Attachment 14. BCA Technical Memorandum

City of Greenville-Drainage Improvements and Stream Restoration at East Fire Tower Road – FY2022 BRIC Application

TECHNICAL MEMORANDUM

FEMA Building Resilient Infrastructure and Communities

Greenville Drainage Improvements and Stream Restoration

Benefit-Cost Analysis Memorandum

December 23, 2022

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Appendices

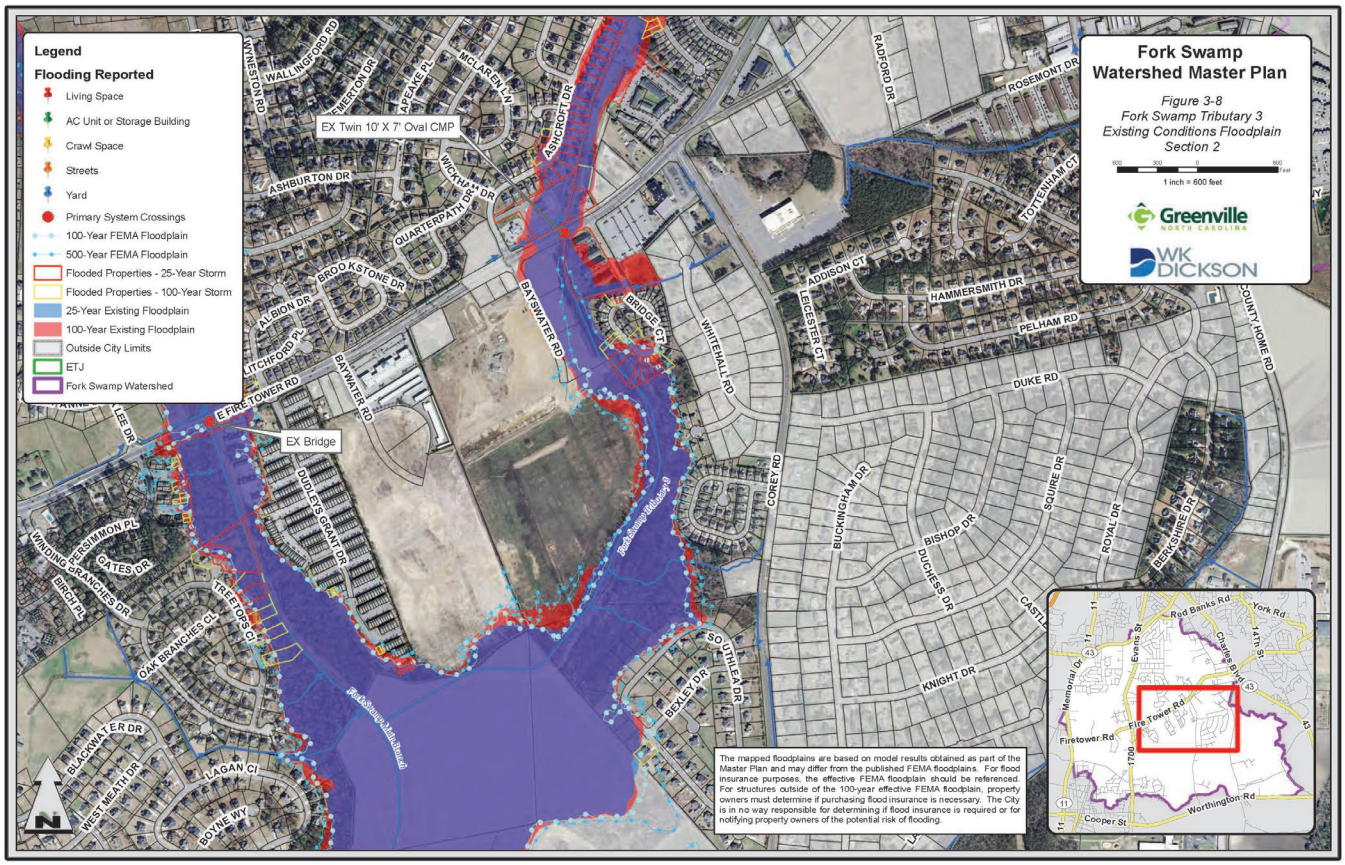
Introduction

FEMA requires that all projects funded through the Building Resilient Infrastructure and Communities (BRIC) program are cost-effective and designed to substantially reduce the risk of future damage, hardship, loss, or suffering resulting from a major disaster. This technical report documents that the Drainage Improvements and Stream Restoration at East Fire Tower Road project (Project) submitted by the City of Greenville under BRIC satisfies applicable cost-effectiveness requirements in compliance with OMB Circular A-94 using FEMA accepted benefit-cost analysis (BCA) methods and tools. This report covers the proposed mitigation activity, BCA approach including pre-mitigation calculations, post-mitigation calculations, and analysis results. Analysis documentation also includes a completed BCA exported from the FEMA BCA Toolkit Version 6.0, and a BCA Report.

Proposed Mitigation Activity

The City of Greenville proposes to implement a series of drainage improvements and floodplain benching along two streams that cross East Fire Tower Road. The two streams currently present a flood risk to East Fire Tower Road, which is a major City thoroughfare, and they also expose several homes to flooding and drainage issues. Taken together, these improvements will lower surface water elevations and stream velocities by increasing flood storage and retention.

Figure 1. Fork Swamp Tributary 3, East Fire Tower Road



Expected 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 flood risk at East Fire Tower Road, which currently floods in a 25-year precipitation event. The BCA is based upon expected losses that will be avoided by mitigating the flood risk to East Fire Tower Road and adjacent homes and the delayed fire and emergency medical response time that would result from a road closure. The project focuses on an area of the Fork Swamp Main Branch, which runs under the East Fire Tower Road Bridge, the most downstream crossing for Fork Swamp Watershed, as well as an unnamed tributary. There are 47 properties between East Fire Tower Road and Summerhaven Drive located in the 25- and 100-year existing conditions floodplain.

Project Overview

This project scope includes a series of floodplain benching improvements along Fork Swamp and an unnamed tributary that will decrease flooding threats to East Fire Tower Road and s surrounding homes. Furthermore, proposed culvert improvements will prevent culvert and roadway failure, which could take 4 weeks to several months to repair. This project was identified and ranked as a priority project in the City's Fork Swamp Watershed Master Plan.

The proposed project will mitigate flooding at two sections of East Fire Tower Road, which has an annual average daily traffic (AADT) count of 33,000. The existing bridge at the road's crossing with the Fork Swamp is operating at a 25-year level of service, which is below the desired l50-year level of service. Additionally, the road's crossing at the Fork Swamp tributary floods during 2-year precipitation events which is below the desired 50-year level of service. Without floodplain improvements this major throughfare is increasingly at risk of being flooded as climate change continues to increase the frequency and severity of precipitation events in the City of Greenville.

The floodplain improvements will also provide a flood reduction benefit to ninety residential properties and is projected to reduce the flood stage to remove at least twenty-six properties from the 100-year floodplain.

The proposed floodplain improvements will bring the bridge crossing on East Fire Tower Road up to the desired 50-year level of service from its current 25-year level of service. To provide a 50-year level of service at this crossing, the project proposes to reduce the tailwater by grading floodplain benches downstream of East Fire Tower Road. This project entails proposed floodplain benching in the right overbank for approximately 2,000 linear feet. The proposed improvements will bring East Fire Tower Road up to the desired 50-year level.

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. Annual maintenance costs include those associated with the routine maintenance necessary during the service life of the project (30 years). This maintenance includes vegetation control and culvert clearing; estimated at approximately $12,000 per year. This assumes a 4-person crew will work for 4 hours per month to maintain the stream segment. Future maintenance needs may include occasionally removing blockages and debris, repairing eroded areas (which should be reduced by the proposed project), trash and debris removal, and vegetation management.

Table 1. Project and Maintenance Costs

Mitigation Activity	Project Cost	Annual Maintenance Cost
Drainage Improvements and Stream Restoration	$12,274,148	$12,000

Project Useful Life

According to the FEMA 2009 BCA Reference Guide, a project useful life of 30 years should be applied to Infrastructure Projects, Culverts with end treatment (see Appendix B). As the culvert improvements under East Fire Tower Road is a functional part of the mitigation activity, in addition to the floodplain benching, a useful life of 30 years was used for the project in the BCA Toolkit.

Benefit-Cost Analysis Approach

Software and References

Following the FEMA BCA Reference Guide and Supplement, this analysis uses the results of a hydraulic study and modeled expected losses for physical damage, roadway loss of function, and delayed fire and emergency medical response time 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 Drainage Improvements and Stream Restoration at Fire Tower Road project addresses the following vulnerabilities:

1. Damages to residential buildings and contents as well as displacement associated with flooding
2. Disruption to the roadway function due to flooding, and the resulting damages and repair costs associated with this vulnerability
3. Delays in fire and EMS emergency response time associated with loss of function to East Fire Tower Road

These vulnerabilities are represented in the FEMA BCA Toolkit using the Damage Frequency Assessment (DFA) module. This BCA methodology document and the Benefit-Cost Estimator contains three mitigation actions, one each for the residential building and contents damage and displacement, road loss of function, and delays in fire and emergency medical response time, each representing damages accrued at 25, 50, and 100-year events. The various losses for the flooding hazard are aggregated in the DFA to determine the overall project benefit-cost ratio (BCR).

Determining Recurrence Intervals

The Fork Swamp Watershed Master Plan used HEC-HMS and HEC-RAS to model the primary systems and simulate the surface runoff response to precipitation for the project area. Data was developed using

topographic, land use, and soils maps in GIS to delineate and calculate the basin areas and Natural Resources Conservation Service (NRCS) hydrologic parameters and input into to the model. As determined by the Fork Swamp Watershed Master Plan (Appendix D), the existing bridge at this crossing is in good condition and currently performs at a 25-year level of service. However, updated HEC modeling performed subsequent to the 2016 report as well as future conditions show that that the bridge will overtop beginning at a 25-year event. Updated models are included as part of the Preliminary Engineering Report (Appendix E).

HEC-RAS modeling was also used to determine the 25 and 100-year surface water elevations for residential properties at risk of flooding. This data was

Residential Flooding

The Fork Swamp Watershed Master Plan used HEC-RAS modeling to identify properties in the vicinity of Fork Swamp Unnamed Tributary 3, shown in Figure 1, that are at risk of flooding and would be mitigated by the proposed project. The report lists 25 and 100-year surface water elevations surface water elevations (SWEL) for each structure, which analysts then interpolated to analyze a 50-year flood event using the following formula: Y- y1= ((y2-y1)/ (x2- x1))* (x2- x1). Analysts then computed flood heights for each event based on the difference between the SWEL and first floor elevations (FFE's) obtained from the Pitt County Assessor's office. Table 2 below depicts the number of residential properties damaged in each scenario while Table 3 depicts surface water elevations for each property and table 4 shows FFE's and flood heights.

Table 2. Residential Properties Affected

Recurrence Interval (Years)	Properties Affected Before Mitigation
25	17
50	20
100	32

Table 3. Surface Water Elevations (SWEL's)

Address	25-Year SWEL (NAVD)	50-Year SWEL (NAVD, Interpolated)	100-Year SWEL (NAVD)
132 PINE BRANCHES CL	60.43	60.63	61.04
133 PINE BRANCHES CL	60.41	60.61	61.01
140 PINE BRANCHES CL	60.35	60.55	60.94
1409 ANGELS END	63.36	63.5	63.78
141 PINE BRANCHES CL	58	58.46	59.38
142 PINE BRANCHES CL	58.39	58.69	59.3
143 PINE BRANCHES CL	58.49	58.81	59.44
1995 SUMMERHAVEN DR, UNIT A	61.7	61.98	62.54
1995 SUMMERHAVEN DR, UNIT B	60.2	60.37	60.72
2002 SHADOWOOD CT, UNIT A	62.8	63.23	64.08
2002 SHADOWOOD CT, UNIT B	62.8	63.21	64.02
2002 TOWER PL, UNIT A	62.7	63.13	63.98
2002 TOWER PL, UNIT B	62.75	63.13	63.9

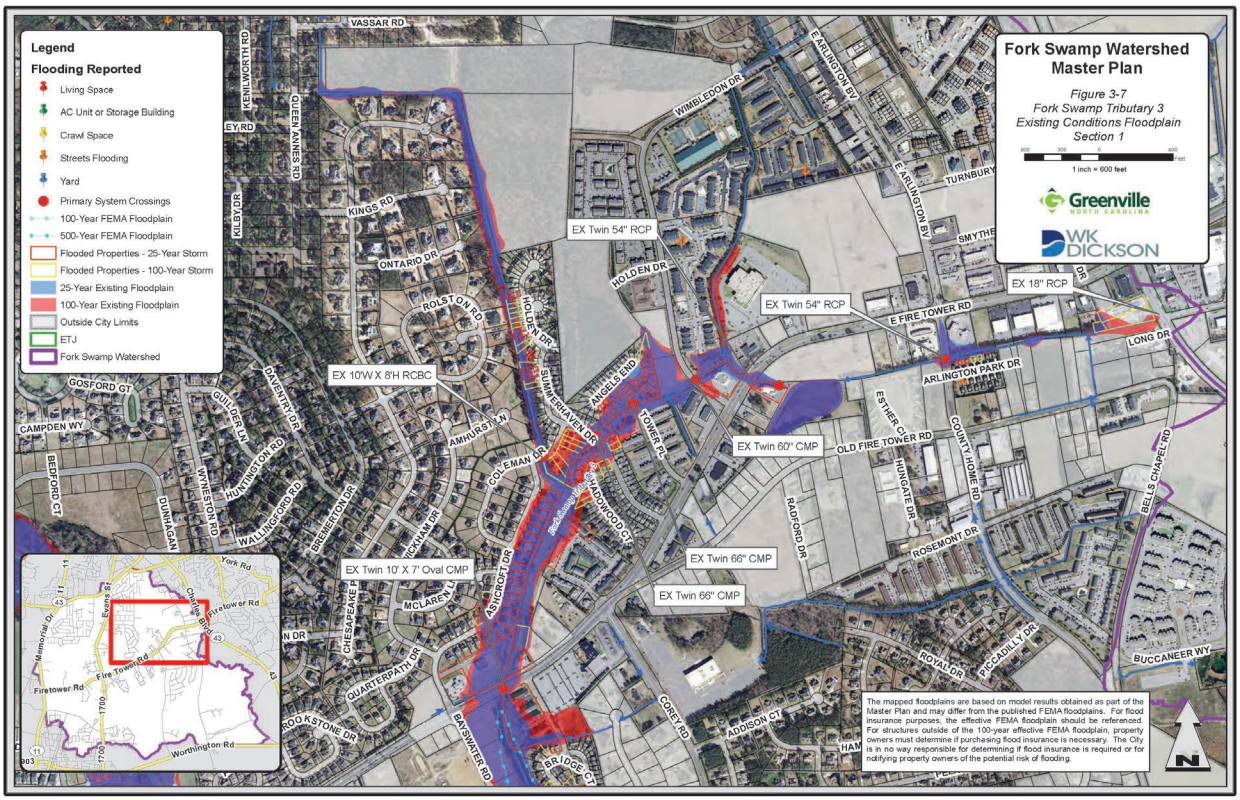
2004 SHADOWOOD COURT UNIT B	61.88	62.14	62.66
2004 SHADOWOOD COURT UNIT A	61.82	62.08	62.59
2006 SHADOWOOD CT, UNIT A	61.71	61.96	62.47
2006 SHADOWOOD CT, UNIT B	61.68	61.93	62.43
2007 SHADOWOOD CT, UNIT A	61.9	62.17	62.71
2007 SHADOWOOD CT, UNIT B	61.57	61.83	62.71
2008 SHADOWOOD CT, UNIT A	61.57	61.81	62.3
2008 SHADOWOOD CT, UNIT B	61.4	61.68	62.35
3909 ASHCROFT DR	60.53	61.70	62.19
4006 WHITEBRIDGE DR	59.24	61.07	64.72
4109 BRIDGE CT	58.39	58.69	59.3
4112 BRIDGE CT	58	58.46	59.38
4114 BRIDGE CT	58.42	58.72	59.33
4118 BRIDGE CT, UNIT A	58.11	58.43	59.07
4118 BRIDGE CT, UNIT B	58.14	58.46	59.1
4120 BRIDGE CT, UNIT A	58.11	58.43	59.07
4120 BRIDGE CT, UNIT B	58.14	58.46	59.11
4122 BRIDGE CT, UNIT A	57	57.68	59.04

Table 4: Residential Flood Heights (Feet)

Address	FFE (NAVD)	25-Year Flooding (Ft)	50-Year Flooding (Ft)	100-Year Flooding (Ft)
132 PINE BRANCHES CL	58.54	1.89	2.09	2.5
133 PINE BRANCHES CL	58.54	1.87	2.07	2.47
140 PINE BRANCHES CL	58.4	1.95	2.15	2.54
1409 ANGELS END	64.02	-0.66	-0.52	-0.24
141 PINE BRANCHES CL	58.4	-0.4	0.06	0.98
142 PINE BRANCHES CL	58.4	-0.01	0.29	0.9
143 PINE BRANCHES CL	58.4	0.09	0.41	1.04
1995 SUMMERHAVEN DR, UNIT A	63.51	-1.81	-1.53	-0.97
1995 SUMMERHAVEN DR, UNIT B	63.51	-3.31	-3.14	-2.79
2002 SHADOWOOD CT, UNIT A	63.49	-0.69	-0.26	0.59
2002 SHADOWOOD CT, UNIT B	63.49	-0.69	-0.28	0.53
2002 TOWER PL, UNIT A	64.06	-1.36	-0.93	-0.08
2002 TOWER PL, UNIT B	64.06	-1.31	-0.93	-0.16
2004 SHADOWOOD COURT UNIT B	62.57	-0.69	-0.43	0.09
2004 SHADOWOOD COURT UNIT A	62.57	-0.75	-0.49	0.02
2006 SHADOWOOD CT, UNIT A	62.22	-0.51	-0.26	0.25
2006 SHADOWOOD CT, UNIT B	62.22	-0.54	-0.29	0.21
2007 SHADOWOOD CT, UNIT A	64.12	-2.22	-1.95	-1.41
2007 SHADOWOOD CT, UNIT B	64.12	-2.55	-2.29	-1.41
2008 SHADOWOOD CT, UNIT A	62.53	-0.96	-0.72	-0.23
2008 SHADOWOOD CT, UNIT B	62.53	-1.13	-0.85	-0.18

3909 ASHCROFT DR	61.93	-1.4	-0.23	0.26
4006 WHITEBRIDGE DR	63.44	-4.2	-2.37	1.28
4109 BRIDGE CT	59.9	-1.51	-1.21	-0.6
4112 BRIDGE CT	60.72	-2.72	-2.26	-1.34
4114 BRIDGE CT	59.48	-1.06	-0.76	-0.15
4118 BRIDGE CT, UNIT A	57.49	0.62	0.94	1.58
4118 BRIDGE CT, UNIT B	57.49	0.65	0.97	1.61
4120 BRIDGE CT, UNIT A	58.42	-0.31	0.01	0.65
4120 BRIDGE CT, UNIT B	58.42	-0.28	0.04	0.69
4122 BRIDGE CT, UNIT A	59.82	-2.82	-2.14	-0.78

Figure 1. Fork Swamp Watershed Unnamed Tributary 3 Map



Building Damages

Calculated flood heights were analyzed alongside building data obtained from the Pitt County Assessor's office, including building type, building value, and square footage and compared against US Army Corps of Engineers North Atlantic Coast Comprehensive Study (NACCS) Depth Damage Curves shown In Table 5 to calculate building damages. The results are reflected in Table 6.

Table 5. Building Depth Damage Curves

Depth-Damage Function - Building					
Building Type	**-2**	**-1**	**0**	**1**	**2**
USACE - USACE Generic 1 story residential (Default)	0.00%	2.50%	13.4%	23.3%	32.1%
USACE - Generic 2 story residential (Default)	0.00%	3.00%	9.3%	15.2%	20.9%

Table 6. Building Damages

Recurrence Interval (Years)	Building Damages
25	$121,341.42
50	$174,953.34
100	$403,337.69

Contents Damages

Contents values were determined by .50 contents to structure value ratio and compared with the same USACE depth damage curves, as shown in Tables 7 and 8.

Table 7. Building Depth Damage Curves

Depth-Damage Function - Contents					
Building Type	**-2**	**-1**	**0**	**1**	**2**
USACE - USACE Generic 1 story residential (Default)	0.00%	2.40%	8.1%	13.3%	17.9%
USACE - Generic 2 story residential (Default)	0.00%	1.00%	5.0%	8.7%	12.2%

Table 8. Contents Damages

Recurrence Interval (Years)	Contents Damages
25	$42,341.45
50	$57,455.12
100	$127,767.52

Displacement

Finally, USACE depth damage curves were applied for displacement days, as follows.

Table 9. Displacement Depth Damage Curves

Depth-Damage Function - Displacement					
Building Type	**-2**	**-1**	**0**	**1**	**2**
USACE - USACE Generic 1 story residential (Default)	-	-	-	45	90
Generic Apartment	-	-	-	45	90

Table 10. Displacement Damages

Recurrence Interval (Years)	Displacement Damages
25	$21,690
50	$21,690
100	$119,295

Social Benefits

The BCA Toolkit specifies that if projects mitigate losses to residential properties, social benefits may be applicable. Given that this activity primarily mitigates residential flooding, including building damage, contents damage, and displacement, analysts expect social benefits to accrue from the project. The number of residents that would benefit was estimated by multiplying the number of residential structures impacted by the 100-year event by the average household size, 2.34, according to US Census data (Appendix H). The number of residents that work was computed by multiplying the total residents by the labor force participation rate for October 2022, 62.2%, according to the US Department of Labor Bureau of Labor Statistics (Appendix I). Table 11 demonstrates these inputs and the expected annual social benefits.

Table 11. Social Benefits

Additional Benefits - Social	Total Damages ($)
Number of Residents	75
Number of Residents That Work	47
Expected Annual Social Benefit ($)	$593,817

Road Damage and Loss of Function

Analysts reviewed the Fork Swamp Watershed Master Plan (Appendix D) and the Preliminary Engineering Report (Attachment F) to model impacts to East Fire Tower Road due to flood events overtopping and scouring the roadway. As part of their report, engineers updated the surface water elevations referenced in the Fork Swamp Watershed Master Plan to the most recent hydraulic conditions and models. Based on the minimum elevation of 58.23 NAVD at the top of the road, analysts noted the hydraulic conditions shown in Table 12.

Table 12. Current Hydraulic Conditions, East Fire Tower Road, Preliminary Engineering Report

Recurrence Interval (Years)	SWEL (NAVD)	Flood Height Over Roadway	Total Discharge (CFS)	Overtopping Discharge (CFS)	Culvert Velocity (FPS)
25	59.2	.97	401.7	9.1	6.7
50	61	2.77	545.8	139.2	7.0
100	61.4	3.17	707.2	302.8	6.9

Based on the flood height, overtopping discharge, and velocity, and the opinion of engineers, analysts projected that overtopping in a 25-year would be sufficient to result in road surface scour and erosion, causing significant damage including washout along both shoulders of the road, impacting both lanes of traffic. Loss of function estimates include time for flood water to recede, engineers to inspect damage, and implement restore the road to pre-flood conditions with filling, grading, and paving.

Similarly, based on the hydraulic conditions and performance of the existing culvert, analysts project that the 50-year event would result in partial damage to the roadway and culvert while the 100-year event would require complete replacement. Based on the opinion of engineers and the City of Greenville, analysts associated each of these repair events with durations where the roadway would suffer loss of function. Damages for the 100-year event are based on the Culvert and Road Surface Replacement line item from the E Fire Tower Road Budget estimate while the 25 and 50-year events each represent a proportionate share of those damages.

These single-event scenarios are described in Table 13.

Table 13. East Fire Tower Road Expected Damages Before Mitigation

Recurrence Interval (Years)	Permanent Repairs	Loss of Function (Days)
25	$550,000	30
50	$1,100,000	90
100	$2,200,000	180

Loss of Function

Analysts used the single-event scenarios described above along with the standard BCA Toolkit roads and bridges methodology to determine the economic loss per day of loss of function. The Estimated Number of One-Way Traffic Detour Trips per Day or average annual daily traffic (AADT) was obtained from the NCDOT

Annual Average Daily Traffic (AADT) Mapping Application (Appendix F) and the detour time and distance were estimated using Google Maps (Attachment H). Table 14 reflect those inputs and the results.

Table 14. Economic Loss Per Day of Loss of Function Parameters

Category	Two-Lane Loss of Function Values
Estimated Number of One-Way Traffic Detour Trips per Day	33,000
Additional Time Per One-Way Trip (minutes)	7
Number of Additional Miles	1.6
Federal Rate (given in BCA Toolkit)	$0.625
Total Economic Loss Per Day of Loss of Function	$170,060

Ecosystem Services

According to the BCA Toolkit, ecosystem service benefits accrue when land use is changed or enhanced by a mitigation activity to provide a higher level of natural benefits. This project enhances the land use by converting open to space to more valuable riparian space by removing fill and connecting it with the floodplain. The mitigation actin will increase the natural and beneficial functions of the area by providing provisioning, regulating, supporting, and cultural services that are largely self-maintaining.

The BCA toolkit calculates ecosystem services benefits based on the number of acres changed or enhanced and the land use. Given that there will be no break in the vegetation cover between the project area and Fork Swamp and that the vegetation can be fed by groundwater or surface water that is intermittently flowing, analysts selected the riparian space type. Table 15 reflects the engineer's calculation of the total project area that will be enhanced with floodplain benching project area.

Table 15. Total Project Area, Preliminary Engineering Report

Area	Bank(s)	Square Feet	Square Yards	Acres
Tributary Upstream	Left bank only	74,000	8,222	1.699
Tributary Downstream	Both banks	215,000	23,889	4.936
Main Branch	Right bank only	198,500	22,056	4.557
Total		487,500	54,167	11.191

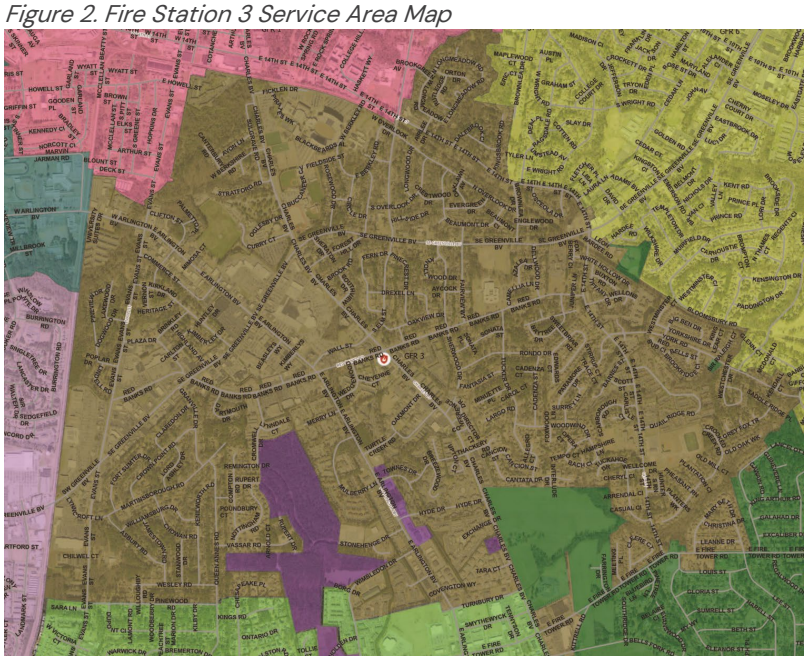
Table 16. Standard Benefits – Ecosystem Services

Ecosystem Services	
Total Project Area (acres or sq. ft):	487,500
Riparian %	100
Expected Annual Ecosystem Services Benefits ($)	416,314

Critical Facility Loss of Function

In addition to damages associated loss of function along East Fire Tower Road, which were valuated based on average one-way traffic trips, analysts sought to capture delays in response time for Greenville Fire Station Number 3, located at 2400 Charles Boulevard. Located approximately two miles from the project area, Greenville Fire Station Number 3 serves an estimated population of 25,045 with fire and emergency medical service. Appendix G depicts the service area for Fire Station 3. Although the fire station is not expected to suffer direct loss of function due to flooding, given that much of its service area is to the south and the east of the station, the City anticipates that fire and emergency medical calls to the south and east of the service area would have to detour should East Fire Tower Road suffer loss of function. A map of Fire Station 3's service area is included as Figure 2.

Figure 2. Fire Station 3 Service Area Map



Given that the BCA Toolkit measures loss of function to fire stations in terms of additional miles traveled, the additional detour distance was entered into the toolkit under the filed "distance in miles between this fire station and the fire station that would provide fire protection for the geographical area normally served by this fire station?" Analysts estimated the detour time and distance using Google Maps for the before and after mitigation conditions and applied the difference in miles as the total detour time, attached as Appendix C. Loss of function days identical to those input in the East Fire Tower Road mitigation action were then entered as Professional Expected Damages Before Mitigation. The inputs of the critical facilities loss of function per day are shown in Table 17.

Table 17. Critical Facilities Properties: Fire Station

Category	Two-Lane Loss of Function Values
People served by fire station	25,045
Type of area served by fire station	Suburban

Distance in miles between this fire station and the fire station that would provide fire protection for the geographical area normally served by this fire station?	0.3
Does the fire station provide Emergency Medical Services (EMS)?	Yes
What is the distance in miles between this fire station and the fire station that would provide EMS for the geographical area normally served by this fire station?	0.3
Total Economic Loss Per Day of Loss of Function	$16,092

Post-Mitigation Assumptions and Level of Protection

After mitigation, the roadway and bridges will be protected from overtopping that occurs from flood events. Hydraulic analysis of the flood mitigation actions (Appendix E) shows that these measures will prevent roadway overtopping up to the at least the 50-year event and reduce damages at the 100-year event. Analysts assumed that residual damages at the 100-year event would be equivalent in cost and scope to those of the pre-mitigation 50-year event.

Current surface water elevations were adjusted to determine residential damages after mitigation. The Preliminary Engineering Report specifies that downstream water surface elevations will be decreased between 0.64 and 1.93 feet in the 25-year storm, between 0.62 and 2.04 feet in the 100-year event. In order to ensure a conservation analysis, the lower bound of these ranges was subtracted from the current SWEL's to determine the SWEL's after mitigation. These SWEL's were then compared to FFE's to determine flood heights and damages after mitigation. Table 18 shows the results of that analysis.

Table 18. Residential Properties Affected After Mitigation

Recurrence Interval (Years)	Properties Affected Before Mitigation	Properties Affected After Mitigation
25	17	9
50	20	15
100	32	22

Tables 19, 20, and 21 show the total professional damages after mitigation for each mitigation action.

Table 19. Professional Expected Damages After Mitigation: Residential

Recurrence Interval	Building Damages	Contents Damages	Displacement Damages	Total Damages ($)
25	$47,685.47	$17,017.35	$0	$64,703
50	$69,617.92	$27,554.92	$0	$97,163
100	$229,151.32	$72,359.11	$54,225	$335,735

Table 20. Professional Expected Damages After Mitigation: Roads

Recurrence Interval	Impact (Days)	Total Damages ($)
100	90	$16,405,400

Table 21. Professional Expected Damages After Mitigation: Critical Facilities

Recurrence Interval	Impact (Days)	Total Damages ($)
100	90	$1,448,253

Analysis Results

FEMA's Alternative Cost-Effectiveness Methodology for Fiscal Year 2022 BRIC and FMA specifies that projects that address climate change impacts will be considered cost-effective if the BCA computed at a 7% discount rate exceeds 0.75 and the BCA computed at a 3% discount rate exceeds 1.0. Given that this project addresses the flood risk that is expected to become more severe due to climate change, the Alternative Cost-Effectiveness Methodology is appropriate. Greenville could receive up to a 130% annual increase in the number of days with precipitation of 3 inches or greater by midcentury from a 1996-2015 baseline average. This predicted increased precipitation will increase the threat of flooding and increase encroachment upon the municipal infrastructure and housing. The proposed project will emphasize nature-based solutions and reduce flood impacts caused by future severe precipitation events.

Given that the analysis performed at a 7% discount rate yielded a BCR of 1.11 and the analysis performed at a 3% discount rate yielded a BCR of 1.72, analysts deemed the project to be cost-effective. The benefit-cost ratio for the project is listed in Tables 22 and 23 below. The BCA Report is provided as Appendix A and the BCA Zip is attached to the project subapplication.

