WATER SUPPLY RESILIENCY PROJECT FOR SRU PUMP STATION ALONG YADKIN RIVER
BENEFIT-COST ANALYSIS TECHNICAL MEMORANDUM

B&V PROJECT NO. 197982

PREPARED FOR

City of Salisbury

4 JANUARY 2022

BLACK & VEATCH

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1. Purpose and Background

Salisbury-Rowan Utilities Department (SRU) provides water and wastewater services to residential and business customers in the municipalities of Salisbury, Granite Quarry, Spencer, East Spencer, China Grove, Rockwell, and some unincorporated areas within Rowan County in North Carolina. SRU has two (2) raw water intakes and one (1) pump station that is located on Hannah Ferry Road at the confluence of the Yadkin River and South Yadkin River. The pump station has been subject to flooding in the past, and flooding has occurred more frequently in the last several years. The access road was flooded 66 days during 2018-2020, and water entered the pump station most recently in November 2020.

In 2020, the SRU Pump Station was shut down twice due to flood events, for five days in February, and then for four days in November. The February event had a reported peak flow of 56,300 cfs at the Yadkin College stream gauge upstream of the pump station and the river level at the pump station reached 640.7 feet (1929 NGVD), while the November event had a reported peak flow of 63,000 cfs and the river level at the pump station reached 643.2 feet (NGVD 29). Water enters the pump station rooms at river level elevation 643 feet (NGVD 29). The peak flows for these two storm events represent approximately a 0.1 annual exceedance probability (AEP), or a 10-year event, based on a flow frequency analysis (FFA) of the Yadkin College USGS gage. The FFA report documentation has been attached with this letter. FEMA lists the 0.01 AEP river level elevation at 648.7 feet (NGVD 29).

Flooding can be expected to worsen with the anticipated impacts of climate change. In order to provide a reliable source of water supply during storm events, the pump station needs to be relocated to where it can be accessed during storm events and the operating floor can be above the 0.01 AEP flood elevation.

2. Benefit-Cost Analysis Data Documentation

The analysis was performed by Black and Veatch under contract with the City of Salisbury. The FEMA BCA toolkit version 6 was utilized to complete the analysis. This memorandum has been prepared to explain and document any BCA data entries that require explanation and citation of data source and act as a guide for the technical review of this benefit-cost analysis.

a. Flow Frequency Analysis

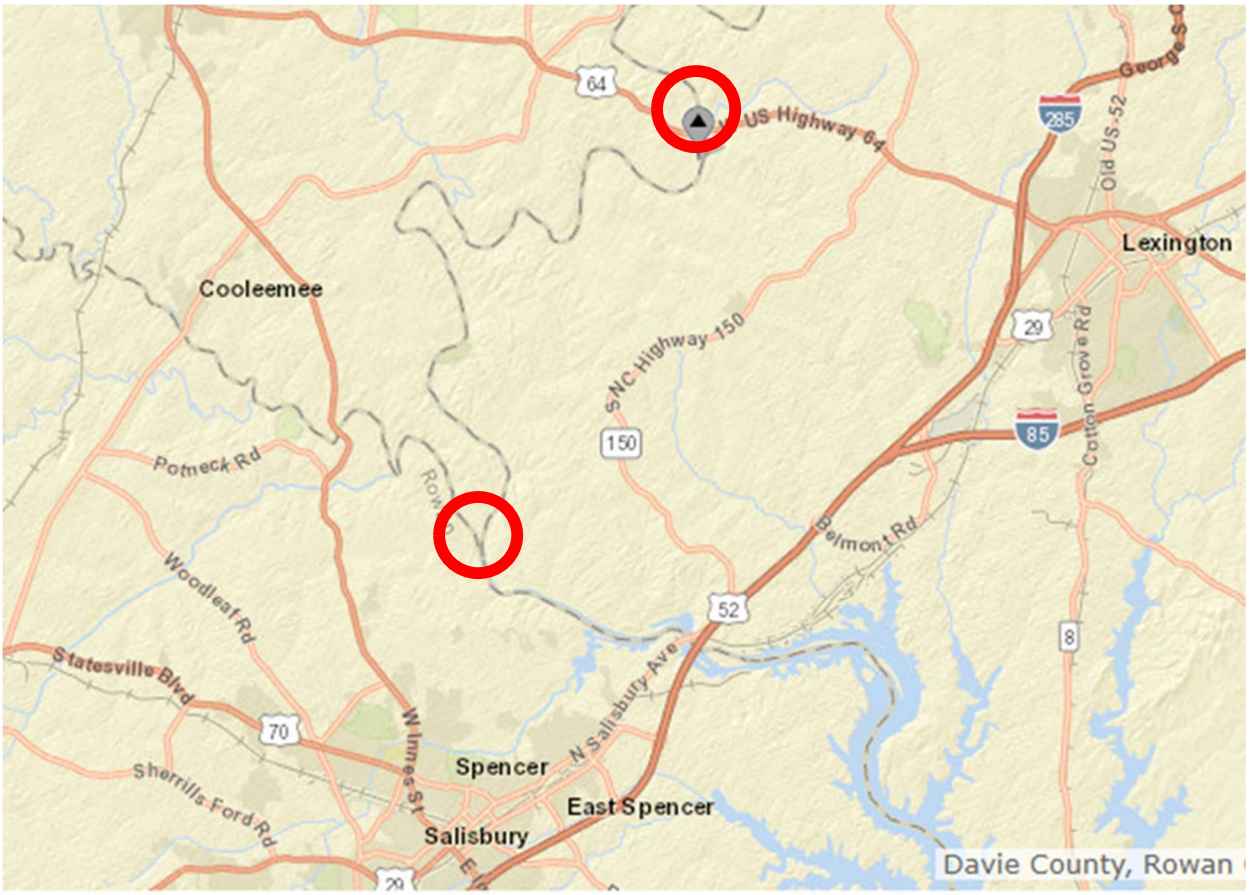
A flow frequency analysis was performed using HEC-SSP 2.2 Bulletin 17. The analysis was performed on the USGS Yadkin River Gage at Yadkin College, which is approximately 17 river miles upstream of the SRU Pump Station.

