manual (January 2020)
- Water Treatment Plant Standards Manual (January 2020; Draft)
- Wastewater Manhole Standards (January 2018)
- Rules and Regulations for Water, Sewer, and Reclaimed Water Services (November 2017)
- Detail Sheet – JEA Pump Station Site-Specific Sheets Master (January 2020)
- Detail Sheet – JEA Pump Station Standard Sheets Master (January 2020)
- Detail Sheet – JEA Wastewater Details (January 2020)
- Detail Sheet – JEA Water and Reclaimed Details (January 2020)

The recommendations discussed are intended to inform modifications to the existing design standards or development and adoption of new design standards by JEA and to guide their application for planning and design of facility upgrades, rehabilitations, and new capital projects to reduce flood risk and build resilience across the JEA water utility enterprise. Additional information, including a full list of recommended revisions to existing standards, can be found in Appendix I, *Activity 9, Design and Construction Standards Review Technical Memorandum*.

9.1 Existing Standards Review

The review of the existing JEA potable water, wastewater, chilled water, and reclaimed water system standards was performed to identify opportunities for enhancement of the standards to mitigate the potential adverse effects resulting from flood and other severe weather events causing service interruptions because of equipment damage and disruptions to system operations. This review of JEA standards includes those standards, details, and guiding documents provided by JEA and those obtained from the JEA website.

The following strategies are our general recommendation to reduce flood risk and increase system reliability against current and future severe weather events:

- Backflow preventers, wherever possible, to prevent backup of wastewater into buildings
- Dual/redundant electrical power supply and communications for all critical electrical and I&C panels
- Avoid use of ductile iron pipe; replace with polyvinyl chloride (PVC) for buried pipe and stainless steel for above ground
- Elevate or floodproof flood sensitive equipment and buildings above the minimum design elevation recommended in the *Flood Risk Reduction Implementation Guide* to address projected future climate change conditions as mapped out in Activity 3
- Seal electrical and control boxes using water-tight connections or submersible equipment

9.2 New Resilience Standards

New design standards recommendations presented to JEA for consideration are intended to reduce flood risk and increase reliability of JEA water, wastewater, reclaimed water, and chilled water systems. They are intended to inform the development of new design standards that will apply to both existing facilities and new capital projects.

These new design standards include Electrical and I&C, Wastewater Conveyance System Improvements, Flood Risk Reduction Standards, Flood Risk Reduction Implementation Guide, and Mitigating Other Natural Hazards.

- The electrical and I&C system recommendations include application of a single, centralized backup generator power station to serve an entire facility and closed-loop transition from primary power to backup power.
- The wastewater conveyance system improvements consist of recommendations, including calibration of the WRF hydraulic models for both dry- and wet-weather flow and provisions for installation of influent flowmeters for new and rehabilitated WRFs.
- The flood risk reduction standards, further described in the *Flood Risk Reduction Implementation Guide*, provide guidance related to the minimum design elevations and associated standards for reducing flood risk and incorporating resilience into the design of both rehabilitation and new construction projects across JEA's water, wastewater, reclaimed water, and chilled water systems.
- Mitigation of other natural threats was also recognized as a critical component of reducing risk and improving reliability of the various water systems, resulting in actions to mitigate high wind and flying debris, lightning, extreme heat, wildfire and building fire, and drought.

The previous considerations and recommendations are provided for awareness, as local and state regulations have historically driven the design criteria used by JEA designs. However, the new standards and recommendations within this document exceed local and state requirements, in some cases, to position JEA's facilities for future severe weather conditions anticipated over the service life of the assets. By planning and investing in the future, JEA is demonstrating leadership around climate and severe weather risk that will improve the performance of their systems and ultimately benefit the communities they serve.

Monitoring of these local and state regulations is recommended as there are changes underway that are expected to become policy in the next couple of years. Awareness of these changes and how they relate to JEA's policies and standards will help to reinforce JEA's position and garner support for continued investment in the future.

9.3 Facility Lookup Tool

Once a facility is selected for upgrades or enhancements as part of the rehabilitation and replacement (r&r), operations and maintenance (O&M), or capital programs, the first step is to collect all relevant data required to determine what assets require intervention. Jacobs has developed a new Facility Lookup Tool that will allow JEA's asset management team to quickly provide additional, necessary data, such as the lowest asset elevation or flood pathway, to JEA Project Managers (PMs) to prepare a project description that mitigates a broader range of facility vulnerabilities and provides guidance on minimum design criteria and overall resilience. Refer to Appendix M, *Facility Lookup Tool and User Guide*.

This tool has been set up using a Microsoft Access database to link to JEA's eAM system and for quick filtering of facilities for use by JEA during this early phase of facility review. The Facility Lookup Tool (refer to will be provided to JEA, upon completion.

Key Findings and Considerations:

- In some cases, the new standards and recommendations within this document exceed local and state requirements. By planning and investing in the future, JEA is demonstrating leadership around climate and severe weather risk, that will improve the performance of their systems and ultimately benefit the communities they serve.

- The City of Jacksonville has begun a stormwater masterplan update intended to reflect the elevated boundary conditions resulting from SLR and the rainfall projections prepared as part of JEA's Resiliency Program.
- The Florida Building Code (FBC) adopted the 2015 International Building Code with amendments. After Hurricane Michael in 2018, the FBC wind map is being revisited for possible revision. By moving to a more robust design standard now, JEA can be ahead of the curve and prepare for the anticipated, more aggressive standards.
- Create a dedicated web page that lists all standards documents on one page with adoption dates and that maintains previous versions, grouped based on the intended user or function of the document, with a short preamble that describes the intent of each document group. This "one-stop shop" site will help ensure that developers and designers are always using the latest versions of these documents.
- Reinforce the need to provide external-facing education and awareness through workshops, fact sheets, and easy to follow "how-to" guides that describe the new process of identifying and mitigating flood and other risks for each project.
- JEA should review all guidance documents, processes, and policies to ensure alignment with the new standards and the broader changes to the process of incorporating resilience into all JEA capital projects.
- Continue coordination with the City of Jacksonville regarding stormwater management policies and flood risk reduction projects.
- Enhance hurricane design criteria mimicking the Miami-Dade County design wind speed.
- Consolidation of JEA standards for ease of use and to prevent duplication of information.
- Update JEA PM Handbook, conduct staff training, and communicate leadership position on planning and designing for climate change to ensure consistent application across the enterprise.
- Engage stakeholders in standards updates to improve contractor and external awareness of the intent behind the new more robust standards.

10. Strategy Prioritization

Jacobs assisted JEA with determining prioritization criteria for their capital projects as part of the Water and Wastewater Capital Program. A workshop was held to determine the prioritization criteria that were most important to JEA and align with JEA's corporate values. These prioritization criteria were modified and applied to the improvement projects from each TO that were combined with the resilience projects to address the broader needs and vulnerabilities for each facility. A score was assigned to each combined resilience capital project for these five prioritization criteria:

- Capacity/System Growth
- Level of Service Improvement
- Redundancy/Operational Flexibility
- Environmental Impact
- Cost Effectiveness

Full criteria descriptions and prioritization weightings can be found in Appendix J, *Activity 10, Capital Project Prioritization Technical Memorandum*.

