

Benefit-Cost Analysis Methods Summary

2022 FEMA BRIC Grant Application

Town of Jonesville, NC – Upper Yadkin River Floodplain Resiliency Initiative

Introduction

This report identifies the data and methods used to complete a benefit cost analysis (BCA) for the Town of Jonesville Upper Yadkin River Floodplain Resiliency initiative. The Town of Jonesville will implement a stream, floodplain, and community resiliency restoration project along four (4) miles of the Yadkin River, incorporating four (4) tributaries. Nature based solutions will be implemented to improve floodplain and stream stability, reduce soil loading into the Yadkin River, enhance terrestrial and aquatic habitats, and continue to build a resilient greenway and park system to serve the residents of Jonesville and the surrounding area. Corresponding attributes will include two (2) miles of pavement along the Jonesville Greenway, installation of an ADA accessible boat access and parking facility to improve emergency response, and re-pavement/rehabilitation of an area of local road prone to riverine flooding.

Project Background

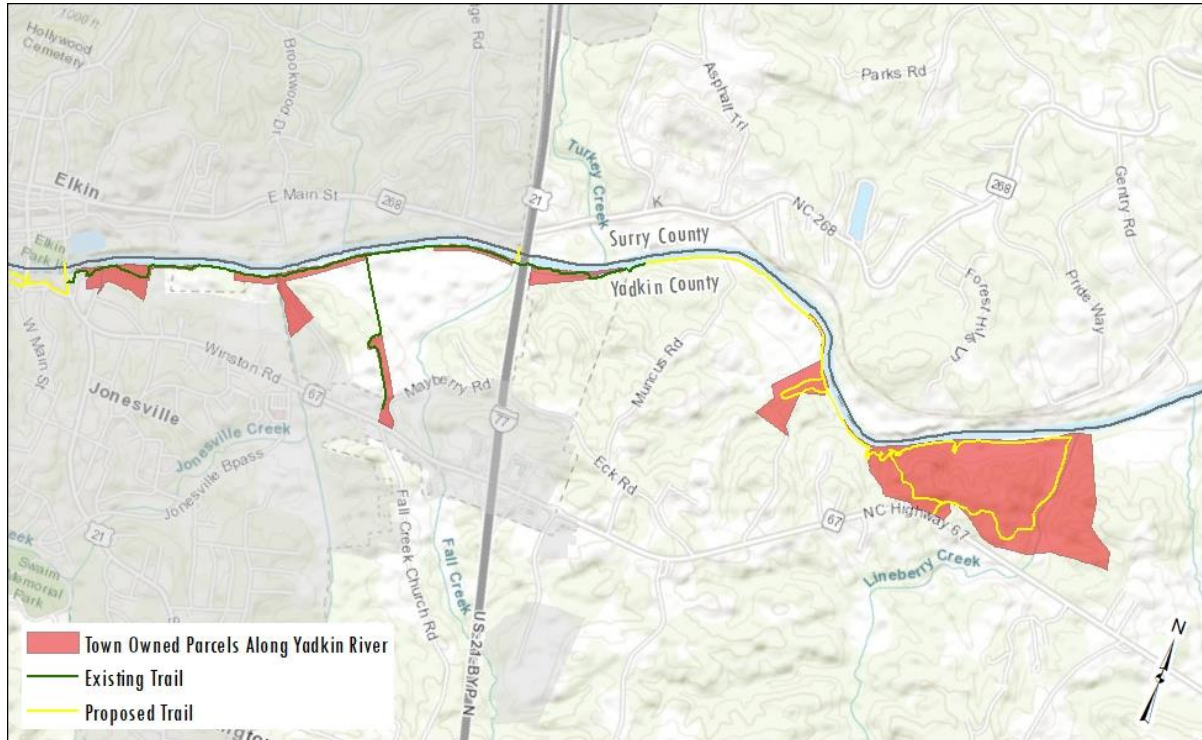
The Town of Jonesville, the oldest town in Yadkin County, is located along the banks of the Yadkin River. The Town has a Low to Moderate Income (LMI) population of 70.41% with the Town-wide annual median household income at \$23,646 or \$1,970 monthly, nearly half the state median household income. Additionally, Jonesville is recognized as an Area of Persistent Poverty and a Historically Disadvantaged Community by the US Department of Transportation.

In 2017, a greenway/park system along the Yadkin River (latitude/longitude 36.2433/-80.8406) was initiated. The greenway /park system will consist of five (5) miles of trails and a park with mountain bike and hiking trails, picnic areas, camping and river access. To date, approximately 2.5 miles of trail with restrooms and two (2) pedestrian bridges have been constructed.