- Total drainage area – 2,280 square miles

Drainage area to Yadkin River just upstream of confluence with South Yadkin River – 2,450 square miles

Drainage area of South Yadkin River at confluence – 907 square miles

Figure 1 Map of Yadkin River USGS Gage at Yadkin College Relative to SRU Pump Station



SRU provided historical data correlating the stream gage flow at Yadkin College to the river water surface elevation at the SRU Pump Station.

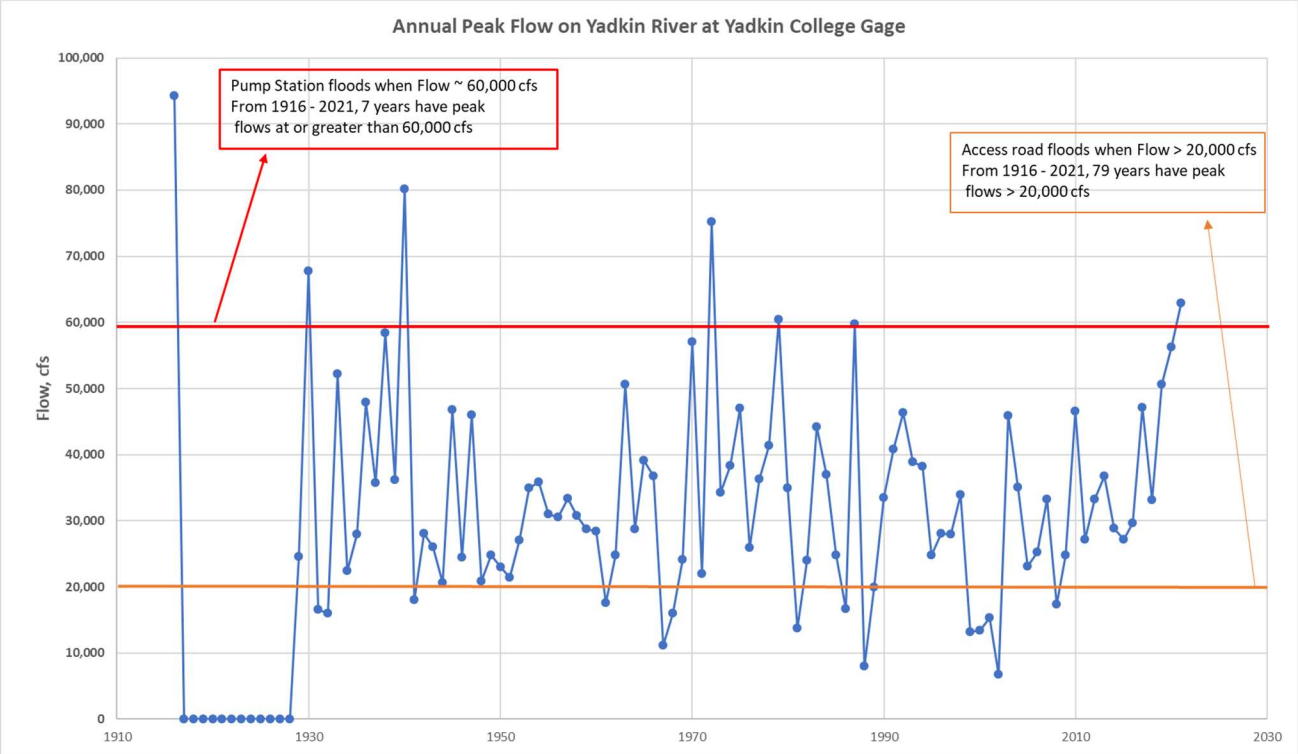
Data was also provided that correlated the water surface elevations to the various hazard levels for the pump station. This information was used to help identify damages at different river levels.

