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Comprehensive Stormwater Plan

Town of Waynesville

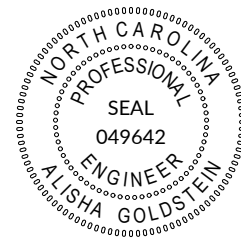
Haywood County

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Glossary

ALTERNATIVES MODEL – hydrologic and hydraulic model for the proposed alternatives to address level of service (LOS) deficiencies identified over the course of the project

CROSS-SECTION- a graphical depiction of the stream and the floodplain at a particular point along the stream

CULVERT- a structure carrying a stream or open drain under a road or railroad

DESIGN STORM – a hypothetical, statistically-defined rainfall event characterized by its frequency (e.g., 10 year, 100-year), duration (e.g., 6-hour, 24-hour), and intensity/temporal distribution (how rainfall is shaped over time) used to establish level of service standards for sizing drainage systems and other infrastructure

DRAINAGE AREA- an area of land where all flowing surface water converges to a single point

EXISTING CONDITIONS MODEL – Hydrologic and hydraulic model based on flows computed for current land use or zoning districts and are routed through existing infrastructure

FLOOD- a general and temporary condition of partial or complete inundation of normally dry land areas

FLOODPLAIN- an area of low-lying ground adjacent to a river, formed mainly of river sediments and subject to flooding

HYDRAULICS- the science of dealing with fluids in motion that is used to determine how a quantity of water will flow through a channel or floodplain

HYDROLOGY- the science of dealing with the distribution and circulation of water in the atmosphere, on land surfaces, and underground that is used to determine flood flow frequencies

IMPERVIOUS SURFACE- A hard surface that prevents water from infiltrating into the ground

INUNDATION- an area over which flood waters extend

INVERT- vertical elevation of specified point; for pipes, interior bottom elevation

LAND USE- the characterization of land surface based on what it is being used for or will be used for in the future

LEVEL OF SERVICE (LOS) – the locally required performance standard for public infrastructure such as culverts, ditches, and closed drainage systems

MANNING’S N- a coefficient which represents the roughness or friction applied to the flow based on the surface characteristics

MODELED STORM – a design storm used within a model to evaluate impacts on drainage systems and infrastructure

OVERBANK- the point on either side of a channel at which flow exceeds the capacity of the channel and goes into the floodplain

OVERLAND FLOW- water that travels across normally dry land

RAINFALL DEPTH- the quantity of rain falling within a storm of a specific duration distributed uniformly over the watershed area

RCP – Reinforced Concrete Pipe

RIVERINE- relating to or situated on a river or riverbank

STORMWATER- water that originates from precipitation, including heavy rain and meltwater

TOPOGRAPHY- A detailed description or representation on a map of the natural and artificial features of an area

TRIBUTARY- a river or stream flowing into a larger river or lake.

USGS – United State Geological Survey

WATERSHED- an overflowing of a large amount of water beyond its normal confines, especially over what is normally dry land

X-YEAR STORM- flood recurrence interval based on the probability of the storm event occurring in a given year

Note: Other definitions can be found in the [NC Stormwater Design Manual](#) and the [Town of Waynesville Land Development Standards, Chapter 17](#).

Executive Summary

The Town of Waynesville (Town) initiated this stormwater master plan to improve the Town's stormwater management system and in support of the Town's National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Permit. The project is grant funded through the LASII (Local Assistance for Stormwater Infrastructure Investments) program. LASII is a North Carolina DEQ program using American Rescue Plan Act (ARPA) funds.

The Town of Waynesville (Town) identified the need for a stormwater asset inventory and stormwater system capital improvement plan to make informed decisions regarding their assets, necessary maintenance, and future capital improvement projects. The project included the following components:

- Town Facility Investigation
- Stormwater Asset Inventory Mapping
- Existing Conditions Hydrologic and Hydraulic Analysis
- Alternative Model to Evaluate Climate Adjusted Storm Events
- Proposed Conceptual Projects
- Capital Improvement Plan
- Growth Assessment and Ordinance Review
- Public Participation

A system inventory was completed within study areas selected for their critical infrastructure needs by Town Staff. The three study areas are Shelton Branch, Hazelwood, and Frog Level. A flood model was developed using the stormwater GIS inventory to assess stormwater infrastructure based on existing conditions. The modeled storms evaluated were the 10-year, 25-year, 50-year, and 100-year 24-hour storm events. Potential areas of concern were identified based on which structures, pipes, and culverts were exceeding capacity during the selected design storm for each infrastructure type.