Table 22. Project Benefit-Cost Ratio: Using 7% Discount Rate

Benefits	Costs	BCR
$13,803,874	**$12,423,056**	**1.11**

Table 23. Project Benefit-Cost Ratio: Using 3% Discount Rate

Benefits	Costs	BCR
$21,459,487	**$12,509,353**	**1.72**

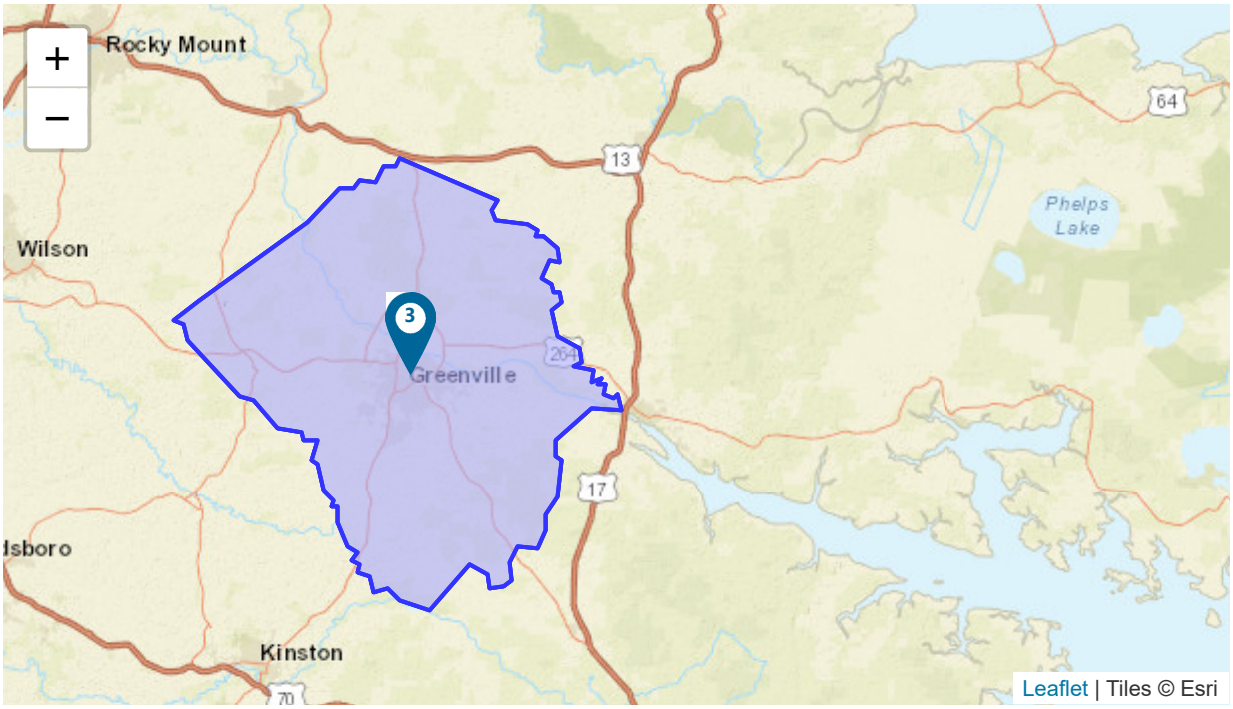
Appendix A: BCA Toolkit Report

Benefit-Cost Calculator

V.6.0 (Build 20221028.1600 | Release Notes)

Benefit-Cost Analysis

Project Name: City of Greenville-Stream Restoration at East Fire Tower Road



				Using 7% Discount Rate			Using 3% Discount Rate (For FY22 BRIC and FMA only)			
Map Marker ▲	Mitigation Title	Property Type	Hazard	Benefits (B)	Costs (C)	BCR (B/C)	Benefits (B)	Costs (C)	BCR (B/C)	
1	Floodplain and Stream Restoration @ Pitt County, North Carolina		DFA - Riverine Flood	$ 691,948	$ 12,423,056	0.06	$ 748,818	$ 12,509,353	0.06	
2	Floodplain and Stream Restoration @ Pitt County, North Carolina		DFA - Riverine Flood	$ 641,386	$ 0	0.00	$ 1,013,088	$ 0	0.00	
3	Floodplain and Stream Restoration @ Pitt County, North Carolina		DFA - Riverine Flood	$ 12,470,540	$ 0	0.00	$ 19,697,581	$ 0	0.00	
TOTAL (SELECTED)				**$ 13,803,874**	**$ 12,423,056**	**1.11**	**$ 21,459,487**	**$ 12,509,353**	**1.72**	
TOTAL				**$ 13,803,874**	**$ 12,423,056**	**1.11**	**$ 21,459,487**	**$ 12,509,353**	**1.72**	

Property Configuration

Property Title:	Floodplain and Stream Restoration @ Pitt County, North Carolina
Property Location:	27858, Pitt, North Carolina
Property Coordinates:	35.5935109, -77.3746684
Hazard Type:	Riverine Flood
Mitigation Action Type:	Floodplain and Stream Restoration
Property Type:	Residential Building
Analysis Method Type:	Professional Expected Damages

Cost Estimation

Floodplain and Stream Restoration @ Pitt County, North Carolina

Project Useful Life (years):	30
Project Cost:	$12,274,148
Number of Maintenance Years:	30 Use Default:Yes
Annual Maintenance Cost:	$12,000

Damage Analysis Parameters - Damage Frequency Assessment

Floodplain and Stream Restoration @ Pitt County, North Carolina

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

Professional Expected Damages Before Mitigation

Floodplain and Stream Restoration @ Pitt County, North Carolina

	OTHER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Damages ($)	Building	Contents	Displacement	Number of Volunteers	Number of Days	Damages ($)
25	0	121,341.42	42,341.45	21,690	0	0	185,373
50	0	174,953.34	57,455.12	21,690	0	0	254,098
100	0	403,337.69	127,767.52	119,295	0	0	650,400

Annualized Damages Before Mitigation

Floodplain and Stream Restoration @ Pitt County, North Carolina

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
25	185,373	4,341
50	254,098	4,065
100	650,400	6,504
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	1,089,872	14,910

Professional Expected Damages After Mitigation

Floodplain and Stream Restoration @ Pitt County, North Carolina

	OTHER	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Damages ($)	Building	Contents	Displacement	Number of Volunteers	Number of Days	Damages ($)
25	0	47,685.47	17,017.35	0	0	0	64,703
50	0	69,617.92	27,544.92	0	0	0	97,163
100	0	229,151.32	72,359.11	54,225	0	0	355,735

Annualized Damages After Mitigation

Floodplain and Stream Restoration @ Pitt County, North Carolina

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
25	64,703	1,586
50	97,163	1,859
100	355,735	3,557
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	517,601	7,002

Standard Benefits - Ecosystem Services

Floodplain and Stream Restoration @ Pitt County, 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

Additional Benefits - Social

Floodplain and Stream Restoration @ Pitt County, North Carolina

Number of Workers:	47
Expected Annual Social Benefits:	$593,817

Benefits-Costs Summary

Floodplain and Stream Restoration @ Pitt County, North Carolina

Total Standard Mitigation Benefits:	$98,131
Total Social Benefits:	$593,817
Total Mitigation Project Benefits:	$691,948
Total Mitigation Project Cost:	$12,423,056
Benefit Cost Ratio - Standard:	0.01
Benefit Cost Ratio - Standard + Social:	0.06

Property Configuration

Property Title:	Floodplain and Stream Restoration @ Pitt County, North Carolina
Property Location:	27858, Pitt, North Carolina
Property Coordinates:	35.5935109, -77.3746684
Hazard Type:	Riverine Flood
Mitigation Action Type:	Floodplain and Stream Restoration
Property Type:	Critical Facility Building
Analysis Method Type:	Professional Expected Damages

Cost Estimation

Floodplain and Stream Restoration @ Pitt County, North Carolina

Project Useful Life (years):	30
Project Cost:	$0
Number of Maintenance Years:	30 Use Default:Yes
Annual Maintenance Cost:	$0

Damage Analysis Parameters - Damage Frequency Assessment

Floodplain and Stream Restoration @ Pitt County, North Carolina

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

Critical Facilities Properties

Floodplain and Stream Restoration @ Pitt County, North Carolina

Critical Facility Type:	Fire Station
Number of people are served by Fire Station:	25,045
Type of Area served by this fire station:	Suburban
Distance in miles between this fire station and the fire station that would provide fire protection for the geographical area normally served by this fire station:	0.3
Fire station provides Emergency Medical Services (EMS):	Yes
Distance in miles between this fire station and the fire station that would provide EMS for the geographical area normally served by this fire station:	0.3
Total ($/day):	16,092

Professional Expected Damages Before Mitigation

Floodplain and Stream Restoration @ Pitt County, North Carolina

	FIRE STATION	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
25	30	0	0	0	0	0	482,751
50	90	0	0	0	0	0	1,448,253
100	180	0	0	0	0	0	2,896,506

Annualized Damages Before Mitigation

Floodplain and Stream Restoration @ Pitt County, North Carolina

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
25	482,751	16,723
50	1,448,253	20,481
100	2,896,506	28,965
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	4,827,510	66,169

Professional Expected Damages After Mitigation

Floodplain and Stream Restoration @ Pitt County, North Carolina

	FIRE STATION	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	Category 1 ($)	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
100	90	0	0	0	0	0	1,448,253

Annualized Damages After Mitigation

Floodplain and Stream Restoration @ Pitt County, North Carolina

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
100	1,448,253	14,482
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	1,448,253	14,482

Standard Benefits - Ecosystem Services

Floodplain and Stream Restoration @ Pitt County, 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

Floodplain and Stream Restoration @ Pitt County, North Carolina

Total Standard Mitigation Benefits:	$641,386
Total Social Benefits:	$0
Total Mitigation Project Benefits:	$641,386
Total Mitigation Project Cost:	$0
Benefit Cost Ratio - Standard:	0
Benefit Cost Ratio - Standard + Social:	0

Property Configuration

Property Title:	Floodplain and Stream Restoration @ Pitt County, North Carolina
Property Location:	27858, Pitt, North Carolina
Property Coordinates:	35.5935109, -77.3746684
Hazard Type:	Riverine Flood
Mitigation Action Type:	Floodplain and Stream Restoration
Property Type:	Roads & Bridges
Analysis Method Type:	Professional Expected Damages

Cost Estimation

Floodplain and Stream Restoration @ Pitt County, North Carolina

Project Useful Life (years):	30
Project Cost:	$0
Number of Maintenance Years:	30 Use Default:Yes
Annual Maintenance Cost:	$0

Damage Analysis Parameters - Damage Frequency Assessment

Floodplain and Stream Restoration @ Pitt County, North Carolina

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

Roads and Bridges Properties

Floodplain and Stream Restoration @ Pitt County, North Carolina

Estimated Number of One-Way Traffic Detour Trips per Day:	33,000
Additional Time per One-Way Detour Trip (minutes):	7
Number of Additional Miles:	1.6
Federal Rate ($):	0.625 Use Default:Yes
Economic Loss Per Day of Loss of Function ($):	170,060

Professional Expected Damages Before Mitigation

Floodplain and Stream Restoration @ Pitt County, North Carolina

	ROADS AND BRIDGES	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	Permanent Repairs	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
25	30	550,000	0	0	0	0	5,651,800
50	90	1,100,000	0	0	0	0	16,405,400
100	180	2,200,000	0	0	0	0	32,810,800

Annualized Damages Before Mitigation

Floodplain and Stream Restoration @ Pitt County, North Carolina

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
25	5,651,800	192,582
50	16,405,400	232,007
100	32,810,800	328,105
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	54,868,000	752,694

Professional Expected Damages After Mitigation

Floodplain and Stream Restoration @ Pitt County, North Carolina

	ROADS AND BRIDGES	OPTIONAL DAMAGES			VOLUNTEER COSTS		TOTAL
Recurrence Interval (years)	Impact (days)	Permanent Repairs	Category 2 ($)	Category 3 ($)	Number of Volunteers	Number of Days	Damages ($)
100	90	1,100,000	0	0	0	0	16,405,400

Annualized Damages After Mitigation

Floodplain and Stream Restoration @ Pitt County, North Carolina

Annualized Recurrence Interval (years)	Damages and Losses ($)	Annualized Damages and Losses ($)
100	16,405,400	164,052
	Sum Damages and Losses ($)	Sum Annualized Damages and Losses ($)
	16,405,400	164,052

Standard Benefits - Ecosystem Services

Floodplain and Stream Restoration @ Pitt County, North Carolina

Total Project Area (sq.ft):	487,500
Percentage of Urban Green Open Space:	0.00%
Percentage of Rural Green Open Space:	0.00%
Percentage of Riparian:	100.00%
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:	$416,314

Benefits-Costs Summary

Floodplain and Stream Restoration @ Pitt County, North Carolina

Total Standard Mitigation Benefits:	$12,470,540
Total Social Benefits:	$0
Total Mitigation Project Benefits:	$12,470,540
Total Mitigation Project Cost:	$0
Benefit Cost Ratio - Standard:	0
Benefit Cost Ratio - Standard + Social:	0

Appendix B: Project Useful Life Summary

Project Type	Useful Life (years)		Comment
	Standard Value	Acceptable Limits (documentation required)	
Acquisition/Relocation			
All Structures	100	100	
Elevation			
Residential Building	30	30–50	
Non-Residential Building	25	25–50	
Public Building	50	50–100	
Historic Buildings	50	50–100	
Structural/Non-Structural Building Project			
Residential Building Retrofit	30	30	
Non-Residential Building Retrofit	25	25–50	
Public Building Retrofit	50	50–100	
Historic Building Retrofit	50	50–100	
Roof Diaphragm Retrofit	30	30	Roof hardening and roof clips
Tornado Safe Room – Residential	30	30	
Tornado Safe Room – Community	30	30–50	Retrofit or small community safe room ≤ 16 people (30 yr), New (50 yr)
Non-Structural Building Elements	30	30	Ceilings, electrical cabinets, generators, parapet walls, or chimneys
Non-Structural Major Equipment	15	15–30	Elevators, HVAC, sprinklers
Non-Structural Minor Equipment	5	5–20	Generic contents, racks, shelves
Infrastructure Projects			
Major Infrastructure (minor localized flood reduction projects)	50	35–100	
Concrete Infrastructure, Flood Walls, Roads, Bridges, Major Drainage System	50	35–50	
Culverts (concrete, PVC, CMP, HDPE, etc.)	30	25–50	Culvert **with** end treatment (i.e., wing walls, end sections, head walls, etc.)
	10	5–20	Culvert **without** end treatment (i.e., wing walls, end sections, head walls, etc.)
Pump Stations, Substations, Wastewater Systems, or Equipment Such as Generators	50	50	Structures
	5	5–30	Equipment
Hurricane Storm Shutters	15	15–30	Depends on type of storm shutter
Utility Mitigation Projects	50	50–100	Major (power lines, cable, hardening gas, water, sewer lines, etc.)
	5	5–30	Minor (backflow values, downspout disconnect, etc.)

Project Type	Useful Life (years)		Comment
	Standard Value	Acceptable Limits (documentation required)	
Miscellaneous Equipment Projects			
Equipment Purchases	2	2–10	Small, portable equipment (e.g., computer)
	30	5–30	Heavy equipment
Wildfire Mitigation Projects			
Defensible Space/Hazardous Fuels Reduction	4	2–4	Brush – Depends on drought conditions
Vegetation Management	1	1	Grass – Depends on geographic location and precipitation
	20	3–20	Forest canopy – Must be maintained every 3 years
Ignition-Resistant Construction	10	10–30	Depends on type of construction and materials used

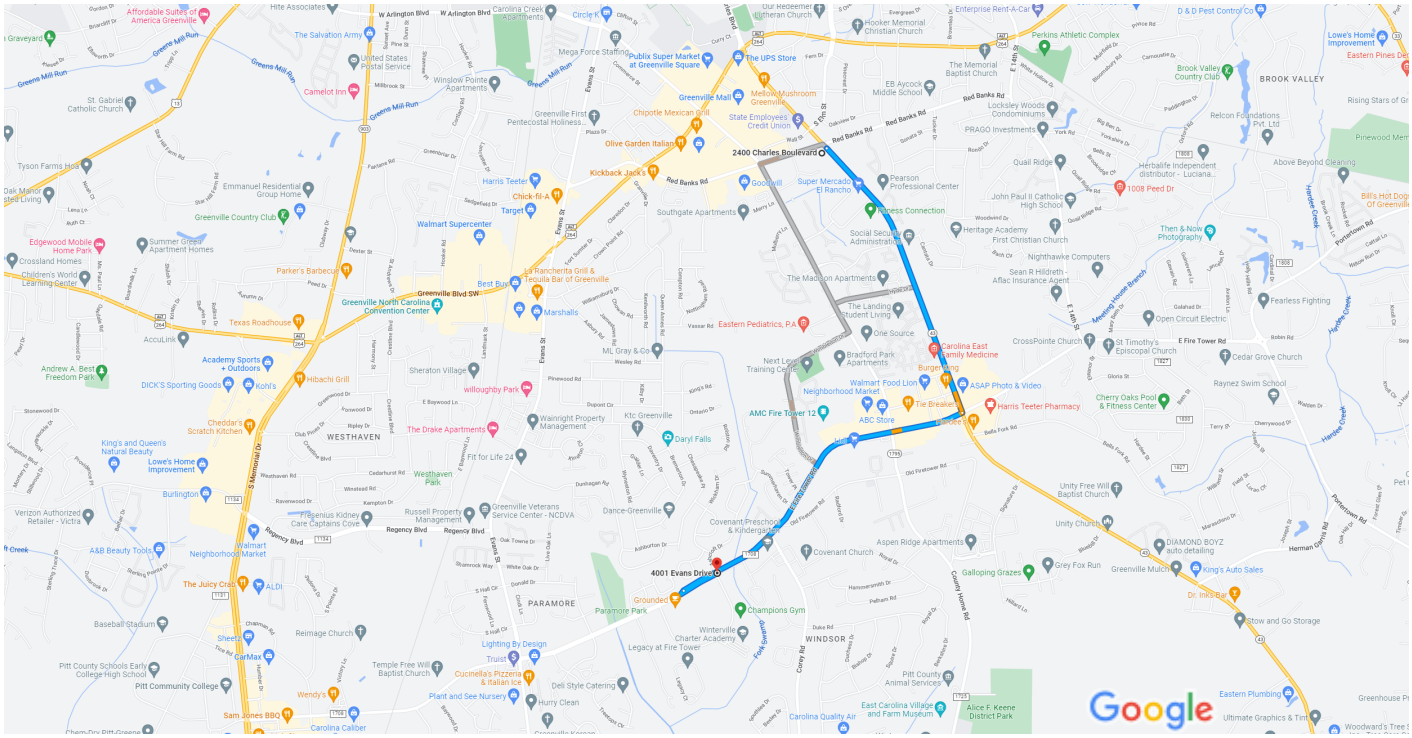
Appendix C: Alternate Route Map

Google Maps

2400 Charles Blvd, Greenville, NC 27858 to 4001 Evans Dr, Winterville, NC 28590

Drive 3.0 miles, 6 min

No Detour



Map data ©2022 1000 ft

2400 Charles Blvd
Greenville, NC 27858

1. Head southeast on S Charles Blvd toward Oakmont Dr
   Pass by McDonald's (on the right in 1.3 mi)

1.3 mi

2. Turn right onto E Fire Tower Rd

1.5 mi

3. Make a U-turn
   Destination will be on the left

0.2 mi

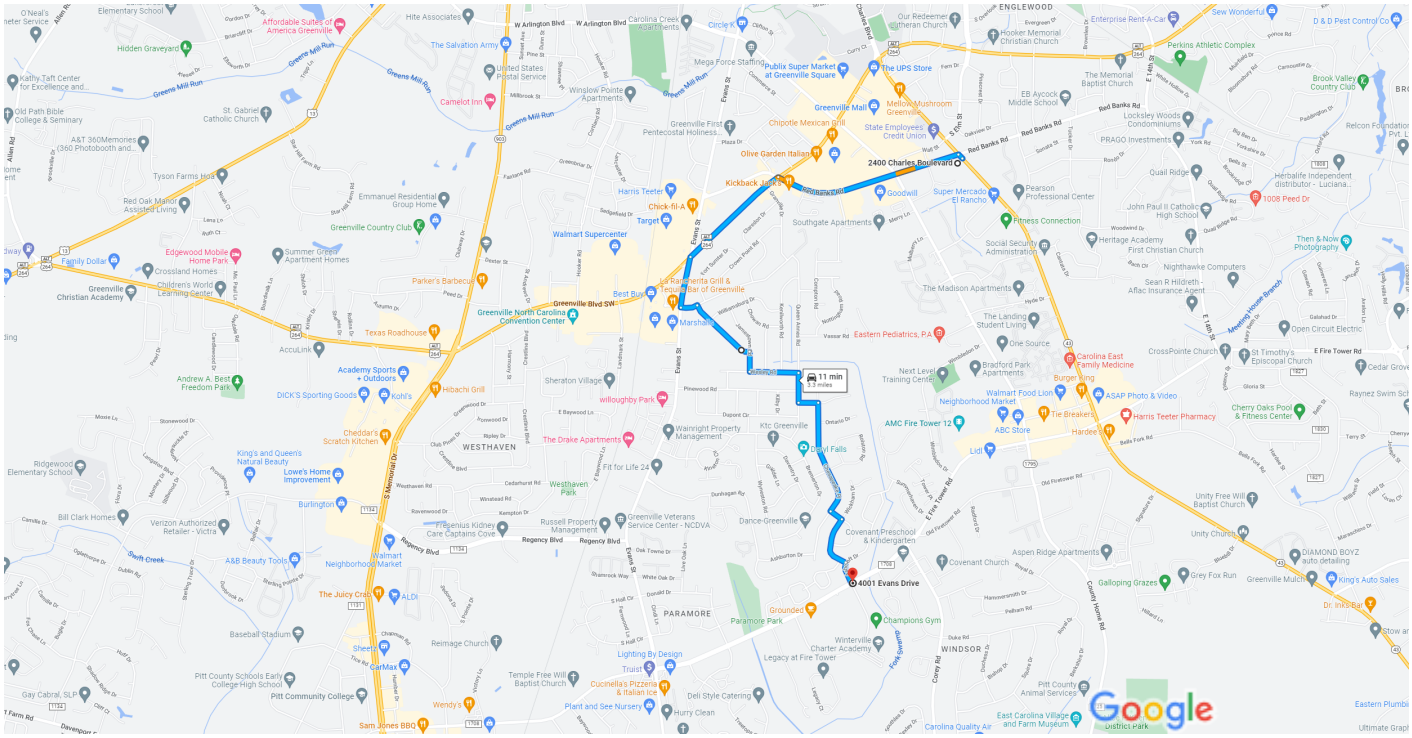
4001 Evans Dr
Winterville, NC 28590

Google Maps

2400 Charles Blvd, Greenville, NC 27858 to 4001 Evans Dr, Winterville, NC 28590

Drive 3.3 miles, 11 min

With Detour



Map data ©2022 1000 ft

2400 Charles Blvd
Greenville, NC 27858

Take Red Banks Rd and Greenville Blvd SE to Martinsborough Rd

5 min (1.6 mi)

1. Head northwest on S Charles Blvd toward Red Banks Rd

128 ft

2. Turn left at the 1st cross street onto Red Banks Rd

0.8 mi

3. Turn left onto Greenville Blvd SE
   Pass by Bojangles (on the right)

0.5 mi

4. Use the left 2 lanes to turn left onto Evans St

0.2 mi

Take Asbury Rd, Wesley Rd, Chesapeake Pl and Wickham Dr to E Fire Tower Rd

6 min (1.8 mi)

5. Turn left onto Martinsborough Rd

387 ft

6. Turn right onto Asbury Rd

0.3 mi

7. Turn right onto Jamestown Rd

453 ft

8. Turn left onto Wesley Rd

0.2 mi

9. Turn right onto Queen Annes Rd

0.1 mi

10. Turn left onto King's Rd

443 ft

11. Turn right at the 1st cross street onto Chesapeake Pl

0.5 mi

12. Turn left onto McLaren Ln

315 ft

13. Turn right at the 1st cross street onto Wickham Dr

0.2 mi

14. Turn right onto Ashcroft Dr

472 ft

15. Turn left onto E Fire Tower Rd

Destination will be on the left

15 sec (72 ft)

4001 Evans Dr
Winterville, NC 28590

Appendix D: Fork Swamp Watershed Master Plan

CITY OF GREENVILLE

FORK SWAMP
WATERSHED MASTER PLAN

WKD # 20140067.00.RA

August 2016

Prepared for

City of Greenville
1500 Beatty Street
Greenville, NC 27834

Prepared by
W. K. Dickson & Co., Inc.
Raleigh, NC
919/782/0495
NC License No. F-0374

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EXECUTIVE SUMMARY

The City of Greenville retained WK Dickson to complete a Master Plan for the Fork Swamp watershed. The goals of this master plan include: (1) evaluate the existing flooding, water quality and erosion problems, (2) recommend and prioritize capital improvements to control existing flooding by reducing the frequency and severity of flooding for property owners, and (3) identify stream stabilization projects to reduce the risk of property loss along streams and reduce sediment loads as a result of erosion. To assist in achieving the goals listed above, WK Dickson completed a stormwater drainage infrastructure inventory for drainage structures and features within the Fork Swamp watershed. Over 2,350 drainage structures and approximately 40 miles of drainage pipes was located and incorporated into a GIS database as part of this effort.

The project included a broad range of stakeholders to collect as much data, information, and tacit knowledge of the watershed as feasible. The general public was solicited through questionnaires mailed to all property owners in the watershed and through an open house public meeting where residents and business owners were encouraged to provide feedback on stormwater issues in the watershed. Information collected from the questionnaires and public meeting can be found in Section 2.1 and Appendix D. City staff served as a critical stakeholder by providing valuable information regarding historical flooding and erosion problems in the watershed as well as providing feedback on potential capital improvements and their prioritization.

The project watershed is approximately ten (10) square miles and is located in the south central portion of Greenville. Approximately 60% of the watershed is contained in the City limits, and it is 75% developed as predominantly residential land use. WK Dickson conducted an Existing Conditions Analysis in order to evaluate the existing hydrologic and hydraulic characteristics of the Fork Swamp watershed. Noted in this report as the Primary System are the following:

- Fork Swamp Main Branch;
- Unnamed Tributary 1 to Fork Swamp (referred to as FSUT1);
- Unnamed Tributary 2 to Fork Swamp Reach 1(referred to as FSUT2R1);
- Unnamed Tributary 2 to Fork Swamp Reach 2(referred to as FSUT2R2); and
- Unnamed Tributary 3 to Fork Swamp (referred to as FSUT3).

These Primary Systems were hydraulically studied in detail and were selected based on historical flooding of residential areas and roadways. Furthermore, high storm flows have eroded channel banks over time causing impacts to private yards, fences, and other property enhancements. In addition to the Primary Systems, select conveyance systems (referred to as secondary systems) in the Fork Swamp watershed were analyzed to determine if they meet the desired City design requirements outlined in Section 1.2. These secondary systems were identified based on feedback from City residents and staff.

As a result of the Existing Conditions Analysis, multiple capital improvement and maintenance projects were identified to reduce the severity and frequency of flooding, stabilize stream banks, and improve water quality through stormwater treatment practices. Additionally, the identified projects meet the City's design requirements outlined in Section 1.2 for future conditions.

The proposed capital projects are as follows with the locations of each project shown on Figure ES-1.

Flood Control Projects

Fork Swamp Main Branch Primary System

East Baywood Lane – The existing twin 72" corrugated metal pipes (CMPs) at this crossing are currently providing a 2-year level of service. The water surface elevations (WSELs) at East Baywood Lane are controlled by the backwater from the downstream railroad crossing. With the proposed downstream improvements, the resultant 25-year WSEL is reduced by over 2 feet. However, East Baywood Lane still does not meet the required 25-year level of service and will operate just below a 10-year level of service. Increasing the capacity at the crossing does not impact the WSEL since the culvert is in outlet control. Furthermore, there is no room available to incorporate floodplain benching immediately downstream of the crossing to try to lower the tailwater. Therefore, no capital improvements are proposed at this location. Reductions in flooding in the vicinity of East Baywood Lane will occur as a result of the railroad crossing and Evans Street projects described below.

Railroad Crossing – The existing twin 84" CMPs at this crossing are currently operating at a 25-year level of service. In order to aid in lowering the tailwater at East Baywood Lane, floodplain benches downstream of the railroad crossing in the left overbank are proposed for approximately 770 linear feet. The floodplain benching will improve the performance of the existing CMPs at the railroad crossing and bring it up to the desired 100-year level of service while also reducing water surface elevations in the Westhaven neighborhood upstream by increasing the cross-sectional area of flow. The proposed improvements would result in up to a 2.3-foot decrease in WSEL for the 25-year event. Lowering the tailwater at the railroad by installing floodplain benching is the only feasible alternative for reducing the water surface elevations in the upstream Westhaven neighborhood. Based on the model results 121 properties are at risk for lowest adjacent grade (LAG) flooding during the 25-year storm upstream of the railroad crossing. The combination of the Evans Street project and the railroad project will remove 15 of these properties from the 25-year floodplain. Approximately 25% of the proposed floodplain bench appears to be located within a Pitt County Drainage District easement based on the Pitt County OPIS website. Coordination with the Drainage District will be required to implement the proposed project. Additionally, the floodplain benching could be

coordinated with the proposed Fork Swamp Greenway referenced in the 2004 Greenway Master Plan. Economy of savings could be provided if both projects are constructed at the same time.

Evans Street – The existing twin 84" CMPs at this crossing are currently providing a 25-year level of service. Since Evans Street is classified as a major thoroughfare, the desired level of service is the 50-year storm. This alternative entails replacing the existing CMPs with twin 7′ x 7′ RCBCs coupled with floodplain benching downstream of the crossing to lower the tailwater. The floodplain benching is proposed in the left overbank for approximately 1,200 linear feet. The improvements proposed will bring Evans Street up to the desired 50-year level of service. It should be noted that NCDOT has an upcoming widening project planned for Evans Street. In order to implement the culvert improvements with this planned roadway widening project, coordination with NCDOT will be required. Depending upon the timing, another option would be to complete this project in phases. Phase 1 would be the installation of the proposed floodplain benching followed by Phase 2, the culvert upgrades. The proposed improvements would result in up to a 2.9-foot decrease in WSEL for the 25-year event. As noted above, 15 out of the 121 properties are expected to be removed from the 25-year floodplain as a result of implementing the railroad and Evans Street improvements. The majority of the proposed floodplain bench appears to be located within a Pitt County Drainage District easement based on the Pitt County OPIS website. Coordination with the Drainage District will be required to implement the proposed project. Additionally, the floodplain benching could be coordinated with the proposed Fork Swamp Greenway referenced in the 2004 Greenway Master Plan. Economy of savings could be provided if both projects are constructed at the same time.

East Fire Tower Road – The existing bridge at this crossing is in good condition and currently performs at a 25-year level or service. Since East Fire Tower Road is a major thoroughfare, the desired level of service is the 50-year storm. In order to provide a 50-year level of service at this crossing, the recommended alternative is to reduce the tailwater by grading floodplain benches downstream of East Fire Tower Road. This alternative entails proposed floodplain benching in the right overbank for approximately 2,000 linear feet. The proposed improvements will bring East Fire Tower Road up to the desired 50-year level of service and provide a reduction in the severity, frequency, and duration of flooding for several properties along Treetops Circle. The proposed improvements would result in up to a 2.3-foot reduction in WSEL for the 25-year event. Additionally, four (4) out of six (6) properties may expect to be removed from the 25-year floodplain and twelve (12) properties from the 100-year floodplain. The majority of the proposed floodplain bench appears to be located within a Pitt County Drainage District easement based on the Pitt County OPIS website. Coordination with the Drainage District will be required to implement the proposed project. The floodplain benching could be coordinated with the proposed Fork Swamp Greenway referenced in the 2004 Greenway Master Plan. Economy of savings could be provided if both projects are constructed at the same time.

Fork Swamp Main Branch Floodplain Benching – In addition to the improvements proposed at and near the individual road crossings, there is a proposed floodplain bench and stream stabilization project located along the main branch of Fork Swamp downstream of FSUT1 and

FSUT2. Approximately 2,670 linear feet of floodplain benching is proposed in the left and right overbank. The proposed project will reduce tailwater for FSUT1 and FSUT2, provide additional floodplain storage and remove four (4) and one (1) properties from the 25-year and 100-year floodplains, respectively. The majority of the proposed floodplain bench appears to be located within a Pitt County Drainage District easement based on the Pitt County OPIS website. Coordination with the Drainage District will be required to implement the proposed project. The floodplain benching could be coordinated with the proposed Fork Swamp Greenway referenced in the 2004 Greenway Master Plan. Economy of savings could be provided if both projects are constructed at the same time.

The total length of the proposed Fork Swamp Greenway is 3.3 miles. Approximately 1.25 miles of the proposed greenway overlaps with the floodplain benching limits. If possible construction of the benching and greenway should be coordinated.

Fork Swamp UT1 (FSUT1) Primary System

Trafalgar Drive – South – The twin 60" CMPs at this crossing are currently providing a 2-year level of service. In order to meet a 25-year level of service, the twin 60" CMPs will remain in place and an additional 60" floodplain culvert will be required along with a new headwall. The proposed improvements will WSEL for the 25-year storm by up to 0.67 feet upstream of Trafalgar Drive- South and remove one property from the 25-year floodplain.

Trafalgar Drive – North – The 60" and 66" CMPs at this crossing are operating at a 2-year level of service. To meet the desired 25-year level of service, it is proposed that the existing CMPs be removed and replaced with twin 8' x 5' RCBCs. The resulting upstream WSEL will be reduced by as much as 0.95 feet in the 25-year if improvements are completed in conjunction with those proposed at Corey Road as described below. This will bring two (2) properties out of the 25-year floodplain and two (2) additional properties out of the 100-year floodplain.