Recent floods have inundated the trailhead park, rendering the facilities unusable for extended periods. In 2020 alone, the greenway flooded four (4) times. Portions of the trail and valuable agricultural land were washed away, and tons of silt, sand and debris were deposited. Local recreational vehicle parks suffered economic losses due to flooding and loss of river access. The proposed project will stabilize streambanks, reduce soil loss, improve terrestrial and aquatic habitat, and re-establish the floodplain, while making the trail resilient to future flood events.

According to raster data, the land area coverage is approximately 50% riparian, 40% forested, 8% open rural green space, and 2% wetland.

Map 1: Jonesville parcels along the Yadkin River and associated land cover



The Project is estimated to cost \$5,901,924.50 (2022 \$'s) for construction.

The FEMA BCA toolkit ver. 6.0 was used to estimate the present value stream of expected annual benefits and costs of The Project.

Benefits considered in the analysis include avoided loss of services, avoided repair and reconstruction costs, and ecosystem services.

The steps and inputs to develop the BCA model are outlined below and are followed by a discussion of the findings.

Methodology

The following sections document the primary assumptions related to the level of protection, professional expected damages as a basis for the analysis, and key inputs into the analysis. All monetary values were updated to current value as needed and adjusted to present value (OMB Circular A-94).

Project Useful Life

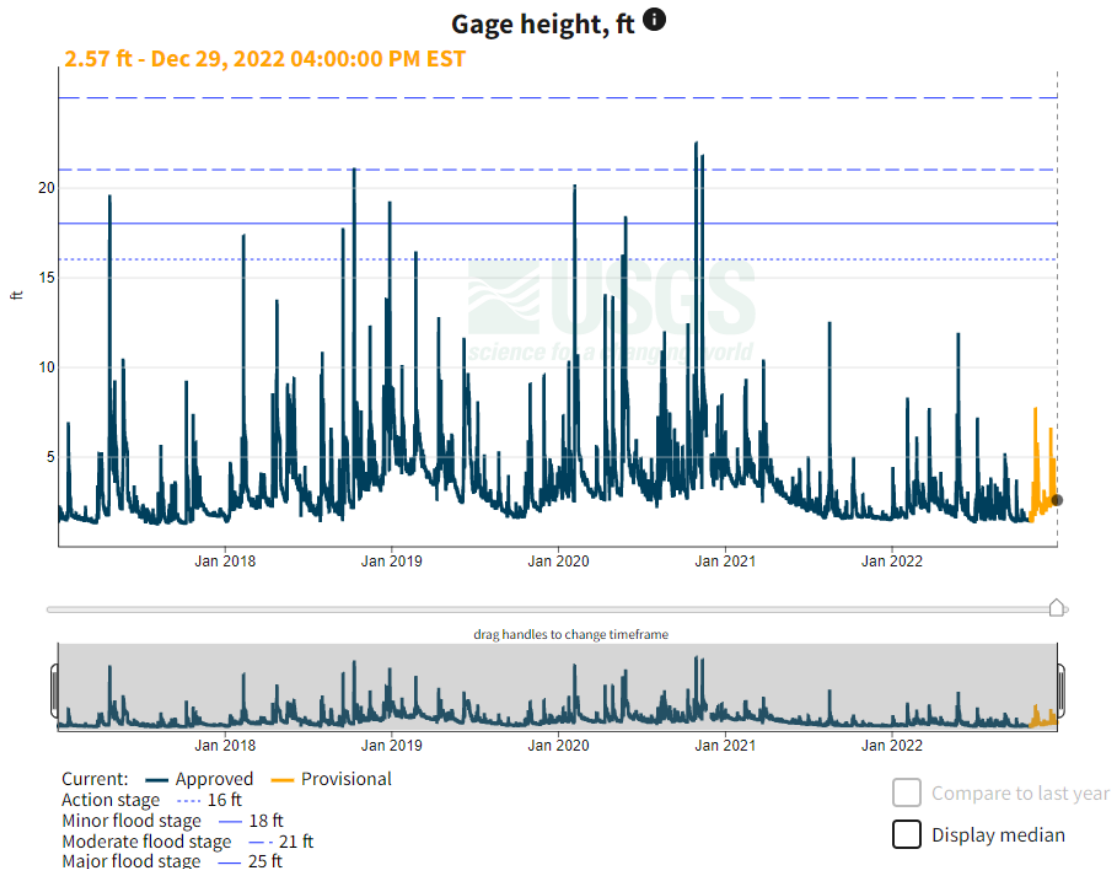
The proposed stream restoration is assumed to have a 50-year useful life in accordance with Appendix D of the FEMA BCA reference guide, Major Infrastructure (minor localized flood reduction projects), standard value 50. Likewise, the proposed boat ramp carries an assumed 50-year useful life, while the repaving projects are assumed to have a 30-year useful life.