Based on input from Town staff, eight priority project areas were selected for conceptual designs. Conceptual stormwater improvements site plans, designed to mitigate flooding conditions for climate adjusted rainfall, and engineer's cost opinions were developed. Only six projects could meet the desired level of service within the site constraints. A summary of the conceptual designs and engineer probable cost opinions are:

- **Waynesville Public Works and Legion Drive:** Improvements focused on increasing system capacity along Legion Drive and Pigeon Street and realigning infrastructure into public right-of-way by adding new infrastructure on Town & Country Drive.
Engineer Cost Opinion: \$1,589,000
- **Broad Street:** Improvements include replacement of the existing culvert to increase capacity on Broad Street, which conveys Shelton Creek.
Engineer Cost Opinion: \$742,000

- **Burke Street & Shelton Street:** Improvements include increasing capacity along Shelton Street and realigning the system behind homes along Broad Street to a new outfall on Shelton Creek.
Engineer Cost Opinion: \$1,719,000
- **Charles Street & Branner Avenue:** Improvements include increasing capacity along Branner Avenue through Charles Street to the outfall north of Water Street.
Engineer Cost Opinion: \$4,080,000
- **Hazelwood Avenue:** Improvements included increasing capacity along Hazelwood Avenue and cross drainage into the system from the intersection with Morgan Street to the outfall on Farmers Branch.
Engineer Cost Opinion: \$613,000
- **Virginia Avenue, Kentucky Avenue & Main Street:** Improvements focused on increasing system capacity for the system starting on Main Street traversing behind homes along Kentucky Avenue and Virginia Avenue to the outfall on Farmers Branch.
Engineer Cost Opinion: \$918,000

Fact sheets and detailed breakdown of the costs for each concept design can be found in **APPENDIX A: PROPOSED CONCEPTS & ENGINEER PROBABLE COST OPINIONS FOR CONCEPTUAL LEVEL IMPROVEMENTS**. These projects were prioritized and incorporated into a capital improvement plan (CIP). The CIP also included staffing and maintenance needs for the townwide stormwater system.

The last component of the stormwater master plan was a growth assessment and ordinance review to evaluate the potential impact of future growth on infrastructure capacity and possible regulatory measures to mitigate stormwater runoff. The recommended actions include: increased protection of riparian buffer; changing the design storm standard for stormwater conveyance and erosion and sediment control; and defining requirements for a downstream impact analysis. Two public meetings were held and a public survey was conducted at the onset of the project to gather information on public identification of stormwater issues and places of concern.

This Stormwater Master Plan is intended to serve as the Town of Waynesville's primary stormwater capital planning and grant-support document for the next 10-15 years. The conceptual projects identified herein provide a framework for prioritizing future design, pursuing external funding, and reducing flood risk to public infrastructure, private property, and critical facilities.

1. Introduction

The Town of Waynesville experiences flooding throughout the town during intense, unnamed storms. The Town is utilizing Local Assistance for Stormwater Infrastructure Investments Program (LASII) to map stormwater infrastructure and develop a master plan for the designated study areas.

1.1 Town Description

The Town of Waynesville (Town) is located within Haywood County, NC and is the county seat. According to the United States Census completed in 2020, The Town has a population of 10,140 people and encompasses approximately 8.94 square miles.

The Town is within the Richland Creek Watershed within Pigeon River subbasin of the French Broad watershed. The municipal boundary including the Extraterritorial Jurisdiction (ETJ) is Dellwood Road by Lake Junaluska to the north, Raccoon Road to the east, Valley View Circle to the south, and Eagles Nest Road to the west. The FEMA floodplain is located along the spine of the Town through many urbanized, densely developed, older areas of Town with aged infrastructure. FEMA is currently updating the preliminary floodplain maps for the County. The FEMA information referenced was last revised April 3, 2012. FEMA is currently updating the preliminary floodplain maps in the County as of February 2026.

The downtown area for Waynesville is located between Richland Creek and Shelton Branch. The spine of downtown along Main Street is the ridge line between the two drainage areas. West of Main Street flows into Richland Creek and East of Main Street flows into Shelton Creek. The neighborhood known as Frog Level located along Richland Creek arose due to the construction of the railroad. It was developed on swampland and is an area that historically has flooded. Hazelwood is a former incorporated town that merged with Waynesville in 1995. Hazelwood is a low-lying area between Browning Branch and Farmers Branch.