- Haz Level 1 – 628.0 ft
    - Pump Station Access Road floods
- Haz Level 2 – 630.0 ft
    - Pump Station land surface floods – access only by boat
- Haz Level 3 – 643.0 ft *
    - Water enters pump station rooms

*Power is disconnected when WSEL = 641.5 ft

Figure 2 shows the historical stream gage data and identifies how often the access road and pump station have flooded over the last 105 years.

Figure 2 Annual Peak Flow on Yadkin River at Yadkin College Gage

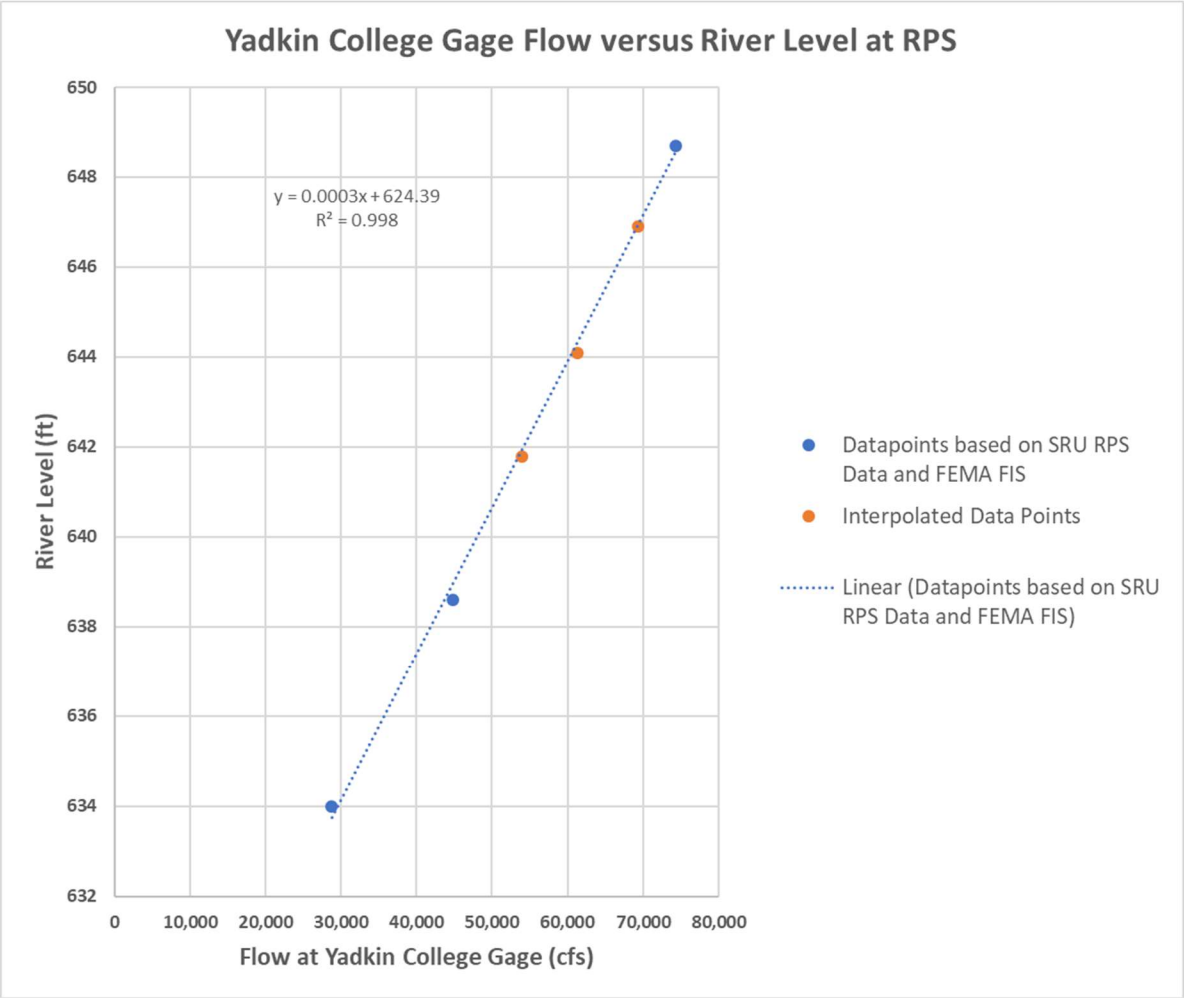


The FEMA FIS data and the data provided by SRU were used to determine the river flows and water surface elevations at the pump station for the various storm events, with some of the data points being interpolated. Table 1 and Figure 3 provide the results of that analysis.

Table 1 Flow Frequency Analysis Results for Various Storm Events

Return Period (Years)	Bulletin 17 FFA Yadkin College Computed Flow (cfs)	River WSEL (1929 NGVD) at RPS (Feet)
2	28,797	634
5	44,889	638.6
10	53,941	641.8
20	61,362	644.1
50	69,352	646.9
100	74,331	648.7
250	78,575	n/a
500	83,264	n/a

Figure 3 Yadkin College Gage Flow Versus River Level at SRU Pump Station



These results were used to determine level of damages for each storm event as part of the Benefit-Cost Ratio determination.

b. Project Cost

The proposed project mitigates risk by constructing a new combined intake structure / pump station operating floor approximately 4.5 feet above the FEMA 0.01 AEP, although climate change and other potential future conditions could increase the flowrate and water surface elevation associate with the FEMA 0.01 AEP. A description of the proposed project is taken from the December 2011 report entitled Pump Station, Intake, and Wastewater Treatment Train Flooding and Sedimentation Study Mitigation Assessment Report, by Black & Veatch. A figure of the proposed project location and a plan/profile sheet from the report are attached to this letter.

A new combined tower Intake Structure & Pump Station will be constructed in the Yadkin River approximately 2,500 feet downstream of the existing intake. The 0.01 annual exceedance probability flood elevation at this new location is approximately 647.7 ft NGVD 29 (647.0 ft NAVD 88) The operating floor slab will be at elevation 652.2 ft NGVD 29 (651.6 ft NAVD 88) to protect from the impacts of flooding. The station will consist of a concrete intake structure and wet well below the operating floor,

three vertical turbine pumps, and a wood framed structure covering the equipment. Total depth from operating floor slab to base slab is approximately 45 feet.