10.1 Project Prioritization and Phasing

To prioritize capital improvement projects identified, information was compiled from TOs 3, 4, 5, 10, 12, 15, and 16 of the Resiliency Program. A total of 240 JEA facilities were evaluated.

Figure 10-1 shows the number of facilities containing recommended improvements, recognizing that there is some overlap between the TOs. The facilities with recommendations were moved forward to be prioritized as projects. In some cases, projects at a single facility were kept separate, such as with the Buckman WRF, which has two projects since the outfall rehabilitation project requires a specialty contractor and would not fit well with the other recommendations at the Buckman WRF.

Once the potential projects were determined, the analysis reviewed whether JEA has an existing project that will address the recommendations made in the resilience TOs. If the existing project will address the resilience recommendations, the resilience project was excluded from the prioritization. Following the analysis, a total of 174 projects were moved into the prioritization.

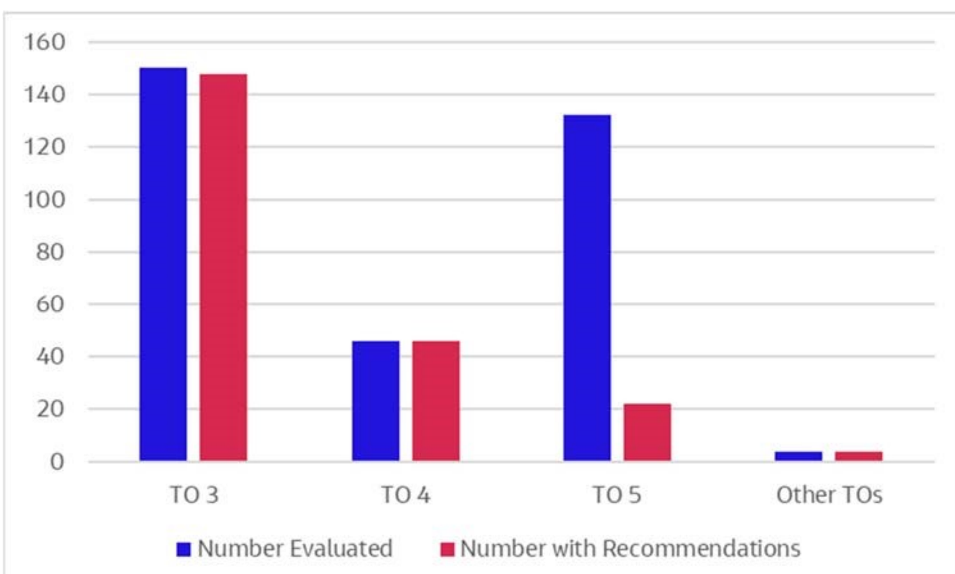


Figure 10-1. Number of Facilities Evaluated and with Recommendations in Each Task Order

Prioritization scores for each of the five prioritization criteria were determined for each project selected under the Resiliency Program. The Capacity/System Growth criterion is used to indicate that a specific project will increase the capacity of the wastewater collection or treatment system since TO 5 was the only Resiliency Program TO that focused on capacity and was only focused on the wastewater system. The Level of Service Improvement criterion was scored based upon the magnitude of a reduced risk of flooding and applied to projects from TO 3, TO 4, or TO 5. The Redundancy/Operational Flexibility criterion was scored based upon the reduction in O&M costs resulting from the project. The Environmental Impact criterion was scored based on a project mitigating known SSOs. The Cost Effectiveness criterion was scored based on capacity improvements identified, generator/motor control center (MCC) replacement improvements identified, and results of the benefit-cost analysis for TO 3 recommendations.

Once each project had a score for each of the five criteria, a spreadsheet was used to calculate the scores and prioritize the 174 projects. The spreadsheet tool was used to perform a sensitivity analysis to evaluate the impact on the rankings of projects based on the following potential weightings:

1) Equal weighting
2) Cost Effectiveness and Redundancy/Operational Flexibility focus
    a) Cost Effectiveness and Redundancy/Operational Flexibility are weighted at 100 percent
    b) Other criteria are weighted at 33 percent
3) Level of Service focus
    c) Level of Service is weighted at 100 percent
    d) Other criteria are weighted at 25 percent
4) The final weighting based on the average of these three was:
    e) Capacity/System Growth: 16 percent
    f) Level of Service Improvement: 23 percent
    g) Redundancy/Operational Flexibility: 23 percent
    h) Environmental Impact: 16 percent
    i) Cost Effectiveness: 23 percent

While there is some difference observed within the rankings, the average ranking, equal weighting, and the average of all weightings produced similar results. Therefore, the prioritized list is based on the equal weighting that was originally presented by JEA.

10.2 Priority Capital Project List Descriptions

Table 10-1 shows the projects that were ranked in the top 20 based on the equal weighting criteria. The priority assigned to each project in Table 10-1 and Appendix J, *Activity 10, Capital Project Prioritization Technical Memorandum* was determined based on the JEA scoring presented in Appendix J. Refer to Appendix K for the Electrical and I&C Systems Assessment and Appendix L for the Wastewater Systems Hydraulic Capacity Assessment.

Table 10-1. Prioritized List of Resilience Projects

Ranking	Facility Name	Priority	Project Type
1	Arlington East WRF	High	Electrical and I&C upgrades (TO 4); Capacity upgrades (TO 5); Effluent Pump Station rehabilitation/upgrades (TO 16)
2	Buckman WRF	High	Flood Resilience upgrades (TO 3); Electrical and I&C upgrades (TO 4); Capacity upgrades (TO 5)
3	Southwest WRF	Med-High	Flood Resilience upgrades (TO 3); Electrical and I&C upgrades (TO 4); Capacity upgrades (TO 5)
4	210 Hollybrook Avenue LS	Med-High	Flood Resilience upgrades (TO 3); Capacity upgrades (TO 5)
5	2045 Utah Avenue LS	Med-High	Flood Resilience upgrades (TO 3)

Table 10-1. Prioritized List of Resilience Projects

Ranking	Facility Name	Priority	Project Type
6	7834 Holiday Road South LS	Med-High	Flood Resilience upgrades (TO 3); Capacity upgrades (TO 5)
7	Buckman WRF Outfall	Med-High	Rehabilitation of Outfall Pipe (TO 12)
8	Nassau Regional WRF	Med-High	Electrical and I&C upgrades (TO 4); Capacity upgrades (TO 5)
9	River Oaks Potable Repump Station	Med-High	Electrical and I&C upgrades (TO 4)
10	10477 Bradley Road LS	Med-High	Electrical and I&C upgrades (TO 4); Capacity upgrades (TO 5)
11	2304 McMillan Street LS	Med-High	Capacity upgrades (TO 5)
12	Main Street WTP	Med-High	Flood Resilience upgrades (TO 3); Electrical and I&C upgrades (TO 4)
13	Main Street WTP Well No. 1	Med-High	Flood Resilience upgrades (TO 3)
14	1023 Laura Street North LS	Med-High	Flood Resilience upgrades (TO 3)
15	604 Water Street LS	Med-High	Flood Resilience upgrades (TO 3)
16	Monterey WRF	Med-High	Flood Resilience upgrades (TO 3); Electrical and I&C upgrades (TO 4); Electrical switchgear replacement/generator addition, influent backup pump, and containment pond (TO 15)
17	Hendricks WTP	Medium	Flood Resilience upgrades (TO 3); Electrical and I&C upgrades (TO 4)
18	Main Street WTP Well No. 10	Medium	Flood Resilience upgrades (TO 3)
19	5301 Evergreen Avenue LS	Medium	Flood Resilience upgrades (TO 3)
20	Mayport WTP	Medium	Flood Resilience upgrades (TO 3)
21	8617 Western Way LS	Medium	Flood Resilience upgrades (TO 3)
22	Deerwood III WTP	Medium	Flood Resilience upgrades (TO 3); Electrical and I&C upgrades (TO 4)
23	Arlington Potable Booster Pump Station	Medium	Electrical and I&C upgrades (TO 4)
24	Deerwood III WTP Well 3	Medium	Electrical and I&C upgrades (TO 4)

