Attachment 14. St. Andrews BCA Technical Report

City of Greenville St. Andrews Drive-Critical Infrastructure Protection and Stream Restoration

Project Application- FY2021 BRIC

TECHNICAL MEMORANDUM

FEMA Building Resilient Infrastructure and Communities Grant Program

City of Greenville St. Andrews Drive – Critical Infrastructure Protection and Stream Restoration

Benefit-Cost Analysis Memorandum

November 22, 2021
v.0

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1. Introduction

FEMA requires that all projects funded through the Building Resilient Infrastructure and Communities (BRIC) program are cost-effective and designed to increase resilience and reduce risk of injuries, loss of life, and damage and destruction of property, including critical services and facilities.

This technical report documents that the St. Andrews Drive – Critical Infrastructure Protection and Stream Restoration project submitted by the City of Greenville, North Carolina under the BRIC Fiscal Year 2021 application cycle satisfies applicable cost-effectiveness requirements in compliance with OMB Circular A-94 using FEMA benefit-cost analysis (BCA) methods and tools. The report covers the proposed mitigation activity, BCA approach including pre-mitigation and post-mitigation losses, benefits to disadvantaged populations, and analysis results. Analysis documentation also includes a completed FEMA BCA Toolkit Version 6.0, and a BCA Report.

2. Proposed Mitigation Activity

The proposed mitigation activity will stabilize a confined section of an unnamed tributary to Greens Mill Run, positioned between Southwest Greenville Boulevard and Fairlane Road, running parallel to St. Andrew's Drive. The stream stabilization project will use nature-based solutions to mitigate erosion of the streambank which threatens potable water, sewer, and electric power utilities as well as several apartments and single-family homes.

2.1 Historic Events and Vulnerability

In accordance with the FEMA BCA Reference Guide and Supplement, expected losses associated with modeled events may be used in the BCA Toolkit. The proposed project will mitigate streambank erosion, which has yet to damage property or infrastructure, but may soon based on increasing rates of erosion witnessed in the stream and increasing intensity and frequency of rainfall events due to climate change. Therefore, the BCA is based upon expected losses that will be avoided by restoring and stabilizing the streambank and channel using the rate of erosion, as recommended in the *FEMA Introduction to Benefit Cost Analysis Unit 7 BCA Training: BCAs for Wildfire, Seismic, and Landslide/Catastrophic Failure Mitigation Projects*.[1]

The actively eroding channel has vertically degraded into its own streambed, resulting in overly high stream banks, loss of hydrologic connectivity to the adjoining floodplain, and lateral migration/erosion. Major instability issues are associated with the channel's overly deep and incised condition (approximately 8 to 14-foot banks). Site evaluations conducted by engineers highlight that many reaches of the project stream are highly unstable, display lateral bank erosion and mass wasting, and will increasingly widen over time because the channel bed has stabilized at its lowest elevation and water velocity and shear force within the stream are now confined within the channel during high volume urban stormwater events. This erosion threatens the following critical infrastructure and property:

- Water and sewer infrastructure. An 8" clay gravity sewer line and 8" PVC water line cross the stream bed in the project area. The sewer line is fully exposed in the channel and is vulnerable to complete failure if impacted by floating debris or the downstream movement of large stones along the streambed. Numerous stormwater pipes also discharge to the channel.

[1] Website: https://www.fema.gov/sites/default/files/2020-04/fema_bca_instructor-guide_unit-7.pdf

- Electric power systems. Two transformer boxes are close to the top of actively eroding banks and is at risk of being compromised by further bank erosion. In addition, bank erosion has exposed a buried electric service line in steel casing.
- Commercial and residential structures. Over thirty residential and commercial properties line the banks of the stream. However, approximately 10 primary structures are close enough to the streambank that they are at risk of being compromised by future erosion within the next 30 years. This does not include vulnerable accessory structures.

Expected losses are estimated using loss of function avoided for public infrastructure through implementation of the proposed project, in addition to physical damages and relocation costs avoided due to residential and commercial structure protection.

2.2 Project Overview

The proposed project in the unnamed stream proposes to stabilize the stream by increasing the elevation of the channel bed, regrading banks, and implementing bio-engineered and stone-based structural enhancements with surface stabilization and natural fiber matting for reinforcement. Additionally, the proposed project will implement intensive revegetation with appropriate native riparian plant species. These actions will prevent future channel downcutting and widening, reduce sediment loading, and reduce vegetation loss, therefore protecting building foundations and municipal utilities. Specifically, the proposed project includes the following:

- Grading to stabilize upper banks along 4,600 feet of the channel (reported in bank-feet);
- Stone toe protection structures or gabion walls for approximately 1,100 feet of the channel;
- Raising the channel bed to provide a minimum of one foot of cover over the exposed sewer pipe, water line, and electric service lines crossing the streambed; and
- Installing grade control structures immediately upstream and downstream of utility crossings to protect them.

Additionally, the project will replant the riparian zone buffer with a riparian seed mix and herbaceous and native woody shrubs and trees. See Figure 1 for the proposed project area and streambed delineation.

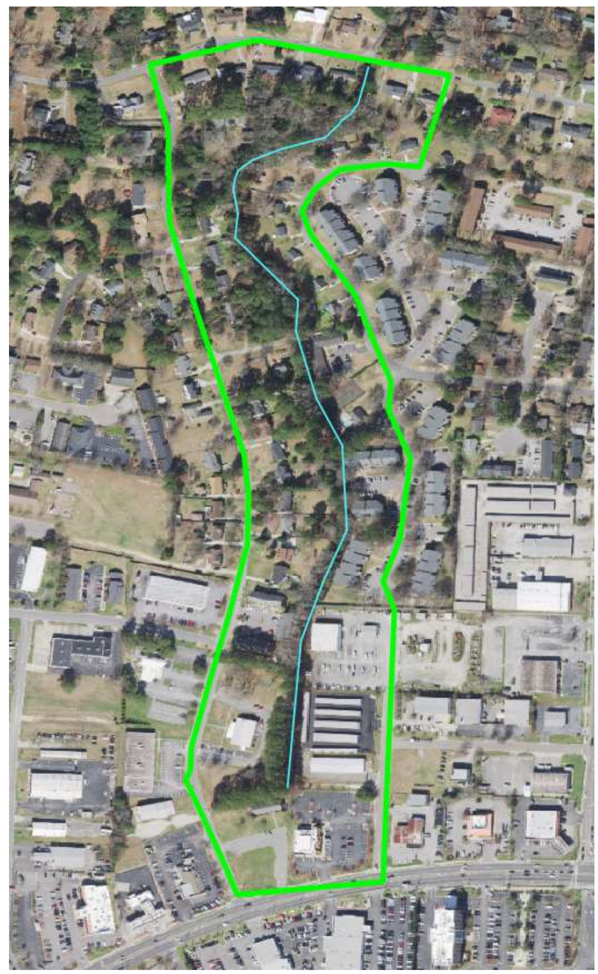

Figure 1. St. Andrews Drive – Critical Infrastructure Protection and Stream Restoration project area.

2.3 Project and Maintenance Costs

Table 1 provides total project and annual maintenance costs for implementing the proposed mitigation activity. Project costs were estimated in accordance with FEMA Hazard Mitigation Assistance (HMA) Guidance and do not include management costs requested. The City of Greenville currently maintains the unnamed stream and has a budget for major repairs and annual inspections. Nevertheless, the City expects that additional maintenance costs will be needed for vegetation control, approximately $3,500 per year. This assumes a 4-person crew will work for 4 hours per month for the stream segment.

Table 1. Project and Maintenance Costs

Mitigation Activity	Project Cost	Annual Maintenance Cost
Stream Restoration and Utility Infrastructure Protection	$4,593,476	$3,500

2.4 Project Useful Life

According to the *Supplemental Guidance for Conducting a Benefit-Cost Analysis for A Floodplain and Stream Restoration Project,* a project useful life of 30 years should be applied to projects that focus on nature-based solutions. As such, a useful life of 30 years was applied for the St. Andrews Critical Infrastructure Protection and Stream Restoration project. See Appendix B for documentation.

2.5 Service Populations

Losses avoided for municipal utilities are accounted for in the BCA Toolkit using service populations and expected functional downtime if compromised by heavy urban rainfall and erosion. Analysts estimated the service area for water, sewer, and electric utilities at risk due to the project stream using geospatial analysis and expert judgement for likely locations of isolation valves within the system. The expected service area for water and sewer utilities and electric power infrastructure are shown in Appendix C. Water and sewer utility system extents are similar and therefore likely have similar service areas.

Analysts estimated the residential population within the utility service areas using existing land uses and U.S. Census data from 2019. Because the identified service areas are smaller than a census block, analysts identified the number of residential units within the service area and compared the service area residential units to the number of block residential units. The percentage of housing units present in the service area was then applied to the census block population count to obtain the population in the service area. Table 2 presents the results of this analysis and the service population inputs for the BCA Toolkit for water, sewer, and electric utility systems that will benefit from the proposed project.

Table 2. Utility Service Area Populations and Values

Properties	Water	Sewer	Electric
Housing Units in Service Area	643	643	181
Percentage of Census Block Group Housing in the Service Area[2]	38.55%	38.55%	10.85%

[2] Estimated by dividing the service area housing units by 1,668 total housing units present in the census block group.

Properties	Water	Sewer	Electric
Service Area Population[3]	1,014	1,014	285
Value of Unit of Service ($/person/day)[4]	$114	$58	$174
Total Value of Service Per Day ($/day)[5]	$115,596	$58,812	$49,590

3. Benefit-Cost Analysis Approach

3.1 Software and References

Following the FEMA BCA Reference Guide and Supplement, this analysis uses a combination of precipitation data, erosion rates, and modeled expected losses for physical damage and municipal utility failure to calculate the damages before and after the proposed mitigation project is implemented. The modeled scenarios use engineering assessments, statistical determinations of likely occurrence, and associated damages during expected events. This is consistent with FEMA's expected damages approach as detailed in the FEMA BCA Reference Guide. The BCA for this project was primarily guided by FEMA's BCA Reference Guide and Supplement and the BCA Toolkit Version 6.0.

The proposed St. Andrews Critical Infrastructure Protection and Stream Restoration project addresses three primary vulnerabilities:

- Disruption in sewer services due to heavy urban rainfall and erosion within the stream that threatens exposed pipelines. Potable water services are also likely vulnerable but are not yet considered at risk of imminent failure without further analysis.
- Disruption in electrical power services due to transformer box locations on the streambank and erosion vulnerabilities for exposed pipelines.
- Damage to commercial and residential buildings due to erosion vulnerabilities, along with associated relocation costs.

These vulnerabilities are represented in the FEMA BCA Toolkit using the Damage Frequency Assessment (DFA) module. Specifically, analysts entered the modeled expected losses as a soil stabilization mitigation action for "Other" property structure types. Losses for the various hazards, infrastructure, and private property are aggregated in the DFA to determine the overall project benefit-cost ratio (BCR).

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[3] Estimated by applying the percentage of housing in the service area to the block group population, 2,631 people.
[4] Default values set forth in the FEMA BCA Toolkit Version 6.0.
[5] Estimated by multiplying the service area population by the value of unit of service.