Level of Protection

Existing

USGS monitoring flood gauge station 02112250 is located directly between Jonesville (southern river bank) and Elkin, NC (northern river bank) and provides extremely accurate data for the immediate surrounding area. The Yadkin reaches flood stage at 18 feet (7 occurrences since 2017) and is considered to be in the action stage at 15 feet, which has occurred at numerous other instances. The river has reached the moderate flood stage of 21 feet 3 times during the study period.

Table 1: Yadkin River flood history 2017-2022; Source US Geological Survey



Proposed

The proposed mitigation project consists of two major components: (1) stream restoration of the south bank of the Yadkin River and four tributaries and (2) paving the greenway and implementing flood proofing measures in adjacent areas. The stream restoration component will consist of sloping approximately 15,500 linear feet of streambanks, 53 rock vanes, and 18 cross vanes. The rock vanes and cross vanes will be constructed with large boulders strategically placed and able to withstand the forces of flood waters. The vanes will protect the streambanks and aid in diverting flood waters back into the main channel of the Yadkin River. To further stabilize the banks, intensive revegetation with riparian grasses, container plants, live stakes, and bare root plants of diverse native species will be planted, monitored and maintained. This nature-based approach will:

- Achieve greater bank stability along the reach of the Yadkin River
- Reduce the severity of erosion and soil loss into the river
- Reduce encroachment of future flood events
- Enhance terrestrial and aquatic habitat

To build resiliency, the greenway will:

- Be relocated or located out of the flood zone where possible
- Be designed and constructed to withstand typical flood events
- Be paved wherever feasibility to prevent loss due to erosion
- Include a shared, permeable surface parking area in conjunction with the ADA compliant emergency boat access.
- Extend repaving to small portions of local roads previously damaged by flood waters

Table 1 below is a summary of the estimated costs to complete the project. Detailed cost tables for each component are provided in Appendix A.

Table 2: Cost estimate (minus contingency)

Item	Construction Costs (minus contingency)
Stream Restoration	\$5,580,468.50
Greenway Pavement and Rehab	\$51,800.00
ADA Compliant Boat Access w/permeable lot	\$222,853.00
Local Road Pavement and Rehab	\$46,803
Total	\$5,901,924.50

Actual Damages

The following narrative provides the methods used to determine the benefit-cost ratio for the Town of Jonesville Upper Yadkin River Floodplain Resiliency Initiative. This analysis follows the

FEMA BCA Reference Guide and Supplement that analyzes historical damages and expected damages following the mitigation project using the FEMA BCA toolkit ver. 6.0. This proposed project will mitigate flooding hazards and associated environmental concerns due to flooding, increase infrastructure resiliency, and improve emergency services with a new river access for search and rescue.

The FEMA BCA Reference Guide and Supplement allows historical loss data to be used to calculate benefits for the BCA. The historical loss data was based on available precipitation records and the nearby USGS gauge station and actual field observations. According to the USGS gauge station, there have been seven (7) flood events within the study area since 2017. While not all floods are preventable, the greenway system can be improved to be more resilient to flood events.

Records from the Jonesville Trails association are complete back to 2019, though there is not a clear delineation of the number of volunteers and number of days spent for each clean-up effort. However, they did assign a dollar amount to each clean-up session, which has been used to annualize the actual dollars spent on clean-up sessions at a one-year recurrence interval as seen in table 2 below.

Damage Year 2020, 100-year flood, actual damages of \$5,797,493 are for engineer (Foggy Mountain Stream Restoration) estimated repair and mitigation costs associated with rectifying the current state of the Yadkin River and secondary watersheds and streambanks.

Table 3: Stream Restoration damages

Damage Year	Recurrence Interval	Damages	Inflated Damages
2020	100	\$5,797,493	\$6,448,501
2019	1	\$9,107	\$10,295

Disruption to the Jonesville Greenway and affected public roadways follows several assumptions. First is directly observed evidence that approximately 50 bicycle and pedestrian users travel through the area each day. For each of those users, loss of greenway and roadway use creates a detour of up to 2 miles (depending on origin and destination) and adds approximately 20 minutes per detour trip. In addition, clean-up efforts from the Town of Jonesville and Jonesville Trails Association were annualized to approximate expenses.

Cost Category	Recurrence Interval	Damages
Annual Clean up	yearly	\$35,798
Lost Use of Facilities	10 days/year	\$6,558

The emergency access boat ramp addresses public safety during flood events and along the river in general. According to news articles, 5 deaths have occurred on the Yadkin River in close proximity to Jonesville in the past decade (see Appendix D for citations). Additionally, countless injuries and non-medical emergencies have arisen during that time span.