10.3 Priority Capital Project Descriptions (placeholder)

11. Final Recommendations and Implementation Road Map

Proactively investing in forward-looking, enhanced design standards and capital improvement projects that provide risk reduction and resilience across JEA's water, wastewater, chilled water, and reclaimed water infrastructure today will ensure the continuity of these critical services against severe weather today and over the service life of the assets. By implementing these projects, strategies and related initiatives to improve energy reliability, build green infrastructure, improve and expand drainage infrastructure, and promote redundancy and adaptive capacity into operations, JEA will demonstrate its continued leadership in climate resilience and benefit from the improved financial performance associated with a proactive approach to mitigating flood risk.

This section includes the final recommendations resulting from the activities performed within the JEA Resiliency Program, which put JEA on a path to continual improvement in system reliability and performance and enhanced customer confidence through avoidance of future system interruptions and SSOs.

11.1 Final Recommendations

11.1.1 Design Criteria and Standards

With the ongoing and planned capital improvement projects, it is critical that JEA adopts new design standards that reflect the current and anticipated flood risk and seek to minimize potential impacts to JEA's systems over their service life. By doing so, the new policies and standards will leverage all capital expenditures across JEA to consistently promote continual improvement in service reliability and operational continuity.

These new and/or enhanced design standards should include Electrical and I&C, Wastewater Conveyance System Improvements, Flood Risk Reduction Standards, Flood Risk Reduction Implementation Guide, and Mitigating Other Natural Hazards.

- The Electrical and I&C System recommendations include application of a single, centralized backup generator power station to serve an entire facility and closed-loop transition from primary power to backup power.
- The wastewater conveyance system improvements consist of recommendations including calibration of the WRF hydraulic models for both dry- and wet-weather flow and provisions for installation of influent flowmeters for new and rehabilitated WRFs.
- The flood risk reduction standards, further described in the *Flood Risk Reduction Implementation Guide*, provide guidance related to the minimum design elevations and associated standards for reducing flood risk and incorporating resilience into the design of both rehabilitation and new construction projects across JEA's water, wastewater, reclaimed water, and chilled water systems.
- Mitigation of other natural threats was also recognized as a critical component of reducing risk and improving reliability of the various water systems, resulting in actions to mitigate high wind and flying debris, lightning, extreme heat, wildfire and building fire, and drought.

The previous considerations and recommendations are provided for awareness, as local and state regulations have historically driven the design criteria used by JEA designs. However, the new standards and recommendations within this document exceed local and state requirements, in some cases, to position JEA's facilities for future severe weather conditions anticipated over the service life of the assets. By planning and investing in the future, JEA is demonstrating leadership around climate and severe weather risk that will improve the performance of their systems and ultimately benefit the communities they serve.

Monitoring of these local and state regulations is recommended as there are changes underway that are expected to become policy in the next couple of years. Awareness of these changes and how they relate to JEA's policies and standards will help to reinforce JEA's position and garner support for continued investment in the future.

11.1.2 Capital Projects

The implementation of these capital projects will require phasing to align with available budgets and management resources with a focus on the most critical systems and those facilities with the highest vulnerabilities to support continued reliable service delivery and avoidance of SSOs.

The following is a list of recommended capital projects prioritized based on the select performance metrics and organized by overall importance for near term implementation and mid-term planning.

- Immediate projects (8 ongoing projects, estimated at $500,000 to $700,000)
  - Defined as improvements to ongoing or planned projects
- Near-term (16 projects/facilities, estimated at $1.5 million to $2.5 million)
  - Defined as Projects/Facilities designated as High and Med-High priority per prioritized CIP list
  - Critical facilities at risk of flooding today (within the current 100- and 500-year flood zones)
- Mid-term (49 projects/facilities, estimated at $2.0 million to $4.0 million)
  - Defined as Projects/Facilities designated as Medium and Med-Low priority per prioritized CIP list
- Long-term (109 projects/facilities, estimated at $1.5 million to $3.0 million)
  - Defined as Projects/Facilities designated as Low priority per prioritized CIP list
  - General enhancements to system reliability and redundancy for lower criticality facilities with lower vulnerabilities

The costs range presented here represents the difference between building to Flood Scenario 2 versus Flood Scenario 7. While these costs do not include equipment replacement or specialty repairs, they summarize the probable construction cost additions to facility rehabilitation projects to incorporate flood risk reduction, hardening, and system redundancy to improve overall reliability and resilience.

While this list provides a general order of priority for implementation, additional considerations are warranted that may affect the order of implementation as discuss in project sequencing section below. Table 11-1 demonstrates this organization of the top priority capital projects recommended.

Table 11-1. High-Priority Capital Projects

Facility Name	Priority	Project Type
Arlington East WRF	High	Electrical, I&C, capacity, and effluent pump station
Buckman WRF	High	Flood risk reduction, Electrical, I&C, and capacity
Southwest WRF	Medium High	Flood risk reduction, Electrical, I&C, and capacity
210 Hollybrook Avenue	Medium High	Flood risk reduction and capacity
2045 Utah Avenue LS	Medium High	Flood risk reduction
7834 Holiday Road South LS	Medium High	Flood risk reduction and capacity
Buckman WRF Outfall	Medium High	Outfall rehabilitation
Nassau Regional WRF	Medium High	Electrical, I&C, and capacity
River Oaks Potable Repump Station	Medium High	Electrical and I&C
10477 Bradley Road LS	Medium High	Electrical, I&C, and capacity

Table 11-1. High-Priority Capital Projects

Facility Name	Priority	Project Type
2304 McMillan Street	Medium High	Capacity upgrades
Main Street WTP	Medium High	Flood risk reduction, Electrical, and I&C
Main Street Wellfield Well No. 1	Medium High	Flood risk reduction
1023 Laura Street North LS	Medium High	Flood risk reduction
604 Water Street LS	Medium High	Flood risk reduction
Monterey WRF	Medium High	Flood risk reduction, Electrical, I&C, influent pumping, and containment pond

11.1.3 Project Timing and Sequencing

A review of project timing and sequencing is outside the scope of this project but is recommended along with a review of ongoing O&M and CIP projects and an analysis of alternative funding and financing mechanisms to support the development of an updated capital plan to implement the recommended capital projects.

The recommended capital projects include improvements to multiple systems combined into a single project to capture cost savings and other synergies between the improvements; however, where applicable, some improvements may be able to be deferred to focus available budget on the most critical aspects of each facility. This requires a design-level evaluation of each recommended project to further prioritize these improvements for the most critical and vulnerable equipment at a given facility.