Corey Road – The existing twin 13' x 4.5' corrugated metal arch pipes at this crossing are relatively new and meet the desired 25-year level of service. However, the WSEL at the upstream Trafalgar Drive – North is impacted by the tailwater from Corey Road. In order to lower the tailwater, it is proposed that twin 48" floodplain culverts be installed along with approximately 2,300 linear feet of floodplain benching in the left and right overbanks downstream of Corey Road. The Corey Road improvements should be constructed prior to culvert upgrades at Trafalgar Drive to provide the desired level of service noted above. The proposed improvements would result in up to 2-foot reduction in WSEL for the 25-year event. This will bring one property out of the 25-year floodplain and an additional property out of the 100-year floodplain.

Fork Swamp UT2 Reach 1 (FSUT2R1) Primary System

Old Tar Road – The existing 72" CMP at this crossing is currently operating at a 2-year level of service. In order to meet the desired 50-year level of service, the existing CMP will need to be replaced with twin 7' x 8' RCBCs with 230 linear feet of floodplain benching in the left and right overbanks proposed downstream of Old Tar Road. The NCDOT maintained Old Tar Road is located immediately west of the existing City limits and the City's ETJ. A portion of the proposed floodplain benching along the left bank would be inside the City limits. Based on the location of the road crossing outside the City limits, the Old Tar Road project is not included as a capital project for the City of Greenville.

Fork Swamp UT2 Reach 2 (FSUT2R2) Primary System

West Fire Tower Road – The existing 10' x 8' reinforced concrete box culvert (RCBC) at this crossing is in good condition and is currently exceeding a 100-year level of service. Therefore, no capital improvements are proposed for West Fire Tower Road.

Fork Swamp UT3 (FSUT3) Primary System

Coleman Drive – The existing triple 10' x 4' RCBCs at this crossing are in good condition and currently meet the desired 25-year level of service. With the downstream improvements recommended along FSUT3, the RCBCs will continue to pass the 25-year storm. Therefore, no capital improvements are proposed at this location.

County Home Road – The twin 48" reinforced concrete pipes (RCPs) at this crossing currently pass a 10-year storm event. Based on its classification as a major thoroughfare, it is required to meet a 50-year level of service. It is proposed that the twin 48" RCPs remain in place and an additional 42" floodplain culvert be installed with approximately 240 linear feet of floodplain benching in the left overbank downstream of Country Home Road. The proposed improvements will bring the crossing up to a 50-year level of service and result in up to a 1.3-foot reduction in WSEL for the 25-year event. This will bring two (2) properties out of the 25-year floodplain and two (2) additional properties out of the 100-year floodplain.

East Fire Tower Road – U/S – The existing twin 54" RCPs at this crossing are currently providing a 2-year level of service. In order to meet the desired 50-year level of service, the twin 54" RCPs under East Fire Tower Road will be replaced with twin 6'x 6' RCBCs. The proposed improvements would result in up to a 1.5-foot reduction in WSEL for the 25-year event and one (1) property being removed from the 25-year floodplain.

Wimbledon Drive – The twin 60" CMPs at this crossing are currently providing a 2-year level of service. In order to meet a 25-year level of service, the twin 60" CMPs will be replaced with twin 10' x 5' RCBCs. Additionally, 245 linear feet of floodplain benching is proposed in the right overbank downstream of Wimbledon Drive. Final limits of the proposed benching may

change to minimize impacts to private property owners. The proposed improvements would result in up to a 1.2-foot reduction in WSEL for the 25-year event and removal of one property from the 25-year floodplain.

Tower Place – The twin 66" CMPs at this crossing are currently operating at a 2-year level of service. In order to meet a 25-year level of service, the twin 66" CMPs will be replaced with twin 10' x 5' RCBCs. The proposed improvements would result in up to a 1.0-foot reduction in WSEL for the 25-year event. This will bring two (2) properties out of the 25-year floodplain and one additional property out of the 100-year floodplain.

Summerhaven Drive – Currently, the twin 66" CMPs at this crossing provides a 2-year level of service. To meet a 25-year level of service, the twin 66" CMPs will be replaced with quad 6' x 6' RCBCs. It is proposed that 115 linear feet of floodplain benching be graded downstream of Summerhaven Drive to help lower the tailwater. The proposed improvements would result in up to a 1.2-foot reduction in WSEL for the 25-year event and seven (7) properties being removed from the 25-year floodplain.

East Fire Tower Road – D/S – The existing twin 10' x 7' corrugated metal ellipse pipes only pass the 2-year storm. To meet a 50-year level of service, it is proposed that the existing culverts be removed and replaced with quad 6' x 7' RCBCs. In addition to the culvert upgrade, a total of 3,240 linear feet of floodplain benching is proposed (990 linear feet upstream of the crossing in the left overbank and 2,250 linear feet downstream of the crossing in the left and right overbanks). The proposed improvements would result in up to 1.9 feet reduction in WSEL for the 25-year event. Additionally, forty-two (42) properties will be removed from the 25- and 100-year floodplain.

The floodplain benching could be coordinated with the proposed Fire Tower to Hub - Connector Greenway referenced in the 2004 Greenway Master Plan. Economy of savings could be provided if both projects are constructed at the same time.

Secondary Systems

Corey Road Closed System – The majority of the system is operating at or above the required 10-year level or service. Therefore, the proposed improvements consist of minimal upgrades including upsizing the downstream discharge pipes along Southlea Drive. The proposed pipe improvements range in size from 24" to 48" RCP. The proposed improvements are expected to decrease WSELs by up to 1.7 feet for the 25-year event.

Trafalgar Drive Closed System – All segments of this system located in the Farrington subdivision are operating above the required 10-year level of service. Therefore, no capital improvements are proposed at this location.

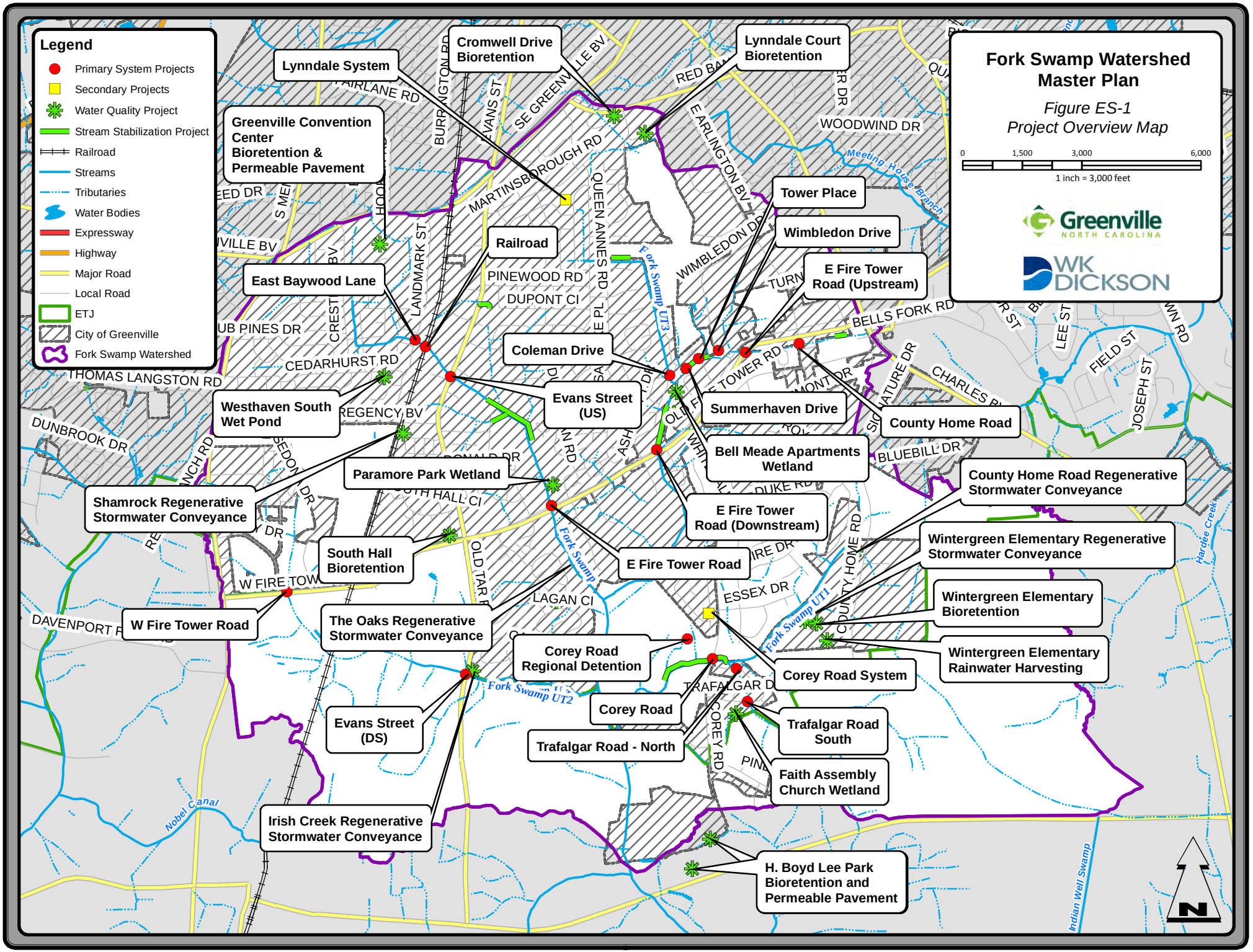
Lynndale System – Seven (7) questionnaires were received from the residents in the Lynndale subdivision reporting yard and street flooding. A study for this area has been completed with

proposed recommendations by River & Associates. The proposed design is included as part of this report. Due to the size of the project, it is recommended that the Lynndale system be completed in three (3) separate phases.

Evans Street Channels – Two (2) channel sections east of Evans Street and south of Pinewood Drive were reported by City staff as being eroded. The channel velocities calculated by the model range between 0.2 and 3.3 feet per second in the 10-year storm event. These channel sections were walked and evaluated by WK Dickson personnel. Based on this evaluation, a stream stabilization project (Project #7) is proposed along the upstream segment.

Regional Detention

A Corey Road facility is proposed in the southern part of the Fork Swamp watershed along FSUT1 adjacent to Corey Road. It is recommended to help offset peak flow increases that will be created as a result of the proposed upstream culvert upgrades. Based on the development of a cursory model, the proposed 20-acre detention pond would lower the flows in the 2-, 10-, 25-, 50-, and 100-year storms by 20 to 25 percent at the confluence of FSUT1 with Fork Swamp. These flow reductions continue through the downstream modeling limits of the Fork Swamp watershed. The regional detention facility will not impact the size of culverts along FSUT1 but will reduce the downstream flows (and therefore the water surface elevations) along the main branch of Fork Swamp. The location of this facility is close to the border of Winterville and outside of the existing City limits, although City residents upstream and downstream of this facility would benefit from the project. The proposed detention facility would be an opportunity to partner with this Winterville and potentially Pitt County. If 25-year detention is required in the areas shown in Section 4.3, then the size of the regional detention area can be substantially reduced to maintain no net increase in the 25-year storm at the study area limits for the future conditions.


Legend
Primary System Projects
Secondary Projects
Water Quality Project
Stream Stabilization Project
Railroad
Streams
Tributaries
Water Bodies
Expressway
Highway
Major Road
Local Road
ETJ
City of Greenville
Fork Swamp Watershed
Fork Swamp Watershed Master Plan
Figure ES-1
Project Overview Map
0
1,500
3,000
6,000
1 inch = 3,000 feet
Greenville
NORTH CAROLINA
WK DICKSON
Lynndale System
Cromwell Drive Bioretention
Lynndale Court Bioretention
Greenville Convention Center Bioretention & Permeable Pavement
Tower Place
Wimbledon Drive
Railroad
East Baywood Lane
E Fire Tower Road (Upstream)
Coleman Drive
Evans Street (US)
Summerhaven Drive
County Home Road
Westhaven South Wet Pond
Bell Meade Apartments Wetland
Paramore Park Wetland
County Home Road Regenerative Stormwater Conveyance
Shamrock Regenerative Stormwater Conveyance
E Fire Tower Road (Downstream)
Wintergreen Elementary Regenerative Stormwater Conveyance
South Hall Bioretention
E Fire Tower Road
W Fire Tower Road
The Oaks Regenerative Stormwater Conveyance
Wintergreen Elementary Bioretention
Wintergreen Elementary Rainwater Harvesting
Corey Road Regional Detention
Corey Road System
Evans Street (DS)
Corey Road
Trafalgar Road South
Trafalgar Road - North
Faith Assembly Church Wetland
Irish Creek Regenerative Stormwater Conveyance
H. Boyd Lee Park Bioretention and Permeable Pavement
Fork Swamp UT3
Fork Swamp UT2
Fork Swamp UT1
Fork Swamp
Meeting House Branch
Hardee Creek
Indian Well Swamp
Nobel Canal
MARTINSBOROUGH RD
QUEEN ANNES RD
PINEWOOD RD
DUPONT CI
WOODWIND DR
EARLINGTON BV
WIMBLEDON DR
BELLS FORK RD
E FIRE TOWER RD
CEDARHURST RD
THOMAS LANGSTON RD
REGENCY BV
DUNBROOK DR
BLUEBILL DR
SOUTH HALL CI
LAGAN CI
ESSEX DR
TRAFALGAR D
COREY RD
COUNTY HOME RD
OLD TAR R
LANDMARK ST
EVANS ST
FIELD ST
JOSEPH ST
LEE ST
CHARLES P
DAVENPORT F
W FIRE TOW
N

Flood Control Prioritization

To appropriately allocate City resources, the flood control projects listed above were prioritized based on the following categories as described in Appendix L:

- Public health and safety
- Severity of street flooding
- Cost effectiveness
- Effect of improvements
- Water quality – BMP
- Open channel – erosion control
- Implementation constraints
- Grant funding
- Constructability

Scores were assigned to each project for the factors listed above to determine the priority list. In some instances, project prioritization will be impacted by the required sequencing of projects to provide the highest possible flood reduction benefits and to reduce or negate any downstream impacts from the proposed projects. Tables ES-1 and ES-2 show the proposed prioritizations and conceptual cost estimates for the Flood Control Improvements. The City should re-visit the prioritization lists annually to determine if priorities should shift. The prioritization scoring for each project and a description of the aforementioned categories is included in Appendix L. The total cost for all of the recommended primary and secondary system improvements in the Fork Swamp watershed is approximately $31,730,000.

Table ES-1: Flood Control Project Prioritization – Primary Systems

Prioritization	Project	Cost
1	Railroad Crossing (Fork Swamp)	$1,000,000
2	Summerhaven Drive (FSUT3)	$650,000
3	Evans Street (Fork Swamp)	$1,920,000
4	Trafalgar Drive - South (FSUT1)	$180,000
5	County Home Road (FSUT3)	$210,000
6	Tower Place (FSUT3)	$640,000
7	East Fire Tower Road (Fork Swamp)	$1,740,000
8	Trafalgar Drive - North (FSUT1)	$440,000
9	Corey Road (FSUT1)	$6,870,000
10	Wimbledon Drive (FSUT3)	$610,000
11	Fork Swamp Main Branch Floodplain Benching	$5,240,000
12	East Fire Tower Road - Downstream (FSUT3)	$4,000,000
13	East Fire Tower Road - Upstream (FSUT3)	$680,000
	Total	$24,180,000

See Appendix L for prioritization details.

Table ES-2: Flood Control Project Prioritization – Secondary Systems

Prioritization	Project	Cost
1	Lynndale Closed System Phase I	$1,010,000
2	Lynndale Closed System Phase II	$3,420,000
3	Lynndale Closed System Phase III	$2,750,000
4	Corey Road Closed System	$370,000
	Total	$7,550,000

See Appendix L for prioritization details.

The additional cost to construct the Corey Road Regional Detention Facility would be $9,500,000 which would include anticipated land acquisition costs.

Stream Stabilization and Water Quality Projects

During the Existing Conditions Analysis, the majority of the streams were quantitatively assessed for stability. Based on this assessment, seven (7) stream stabilization projects were identified as shown on Figure ES-1. Potential components of the stabilization project include, flattening the slope of the channel banks, installing erosion control matting and plantings, rock grade control structures, retaining walls, and rip-rap. The stabilization project will protect residential yards, fences, and structures from further erosion, and substantially decrease the in-stream sediment loads to downstream receiving waters.

In additions to the stream stability projects, eighteen (18) water quality BMP retrofit projects were recommended. Potential project locations were initially identified using available GIS data by focusing on locations with contributing drainage areas that are highly impervious and preferably on publically-owned land. Impervious areas typically generate the highest concentration of pollutants, so treating the runoff from these areas would provide more pollutant material than treating water that carried fewer pollutants. Publically-owned land is ideal for BMP retrofits to reduce or eliminate potential land acquisition costs. See Section 5.2 for additional evaluation criteria for BMP retrofit sites. Potential locations that were identified using GIS were then presented to the City. Following concurrence with the City, the final list of BMPs were field inspected to determine any project constraints present that may not be discernible from GIS data, such as utility conflicts, limited access to the site, or private property conflicts.

The stream stabilization and water quality projects were prioritized using categories similar to those used to prioritize the flood control projects described above (See Appendix L). Cost effectiveness for the stream stabilization project was calculated based on a cost per linear foot of stabilized stream while for water quality projects, it was calculated based on a cost per impervious acre treated. Tables ES-3 and ES-4 show the prioritization of the stream stabilization and water quality projects along with estimates of their preliminary cost.

Table ES-3: Stream Stabilization Prioritization

Prioritization	Project	Cost
1	Evans Street	$130,000
2	Live Oak Lane	$280,000
3	Tower Place	$140,000
4	Charles Boulevard	$90,000
5	East Fire Tower Road	$230,000
6	Queen Annes Road	$220,000
N/A*	Corey Road*	$590,000
	Total	$1,090,000*

*The Corey Road Stream Project is located outside City Limits and therefore was not ranked or included in the total cost. However, improvements will benefit residents in the City limits. See Appendix L for prioritization details.

Table ES-4: Water Quality Project Prioritization

Prioritization	Project	Cost
1	WGP Properties Regenerative Stormwater Conveyance	$60,000
2	H. Boyd Lee Park Bioretention	$340,000
3	Wintergreen Elementary Rainwater Harvesting	$20,000
4	Wintergreen Elementary Bioretention	$310,000
5	South Hall Bioretention	$240,000
6	Lynndale Court Bioretention	$150,000
7	Shamrock Regenerative Stormwater Conveyance	$130,000
8	Paramore Park Wetland	$210,000
9	H. Boyd Lee Park Permeable Pavement	$970,000
10	County Home Road Regenerative Stormwater Conveyance	$490,000
11	The Oaks Regenerative Stormwater Conveyance	$200,000
12	Wintergreen Elementary Regenerative Stormwater Conveyance	$180,000
13	Cromwell Drive Bioretention	$350,000
14	Belle Meade Apartments Wetland	$570,000
15	Faith Assembly Church Pond Retrofit	$270,000
16	Westhaven South Wetland	$820,000
17	Irish Creek Regenerative Stormwater Conveyance	$250,000
18	Greenville Convention Center Permeable Pavement	$2,870,000
	Total	$8,430,000

See Appendix L for prioritization details.

25-Year Detention Analysis

As part of the Fork Swamp Master Plan, an analysis was completed to determine if there are areas within the watershed that should be considered "well documented water quantity problems" requiring detention for the 25-year, 24-hour storm event. As noted in Section 3.1, documented flooding issues are located along Fork Swamp Main Branch, Unnamed Tributary 3, and Unnamed Tributary 1 including the area between Baywood Lane and Treetops Circle along Fork Swamp Main Branch, the area between Corey Road and Trafalgar Drive along Unnamed Tributary 1, and the area between East Fire Tower Road and County Home Road along Unnamed Tributary 3. Large portions of the Fork Swamp watershed are already fully developed, however there are some areas of the watershed where the future conditions 25-year flows could be greater than 10% higher than the current existing flows. These areas are outlined in Section 4.3.

If 25-year detention is required in the proposed areas, the need for culvert improvements will not be eliminated but the recommended culvert sizes could be decreased. Although the cost savings to the City would not be substantial, the severity, frequency, and duration of flooding would be reduced, which would in return provide savings to the property owners.

The Corey Road Regional Detention area is the largest portion of the overall cost for flood control projects in the Fork Swamp watershed ($9,500,000). As previously noted, this project is proposed to address increases in the 25-year flows as a result of increasing upstream capacity and proposed future development. If the City requires 25-year detention for portions of the watershed as shown in Section 4.3, the size of the Corey Road regional detention area can be reduced, which would substantially lower the cost of the proposed detention area by approximately $5 million.

INTRODUCTION

1.1 PROJECT DESCRIPTION

The City of Greenville retained WK Dickson to complete a Watershed Master Plan for the Fork Swamp watershed. As shown in Figure 1-1, the Fork Swamp watershed is located in the south central portion of Greenville and generally drains north to south ultimately discharging to the Neuse River. As noted in the Executive Summary, the goals of the Master Plan include: (1) evaluate the existing flooding, water quality and erosion problems, (2) recommend and prioritize capital improvements to control existing flooding by reducing the frequency and severity of flooding for property owners, and (3) identify stream stabilization projects to reduce the risk of property loss along streams and reduce sediment loads as a result of erosion. To assist in achieving the goals listed above, WK Dickson completed a stormwater drainage infrastructure inventory for drainage structures and features within the Fork Swamp watershed.

The Master Plan includes an evaluation of the segment of Fork Swamp from East Baywood Lane at the upstream end to approximately 900 feet upstream of the Worthington Road crossing at the existing City limits. The following tributaries were evaluated as part of this Master Plan:

- Fork Swamp UT1 from approximately 250 feet upstream of the Trafalgar Drive – South crossing at the upstream end to its confluence with Fork Swamp at the downstream end;
- Fork Swamp UT2R1 from the Old Tar Toad crossing at the upstream end to its confluence with Fork Swamp at the downstream end;
- Fork Swamp UT2R2 from approximately 300 feet downstream of the Regency Boulevard crossing at the upstream end to the West Fire Tower Road crossing at the downstream end; and
- Fork Swamp UT3 from the Queen Annes Road crossing and Charles Boulevard at the upstream end to its confluence with Fork Swamp at the downstream end.

Additionally, four (4) conveyance systems that drain to the primary systems were evaluated. For the purposes of this report, Fork Swamp and its tributaries (FSUT1, FSUT2R1, FSUT2R2, and FSUT3) will be noted as primary systems and the conveyance systems will be noted as secondary systems. A project area map showing the Fork Swamp watershed and the conveyance systems evaluated as part of this Master Plan is included as Figure 1-2. Detailed hydraulic analysis included the following:

- Primary System – Fork Swamp
    - East Baywood Lane Culvert
    - Railroad Crossing Culvert
    - Evans Street Culvert
    - East Fire Tower Road Bridge

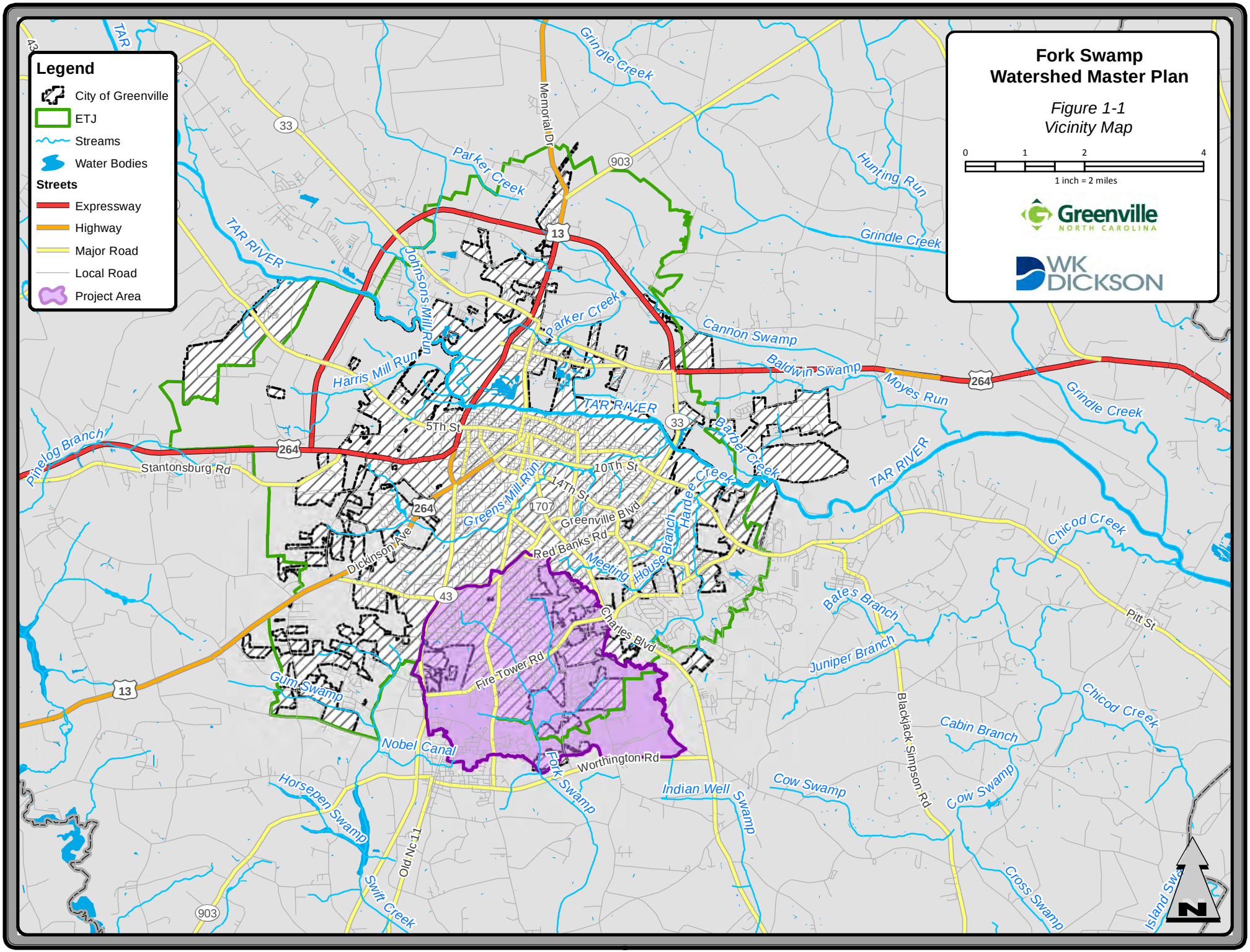
- Primary System – FSUT1
  - Trafalgar Drive – South Culvert
  - Trafalgar Drive – North Culvert
  - Corey Road Culvert

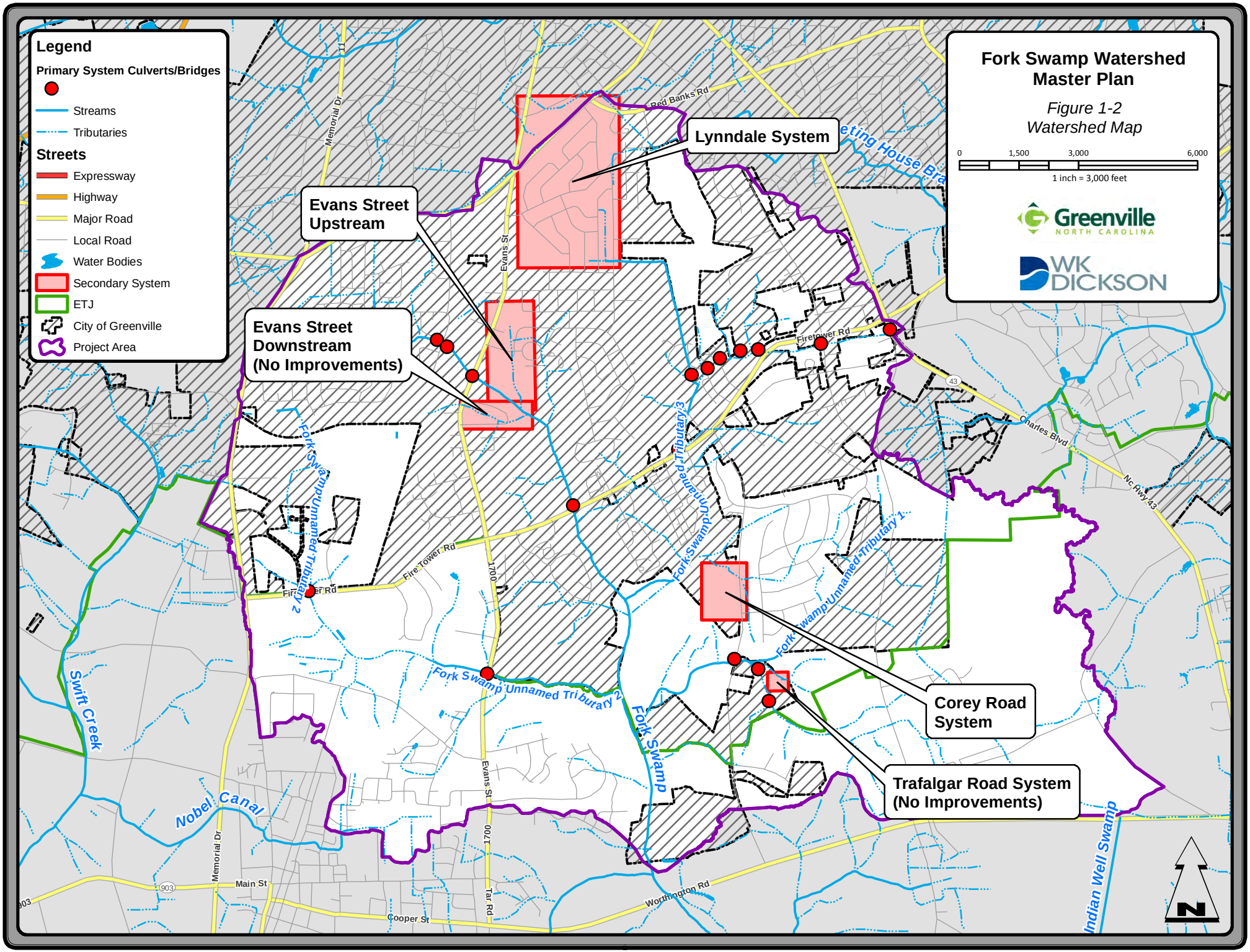
- Primary System – FSUT2R1
  - Old Tar Road Culvert

- Primary System – FSUT2R2
  - West Fire Tower Road Culvert

- Primary System – FSUT3
  - Coleman Drive Culvert
  - County Home Culvert
  - East Fire Tower Road – Upstream Culvert
  - Wimbledon Drive Culvert
  - Tower Place Culvert
  - Summerhaven Drive Culvert
  - East Fire Tower Road – Downstream Culvert

- Secondary Systems
  - Corey Road System
  - Trafalgar System
  - Lynndale System
  - Evans Street Channel System


Legend
City of Greenville
ETJ
Streams
Water Bodies
Streets
Expressway
Highway
Major Road
Local Road
Project Area
Fork Swamp
Watershed Master Plan
Figure 1-1
Vicinity Map
0
1
2
4
1 inch = 2 miles
Greenville
NORTH CAROLINA
WK DICKSON
Grindle Creek
Memorial Dr
Parker Creek
Hunting Run
TAR RIVER
Johnsons Mill Run
Harris Mill Run
Cannon Swamp
Baldwin Swamp
Moyes Run
Pinelog Branch
Stantonsburg Rd
5Th St
10Th St
14Th St
Greens Mill Run
Barber Creek
Hardee Creek
Greenville Blvd
Red Banks Rd
Meeting House Branch
Dickinson Ave
Chicod Creek
Bates Branch
Pitt St
Charles Blvd
Fire Tower Rd
Juniper Branch
Gum Swamp
Nobel Canal
Worthington Rd
Blackjack Simpson Rd
Cabin Branch
Horsepen Swamp
Old Nc 11
Swift Creek
Indian Well Swamp
Cow Swamp
Cross Swamp
33
903
13
264
43
1707
N


Legend
Primary System Culverts/Bridges
Streams
Tributaries
Streets
Expressway
Highway
Major Road
Local Road
Water Bodies
Secondary System
ETJ
City of Greenville
Project Area
Fork Swamp Watershed Master Plan
Figure 1-2
Watershed Map
0
1,500
3,000
6,000
1 inch = 3,000 feet
Greenville
NORTH CAROLINA
WK DICKSON
Lynndale System
Evans Street Upstream
Evans Street Downstream (No Improvements)
Corey Road System
Trafalgar Road System (No Improvements)
Red Banks Rd
Memorial Dr
Evans St
Fire Tower Rd
Firetower Rd
Charles Blvd
NC Hwy 43
Fork Swamp Unnamed Tributary 2
Fork Swamp Unnamed Tributary 3
Fork Swamp Unnamed Tributary 1
Fork Swamp
Swift Creek
Nobel Canal
Main St
Cooper St
Worthington Rd
Tar Rd
Indian Well Swamp
1700
903
43
N

1.2 DESIGN STANDARDS AND CRITERIA

The following design storms were used to evaluate the performance of the primary and secondary systems in this Master Plan:

- 10-year storm event – piped collection systems;
- 25-year storm event – minor thoroughfare roadway bridges and culverts;
- 50-year storm event – major thoroughfare roadway bridges and culverts;
- 100-year storm event – structural flooding of homes; and
- 100-year storm event – overtopping of railroad.

Table 1-1 shows the applicable storm for the project areas evaluated as part of this Master Plan. The corresponding rainfall depths for the design storms are included in Appendix A.