The United States Department of Transportation uses the KABCO injury designation scale to assess the dollar amount associated with different injuries or fatalities. The 2020-dollar amount assigned by USDOT is \$11,600,000 for a fatality. This BCA assumes that emergency response can reduce the interval of an average of 1 death every 2 years to a reasonably assumed average of 1 death every 2.5 years. Including improved response times for injuries and other non-medical emergencies would increase the BCA ratio drastically.

Damages after Mitigation

This project will minimize the damages after mitigation by building resilient infrastructure and reducing the frequency of flood events. The stream restoration component will stabilize streambanks reducing erosion of the greenway trail and adjacent agricultural lands. The greenway trail will be paved to keep from being washed away and to facilitate clean up after a flood event. Minimal flood related clean-up is approximated to 1 closure day per year and \$100 of expense.

The rate of reducing fatalities (from 1 death every 2 years to 1 death every 2.5 years) along the river through improved emergency response is valued at \$1.16 million according to USDOT's KABCO injury designation scale.

This was used to estimate the damages after the proposed mitigation in the FEMA BCA Calculator.

Project Useful Life and Maintenance Costs

This project will include stream restoration and streambank stabilization. The expected lifespan of the stream restoration components and boat ramp installation are 50 years, with an expected useful life of 30 years for paving/repaving. However, with proper maintenance and rehab efforts, this life expectancy could be extended significantly.

The Town of Jonesville has \$2,000 per year budgeted for greenway maintenance and that figure is not expected to change with improvements. Similar upkeep funding can be expected for the emergency boat access. Roadway right-of-way will be dedicated to the State of North Carolina and the North Carolina Department of Transportation can be expected to continue upkeep of the repaved and rehabilitated section of roadway.

Results

The benefit-cost ratio for this project is shown in the table below. Costs provided in the determination of the BCR include maintenance costs over the project useful life. Using the 3% Discount Rate approved for FY22 BRIC and FMA applications, the **total project BCR is 23.15** which demonstrates that the proposed project is an **extremely cost-effective solution** and will greatly benefit the Town of Jonesville and the region. The BCA Report is provided in Appendix B.

Town of Jonesville | Upper Yadkin River Floodplain Resiliency Initiative
Benefit-Cost Analysis Methods Summary

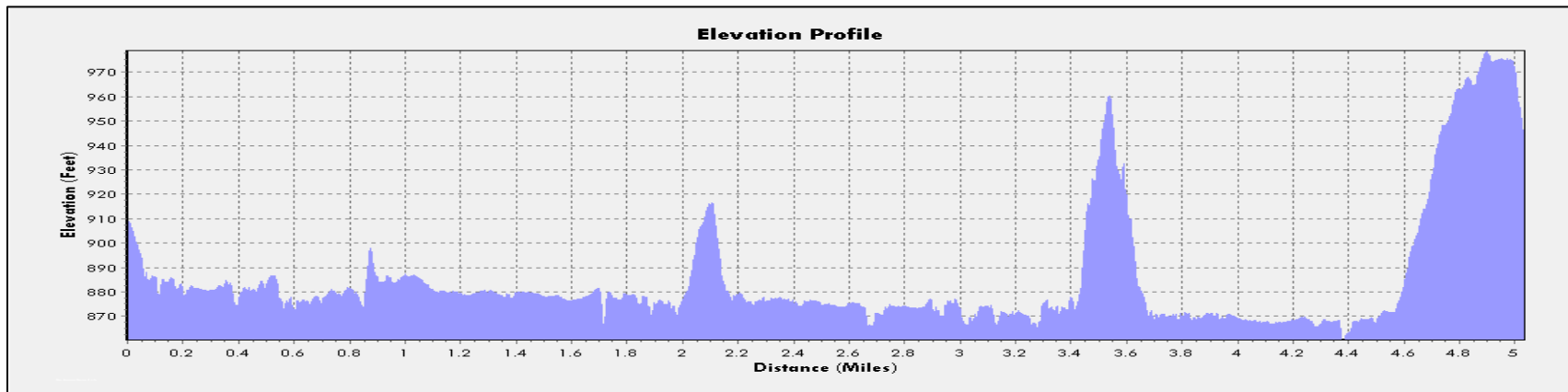
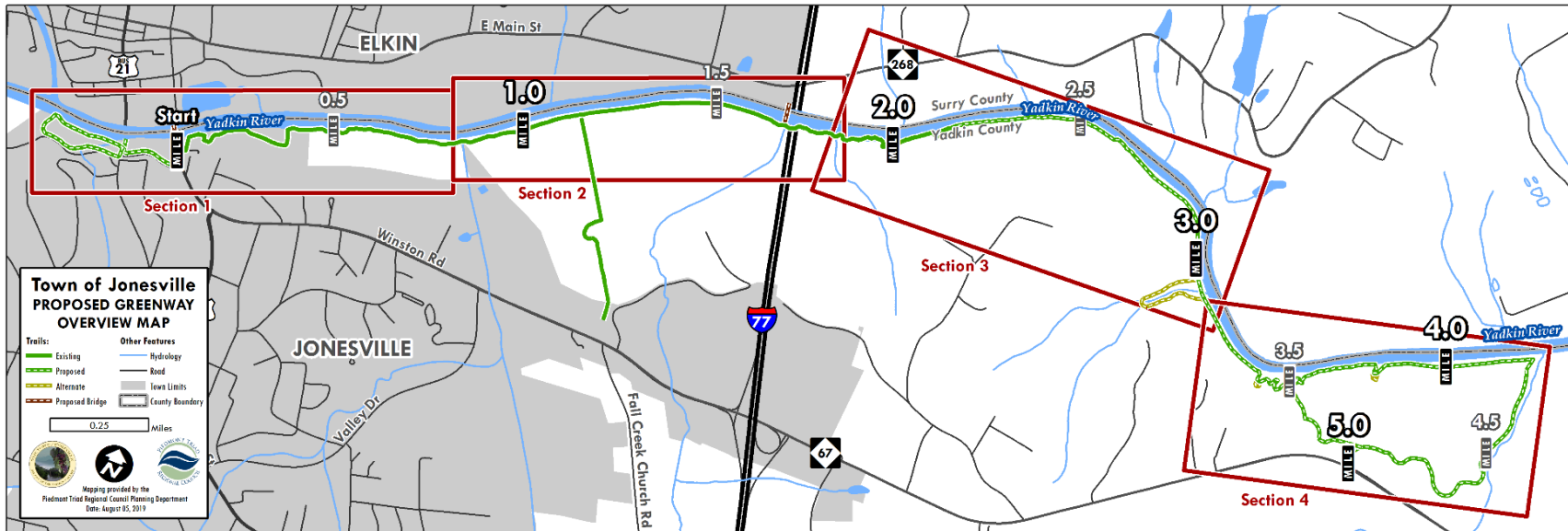
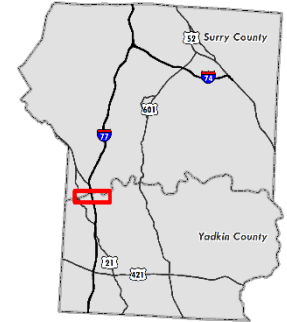