3.2 Loss of Wastewater Services due to Heavy Urban Rainfall and Erosion

An 8" clay gravity sewer line crosses the stream bed in the project area. Figure 2 demonstrates that the sewer line is fully exposed in the channel and vulnerable to complete failure if impacted by floating debris or the downstream movement of large stones along the streambed. Numerous stormwater pipes also discharge to the channel, and an upward trend in the number of heavy rainfall events (days with more than 3 inches of rain) observed by the North Carolina Climate Science Report indicates that higher flow within the stream is a likely future condition that could cause damage to the sewer line. According to NOAA's Precipitation Point Frequency Estimates for Greenville, a heavy rainfall event with approximately 3 inches of rain correlates to a 1 to 5-year precipitation event, depending on the duration. Appendix D contains the Greenville, North Carolina NOAA PDS-based point precipitation frequency estimates with 90-percent confidence intervals.

Figure 2. Exposed Sewer Asbestos Cement Pipe Crossing

The City's Greens Mill Run Watershed Master Plan conducted stream stability assessments for all named and unnamed streams in the watershed. Part of the stability assessment established bankfull channel dimensions (width, mean depth, maximum depth, cross-sectional area, width-to-depth ratio, and entrenchment ratio) after determining the bankfull elevation for each stream. The bankfull elevation is defined as that associated with channel-forming discharge that is typically between the 1- and 2-year storm events. According to the NOAA point precipitation frequency estimates, a 2-year precipitation event in Greenville could produce between 3.14 and 3.76 inches of rain in a 12 and 24-hour period, respectively.

Because the bankfull elevation is that which shapes the channel, BCA analysts assume that the 2-year precipitation event produces enough rain to carry debris and cause further erosion of the stream, both of which would likely damage the exposed sewer line. Furthermore, use of the 2-year return period corresponds with local definitions of a heavy rainfall event. Table 3 provides functional downtime estimates for the 2-year return period based on expert judgement and typical emergency repair and restoration sequences for such infrastructure.

Table 3. Precipitation Return Periods and Wastewater Service Functional Downtime Assumptions

Rainfall Amount	Return Period	Pipeline Damage Expected	Functional Downtime Estimates
3.14 – 3.76 inches	2-year	Pipelines are washed out and/or ruptured by stream debris carried by higher velocity flows.	Total of 48 hours: • Day 1: Identify loss of service. 24-36 hours for flow to recede until sewer line failure can be identified and accessed by utility staff. • Day 2: Begin temporary bypass operations. Utility staff will stabilize access to the broken pipe location and establish a temporary repair.

3.3 Loss of Electric Power Services due to Erosion

The primary threat facing infrastructure and properties in the project area is erosion of the unnamed stream banks due to heavy rain events and significant increase in creek discharges and flow volume. Over the last several years, erosion has occurred at an exponentially higher rate due to increased severity of storms in the region and increased rainfall frequencies. Due to the composition of soils in the area, vertical erosion has reached its peak and lateral erosion is now the primary concern along the creek.

Site evaluations based on the city's Channel Evolution Model highlight that many areas of the project stream are highly unstable, display lateral bank erosion and mass wasting, and will increasingly widen over time because the channel bed has stabilized at its lowest elevation. Going forward, engineering experts estimate the lateral erosion rate will be 1 – 1.2 feet per year. By virtue of predictable natural channel evolution, the channel's configuration will progress to a wide and sinuous channel with more extreme bank erosion and soil wasting. Appendix E contains a preliminary engineering report from KCI Engineering with these findings and future conditions analysis.

There are two electric transformer boxes that are within inches of the top of actively eroding banks (Figure 3 and Figure 4), and bank erosion has exposed a buried electric service line steel casing (Figure 5, foreground). The transformer boxes and electric service line are vulnerable to failure under erosion conditions; boxes are at risk of falling in the stream if the foundation is undermined by eroding soil. Furthermore, continued and increasing exposure of the electric service line may cause the line to break. These actions threaten electric power service for the expected service population in Table 2 above.

Figure 3. Transformer box near eroded streambank

Figure 4. Second transformer box near eroded streambank

Figure 5. Exposed Steel-Cased Electric Service Line

BCAs for erosion mitigation projects associate a likelihood of occurrence (or return period) with the time at which damage occurs based on the erosion rate. Based on a 1.1-foot average annual rate of streambed erosion the proximity of the transformer boxes to the streambed, and severe exposure of electric service lines, analysts estimate that the electrical equipment could fail in the next year if left unprotected. Table 4 presents the assumptions for expected catastrophic failure estimates.

Table 4. Electric Power Failure Due to Erosion

Rate of Erosion	Distance from Stream Bank	Expected Failure Timeline
1.1 feet (13.2 inches)	12 inches	0.9 Years (rounded up to 1 year)

If one or all of these assets were to fail, analysts assume at least two days of power service disruption for the utility company to dispatch workers, inspect the site, and replace the transformer boxes. This is a conservative estimate of functional disruption time, as transformer box equipment and other supplies may not be readily available if full replacement is needed. Additionally, this does not account for damage experienced by the exposed electric service line, which would extend the repair time and restoration of power service if it were to occur.

3.4 Private Property Losses due to Erosion

Ten private properties located along the stream are vulnerable to foundation failure and catastrophic loss due to bank erosion. Private property losses are calculated based on the likelihood that structures will experience catastrophic failure, or full loss, if no actions are taken to mitigate or slow a 1.1-foot annual erosion rate.

Full loss is quantified through the replacement cost of buildings and their contents. As shown in Table 5, the replacement cost for each structure is calculated using the square footage of each building and multiplied by the FEMA standard value for building replacement costs, $100 per square foot. The content value is also calculated using FEMA standard values and defaults from the BCA Toolkit Version 6.0.

Distance from the stream was measured using the ESRI ArcGIS measuring tool. Documentation for measurements is provided in Appendix F.

Table 5. Vulnerable Private Property and Number of Years Until Erosion Causes Full Loss

Structure Address	Structure Type	Square Footage[6]	Building Replacement Cost[7]	Content Value[8]	Distance from Stream (in ft)	Years Until Erosion Causes Full Loss
1530 Bridle Court	Apartments	7,820	$782,000	$782,000	6	5
319 St. Andrews Drive	Multi-Family Townhome	1,662	$166,200	$166,200	13	12
319 St. Andrews Drive	Multi-Family Townhome	1,278	$127,800	$127,800	13	12
319 St. Andrews Drive	Multi-Family Townhome	1,662	$166,200	$166,200	13	12
319 St. Andrews Drive	Multi-Family Townhome	1,278	$127,800	$127,800	13	12

[6] As reported by the Pitt County Property Appraiser
[7] Valued at $100 per square foot, per FEMA Toolkit 6.0 Default Values
[8] Valued at 100% of the building replacement cost with the exception of 1530 Hooker Road, which used a 47% content value based on the FEMA Toolkit Default for Light Industrial buildings.

Structure Address	Structure Type	Square Footage[6]	Building Replacement Cost[7]	Content Value[8]	Distance from Stream (in ft)	Years Until Erosion Causes Full Loss
319 St. Andrews Drive	Multi-Family Townhome	1,662	$166,200	$166,200	13	12
305 Bridle Court	Multi-Family Townhome	6,528	$652,800	$652,800	16	15
1548 Bridle Court	Apartments	3,910	$391,000	$391,000	17	15
1530 Hooker Road	Commercial Warehouse	12,656	$1,265,600	$594,832	21	19
1574 Bridle Court	Apartments	7,820	$782,000	$782,000	24	22

Displacement costs are also quantified as expected losses incurred by private property owners due to stream erosion. Analysts made the conservative assumption that residents would require a minimum of 1 month to permanently relocate if streambank erosion were to cause catastrophic failure of their home, during which those residents would require alternative lodging. In accordance with the FEMA BCA Toolkit, analysts quantified displacement using the average per diem cost for lodging and food in North Carolina: $155/day. Appendix G contains documentation for the per diem rates used.

The number of residents was estimated using the number of expected units at each residential property and multiplying by the average persons per household from Census Quickfacts: 2.32. Table 6 contains displacement figures used for inputs to the BCA Toolkit

Table 6. Displacement Costs

Structure Address	Structure Type	Number of Units	Number of Residents	Displacement Costs
1530 Bridle Court	Apartments	16	37.12	$172,608
319 St. Andrews Drive	Multi-Family Townhome	1	2.32	$10,788
319 St. Andrews Drive	Multi-Family Townhome	1	2.32	$10,788
319 St. Andrews Drive	Multi-Family Townhome	1	2.32	$10,788
319 St. Andrews Drive	Multi-Family Townhome	1	2.32	$10,788
319 St. Andrews Drive	Multi-Family Townhome	1	2.32	$10,788
305 Bridle Court	Multi-Family Townhome	14	32.48	$151,032
1548 Bridle Court	Apartments	8	18.56	$86,304
1530 Hooker Road	Commercial Warehouse	0	0	$0
1574 Bridle Court	Apartments	16	37.12	$172,608

4. Pre-Mitigation Loss Estimates

Analysts entered the expected pre-mitigation loss estimates into a single mitigation activity using the DFA module. Analysts made the following key assumptions for inputs:

- Wastewater and electric power services will continue to be impacted by precipitation and erosion of the streambed and banks if left unmitigated, even though both systems are at risk of imminent failure. As precipitation and erosion continues to occur, system components and pipelines will become more exposed and likely cause further loss than estimated in this analysis from both a duration and a consequence perspective. Therefore, the pre-mitigation expected losses for wastewater and electric power services beyond the 1 and 2-year return periods, respectively, are considered conservative (low) estimates of loss.
- Private property losses associated with erosion will incrementally accrue over time if left unmitigated; once a structure incurs catastrophic failure, or full loss, it cannot be lost again. Therefore, the private property losses for each return period represent the full loss expected for that return period only. This approach avoids unintended double-counting in the DFA module.

Table 7 represents the inputs for the BCA Toolkit.

Table 7. Pre-Mitigation Loss Estimates for St. Andrews Drive Project

Return Period	Loss of Wastewater Services	Loss of Electric Power Services	Private Property Losses			Total
			Building Damage	Contents Losses	Displacement Costs	
1	$0	$99,180	$0	$0	$0	$99,180
2	$117,624	$99,180	$0	$0	$0	$216,804
5	$117,624	$99,180	$782,000	$782,000	$172,608	$1,953,412
12	$117,624	$99,180	$754,200	$754,200	$53,940	$1,779,144
15	$117,624	$99,180	$1,043,800	$1,043,800	$237,336	$2,541,740
19	$117,624	$99,180	$1,265,600	$594,832	$0	$2,077,236
22	$117,624	$99,180	$782,000	$782,000	$172,608	$1,953,412

5. Post-Mitigation Loss Estimates and Project Level of Protection

After mitigation, the private properties and municipal utilities will be protected via streambank stabilization measures from current and future erosion, as the proposed project would also bury exposed utility lines. To ensure a conservative analysis, analysts assumed that the stabilization measures will remain effective through the end of the project's 30-year useful life. After a 30-year period, it is assumed that erosion would resume at the established 1.1-foot annual rate. This assumption is aligned with guidance in the *Unit 7 BCA Training* referenced above. Table 8 presents the post-mitigation losses input into the BCA Toolkit.