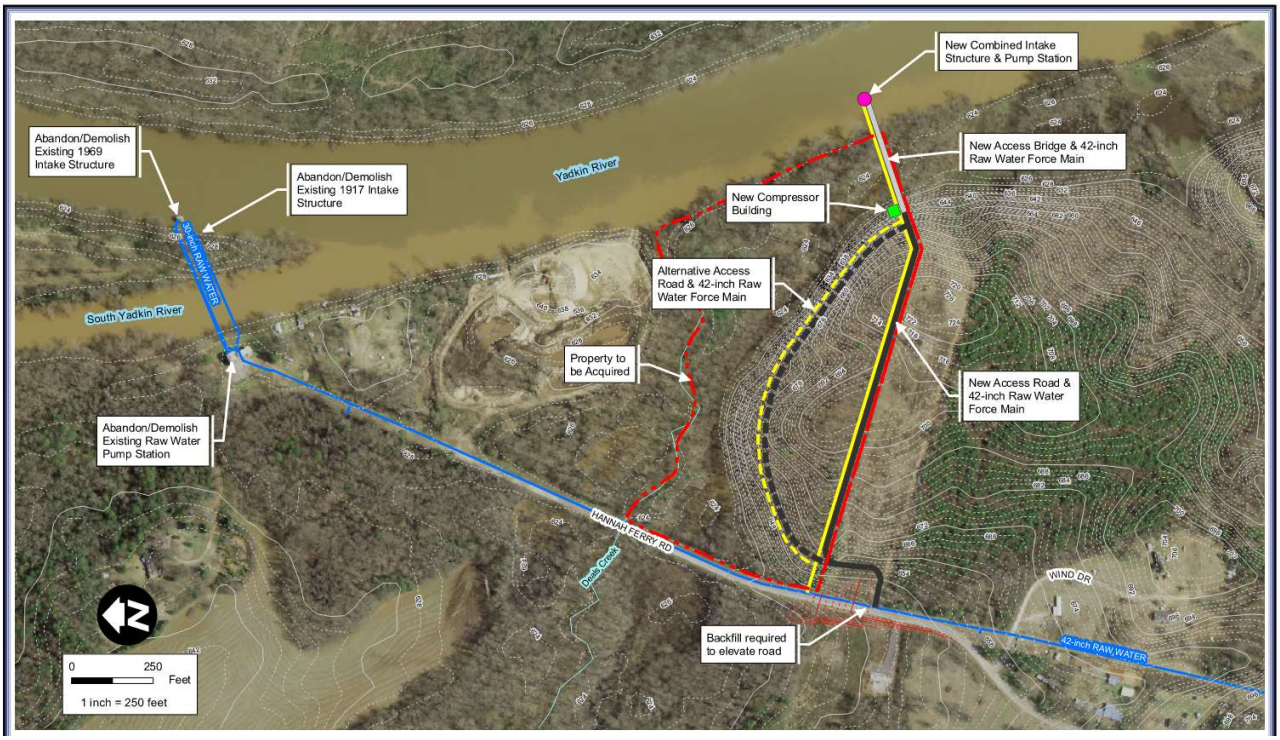
A concrete access bridge will be constructed from the structure to the adjacent land surface at elevation 652.2 ft NGVD 29 (651.6 ft NAVD 88) to provide access during flood events, including those above the 0.01 AEP.

A 42-inch ductile iron force main will be installed from the structure to convey pumped raw water to the existing 42-inch main and the existing intake structure and raw water pump station will be decommissioned once the new facilities are in operation.

A new gravel access drive from Hannah Ferry Road to the access bridge will be constructed parallel to the raw water force main.

Figure 4 shows the proposed project.

Figure 4 New Combined Tower Intake Structure and Pump Station



The Project Cost has been estimated by Black & Veatch to be $29,997,000. Cost details are provided in Figure 5. This is the cost of the project that would require a non-federal match of at least 25%. **SRU has a match commitment letter from Cube Yadkin Generation, LLC that says they will provide a financial no-federal commitment of up to $9 million, which is equal to 30% of the project cost. This letter is included as an attachment to the application.**

Additional costs related to grant management costs are included in the application of 5%, or $1,499,850. These management costs are funded by FEMA 100%, and do not require a non-federal match.

For this Benefit-Cost Analysis, the grant management costs have been included in the Total Cost to be used in determining the Benefit Cost Ratio.

Figure 5 Opinion of Probable Construction Cost

Item		Total
Yadkin River Raw Water Intake and Pumping Station		
Sitework	$	170,000.00
Pipelines	$	4,469,000.00
Intake/Pumping Station	$	8,406,000.00
Compressor Building	$	511,000.00
Access Bridge	$	886,000.00
Existing Pump Station Demolition	$	2,510,000.00
Subtotal Direct Cost	**$**	**16,952,000.00**
General Conditions (15%)	$	2,543,000
Bonds and Insurance (1.25%)	$	212,000
Contractor OH & Profit (10%)	$	1,971,000
Escalation to Midpoint of Construction (8.16%)	$	2,222,000
Total Bid Price	**$**	**23,900,000**
Land Acquisition	$	122,000
Pre-Award Costs: Engineering (15%) and Planning/Admin (10%)	$	5,975,000
TOTAL PROJECT COST	**$**	**29,997,000**
FEMA Grant Management Costs (5%)	**$**	**1,499,850**
TOTAL COST USED FOR BENEFIT-COST RATIO	**$**	**31,496,850**

c. Damages Assumptions

- Pre- and Post-Project Damages include:

  Daily Cost for Temporary Pumping – assumed $5,000/day including $4,500 for pump rental or purchase and gas for two pumps, and $500 in additional labor costs.