Proposed Project	Benefits	Costs	BCR
Stream Restoration	\$61,162,602	\$5,718,476	19.53
Greenway Paving & Roadway Repaving	\$516,216	\$123,421	5.92
Emergency Boat Access	\$16,008,866	\$250,454	108.8
Total	\$77,687,684	\$6,092,351	23.15

Appendix A – Project Layout

Project Study Area

The alignment study area runs 5 miles along the Yadkin River from the trailhead at Sgt. Gregory L. Martin Memorial Park to the new 154 acre land acquisition bordered by Lineberry Creek and NC 67 (see Section 4 below). There are future plans to continue the Yadkin River Greenway east to US 601. There are additional trail planning activities and efforts on the north side of the Yadkin River in Elkin and Surry County, but this study focuses on the land trail opportunities and amenities on the south side of the Yadkin River. The report is divided into 4 sections as shown below and mileage markers from the trailhead are included for reference. Also included is an elevation profile of the trail route as planned.



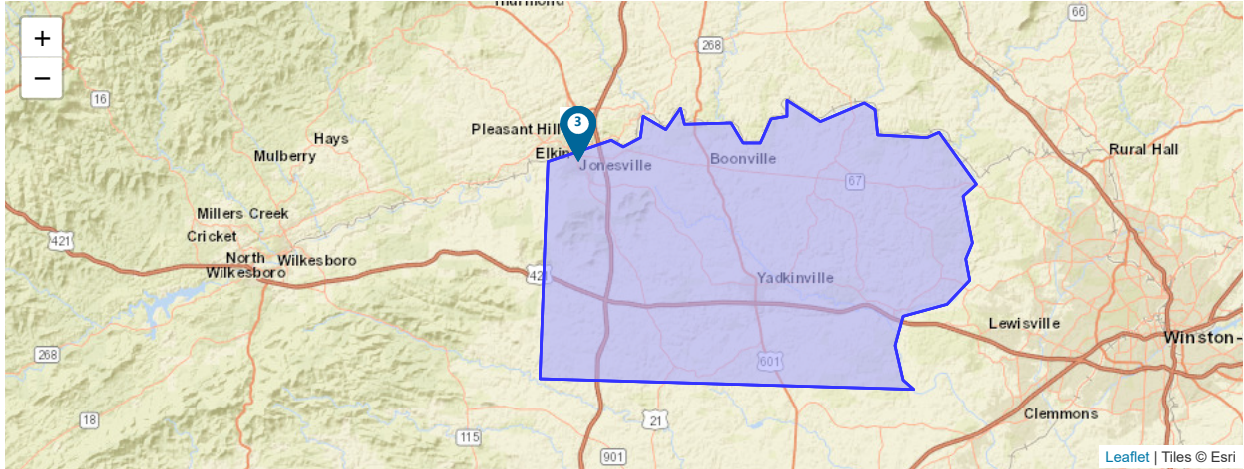
Appendix B – Itemized Cost Tables

Appendix C – EPA Generated BCA Report



Benefit-Cost Analysis

Project Name: Upper Yadkin River Floodplain Resiliency Initiative



Map Marker	Mitigation Title	Property Type	Hazard	Using 7% Discount Rate			Using 3% Discount Rate (For FY22 BRIC and FMA only)		
				Benefits (B)	Costs (C)	BCR (B/C)	Benefits (B)	Costs (C)	BCR (B/C)
1	Floodplain and Stream Restoration @ Jonesville, North Carolina		DFA - Riverine Flood	\$ 61,162,602	\$ 5,718,476	10.70	\$ 114,030,016	\$ 5,837,766	19.53
2	Floodproofing Measures @ Jonesville, North Carolina		DFA - Riverine Flood	\$ 516,216	\$ 123,421	4.18	\$ 815,378	\$ 137,804	5.92
3	Other @ Jonesville, North Carolina		DFA - Riverine Flood	\$ 16,008,866	\$ 250,454	63.92	\$ 29,846,527	\$ 274,313	108.80
TOTAL (SELECTED)				\$ 77,687,684	\$ 6,092,351	12.75	\$ 144,691,921	\$ 6,249,883	23.15
TOTAL				\$ 77,687,684	\$ 6,092,351	12.75	\$ 144,691,921	\$ 6,249,883	23.15

Property Configuration

Property Title:	Floodplain and Stream Restoration @ Jonesville, North Carolina
Property Location:	28642, Yadkin, North Carolina
Property Coordinates:	36.237010000000055, -80.84324999999995
Hazard Type:	Riverine Flood
Mitigation Action Type:	Floodplain and Stream Restoration
Property Type:	Other
Analysis Method Type:	Historical Damages

Cost Estimation
Floodplain and Stream Restoration @ Jonesville, North Carolina

Project Useful Life (years):	50
Project Cost:	\$5,580,469
Number of Maintenance Years:	50 Use Default: Yes
Annual Maintenance Cost:	\$10,000

Comments

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Mitigation Project Cost:
See appendix A

Damage Analysis Parameters - Damage Frequency Assessment
Floodplain and Stream Restoration @ Jonesville, North Carolina

Year of Analysis was Conducted:	2022
Year Property was Built:	2017
Analysis Duration:	5 Use Default: No

Historical Damages Before Mitigation
Floodplain and Stream Restoration @ Jonesville, North Carolina

Damage Year	Recurrence Interval (years)	OTHER			OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL	
		Damages (\$)	General Fund (\$)	TDA Expenditures (\$)	Other(\$)	Number of Volunteers	Number of Days	Damages (\$)	Current Dollars?	Inflated Damages (\$)	
2020	100	5,797,493	0	0	0	0	0	0	5,797,493	No	6,448,501
2019	1	9,106.71	0	0	0	0	0	0	9,107	No	10,295

Comments

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Damages Before Mitigation:
2019 Damage year w/ 1 year interval is annualized cost born by Jonesville Trails Association for clean up and restoration 2020 Damage year w/100 year interval is estimate for riverbank stabilization and stream restoration

Annualized Damages Before Mitigation
Floodplain and Stream Restoration @ Jonesville, North Carolina

Annualized Recurrence Interval (years)	Damages and Losses (\$)	Annualized Damages and Losses (\$)
1	10,295	255,082
100	6,448,501	64,484
Sum Damages and Losses (\$)		Sum Annualized Damages and Losses (\$)
	6,458,796	319,566

Expected Damages After Mitigation
Floodplain and Stream Restoration @ Jonesville, North Carolina

Recurrence Interval (years)	OTHER			OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
	Damages (\$)	General Fund (\$)	TDA Expenditures (\$)	Other(\$)	Number of Volunteers	Number of Days	Damages (\$)		
0	0	0	0	0	0	0	0	0	

Annualized Damages After Mitigation
Floodplain and Stream Restoration @ Jonesville, North Carolina

Annualized Recurrence Interval (years)	Damages and Losses (\$)	Annualized Damages and Losses (\$)
	Sum Damages and Losses (\$)	Sum Annualized Damages and Losses (\$)
10	0	0