Coordination between the recommended projects and the ongoing and planned capital projects is critical to ensure the best use of available funding to meet near term needs and maintain operations of critical infrastructure. This also ensures that there is no duplication of efforts and that projects that impact other facilities and assets are identified early to promote overall system performance and avoid unintended consequences.

Other considerations for sizing and sequencing recommended capital projects may include:

- Projects focused on improving existing capacity
- Seasonal demands/flows
- Projects in support of new developments to meet planned demands
- Available budgets and financing capacity
- Project sizing for procurement, management, and resource allocation
- Project sizing for emergency ingress/egress

11.2 Funding and Financing Alternatives

11.2.1 Utility Rates and JEA General Fund

A review of the utility rates and rate structure is outside of the scope of this project but is recommended along with an analysis of alternative funding and financing mechanisms to support the development of an updated capital plan and to implement the recommended projects.

11.2.2 State and Federal Grants

A review of state and federal grants is outside the scope of this project but is recommended to determine eligibility and timing to support the implementation of the recommended projects. Available grant programs may include Housing and Urban Development (HUD) and Community Development Block Grant (CDBG)

Regional Planning and Climate Resilience, FEMA Hazard Mitigation Grant Program (HMGP), FDEP Resilient Coastlines Program, and Florida Department of Economic Opportunity (FDEO) Community Resilience Initiative.

11.2.3 State Revolving Funds (SRF)

A review of the FDEP Clean Water and Drinking Water state revolving fund program providing low interest loans is outside the scope of this project but is recommended to determine eligibility and timing to support the implementation of the recommended projects.

11.2.4 Federal Infrastructure Package Funding and Stimulus Program

A review of the federal infrastructure package funding and stimulus program is outside the scope of this project but is recommended to determine eligibility and timing to support the implementation of the recommended projects.

11.3 Industry Best Practices and Benchmark Assessment

As part of the JEA Resiliency Program, Jacobs researched ongoing resilience best practices for 13 utilities across the U.S. to establish an industry-based performance benchmark and influence the program for JEA's benefit based on lessons learned from other utilities. This section provides a brief summary of the findings from that effort.

In collaboration with JEA, several climate resilience related categories were selected for the literature search and for the benchmarking with peer utilities. The working group selected 13 utilities to be queried about climate resilience activities. However, when contacted by Jacobs to complete a questionnaire, many of them declined to respond. Nevertheless, Jacobs was able to gather information on their resilience measures and suggested metrics for the purposes of establishing a performance benchmark.

Many of the 13 utilities researched are using climate models to forecast precipitation and SLR to determine flood elevations. Some have also developed, or are developing, decision-making frameworks and tools to address the uncertainties of future extreme weather events, along with planning the timing and extent of investments for implementing resilience measures. These measures are being used by each of the utilities to mitigate potential impacts of extreme weather events related to their ability to provide reliable utility services.

Identifying and understanding how fellow members of the water and wastewater utility sector are addressing severe weather and climate-related risks provides valuable guidance in planning JEA's mitigation strategies and operational tactics for protecting its infrastructure, employees, and customers. These suggested metrics, seen in Table 11-2, allow JEA to engage in adopting climate models or decision-making frameworks for evaluating progress to become more resilient to the impacts of extreme weather events.

Table 11-2. Suggested Metrics to Measure Progress Toward Risk Reduction and Resilience

Metric	Reported As	Frequency	Calculation
Number of SSOs	Number per 100 miles of pipe	Monthly	(Total number of SSOs during the month) x 100 / Total number of miles of gravity sewers and force mains
Quantity of SSOs	Gallons per 100 miles of pipe	Monthly	(Total gallons of SSOs during the month) x 100 / Total number of miles of gravity sewers and force mains
SSOs at Wastewater Pump Stations Due to Power Loss	Percentage	Monthly	(Total gallons of SSOs during the month) / Total number wastewater pump stations
Onsite Generators with Auto-transfer or Pony Pumps at Pump Stations	Percentage	Annually	Number of pump stations having onsite generators with automatic transfer or pony pumps / Total number of pump stations

Table 11-2. Suggested Metrics to Measure Progress Toward Risk Reduction and Resilience

Metric	Reported As	Frequency	Calculation
Pump Station Lightning Protection	Percentage	Annually	Number of pump stations having lightning protection compliant with NFPA standards / Total number of pump stations
Inflow and Infiltration by WWTP Sewershed	Percentage	Annually	Refer to U.S. Environmental Protection Agency (EPA)'s *Quick Guide for Estimating Infiltration and Inflow* or other acceptable methodology
Flooding Potential at 100-year Flood (Buildings)	Percentage	Annually	Number of buildings with first floor elevation and/or penetrations below 100-year floodplain / Total number of buildings
Flooding Potential at 500-year Flood (Buildings)	Percentage	Annually	Number of buildings with first floor elevation and/or penetrations below 500-year floodplain / Total number of buildings
Flooding Potential at 100-year Flood (Equipment)	Percentage	Annually	Number of locations with non-submersible equipment vulnerable to 100-year flood / Total number of locations with mechanical, electrical, and/or IT equipment
Flooding Potential at 500-year Flood (Equipment)	Percentage	Annually	Number of locations with non-submersible equipment vulnerable to 500-year flood / Total number of locations with mechanical, electrical, and/or IT equipment
Access to Critical Facilities at 100-year Flood	Percentage	Annually	Number of critical facilities that would be inaccessible at a 100-year flood / Total number of critical facilities
Access to Critical Facilities at 500-year Flood	Percentage	Annually	Number of critical facilities that would be inaccessible at a 500-year flood / Total number of critical facilities
Access to Hydrants at 100-year Flood	Percentage	Annually	Number of hydrants that would be inaccessible at a 100-year flood / Total number of hydrants
Access to Hydrants at 500-year Flood	Percentage	Annually	Number of hydrants that would be inaccessible at a 500-year flood / Total number of hydrants
Boil Water Advisories Not Associated with Main Breaks	Number	Annually	Number of boil water advisories issued due to low pressure or no water not associated with main breaks
Customers Affected by Boil Water Advisories Not Associated with Main Breaks	Affected customers per 10,000 accounts	Annually	(Number of customer accounts affected by boil water advisories due to low pressure or no water not associated with main breaks) x 10,000 / Total number of customer accounts
Change in Wellfield Chloride Levels	Percentage increase in chlorides in each wellfield	Monthly	(Concentration of chlorides in current month) – (Concentration of chlorides in previous month) / Concentration of chlorides in previous month
Change in Wellfield Total Dissolved Solids (TDS) Levels	Percentage increase in TDS in each wellfield	Monthly	(Concentration of TDS in current year) – (Concentration of chlorides in previous year) / Concentration of TDS in previous year

11.4 Stakeholder Engagement

The addition of new resilience standards will be disruptive to the local development community and JEA contractors, requiring education and awareness communications to promote compliance and a smooth transition. As part of the Resiliency Program, the Jacobs team reviewed multiple ongoing JEA projects and provided guidance related to reducing flood risk and building system resilience. These guidance memorandums were received by JEA PMs with mixed reviews, and many questions arose since they exceeded the current regulatory requirements and JEA policies. This same response is anticipated by contractors outside of the JEA organization, reinforcing the need to provide external-facing education and awareness.