Table 1-1: Project Area Design Standards and Criteria

Drainage Type	Design Storm (years)	Project Area
Piped Collection Systems	10	• Corey Road System • Trafalgar System • Lynndale System
Minor Thoroughfare Roadway Crossings	25	• East Baywood Lane Culvert (Fork Swamp) • East Fire Tower Road Bridge (Fork Swamp) • Trafalgar Drive – South Culvert (FSUT1) • Trafalgar Drive – North Culvert (FSUT1) • Corey Road Culvert (FSUT1) • Old Tar Road Culvert (FSUT2R1) • Coleman Drive Culvert (FSUT3) • Wimbledon Drive Culvert (FSUT3) • Tower Place Culvert (FSUT3) • Summerhaven Drive Culvert (FSUT3)
Major Thoroughfare Roadway Crossings	50	• Evans Street Culvert (Fork Swamp) • West Fire Tower Road Culvert(FSUT2R2) • County Home Road Culvert (FSUT3) • East Fire Tower Road – U/S Culvert (FSUT3) • East Fire Tower Road – D/S Culvert (FSUT3)
Railroad Crossing	100	• Fork Swamp – Culvert

EXISTING WATERSHED CONDITIONS

2.1 CITIZEN INPUT

The Master Plan included a citizen input component to solicit feedback and information regarding stormwater impacts and future stormwater management in the City. In August of 2014, the City began distribution of questionnaires related to stormwater management property owners in the Fork Swamp watershed. Thirty-six (36) questionnaires were completed and returned to the City for consideration from Fork Swamp watershed property owners. The questionnaire results were georeferenced according to the address of the questionnaire respondent (See Figure 2-1). There was one response that was located outside of the City limits. Seven (7) of the respondents indicated some level of property flooding, with one (1) property owners experiencing living space flooding, (4) four crawl space flooding, and 2 (two) AC/storage at least once per year. Twenty-four (24) respondents identified locations where street flooding occurs while another ten (10) residents reported yard flooding. A total of five (5) residents reported erosion threatening streets, yards, garages, or fences. See Figure 2-2 for locations of reported erosion. A sample questionnaire and the tabulated results are provided in Appendix D.

On November 4, 2014, the City provided another avenue for obtaining citizen input by holding a public meeting. An open house format allowed property owners to attend at their convenience and speak to City staff or representatives from WK Dickson. Nine (9) residents from the watershed provided feedback at the meeting. All of these residents were located within the City limits. Minutes from this meeting are included in Appendix D. The results and comments from the citizen's input contributed significantly to the identification and prioritization of problem areas, and validation of model results.

2.2 WATERSHED CHARACTERISTICS

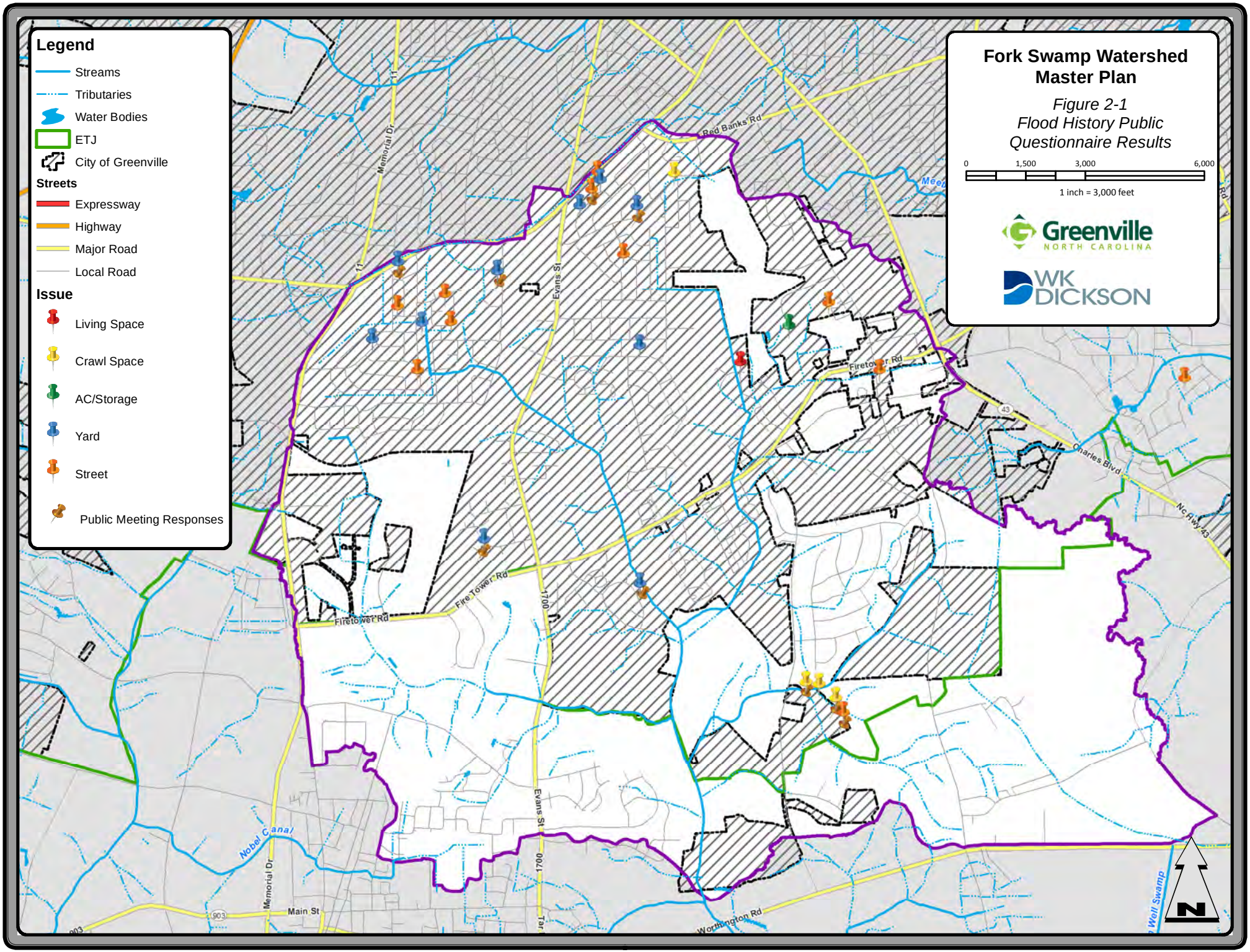
The Fork Swamp watershed is approximately 6,800 acres (10.6 square miles) between its downstream boundary in the vicinity of Worthington Road and its upstream boundary along SE Greenville Boulevard. Approximately 60% of this total watershed area is located within the City limits. Land use in the watershed is approximately 75 percent built out as shown on the Existing Conditions Land Use Map included in Appendix C. The existing land use in the watershed is mostly residential and smaller percentages of commercial, office, and institutional (See Table 2-1a). The soils within the watershed are predominately NRCS hydrologic groups B/D and C as shown on the Soils Map included in Appendix C. More detailed information about the land use and soils in the Fork Swamp watershed is provided in Appendix A.

Table 2-1a: Fork Swamp Watershed Existing Land Use

Land Use Category	Area (acres)
Commercial	452
Mixed Use/Office/Institutional	29
Office/Institutional/Multi-Family	293
Office/Institutional/Medical	67
High Density Residential	508
Medium Density Residential	1,149
Low Density Residential	572
Very Low Density Residential	905
Conservation/Open Space	2,067
Right-of-Way	733
Industrial	32

Table 2-1b: Fork Swamp Watershed Future Land Use

Land Use Category	Area (acres)
Commercial	617
Mixed Use/Office/Institutional	33
Office/Institutional/Multi-Family	381
Office/Institutional/Medical	67
High Density Residential	623
Medium Density Residential	2,074
Low Density Residential	576
Very Low Density Residential	1,146
Conservation/Open Space	628
Right-of-Way	733
Industrial	32


Legend
Streams
Tributaries
Water Bodies
ETJ
City of Greenville
Streets
Expressway
Highway
Major Road
Local Road
Issue
Living Space
Crawl Space
AC/Storage
Yard
Street
Public Meeting Responses
Fork Swamp Watershed Master Plan
Figure 2-1
Flood History Public Questionnaire Results
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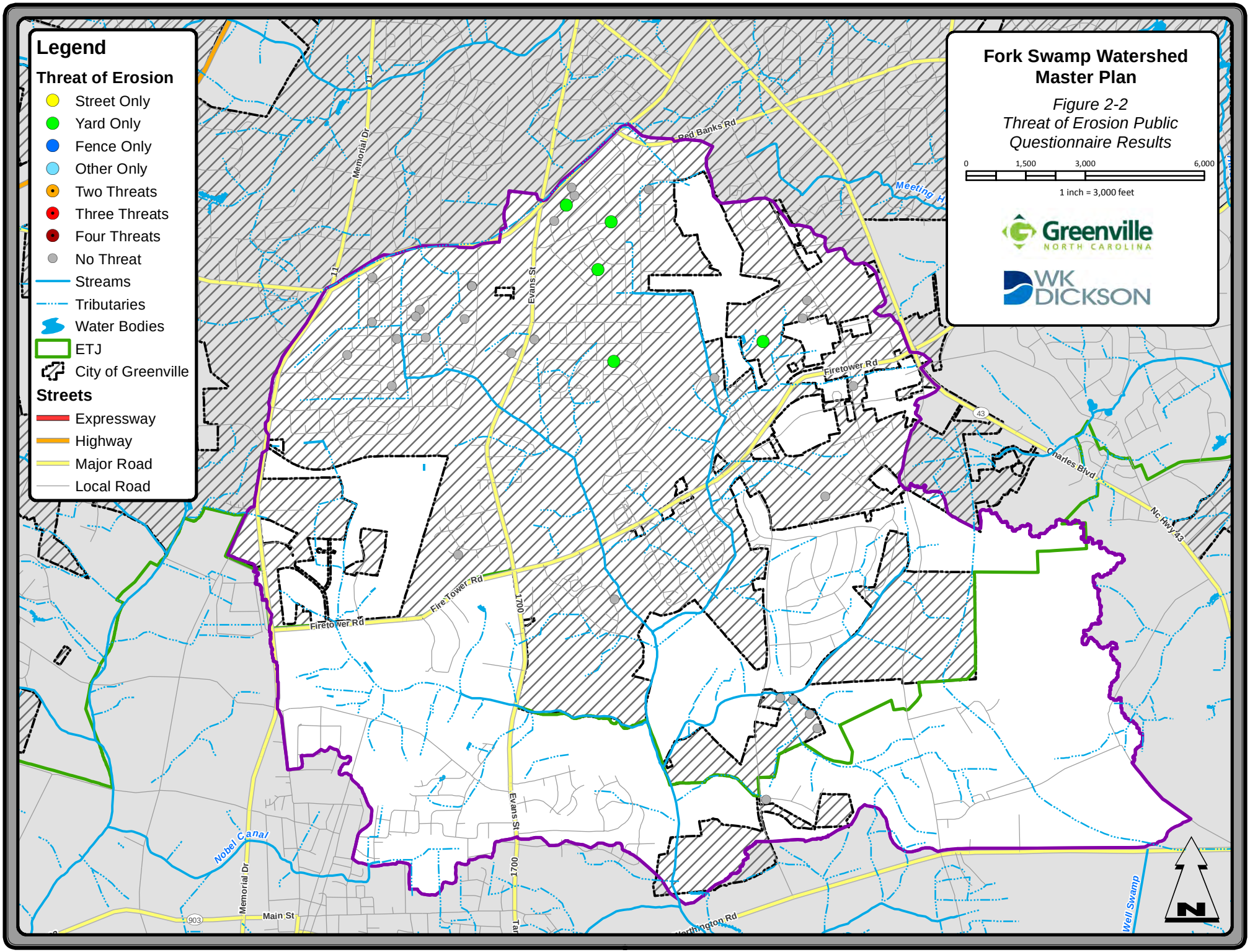
1,500
3,000
6,000
1 inch = 3,000 feet
Greenville
NORTH CAROLINA
WK DICKSON
Red Banks Rd
Memorial Dr
Evans St
Fire Tower Rd
Firetower Rd
Charles Blvd
NC Hwy 43
Main St
Worthington Rd
Nobel Canal
Well Swamp
N


Legend
Threat of Erosion
Street Only
Yard Only
Fence Only
Other Only
Two Threats
Three Threats
Four Threats
No Threat
Streams
Tributaries
Water Bodies
ETJ
City of Greenville
Streets
Expressway
Highway
Major Road
Local Road
Fork Swamp Watershed Master Plan
Figure 2-2
Threat of Erosion Public Questionnaire Results
0
1,500
3,000
6,000
1 inch = 3,000 feet
Greenville
NORTH CAROLINA
WK DICKSON
Red Banks Rd
Memorial Dr
Evans St
Firetower Rd
Fire Tower Rd
Charles Blvd
NC Hwy 43
Nobel Canal
Main St
Worthington Rd
Well Swamp
N

2.3 EXISTING CONDITIONS SURVEY AND FIELD DATA COLLECTION

For the Fork Swamp Watershed Master Plan, stormwater utility infrastructure throughout the watershed was collected by WK Dickson and River & Associates personnel to compile a Geographic Information System (GIS) stormwater inventory database for the City. This was accomplished by using Global Positioning Systems (GPS) at the primary means of data capture. Survey grade employed GPS to locate the x, y, and z coordinates of each visible stormwater system structure and conventional surveying techniques to obtain attributes including but not limited to size, material, slope, and length. The data was collected using horizontal datum NAD 1983 and vertical datum NAVD 1988. A total of 2,379 closed system structures and 208,261 linear feet of pipe were collected as part of the inventory. Tables 2-2 and 2-3 summarize the inventory collected in the Fork Swamp watershed.

Table 2-2: Inventory Summary – Closed System Structures

Structure Type	Number Surveyed
Yard Inlet	220
Drop Inlet	65
Junction Box	103
Pipe End	533
Pond Structure	8
Slab Top Inlet	8
Catch Basin	1,416
Underground Pipe Junction	26

Table 2-3: Inventory Summary – Pipes

Size	Length (Linear Feet)
12″ Diameter	152
15″ Diameter	35,292
18″ Diameter	40,753
24″ Diameter	47,174
30″ Diameter	27,939
36″ Diameter	23,640
42″ Diameter	10,895
48″ Diameter	9,458
54″ Diameter	2,647
60″ Diameter	2,036
66″ Diameter	799
72″ Diameter	525
84″ Diameter	382

Data was obtained for those open channels required to complete connectivity for modeling purposed. Attributes such as shape, lining type, bed type, flow, bottom width, top width, and bank heights were collected for 160 open channel sections totaling over 24 miles in length. For those sections of open channel where more detailed information was required for model input, cross sections were surveyed. Data including elevations for the top of the back, bottom of bank, and channel centerline was obtained for eighty-nine (89) cross sections to supplement the existing FEMA Cross section data. One (1) bridge was also included in the inventory. Refer to the City of Greenville's Storm Water System Inventory Standard Operating Procedures for additional information about the processes and details of the inventory database.

EXISTING WATERSHED ANALYSIS

3.1 PRIMARY SYSTEM HYDROLOGIC AND HYDRAULIC ANALYSES

3.1.1 HYDROLOGY

The purpose of the hydrologic analysis is to estimate the magnitude of selected frequency floods for the Fork Swamp Watershed. The United States Army Corps of Engineers (USACE) HEC-HMS was selected to model the primary systems. HEC-HMS simulates the surface runoff response to precipitation for an interconnected system of surfaces, channels, and ponds. Input data for the HEC-HMS model was developed using topographic, land use, and soils maps in GIS to delineate and calculate the basin areas and Natural Resources Conservation Service (NRCS) hydrologic parameters. Detailed descriptions of the model parameters can be found in Appendices A and B.

The HEC-HMS model offers a variety of methods for simulating the rainfall-runoff response, hydrograph development, channel and pond routing. The selection of methods for the analyses is based on the study objectives, data availability, and watershed characteristics. The precipitation data for the 24-hour duration, Type III storm was used to represent the synthetic rainfall event. The Type III storm was selected based on the location of the City of Greenville. The geographic boundaries for the different NRCS rainfall distributions are shown on Figure B-2 of NRCS document Urban Hydrology for Small Watersheds, dated June 1986 and commonly referred to as TR-55 (See Appendix A). As shown in TR-55 for the coastal regions of North Carolina including Greenville, a Type III storm is more characteristic. The NRCS curve number approach was selected to calculate runoff volumes from the precipitation data, and the sub-basin unit hydrographs for these flood volumes were developed using the NRCS lag times.

Peak flows for the primary systems were developed for the 2-, 10- , 25- , 50- and 100-year storm events. The existing conditions flows were developed assuming attenuation occurs at the following locations:

- East Baywood Lane (Fork Swamp)
- Railroad Crossing (Fork Swamp)
- Evans Street (Fork Swamp)
- Corey Road (FSUT1)
- Trafalgar Drive - North (FSUT1)
- Trafalgar Drive - South (FSUT1)
- West Fire Tower Road (FSUT2R2)
- County Home Road (FSUT3)
- East Fire Tower Road – Upstream (FSUT3)
- Wimbledon Drive (FSUT3)
- Tower Place (FSUT3)
- Coleman Drive (FSUT3)

Storage routing was modeled just upstream of the culverts listed above because of the large storage volume available behind the pipe's entrance. The culverts that have not been included provide little to no accessible storage volume in the area upstream of its respective crossing. The results of the hydrologic model used as input for HEC-RAS are summarized in Table 3-1. A hard copy of the HEC-HMS output is included as Appendix H. The CD found in Appendix J contains this digital information.

Table 3-1: Existing Conditions Flows from HEC-HMS for Fork Swamp Watershed

HEC-HMS Node	Road Name / Location	HEC-RAS Station	Storm Event				
			2-year (cfs)	10-year (cfs)	25-year (cfs)	50-year (cfs)	100-year (cfs)
FORK SWAMP							
East Baywood Lane	East Baywood Lane	55891	188	352	468	569	681
Railroad	Railroad	55592	251	475	629	765	916
Evans Street	Evans Street	54609	256	486	642	784	937
E Fire Tower Road (Bridge)	East Fire Tower Road	50168	438	844	1,138	1,395	1,681
ADD FSUT3 to FS	Confluence of FSUT3 and Fork Swamp	46863	538	1,055	1,414	1,756	2,122
ADD FSUT2	Confluence of FSUT2 and Fork Swamp	44420	757	1,477	2,003	2,486	3,052
ADD FSUT1	Confluence of FSUT1 and Fork Swamp	43230	963	1,937	2,637	3,288	4,025
FORK SWAMP UT1							
U/S Limit FSUT1	Upstream Limit of FSUT1/Trafalgar Drive – South	5103	107	223	309	387	474
Trafalgar Drive	Trafalgar Drive – North	4235	111	231	319	399	490
Corey Road – FSUT1	Corey Road	3380	195	410	577	719	897
FORK SWAMP UT2R1							
ADD FSUT2-7B	Old Tar Road	3499	215	439	604	752	914
FORK SWAMP UT2R2							
U/S Limit FSUT2	Upstream Limit of FSUT2	4262	49	90	118	143	171
West Fire Tower	West Fire Tower Road	303	99	201	276	343	419
FORK SWAMP UT3							
U/S Limit FSUT3	Upstream Limit of FSUT3	4360	108	213	290	358	434

HEC-HMS Node	Road Name / Location	HEC-RAS Station	Storm Event				
			2-year (cfs)	10-year (cfs)	25-year (cfs)	50-year (cfs)	100-year (cfs)
Coleman Drive	Coleman Drive	289	141	290	401	500	612
County Home	County Home Road	10420	62	113	148	178	211
East Fire Tower Road – North	East Fire Tower Road – U/S	8790	89	163	202	250	295
Wimbledon Drive	Wimbledon Drive	8238	142	260	331	409	486
Tower Pl_ Summerhaven Dr	Tower Place/ Summerhaven Drive	7694/ 7287	159	302	392	487	583
East Fire Tower Road - South	East Fire Tower Road – D/S	5065	308	610	810	1,012	1,220

3.1.2 HYDRAULICS

The purpose of the hydraulic analysis is to determine an existing level of flooding for the storm drainage network and to develop proposed solutions to mitigate flooding. The USACE HEC-RAS was selected to model the primary systems to remain consistent the existing FEMA modeling. HEC-RAS calculates water surface profiles for steady, gradually varied flow in channels and floodplains. The standard backwater analysis for sub-critical flow was modeled for the Fork Swamp Watershed. The model calculates the effect of obstructions, such as culverts, and building structures in the channel and floodplain on the water surface profile. The hydraulic computations are based on the solution of a one-dimensional energy equation with energy loss due to friction evaluated by Manning's equation. Input data for HEC-RAS include the following:

- Cross-section geometry of the channel and floodplain;
- Roughness coefficients to describe characteristics of the channel and floodplain;
- Size, shape, and characteristics of culverts and roadways along the stream reach; and
- Energy loss coefficients for flow in the channel and at roadway crossings.

Channel cross sections utilized in the HEC-RAS model were based on the existing FEMA cross sections and WK Dickson surveyed cross sections. The channel cross sections were merged with State LiDAR data to develop cross sections spanning the entire floodplain area.

There were five (5) separate HEC-RAS models developed to analyze the stream reaches located in the Fork Swamp watershed. The starting water surface elevations for the HEC-RAS models were calculated using the slope-area method for three (3) of the models. The calculated normal depths are as follows:

- 0.0037 feet/feet for Fork Swamp Main Branch

- 0.0043 feet/feet for Fork Swamp UT2-R2
- 0.0035 feet/feet for Fork Swamp UT3

For the Fork Swamp UT1 (FSUT1) and Fork Swamp UT2-R1 (FSUT2R1) HEC-RAS models, the starting water surfaces elevations were set based on values calculated in the Fork Swamp Main Branch HEC-RAS model.

Hydraulic Performance

Sixteen (16) roadway crossings were analyzed for flooding potential for the primary system. Descriptions of the existing primary system crossings analyzed are summarized in Table 3-2. Pictures 3-1 through 3-14 of this report provide a visual image of the primary system crossings.

Table 3-2: Existing Condition of Primary System Crossings

Location	Size/Material	Condition
East Baywood Lane (Main Branch)	Twin 72″ CMPs	Good
Railroad (Main Branch)	Twin 84″ CMPs	Fair
Evans Street (Main Branch)	Twin 84″ CMPs	Fair
East Fire Tower Road(Main Branch)	Bridge	Good
Trafalgar Drive – South (FSUT1)	Twin 60″ CMPs	Good
Trafalgar Drive – North (FSUT1)	60″ CMP and 66″ CMP	Good
Corey Road (FSUT1)	Twin 13′ x 4.5′ CMP Arches	Good
Old Tar Toad (FSUT2-R1)	72″ CMP	Poor – Rusted Bottom
West Fire Tower Road (FSUT2 – R2)	10′ x 8′ RCBC	Good
Coleman Drive (FSUT3)	Triple 10′ x 4′ RCBCs	Good
County Home Road (FSUT3)	Twin 48″ RCPs	Good
East Fire Tower Road – U/S (FSUT3)	Twin 54″ RCPs	Good
Wimbledon Drive (FSUT3)	Twin 60″ CMPs	Fair
Tower Place (FSUT3)	Twin 66″ CMPs	Fair
Summerhaven Drive (FSUT3)	Twin 66″ CMPs	Fair
East Fire Tower Road – U/S (FSUT3)	Twin 10′ x 7′ CMP Ellipses	Good

Picture 3-1. East Baywood Lane Culvert – Upstream Face

Picture 3-2. Railroad Crossing Culvert – Upstream Face

Picture 3-3. Evans Street Culvert – Downstream Face

Picture 3-4. Trafalgar Drive – South Culvert – Downstream Face

Picture 3-5. Trafalgar Drive – North Culvert – Downstream Face

Picture 3-6. Corey Road Culvert – Upstream Face

Picture 3-7. West Fire Tower Road Culvert – Downstream Face

Picture 3-8. Coleman Drive Culvert – Downstream Face

Picture 3-9. County Home Road Culvert – Upstream Face

Picture 3-10. East Tower Road –U/S Culvert – Upstream Face

Picture 3-11. Wimbledon Drive Culvert – Upstream Face

Picture 3-12. Tower Place Culvert – Downstream Face

Picture 3-13. Summerhaven Drive Culvert – Upstream Face

Picture 3-14. East Tower Road –D/S Culvert – Upstream Face

The 2-, 10-, 25-, 50- and 100-year existing conditions flood elevations for the primary system crossings are identified in Table 3-3. The minimum elevations at the top of the road for each crossing are also listed in Table 3-3. Along Fork Swamp, none of the four crossings are meeting its desired level of service. East Baywood Lane is operating at a 2-year level of service while the railroad crossing, Evans Street, East Fire Tower Road have a 25-year level of service. The desired level of service for East Baywood Lane and the railroad crossing are the 25-year and 100-year storms, respectively. Evans Street and East Fire Tower Road are major thoroughfares with a desired 50-year level of service.

Along FSUT1, one out of the three crossings is meeting its desired level of service. The desired level of service for Trafalgar Drive – South, Trafalgar Drive – North, and Corey Road is the 25-year storm. As shown in Table 3-3, Trafalgar Drive – South is providing a 2-year level of service while Trafalgar Drive – North is providing a 10-year level of service. The new culvert at the Corey Road crossing is performing at the desired 25-year level of service.

There is only one roadway crossing along FSUT2R1, Old Tar Road. It is located on the edge of the City's limit and operating at a 2-year level of service. This is below the 25-year desired level of service. Along FSUT2R2 there is one roadway crossing, West Fire Tower Road. The desired level of service at this location is 50-year. Currently, West Fire Tower Road exceeds a 100-year storm with over 18 inches of freeboard.

Along FSUT3, one out of the seven crossings is meeting its desired level of service. As shown in Table 3-3, only Coleman Drive is providing the desired 25-year level of service while the remaining Wimbledon Drive, Tower Place, and Summerhaven Drive are performing at a 2-year level of service. The desired level of service for Coleman Drive, Wimbledon Drive, Tower Place, and Summerhaven Drive is the 25-year storm. County Home Road, East Fire Tower Road – U/S, and East Fire Tower Road – D/S are desired to meet a 50-year level of service. Currently, County Home Road provides a 10-year level of service while East Fire Tower Road – U/S and East Fire Tower Road – D/S only operate at a 2-year level or service.

Table 3-3: Hydraulic Performance for Existing Conditions Roadway Flooding

Location	Minimum Elevation at Top of Road (feet NAVD)	Desired Level of Service (Year)	Calculated Water Surface Elevations (feet NAVD)				
			2-year flood	10-year flood	25-year flood	50-year flood	100-year flood
FORK SWAMP							
East Baywood Lane (Culvert)	66.01	25-year	63.88	**66.27**	**68.77**	**70.98**	**71.36**
Railroad (Culvert)	70.89	100-year	63.05	65.99	68.74	**70.97**	**71.35**
Evans Street (Culvert)	66.51	50-year	61.42	63.97	65.78	**66.88**	**67.20**
East Fire Tower Road (Bridge)	58.23	50-year	55.49	57.02	57.39	**58.33**	**58.68**
FORK SWAMP UT1							
Trafalgar Drive – South (Culvert)	55.81	25-year	53.69	**55.95**	**56.29**	**56.48**	**56.63**
Trafalgar Drive – North (Culvert)	54.35	25-year	53.05	**54.67**	**55.14**	**55.43**	**55.78**
Corey Road (Culvert)	54.81	25-year	52.31	53.39	54.26	**55.05**	**55.43**
FORK SWAMP UT2R1							
Old Tar Road (Culvert)	55.64	25-year	55.44	**56.26**	**56.59**	**56.71**	**56.86**
FORK SWAMP UT2R2							
West Fire Tower Road (Culvert)	65.70	50-year	60.61	61.90	62.67	63.30	63.96
FORK SWAMP UT3							
Coleman Drive (Culvert)	61.97	25-year	59.18	61.26	61.96	**62.44**	**62.81**
County Home Road (Culvert)	65.81	50-year	63.09	65.51	**66.13**	**66.45**	**66.72**
East Fire Tower Road – U/S (Culvert)	64.51	50-year	61.96	**64.72**	**64.96**	**65.16**	**65.32**
Wimbledon Drive (Culvert)	63.61	50-year	61.69	**64.09**	**64.25**	**64.35**	**64.44**
Tower Place (Culvert)	63.01	25-year	60.62	**63.02**	**63.29**	**63.45**	**63.58**
Summerhaven Drive (Culvert)	61.51	25-year	59.81	**62.13**	**62.49**	**62.75**	**62.93**
East Fire Tower Road – U/S (Culvert)	59.51	25-year	57.48	**59.74**	**60.20**	**60.49**	**60.72**

*Bold text indicates the existing water surface has exceeded the crest or low point in the road thereby causing flooding.

** Green shade indicates crossing meets desired level of service. Red shade indicates crossing does not meet desired level of service.

In addition to evaluating the roadway crossings, an evaluation was performed to determine the residences along the primary system streams that are at risk of flooding during the 25- and 100-year storm event. The existing 25- and 100- year floodplains for these streams are shown in Figures 3-1 through 3-8. The mapped floodplains are based on model results obtained as part of the Master Plan and may differ from the published FEMA floodplains. For flood insurance

purposes, the effective FEMA floodplain should be referenced. For structures outside of the 100-year effective FEMA floodplain, property owners must determine if purchasing flood insurance is necessary. The City is in no way responsible for determining if flood insurance is required or for notifying property owners of the potential risk of flooding.

Tables 3-4 through 3-8 lists the lowest adjacent grade elevations along with the existing 25- and 100-year water surface elevation for those properties at risk of flooding. The lowest adjacent grade (LAG) elevations shown in the table are not surveyed and are estimated based on the State of North Carolina's LiDAR data. LAG flooding shown in the tables may not result in actual LAG or finished floor flooding, but it is indicative of structures being at risk of flooding.