Table 8. Post-Mitigation Loss Estimates for St. Andrews Drive Project

Return Period	Loss of Wastewater Services	Loss of Electric Power Services	Private Property Losses			Total
			Building Damage	Contents Losses	Displacement Costs	
31	$0	$99,180	$0	$0	$0	$99,180
32	$117,624	$99,180	$0	$0	$0	$216,804

Return Period	Loss of Wastewater Services	Loss of Electric Power Services	Private Property Losses			Total
			Building Damage	Contents Losses	Displacement Costs	
35	$117,624	$99,180	$782,000	$782,000	$172,608	$1,953,412
42	$117,624	$99,180	$754,200	$754,200	$53,940	$1,779,144
45	$117,624	$99,180	$1,043,800	$1,043,800	$237,336	$2,541,740
49	$117,624	$99,180	$1,265,600	$594,832	$0	$2,077,236
52	$117,624	$99,180	$782,000	$782,000	$172,608	$1,953,412

6. Analysis Results

The benefit-cost ratio for the project is listed in Table 9 below. Costs provided in the determination of the BCR include maintenance costs over the project useful life of the mitigation project. The total project BCR is 1.60 which demonstrates that the mitigation project is a cost-effective solution. The BCA Report is provided in Appendix A and the BCA Excel Spreadsheet is attached to the project application.

Table 9. St. Andrews Drive- Critical Infrastructure Protection and Stream Restoration Project Benefit-Cost Ratio

Description	Benefits	Costs	BCR
St. Andrews Drive- Critical Infrastructure Protection and Stream Restoration	$7,429,765	$4,636,908	1.60

7. Benefits to Disadvantaged Populations

The benefitting area of the St. Andrew's Drive – Critical Infrastructure Protection and Stream Restoration Project is defined by the sewer utility service area affected by stream erosion. According to American Community Survey 5-year Estimates for 2019, the benefitting area's residential population is 48 percent minority populations, with 45 percent of all residents qualifying as low- and moderate-income individuals. These estimates are much higher when compared to the United States' socioeconomic makeup: 37 percent minority.

Mitigating erosion from the streambanks will provide substantial economic and social benefits to residents. In addition to mitigating physical damages and community displacement, thereby saving residents money and keeping the community whole, the project will also address life safety concerns. The social vulnerability characteristics presented in the project's benefitting area demonstrate that the project directly aligns with Executive Order 14008 and the Justice40 Initiative. The Justice40 Initiative is a whole-of-government effort to deliver at least 40 percent of the overall benefits from Federal investments in climate and clean energy to disadvantaged communities. According to the Center for Disease Control and Prevention Social Vulnerability Index (CDC SVI), **approximately 47% of the project's benefitting area meet one of 15 social vulnerability factors, which amounts to $3,491,990 of the total project benefits.**

Appendix A BCA Toolkit Report

FEMA Benefit-Cost Calculator

V.6.0 (Build 20211021.0641)

Benefit-Cost Analysis

Project Name: St. Andrews Drive – Critical Infrastructure Protection and Stream Restoration Project [Copied on 11/22/2021 @ 12:43:30] [Copied on 11/22/2021 @ 22:10:0]

Map Marker ▲	Mitigation Title	Property Type	Hazard	Benefits (B)	Costs (C)	BCR (B/C)
1	Soil Stabilization @ Greenville, North Carolina	•••	DFA - Landslide	$ 7,429,765	$ 4,636,908	1.60
TOTAL (SELECTED)				**$ 7,429,765**	**$ 4,636,908**	**1.60**
TOTAL				**$ 7,429,765**	**$ 4,636,908**	**1.60**

Property Configuration

Property Title:	Soil Stabilization @ Greenville, North Carolina
Property Location:	27834, Pitt, North Carolina
Property Coordinates:	35.61215, -77.38076
Hazard Type:	Landslide
Mitigation Action Type:	Soil Stabilization
Property Type:	Other
Analysis Method Type:	Historical Damages

Cost Estimation

Soil Stabilization @ Greenville, North Carolina

Project Useful Life (years):	30
Project Cost:	$4,593,476
Number of Maintenance Years:	30 Use Default:Yes
Annual Maintenance Cost:	$3,500

Damage Analysis Parameters - Damage Frequency Assessment

Soil Stabilization @ Greenville, North Carolina

Year of Analysis Conducted:	2021
Year Property was Built:	1977
Analysis Duration:	45 Use Default:Yes

Professional Expected Damages Before Mitigation

Soil Stabilization @ Greenville, North Carolina

Found 2 error(s):

- Damage Years are required.
- Damage Years should be less than the Analysis Year and should be greater than the Year Built.

	OTHER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Damages ($)	Contents	Displacement	Loss of Wastewater and Electric Power Service	Number of Volunteers	Number of Days	Damages ($)
1	0	0	0	99,180	0	0	99,180
2	0	0	0	216,804	0	0	216,804
5	782,000	782,000	172,608	216,804	0	0	1,953,412
12	754,200	754,200	53,940	216,804	0	0	1,779,144
15	1,043,800	1,043,800	237,336	216,804	0	0	2,541,740
19	1,265,600	594,832	0	216,804	0	0	2,077,236
22	782,000	782,000	172,608	216,804	0	0	1,953,412

Annualized Damages Before Mitigation

Soil Stabilization @ Greenville, North Carolina

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
1	99,180	73,319
2	216,804	195,232
5	1,953,412	217,495
12	1,779,144	35,442
15	2,541,740	32,250
19	2,077,236	14,457
22	1,953,412	88,791
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	10,620,928	656,986

Professional Expected Damages After Mitigation

Soil Stabilization @ Greenville, North Carolina

	OTHER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Damages ($)	Contents	Displacement	Loss of Wastewater and Electric Power Service	Number of Volunteers	Number of Days	Damages ($)
31	0	0	0	99,180	0	0	99,180
32	0	0	0	216,804	0	0	216,804
35	782,000	782,000	172,608	216,804	0	0	1,953,412
42	754,200	754,200	53,940	216,804	0	0	1,779,144
45	1,043,800	1,043,800	237,336	216,804	0	0	2,541,740
49	1,265,600	594,832	0	216,804	0	0	2,077,236
52	782,000	782,000	172,608	216,804	0	0	1,953,412

Annualized Damages After Mitigation

Soil Stabilization @ Greenville, North Carolina

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
31	99,180	148
32	216,804	1,743
35	1,953,412	8,877
42	1,779,144	3,375
45	2,541,740	4,168
49	2,077,236	2,372
52	1,953,412	37,565
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	10,620,928	58,248

Standard Benefits - Ecosystem Services
Soil Stabilization @ Greenville, 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
Soil Stabilization @ Greenville, North Carolina

Total Standard Mitigation Benefits:	$7,429,765
Total Social Benefits:	$0
Total Mitigation Project Benefits:	$7,429,765
Total Mitigation Project Cost:	$4,636,908
Benefit Cost Ratio - Standard:	1.60
Benefit Cost Ratio - Standard + Social:	1.60

Appendix B Project Useful Life Documentation

Supplemental Guidance For Conducting a Benefit-Cost Analysis (BCA) for a Floodplain and Stream Restoration Project

1. Purpose

According to the FY2016 Pre-Disaster Mitigation (PDM) program Notice of Funding Opportunity (NOFO), Climate Resilient Mitigation Activities are eligible for PDM funding. The NOFO lists the Floodplain and Stream Restoration (FSR) project type as one of these eligible project types. Because the benefits that could be applicable to an FSR project have not yet been incorporated into the BCA Tool, this document was developed to assist users of FEMA's BCA Tool in performing a benefit cost analysis for an FSR project. The process for conducting a BCA may involve inputting data in existing data fields in the BCA Tool, using a FEMA-created spreadsheet, and/or calculating losses manually and then entering them into new loss category fields in the BCA Tool.

2. Floodplain and Stream Restoration Project Type

An FSR project is used primarily to reduce flood risk and erosion by providing stable reaches, but it also can be used to help mitigate drought. FSR projects typically encompass the restoration of the stream's active channel and streambanks, as well as the adjacent floodplain and riparian zones by deflecting, redirecting, or retarding flows. They restore the soil, hydrology and vegetation conditions in the project area and mimic the pre-development, or pre-alteration, natural channel/floodplain connectivity. FSR projects result in providing baseflow recharge, water supply augmentation, floodwater storage, water quality renovation, terrestrial and aquatic wildlife habitat, and recreation opportunities.

3. BCA Tool Modules Used to Conduct a BCA

The first step in completing a cost effectiveness analysis for an FSR project is to determine the type of damages and losses that would be mitigated by the proposed project. Then determine which module of the BCA Tool should be used to conduct the BCA.

- Use the **Flood Module** if all of the following conditions are met:
  - The proposed project will lower flood levels to existing, floodprone structures.
  - Structure-specific data are available, such as the square footage and first floor elevation for each structure.
  - A detailed study of the effectiveness of the proposed project has been completed, such as a hydrology and hydraulics ("H&H") study. Such a study will identify how much the proposed project would reduce the flood depths for each structure.

- Use the **Damage Frequency Assessment (DFA) Module** if the proposed project would result in mitigating any of the following categories of losses:

- Loss of function of public infrastructure (i.e., roads and bridges)
- Loss of function of utilities
- Loss of function of critical facilities, i.e., police stations, hospitals, or fire stations
- Agricultural and crop losses

It is possible to use **both** modules to analyze one project. The Flood Module would be used to assess the avoided damages to structures, and the DFA Module would be used to assess the avoided losses to public infrastructure, utilities, critical facilities, or crops.

Section 4 describes common data that will need to be inputted no matter which BCA Tool Module is used. Section 5 provides guidance on entering data used in the Flood Module, and Section 6 provides guidance on entering data used in the DFA Module.

4. Common Data Inputs

The following BCA Tool data are required to be entered no matter whether the Flood Module, DFA Module, or both modules are used to conduct an analysis:

- **Project Useful Life**: The FEMA standard value for the project useful life of an FDS project is 30 years. If a user enters a different value, supporting documentation from an expert should be provided.
- **Mitigation Project Cost**: The project cost estimate must be developed by a licensed professional and must meet the same programmatic requirements as for any hazard mitigation project. For more information about the requirements developing a cost estimate, refer to Section H.4.3 (p. 64) of FEMA's FY15 *Hazard Mitigation Assistance Guidance*.
- **Annual Project Maintenance Cost**: Annual operation and maintenance costs generally range from 0.5% to 1% of the construction costs and can include labor costs (for system operation and maintenance, regulatory requirements, and administration) and material and equipment costs (e.g., fencing, trails, equipment, parts replacement, inlet/outlet controls, and scour protection). Like the project costs, these estimates must be developed and documented by a licensed professional.