This education and awareness would be provided through workshops, fact sheets, and easy to follow "how-to" guides that describe the new process of identifying and mitigating flood and other risks for each project. This stakeholder engagement will prove invaluable to JEA by helping to mitigate potential project cost increases and delays and by streamlining the design and approval process for projects.

For internal stakeholders, including JEA PMs, operators, and grid and plant managers, a position statement and fact sheet is highly recommended that states JEA leadership's position on resilience and how it should be embraced and incorporated into all aspects of JEA operations, including planning, design, construction, operations, and maintenance of JEA assets and facilities. This important educational campaign will ensure that all projects are performed consistently to capture the most value for JEA while positioning JEA's systems for continued reliability in the face of an uncertain climate and severe weather future.

Like most organizations, JEA staff may rely on additional guidance documents and procedures to support JEA PMs in developing and delivering projects. It is recommended that all guidance documents, processes, and policies be reviewed by JEA to ensure alignment with the new standards and the broader changes to the process of incorporating resilience into all JEA capital projects.

11.5 Plan Maintenance and Update Frequency

Under the Global Change Research Act of 1990, the U.S. National Climate Assessment (NCA) is commissioned by U.S. Congress to consider future SLR trends and synthesize current scientific literature on global SLR into a report published every 4 years. The NCA is a multi-agency effort, led by NOAA, providing SLR scenarios that can be used for assessing potential impacts. Global SLR scenarios are influenced by two main factors, which include thermal expansion caused by warming of the ocean (since water expands as it warms) and increased melting of land-based ice, such as glaciers and ice sheets (https://oceanservice.noaa.gov/facts/sealevel.html).

As climate and severe weather conditions continue to evolve, updates to this JEA Resilience Plan and the corresponding flood elevations will be required. It is recommended that this plan be updated no less than every 4 to 5 years to coincide with the release of new climate scenarios and SLR projections as published by NOAA and the NCA. Updated rainfall and tidal data should also be used in concert with the updated projections. The plan update should also reflect changes in other data inputs from local sources, including new policies and regulations, design guidance, or direction from the JEA board. They should also consider impacts on current recommendations, minimum design standards, and JEA priorities for capital investment.

Data inputs that may drive the update frequency of this Implementation Guide, include:

- New SLR projections by USACE, NOAA, NCA, Intergovernmental Panel on Climate Change (IPCC), and other scientific organizations
  - Typically updated every 4 to 5 years; may include locally adopted projections
- New ground surface elevation data from updated surface digital elevation model (DEM)
  - Light detection and ranging (LiDAR) surface mapping is typically performed every 5 years to reflect changes in land form from development expansion
- Updated water levels used as boundary conditions from tide gauges along the St. Johns River
- Updated rainfall data, based on latest NOAA Atlas 14 local rain gauge data
- Updated rainfall projections
- Updated stormwater or flood modeling results by City of Jacksonville or St. Johns River Water Management District (SJRWMD)

- Updated USACE St. Johns River dredging project information, including river depths and water level modeling
- Updated FEMA flood mapping information, with upcoming release of Risk Map 2.0
- Updated NHC sea, lake, and overland surge from hurricane, maximum of maximums (SLOSH MOM) surge modeling
- Storm events (rainfall and surge) that cause damage to JEA facilities or other property in the service area

12. Complete Evaluated Facility List

The following is a full list of JEA facilities evaluated as part of this study, with performance metrics used to prioritize projects/facilities. An excel spreadsheet containing this information has also been submitted to JEA.

Table 12-1. Full List of Evaluated Facilities with Prioritization Rankings

Facility Name	Facility Type	CIP Ranking (High/Medium/ Low)	Final CIP Ranking	Monetized Risk (direct impacts)	# of assets at Risk*	Scenario 4 Risk Ranking (including business losses)	Within current 100-year flood zone (as of 2020)	Within current 500-year flood zone (as of 2020)	Scenario 2 ROI**	Scenario 4 ROI**	Scenario 7 ROI**
Arlington East WRF	WWTP	High	1				no	no			
Buckman WRF	WWTP	High	2	$919,100	54	4	No	no	3.02	0.43	0.35
Southwest WRF	WWTP	Medium High	3	$23,300	37	5	No	no	111.21	113.15	13.48
210 Hollybrook Av	Lift Station	Medium High	4	$1,044,100	2	4	Yes	yes	22.27	22.28	27.08
2045 Utah Av	Lift Station	Medium High	5	$421,500	3	5	Yes	yes	91.82	98.89	133.47
7834 Holiday Rd S	Lift Station	Medium High	6	$1,137,900	5	5	no	yes	38.58	42.63	53.96
Buckman Outfall	WWTP	Medium High	7				no	no			
Nassau Regional WRF	WWTP	Medium High	8				no	no			
River Oaks Potable Repump Station	Repump Station	Medium High	9				no	no			
10477 Bradley Road	Lift Station	Medium High	10				no	no			
2304 McMillan St	Lift Station	Medium High	11				no	no			
Main St WTP	WTP	Medium High	12	$4,143,400	9	5	Yes	yes	8.42	11.30	11.96
Main Street Wellfield Well 1	Well	Medium High	13	$592,200	2	4	Yes	yes	94.94	81.98	84.98
1023 Laura St N	Lift Station	Medium High	14	$91,500	8	5	Yes	yes	24.96	26.07	30.84
604 Water St	Lift Station	Medium High	15	$77,500	6	4	No	yes	11.27	11.73	6.71
Monterey WRF	WWTP	Medium High	16	$904,800	32	4	No	no	1.16	1.16	1.32

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Facility Name	Facility Type	CIP Ranking (High/Medium/ Low)	Final CIP Ranking	Monetized Risk (direct impacts)	# of assets at Risk*	Scenario 4 Risk Ranking (including business losses	Within current 100-year flood zone (as of 2020)	Within current 500-year flood zone (as of 2020)	Scenario 2 ROI**	Scenario 4 ROI**	Scenario 7 ROI**
Hendricks WTP	WTP	Medium	17	$1,877,700	3	5	Yes	no	10.08	8.38	8.38
Main Street Wellfield Well 10	Well	Medium	18	$793,600	5	4	Yes	yes	11.45	12.00	10.40
5301 Evergreen Av	Lift Station	Medium	19	$654,500	2	4	Yes	yes	9.56	11.00	10.45
Mayport WTP	WTP	Medium	20	$887,600	5	4	No	yes	16.47	13.11	13.11
8617 Western Wy	Booster Lift Station	Medium	21	$861,900	9	4	No	no	10.07	10.08	11.66
Deerwood 3 WTP	WTP	Medium	22	$197,800	16	2	No	no	7.21	7.21	7.56
Arlington Booster Pump Station	Potable Water Booster Station	Medium	23				no	no			
Deerwood III Wellfield Well 3	Well	Medium	24				yes	yes			
St Johns Forest WTP 1	WTP	Medium	25	$696,700	10	4	yes	yes	12.92	12.92	15.70
Main Street Wellfield Well 3	Well	Medium	26	$640,700	1	3	Yes	yes	24.71	17.09	21.36
7200 AC Skinner Py	Lift Station	Medium	27	$543,200	5	5	Yes	yes	7.18	7.20	6.16
6947 Norwood Av	Lift Station	Medium	28	$204,800	15	2	Yes	yes	2.70	3.39	3.39
Downtown CWP	CWP	Medium	29	$980,400	8	4	No	no	10.39	17.96	17.96
4140 Kingsbury St	Lift Station	Medium	30	$22,000	11	1	No	no	13.75	13.78	4.56
1202 Bunker Hill Bv	Vacuum Station	Medium	31	$3,090,300	6	5	Yes	yes	24.72	22.82	21.42
544 Bowlan St	Lift Station	Medium	32	$936,900	13	4	Yes	yes	5.13	5.82	6.84
St. Johns Forest Wellfield Well 3	Well	Medium	33	$396,400	1	3	yes	yes	10.88	10.88	15.02
8431 Springtree Rd	Lift Station	Medium	34	$142,500	6	1	Yes	yes	3.09	3.09	3.80