Standard Benefits - Ecosystem Services
Floodplain and Stream Restoration @ Jonesville, North Carolina

Total Project Area (acres):	166.5
Percentage of Urban Green Open Space:	0.00%
Percentage of Rural Green Open Space:	10.00%
Percentage of Riparian:	50.00%
Percentage of Coastal Wetlands:	0.00%
Percentage of Inland Wetlands:	0.00%
Percentage of Forests:	40.00%
Percentage of Coral Reefs:	0.00%
Percentage of Shellfish Reefs:	0.00%
Percentage of Beaches and Dunes:	0.00%
Expected Annual Ecosystem Services Benefits:	\$4,112,267

Comments

- Percent Riparian:**
approximated using raster data
- Percent Forests:**
approximated using raster data
- Percent Rural Green Open Space:**
approximated using raster data

Benefits-Costs Summary
Floodplain and Stream Restoration @ Jonesville, North Carolina

Total Standard Mitigation Benefits:	\$61,162,602
Total Social Benefits:	\$0
Total Mitigation Project Benefits:	\$61,162,602
Total Mitigation Project Cost:	\$5,718,476
Benefit Cost Ratio - Standard:	10.70
Benefit Cost Ratio - Standard + Social:	10.70

Property Configuration	
Property Title:	Floodproofing Measures @ Jonesville, North Carolina
Property Location:	28642, Yadkin, North Carolina
Property Coordinates:	36.237010000000055, -80.84324999999995
Hazard Type:	Riverine Flood
Mitigation Action Type:	Floodproofing Measures
Property Type:	Roads & Bridges
Analysis Method Type:	Historical Damages

Cost Estimation	
Floodproofing Measures @ Jonesville, North Carolina	
Project Useful Life (years):	30
Project Cost:	\$98,603
Number of Maintenance Years:	30 Use Default:Yes
Annual Maintenance Cost:	\$2,000

Comments

- Annual Maintenance Cost:**
 Jonesville appropriates \$2k/year for sidewalk and pavement cleaning and repair from their general fund

Damage Analysis Parameters - Damage Frequency Assessment	
Floodproofing Measures @ Jonesville, North Carolina	
Year of Analysis was Conducted:	2022
Year Property was Built:	0
Analysis Duration:	10 Use Default:Yes

Roads and Bridges Properties	
Floodproofing Measures @ Jonesville, North Carolina	
Estimated Number of One-Way Traffic Detour Trips per Day:	50
Additional Time per One-Way Detour Trip (minutes):	20
Number of Additional Miles:	2
Federal Rate (\$):	0.625 Use Default:Yes
Economic Loss Per Day of Loss of Function (\$):	655.83

Comments

- Number of Trips:**
 approximately 50 bike and pedestrian users per day
- Time per Trip:**
 approximately 20 minutes per trip
- Number of Miles:**
 users lose use of full 2 miles of greenway

Historical Damages Before Mitigation										
Floodproofing Measures @ Jonesville, North Carolina										
Damage Year	Recurrence Interval (years)	ROADS AND BRIDGES	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL		
		Impact (days)	Category 1 (\$)	Category 2 (\$)	Category 3 (\$)	Number of Volunteers	Number of Days	Damages (\$)	Current Dollars?	Inflated Damages (\$)
2022	1	10	35,797.6	0	0	0	0	42,356	No	42,356

Comments

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Damages Before Mitigation:

1 year recurrence interval used for averaged yearly damage from past 5 years

Annualized Damages Before Mitigation
Floodproofing Measures @ Jonesville, North Carolina

Annualized Recurrence Interval (years)	Damages and Losses (\$)	Annualized Damages and Losses (\$)
1	42,356	42,356
Sum Damages and Losses (\$)		Sum Annualized Damages and Losses (\$)
	42,356	42,356

Expected Damages After Mitigation
Floodproofing Measures @ Jonesville, North Carolina

Recurrence Interval (years)	ROADS AND BRIDGES		OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
	Impact (days)	Category 1 (\$)	Category 2 (\$)	Category 3 (\$)	Number of Volunteers	Number of Days	Damages (\$)	
1	1	100	0	0	0	0	756	

Comments

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Damages After Mitigation:

expected light clean up

Annualized Damages After Mitigation
Floodproofing Measures @ Jonesville, North Carolina

Annualized Recurrence Interval (years)	Damages and Losses (\$)	Annualized Damages and Losses (\$)
1	756	756
Sum Damages and Losses (\$)		Sum Annualized Damages and Losses (\$)
	756	756