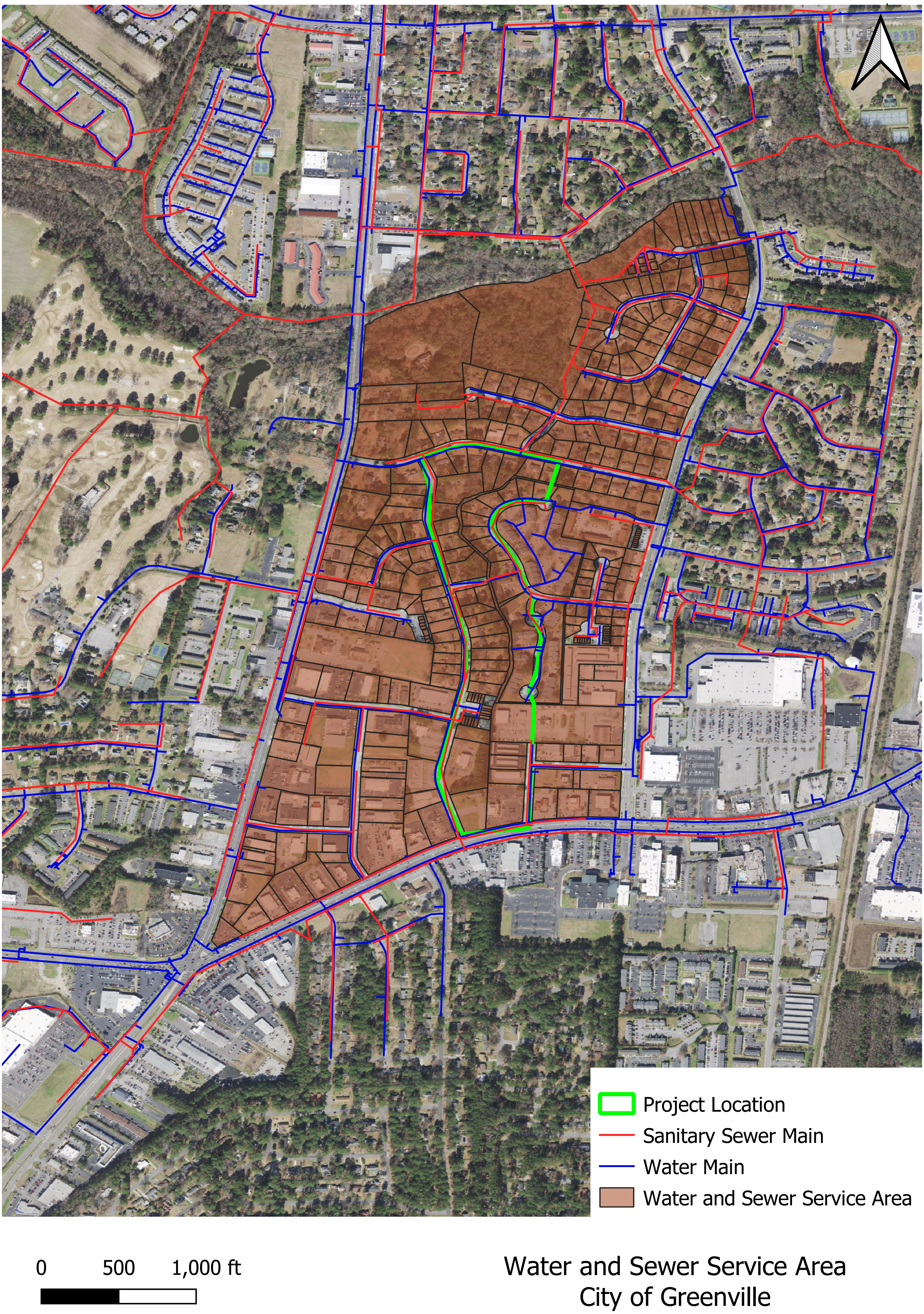
5. Flood Module Data Inputs

The data required to be entered when using the Flood Module to conduct a BCA are associated with elevations and discharges before and after mitigation and data needed to calculate environmental/ecosystem benefits.

5.1 Elevations and Discharges After Mitigation

On the Riverine Elevation and Discharge Data screen, first select the "Show After Mitigation" button to change the data entry table. In the table associated with each structure (see screen capture below), enter the flood elevations after mitigation and the discharges after mitigation for each recurrence interval.

Appendix C Utility Service Area Maps



Water and Sewer Service Area
City of Greenville
Greenville, North Carolina

Electric Service Area
City of Greenville
Greenville, North Carolina

Appendix D NOAA Point Precipitation Frequency Estimates

NOAA Atlas 14, Volume 2, Version 3 GREENVILLE 2
Station ID: 31-3638
Location name: Greenville, North Carolina, USA*
Latitude: 35.6333°, Longitude: -77.4°
Elevation:
Elevation (station metadata): 32 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.440 (0.402-0.481)	0.515 (0.470-0.564)	0.593 (0.540-0.647)	0.670 (0.608-0.731)	0.755 (0.682-0.824)	0.826 (0.743-0.900)	0.893 (0.798-0.971)	0.959 (0.851-1.04)	1.04 (0.918-1.14)	1.12 (0.974-1.22)
10-min	0.703 (0.642-0.768)	0.824 (0.752-0.901)	0.950 (0.865-1.04)	1.07 (0.972-1.17)	1.20 (1.09-1.31)	1.32 (1.18-1.43)	1.42 (1.27-1.54)	1.52 (1.35-1.66)	1.65 (1.45-1.80)	1.76 (1.53-1.92)
15-min	0.879 (0.803-0.961)	1.04 (0.946-1.13)	1.20 (1.09-1.31)	1.36 (1.23-1.48)	1.53 (1.38-1.67)	1.67 (1.50-1.82)	1.79 (1.60-1.95)	1.92 (1.70-2.09)	2.07 (1.83-2.26)	2.20 (1.93-2.40)
30-min	1.21 (1.10-1.32)	1.43 (1.31-1.57)	1.71 (1.56-1.86)	1.96 (1.78-2.14)	2.26 (2.04-2.47)	2.51 (2.26-2.73)	2.75 (2.46-2.99)	2.99 (2.65-3.25)	3.30 (2.91-3.60)	3.57 (3.12-3.89)
60-min	1.50 (1.37-1.64)	1.80 (1.64-1.96)	2.19 (1.99-2.39)	2.56 (2.32-2.79)	3.01 (2.72-3.28)	3.40 (3.06-3.71)	3.78 (3.38-4.11)	4.19 (3.72-4.56)	4.74 (4.17-5.16)	5.21 (4.55-5.68)
2-hr	1.76 (1.60-1.94)	2.12 (1.93-2.32)	2.64 (2.39-2.88)	3.14 (2.84-3.43)	3.79 (3.41-4.12)	4.37 (3.91-4.75)	4.95 (4.41-5.39)	5.59 (4.94-6.08)	6.48 (5.69-7.05)	7.26 (6.32-7.92)
3-hr	1.88 (1.71-2.08)	2.25 (2.04-2.50)	2.82 (2.55-3.12)	3.38 (3.05-3.73)	4.12 (3.70-4.54)	4.80 (4.28-5.28)	5.51 (4.89-6.05)	6.29 (5.53-6.90)	7.40 (6.44-8.13)	8.41 (7.24-9.25)
6-hr	2.24 (2.04-2.48)	2.69 (2.45-2.98)	3.36 (3.05-3.71)	4.04 (3.65-4.45)	4.94 (4.45-5.44)	5.77 (5.16-6.34)	6.65 (5.90-7.30)	7.62 (6.70-8.34)	9.00 (7.81-9.86)	10.3 (8.80-11.3)
12-hr	2.62 (2.38-2.89)	3.14 (2.86-3.47)	3.95 (3.58-4.36)	4.78 (4.31-5.27)	5.88 (5.27-6.46)	6.92 (6.15-7.58)	8.02 (7.05-8.78)	9.24 (8.05-10.1)	11.0 (9.45-12.1)	12.7 (10.7-13.9)
24-hr	3.10 (2.87-3.36)	3.76 (3.49-4.09)	4.86 (4.50-5.28)	5.81 (5.36-6.31)	7.23 (6.62-7.85)	8.47 (7.67-9.21)	9.84 (8.82-10.7)	11.4 (10.1-12.4)	13.7 (11.9-15.1)	15.7 (13.4-17.4)
2-day	3.58 (3.32-3.90)	4.34 (4.03-4.73)	5.57 (5.16-6.06)	6.63 (6.12-7.21)	8.24 (7.52-8.94)	9.64 (8.72-10.5)	11.2 (10.0-12.2)	13.0 (11.4-14.2)	15.7 (13.5-17.3)	18.0 (15.3-20.0)
3-day	3.82 (3.55-4.14)	4.62 (4.30-5.01)	5.90 (5.47-6.39)	6.98 (6.45-7.56)	8.60 (7.87-9.30)	10.00 (9.06-10.8)	11.5 (10.4-12.6)	13.3 (11.7-14.5)	15.8 (13.7-17.4)	18.0 (15.4-20.1)
4-day	4.05 (3.78-4.38)	4.90 (4.57-5.29)	6.22 (5.78-6.72)	7.33 (6.78-7.92)	8.97 (8.22-9.67)	10.4 (9.40-11.2)	11.9 (10.7-12.9)	13.5 (12.0-14.7)	16.0 (14.0-17.5)	18.1 (15.5-20.2)
7-day	4.77 (4.45-5.14)	5.74 (5.36-6.19)	7.22 (6.73-7.77)	8.45 (7.83-9.09)	10.2 (9.40-11.0)	11.7 (10.7-12.6)	13.3 (12.0-14.4)	15.0 (13.5-16.3)	17.5 (15.5-19.2)	19.6 (17.0-21.6)
10-day	5.44 (5.10-5.83)	6.52 (6.11-6.99)	8.08 (7.55-8.67)	9.37 (8.73-10.1)	11.2 (10.4-12.1)	12.8 (11.7-13.8)	14.5 (13.2-15.6)	16.2 (14.6-17.6)	18.8 (16.7-20.5)	20.9 (18.3-23.0)
20-day	7.37 (6.90-7.89)	8.78 (8.22-9.41)	10.7 (10.00-11.5)	12.3 (11.4-13.1)	14.5 (13.4-15.5)	16.3 (15.0-17.5)	18.2 (16.7-19.6)	20.3 (18.4-21.8)	23.2 (20.7-25.1)	25.5 (22.6-27.8)
30-day	9.15 (8.59-9.73)	10.9 (10.2-11.6)	13.1 (12.3-13.9)	14.8 (13.9-15.8)	17.3 (16.1-18.4)	19.2 (17.8-20.5)	21.2 (19.6-22.7)	23.3 (21.3-25.0)	26.1 (23.7-28.2)	28.4 (25.5-30.7)
45-day	11.4 (10.7-12.1)	13.5 (12.7-14.3)	16.1 (15.1-17.1)	18.2 (17.1-19.3)	21.1 (19.8-22.5)	23.5 (21.9-25.1)	26.0 (24.0-27.8)	28.5 (26.2-30.6)	32.1 (29.1-34.6)	34.9 (31.4-37.8)
60-day	13.7 (13.0-14.5)	16.2 (15.3-17.2)	19.0 (18.0-20.2)	21.3 (20.1-22.6)	24.4 (23.0-25.9)	26.9 (25.2-28.5)	29.3 (27.4-31.2)	31.8 (29.5-33.9)	35.2 (32.3-37.7)	37.7 (34.3-40.6)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.
Please refer to NOAA Atlas 14 document for more information.