Table 12-1. Full List of Evaluated Facilities with Prioritization Rankings

Facility Name	Facility Type	CIP Ranking (High/Medium/ Low)	Final CIP Ranking	Monetized Risk (direct impacts)	# of assets at Risk*	Scenario 4 Risk Ranking (including business losses)	Within current 100-year flood zone (as of 2020)	Within current 500-year flood zone (as of 2020)	Scenario 2 ROI**	Scenario 4 ROI**	Scenario 7 ROI**
8460 Brierwood Rd	Lift Station	Medium	35	$93,400	4	2	Yes	yes	3.01	4.43	4.43
1705 Hodges Bv	Lift Station	Medium	36	$45,600	8	1	Yes	yes	3.42	3.08	1.45
Ponce De Leon WRF	WWTP	Medium	37	$1,209,300	3	5	No	yes	12.48	8.53	8.31
1706 Boulevard Av	Lift Station	Medium	38	$71,600	9	3	No	yes	26.52	26.55	17.08
2809 5th St W	Lift Station	Medium	39	$400,600	1	2	No	no	6.06	6.06	7.45
Ridenour Wellfield Well 7	Well	Medium	40	$248,400	1	2	No	no	56.33	56.50	98.91
94 32nd St E	Lift Station	Medium	41	$81,300	14	2	No	no	3.23	3.26	4.60
6350 Ginnie Springs Rd	Lift Station	Medium	42				no	no			
9898 Gate Py N	Lift Station	Medium	43				no	no			
Cedar Bay WRF	WWTP	Medium	44				no	no			
6927 Hanson Dr N	Lift Station	Medium Low	45	$270,700	6	3	Yes	yes	15.41	15.54	19.97
1060 Ellis Rd N	Lift Station	Medium Low	46	$50,100	8	1	Yes	yes	14.23	14.23	11.22
Nassau WTP 1	WTP	Medium Low	47	$261,500	20	2	No	no	5.45	5.45	6.10
7702 Lenox Av	Lift Station	Medium Low	48	$216,400	13	2	Yes	yes	1.41	1.41	2.72
4522 Town Center Py	Lift Station	Medium Low	49	$118,700	4	1	Yes	yes	0.52	0.53	1.54
5730 Kinlock Dr S	Lift Station	Medium Low	50	$112,300	27	2	Yes	yes	1.83	2.24	2.87
3300 San Pablo Rd S	Lift Station	Medium Low	51	$18,900	4	2	Yes	yes	0.00	34.03	19.32
6801 Rhone Dr	Lift Station	Medium Low	52	$167,000	4	2	No	yes	1.08	1.74	1.74
487 Grove Park Bv	Lift Station	Medium Low	53	$408,600	2	3	No	no	3.23	3.08	3.61
3806 Herschel St	Lift Station	Medium Low	54	$156,500	2	1	No	no	2.04	2.04	3.00
14041 Bartram Park Bv	Lift Station	Medium Low	55	$42,200	2	1	No	no	0.25	0.56	0.25

Table 12-1. Full List of Evaluated Facilities with Prioritization Rankings

Facility Name	Facility Type	CIP Ranking (High/Medium/ Low)	Final CIP Ranking	Monetized Risk (direct impacts)	# of assets at Risk*	Scenario 4 Risk Ranking (including business losses)	Within current 100-year flood zone (as of 2020)	Within current 500-year flood zone (as of 2020)	Scenario 2 ROI**	Scenario 4 ROI**	Scenario 7 ROI**
Greenland WTP	WTP	Medium Low	56				no	no			
4147 Ferber Rd	Lift Station	Medium Low	57				no	no			
7615 Pritchard Rd	Lift Station	Medium Low	58				no	no			
Main Street Wellfield Well 6A	Well	Medium Low	59	$77,300	4	1	no	no	2.99	3.42	5.99
847 Hickory Hill Dr	Lift Station	Medium Low	60	$884,100	3	4	Yes	yes	12.05	12.05	12.12
2732 Scott Mill LA	Vacuum Station	Medium Low	61	$589,400	19	4	yes	yes	4.38	8.63	6.17
2251 McCoy Creek Bv	Lift Station	Medium Low	62	$70,200	8	3	Yes	yes	10.38	10.41	13.68
130 Metz St	Vacuum Station	Medium Low	63	$1,165,600	37	4	No	no	8.13	8.13	8.13
Julington Creek Plantation WRF	WWTP	Medium Low	64	$780,600	1	4	No	no	0.00	2.46	0.33
Ponte Vedra WRF	WWTP	Medium Low	65	$118,200	11	0	No	no	0.00	0.00	0.77
8602 Zoo Rd	Lift Station	Low	66	$222,100	10	3	Yes	yes	5.42	6.40	6.40
7211 Rhode Island Dr E	Lift Station	Low	67	$190,200	7	2	Yes	yes	3.24	3.24	3.24
4100 Harbor View Dr	Lift Station	Low	68	$182,300	7	2	Yes	yes	4.60	6.06	8.08
5490 Shindler Dr	Lift Station	Low	69	$173,200	4	1	Yes	yes	4.37	4.37	5.37
Main Street Wellfield Well 6	Well	Low	70	$65,100	3	1	Yes	yes	0.31	0.75	0.94
10182 Bradley Rd	Lift Station	Low	71	$18,100	1	1	Yes	yes	-0.61	-0.61	-0.21
3431 Kernan Bv S	Lift Station	Low	72	$14,900	17	1	Yes	yes	8.18	8.21	8.20
5233 5th St W	Lift Station	Low	73	$369,600	6	3	No	no	3.49	3.49	4.55
14802 Bartram Park Bv	Lift Station	Low	74	$31,400	5	1	No	no	0.24	0.24	-0.06