- Statesville Interconnect Water - $13,200/day for 2MGD

  Based on additional cost to purchase emergency water compared to pumping and treating their own raw water.

Assumed this water needed for 10yr storm and greater

- Loss of Service - $4,400,400/day

38,600 residents impacted (portion of total residents (48,900) not receiving Statesville water for average day demands)

$114/day/capita damages per FEMA guidance

- Pump Station Repairs – varies per storm event based on water level reaching and entering pump station.

- Storm Event assumptions include:
  - 10-year Storm

    Pump station electricity is shut down. Once flood water has receded, temporary pumping can begin to allow any moisture to dry. 0.5 day lost service. No facility damages assumed.

  - 20-year Storm

    Six months to replace damaged pump station components. Temporary pumping and Interconnect water for 6 months. Over 6-month period, average of 11 days of access road flooding, impacting temp pumps. 6 days lost service assumed over this 6-month period.

  - 50-year Storm

    Nine months to replace damaged pump station components. Temporary pumping and Interconnect water for 9 months. Over 9-month period, average of 16 days of access road flooding, impacting temp pumps. 10 days lost service assumed over this 9-month period.

  - 100-year Storm

    Twelve months to replace damaged pump station components. Temporary pumping and Interconnect water for 12 months. Over 12-month period, average of 22 days of access road flooding, impacting temp pumps. 14 days lost service assumed over this 12-month period.

- Post-Project Damages assume there may be a small impact from the 500-year storm event. The proposed project is 4.5 feet above the 100-year storm event elevation, but the 500-year storm event elevation is unknown.

The FEMA BCA Toolkit Calculator was used to calculate the Benefit-Cost Ratio. Tables 2 and 3 provide the pre- and post-project damages cost calculations.

Table 2 Pre-Project Damages Cost Calculation

Recurrence Interval (yr)	River WSEL (ft - NGVD 29)	Loss of Service (days)	Loss of Service ($)	Temp Pumping (days)	Temp Pumping ($)	Interconnect Water (days)	Interconnect Water ($)	Facility Damages ($)	Total Damages ($)
10	641.8	0.5	2,200,200	1	5,000	2	26,400	0	2,231,600
20	644.1	6	26,402,400	180	900,000	180	2,376,000	2,000,000	31,678,400
50	646.9	10	44,004,000	270	1,350,000	270	3,564,000	4,000,000	52,918,000
100	648.7	14	61,605,600	365	1,800,000	365	4,818,000	10,000,000	78,223,600

Notes: Loss of Service Cost = $4,400,400 per day
Temporary Pumping Cost = $5,000 per day
Interconnect Water Cost = $13,200 per day

Table 3 Post-Project Damages Cost Calculation

Recurrence Interval (yr)	River WSEL (ft - NGVD 29)	Loss of Service (days)	Loss of Service ($)	Temp Pumping (days)	Temp Pumping ($)	Interconnect Water (days)	Interconnect Water ($)	Facility Damages ($)	Total Damages ($)
500	n/a	1	4,400,400	1	5,000	2	26,400	0	4,431,800

Notes: Loss of Service Cost = $4,400,400 per day
Temporary Pumping Cost = $5,000 per day
Interconnect Water Cost = $13,200 per day

d. Benefit-Cost Ratio

Based on the results of the FEMA BCA Toolkit analysis:

Benefits of the project were calculated to be $42,305,456 (see Appendix).
Project cost is estimated to be $31,496,850.
Benefit-Cost Ratio is 1.34.