1.2 Study Areas

The geographic area for the study was limited in scope due to budget constraints. Town staff selected study areas based on critical infrastructure needs with known issues of flooding. There were three study areas:

- Frog Level
 - Drainage area to Richland Creek from Miller Street in the south to Henry Street in the north.
 - There are several stormwater systems that originate close to Main Street and extend northwest to outfalls on Richland Creek,
 - Richland Creek has a FEMA mapped floodplain identified on FIRM Map 3700861500J and 3700861600J.
 - The neighborhood is a mix of business, government, and religious buildings.

- Shelton Branch

- Drainage area to Shelton Creek between McCracken Street to the south and East Street to the north.
 - There are many stormwater systems that discharge to outfalls on Shelton Branch along the east and west banks of the river.
 - Shelton Creek has a FEMA mapped floodplain identified on FIRM Map 3700861500J
 - The neighborhood is primarily a mix of businesses along Pigeon Road and residential homes. The municipal Public Works and Cemetery is within the drainage area.
- Hazelwood
- Drainage area to Farmers Branch from Kentucky Avenue in the south to Hazelwood Park off Brankris Drive in the north.
 - Farmers Branch has a FEMA mapped floodplain identified on FIRM Map 3700860500J.
 - The neighborhood is a mix of business, residential homes, with some commercial industrial activity.

The project extents can be seen in **Figure 1** below. The FEMA mapped floodplain for Richland Creek, Shelton Branch, and Farmer's Branch as shown on FIRM Maps are included in **APPENDIX B: REFERENCE MATERIALS**.

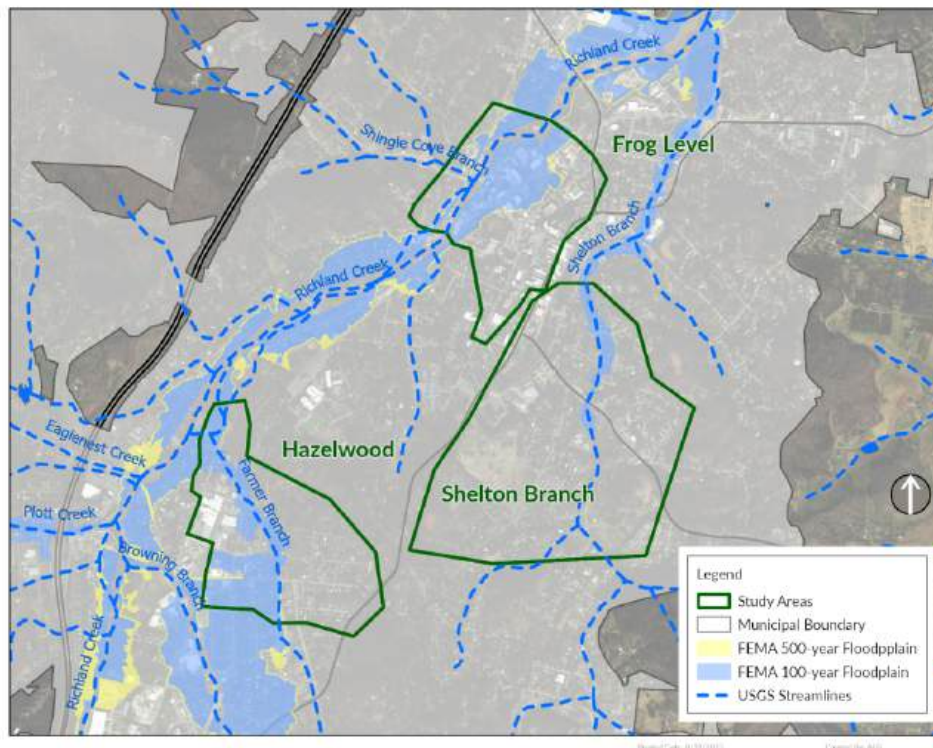


Figure 1. Site Map

2. Town Facility Investigation

The Town of Waynesville identified five Town owned facilities for visual inspection of existing drainage infrastructure on each facility property. These inspections were conducted to make recommendations for repair maintenance and identify any opportunities for green infrastructure retrofits. An assessment form was developed for the field visit to evaluate the condition of the infrastructure. The assessment included an evaluation of capacity, drainage area, trash, and condition of infrastructure and vegetation as warranted. These attributes were assessed according to a metric of pass, minor, moderate, and severe. The qualitative indicators informing the visual inspection rating are summarized in a table included in **APPENDIX C: TOWN FACILITY INVESTIGATION**.