Table 3-4: Existing Conditions At-Risk Properties/Structures – Fork Swamp

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
4004 ALBION DR	58.70	57.68	**58.77**
102 AMBER LN	70.00	68.80	**71.36**
103 AMBER LN	70.00	68.80	**71.36**
104 AMBER LN	70.00	68.80	**71.36**
102 ANTLER RD	70.00	68.80	**71.36**
103 ANTLER RD	70.53	68.80	**71.36**
104 ANTLER RD	70.00	68.80	**71.36**
105 ANTLER RD	70.16	68.80	**71.36**
106 ANTLER RD	70.00	68.80	**71.36**
107 ANTLER RD	70.16	68.80	**71.36**
108 ANTLER RD	70.00	68.80	**71.36**
109 ANTLER RD	70.62	68.80	**71.36**
110 ANTLER RD	70.00	68.80	**71.36**
111 ANTLER RD	70.62	68.80	**71.36**
112 ANTLER RD	70.05	68.80	**71.36**
114 ANTLER RD	71.02	68.80	**71.36**
126 ANTLER RD	70.37	68.80	**71.36**
129 ANTLER RD	71.10	68.80	**71.36**
131 ANTLER RD	70.00	68.80	**71.36**
133 ANTLER RD	70.00	68.80	**71.36**
100 E BAYWOOD LN	69.33	68.80	**71.36**
101 E BAYWOOD LN	69.16	68.80	**71.36**
102 E BAYWOOD LN	69.57	68.80	**71.36**
103 E BAYWOOD LN	69.16	68.80	**71.36**
104 E BAYWOOD LN	69.57	68.80	**71.36**
105 E BAYWOOD LN	69.03	68.80	**71.36**
106 E BAYWOOD LN	68.29	**68.80**	**71.36**
107 E BAYWOOD LN	69.03	68.80	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
201 E BAYWOOD LN	68.00	**68.80**	**71.36**
203 E BAYWOOD LN	68.00	**68.80**	**71.36**
205 E BAYWOOD LN	68.00	**68.80**	**71.36**
3101 E BAYWOOD LN	69.06	68.80	**71.36**
3200 E BAYWOOD LN	68.01	**68.80**	**71.36**
3202 E BAYWOOD LN	69.79	68.80	**71.36**
3203 E BAYWOOD LN	70.00	68.80	**71.36**
3205 E BAYWOOD LN	70.00	68.80	**71.36**
3301 E BAYWOOD LN	70.00	68.79	**71.36**
3303 E BAYWOOD LN	70.00	68.78	**71.36**
3400 E BAYWOOD LN	68.59	**68.78**	**71.36**
3402 E BAYWOOD LN	68.00	**68.78**	**71.36**
3403 E BAYWOOD LN	68.00	**68.77**	**71.35**
3404 E BAYWOOD LN	66.00	**68.77**	**71.36**
3405 E BAYWOOD LN	66.02	**68.77**	**71.35**
3406 E BAYWOOD LN	66.00	**68.77**	**71.36**
3407 E BAYWOOD LN	66.02	**68.77**	**71.35**
3409 E BAYWOOD LN	66.02	**68.77**	**71.35**
3411 E BAYWOOD LN	66.00	**68.77**	**71.35**
3501 E BAYWOOD LN	66.00	**68.77**	**71.35**
3503 E BAYWOOD LN	66.00	**68.77**	**71.35**
3505 E BAYWOOD LN	65.34	**68.77**	**71.35**
3601 E BAYWOOD LN	65.34	**68.77**	**71.35**
3603 E BAYWOOD LN	69.62	68.77	**71.35**
100 S BAYWOOD LN	66.31	**68.80**	**71.36**
102 S BAYWOOD LN	68.03	**68.80**	**71.36**
103 S BAYWOOD LN	69.33	68.80	**71.36**
104 S BAYWOOD LN	67.72	**68.80**	**71.36**
105 S BAYWOOD LN	70.00	68.80	**71.36**
106 S BAYWOOD LN	70.00	68.80	**71.36**
107 S BAYWOOD LN	70.00	68.80	**71.36**
108 S BAYWOOD LN	70.00	68.80	**71.36**
109 S BAYWOOD LN	70.00	68.80	**71.36**
110 S BAYWOOD LN	69.19	68.80	**71.36**
111 S BAYWOOD LN	70.00	68.80	**71.36**
112 S BAYWOOD LN	69.19	68.80	**71.36**
114 S BAYWOOD LN	68.86	68.80	**71.36**
116 S BAYWOOD LN	68.86	68.80	**71.36**
202 S BAYWOOD LN	68.00	**68.80**	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
203 S BAYWOOD LN	70.00	68.80	**71.36**
204 S BAYWOOD LN	70.00	68.80	**71.36**
205 S BAYWOOD LN	70.00	68.80	**71.36**
206 S BAYWOOD LN	70.00	68.80	**71.36**
207 S BAYWOOD LN	70.00	68.80	**71.36**
208 S BAYWOOD LN	70.00	68.80	**71.36**
209 S BAYWOOD LN	70.00	68.80	**71.36**
210 S BAYWOOD LN	70.00	68.80	**71.36**
211 S BAYWOOD LN	70.00	68.80	**71.36**
207 BELVEDERE DR	71.17	68.80	**71.36**
209 BELVEDERE DR	70.00	68.80	**71.36**
210 BELVEDERE DR	70.00	68.80	**71.36**
211 BELVEDERE DR	70.00	68.80	**71.36**
212 BELVEDERE DR	70.00	68.80	**71.36**
213 BELVEDERE DR	70.00	68.80	**71.36**
214 BELVEDERE DR	70.00	68.80	**71.36**
215 BELVEDERE DR	70.00	68.80	**71.36**
217 BELVEDERE DR	70.00	68.80	**71.36**
218 BELVEDERE DR	70.00	68.80	**71.36**
219 BELVEDERE DR	70.00	68.80	**71.36**
220 BELVEDERE DR	70.00	68.80	**71.36**
222 BELVEDERE DR	70.00	68.80	**71.36**
302 BELVEDERE DR	70.60	68.80	**71.36**
204 BENT CREEK DR	67.15	**68.79**	**71.36**
206 BENT CREEK DR	69.89	68.80	**71.36**
208 BENT CREEK DR	65.64	**68.80**	**71.36**
210 BENT CREEK DR	70.31	68.80	**71.36**
3800 BOXWOOD LN	70.00	68.80	**71.36**
3802 BOXWOOD LN	70.00	68.80	**71.36**
3804 BOXWOOD LN	70.00	68.80	**71.36**
3806 BOXWOOD LN	70.00	68.80	**71.36**
102 BRIARWOOD DR	70.00	68.80	**71.36**
103 BRIARWOOD DR	70.00	68.80	**71.36**
104 BRIARWOOD DR	70.00	68.80	**71.36**
105 BRIARWOOD DR	70.00	68.80	**71.36**
106 BRIARWOOD DR	70.00	68.80	**71.36**
107 BRIARWOOD DR	70.00	68.80	**71.36**
200 BRISTOL CT	67.74	**68.80**	**71.36**
201 BRISTOL CT	67.49	**68.80**	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
202 BRISTOL CT	68.90	68.80	**71.36**
203 BRISTOL CT	69.90	68.80	**71.36**
204 BRISTOL CT	68.90	68.80	**71.36**
205 BRISTOL CT	70.86	68.80	**71.36**
206 BRISTOL CT	69.78	68.80	**71.36**
207 BRISTOL CT	70.86	68.80	**71.36**
208 BRISTOL CT	70.00	68.80	**71.36**
209 BRISTOL CT	71.28	68.80	**71.36**
210 BRISTOL CT	70.00	68.80	**71.36**
211 BRISTOL CT	71.28	68.80	**71.36**
212 BRISTOL CT	70.00	68.80	**71.36**
731 CEDAR RIDGE DR	53.17	52.29	**53.31**
737 CEDAR RIDGE DR	53.17	52.28	**53.30**
743 CEDAR RIDGE DR	51.77	**52.26**	**53.28**
749 CEDAR RIDGE DR	51.77	**52.25**	**53.27**
751 CEDAR RIDGE DR	53.20	52.23	**53.25**
329 CEDARHURST RD	70.38	68.80	**71.36**
330 CEDARHURST RD	70.00	68.80	**71.36**
332 CEDARHURST RD	70.00	68.80	**71.36**
400 CEDARHURST RD	70.00	68.80	**71.36**
401 CEDARHURST RD	70.00	68.80	**71.36**
402 CEDARHURST RD	70.00	68.80	**71.36**
403 CEDARHURST RD	70.00	68.80	**71.36**
404 CEDARHURST RD	70.00	68.80	**71.36**
405 CEDARHURST RD	70.00	68.80	**71.36**
407 CEDARHURST RD	70.00	68.80	**71.36**
500 CEDARHURST RD	70.00	68.80	**71.36**
502 CEDARHURST RD	70.00	68.80	**71.36**
503 CEDARHURST RD	70.00	68.80	**71.36**
504 CEDARHURST RD	70.00	68.80	**71.36**
505 CEDARHURST RD	70.00	68.80	**71.36**
506 CEDARHURST RD	70.00	68.80	**71.36**
507 CEDARHURST RD	70.00	68.80	**71.36**
508 CEDARHURST RD	70.00	68.80	**71.36**
509 CEDARHURST RD	70.00	68.80	**71.36**
510 CEDARHURST RD	69.74	68.80	**71.36**
511 CEDARHURST RD	70.00	68.80	**71.36**
512 CEDARHURST RD	69.74	68.80	**71.36**
513 CEDARHURST RD	70.00	68.80	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
514 CEDARHURST RD	70.00	68.80	**71.36**
515 CEDARHURST RD	70.62	68.80	**71.36**
516 CEDARHURST RD	70.25	68.80	**71.36**
601 CEDARHURST RD	70.62	68.80	**71.36**
603 CEDARHURST RD	70.07	68.80	**71.36**
604 CEDARHURST RD	70.00	68.80	**71.36**
605 CEDARHURST RD	70.00	68.80	**71.36**
606 CEDARHURST RD	70.00	68.80	**71.36**
607 CEDARHURST RD	70.00	68.80	**71.36**
608 CEDARHURST RD	70.00	68.80	**71.36**
609 CEDARHURST RD	70.00	68.80	**71.36**
700 CEDARHURST RD	70.00	68.80	**71.36**
701 CEDARHURST RD	70.00	68.80	**71.36**
702 CEDARHURST RD	70.00	68.80	**71.36**
703 CEDARHURST RD	70.00	68.80	**71.36**
600 CHELTENHAM DR	70.58	68.80	**71.36**
608 CHELTENHAM DR	70.00	68.80	**71.36**
612 CHELTENHAM DR	70.00	68.80	**71.36**
628 CHELTENHAM DR	70.65	68.80	**71.36**
102 CLAYBOURNE CT	69.14	68.80	**71.36**
104 CLAYBOURNE CT	69.14	68.80	**71.36**
106 CLAYBOURNE CT	69.14	68.80	**71.36**
108 CLAYBOURNE CT	70.00	68.80	**71.36**
201 CLAYBOURNE CT	68.00	**68.80**	**71.36**
103 CLUB PINES DR	70.32	68.80	**71.36**
200 CLUB PINES DR	70.94	68.80	**71.36**
205 CLUB PINES DR	70.38	68.80	**71.36**
206 CLUB PINES DR	72.00	68.80	**71.36**
300 CLUB PINES DR	70.62	68.80	**71.36**
301 CLUB PINES DR	70.21	68.80	**71.36**
302 CLUB PINES DR	70.19	68.80	**71.36**
303 CLUB PINES DR	70.21	68.80	**71.36**
304 CLUB PINES DR	70.19	68.80	**71.36**
305 CLUB PINES DR	70.53	68.80	**71.36**
400 CLUB PINES DR	70.00	68.80	**71.36**
401 CLUB PINES DR	70.00	68.80	**71.36**
402 CLUB PINES DR	70.00	68.80	**71.36**
403 CLUB PINES DR	70.00	68.80	**71.36**
500 CLUB PINES DR	70.00	68.80	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
503 CLUB PINES DR	70.00	68.80	**71.36**
507 CLUB PINES DR	70.00	68.80	**71.36**
601 CLUB PINES DR	70.00	68.80	**71.36**
603 CLUB PINES DR	70.91	68.80	**71.36**
3296 COLONY CT	70.00	68.80	**71.36**
898 CORBETT ST	52.90	51.99	**52.98**
4698 COREY RD	48.00	**52.13**	**53.13**
102 CRESTLINE PL	69.07	68.80	**71.36**
104 CRESTLINE PL	70.00	68.80	**71.36**
200 CRESTLINE BV	70.64	68.80	**71.36**
202 CRESTLINE BV	70.00	68.80	**71.36**
203 CRESTLINE BV	72.00	68.80	**71.36**
204 CRESTLINE BV	70.00	68.80	**71.36**
205 CRESTLINE BV	70.00	68.80	**71.36**
206 CRESTLINE BV	70.00	68.80	**71.36**
207 CRESTLINE BV	70.00	68.80	**71.36**
208 CRESTLINE BV	70.00	68.80	**71.36**
209 CRESTLINE BV	70.00	68.80	**71.36**
210 CRESTLINE BV	70.00	68.80	**71.36**
211 CRESTLINE BV	70.00	68.80	**71.36**
212 CRESTLINE BV	70.00	68.80	**71.36**
213 CRESTLINE BV	70.00	68.80	**71.36**
214 CRESTLINE BV	70.00	68.80	**71.36**
215 CRESTLINE BV	70.00	68.80	**71.36**
216 CRESTLINE BV	70.00	68.80	**71.36**
217 CRESTLINE BV	69.26	68.80	**71.36**
300 CRESTLINE BV	70.00	68.80	**71.36**
301 CRESTLINE BV	70.00	68.80	**71.36**
302 CRESTLINE BV	70.00	68.80	**71.36**
303 CRESTLINE BV	68.85	68.80	**71.36**
304 CRESTLINE BV	70.00	68.80	**71.36**
305 CRESTLINE BV	68.85	68.80	**71.36**
307 CRESTLINE BV	68.43	**68.80**	**71.36**
309 CRESTLINE BV	66.12	**68.80**	**71.36**
311 CRESTLINE BV	66.12	**68.80**	**71.36**
313 CRESTLINE BV	70.00	68.80	**71.36**
400 CRESTLINE BV	70.00	68.80	**71.36**
401 CRESTLINE BV	69.20	68.80	**71.36**
402 CRESTLINE BV	70.00	68.80	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
403 CRESTLINE BV	69.20	68.80	**71.36**
404 CRESTLINE BV	70.00	68.80	**71.36**
405 CRESTLINE BV	70.00	68.80	**71.36**
406 CRESTLINE BV	70.16	68.80	**71.36**
407 CRESTLINE BV	70.00	68.80	**71.36**
408 CRESTLINE BV	70.16	68.80	**71.36**
409 CRESTLINE BV	70.00	68.80	**71.36**
410 CRESTLINE BV	70.78	68.80	**71.36**
411 CRESTLINE BV	70.00	68.80	**71.36**
412 CRESTLINE BV	70.00	68.80	**71.36**
413 CRESTLINE BV	70.00	68.80	**71.36**
415 CRESTLINE BV	71.36	68.80	**71.36**
501 CRESTLINE BV	66.00	**68.80**	**71.36**
502 CRESTLINE BV	71.88	68.80	**71.36**
503 CRESTLINE BV	66.00	**68.80**	**71.36**
504 CRESTLINE BV	71.14	68.80	**71.36**
505 CRESTLINE BV	67.93	**68.80**	**71.36**
506 CRESTLINE BV	70.00	68.80	**71.36**
507 CRESTLINE BV	67.93	**68.80**	**71.36**
508 CRESTLINE BV	70.00	68.80	**71.36**
509 CRESTLINE BV	70.00	68.80	**71.36**
511 CRESTLINE BV	70.00	68.80	**71.36**
512 CRESTLINE BV	70.00	68.80	**71.36**
513 CRESTLINE BV	70.00	68.80	**71.36**
514 CRESTLINE BV	70.40	68.80	**71.36**
515 CRESTLINE BV	70.00	68.80	**71.36**
517 CRESTLINE BV	70.00	68.80	**71.36**
519 CRESTLINE BV	70.49	68.80	**71.36**
522 CRESTLINE BV	70.17	68.80	**71.36**
524 CRESTLINE BV	70.17	68.80	**71.36**
526 CRESTLINE BV	70.00	68.80	**71.36**
528 CRESTLINE BV	70.00	68.80	**71.36**
530 CRESTLINE BV	70.00	68.80	**71.36**
531 CRESTLINE BV	70.95	68.80	**71.36**
532 CRESTLINE BV	70.00	68.80	**71.36**
533 CRESTLINE BV	70.00	68.80	**71.36**
534 CRESTLINE BV	70.00	68.80	**71.36**
535 CRESTLINE BV	70.00	68.80	**71.36**
536 CRESTLINE BV	70.00	68.80	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
537 CRESTLINE BV	70.00	68.80	**71.36**
538 CRESTLINE BV	70.00	68.80	**71.36**
539 CRESTLINE BV	70.00	68.80	**71.36**
540 CRESTLINE BV	70.00	68.80	**71.36**
543 CRESTLINE BV	70.00	68.80	**71.36**
545 CRESTLINE BV	70.00	68.80	**71.36**
547 CRESTLINE BV	70.00	68.80	**71.36**
3401 CUTLER CT	69.09	68.78	**71.36**
3402 CUTLER CT	68.00	**68.80**	**71.36**
3403 CUTLER CT	68.00	**68.79**	**71.36**
102 DARWIN CT	70.47	68.80	**71.36**
104 DARWIN CT	70.47	68.80	**71.36**
106 DARWIN CT	70.00	68.80	**71.36**
108 DARWIN CT	70.00	68.80	**71.36**
4246 DUDLEYS GRANT DR 1	54.00	**54.20**	**54.96**
4246 DUDLEYS GRANT DR 2	54.00	**54.20**	**54.96**
4246 DUDLEYS GRANT DR 3	54.00	**54.20**	**54.96**
4267 DUDLEYS GRANT DR H	54.00	53.38	**54.23**
4267 DUDLEYS GRANT DR I	54.00	53.46	**54.29**
4271 DUDLEYS GRANT DR A	54.10	53.30	**54.16**
4271 DUDLEYS GRANT DR B	54.10	53.27	**54.14**
4271 DUDLEYS GRANT DR C	54.10	53.25	**54.12**
4271 DUDLEYS GRANT DR D	51.68	**53.08**	**53.98**
4272 DUDLEYS GRANT DR A	54.10	53.26	**54.14**
4275 DUDLEYS GRANT DR F	51.68	**53.08**	**53.98**
4275 DUDLEYS GRANT DR E	51.68	**53.13**	**54.03**
4275 DUDLEYS GRANT DR D	51.68	**53.05**	**53.97**
4275 DUDLEYS GRANT DR C	51.68	**53.05**	**53.97**
4275 DUDLEYS GRANT DR B	51.68	**53.08**	**53.98**
4202 DUNHAGAN RD	58.47	**58.87**	**59.69**
4204 DUNHAGAN RD	58.00	**58.62**	**59.49**
4206 DUNHAGAN RD	58.64	58.53	**59.41**
4208 DUNHAGAN RD	58.00	**58.42**	**59.33**
3400 DUNHAVEN DR	68.00	**68.80**	**71.36**
3402 DUNHAVEN DR	68.00	**68.80**	**71.36**
3403 DUNHAVEN DR	68.00	**68.80**	**71.36**
3404 DUNHAVEN DR	68.73	**68.80**	**71.36**
3405 DUNHAVEN DR	68.00	**68.80**	**71.36**
3406 DUNHAVEN DR	68.72	**68.80**	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
3407 DUNHAVEN DR	68.00	**68.80**	**71.36**
3408 DUNHAVEN DR	67.11	**68.80**	**71.36**
3409 DUNHAVEN DR	68.00	**68.79**	**71.36**
3410 DUNHAVEN DR	68.00	**68.80**	**71.36**
3411 DUNHAVEN DR	67.25	**68.79**	**71.36**
3412 DUNHAVEN DR	68.00	**68.80**	**71.36**
3414 DUNHAVEN DR	68.00	**68.79**	**71.36**
3416 DUNHAVEN DR	68.00	**68.78**	**71.36**
430 E FIRE TOWER RD	53.31	**56.09**	**58.86**
413 FORREST PK	58.54	**59.30**	**60.06**
416 FORREST PK	60.00	59.35	**60.10**
417 FORREST PK	58.54	**59.33**	**60.08**
420 FORREST PK	58.00	**59.43**	**60.17**
424 FORREST PK	58.00	**59.45**	**60.19**
428 FORREST PK	58.00	**59.44**	**60.18**
432 FORREST PK	58.00	**59.32**	**60.07**
436 FORREST PK	58.00	**59.25**	**60.01**
440 FORREST PK	58.00	**59.17**	**59.95**
441 FORREST PK	58.54	**59.28**	**60.04**
448 FORREST PK	59.07	**59.12**	**59.90**
449 FORREST PK	60.00	59.24	**60.01**
2187 FRANKLIN DR	49.13	**52.19**	**53.20**
2197 FRANKLIN DR	49.79	**52.15**	**53.15**
100 GREENWOOD DR	70.00	68.80	**71.36**
102 GREENWOOD DR	70.97	68.80	**71.36**
103 GREENWOOD DR	70.00	68.80	**71.36**
104 GREENWOOD DR	70.00	68.80	**71.36**
105 GREENWOOD DR	70.55	68.80	**71.36**
106 GREENWOOD DR	70.20	68.80	**71.36**
108 GREENWOOD DR	70.20	68.80	**71.36**
111 GREENWOOD DR	71.22	68.80	**71.36**
113 GREENWOOD DR	70.00	68.80	**71.36**
115 GREENWOOD DR	70.52	68.80	**71.36**
116 GREENWOOD DR	71.10	68.80	**71.36**
118 GREENWOOD DR	70.38	68.80	**71.36**
120 GREENWOOD DR	70.20	68.80	**71.36**
121 GREENWOOD DR	71.32	68.80	**71.36**
123 GREENWOOD DR	71.32	68.80	**71.36**
200 GREENWOOD DR	70.00	68.80	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
202 GREENWOOD DR	70.00	68.80	**71.36**
204 GREENWOOD DR	70.00	68.80	**71.36**
205 GREENWOOD DR	70.00	68.80	**71.36**
206 GREENWOOD DR	70.00	68.80	**71.36**
208 GREENWOOD DR	70.00	68.80	**71.36**
212 GREENWOOD DR	70.00	68.80	**71.36**
301 GREENWOOD DR	70.00	68.80	**71.36**
303 GREENWOOD DR	70.00	68.80	**71.36**
401 GREENWOOD DR	68.23	**68.80**	**71.36**
403 GREENWOOD DR	68.48	**68.80**	**71.36**
405 GREENWOOD DR	68.48	**68.80**	**71.36**
200 HARMONY ST	70.88	68.80	**71.36**
201 HARMONY ST	70.00	68.80	**71.36**
203 HARMONY ST	70.00	68.80	**71.36**
204 HARMONY ST	70.95	68.80	**71.36**
205 HARMONY ST	70.00	68.80	**71.36**
206 HARMONY ST	70.00	68.80	**71.36**
207 HARMONY ST	70.00	68.80	**71.36**
208 HARMONY ST	70.00	68.80	**71.36**
209 HARMONY ST	70.00	68.80	**71.36**
210 HARMONY ST	70.00	68.80	**71.36**
211 HARMONY ST	70.00	68.80	**71.36**
212 HARMONY ST	70.00	68.80	**71.36**
213 HARMONY ST	70.00	68.80	**71.36**
214 HARMONY ST	70.00	68.80	**71.36**
215 HARMONY ST	70.00	68.80	**71.36**
216 HARMONY ST	70.00	68.80	**71.36**
217 HARMONY ST	68.05	**68.80**	**71.36**
219 HARMONY ST	68.05	**68.80**	**71.36**
219 HARTFORD ST	70.62	68.80	**71.36**
318 HAVEN DR	68.31	**68.80**	**71.36**
320 HAVEN DR P1	70.00	68.78	**71.36**
320 HAVEN DR P5	70.00	68.78	**71.36**
320 HAVEN DR P-6	70.00	68.78	**71.36**
322 HAVEN DR 2	70.00	68.78	**71.36**
322 HAVEN DR 4	70.00	68.78	**71.36**
322 HAVEN DR 7	70.00	68.78	**71.36**
322 HAVEN DR N1	70.00	68.78	**71.36**
322 HAVEN DR N-5	70.00	68.78	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
322 HAVEN DR N8	70.00	68.78	**71.36**
324 HAVEN DR 3	70.00	68.79	**71.36**
324 HAVEN DR 4	70.00	68.79	**71.36**
324 HAVEN DR L6	70.00	68.79	**71.36**
324 HAVEN DR L1	70.00	68.79	**71.36**
324 HAVEN DR L5	70.00	68.79	**71.36**
324 HAVEN DR L2	70.00	68.79	**71.36**
326 HAVEN DR O6	70.00	68.80	**71.36**
326 HAVEN DR O3	70.00	68.80	**71.36**
326 HAVEN DR O-2	70.00	68.80	**71.36**
326 HAVEN DR O5	70.00	68.80	**71.36**
328 HAVEN DR 8	70.00	68.80	**71.36**
328 HAVEN DR M1	70.00	68.80	**71.36**
328 HAVEN DR M2	70.00	68.80	**71.36**
328 HAVEN DR M3	70.00	68.80	**71.36**
328 HAVEN DR M4	70.00	68.80	**71.36**
328 HAVEN DR M5	70.00	68.80	**71.36**
328 HAVEN DR M6	70.00	68.80	**71.36**
328 HAVEN DR M7	70.00	68.80	**71.36**
330 HAVEN DR 4K	70.00	68.80	**71.36**
330 HAVEN DR 5K	66.00	**68.80**	**71.36**
330 HAVEN DR 6K	70.00	68.80	**71.36**
330 HAVEN DR 1K	70.00	68.80	**71.36**
330 HAVEN DR 3K	70.00	68.80	**71.36**
330 HAVEN DR 2K	70.00	68.80	**71.36**
332 HAVEN DR R1	70.00	68.80	**71.36**
332 HAVEN DR R2	70.00	68.80	**71.36**
332 HAVEN DR R3	70.00	68.80	**71.36**
332 HAVEN DR R4	70.00	68.80	**71.36**
332 HAVEN DR R5	70.00	68.80	**71.36**
332 HAVEN DR R6	70.00	68.80	**71.36**
332 HAVEN DR R7	70.00	68.80	**71.36**
332 HAVEN DR R8	70.00	68.80	**71.36**
334 HAVEN DR Q-1	70.00	68.80	**71.36**
334 HAVEN DR Q-2	70.00	68.80	**71.36**
334 HAVEN DR Q-3	70.00	68.80	**71.36**
334 HAVEN DR Q-4	70.00	68.80	**71.36**
334 HAVEN DR Q-5	70.00	68.80	**71.36**
334 HAVEN DR Q-6	70.00	68.80	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
334 HAVEN DR Q-7	70.00	68.80	**71.36**
334 HAVEN DR Q-8	70.00	68.80	**71.36**
334 HAVEN DR Q-9	66.00	**68.80**	**71.36**
336 HAVEN DR T1	69.06	68.80	**71.36**
336 HAVEN DR T2	69.06	68.80	**71.36**
336 HAVEN DR T3	69.06	68.80	**71.36**
336 HAVEN DR T4	69.06	68.80	**71.36**
336 HAVEN DR T5	69.06	68.80	**71.36**
336 HAVEN DR T6	69.06	68.80	**71.36**
338 HAVEN DR S1	69.22	68.80	**71.36**
338 HAVEN DR S2	69.22	68.80	**71.36**
338 HAVEN DR S3	69.22	68.80	**71.36**
338 HAVEN DR S4	66.47	**68.80**	**71.36**
338 HAVEN DR S5	69.22	68.80	**71.36**
338 HAVEN DR S6	69.22	68.80	**71.36**
338 HAVEN DR S7	69.22	68.80	**71.36**
340 HAVEN DR U-1	68.31	**68.80**	**71.36**
340 HAVEN DR U2	68.31	**68.80**	**71.36**
340 HAVEN DR U3	69.18	68.80	**71.36**
340 HAVEN DR U-4	69.18	68.80	**71.36**
340 HAVEN DR U5	69.18	68.80	**71.36**
340 HAVEN DR U6	69.18	68.80	**71.36**
342 HAVEN DR V-1	68.00	**68.80**	**71.36**
342 HAVEN DR V-2	68.31	**68.80**	**71.36**
342 HAVEN DR V-3	68.31	**68.80**	**71.36**
342 HAVEN DR V-4	68.31	**68.80**	**71.36**
342 HAVEN DR V5	68.31	**68.80**	**71.36**
342 HAVEN DR V6	68.31	**68.80**	**71.36**
344 HAVEN DR W1	68.00	**68.80**	**71.36**
344 HAVEN DR W2	68.00	**68.80**	**71.36**
344 HAVEN DR W3	68.00	**68.80**	**71.36**
344 HAVEN DR W4	68.00	**68.80**	**71.36**
344 HAVEN DR W5	68.00	**68.80**	**71.36**
344 HAVEN DR W6	68.00	**68.80**	**71.36**
344 HAVEN DR W7	68.00	**68.80**	**71.36**
344 HAVEN DR W-8	68.00	**68.80**	**71.36**
344 HAVEN DR W-9	68.00	**68.80**	**71.36**
346 HAVEN DR 2	66.00	**68.80**	**71.36**
346 HAVEN DR 3	66.00	**68.80**	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
346 HAVEN DR 6	68.00	**68.80**	**71.36**
346 HAVEN DR 8	68.00	**68.80**	**71.36**
346 HAVEN DR X 1	66.00	**68.80**	**71.36**
346 HAVEN DR X-4	68.00	**68.80**	**71.36**
346 HAVEN DR X-5	68.00	**68.80**	**71.36**
346 HAVEN DR X7	68.00	**68.80**	**71.36**
346 HAVEN DR X-9	68.00	**68.80**	**71.36**
348 HAVEN DR 1	66.47	**68.80**	**71.36**
348 HAVEN DR 2	66.47	**68.80**	**71.36**
348 HAVEN DR 3	66.00	**68.80**	**71.36**
348 HAVEN DR AA-4	66.00	**68.80**	**71.36**
348 HAVEN DR AA-5	66.00	**68.80**	**71.36**
348 HAVEN DR AA-6	66.00	**68.80**	**71.36**
350 HAVEN DR Z1	68.00	**68.80**	**71.36**
350 HAVEN DR Z-2	68.00	**68.80**	**71.36**
350 HAVEN DR Z3	68.00	**68.80**	**71.36**
350 HAVEN DR Z-4	68.00	**68.80**	**71.36**
350 HAVEN DR Z-5	69.22	68.80	**71.36**
350 HAVEN DR Z-6	69.22	68.80	**71.36**
352 HAVEN DR Y 4	68.00	**68.80**	**71.36**
352 HAVEN DR Y-1	69.06	68.80	**71.36**
352 HAVEN DR Y-2	69.06	68.80	**71.36**
352 HAVEN DR Y-3	68.00	**68.80**	**71.36**
352 HAVEN DR Y-5	68.00	**68.80**	**71.36**
352 HAVEN DR Y-6	68.00	**68.80**	**71.36**
102 HEARTHSIDE DR	70.08	68.80	**71.36**
103 HEARTHSIDE DR	70.00	68.80	**71.36**
104 HEARTHSIDE DR	70.08	68.80	**71.36**
105 HEARTHSIDE DR	70.00	68.80	**71.36**
106 HEARTHSIDE DR	70.30	68.80	**71.36**
107 HEARTHSIDE DR	70.00	68.80	**71.36**
108 HEARTHSIDE DR	70.00	68.80	**71.36**
109 HEARTHSIDE DR	70.00	68.80	**71.36**
110 HEARTHSIDE DR	70.00	68.80	**71.36**
112 HEARTHSIDE DR	70.00	68.80	**71.36**
114 HEARTHSIDE DR	70.00	68.80	**71.36**
116 HEARTHSIDE DR	70.00	68.80	**71.36**
103 IRONWOOD DR	70.00	68.80	**71.36**
104 IRONWOOD DR	70.57	68.80	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
105 IRONWOOD DR	70.00	68.80	**71.36**
106 IRONWOOD DR	70.57	68.80	**71.36**
107 IRONWOOD DR	70.00	68.80	**71.36**
108 IRONWOOD DR	70.75	68.80	**71.36**
109 IRONWOOD DR	70.00	68.80	**71.36**
110 IRONWOOD DR	70.85	68.80	**71.36**
111 IRONWOOD DR	70.00	68.80	**71.36**
112 IRONWOOD DR	70.85	68.80	**71.36**
400 KEMPTON DR	70.00	68.80	**71.36**
402 KEMPTON DR	70.00	68.80	**71.36**
403 KEMPTON DR	71.30	68.80	**71.36**
404 KEMPTON DR	70.00	68.80	**71.36**
405 KEMPTON DR	70.00	68.80	**71.36**
406 KEMPTON DR	70.40	68.80	**71.36**
407 KEMPTON DR	71.17	68.80	**71.36**
408 KEMPTON DR	70.00	68.80	**71.36**
410 KEMPTON DR	70.00	68.80	**71.36**
412 KEMPTON DR	70.00	68.80	**71.36**
506 KEMPTON DR	70.00	68.80	**71.36**
507 KEMPTON DR	70.57	68.80	**71.36**
508 KEMPTON DR	70.00	68.80	**71.36**
510 KEMPTON DR	70.87	68.80	**71.36**
604 KEMPTON DR	70.00	68.80	**71.36**
606 KEMPTON DR	70.00	68.80	**71.36**
607 KEMPTON DR	71.55	68.80	**71.36**
700 KEMPTON DR	70.00	68.80	**71.36**
702 KEMPTON DR	70.00	68.80	**71.36**
0 LANDMARK ST	70.00	68.77	**71.35**
326 LANDMARK ST O1	70.00	68.80	**71.36**
326 LANDMARK ST O4	70.00	68.80	**71.36**
338 LANDMARK ST	69.22	68.80	**71.36**
3229 LANDMARK ST	70.61	68.75	**71.36**
3243 LANDMARK ST	70.00	68.77	**71.36**
3256 LANDMARK ST A1	70.00	68.78	**71.36**
3256 LANDMARK ST A2	70.00	68.77	**71.36**
3256 LANDMARK ST A3	70.00	68.77	**71.36**
3256 LANDMARK ST A4	70.00	68.77	**71.36**
3256 LANDMARK ST A5	70.00	68.77	**71.36**
3256 LANDMARK ST A6	70.00	68.78	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
3258 LANDMARK ST B1	70.00	68.78	**71.36**
3258 LANDMARK ST B2	70.00	68.78	**71.36**
3258 LANDMARK ST B3	70.00	68.78	**71.36**
3258 LANDMARK ST B4	70.00	68.78	**71.36**
3258 LANDMARK ST B5	70.00	68.78	**71.36**
3258 LANDMARK ST B6	70.00	68.78	**71.36**
3258 LANDMARK ST B7	70.00	68.78	**71.36**
3260 LANDMARK ST C1	70.00	68.78	**71.36**
3260 LANDMARK ST C2	70.00	68.77	**71.36**
3260 LANDMARK ST C3	70.00	68.77	**71.36**
3260 LANDMARK ST C4	70.00	68.77	**71.36**
3260 LANDMARK ST C5	70.00	68.78	**71.36**
3260 LANDMARK ST C6	70.00	68.77	**71.36**
3262 LANDMARK ST D1	70.00	68.78	**71.36**
3262 LANDMARK ST D2	70.00	68.78	**71.36**
3262 LANDMARK ST D3	70.00	68.78	**71.36**
3262 LANDMARK ST D4	70.00	68.77	**71.36**
3262 LANDMARK ST D5	70.00	68.77	**71.36**
3262 LANDMARK ST D6	70.00	68.78	**71.36**
3262 LANDMARK ST E1	70.00	68.78	**71.36**
3262 LANDMARK ST E2	70.00	68.77	**71.36**
3262 LANDMARK ST E3	70.00	68.78	**71.36**
3262 LANDMARK ST E4	70.00	68.78	**71.36**
3262 LANDMARK ST E5	70.00	68.78	**71.36**
3262 LANDMARK ST E6	70.00	68.78	**71.36**
3262 LANDMARK ST E7	70.00	68.78	**71.36**
3264 LANDMARK ST F1	70.00	68.77	**71.36**
3264 LANDMARK ST F2	70.00	68.78	**71.36**
3264 LANDMARK ST F3	70.00	68.78	**71.36**
3264 LANDMARK ST F4	70.00	68.78	**71.36**
3264 LANDMARK ST F5	70.00	68.78	**71.36**
3264 LANDMARK ST F6	70.00	68.78	**71.36**
3264 LANDMARK ST G1	70.00	68.77	**71.36**
3264 LANDMARK ST G2	70.00	68.78	**71.36**
3264 LANDMARK ST G3	70.00	68.77	**71.36**
3264 LANDMARK ST G4	70.00	68.77	**71.36**
3264 LANDMARK ST G5	70.00	68.77	**71.36**
3264 LANDMARK ST G6	70.00	68.78	**71.36**
3264 LANDMARK ST G7	70.00	68.78	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
3264 LANDMARK ST G8	70.00	68.78	**71.36**
3264 LANDMARK ST G9	70.00	68.77	**71.36**
3275 LANDMARK ST	70.00	68.77	**71.35**
3300 LANDMARK ST	70.00	68.78	**71.36**
3300 LANDMARK ST A-1	70.00	68.78	**71.36**
3300 LANDMARK ST A-2	70.00	68.78	**71.36**
3300 LANDMARK ST A-3	70.00	68.78	**71.36**
3300 LANDMARK ST A-4	70.00	68.78	**71.36**
3300 LANDMARK ST A-4	70.00	68.78	**71.36**
3300 LANDMARK ST A-5	70.00	68.78	**71.36**
3300 LANDMARK ST A-6	70.00	68.78	**71.36**
3308 LANDMARK ST B1	70.00	68.78	**71.36**
3308 LANDMARK ST B2	70.00	68.78	**71.36**
3308 LANDMARK ST B3	70.00	68.77	**71.36**
3308 LANDMARK ST B4	70.00	68.78	**71.36**
3308 LANDMARK ST B5	70.00	68.77	**71.36**
3320 LANDMARK ST C-1	69.37	68.76	**71.35**
3320 LANDMARK ST C-2	70.00	68.78	**71.36**
3320 LANDMARK ST C-3	70.00	68.78	**71.36**
3320 LANDMARK ST C-4	70.00	68.78	**71.36**
3320 LANDMARK ST C-5	70.00	68.77	**71.36**
3320 LANDMARK ST C-6	70.00	68.78	**71.36**
3320 LANDMARK ST C-7	70.00	68.78	**71.36**
3320 LANDMARK ST C-8	70.00	68.78	**71.36**
3320 LANDMARK ST C-9	70.00	68.78	**71.36**
3326 LANDMARK ST D1	70.00	68.77	**71.36**
3326 LANDMARK ST D2	70.00	68.78	**71.36**
3326 LANDMARK ST D3	70.00	68.78	**71.36**
3326 LANDMARK ST D4	70.00	68.77	**71.36**
3326 LANDMARK ST D5	70.00	68.77	**71.36**
3326 LANDMARK ST D6	70.00	68.77	**71.36**
3326 LANDMARK ST D7	70.00	68.77	**71.36**
3326 LANDMARK ST D8	70.00	68.78	**71.36**
3336 LANDMARK ST H1	70.00	68.77	**71.36**
3336 LANDMARK ST H2	70.00	68.77	**71.36**
3336 LANDMARK ST H3	70.00	68.78	**71.36**
3336 LANDMARK ST H4	70.00	68.78	**71.36**
3336 LANDMARK ST H5	70.00	68.77	**71.36**
3336 LANDMARK ST H6	70.00	68.77	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
3336 LANDMARK ST H7	70.00	68.78	**71.36**
3336 LANDMARK ST H8	70.00	68.78	**71.36**
3344 LANDMARK ST I1	70.00	68.78	**71.36**
3344 LANDMARK ST I2	70.00	68.77	**71.36**
3344 LANDMARK ST I3	70.00	68.77	**71.36**
3344 LANDMARK ST I4	70.00	68.78	**71.36**
3344 LANDMARK ST I5	70.00	68.78	**71.36**
3344 LANDMARK ST I6	70.00	68.77	**71.36**
3344 LANDMARK ST I7	70.00	68.77	**71.36**
3344 LANDMARK ST I8	70.00	68.78	**71.36**
3348 LANDMARK ST J1	66.08	**68.79**	**71.36**
3348 LANDMARK ST J2	66.08	**68.79**	**71.36**
3348 LANDMARK ST J3	66.08	**68.80**	**71.36**
3348 LANDMARK ST J4	66.08	**68.79**	**71.36**
3348 LANDMARK ST J5	66.08	**68.79**	**71.36**
3348 LANDMARK ST J6	66.08	**68.79**	**71.36**
3348 LANDMARK ST J7	66.08	**68.79**	**71.36**
3385 LANDMARK ST	67.79	**68.77**	**71.35**
3395 LANDMARK ST	70.00	68.77	**71.35**
3398 LANDMARK ST	70.00	68.77	**71.36**
3401 LANDMARK ST	69.13	68.77	**71.35**
100 LINDENWOOD DR	70.00	68.80	**71.36**
102 LINDENWOOD DR	68.47	**68.80**	**71.36**
104 LINDENWOOD DR	68.47	**68.80**	**71.36**
106 LINDENWOOD DR	69.76	68.80	**71.36**
108 LINDENWOOD DR	69.76	68.80	**71.36**
202 LINDENWOOD DR	70.00	68.80	**71.36**
204 LINDENWOOD DR	70.00	68.80	**71.36**
513 MARY LEE CT	56.96	**58.18**	**59.14**
517 MARY LEE CT	56.96	**58.17**	**59.13**
3525 S MEMORIAL DR	70.00	68.80	**71.36**
3535 S MEMORIAL DR	70.00	68.80	**71.36**
401 MIDDLEBURY DR	70.00	68.80	**71.36**
403 MIDDLEBURY DR	70.00	68.80	**71.36**
405 MIDDLEBURY DR	70.00	68.80	**71.36**
4101 PARMER PL	59.07	**59.14**	**59.92**
4105 PARMER PL	59.19	59.06	**59.85**
4113 PARMER PL	58.04	**58.93**	**59.75**
132 PINE BRANCHES CL	57.00	56.59	**57.37**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
133 PINE BRANCHES CL	57.00	56.59	**57.37**
140 PINE BRANCHES CL	54.00	**56.39**	**57.16**
141 PINE BRANCHES CL	54.00	**56.35**	**57.12**
142 PINE BRANCHES CL	57.00	56.39	**57.16**
143 PINE BRANCHES CL	57.00	56.45	**57.23**
170 PINE BRANCHES CL	56.00	**56.21**	**56.98**
172 PINE BRANCHES CL	54.84	**56.26**	**57.03**
173 PINE BRANCHES CL	54.84	**56.17**	**56.94**
180 PINE BRANCHES CL	55.58	**56.07**	**56.84**
181 PINE BRANCHES CL	55.58	**55.98**	**56.75**
103 PLACID WY	70.88	68.80	**71.36**
201 PLACID WY	70.84	68.80	**71.36**
202 PLACID WY	70.00	68.80	**71.36**
203 PLACID WY	70.84	68.80	**71.36**
103 RAVENWOOD DR	70.00	68.80	**71.36**
105 RAVENWOOD DR	70.00	68.80	**71.36**
107 RAVENWOOD DR	70.00	68.80	**71.36**
109 RAVENWOOD DR	70.00	68.80	**71.36**
111 RAVENWOOD DR	70.00	68.80	**71.36**
112 RAVENWOOD DR	70.00	68.80	**71.36**
114 RAVENWOOD DR	70.00	68.80	**71.36**
116 RAVENWOOD DR	70.00	68.80	**71.36**
200 RAVENWOOD DR	70.00	68.80	**71.36**
201 RAVENWOOD DR	70.00	68.80	**71.36**
202 RAVENWOOD DR	70.00	68.80	**71.36**
203 RAVENWOOD DR	70.00	68.80	**71.36**
204 RAVENWOOD DR	70.00	68.80	**71.36**
206 RAVENWOOD DR	70.00	68.80	**71.36**
300 RAVENWOOD DR	70.00	68.80	**71.36**
301 RAVENWOOD DR	70.00	68.80	**71.36**
302 RAVENWOOD DR	70.00	68.80	**71.36**
303 RAVENWOOD DR	70.00	68.80	**71.36**
304 RAVENWOOD DR	70.00	68.80	**71.36**
878 RAY CRAWFORD DR	49.97	**50.54**	**51.50**
886 RAY CRAWFORD DR	49.97	**50.53**	**51.49**
894 RAY CRAWFORD DR	49.25	**50.51**	**51.47**
895 RAY CRAWFORD DR	50.00	**50.73**	**51.69**
899 RAY CRAWFORD DR	50.00	**50.70**	**51.66**
901 RAY CRAWFORD DR	49.34	**50.62**	**51.58**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
902 RAY CRAWFORD DR	48.00	**50.45**	**51.41**
903 RAY CRAWFORD DR	48.09	**50.54**	**51.50**
117 RIPLEY DR	70.00	68.80	**71.36**
120 RIPLEY DR	70.31	68.80	**71.36**
122 RIPLEY DR	70.31	68.80	**71.36**
124 RIPLEY DR	71.32	68.80	**71.36**
102 SHAMROCK CI	70.00	68.80	**71.36**
104 SHAMROCK CI	70.00	68.80	**71.36**
106 SHAMROCK CI	70.00	68.80	**71.36**
108 SHAMROCK CI	70.00	68.80	**71.36**
807 SPRING RUN RD	54.00	51.37	**52.33**
813 SPRING RUN RD	50.71	**51.25**	**52.20**
825 SPRING RUN RD	50.71	**51.09**	**52.05**
835 SPRING RUN RD	50.00	**50.93**	**51.89**
0 STAFFORDSHIRE RD	69.56	68.80	**71.36**
103 STAFFORDSHIRE RD	69.67	68.80	**71.36**
200 STAFFORDSHIRE RD	68.82	68.80	**71.36**
201 STAFFORDSHIRE RD	69.56	68.80	**71.36**
202 STAFFORDSHIRE RD	70.00	68.80	**71.36**
203 STAFFORDSHIRE RD	70.00	68.80	**71.36**
204 STAFFORDSHIRE RD	70.00	68.80	**71.36**
205 STAFFORDSHIRE RD	70.00	68.80	**71.36**
207 STAFFORDSHIRE RD	70.00	68.80	**71.36**
209 STAFFORDSHIRE RD	70.00	68.80	**71.36**
211 STAFFORDSHIRE RD	70.00	68.80	**71.36**
213 STAFFORDSHIRE RD	70.00	68.80	**71.36**
302 SYCAMORE BRANCHES CL	53.60	**55.15**	**55.91**
303 SYCAMORE BRANCHES CL	56.96	55.48	**56.25**
304 SYCAMORE BRANCHES CL	54.00	**55.56**	**56.33**
3608 THORNBROOK DR	70.00	68.80	**71.36**
3612 THORNBROOK DR	70.00	68.80	**71.36**
3616 THORNBROOK DR	68.16	**68.80**	**71.36**
3625 THORNBROOK DR	70.00	68.80	**71.36**
3635 THORNBROOK DR	70.34	68.80	**71.36**
3644 THORNBROOK DR	70.00	68.80	**71.36**
3648 THORNBROOK DR	70.55	68.80	**71.36**
3652 THORNBROOK DR	70.55	68.80	**71.36**
3656 THORNBROOK DR	70.39	68.80	**71.36**
4104 TREETOPS CI	53.15	**53.86**	**54.64**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
4108 TREETOPS CI	54.50	54.07	**54.84**
4112 TREETOPS CI	53.67	**54.41**	**55.16**
4114 TREETOPS CI	53.67	**54.50**	**55.25**
4116 TREETOPS CI	55.19	54.70	**55.45**
4118 TREETOPS CI	55.19	54.70	**55.45**
908 VAN GERT DR	49.74	**52.24**	**53.26**
912 VAN GERT DR	49.48	**52.22**	**53.24**
916 VAN GERT DR	50.69	**52.18**	**53.20**
944 VAN GERT DR	48.99	**51.99**	**52.98**
3700 WALNUT DR	70.00	68.80	**71.36**
3702 WALNUT DR	70.00	68.80	**71.36**
3703 WALNUT DR	70.00	68.80	**71.36**
3704 WALNUT DR	70.00	68.80	**71.36**
3705 WALNUT DR	70.00	68.80	**71.36**
3707 WALNUT DR	70.00	68.80	**71.36**
3709 WALNUT DR	70.00	68.80	**71.36**
3801 WALNUT DR	70.00	68.80	**71.36**
3802 WALNUT DR	70.97	68.80	**71.36**
3803 WALNUT DR	70.00	68.80	**71.36**
104 WESTHAVEN RD	70.00	68.80	**71.36**
105 WESTHAVEN RD	70.18	68.80	**71.36**
107 WESTHAVEN RD	70.00	68.80	**71.36**
109 WESTHAVEN RD	70.00	68.80	**71.36**
111 WESTHAVEN RD	68.75	**68.80**	**71.36**
113 WESTHAVEN RD	70.00	68.80	**71.36**
200 WESTHAVEN RD	70.00	68.80	**71.36**
201 WESTHAVEN RD	70.00	68.80	**71.36**
202 WESTHAVEN RD	70.00	68.80	**71.36**
203 WESTHAVEN RD	70.00	68.80	**71.36**
205 WESTHAVEN RD	70.00	68.80	**71.36**
206 WESTHAVEN RD	70.00	68.80	**71.36**
206 WESTHAVEN RD	70.00	68.80	**71.36**
207 WESTHAVEN RD	70.00	68.80	**71.36**
208 WESTHAVEN RD	70.00	68.80	**71.36**
209 WESTHAVEN RD	70.00	68.80	**71.36**
210 WESTHAVEN RD	70.00	68.80	**71.36**
211 WESTHAVEN RD	70.00	68.80	**71.36**
212 WESTHAVEN RD	70.00	68.80	**71.36**
300 WESTHAVEN RD	70.00	68.80	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
302 WESTHAVEN RD	70.00	68.80	**71.36**
400 WESTHAVEN RD	70.00	68.80	**71.36**
402 WESTHAVEN RD	70.00	68.80	**71.36**
403 WESTHAVEN RD	70.00	68.80	**71.36**
404 WESTHAVEN RD	70.00	68.80	**71.36**
405 WESTHAVEN RD	70.00	68.80	**71.36**
407 WESTHAVEN RD	70.00	68.80	**71.36**
501 WESTHAVEN RD	70.00	68.80	**71.36**
502 WESTHAVEN RD	70.00	68.80	**71.36**
500 WINSTEAD RD	70.00	68.80	**71.36**
501 WINSTEAD RD	70.46	68.80	**71.36**
502 WINSTEAD RD	70.00	68.80	**71.36**
503 WINSTEAD RD	70.69	68.80	**71.36**
504 WINSTEAD RD	70.00	68.80	**71.36**
505 WINSTEAD RD	70.69	68.80	**71.36**
506 WINSTEAD RD	70.00	68.80	**71.36**
507 WINSTEAD RD	70.00	68.80	**71.36**
508 WINSTEAD RD	70.00	68.80	**71.36**
509 WINSTEAD RD	70.00	68.80	**71.36**
510 WINSTEAD RD	70.00	68.80	**71.36**
511 WINSTEAD RD	70.34	68.80	**71.36**
600 WINSTEAD RD	70.00	68.80	**71.36**
601 WINSTEAD RD	70.05	68.80	**71.36**
602 WINSTEAD RD	70.00	68.80	**71.36**
603 WINSTEAD RD	70.05	68.80	**71.36**
604 WINSTEAD RD	70.00	68.80	**71.36**
605 WINSTEAD RD	70.01	68.80	**71.36**
606 WINSTEAD RD	70.00	68.80	**71.36**
607 WINSTEAD RD	69.66	68.80	**71.36**
608 WINSTEAD RD	70.00	68.80	**71.36**
868 WINTERFIELD DR	50.62	50.19	**51.16**
874 WINTERFIELD DR	50.62	50.25	**51.22**
882 WINTERFIELD DR	50.97	50.37	**51.34**
888 WINTERFIELD DR	50.97	50.37	**51.34**
101 WOODHAVEN RD	68.00	**68.80**	**71.36**
102 WOODHAVEN RD	69.64	68.80	**71.36**
102 WOODHAVEN CT	70.00	68.80	**71.36**
103 WOODHAVEN RD	68.00	**68.80**	**71.36**
104 WOODHAVEN CT	70.00	68.80	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
105 WOODHAVEN RD	69.49	68.80	**71.36**
106 WOODHAVEN CT	70.00	68.80	**71.36**
107 WOODHAVEN RD	70.00	68.80	**71.36**
108 WOODHAVEN CT	70.00	68.80	**71.36**
200 WOODHAVEN RD	70.00	68.80	**71.36**
201 WOODHAVEN RD	70.00	68.80	**71.36**
202 WOODHAVEN RD	70.00	68.80	**71.36**
203 WOODHAVEN RD	69.69	68.80	**71.36**
205 WOODHAVEN RD	69.69	68.80	**71.36**
206 WOODHAVEN RD	70.00	68.80	**71.36**
207 WOODHAVEN RD	69.49	68.80	**71.36**
208 WOODHAVEN RD	70.00	68.80	**71.36**
210 WOODHAVEN RD	70.00	68.80	**71.36**
211 WOODHAVEN RD	70.00	68.80	**71.36**
212 WOODHAVEN RD	70.00	68.80	**71.36**
213 WOODHAVEN RD	70.00	68.80	**71.36**
215 WOODHAVEN RD	70.00	68.80	**71.36**
217 WOODHAVEN RD	70.00	68.80	**71.36**
219 WOODHAVEN RD	70.00	68.80	**71.36**
301 WOODHAVEN RD	68.00	**68.80**	**71.36**
100 WOODSTOCK DR	68.00	**68.80**	**71.36**
102 WOODSTOCK DR	68.00	**68.80**	**71.36**
103 WOODSTOCK DR	68.82	68.80	**71.36**
104 WOODSTOCK DR	68.00	**68.80**	**71.36**
106 WOODSTOCK DR	68.00	**68.80**	**71.36**
108 WOODSTOCK DR	68.00	**68.80**	**71.36**
110 WOODSTOCK DR	68.00	**68.80**	**71.36**
112 WOODSTOCK DR	68.00	**68.80**	**71.36**
114 WOODSTOCK DR	64.00	**68.80**	**71.36**
116 WOODSTOCK DR	64.00	**68.80**	**71.36**
200 WOODSTOCK DR	66.38	**68.80**	**71.36**
202 WOODSTOCK DR	66.38	**68.80**	**71.36**
203 WOODSTOCK DR	67.31	**68.80**	**71.36**
204 WOODSTOCK DR	68.84	68.80	**71.36**
206 WOODSTOCK DR	68.00	**68.80**	**71.36**
207 WOODSTOCK DR	67.74	**68.80**	**71.36**
208 WOODSTOCK DR	68.00	**68.80**	**71.36**
209 WOODSTOCK DR	67.74	**68.80**	**71.36**
210 WOODSTOCK DR	68.00	**68.80**	**71.36**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
211 WOODSTOCK DR	68.00	**68.80**	**71.36**
212 WOODSTOCK DR	68.00	**68.80**	**71.36**
214 WOODSTOCK DR	68.00	**68.80**	**71.36**
215 WOODSTOCK DR	68.00	**68.80**	**71.36**
216 WOODSTOCK DR	68.00	**68.80**	**71.36**
217 WOODSTOCK DR	68.11	**68.80**	**71.36**
218 WOODSTOCK DR	68.00	**68.80**	**71.36**
219 WOODSTOCK DR	68.71	**68.80**	**71.36**
220 WOODSTOCK DR	70.00	68.80	**71.36**
221 WOODSTOCK DR	68.71	**68.80**	**71.36**
222 WOODSTOCK DR	70.00	68.80	**71.36**
223 WOODSTOCK DR	70.00	68.80	**71.36**
224 WOODSTOCK DR	70.00	68.80	**71.36**