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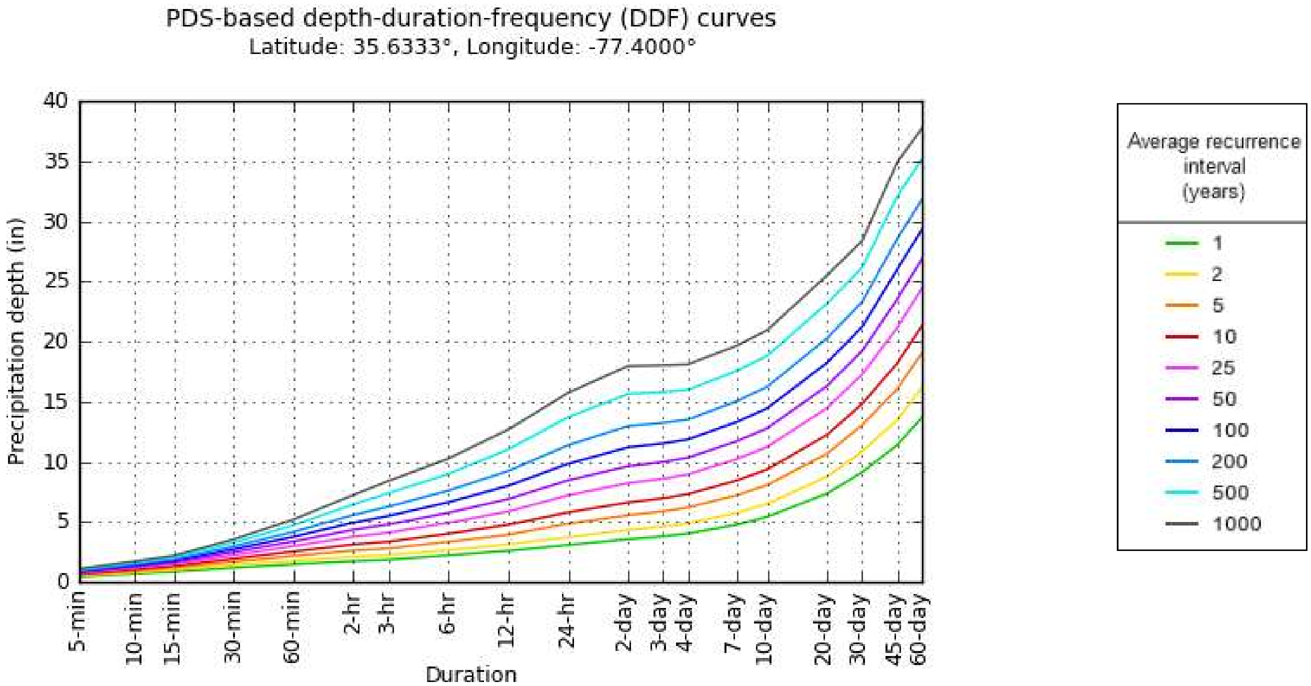
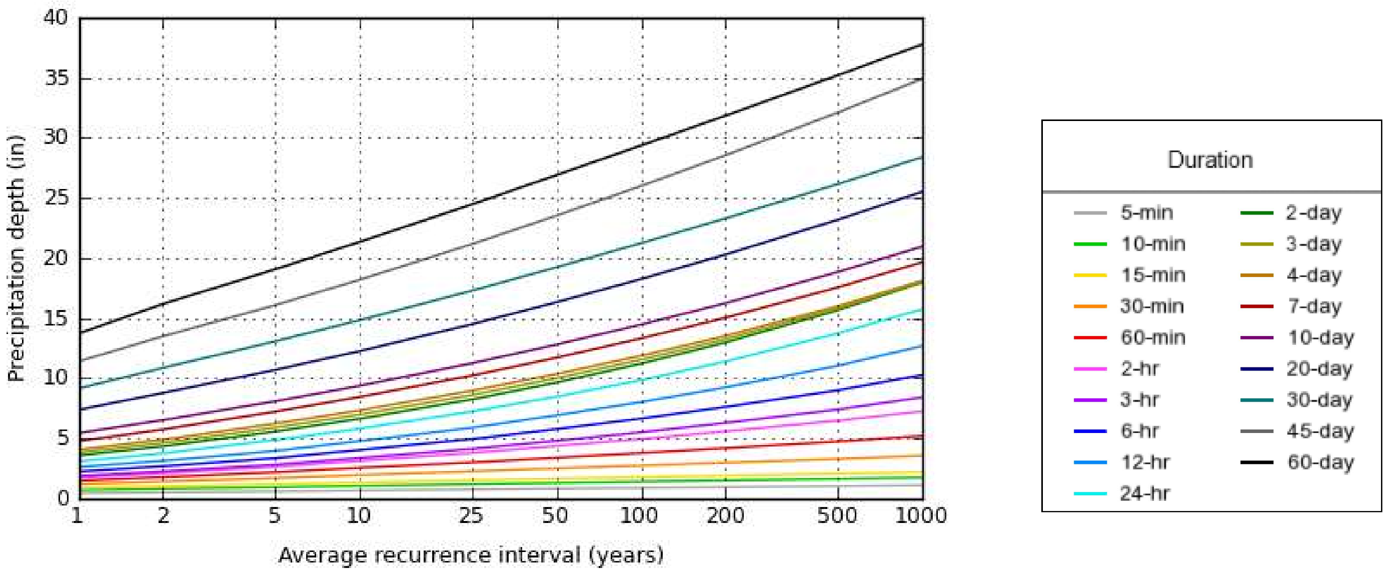
PF graphical





NOAA Atlas 14, Volume 2, Version 3

Created (GMT): Fri Nov 19 00:05:56 2021

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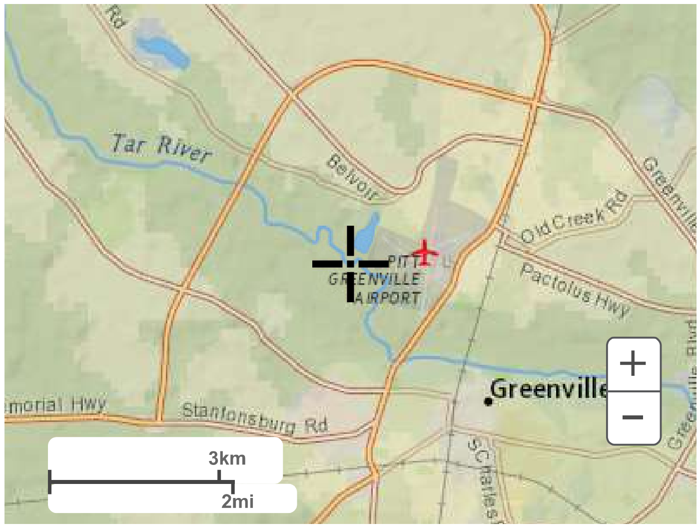
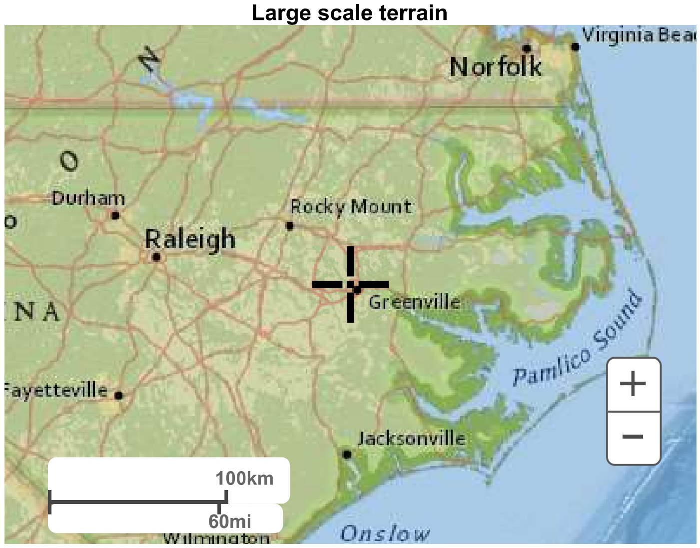
Maps & aerials

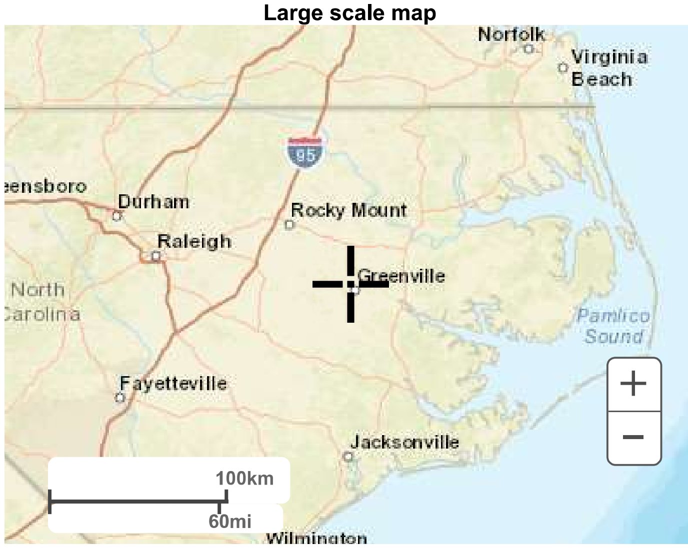
Small scale terrain



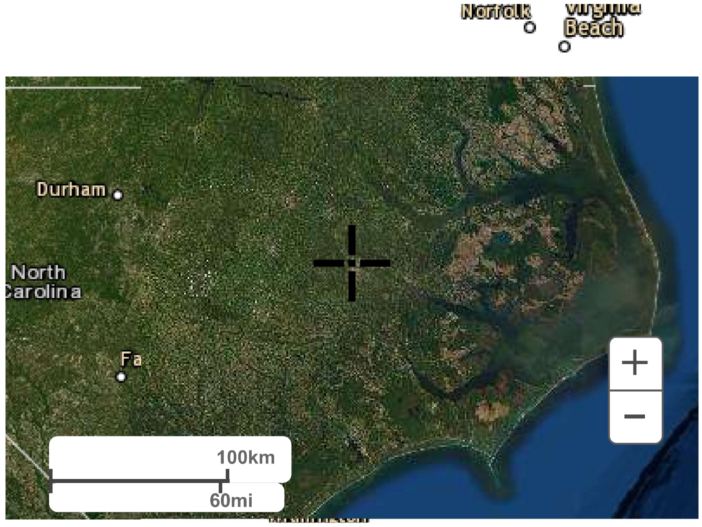
Large scale terrain



Large scale map



Large scale aerial



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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Appendix E Preliminary Engineering Report

St. Andrews Drive Stream Restoration/Stabilization and Utility Protection Project

Scope

This proposed stream restoration/stabilization and utility protection project is located near and parallel to St. Andrews Drive in Greenville, NC within a reach of an unnamed tributary to Greens Mill Run between Southwest Greenville Boulevard and Fairlane Road. The project extends for approximately 3,200 feet along the tributary, the majority of which is degraded. The site's drainage area is approximately 0.19 square miles with 96 percent urban land-use and 41 percent impervious area. Wetlands are not present within the floodplain corridor per the NWI.