Benefits-Costs Summary
Floodproofing Measures @ Jonesville, North Carolina

Total Standard Mitigation Benefits:	\$516,216
Total Social Benefits:	\$0
Total Mitigation Project Benefits:	\$516,216
Total Mitigation Project Cost:	\$123,421
Benefit Cost Ratio - Standard:	4.18
Benefit Cost Ratio - Standard + Social:	4.18

Property Configuration

Property Title:	Other @ Jonesville, North Carolina
Property Location:	28642, Yadkin, North Carolina
Property Coordinates:	36.237010000000055, -80.84324999999995
Hazard Type:	Riverine Flood
Mitigation Action Type:	Other
Property Type:	Other
Analysis Method Type:	Professional Expected Damages

Cost Estimation
Other @ Jonesville, North Carolina

Project Useful Life (years):	50
Project Cost:	\$222,853
Number of Maintenance Years:	50 Use Default:Yes
Annual Maintenance Cost:	\$2,000

Damage Analysis Parameters - Damage Frequency Assessment
Other @ Jonesville, North Carolina

Year of Analysis was Conducted:	2022
Year Property was Built:	0
Analysis Duration:	10 Use Default:Yes

Professional Expected Damages Before Mitigation
Other @ Jonesville, North Carolina

Recurrence Interval (years)	OTHER			OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
	Damages (\$)	Drowning (\$)	Category 3 (\$)	Category 3 (\$)	Category 3 (\$)	Number of Volunteers	Number of Days	Damages (\$)	
2	0	11,600,000	0	0	0	0	0	11,600,000	

Comments

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Damages Before Mitigation:

According to available news reports, 5 deaths have been reported on the Yadkin River in the vicinity of Jonesville in the past 10 years. Those were on 8/2/12, 9/5/17, 4/16/21, 5/22/22, and 7/15/22. Injury recurrence rate calculated with feedback from Yadkin and Surry County EMS. Values were calculated using USDOT KABCO values for deaths and injuries.

Annualized Damages Before Mitigation
Other @ Jonesville, North Carolina

Annualized Recurrence Interval (years)	Damages and Losses (\$)	Annualized Damages and Losses (\$)
2	11,600,000	5,799,999
Sum Damages and Losses (\$)		Sum Annualized Damages and Losses (\$)
	11,600,000	5,799,999

Professional Expected Damages After Mitigation
Other @ Jonesville, North Carolina

Recurrence Interval (years)	OTHER			OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
	Damages (\$)	Drowning (\$)	Category 3 (\$)	Category 3 (\$)	Category 3 (\$)	Number of Volunteers	Number of Days	Damages (\$)	
2.5	0	11,600,000	0	0	0	0	0	11,600,000	

Annualized Damages After Mitigation
Other @ Jonesville, North Carolina

Annualized Recurrence Interval (years)	Damages and Losses (\$)	Annualized Damages and Losses (\$)
2.5	11,600,000	4,639,999
Sum Damages and Losses (\$)		Sum Annualized Damages and Losses (\$)
	11,600,000	4,639,999

Standard Benefits - Ecosystem Services
Other @ Jonesville, North Carolina

Total Project Area (acres):	0
Percentage of Urban Green Open Space:	0.00%
Percentage of Rural Green Open Space:	0.00%
Percentage of Riparian:	0.00%
Percentage of Coastal Wetlands:	0.00%
Percentage of Inland Wetlands:	0.00%
Percentage of Forests:	0.00%
Percentage of Coral Reefs:	0.00%
Percentage of Shellfish Reefs:	0.00%
Percentage of Beaches and Dunes:	0.00%
Expected Annual Ecosystem Services Benefits:	\$0

Benefits-Costs Summary
Other @ Jonesville, North Carolina

Total Standard Mitigation Benefits:	\$16,008,866
Total Social Benefits:	\$0
Total Mitigation Project Benefits:	\$16,008,866
Total Mitigation Project Cost:	\$250,454
Benefit Cost Ratio - Standard:	63.92
Benefit Cost Ratio - Standard + Social:	63.92

Appendix D – Press Reports Cited

FOX8 WGHP. (2012, August 26). *Jonesville man drowns in Yadkin River while fishing*. FOX8 WGHP. Retrieved January 5, 2023, from <https://myfox8.com/news/jonesville-man-drowns-in-yadkin-river-while-fishing/>

kburns@yadkinripple.com, K. B. H. (2022, March 22). *Investigation continues into teen's death*. Yadkin Ripple. Retrieved January 5, 2023, from <https://www.yadkinripple.com/news/20957/investigation-continues-into-teens-death>

Report, S. (2017, September 5). *Roaring river man drowns on Yadkin River*. Mt. Airy News. Retrieved January 5, 2023, from <https://www.mtairynews.com/news/53919/roaring-river-man-drowns-on-yadkin-river>

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