*Bold text indicates LAG flooding.

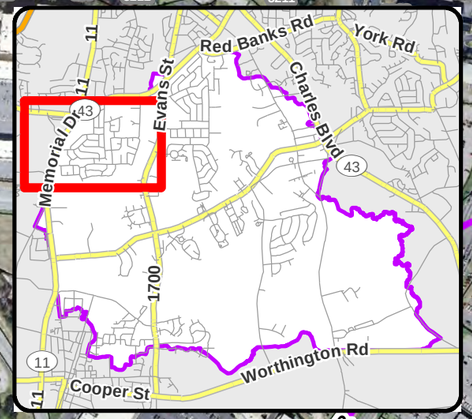
As shown in Table 3-4, 165 properties along Fork Swamp were identified for being at risk of flooding in the 25-year storm event and an additional 704 properties were identified for the 100-year event. There were several residents that provided feedback indicating that they are experiencing yard and AC/storage building flooding along Fork Swamp.

Legend

- Primary System Crossings

Flooding Reported

- Living Space
- AC Unit or Storage Building
- Crawl Space
- Streets
- Yard
- Flooded Properties - 25-Year Storm
- Flooded Properties - 100-Year Storm
- 100-Year FEMA Floodplain
- 500-Year FEMA Floodplain
- 25-Year Existing Floodplain
- 100-Year Existing Floodplain
- Parcels
- Outside City Limits
- ETJ
- Fork Swamp Watershed



The mapped floodplains are based on model results obtained as part of the Master Plan and may differ from the published FEMA floodplains. For flood insurance purposes, the effective FEMA floodplain should be referenced. For structures outside of the 100-year effective FEMA floodplain, property owners must determine if purchasing flood insurance is necessary. The City is in no way responsible for determining if flood insurance is required or for notifying property owners of the potential risk of flooding.

HARTFORD ST
LANDMARK ST
BELVEDERE DR
HARMONY ST
CRESTLINE BV
S MEMORIAL DR
MALL DR
GREENWOOD DR
RIPLEY DR
ANTLER RD
S BAYWOOD LN
BRISTOL CT
RAVENWOOD DR
REGENCY BV
EVANS ST
WELLINGHAM AV
DUNHAGAN RD
KEYS CT

EX Twin 72" CMP

EX Twin 84" CMP

EX Twin 84" CMP

Fork Swamp Watershed Master Plan

Figure 3-1
Fork Swamp Existing Conditions Floodplain Section 1

500 250 0 500 Feet

1 inch = 500 feet

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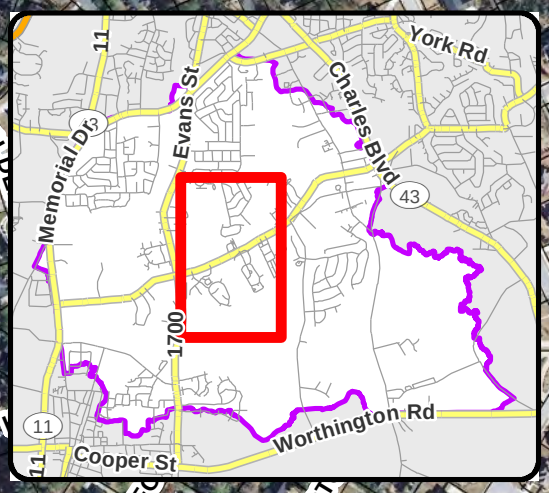
The mapped floodplains are based on model results obtained as part of the Master Plan and may differ from the published FEMA floodplains. For flood insurance purposes, the effective FEMA floodplain should be referenced. For structures outside of the 100-year effective FEMA floodplain, property owners must determine if purchasing flood insurance is necessary. The City is in no way responsible for determining if flood insurance is required or for notifying property owners of the potential risk of flooding.



Legend

Flooding Reported

- Living Space
- Crawl Space
- AC Unit or Storage Building
- Streets
- Yard
- Primary System Crossings
- 100-Year FEMA Floodplain
- 500-Year FEMA Floodplain
- Flooded Properties - 25-Year Storm
- Flooded Properties - 100-Year Storm
- 25-Year Existing Floodplain
- 100-Year Existing Floodplain
- Outside City Limits
- ETJ
- Fork Swamp Watershed

BEDFORD CT
WYNESTON RD
DUNHAGAN RD
WALLINGFORD
BREMERTON
CHESAPEAKE PL
WICKHAM
FORREST PK
ASHBURTON DR
LIVE OAK LN
WHITE OAK DR
DONALD DR
MARY LEE CT
JACK PL
BECKY ANNE DR
ALMA LEE DR
Fork Swamp Main Branch
EX Bridge
QUARTERPATH DR
BROOKSTONE DR
LITCHFORD PL
E FIRE TOWER RD
ALBION DR
BAYWATER RD
BAYSWATER RD
DUDLEYS GRANT DR
PERSIMMON PL
GATES DR
WINDING BRANCHES DR
BIRCH PL
TREETOPS CI
OAK BRANCHES
BOYNE WY
LAGAN CI
Fork Swamp Tributary 3

Fork Swamp Watershed Master Plan

Figure 3-2
Fork Swamp Existing Conditions
Floodplain Section 2

500 250 0 500 Feet

1 inch = 500 feet

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EX 72" CMP

EX Twin 54" CMP Arch

EX Twin 66" CMP

EX Twin 60" CMP

OLD TAR RD

WEST MEATH DR

LAGAN CI

SLANEY LP

GALWAY DR

TRAFALGAR DR

COREY RD

VAN-GERT DR

VICKSBURG D

PL

Fork Swamp Tributary 1

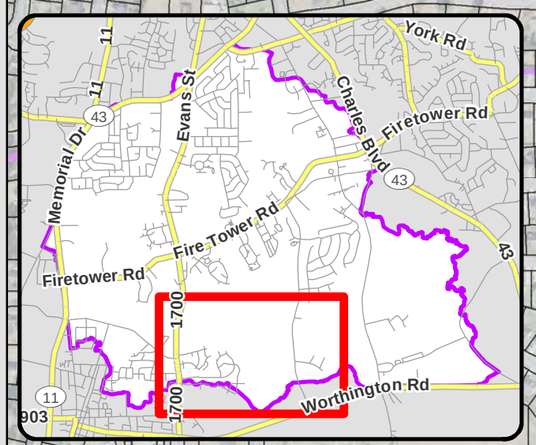
Fork Swamp Tributary 2

Fork Swamp Main Branch

Legend

Flooding Reported

- Living Space
- AC Unit or Storage Building
- Crawl Space
- Streets
- Yard
- Primary System Crossings
- Flooded Properties - 25-Year Storm
- Flooded Properties - 100-Year Storm
- 100-Year FEMA Floodplain
- 500-Year FEMA Floodplain
- 25-Year Existing Floodplain
- 100-Year Existing Floodplain
- Outside City Limits
- ETJ
- Fork Swamp Watershed



Fork Swamp Watershed Master Plan

Figure 3-3
Fork Swamp
Existing Conditions
Floodplain Section 3

600 300 0 600 Feet

1 inch = 600 feet

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The mapped floodplains are based on model results obtained as part of the Master Plan and may differ from the published FEMA floodplains. For flood insurance purposes, the effective FEMA floodplain should be referenced. For structures outside of the 100-year effective FEMA floodplain, property owners must determine if purchasing flood insurance is necessary. The City is in no way responsible for determining if flood insurance is required or for notifying property owners of the potential risk of flooding.

Table 3-5: Existing Conditions At-Risk Properties/Structures – FSUT1

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
1203 TRAFALGAR DR	55.30	54.70	**55.78**
1205 TRAFALGAR DR	54.84	54.79	**55.86**
1209 TRAFALGAR DR	52.98	**55.10**	**55.90**
1210 TRAFALGAR DR	54.40	**55.25**	**55.96**
1214 TRAFALGAR DR	55.80	55.14	**55.99**
1215 TRAFALGAR DR	52.55	**55.14**	**55.93**
1404 TRAFALGAR DR	54.25	**55.38**	**56.16**
1405 TRAFALGAR DR	54.17	**56.36**	**56.76**
1407 TRAFALGAR DR	55.86	**56.33**	**56.71**
1409 TRAFALGAR DR	55.86	**56.29**	**56.70**
4800 TREVVETT CI	54.00	**55.30**	**56.01**
4801 TREVVETT CI	54.82	**55.36**	**56.08**
812 VAN GERT DR	51.56	**53.47**	**54.62**
816 VAN GERT DR	50.51	**53.47**	**54.62**
820 VAN GERT DR	50.51	**53.46**	**54.61**

*Bold text indicates LAG flooding.

As shown in Table 3-5, twelve (12) properties along FSUT1 were identified for being at risk of flooding in the 25-year storm event and an additional three (3) properties were identified for the 100-year event. Residents along this stream reach have provided feedback indicating that they are experiencing yard, crawl space and AC/storage building flooding.

Fork Swamp Watershed Master Plan

Figure 3-4
Fork Swamp Tributary 1
Existing Conditions Floodplain

400 200 0 400 Feet

1 inch = 400 feet

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Legend

Flooding Reported

- Living Space
- AC Unit or Storage Building
- Crawl Space
- Streets
- Yard
- Primary System Crossings
- 100-Year FEMA Floodplain
- 500-Year FEMA Floodplain
- Flooded Properties - 25-Year Storm
- Flooded Properties - 100-Year Storm
- 25-Year Existing Floodplain
- 100-Year Existing Floodplain
- Outside City Limits
- ETJ
- Fork Swamp Watershed

BEXLEY DR
SOUTHLEA DR
WEST ESSEX DR
KNIGHT DR
BUCKINGHAM DR
ESSEX DR
LADY DI DR
COREY RD
ST JOHN DR
TREVETT CI
TRAFALGAR DR
J HICKS RD
VAN-GERT DR

EX Twin 54" CMP Arch
EX Twin 66" CMP
EX Twin 60" CMP

Fork Swamp Tributary 1
Fork Swamp Main Branch

The mapped floodplains are based on model results obtained as part of the Master Plan and may differ from the published FEMA floodplains. For flood insurance purposes, the effective FEMA floodplain should be referenced. For structures outside of the 100-year effective FEMA floodplain, property owners must determine if purchasing flood insurance is necessary. The City is in no way responsible for determining if flood insurance is required or for notifying property owners of the potential risk of flooding.

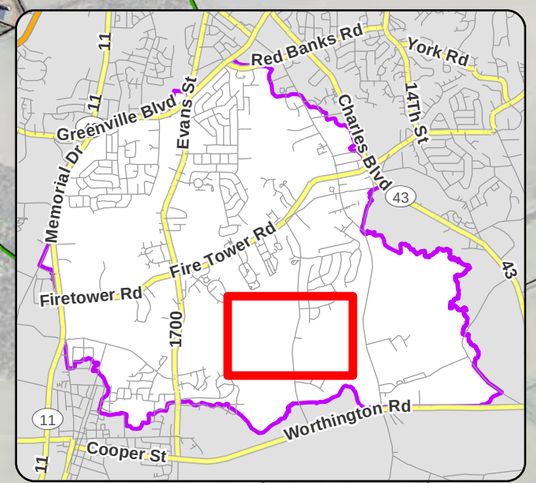

Table 3-6: Existing Conditions At-Risk Properties/Structures – FSUT2 R1

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
595 CEDAR RIDGE DR	53.45	**54.41**	**55.44**
603 CEDAR RIDGE DR	53.38	**54.43**	**55.40**
611 CEDAR RIDGE DR	52.50	**54.36**	**55.36**
619 CEDAR RIDGE DR	52.50	**54.33**	**55.35**
623 CEDAR RIDGE DR	52.05	**54.28**	**55.30**
631 CEDAR RIDGE DR	52.05	**54.23**	**55.26**
639 CEDAR RIDGE DR	51.71	**54.18**	**55.23**
647 CEDAR RIDGE DR	53.51	**54.10**	**55.17**
650 CEDAR RIDGE DR	54.00	**54.06**	**55.14**
657 CEDAR RIDGE DR	53.51	**54.05**	**55.14**
675 CEDAR RIDGE DR	53.10	**53.90**	**55.03**
681 CEDAR RIDGE DR	52.90	**53.85**	**54.99**
689 CEDAR RIDGE DR	52.80	**53.82**	**54.98**
697 CEDAR RIDGE DR	53.40	**53.78**	**54.95**
705 CEDAR RIDGE DR	53.60	**53.76**	**54.92**
711 CEDAR RIDGE DR	53.20	**53.73**	**54.90**
719 CEDAR RIDGE DR	52.25	**53.71**	**54.88**
725 CEDAR RIDGE DR	52.25	**53.69**	**54.87**
731 CEDAR RIDGE DR	53.17	**53.67**	**54.85**
4410 DONEGAL CT	54.30	**54.42**	**55.41**
4442 GALWAY DR	53.26	**53.93**	**55.05**
4448 GALWAY DR	53.68	53.67	**55.00**
4454 GALWAY DR	53.86	53.85	**54.95**
4460 GALWAY DR	54.10	53.74	**54.91**
4466 GALWAY DR	53.50	**53.70**	**54.89**
2116 HAWKS NEST LN	54.00	**54.05**	**55.13**
650 MILTON DR	56.60	56.59	**56.92**
651 MILTON DR	56.90	**56.90**	**56.97**
2121 NORTH STAR LN	54.40	54.11	**55.18**
2129 NORTH STAR LN	54.47	54.08	**55.15**
2137 NORTH STAR LN	55.00	54.05	**55.14**
CEDAR RIDGE DR PUMP STATION	52.30	**54.00**	**55.10**

*Bold text indicates LAG flooding.

As shown in Table 3-6, twenty-five (25) properties along FSUT2R1 were identified for being at risk of flooding in the 25-year storm event and an additional seven (7) properties were identified for the 100-year event. There were no reports of flooding received from residents along this stream reach.