The actively eroding channel has cut down into its own streambed (i.e., vertical degradation) which has resulted in overly high stream banks, loss of hydrologic connectivity to the adjoining floodplain, and lateral migration (erosion). The vertical degradation and lateral migration have exposed several elements of municipal infrastructure. If stabilization measures are not immediately installed, numerous gas, electric, sanitary sewer, and stormwater utilities; commercial and residential structures; fences; and, other adjacent features are at risk of being damaged by the predicted bank erosion.

This stream stabilization/restoration project seeks to stabilize the channel by installing bioengineered structures to protect the municipal infrastructure within and adjacent to the stream corridor and, to improve the channel conditions and impart greater resilience at the site. The project proposes to install hard (stone) structures where necessary to protect municipal infrastructure and physical structures; otherwise, nature-based solutions will be installed to create diverse habitats within the aquatic and riparian ecosystems and an aesthetically pleasing stream system. The project also seeks to create areas of accessible floodplain along the riparian corridor to alleviate the erosive forces currently acting within the channel and to create hydraulic storage capacity.

Existing Conditions

Most of the project stream channel is deeply incised with bank heights of approximately 8 feet to 14 feet (Figure 1). The stream is hydraulically disconnected from its floodplain; the absence of rack lines or other evidence of recent flooding on the adjacent floodplain indicates that the stream is unable to access the floodplain. The channel at the upstream and downstream limits of the project is moderately incised, with bank heights of approximately 3 feet to 4 feet. There is a small section in the upstream area where a low bench was graded into the right bank and is vegetated (Figure 2). Although the left bank is nearly vertical at this location, this stream section appears to be stable because of the beneficial right bench. Existing stream bank revetments (stacked concrete sandbags, riprap, etc.) are present at several locations.

Figure 1. Typical channel erosion, 9 feet deep, 14 feet wide.

Figure 2. Graded floodplain bench and 2:1 tie-in grading.

An 8” clay gravity sewer line, an 8” PVC water line and several electric service lines cross the stream bed in the middle section of the project (near alignment station 18+50 on the submitted plans). The sewer line is fully exposed in the channel (Figure 3a) and is vulnerable to complete failure if impacted by floating debris or the downstream movement of large stones along the streambed. Numerous stormwater pipes discharge to the channel (Figure 3b). There are two electric transformer boxes that are close to the top of actively eroding banks and several areas of localized bank scour threaten housing and commercial structures (Figures 4a and 4b). Bank erosion has exposed a buried electric service line steel casing (Figure 5, foreground) and is threatening the structural integrity of a residential building at 313 St. Andrews Drive (Figure 5, background). The top of bank is also close to the Keswick Apartment’s pool deck (Figure 6) and several residential fences and outbuildings (Figure 7). Water and gas line are buried near the culvert under Fairlane Road.

Figures 3a & 3b. Exposed sewer line and SW discharge upstream of sewer line.

Figure 4a & 4b. Two electric transformer boxes near the top of the back.

Figure 5. Exposed electric service casing pipe (foreground) and threatened structure (background).

Figure 6. Threatened pool deck (visible as white surface at right)

Figure 7. Threatened private fence and outbuilding (visible at top left)

The majority of the channel's riparian buffer is vegetated with a mix of herbaceous and woody shrubs and overstory trees. There are numerous locations where bank scour has exposed tree root balls along the channel bank and also caused several trees to fall into or across the channel. The floodplain is maintained (mowed) to the top of the bank within numerous properties.

Major instability issues are associated with the existing channel's incised (overly deep) condition. The water velocity and erosive energy (shear force) within the stream are confined completely within the channel during high volume urban stormwater events that are now statistically more likely. Site evaluations based on the Channel Evolution Model highlight that many sub-reaches of the project stream are highly unstable, display lateral bank erosion and mass wasting, and will increasingly widen over time because the channel bed has stabilized at its lowest elevation. Going forward, the estimated lateral erosion rate is 1.0-1.2 feet per year in locations where the channel has reached a vertically stable bed condition and, by virtue of predictable natural channel evolution, will move toward a widened and sinuous channel with more extreme bank erosion and soil wasting. This prediction and estimation of the proceeding phases and lateral channel erosion rate is based on the model of channel evolution as described by the Federal Interagency Stream Restoration Working Group (FISRWG, 1998), based on the work of Simon (1989).

Concept Design Approach

The design approach set forth herein recommends a combination of floodplain benching, bank regrading, bio-engineered structural enhancements (where most applicable), stone-based structural enhancements (only where necessary), surface stabilization with natural fiber matting for reinforcement, and intensive revegetation with appropriate native riparian plant species. The channel bed elevation will be increased within most of the restoration channel.

Bank stabilization, channel modifications, and grade control structures are proposed to protect building foundations and municipal utilities, prevent future channel downcutting and widening, reduce sediment loading, and reduce tree losses. These objectives are achieved by implementing several design elements:

- Construct low elevation floodplain benches and grade from the floodplain bench to the existing floodplain at a maximum 2H:1V slope.
- Install stone bank toe (of slope) protection or gabion walls where utilities and structures constrain creation of a floodplain bench.
- Increase the channel bed elevation within most of the restoration channel and specifically over the existing utility crossings to restore their intended subsurface condition.
- Install grade controls (e.g., cross vanes, step pools).
- Stabilize graded and disturbed areas with natural fiber material (coir mat) and plantings (live stakes, shrubs, trees and permanent seeding).

Grading to create a low elevation floodplain bench and stabilize the upper banks, similar to the stable upstream section near 403 St. Andrews Drive, is proposed for approximately 4,600 feet of channel (the combined length of the stabilized left and right bank lengths). Implementing floodplain benching will provide additional flow area and mitigate some of the high shear stresses acting on the existing stream bank.

Stone toe protection structures or gabion walls are proposed for approximately 1,100 feet of channel (the combined length of the stabilized left and right bank lengths) to provide protection where existing infrastructure is close to the top of the bank or is buried within the bank parallel to the channel, and insufficient space exists to create a floodplain bench and setback from the top of the bank is needed. These hardened bank structures are proposed specifically near the residential structures located at 313 St. Andrews Drive, 319 St. Andrews Drive, 305 Bridle Circle, 302 Sedgefield Drive, and the commercial structures at 1530 Hooker Road.

There is a clay gravity sewer pipe fully exposed in the channel bed near the end of Sedgefield Drive. A water supply line and electric service lines also cross under the channel bed within 50 linear feet of the exposed sewer crossing. The channel bed will be raised to provide one foot of cover (minimum) over the sewer pipe, water line and electric service lines. Grade control structures will be installed immediately upstream, between and downstream of the utility crossings to protect them. A minimum of ten grade controls are recommended over the length of the proposed restoration to prevent future headcut migration and channel incision within the filled and elevated channel bed, and to connect the channel to the floodplain where possible. When a channel is “connected” to its floodplain, high flow events will have access to the adjacent floodplain, will spread out and have reduced water velocities, which will greatly reduce erosive forces (shear forces) within the channel.

All the channel banks that are graded during the restoration will be covered with natural fiber mat (coir mat) where the bank area doesn’t include a stone protection structure. Similarly, all the graded slopes and disturbed ground not designated to receive turf seeding will receive 4 inches of topsoil and be protected by natural fiber matting. The final planting plan for the stream banks will include live stakes and both temporary (during construction) and permanent (post-construction) seed mixes that are suitable for frequent flooding conditions. The riparian buffer zone disturbed during construction will be replanted with a riparian seed mix and herbaceous and native woody shrubs and trees appropriate for riparian conditions. Existing turf disturbed during construction will be reseeded with a turf seed mix.

References

Federal Interagency Stream Restoration Working Group (FISRWG). 1998. *Stream Corridor Restoration: Principles, Processes and Practices.* Springfield, Va: National Technical Information Service.

Simon, A. 1989. A model of channel response in disturbed alluvial channels. *Earth Surface Processes and Landforms* 14(1):11-26.

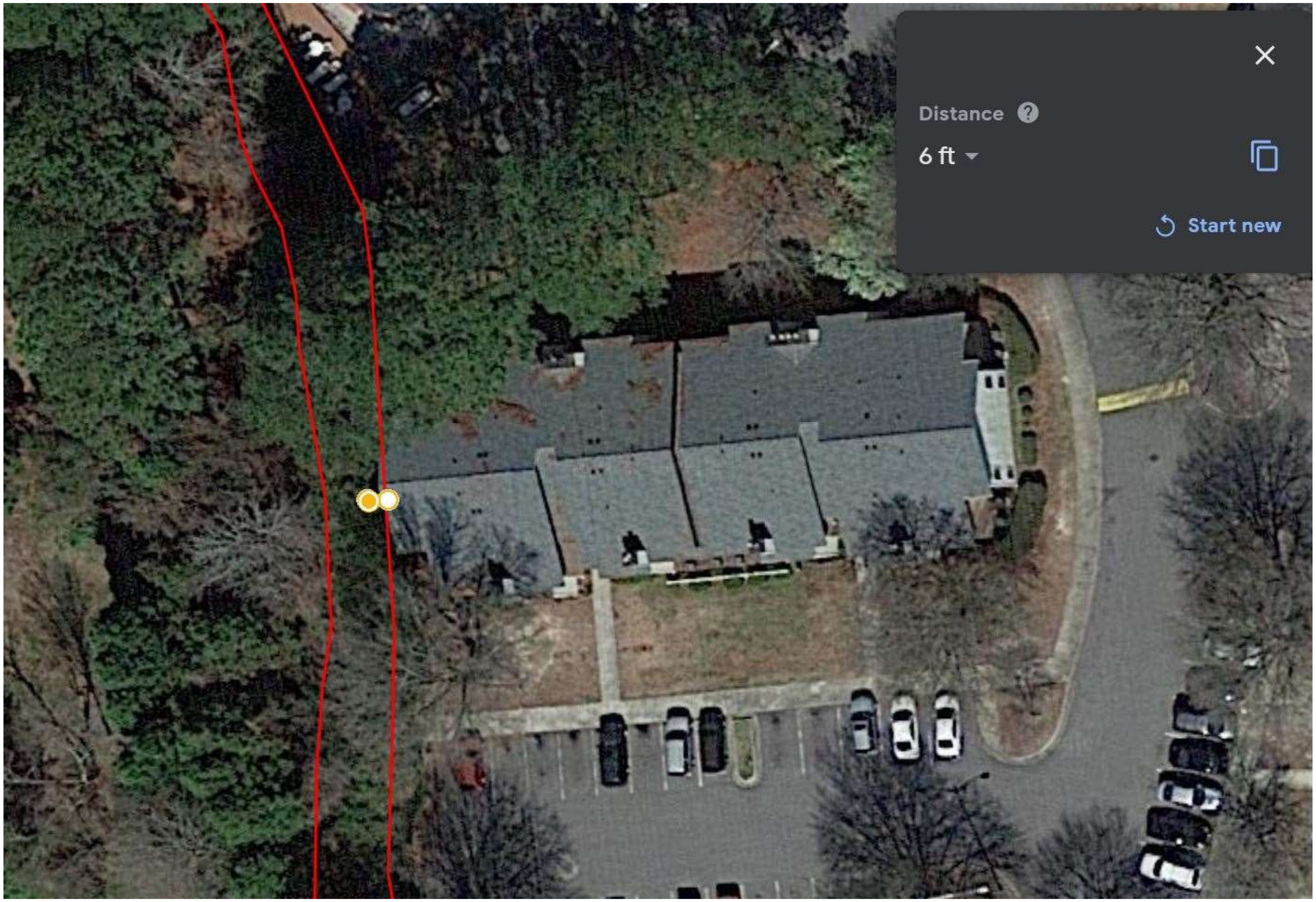
Appendix F Distance to Streambank Measurements