This inspection form was loaded into the ArcGIS Field Map application to facilitate field inspections from a smartphone. The application also enabled photos to be linked to specific points. The output from this mapping exercise was a relational geodatabase relating quantitative and qualitative information about infrastructure and provides photographic reference. Additionally, actions for each site such as repair, evaluation, or maintenance were identified with follow-up notes for the suggested action. The resulting infrastructure condition rating tables, summary exhibits, and a photo log are provided in **APPENDIX C: TOWN FACILITY INVESTIGATION**. The site visit to Waynesville's facilities occurred on December 12, 2023.

2.1 Public Works

The Town's Public Work facility is located at 129 Legion Drive. There is one enclosed building on the site which has several offices and an indoor garage for vehicle maintenance. Around the perimeter of the site, there are bays that are open on three sides and enclosed by a roof. These bays are used for storing materials and trucks for the various crews. In the garage area, there is a floor drain that runs the length of the garage. There is one catchbasin in the corner of the garage by the eye-washing station. The staff shared that a dye test had confirmed that the catchbasin and floor drain were connected. The floor drain has an approximately four-inch outlet pipe. There is a cleanout outside the building for this pipe. There are no oil separators installed in any catchbasin on the property. It is recommended that the Town install two oil separators at CB-4 and CB-3 prior to stormwater flows leaving the site.

After the MS4 audit in 2019, the Town has educated staff on illicit discharge and has provided drip pans and absorbent pads to collect any oil and grease that has spilled. The machine shop area is cleaned weekly. The staff stated that cars are not washed in the garage but may receive spot cleaning. The public work staff is aware of good housekeeping practice for the facility. Haywood Waterkeeper inspects the facility every four months. During the MS4 audit in 2025, staff were informed that the facility needs a separate NPDES permit and should conduct periodic water testing at the outfall to ensure no illicit discharge. The Town of Waynesville was issued a certificate of coverage to discharge stormwater from the Public Works facility under the NPDES General Permit for the Public Works Facility on December 15, 2025.

There are three catchbasins located in the bays identified as CB-PW, CB-2, and CB-3 and one catchbasin in the parking lot identified as CB-4. All these catchbasins have a filter sock surrounding the drain to filter out sediment and oils. Filter socks are a best management practice

since the bays are heavily trafficked by vehicles and contain stockpiles of materials (i.e. sand, mulch, dirt, etc.). The catchbasin on the eastern edge of the site is separated by a three-foot concrete barrier to a gravel stockpile. Gravel was observed on both sides of the barrier. At all the catchbasins in the bays, sediment accumulation and standing water inside the catchbasin was observed. It is recommended to frequently inspect and clean out catchbasins and/or replace filter socks to prevent sediment accumulation. Additionally, sweeping paved vehicular trafficked areas is recommended. The catchbasin in the parking lot has some sediment and standing water but relatively less than those observed in the bays.

The staff noted that catchbasin CB-PW and CB-2 in the storage bay areas is connected to the sanitary sewer system (see **APPENDIX C: TOWN FACILITY INVESTIGATION**). This connection was completed during a renovation approximately five years ago and anecdotally confirmed via a recent dye test. The survey of the facility identified CB-PW and CB-2 connects to a CB-3 located in the easternmost bay. The system discharges beyond the eastern edge of the property boundary and flows overland into the system that carries the flow from the northern portion of the Public Works facility. The combined flow discharges to Shelton Branch south of Pigeon Street.

2.2 Fire Station #2 and Finance Building

Fire Station #2 and the Town finance building are housed together at 280 Georgia Avenue. The east portion of the building and parking lot is within the FEMA defined floodplain. The Farmer Branch stream is piped through the site and daylights north of the property.

The fire station has an enclosed garage area for two vehicles with a catchbasin within each parking bay. The discharge point for the floor drains in the garage is unknown. Due to the limited capacity of these floor drains, the crew stated that they do not wash vehicles inside. There is one storm catchbasin recessed in the center of the parking lot. Based on sediment residue and flow patterns, it is apparent that water ponds in the parking lot and overflows to the west and north. The storm catchbasin connects to a pipe that originates from a catchbasin alongside Brown Avenue and discharges on the north side of the parking lot. The pipes convey runoff and the Farmer Branch streamflow. There is gully erosion above the pipe outfall due to water overtopping the parking lot and rushing down the bank towards the stream. This gully erosion needs to be stabilized to prevent damage to the culvert. There is an outfall on the west side of the parking lot consisting of a concrete lined channel to the railroad ditch. The catchbasin on the east side of Brown Street is missing the curb and needs to be replaced.