Table 3-7: Existing Conditions At-Risk Properties/Structures – FSUT2 R2

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
505 HILLSHADE CT , UNIT B	71.33	**71.98**	**72.23**
505 HILLSHADE CT , UNIT A	71.82	**71.98**	**72.23**
509 HILLSHADE CT , UNIT B	71.33	**71.98**	**72.23**
509 HILLSHADE CT , UNIT A	71.33	**71.98**	**72.23**
3901 SEDONA DR , UNIT B	70.22	**71.98**	**72.23**
3901 SEDONA DR , UNIT A	70.22	**71.98**	**72.23**
3905 SEDONA DR , UNIT B	71.82	**71.97**	**72.22**
3905 SEDONA DR , UNIT A	70.22	**71.98**	**72.23**
3909 SEDONA DR , UNIT A	71.82	71.70	**72.16**
3909 SEDONA DR , UNIT B	71.82	71.70	**72.06**
205 SOUTH POINTE DR , UNIT A	70.00	**71.98**	**72.24**
208 SOUTH POINTE DR , UNIT B	70.22	**71.98**	**72.23**
208 SOUTH POINTE DR , UNIT A	70.22	**71.98**	**72.23**
209 SOUTH POINTE DR , UNIT A	70.00	**71.98**	**72.24**
209 SOUTH POINTE DR , UNIT B	70.00	**71.98**	**72.24**
213 SOUTH POINTE DR , UNIT A	70.00	**71.98**	**72.24**
213 SOUTH POINTE DR , UNIT B	70.00	**71.98**	**72.24**
217 SOUTH POINTE DR , UNIT A	70.00	**71.98**	**72.24**
217 SOUTH POINTE DR , UNIT B	70.00	**71.98**	**72.24**
220 SOUTH POINTE DR , UNIT B	70.39	**71.98**	**72.23**
220 SOUTH POINTE DR , UNIT A	70.39	**71.98**	**72.23**
221 SOUTH POINTE DR , UNIT A	70.00	**71.98**	**72.24**
221 SOUTH POINTE DR , UNIT B	70.00	**71.98**	**72.24**
305 SOUTH POINTE DR , UNIT A	70.00	**71.97**	**72.23**
305 SOUTH POINTE DR , UNIT B	70.00	**71.97**	**72.23**
341 SOUTH POINTE DR , UNIT B	72.00	71.88	**72.13**
341 SOUTH POINTE DR , UNIT A	72.00	71.92	**72.16**
401 SOUTH POINTE DR , UNIT B	72.00	71.79	**72.04**
401 SOUTH POINTE DR , UNIT A	72.00	71.81	**72.06**

*Bold text indicates LAG flooding.

As shown in Table 3-7, twenty-three (23) properties along FSUT2R2 were identified for being at risk of flooding in the 25-year storm event and an additional six (6) properties were identified for the 100-year event. There were no reports of flooding received from residents along this stream reach.

Fork Swamp Watershed Master Plan

Figure 3-5
Fork Swamp Tributary 2 Reach 1
Existing Conditions Floodplain

400 200 0 400 Feet

1 inch = 400 feet

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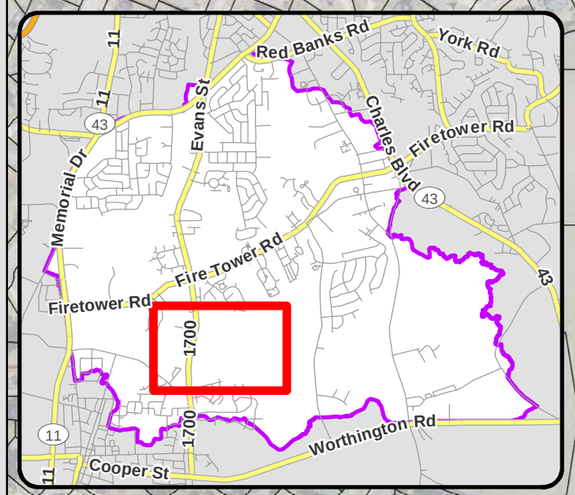
Legend

Flooding Reported

- Living Space
- AC Unit or Storage Building
- Crawl Space
- Streets
- Yard
- Primary System Crossings
- 100-Year FEMA Floodplain
- 500-Year FEMA Floodplain
- Flooded Properties - 25-Year Storm
- Flooded Properties - 100-Year Storm
- 25-Year Existing Floodplain
- 100-Year Existing Floodplain
- Outside City Limits
- ETJ
- Fork Swamp Watershed

TREETOPS CI
BLACKWATER DR
GUINESS DR
WEST MEATH DR
BOYNE WY
LAGAN CI
OLD TAR RD
SLANEY LP
GALWAY DR
EX 72" CMP
Fork Swamp Tributary 2
Fork Swamp Main Branch
Fork Swamp Tributary 1
VAN GERT DR



The mapped floodplains are based on model results obtained as part of the Master Plan and may differ from the published FEMA floodplains. For flood insurance purposes, the effective FEMA floodplain should be referenced. For structures outside of the 100-year effective FEMA floodplain, property owners must determine if purchasing flood insurance is necessary. The City is in no way responsible for determining if flood insurance is required or for notifying property owners of the potential risk of flooding.

Fork Swamp Watershed Master Plan

Figure 3-6
Fork Swamp Tributary 2 Reach 2
Existing Conditions Floodplain

400 200 0 400 Feet

1 inch = 400 feet

Greenville NORTH CAROLINA

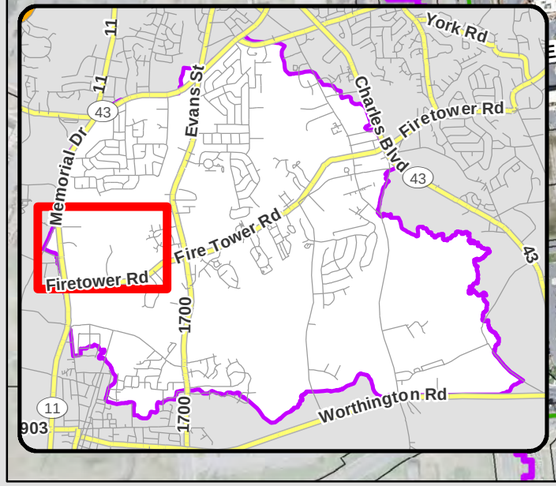
WK DICKSON

Legend

Flooding Reported

- Living Space
- AC Unit or Storage Building
- Crawl Space
- Streets
- Yard
- Primary System Crossings
- 100-Year FEMA Floodplain
- 500-Year FEMA Floodplain
- Flooded Properties - 25-Year Storm
- Flooded Properties - 100-Year Storm
- 25-Year Existing Floodplain
- 100-Year Existing Floodplain
- Outside City Limits
- ETJ
- Fork Swamp Watershed

SOUTH SQUARE DR
GRANADA DR
SEDONA DR
LUCERNE CT
SOUTH POINTE DR
SOUTHPARK DR
SOUTH SQUARE DR
CHAPMAN RD
TICE RD
HUMBER DR
WHITLEY DR
VICTORY LN
W FIRE TOWER RD
EX 10'W X 8'H RCBC
Fork Swamp Tributary 2
HARDWICK CT SOUTHAMPTON
SOUTH HALL CI
KIPLING CT
DOBBS CT
BLARNEY ST
WY



The mapped floodplains are based on model results obtained as part of the Master Plan and may differ from the published FEMA floodplains. For flood insurance purposes, the effective FEMA floodplain should be referenced. For structures outside of the 100-year effective FEMA floodplain, property owners must determine if purchasing flood insurance is necessary. The City is in no way responsible for determining if flood insurance is required or for notifying property owners of the potential risk of flooding.

N

Table 3-8: Existing Conditions At-Risk Properties/Structures – FSUT3

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
1303 ANGELS END, UNIT A	62.00	**62.61**	**63.12**
1303 ANGELS END, UNIT B	62.50	**62.59**	**63.08**
1305 ANGELS END, UNIT A	62.50	**62.54**	**63.01**
1305 ANGELS END, UNIT B	62.61	62.53	**63.01**
1402 ANGELS END, UNIT A	62.00	**63.36**	**63.69**
1402 ANGELS END, UNIT B	62.11	**63.33**	**63.64**
1404 ANGELS END, UNIT A	62.00	**63.38**	**63.73**
1404 ANGELS END, UNIT B	62.00	**63.38**	**63.73**
1406 ANGELS END, UNIT A	62.04	**63.39**	**63.74**
1409 ANGELS END, UNIT B	62.04	**63.37**	**63.79**
1409 ANGELS END, UNIT A	63.66	63.36	**63.78**
1903 ARLINGTON PARK DR	64.72	**66.29**	**66.87**
1907 ARLINGTON PARK DR	66.20	**66.31**	**66.88**
1911 ARLINGTON PARK DR	66.80	66.16	**66.88**
1915 ARLINGTON PARK DR	66.80	66.18	**66.89**
3709 ASHCROFT DR	60.00	**61.45**	**62.19**
3713 ASHCROFT DR	60.70	**61.34**	**62.07**
3717 ASHCROFT DR	59.73	**61.28**	**62.01**
3721 ASHCROFT DR	59.73	**61.17**	**61.90**
3725 ASHCROFT DR	58.29	**61.06**	**61.79**
3729 ASHCROFT DR	58.29	**60.96**	**61.68**
3733 ASHCROFT DR	60.03	**60.86**	**61.57**
3805 ASHCROFT DR	60.03	**60.82**	**61.52**
3901 ASHCROFT DR	59.22	**60.66**	**61.32**
3905 ASHCROFT DR	59.22	**60.57**	**61.22**
3909 ASHCROFT DR	58.00	**60.53**	**61.17**
3913 ASHCROFT DR	58.00	**60.47**	**61.10**
3916 ASHCROFT DR	59.79	59.70	**61.13**
3920 ASHCROFT DR	59.79	**60.43**	**61.04**
3921 ASHCROFT DR	56.51	**60.41**	**61.01**
3925 ASHCROFT DR	58.84	**60.35**	**60.94**
3928 ASHCROFT DR	58.84	**60.38**	**60.97**
3929 ASHCROFT DR	58.84	**60.33**	**60.90**
3933 ASHCROFT DR	58.48	**60.26**	**60.81**
3936 ASHCROFT DR	60.52	60.37	**60.92**
3937 ASHCROFT DR	59.70	**60.25**	**60.79**
4100 BRIDGE CT, UNIT A	58.02	**59.09**	**59.98**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
4100 BRIDGE CT, UNIT B	58.02	**59.09**	**59.98**
4107 BRIDGE CT	58.00	**58.00**	**59.38**
4109 BRIDGE CT	58.00	**58.39**	**59.30**
4110 BRIDGE CT, UNIT A	58.50	58.49	**59.44**
4110 BRIDGE CT, UNIT B	59.50	58.60	**59.51**
4112 BRIDGE CT	58.00	**58.00**	**59.38**
4114 BRIDGE CT	58.00	**58.42**	**59.33**
4116 BRIDGE CT	54.00	**58.27**	**59.21**
4118 BRIDGE CT, UNIT B	56.21	**58.14**	**59.10**
4118 BRIDGE CT, UNIT A	56.21	**58.11**	**59.07**
4120 BRIDGE CT, UNIT B	56.21	**58.14**	**59.11**
4120 BRIDGE CT, UNIT A	56.21	**58.11**	**59.07**
4122 BRIDGE CT	57.60	57.00	**59.04**
3730 CHARLES BV	69.00	**70.17**	**70.84**
3740 CHARLES BV	70.50	**70.53**	**71.06**
2001 COLEMAN DR, UNIT A	62.00	**62.00**	**62.79**
2001 COLEMAN DR, UNIT B	62.00	**62.00**	**62.79**
2003 COLEMAN DR, UNIT A	62.00	61.90	**62.73**
2003 COLEMAN DR, UNIT B	60.96	**61.90**	**62.66**
2005 COLEMAN DR, UNIT A	62.00	61.70	**62.53**
2005 COLEMAN DR, UNIT B	62.00	61.70	**62.54**
915 E FIRE TOWER RD	60.16	**60.20**	**60.72**
1011 E FIRE TOWER RD	63.80	60.30	**63.81**
1025 E FIRE TOWER RD	60.19	**60.22**	**60.76**
1209 E FIRE TOWER RD	60.75	**61.03**	**61.76**
1213 E FIRE TOWER RD	60.50	**61.20**	**61.93**
1604 E FIRE TOWER RD	64.04	**64.97**	**65.33**
1605 E FIRE TOWER RD	64.00	**64.28**	**64.48**
2050 E FIRE TOWER RD	68.00	**68.00**	**68.79**
1110 HOLDEN DR, UNIT A	62.00	**63.04**	**64.27**
1112 HOLDEN DR, UNIT B	63.90	62.95	**64.21**
1112 HOLDEN DR, UNIT A	64.10	62.95	**64.17**
1114 HOLDEN DR, UNIT B	64.00	62.90	**64.12**
1114 HOLDEN DR, UNIT A	63.73	62.80	**64.08**
1200 HOLDEN DR, UNIT B	63.73	62.80	**64.02**
1200 HOLDEN DR, UNIT A	63.73	62.70	**63.98**
1202 HOLDEN DR, UNIT A	60.00	**62.75**	**63.90**
1202 HOLDEN DR, UNIT B	63.73	62.70	**63.94**

Address	LAG (feet NAVD)	Calculated Water Surface Elevations (feet NAVD)	
		25-year flood	100-year flood
1204 HOLDEN DR, UNIT B	60.00	**60.00**	**63.86**
1204 HOLDEN DR, UNIT A	60.00	**60.00**	**63.82**
2000 SHADOWOOD CT, UNIT B	61.17	**62.09**	**62.82**
2000 SHADOWOOD CT, UNIT A	61.17	**62.02**	**62.78**
2002 SHADOWOOD CT, UNIT B	60.96	**61.98**	**62.75**
2002 SHADOWOOD CT, UNIT A	60.96	**61.96**	**62.74**
2004 SHADOWOOD CT, UNIT B	60.96	**61.88**	**62.66**
2004 SHADOWOOD CT, UNIT A	60.96	**61.82**	**62.59**
2006 SHADOWOOD CT, UNIT B	60.50	**61.71**	**62.47**
2006 SHADOWOOD CT, UNIT A	60.60	**61.68**	**62.43**
2007 SHADOWOOD CT, UNIT A	62.67	61.90	**62.71**
2008 SHADOWOOD CT, UNIT B	62.00	61.57	**62.35**
2008 SHADOWOOD CT, UNIT A	62.00	61.57	**62.30**
2010 SHADOWOOD CT, UNIT B	61.50	61.40	**62.25**
2010 SHADOWOOD CT, UNIT A	61.50	61.40	**62.20**
4327 SOUTHLEA DR	53.30	53.00	**54.52**
1802 SUMMERHAVEN DR, UNIT A	63.50	62.50	**63.64**
1804 SUMMERHAVEN DR, UNIT B	62.00	**62.49**	**63.56**
1804 SUMMERHAVEN DR, UNIT A	61.50	**62.45**	**63.51**
1806 SUMMERHAVEN DR, UNIT B	62.50	62.45	**63.50**
1806 SUMMERHAVEN DR, UNIT A	62.50	62.41	**63.45**
1995 SUMMERHAVEN DR, UNIT B	62.39	**62.50**	**62.94**
1995 SUMMERHAVEN DR, UNIT A	62.30	**62.50**	**62.94**
1997 SUMMERHAVEN DR, UNIT A	62.39	62.30	**62.95**
1997 SUMMERHAVEN DR, UNIT B	62.39	62.30	**62.88**
2000 SUMMERHAVEN DR, UNIT B	62.00	**62.00**	**62.76**
2000 SUMMERHAVEN DR, UNIT A	62.00	**62.00**	**62.75**
2007 SUMMERHAVEN DR, UNIT B	62.50	61.80	**62.59**
2001 TOWER PL, UNIT B	62.11	**63.22**	**63.54**
2001 TOWER PL, UNIT A	62.44	**63.11**	**63.47**
2002 TOWER PL, UNIT B	62.00	**62.68**	**63.21**
2002 TOWER PL, UNIT A	62.00	**62.68**	**63.21**
2003 TOWER PL, UNIT B	62.00	**63.28**	**63.57**
2003 TOWER PL, UNIT A	62.00	**63.14**	**63.49**
2004 TOWER PL	60.37	**62.60**	**63.10**
4006 WHITEBRIDGE DR	58.71	**59.24**	**60.12**

*Bold text indicates LAG flooding.

As shown in Table 3-8, eighty-one (81) properties along FSUT3 were identified for being at risk of flooding in the 25-year storm event and an additional thirty (30) properties were identified for the 100-year event. There were no reports of flooding received from residents along this stream reach.

Appendix E: Preliminary Engineering Report

KCI
ISO 9001:2015 CERTIFIED
ENGINEERS • PLANNERS • SCIENTISTS • CONSTRUCTION MANAGERS
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City of Greenville–Drainage Improvements and Stream Restoration at East Fire Tower Road

Scope

This proposed Greenville, NC flood reduction and stream restoration project involves a major capacity increase of the culvert where Fork Swamp Unnamed Tributary 3 (FSUT3) crosses East Fire Tower Road. It also includes extensive floodplain benching in three reaches along the tributary: approximately 990 LF (on the left side) of the channel reach upstream of East Fire Tower Road, along approximately 2250 LF (on both sides) of the channel reach downstream of the crossing, and along the Fork Swamp mainstem (right side), just downstream of where it crosses East Fire Tower Road, approximately 3,000 feet west of the FSUT3 crossing. Since East Fire Tower Road is a major thoroughfare, the desired level of service is the 50-year storm. However, the existing culvert at the FSUT3 crossing only has a 2-year level of service, with the 5-year and 10-year storms causing significant backwater and potential scour due to significant hydraulic head behind the culverts. Greater intensity storms beyond these, such as the 25-year, 50-year and 100-year storms overtop the Fire Tower Road and pose an increasing likelihood of partial or complete failure of the existing culvert at FSUT3.

By increasing the capacity of the FSUT3 culvert under Fire Tower Road and increasing the hydraulic storage capacity along the riparian corridors of both streams, the project seeks to provide a 50-year level of service and reduce flooding impacts to several surrounding homes which are currently located in the mapped floodplain along the two streams. The project also seeks to minimize or eliminate the instances of floodwater overtopping East Fire Tower Road and reduce the structural risk at the culvert crossing there. The disturbance associated with constructing the extensive area of floodplain benching also creates the opportunity to improve stream stabilization and restoration along the channel reaches slated for modification.

Existing Conditions

The drainage areas to the two project sites are nearly equal at approximately 2.1 square miles. The FSUT3 drainage is 82 percent urban land-use; wetlands are present upstream of the project and within the floodplain corridor of the downstream sub-reach per the National Wetlands Inventory. The valley slope in the FSUT3 upstream reach is approximately 0.15 percent. The valley slope in the downstream FSUT3 reach is approximately 0.05 percent. The Fork Swamp mainstem drainage is 80 percent urban land-use and 24 percent impervious area. The valley slope of the mainstem is very low at approximately 0.02 percent.

East Fire Tower Road is the most downstream crossing for FSUT3. Currently, the twin 10’ X 7’ corrugated metal ellipse culvert pipes (Figures 1 and 2) have a 2-year level of service. The 5-year and 10-year storm events do not overtop the road, instead building up significant hydraulic head behind the culverts and create the potential for severe scour. Storms of greater intensity pose the risk of overtopping East Fire Tower Road for brief periods of time during the events. Perhaps more important, larger storms, such as

those recurring at the 25-year, 50-year, 100-year interval, pose an increasing risk of failure of the culvert due to partial collapses of the pipes and/or roadway damage from excessive scour around the structure and on side berms during storm events, with the largest storms posing an increasing likelihood that the culvert may be completely washed out.

Figure 1. Existing FSUT3 Culvert Pipes at E. Fire Tower Rd. – Upstream Face.

Figure 1. Existing FSUT3 Culvert Pipes at E. Fire Tower Rd. – Downstream Face.

FSUT3 is a FEMA-regulated stream. KCI staff downloaded the effective FEMA model and exported the flow projections and expected culvert performance for the various recurrence interval storms (Table1). As crest of East Fire Tower Road is at 59.5 feet elevation at FSUT3, based on the model predictions, the roadway will overtop during any event beyond the intensity the 10-year storm. Given that these predictions are generated from a steady-state HEC-RAS model, it is difficult to determine the duration of time overtopping might occur during a given storm event. However, note that the model predicts that, during the 50-year storm, approximately 406 cubic feet per second (cfs) is flowing through the culvert, while 139 cfs is passing over the top. Based on professional judgement and experience with culvert failures, that degree of flow (and associated scour and erosion) results in a 75% likelihood of a partial culvert/roadway failure and an estimated 50% likelihood of total failure. Model predictions for the 100-year storm indicate that approximately 404 cubic feet per second (cfs) will flow through the culvert, while 303 cfs will pass over the top, resulting in a 100% likelihood of a partial culvert/roadway failure and an estimated 75% likelihood of total failure. A partial failure would likely result in a loss of service for East Fire Tower Road of 30 days for repairs and a total failure would result in a loss of service for 4 months for culvert replacement, based on current estimates of contractor and material availability.

Table 1. FSUT3 Peak Flood Elevations and Predicted Storm Flows at East Fire Tower Road

East Fire Tower Road Culvert Performance					
Return Period (YR)	Culvert Discharge (cfs)	Overtopping Discharge (cfs)	Total Discharge (cfs)	Culvert Velocity (fps)	Water Surface Elevations (NAVD88)
10	259.8	-	259.8	4.4	59.2
25	392.6	9.1	401.7	6.7	61.0
50	406.6	139.2	545.8	7.0	61.4
100	404.4	302.8	707.2	6.9	61.6
500	390.1	805.8	1195.9	6.7	62.1
Fut - 20%	399.7	439.3	839	6.8	61.8
Fut - 35%	391	733	1124	6.7	62.1

In addition to the problems faced at FSUT3, drainage and hydraulic improvements are needed where the Fork Swamp mainstem crosses East Fire Tower Road approximately 3,000 LF west of the FSUT3 crossing. The existing bridge at the crossing is in good condition and will accommodate the 25-year storm. However, storms of greater intensity (50-yrear or more) pose a risk of short-term losses of service for Fire Tower Road due to overtopping and the risk of longer loses of service that may result from repairs to address structural damage inflicted by overtopping storm events.

The project area stream channels are incised (hydraulically disconnected from the overbank floodplain) with bank heights of approximately 6 feet to 11 feet (Figures 3 - 8). As the pictures and the reported channel widths and depths indicate, the dimensions of FSUT3 and the Fork Swamp mainstem are very consistent within the project area, except for a gradual widening of the channel on the lower end of FSUT3. Throughout all channel reaches within the project area, the consistent absence of rack lines or other evidence of recent flooding on the adjacent floodplains indicates that these channels have little or no access to their adjacent floodplains.

Figure 3. FSUT3 Cross Section #1, Upstream of E. Fire Tower Rd. - 11 feet deep, 8 feet wide.

Figure 4. FSUT3 Cross Section #2, Upstream of E. Fire Tower Rd. – 9 feet deep, 8 feet wide.

Figure 5. FSUT3 Cross Section #3, Downstream of E. Fire Tower Rd. – 8 feet deep, 10 feet wide.

Figure 6. FSUT3 Cross Section #4, Downstream of E. Fire Tower Rd. - 6 feet deep, 20 feet wide.

Figure 7. Fork Swamp Cross Section #1, Downstream of E. Fire Tower Rd. – 6 feet deep, 14 feet wide.

Figure 8. Fork Swamp Cross Section #2, Downstream of E. Fire Tower Rd. - 7 feet deep, 14 feet wide.

The left floodplain of the upstream FSUT3 sub-reach is open, regularly mowed turf grass; however, there is a non-manicured grassy buffer and a line of mature trees growing along the top of the left bank. The upstream FSUT3 right floodplain consists of the fences and landscaping of private properties. The buffer between the right top of bank and the property fences is 15 to 20 feet wide. Both overbanks of the downstream FSUT3 sub-reach are wooded corridors limited in width by residential development (on the left) and commercial development (on the right). The wooded corridor width varies from 5 feet to 40 feet for most of the sub-reach, then becomes wider as the tributary flows southward. The parking lot for an apartment complex near the beginning of the downstream sub-reach is approximately 20 feet from the channel top of bank. The nearest residential home to the channel is approximately 40 feet from the top of bank.

The left floodplain of the Fork Swamp mainstem is maintained (mowed) within the sewer easement that parallels the channel. However, there is a buffer of dense grass and invasive species between the easement and the channel top of bank that is approximately 20 feet wide. Most of the mainstem right overbank riparian buffer is not less than 80 feet wide and is vegetated with a mix of herbaceous and woody shrubs and mature overstory trees. The nearest private residential home is approximately 135 feet from the right top of bank. The nearest residential apartment structure is approximately 70 feet from the left top of bank.

Instability issues are associated with the incised (overly deep) conditions of the project channels. The water velocities and erosive energies (shear forces) within the channels are confined completely within the banks during high volume urban stormwater events that are now statistically more likely to occur. Going forward, by virtue of predictable natural channel evolution, the channels will evolve toward a widened and sinuous condition 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

FSUT3 Drainage/Hydraulic Improvements

To meet the desired 50-year level of service, it is proposed that the existing culverts be upsized to a double 14' x 7' reinforce concrete box culvert (RCBC) structure like that shown in Figure 9. Some CAD typical detail drawings of the proposed culvert are also included in Appendix A. In addition to the culvert improvement, a total of 3,240 linear feet of floodplain benching is proposed (990 linear feet upstream of the crossing in the left overbank and 2,250 linear feet downstream of the crossing in both overbanks). The improved culvert and hydraulic storage generated by the benched areas will greatly reduce the incidence of overtopping and reduce the risk of partial and total failures of the culvert structure at East Fire Tower Road. The improvements proposed for FSUT3 at, above, and below East Tower Road are depicted in Figure 10.

Figure 9. Example Large-Scale Double Culvert Structure

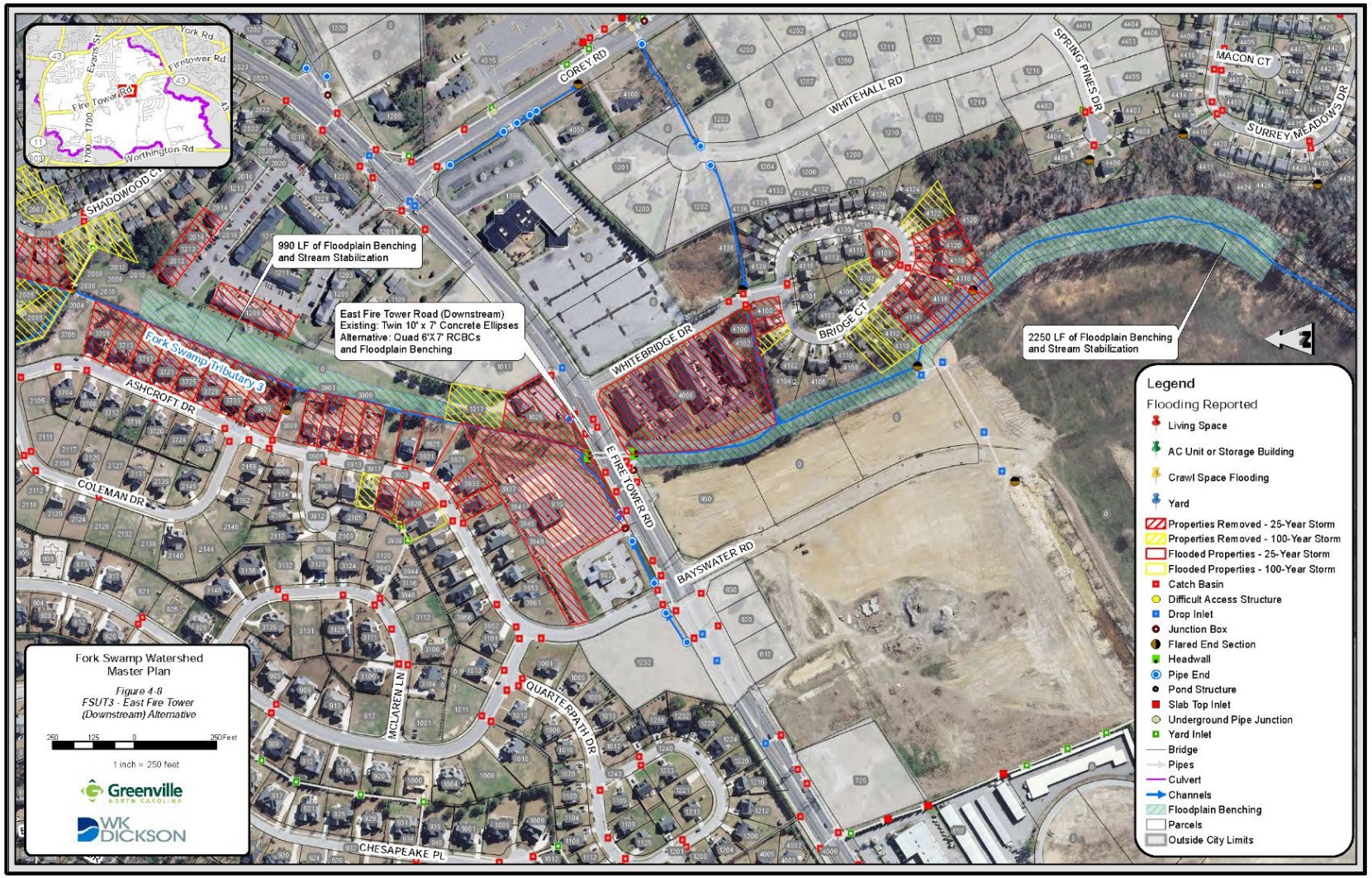


Figure 10. FSUT3 East Fire Tower Downstream Alternative

The resulting upstream water surface elevation will be decreased by as much as 1.94 feet in the 25-year storm event and 0.77 feet in the 100-year storm event. There are forty-seven (47) properties between East Fire Tower Road – D/S and Summerhaven Drive located in the 25- and 100-year existing conditions floodplain. Twenty-eight (28) will be removed from the 25-year floodplain and fourteen (14) additional from the 100-year floodplain. While the water surface elevations will be reduced for the remaining five (5) properties, they remain in the 25- and 100-year floodplains. The properties will continue to experience flooding, but the severity and frequency will be reduced.

The downstream water surface elevation will also be decreased because of the proposed Fork Swamp mainstem floodplain benching. The reduction will range between 0.64 and 1.93 feet in the 25-year storm and 0.62 and 2.04 feet in the 100-year storm. There are fifteen (15) properties located in the 25-and 100-year existing conditions floodplains. All of these properties downstream of East Fire Tower Road – D/S will be removed from the 100-year floodplain as a result of the proposed improvements.

Fork Swamp Drainage/Hydraulic Improvements

To provide a 50-year level of service at this Fork Swamp crossing, the recommended project is to reduce the tailwater by grading floodplain benches downstream of East Fire Tower Road. As shown in Figure 11, this portion of the project entails proposed floodplain benching in the right overbank for approximately 2,000 linear feet.

The proposed improvements will bring East Fire Tower Road up to the desired 50-year level of service. The reductions in water surface elevation will range from 0.28 to 2.31 feet in the 25-year storm event downstream of East Fire Tower Road. This will provide potential flood relief to the Treetops Circle residents. There are six (6) properties in the existing conditions 25-year floodplain and sixteen (16) additional properties in the 100-year floodplain that have potential to experience LAG or structural flooding. The water surface elevation will be reduced for all of these properties. Four (4) will be removed from the 25-year floodplain and twelve (12) from the 100-year floodplain with the implementation of this project. The remaining properties will continue to be exposed to lowest adjacent grade or structural flooding, although the flooding depth will be reduced. Significant economies of scale can be realized by combining this portion of the proposed project with the floodplain benching and culvert replacement project at the FSUT3 crossing.