Distance to Streambank Photos

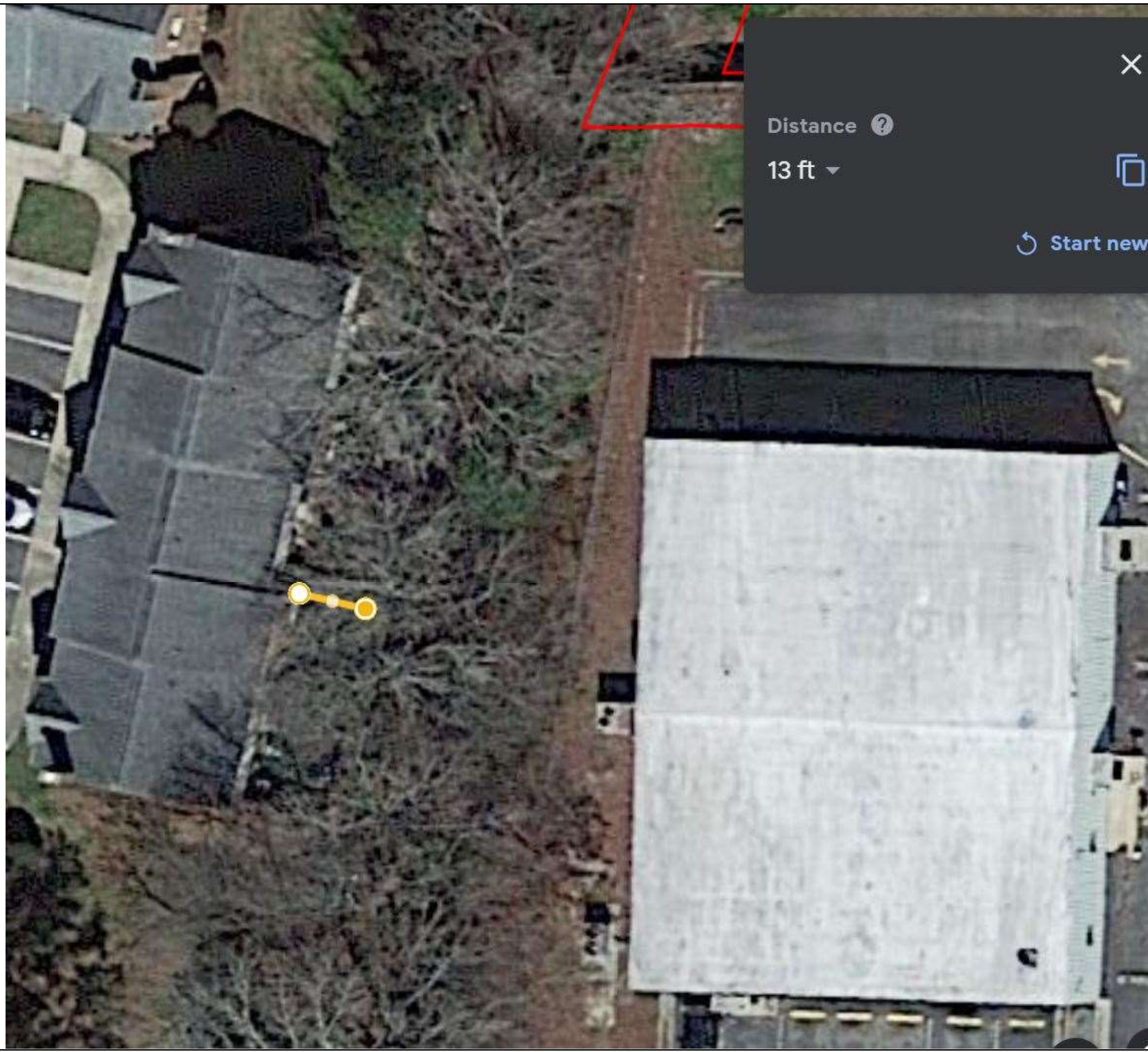
City of Greenville St. Andrews Drive- Critical Infrastructure Protection and Stream Restoration

FY2021 FEMA BRIC Application

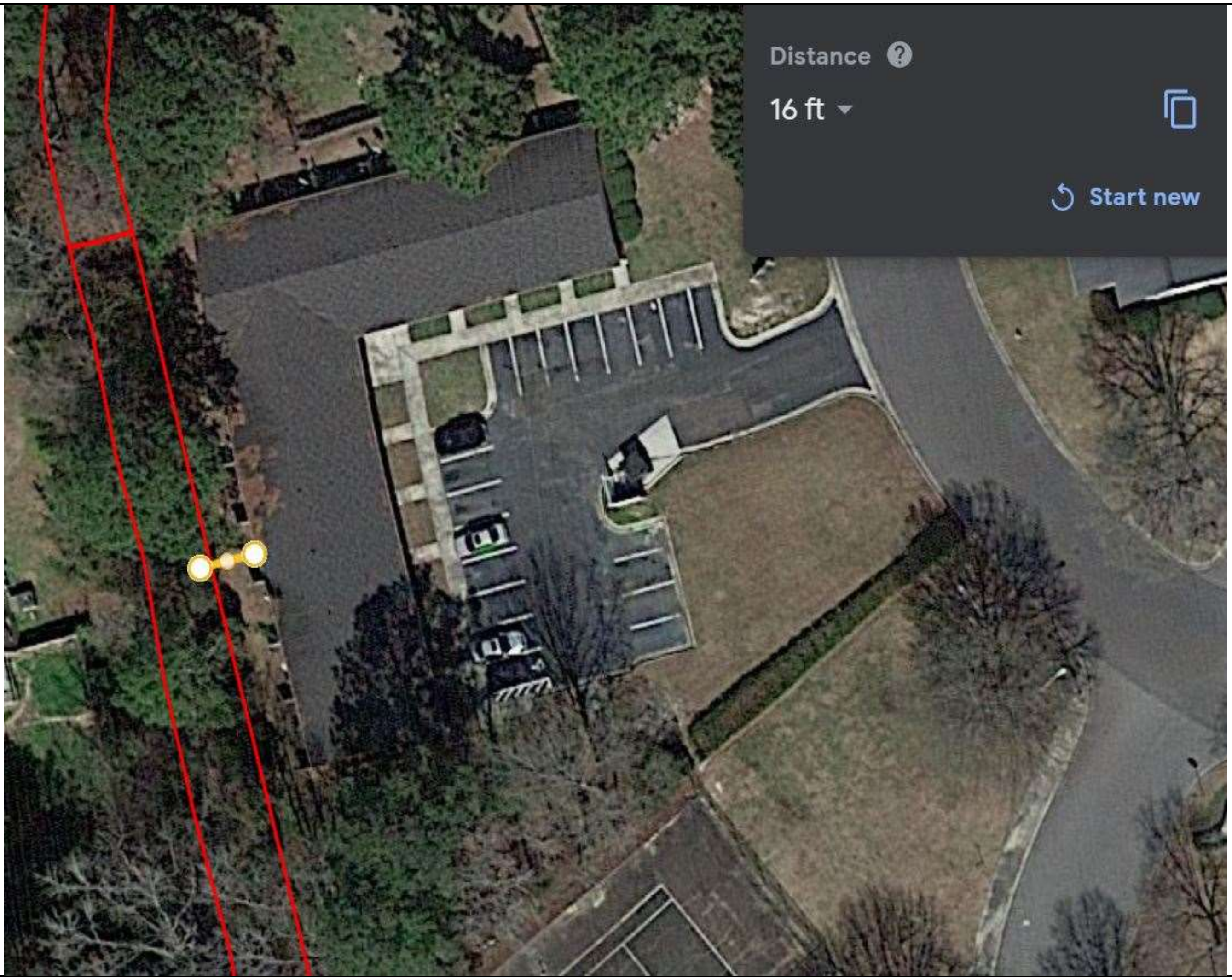
Structures Identified for Benefit-Cost Analysis