Staff on site related that the parking lot and roadway can fill with standing water for a period following storms. These statements and visual observations indicate that there may be capacity issues in the pipe or clogging in the catchbasin. The next step is to vacuum the catchbasin to remove sediment and debris and survey the system. After discussions with the Town, the drainage basin encompassing this site was selected for further survey exploration and conceptual design improvements. After damage incurred by Hurricane Helene, the Town performed repair work and pipe replacement for failing pipes and resurfacing of the parking lot.

2.3 Hazelwood Neighborhood

Based on the noted flooding in and around the fire station, the site visit included a walk through the adjacent Hazelwood Neighborhood. This low-lying neighborhood is located along Farmer Branch in a FEMA mapped floodplain. A visual inspection was conducted of four catchbasins on Westwood Circle near Dutch Fisher Memorial Park. These catchbasins had evidence of sediment deposition. From conversations with residents, there is localized flooding in some backyards. It was relayed that a resident who lived adjacent to Farmer Branch incurred structural damage from floods.

2.4 Greenway Rain Garden by Lake Junaluska

The rain garden is located at the entrance to the greenway across from Lake Junaluska, just below U.S. 19 adjacent to a parking lot. The rain garden was built as a demonstration project in 2021 to treat runoff off U.S. 19. The stormwater runoff from the road outfalls into a riprap lined channel with three check dams before flowing into the planting area. From the planting area, the runoff is conveyed into a riprap channel to a culvert underneath the driveway which discharges into Richland Creek. The conveyance channel into the planting bed had sediment accumulation particularly in the section prior to the planting bed. This evidence indicates that water may back up into the channel. The upstream end of the culvert has been crushed limiting the pipe capacity and should be replaced.

2.5 There has been ongoing maintenance issues at this site due to sediment, trash, and vegetation health. Town staff noted that vegetation has died three times in this area. It is suspected that there is either a high groundwater table and/or high volumes of runoff to the rain garden relative to its size. Diverting flow or reducing the drainage area would help reduce the volume of runoff. The adjacent roadway is managed by NCDOT who is proposing a realignment. Due to the ongoing maintenance challenges and planned road project, it is recommended to remove the rain garden and replace the culvert.

Greenway behind Mountain Creek Apartments

This site was formerly a commercial business with a parking lot that extended into the floodplain close to the creek. The site was recently redeveloped into apartment buildings that were constructed outside of the floodplain. The parking lot in the floodplain was removed and redesigned with a greenway. The apartments buildings have stormwater control measures to detain and slow down the release of stormwater runoff from the property. There are some impervious areas associated with the apartment complex such as a sidewalk and downspouts from the rear balconies which are not conveyed into the stormwater control measure. Instead, these area outfall onto the grass beside the greenway.

During the site visit which occurred two days after a storm, there was standing water and pockets of ice on the greenway. Due to the location of this area in the floodplain, the recommended course of action would be to amend the soils and revegetate the area to absorb water and stabilize the riparian buffer from potential erosion.

2.6 Cost Estimates

The Town requested planning-level cost estimates for issues identified as severe to ensure that immediate replacement or repair would be pursued and for select projects to pursue grant opportunities. The two cost estimates presented in **Table 1** is for replacing the curb along the west side of Brown Avenue by Farmers Branch. The curb is part of the sidewalk slab that also serves as a bridge over Farmer Branch stream. The gutter portion of the curb has fallen off exposing the rebar. This project is identified as severe to avoid endangering the stability of the catchbasin further and to prevent any physical harm to a pedestrian. The material cost is provided below assuming that the labor would be done with a Town crew.