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Facility Name	Facility Type	CIP Ranking (High/Medium/ Low)	Final CIP Ranking	Monetized Risk (direct impacts)	# of assets at Risk*	Scenario 4 Risk Ranking (including business losses)	Within current 100-year flood zone (as of 2020)	Within current 500-year flood zone (as of 2020)	Scenario 2 ROI**	Scenario 4 ROI**	Scenario 7 ROI**
Southwest Wellfield Well 2	Well	Low	75	$3,767,400	3	1	No	no	3.69	3.69	4.10
Mandarin WRF	WWTP	Low	76				no	no			
Arlington WTP	WTP	Low	77				no	no			
Ridenour WTP	WTP	Low	78				no	no			
Southwest WTP	WTP	Low	79				no	no			
Springfield CWP	CWP	Low	80				no	no			
Arlington Wellfield Well 4	Well	Low	81				no	no			
2111 Cole Flyer Rd	Lift Station	Low	82				no	no			
5219 Golf Course Dr	Lift Station	Low	83	$150,700	7	2	Yes	yes	2.21	3.49	4.64
2588 Lofberg Drive	Lift Station	Low	84				yes	yes			
Arlington Wellfield Well 5	Well	Low	85	$328,400	5	2	No	no	0.00	0.00	135.95
8104 Argyle Forest Bv	Lift Station	Low	86	$38,500	13	1	No	no	0.06	0.06	0.45
12733 Abess Bv	Lift Station	Low	87				no	no			
13383 Tropic Egret Dr	Lift Station	Low	88				no	no			
4511 Spring Park Rd	Lift Station	Low	89				no	no			
5642 J Ray Circle S	Lift Station	Low	90				no	no			
7133 Southside Bv	Lift Station	Low	91				no	no			
9733 Bayou Bluff Dr	Lift Station	Low	92				no	no			
834 Bay St E	Lift Station	Low	93	$602,700	4	2	Yes	yes	0.00	4.21	40.85

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Facility Name	Facility Type	CIP Ranking (High/Medium/ Low)	Final CIP Ranking	Monetized Risk (direct impacts)	# of assets at Risk*	Scenario 4 Risk Ranking (including business losses)	Within current 100-year flood zone (as of 2020)	Within current 500-year flood zone (as of 2020)	Scenario 2 ROI**	Scenario 4 ROI**	Scenario 7 ROI**
Brierwood Wellfield Well 5	Well	Low	94	$353,300	3	2	yes	yes	0.00	0.00	47.92
420 Tresca Rd	Lift Station	Low	95	$204,100	5	2	Yes	yes	1.69	1.69	2.47
8100 Grampell Dr	Lift Station	Low	96	$190,100	4	2	yes	yes	3.12	3.12	4.95
331 Laurina St	Lift Station	Low	97	$117,300	20	2	Yes	yes	2.29	3.79	3.79
1509 El Prado Rd	Lift Station	Low	98	$104,500	7	2	Yes	yes	8.34	2.28	3.67
10656 Kennedy Ln	Lift Station	Low	99	$82,900	8	2	Yes	yes	1.23	1.23	1.79
8622 Beechern Ln	Lift Station	Low	100	$72,500	23	1	Yes	yes	3.07	4.13	4.52
3650 Salisbury Rd	Lift Station	Low	101	$54,700	15	1	Yes	yes	1.51	1.52	6.10
512 Arlington Place	Lift Station	Low	102	$46,700	9	1	Yes	yes	5.32	6.09	6.25
10410 Lawson Rd	Lift Station	Low	103	$30,700	7	1	Yes	yes	2.00	2.01	2.89
8671 Osprey Ln	Lift Station	Low	104	$21,400	5	1	Yes	yes	2.95	3.04	3.88
10837 Blue Pacific Ct	Lift Station	Low	105	$19,400	9	1	Yes	yes	6.89	7.11	2.25
1140 Knoll Dr W	Lift Station	Low	106	$18,400	29	1	Yes	yes	4.87	4.88	1.54
11247 Beacon Dr	Lift Station	Low	107	$45,500	4	1	no	yes	2.26	3.24	3.24
A1A North WTP	WTP	Low	108	$32,200	14	1	No	yes	0.18	0.81	8.52
Hogans Creek CWP	CWP	Low	109	$257,500	4	1	No	no	0.50	0.50	0.50
8560 Fury Dr	Lift Station	Low	110	$220,600	5	1	No	no	-0.48	-0.48	3.16
Greenland Wellfield Well 2	Well	Low	111	$77,100	5	0	No	no	0.00	0.00	27.28
11452 Renne Dr W	Lift Station	Low	112	$74,800	3	1	No	no	1.74	1.85	2.91
4211 Woodmere St	Lift Station	Low	113	$47,700	1	1	No	no	3.14	1.01	1.01

Table 12-1. Full List of Evaluated Facilities with Prioritization Rankings

Facility Name	Facility Type	CIP Ranking (High/Medium/ Low)	Final CIP Ranking	Monetized Risk (direct impacts)	# of assets at Risk*	Scenario 4 Risk Ranking (including business losses)	Within current 100-year flood zone (as of 2020)	Within current 500-year flood zone (as of 2020)	Scenario 2 ROI**	Scenario 4 ROI**	Scenario 7 ROI**
7039 Alachua Av	Lift Station	Low	114	$27,200	9	1	No	no	-0.77	-0.77	-0.77
718 Standish Pl	Lift Station	Low	115	$ -	23	0	No	no	0.00	-1.00	-1.00
14600 Cedar Island Dr	Lift Station	Low	116	$68,500	7	1	Yes	yes	-0.79	-0.23	1.29
Ponte Vedra North WTP	WTP	Low	117	$42,300	6	1	Yes	yes	0.00	0.71	0.71
2740 CR 210	Booster Lift Station	Low	118	$28,900	23	1	yes	yes	-0.81	-0.81	-0.41
San Marco CWP	CWP	Low	119	$ -	14	0	no	yes	0.00	-1.00	-1.00
2415 D St	Lift Station	Low	120	$11,700	6	1	No	no	3.10	3.10	2.92
2520 Orange Picker Rd	Lift Station	Low	121				no	no			
2084 ST Johns Py	Lift Station	Low	122	$45,500	11	0	Yes	yes	0.00	0.00	0.43
1818 Willowbranch Terrace	Lift Station	Low	123	$ -	6	0	No	yes	0.00	-1.00	-1.00
6868 Belfort Oaks Pl	Lift Station	Low	124	$95,900	5	0	No	no	0.00	0.00	4.12
10797 Ft Caroline Rd	Lift Station	Low	125	$200	4	1	No	no	0.00	-0.80	-0.82
6705 Cherborg Av N	Lift Station	Low	126	$204,900	10	2	Yes	yes	1.24	1.36	2.41
2391 Brest Rd	Lift Station	Low	127	$141,400	4	1	Yes	yes	1.86	2.44	4.35
11260 Beach Bv	Lift Station	Low	128	$98,700	12	1	yes	yes	0.73	0.73	0.79
1990 Greenwood St	Lift Station	Low	129	$87,300	5	1	Yes	yes	-0.25	0.63	2.26
74 Baisden Rd	Lift Station	Low	130	$72,600	4	1	Yes	yes	0.70	0.80	1.10
4526 Detaillie Dr	Lift Station	Low	131	$54,200	9	1	Yes	yes	2.04	2.36	3.21
6267 Whispering Oaks Dr N (6268)	Lift Station	Low	132	$49,100	18	1	Yes	yes	0.17	0.35	0.35
4807 Ducheneau Dr	Lift Station	Low	133	$44,400	18	1	Yes	yes	2.98	3.00	3.89