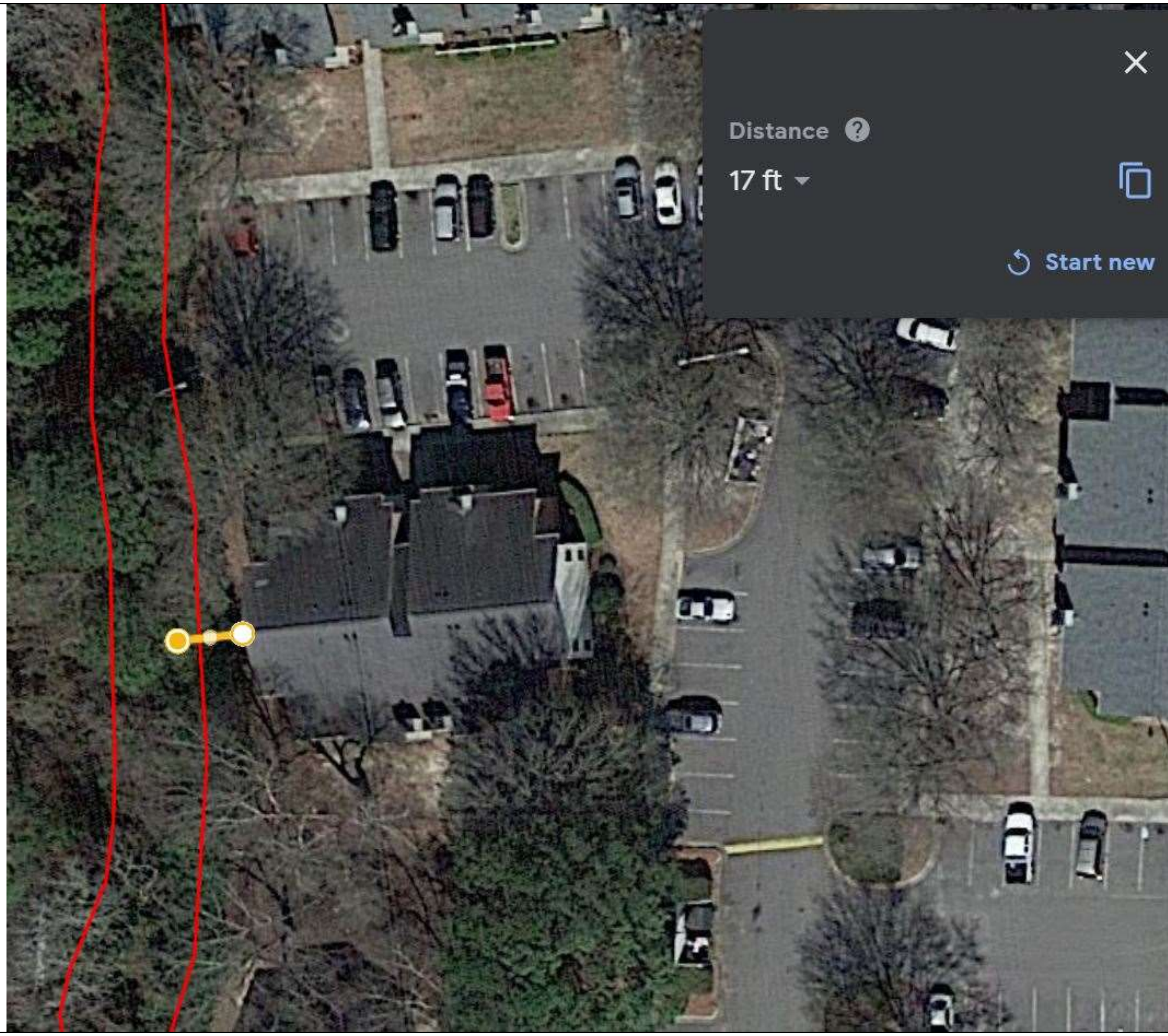
1530 Bridle Court



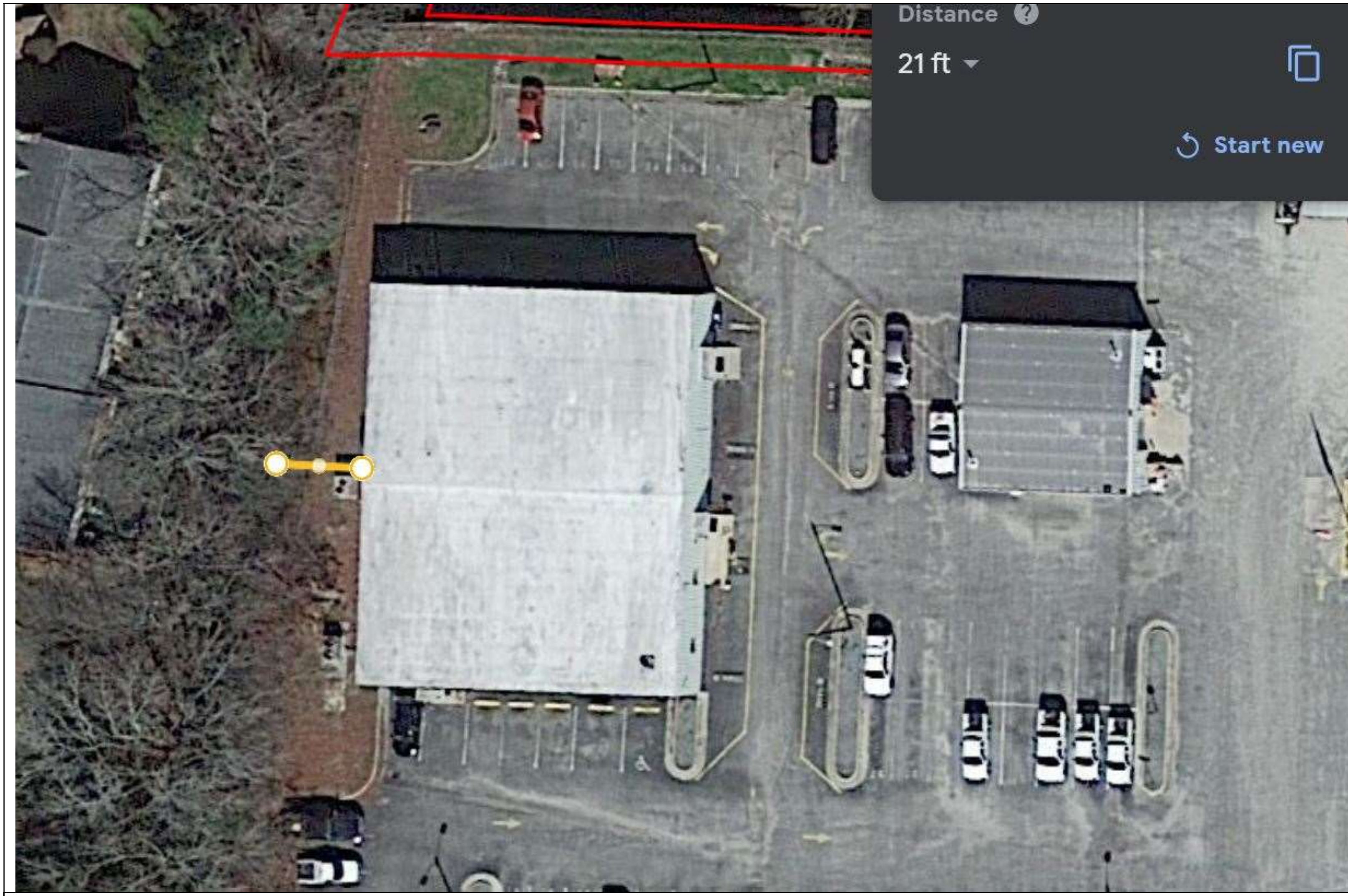
319 St. Andrews Drive Condos



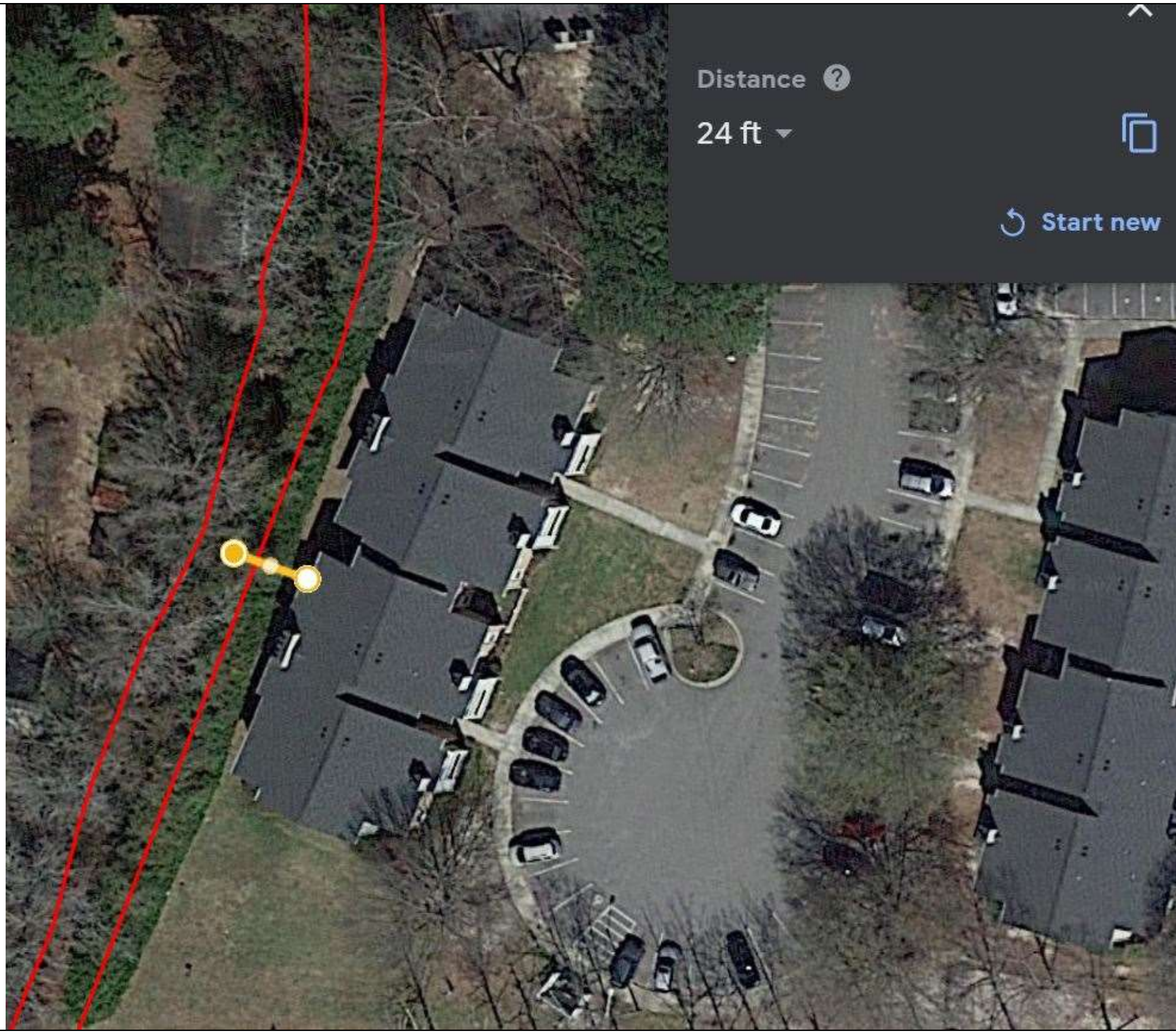
305 Bridle Court



1548 Bridle Court



1530 Hooker Road



1574 Bridle Court

Appendix G Pier Diem Rates

North Carolina Per Diem Rates for FY 2022

There are ten areas in North Carolina for which location-specific per diem rates are specified by the federal government. For travel to areas within North Carolina that do not have specified per diem rates, the general per diem rates are used.

The per diem rates shown here are effective beginning **October 2021**. For a full schedule of per diem rates by month and year for these areas, click on any of the North Carolina destination names below.

General North Carolina Per Diems:

$96.00	$59.00
per night lodging	per day meals

Destination	County	Meal Rate	Lodging Rate
Asheville	Buncombe County	$64.00	$120.00
Atlantic Beach / Morehead City	Carteret County	$64.00	$100.00
Chapel Hill	Orange County	$74.00	$111.00
Charlotte	Mecklenburg County	$69.00	$129.00
Durham	Durham County	$64.00	$115.00
Fayetteville	Cumberland County	$64.00	$109.00
Greensboro	Guilford County	$64.00	$112.00
Kill Devil Hills	Dare County	$74.00	$96.00
Raleigh	Wake County	$64.00	$123.00
Wilmington	New Hanover County	$59.00	$119.00

Per-diems for other cities in North Carolina:

If you are traveling to a city in North Carolina that does not have a specific per diem rate the standard per-diem rates of **$96.00 per night** for lodging and **$59.00 per day** for meals and incidentals apply.