The FEMA BCA Toolkit results are included as an Appendix to this Technical Memorandum.

e. Lower Bounds Analysis

The Benefit Cost Analysis performed in calculating a BCR of 1.34 did not incorporate all of the damages that, in reality, exist. One example is the lost revenue experienced by SRU when the pump station needs to be shut down. A second example is the impact of or on some of the highest water use customers. The analysis assumed that residents would receive the 2 MGD emergency interconnect water. In reality, that water would likely be used to meet needs at the Rowan Power Plant and the two hospitals in the area. This would likely increase the number of residents impacted by Loss of Service to nearly the entire 48,900; or should the residents receive the water instead of the Power Plant and Hospitals, the cost impacts from that would be even more significant.

Other impacts not considered in the BCA include:

- Loss of Revenue to SRU ($73,374 per day)

- Impacts to fire and police operations, including property damage and/or loss of life due to lack of fire protection
- Fire department staff time required to boat SRU staff to the raw water intake pump station
- Lost revenue to local businesses and industries

Appendix

FEMA BCA Toolkit Analysis Results

Build 20211228.2010

Project Summary

Mitigation Title	Hazard	Benefits (B)	Costs (C)	BCR (B/C)
Other @ Salisbury, North Carolina	FA - Riverine Floo	$42,305,456	$31,496,850	1.34
	Total	$42,305,456	$31,496,850	1.34

Property Configuration

Property Title:	Other @ Salisbury, North Carolina
Property Location:	28144, Rowan, North Carolina
Property Coordinates:	35.66717, -80.46963
Hazard Type:	Riverine Flood
Mitigation Action Type:	Other
Property Type:	Utilities
Analysis Method Type:	Professional Expected Damages

Cost Estimation — Other @ Salisbury, North Carolina

Project Useful Life (years):	50		
Project Cost:	$31,496,850		
Number of Maintenance Years:	50	Use Default:	Yes
Annual Maintenance Cost:	$0		

Damage Analysis Parameters - Damage Frequency Assessment — Other @ Salisbury, North Carolina

Year of Analysis Conducted:	2021		
Year Property was Built:	1970		
Analysis Duration:	52	Use Default:	Yes

Utilities Properties — Other @ Salisbury, North Carolina

Type of Service:	Potable Water		
Number of Customers Served:	38,600		
Value of Unit of Service ($/person/day):	$114	Use Default:	Yes
Total Value of Service Per Day ($/day):	$4,400,400		

Professional Expected Damages Before Mitigation — Other @ Salisbury, North Carolina

	Potable Water	Optional Damages			Volunteer Costs		Total
Recurrence Interval (years)	Impact (days)	Temporary Pumping	Purchased Raw Water	Facility Damages	Number of Volunteers	Number of Days	Damages ($)
10	0.5	5,000	26,400	0	0	0	2,231,600
20	6	900,000	2,376,000	2,000,000	0	0	31,678,400
50	10	1,350,000	3,564,000	4,000,000	0	0	52,918,000
100	14	1,800,000	4,818,000	10,000,000	0	0	78,223,600

Annualized Damages Before Mitigation		Other @ Salisbury, North Carolina
Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
10	2,231,600	420,397
20	31,678,400	1,228,300
50	52,918,000	643,385
100	78,223,600	782,228
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	165,051,600	3,074,310

Professional Expected Damages After Mitigation		Other @ Salisbury, North Carolina					
	Potable Water	Optional Damages			Volunteer Costs		Total
Recurrence Interval (years)	Impact (days)	Temporary Pumping	Purchased Raw Water	Facility Damages	Number of Volunteers	Number of Days	Damages ($)
500	1	5,000	26,400	0	0	0	4,431,800

Annualized Damages After Mitigation		Other @ Salisbury, North Carolina
Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
500	4,431,800	8,863
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	4,431,800	8,863

Standard Benefits - Ecosystem Services		Other @ Salisbury, North Carolina
Total Project Area (acres):	0	
Percentage of Green Open Space:	0.00%	
Percentage of Riparian:	0.00%	
Percentage of Wetlands:	0.00%	
Percentage of Forests:	0.00%	
Percentage of Marine Estuary:	0.00%	
Expected Annual Ecosystem Services Benefits:	$0	

Benefits-Costs Summary		Other @ Salisbury, North Carolina
Total Standard Mitigation Benefits:	$42,305,456	
Total Social Benefits:	$0	
Total Mitigation Project Benefits:	$42,305,456	
Total Mitigation Project Cost:	$31,496,850	
Benefit Cost Ratio - Standard:	1.34	
Benefit Cost Ratio - Standard + Social:	1.34	