Table 12-1. Full List of Evaluated Facilities with Prioritization Rankings

Facility Name	Facility Type	CIP Ranking (High/Medium/ Low)	Final CIP Ranking	Monetized Risk (direct impacts)	# of assets at Risk*	Scenario 4 Risk Ranking (including business losses	Within current 100-year flood zone (as of 2020)	Within current 500-year flood zone (as of 2020)	Scenario 2 ROI**	Scenario 4 ROI**	Scenario 7 ROI**
11604 St Joseph Rd	Lift Station	Low	134	$41,500	6	1	Yes	yes	2.66	2.66	3.58
11035 Creekwood Dr	Lift Station	Low	135	$16,500	22	1	Yes	yes	2.19	2.19	2.80
7150 Civic Club Dr	Lift Station	Low	136	$148,400	5	1	No	yes	2.94	2.96	5.01
Ponce De Leon WTP	WTP	Low	137								
1920 Bishop Estates Rd	Potable Water Booster Station	Low	138	$34,800	1	1	No	no	0.00	1.27	0.61
4516 Morrison St	Lift Station	Low	139	$33,600	5	1	No	no	0.07	0.18	0.12
3231 Hermitage Rd E	Lift Station	Low	140	$37,300	20	1	Yes	yes	-0.20	-0.19	0.03
1646 45th St W	Lift Station	Low	141	$31,900	14	1	Yes	yes	1.02	0.67	1.84
1530 Broward Rd	Lift Station	Low	142	$31,700	6	1	Yes	yes	0.26	0.93	1.46
581 Queens Harbor Bv N	Lift Station	Low	143	$31,300	8	1	Yes	yes	0.90	0.03	-0.25
1520 Hammond Bv	Lift Station	Low	144	$27,900	7	1	Yes	yes	0.45	0.45	1.36
7263 Secret Wood Tl	Lift Station	Low	145	$27,400	4	1	Yes	yes	1.06	1.21	2.16
1894 Challen Av	Lift Station	Low	146	$24,100	6	1	Yes	yes	0.12	0.52	0.87
1108 Barnwell Rd	Vacuum Station	Low	147	$16,000	18	1	yes	yes	0.00	0.37	-0.73
4110 Atlantic Bv	Lift Station	Low	148				no	no			
10468 Indian Walk Rd	Lift Station	Low	149				no	no			
6630 Broadway Av	Lift Station	Low	150	$22,900	3	1	Yes	yes	0.00	0.00	62.10
4959 Ortega Hills Dr	Lift Station	Low	151	$22,200	1	1	Yes	yes	0.44	-0.01	-0.01
US-1 Reclaim Pressure Booster Station	Reclaimed Booster Lift Station	Low	152	$21,700	16	1	yes	yes	0.00	0.00	0.10
2004 La Vaca Rd	Lift Station	Low	153	$17,400	7	1	Yes	yes	1.60	-0.19	0.62

Table 12-1. Full List of Evaluated Facilities with Prioritization Rankings

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1888 Powell Pl	Lift Station	Low	154	$16,000	8	1	Yes	yes	-0.22	-0.04	0.64
95135 Brady Point Rd	Lift Station	Low	155	$11,300	8	1	Yes	yes	-0.29	-0.41	-0.12
7017 7019 San Fernando Pl	Lift Station	Low	156	$11,200	6	0	Yes	yes	-1.00	-1.00	-0.38
Mayport Wellfield Well 1	Well	Low	157	$9,700	1	1	yes	yes	-0.83	-0.52	-0.61
96135 Marsh Lakes	Lift Station	Low	158	$8,800	18	1	Yes	yes	-1.00	-0.63	-0.32
11220 Alumni Wy	Lift Station	Low	159	$6,900	5	1	Yes	yes	-0.22	-0.21	0.27
2010 Lewis Industrial Dr	Lift Station	Low	160	$6,700	14	0	Yes	yes	0.00	0.00	8.51
11082 Beckley Pl	Lift Station	Low	161	$2,300	9	0	Yes	yes	0.00	0.00	-0.61
St. Johns Forest Wellfield Well	Well	Low	162	$1,000	1	1	yes	yes	-0.98	-0.98	-0.97
536 LE Master Dr	Lift Station	Low	163	$ -	10	0	yes	yes	0.00	-1.00	-1.00
7863 Little Fox Ln	Lift Station	Low	164	$ -	7	0	Yes	yes	0.00	0.00	-1.00
96515 Otter Run	Lift Station	Low	165	$1,400	5	1	No	yes	0.00	-0.78	-0.89
Corona Rd WTP	WTP	Low	166	$8,900	4	1	No	no	0.00	-0.79	-0.79
Mayport Wellfield Well 2	Well	Low	167	$4,800	1	1	no	no	-0.86	-0.56	-0.56
Corona Road Wellfield Well 1	Well	Low	168	$100	7	1	No	no	0.00	0.00	-0.99
Main Street Wellfield Well 12	Well	Low	169	$180,000	2	0	Yes	yes	0.00	0.00	66.29
Fairfax Wellfield Well 4	Well	Low	170	$ -	15	0	yes	yes	0.00	0.00	-1.00
Ponte Vedra North Wellfield Well 1	Well	Low	171	$ -	3	0	yes	yes	0.00	0.00	-1.00

Table 12-1. Full List of Evaluated Facilities with Prioritization Rankings

Facility Name	Facility Type	CIP Ranking (High/Medium/ Low)	Final CIP Ranking	Monetized Risk (direct impacts)	# of assets at Risk*	Scenario 4 Risk Ranking (including business losses)	Within current 100-year flood zone (as of 2020)	Within current 500-year flood zone (as of 2020)	Scenario 2 ROI**	Scenario 4 ROI**	Scenario 7 ROI**
Ponce de Leon Wellfield Well 1	Well	Low	172	$ -	8	0	No	no	-1.00	-1.00	-1.00
Oakridge Wellfield Well 2	Well	Low	173	$200	5	0	No	no	0.00	0.00	-0.99
St. Johns North Wellfield Well 2	Well	Low	174	$ -	3	0	No	no	0.00	0.00	-1.00
11305 Harts Rd	Lift Station	#N/A		$488,900	9	4	Yes	yes	2.15	3.40	3.27
1636 Talleyrand Av	Lift Station	#N/A		$346,600	3	5	No	no	52.53	52.53	52.53
253 State Rd A1A N	Vacuum Station	#N/A		$201,300	15	0	No	no	0.00	0.00	4.94
3254 Townsend Bv	Lift Station	#N/A		$338,800	5	3	Yes	yes	0.86	0.86	1.11
4881 Timuquana Rd	Lift Station	#N/A		$345,700	17	3	no	no	2.34	3.25	2.96
5104 118th St	Lift Station	#N/A		$438,400	10	3	Yes	yes	3.73	2.99	4.66
6217 Wilson Blvd	Lift Station	#N/A		$235,000	6	1	No	yes	1.28	1.47	1.92
Norwood WTP	WTP	#N/A		$166,600	9	0	No	no	0.00	0.00	0.81

Notes:

Facilities missing cost information were included in the CIP Prioritization (recommendations from TOs 4, 5, 12, and/or 16), but not in the BCA calculations (TO 3)

The cost estimates prepared in this TO are facility planning level estimates and are considered a Class 5 estimate in the Association for the Advancement of Cost Engineering (AACE) International classification system. Based on AACE guidelines, Class 5 estimates range in accuracy from -20 to -50 percent on the low side and +30 to +100 percent on the high side. A 25-percent contingency was added to the sub-totaled estimated cost of each item.

** Asset is considered at risk if the asset elevation is below the flood elevation of any of the current or future condition scenarios*

*** It should be noted that the ROIs for the WWTPs and CWPs do not include business losses*