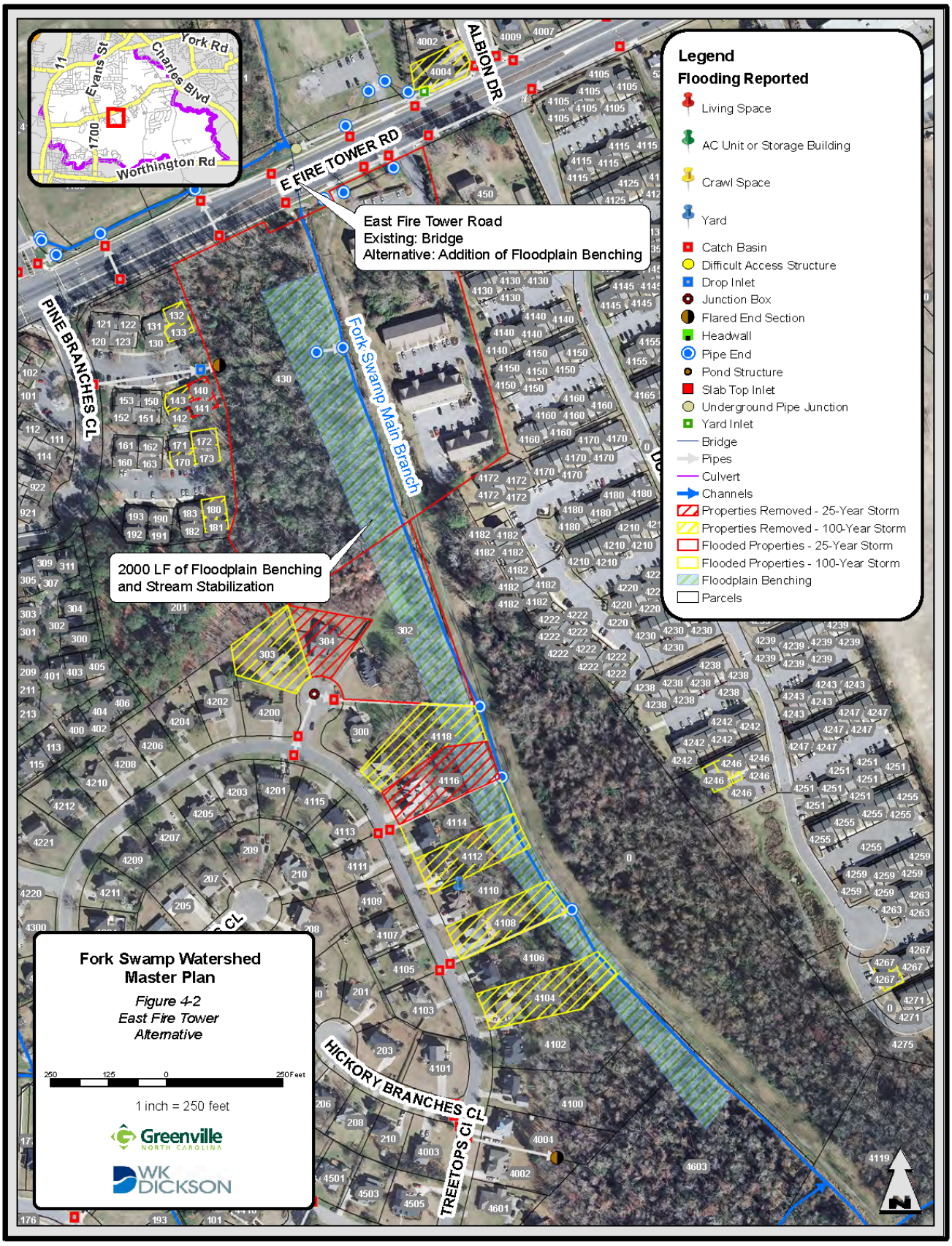


Figure 11. East Fire Tower Alternative

Taken collectively, the three floodplain benching areas create a total of 66,700 cubic yards, or approximately 41 acre-feet of new hydraulic storage capacity within the riparian corridors of the Fork Swamp watershed with the following volumes in each bend segment:

- FSUT3 Upstream of East Fire Tower Road – 8,100 CY (5 Acre-Fee)
- FSUT3 Downstream of East Fire Tower Road – 27,700 CY (17 Acre-Feet)
- Fork Swamp Downstream of East Fire Tower Road – 30,900 CY (19 Acre-Feet)

Proposed cross-sections illustrating the dimensions and configurations of the three floodplain benching areas are presented in Appendix A. These cross-sections demonstrate the proposed vertical changes in grade for the stream restoration improvements are not significant; however, the combined floodplain bench improvements will provide notable floodplain function and flood risk reduction benefits through increased hydraulic storage.

Nature-Based Improvements

For the stream restoration and floodplain benching portion of the project, 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.

Bank stabilization, channel modifications, and grade control structures are proposed to protect municipal utilities, prevent future channel downcutting and widening, reduce sediment loading, and reduce tree losses caused by erosion. 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.
- 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).

Implementing floodplain benching will provide additional flow area and mitigate some of the high shear stresses acting on the existing stream bank. When a channel is “connected” to its floodplain, high flow events will have access to the adjacent floodplain, and will spread out and have reduced water velocities, all of which will greatly reduce erosive forces (shear forces) within the channel.

Stone toe protection structures will provide protection where existing infrastructure is close to the top of the bank or is buried within the bank parallel to the channel, but insufficient space exists to create a floodplain bench and setback from the top of the bank is needed.

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

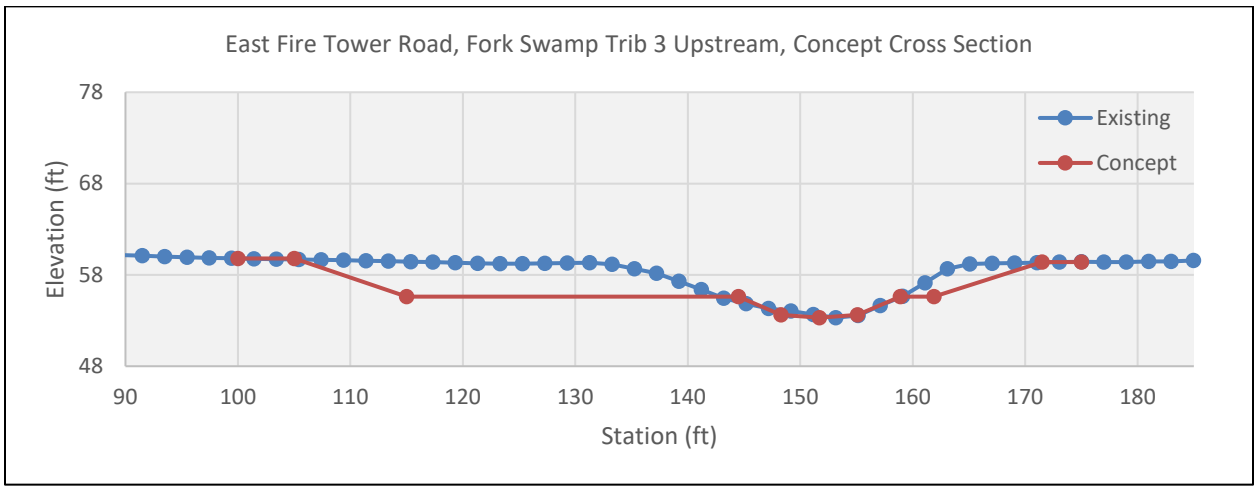
Federal Interagency Stream Restoration Working Group (FISRWG). 1998. *Stream Corridor Restoration: Principles, Processes and Practices.* Springfield, Va: National Technical Information Service.

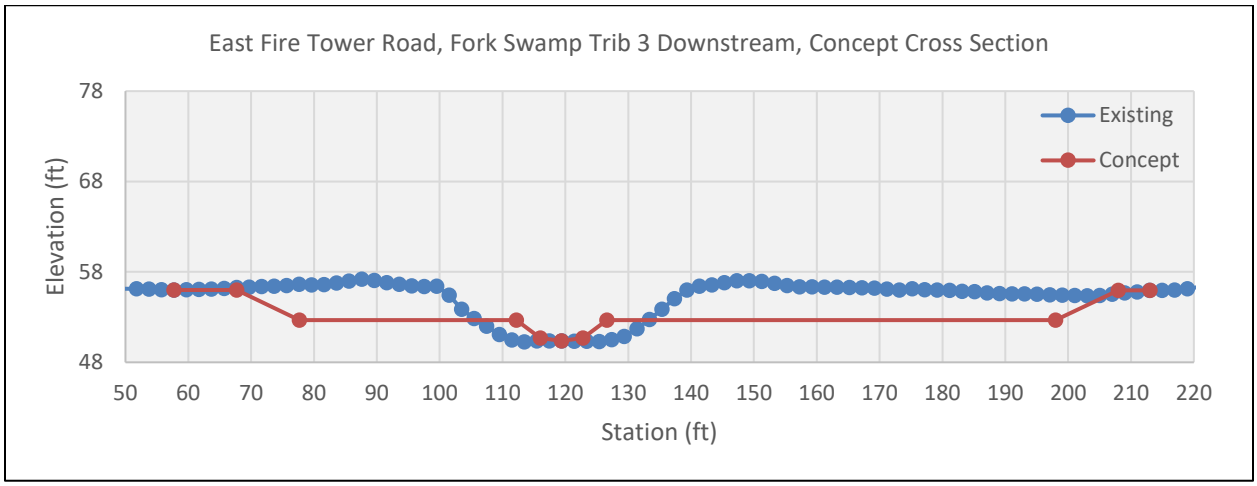
Simon, A. 1989. A model of channel response in disturbed alluvial channels. *Earth Surface Processes and Landforms* 14(1):11-26.

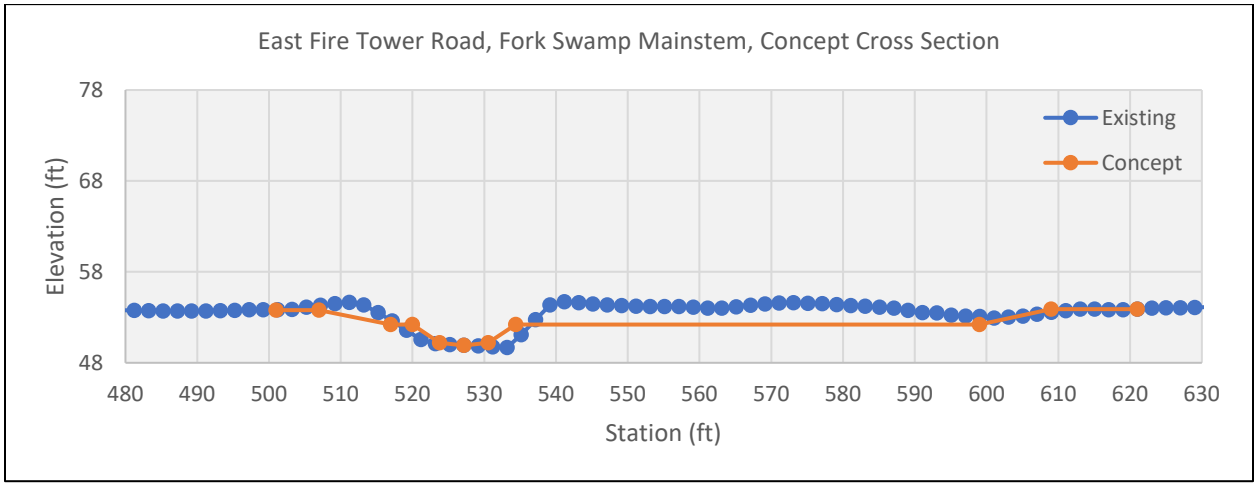
Fork Swamp Watershed Stormwater Master Plan (WSMP). 2016. Prepared for the City of Greenville by W.K. Dickson & Company, Inc.

APPENDIX A

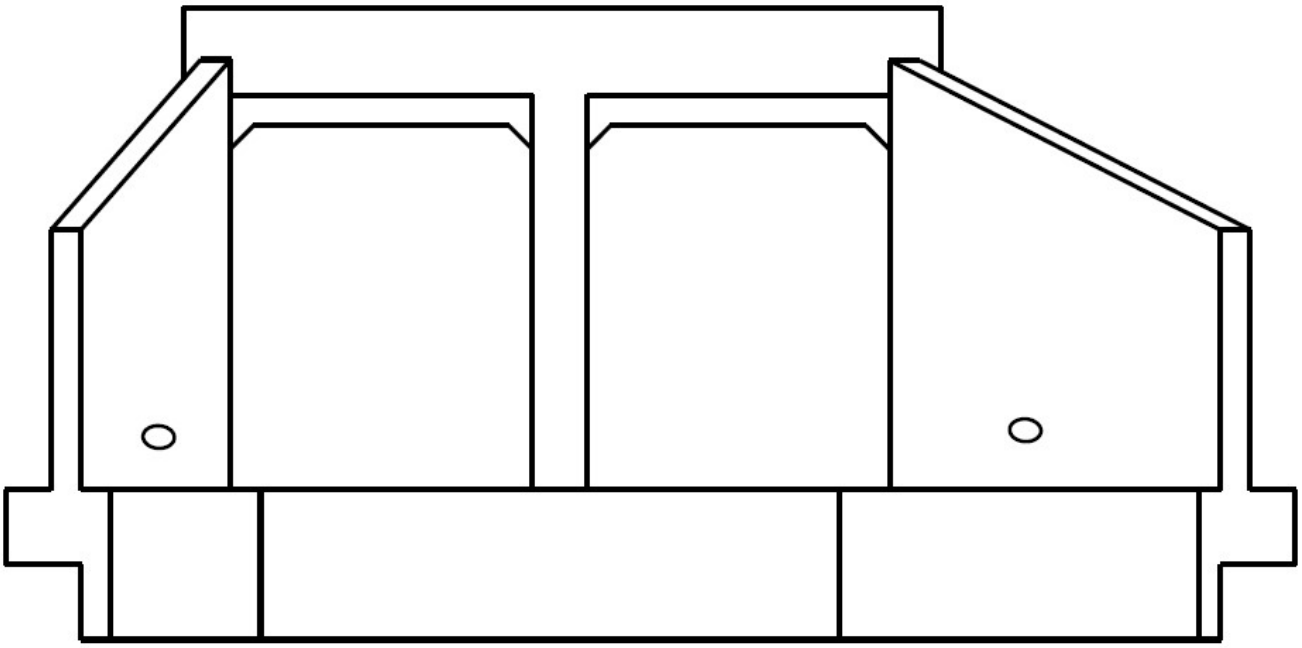
Floodplain Benching Areas – Conceptual Cross-Sections



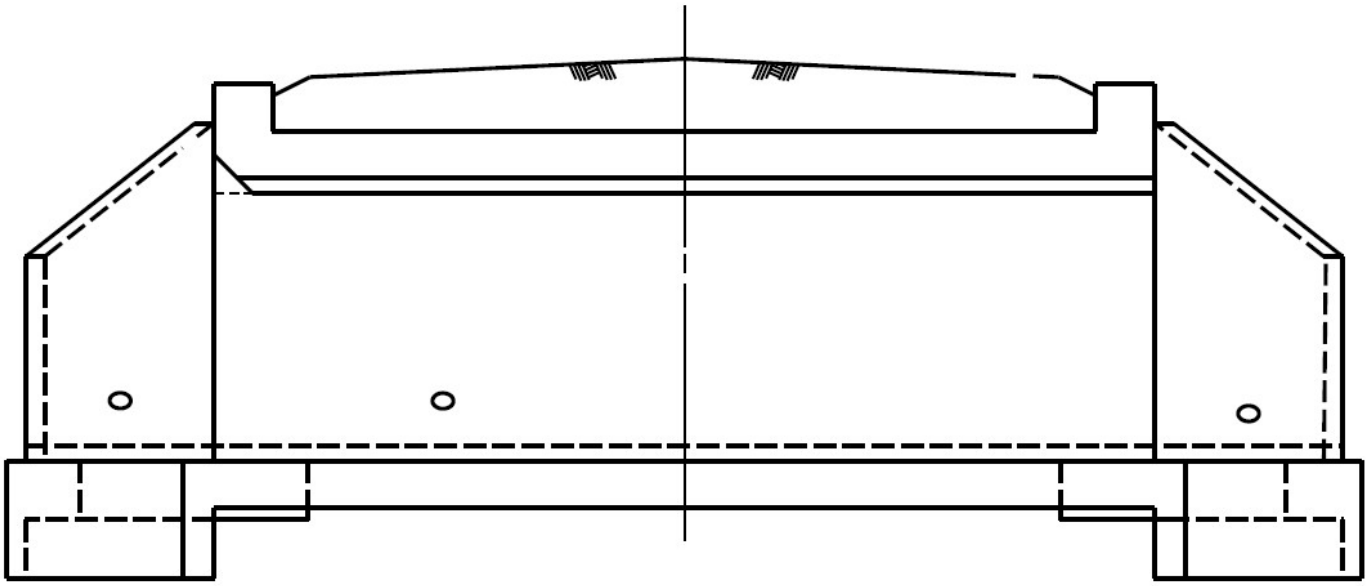




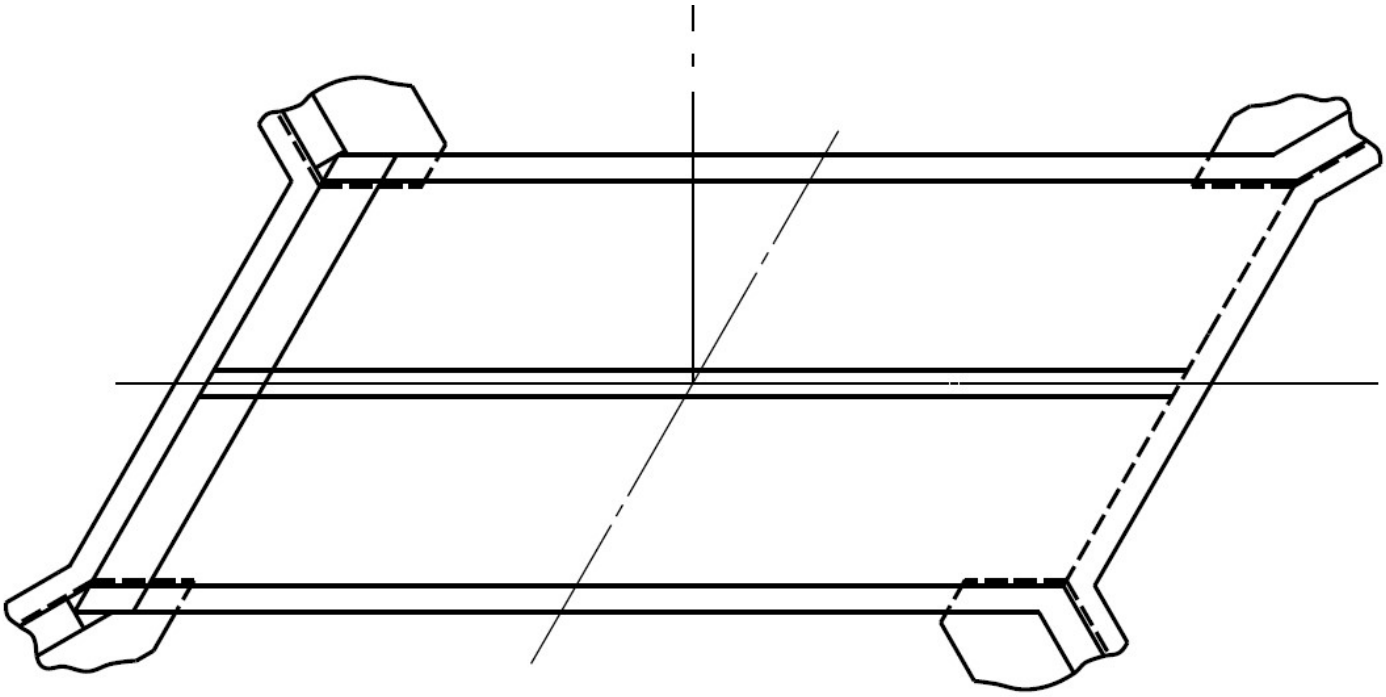
CAD Typical Details for Proposed Culvert Structure



End Elevation

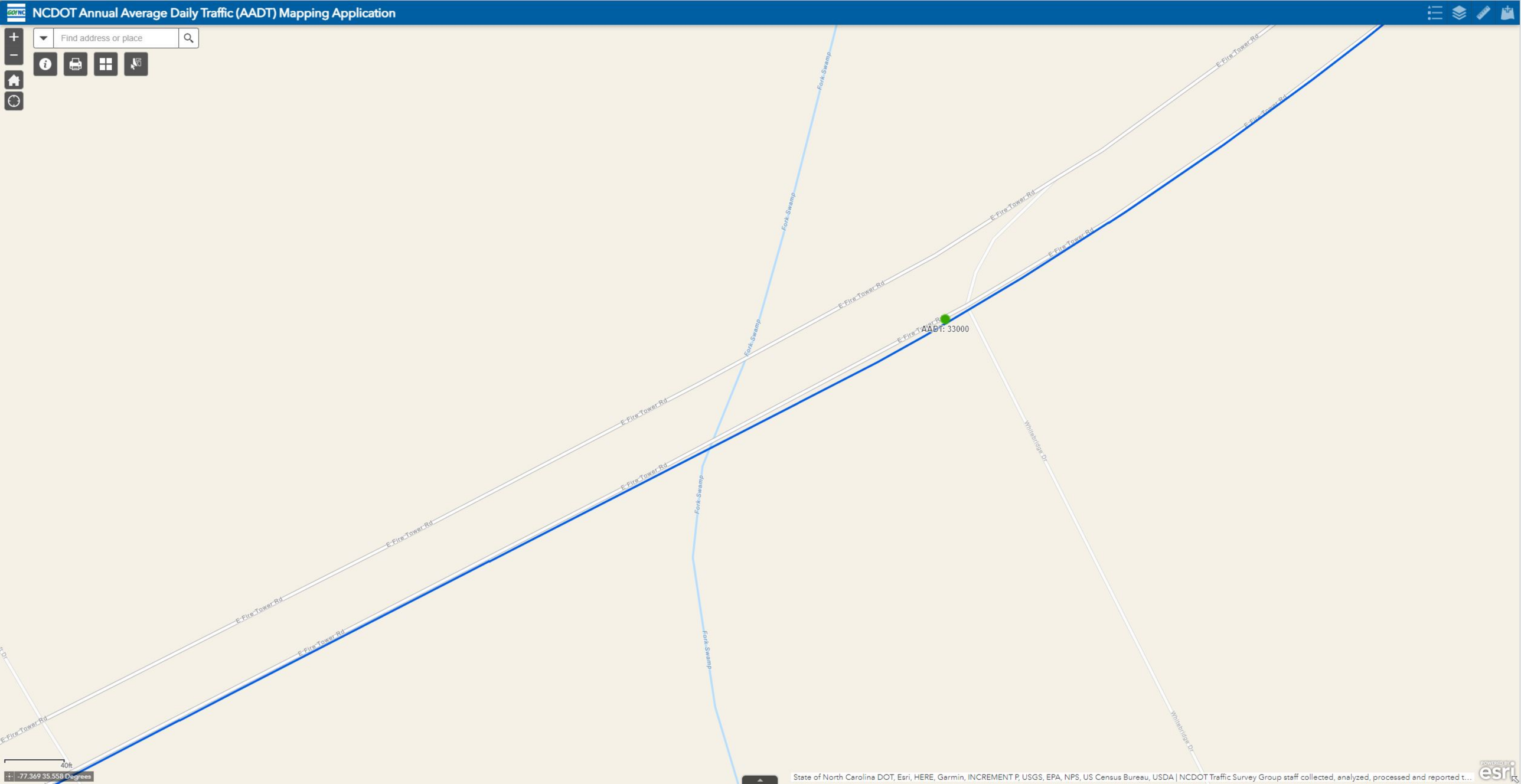


Elevation View - Section across Road

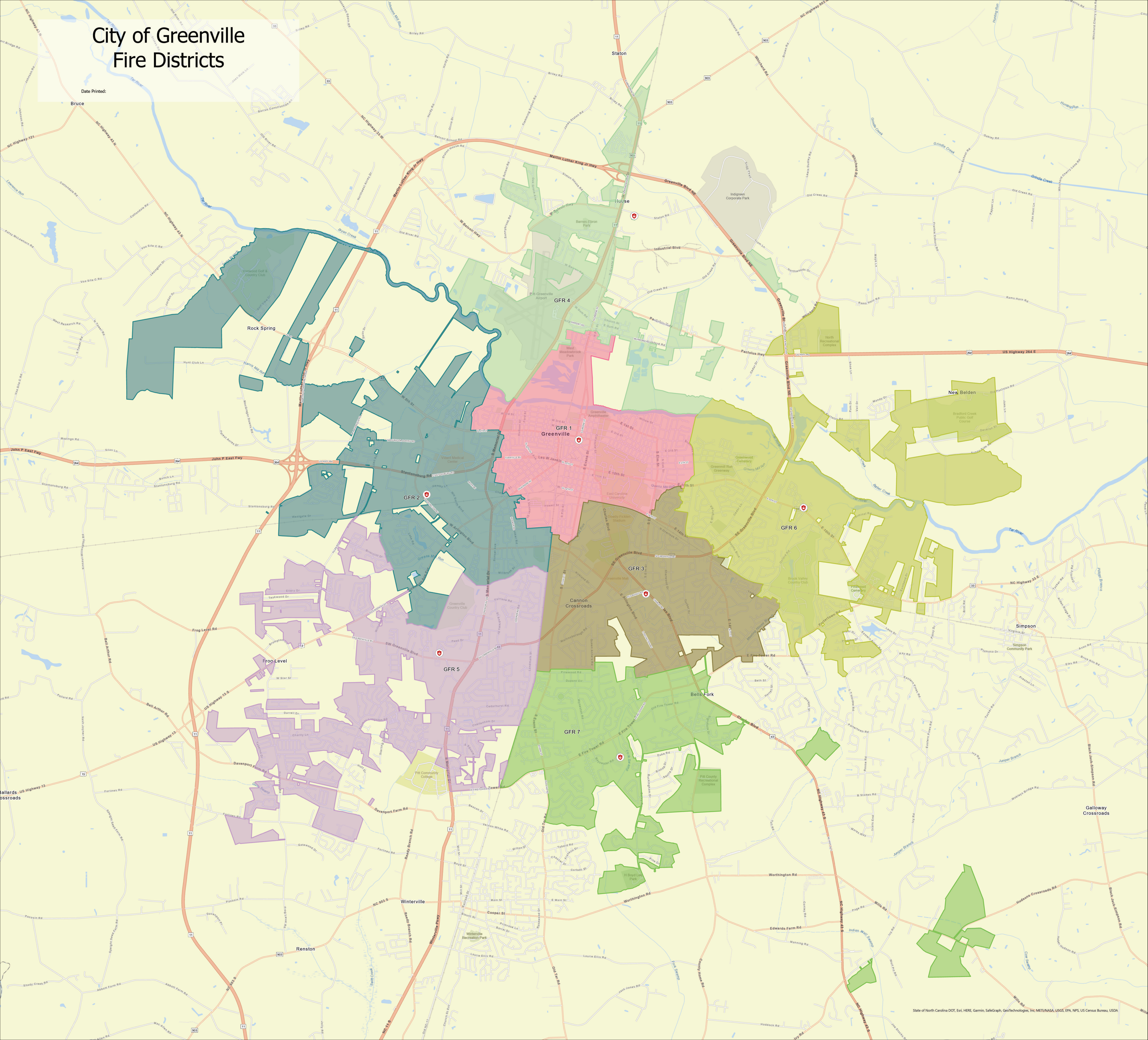


Plan View

Appendix F: NCDOT Annual Average Daily Traffic (AADT) Mapping Application


NCDOT Annual Average Daily Traffic (AADT) Mapping Application
Find address or place
E Fire Tower Rd
Fork Swamp
Whitebridge Dr
AADT: 33000
40ft
-77.369 35.558 Degrees
State of North Carolina DOT, Esri, HERE, Garmin, INCREMENT P, USGS, EPA, NPS, US Census Bureau, USDA | NCDOT Traffic Survey Group staff collected, analyzed, processed and reported t...

Appendix G: Fire Station 3 Service Area



City of Greenville
Fire Districts
Date Printed:
GFR 1
GFR 2
GFR 3
GFR 4
GFR 5
GFR 6
GFR 7
Greenville
Staton
Rouse
Bruce
Rock Spring
New Belden
Simpson
Cannon Crossroads
Frog Level
Bells Fork
Winterville
Renston
Galloway Crossroads
Indigreen Corporate Park
Pitt-Greenville Airport
East Carolina University
Pitt Community College
Pitt County Recreational Complex
North Recreational Complex
Greenville Country Club
Winterville Recreation Park
Tar River
John P East Fwy
Greenville Blvd NE
US Highway 264 E
Martin Luther King Jr Hwy
Stantonsburg Rd
Memorial Dr
SW Greenville Blvd
E Fire Tower Rd
Fire Tower Rd
Worthington Rd
Davenport Farm Rd
Frog Level Rd
NC Highway 43 S
NC Highway 33 E
US Highway 13
State of North Carolina DOT, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA

Appendix H: US Census Quick Facts – Greenville, NC

United States Census Bureau

QuickFacts

Greenville city, North Carolina

QuickFacts provides statistics for all states and counties, and for cities and towns with a ***population of 5,000 or more***.

Table

All Topics	Greenville city, North Carolina
Population Estimates, July 1 2021, (V2021)	**88,728**
PEOPLE	
Population	
Population Estimates, July 1 2021, (V2021)	**88,728**
Population estimates base, April 1, 2020, (V2021)	87,882
Population, percent change - April 1, 2020 (estimates base) to July 1, 2021, (V2021)	1.0%
Population, Census, April 1, 2020	87,521
Population, Census, April 1, 2010	84,554
Age and Sex	
Persons under 5 years, percent	6.0%
Persons under 18 years, percent	19.9%
Persons 65 years and over, percent	9.7%
Female persons, percent	54.9%
Race and Hispanic Origin	
White alone, percent	52.9%
Black or African American alone, percent (a)	39.2%
American Indian and Alaska Native alone, percent (a)	0.4%
Asian alone, percent (a)	2.4%
Native Hawaiian and Other Pacific Islander alone, percent (a)	0.0%
Two or More Races, percent	3.1%
Hispanic or Latino, percent (b)	4.4%
White alone, not Hispanic or Latino, percent	50.9%
Population Characteristics	
Veterans, 2016-2020	3,804
Foreign born persons, percent, 2016-2020	4.2%
Housing	
Housing units, July 1, 2021, (V2021)	X
Owner-occupied housing unit rate, 2016-2020	33.6%
Median value of owner-occupied housing units, 2016-2020	$159,400
Median selected monthly owner costs -with a mortgage, 2016-2020	$1,288
Median selected monthly owner costs -without a mortgage, 2016-2020	$541
Median gross rent, 2016-2020	$823
Building permits, 2021	X
Families & Living Arrangements	
Households, 2016-2020	36,859
Persons per household, 2016-2020	2.34
Living in same house 1 year ago, percent of persons age 1 year+, 2016-2020	67.4%
Language other than English spoken at home, percent of persons age 5 years+, 2016-2020	5.7%
Computer and Internet Use	
Households with a computer, percent, 2016-2020	92.4%
Households with a broadband Internet subscription, percent, 2016-2020	85.0%
Education	
High school graduate or higher, percent of persons age 25 years+, 2016-2020	92.3%
Bachelor's degree or higher, percent of persons age 25 years+, 2016-2020	37.8%
Health	
With a disability, under age 65 years, percent, 2016-2020	8.8%
Persons without health insurance, under age 65 years, percent	9.4%
Economy	
In civilian labor force, total, percent of population age 16 years+, 2016-2020	63.2%

In civilian labor force, female, percent of population age 16 years+, 2016-2020	59.2%
Total accommodation and food services sales, 2017 ($1,000) (c)	363,859
Total health care and social assistance receipts/revenue, 2017 ($1,000) (c)	2,069,633
Total transportation and warehousing receipts/revenue, 2017 ($1,000) (c)	55,567
Total retail sales, 2017 ($1,000) (c)	1,782,838
Total retail sales per capita, 2017 (c)	$19,389
Transportation	
Mean travel time to work (minutes), workers age 16 years+, 2016-2020	18.0
Income & Poverty	
Median household income (in 2020 dollars), 2016-2020	$42,612
Per capita income in past 12 months (in 2020 dollars), 2016-2020	$26,127
Persons in poverty, percent	⚠ 27.3%

BUSINESSES

Businesses	
Total employer establishments, 2020	X
Total employment, 2020	X
Total annual payroll, 2020 ($1,000)	X
Total employment, percent change, 2019-2020	X
Total nonemployer establishments, 2019	X
All employer firms, Reference year 2017	1,954
Men-owned employer firms, Reference year 2017	1,059
Women-owned employer firms, Reference year 2017	304
Minority-owned employer firms, Reference year 2017	239
Nonminority-owned employer firms, Reference year 2017	1,326
Veteran-owned employer firms, Reference year 2017	S
Nonveteran-owned employer firms, Reference year 2017	1,400

GEOGRAPHY

Geography	
Population per square mile, 2020	2,391.5
Population per square mile, 2010	2,443.3
Land area in square miles, 2020	36.60
Land area in square miles, 2010	34.61
FIPS Code	3728080

About datasets used in this table

Value Notes

⚠ Estimates are not comparable to other geographic levels due to methodology differences that may exist between different data sources.

Some estimates presented here come from sample data, and thus have sampling errors that may render some apparent differences between geographies statistically indistinguishable. Click the Quick Info ⓘ icon to th row in TABLE view to learn about sampling error.

The vintage year (e.g., V2021) refers to the final year of the series (2020 thru 2021). Different vintage years of estimates are not comparable.

Users should exercise caution when comparing 2016-2020 ACS 5-year estimates to other ACS estimates. For more information, please visit the 2020 5-year ACS Comparison Guidance page.

Fact Notes

(a) Includes persons reporting only one race
(c) Economic Census - Puerto Rico data are not comparable to U.S. Economic Census data
(b) Hispanics may be of any race, so also are included in applicable race categories

Value Flags

- Either no or too few sample observations were available to compute an estimate, or a ratio of medians cannot be calculated because one or both of the median estimates falls in the lowest or upper in open ended distribution.
F Fewer than 25 firms
D Suppressed to avoid disclosure of confidential information
N Data for this geographic area cannot be displayed because the number of sample cases is too small.
FN Footnote on this item in place of data
X Not applicable
S Suppressed; does not meet publication standards
NA Not available
Z Value greater than zero but less than half unit of measure shown

QuickFacts data are derived from: Population Estimates, American Community Survey, Census of Population and Housing, Current Population Survey, Small Area Health Insurance Estimates, Small Area Income and P Estimates, State and County Housing Unit Estimates, County Business Patterns, Nonemployer Statistics, Economic Census, Survey of Business Owners, Building Permits.