Table 1. Brown Street Curb Replacement

MATERIAL COST				
Structure	Quantity*	Unit	Unit Price	Total
Reinforced Concrete Deck Slab	50	SF	\$ 10	\$ 500
Guardrail	10	LF	\$ 20	\$ 200
Roadway Restoration	20	SY	\$ 100	\$ 2,000
MATERIALS SUBTOTAL				\$ 2,700

The Town requested a planning level cost estimate for a riparian revegetation plan along the Richland Creek greenway as provided in **Table 2**. The site area by the greenway is in a floodplain which prohibits any grading from occurring. Constructing a stormwater control measure to provide detention would be infeasible. The recommended activities are stabilization of the streambank and deep-rooted vegetation to absorb and slow down runoff. Restoration of vegetation involves erosion control measures, soil amendments, invasive removal and eradication, sleeves for plant protection and mowing/maintenance over an establishment period of several years.

Prior to any improvements, the soil should be investigated on site to determine the type and quantity for any amendments. Site preparation should also include loosening compacted soil before any planting. Also in the pre-planning, a planting and maintenance plan should be devised to appropriately site and outline establishment needs for the plants. The project costs could range widely depending on the desired outcome, source of labor for installation and maintenance, and the composition of the existing soils. The following estimated costs for revegetation were determined for a 20,000-sf area which is roughly equivalent to the area besides the greenway. The costs don't include installation and maintenance labor, erosion control, and soil preparation which would need to be determined.

Table 2. Greenway Revegetation and Streambank Stabilization

REVEGETATION PLAN

Structure	Assumptions	Total
Grasses	Hydroseed the entire area	\$4,000 - \$6,000
Native Grasses	2.5" pots planted 3' on center	\$10,000 - \$12,000
Tree Seedling	USFS seedling planted 5' on center	\$2,000 - \$3,000
Caliper trees	1.5" caliper nursery trees planted 20' on center (usually includes soil amendments and warrantee)	\$20,000 - \$23,000

A recommended course of action would be to hydroseed and to implement one of the two planting options above. This plan would stabilize the soil and provide a buffer along the greenway. A minimum budget of \$7,000-12,000 is recommended until more investigation and planning is carried out. The list below constitutes appropriate native plants for the site.

Table 3. Native Plant Options for Greenway Revegetation

Trees	
<i>Pinus strobus</i>	Eastern White Pine
<i>Quercus coccinea</i>	Scarlett Oak
<i>Quercus alba</i>	White Oak
Small Trees	
<i>Amelanchier stolonifera</i>	Serviceberry
<i>Aesculus</i>	Buckeye
<i>Ilex opaca</i>	American Holly
<i>Juniperus virginiana</i>	Red Cedar
Shrubs	
<i>Viburnum prunifolium</i>	Blackhaw
<i>Itea virginica</i>	Sweetspire
<i>Aronia arbutifolia</i>	Chokeberry
<i>Viburnum dentatum</i>	Possumhaw
<i>Cephalotaxus occidentalis</i>	Button Bush
Ornamental Grasses (may be non-native)	
<i>Andropogon</i>	Blue Stem
<i>Erogrostis</i>	Weeping Love Grass
<i>Festuca</i>	Fescue
<i>Schizachyrium scoparium</i>	Little Blue Stem
Non-native Grass for Hydroseeding	
<i>Erogrostis curvula</i>	Weeping Lovegrass

Actions that are not an immediate concern are not presented in this cost estimate. Some of the issues in the visual facilities inspection require further investigation of the drainage infrastructure sizing before recommendations can be made to reduce flooding or address water quality.

The rain garden off the greenway has a pipe under the driveway that has been compromised. With the rain garden not functioning and any overflow not endangering property or safety, the pipe replacement is not an immediate concern but does need to be addressed.

An oil grit separator is recommended to remove floating oil and grease and heavy sediments from stormwater runoff at the public works facility in catchbasin CB-4 in the parking lot and CB-3 in the storage bay. Cisterns could be utilized at either or both the Fire Station and Public Works Facility to lessen the stormwater runoff from each site. The collected runoff could be used to wash cars. Based on site topography and limited space constraints, no additional green infrastructure was identified based upon initial desktop and field review.

3. Stormwater Asset Inventory & GIS Data Characterization

A system inventory of the drainage infrastructure and outfalls was completed within the selected study areas throughout the Town. The information collected in the survey was compiled into an inventory that included the locations of pipes and structures and structure attributes such as invert elevation, pipe diameter, and pipe material. Additionally, an approach photo of the structure and a 360-degree photo inside the structure when possible were taken and linked to the attributes within a GIS database.

A field visit by engineering staff followed the survey to verify drainage connectivity and collect information on roadside ditches. Discrepancies between the survey and what was identified in the field were flagged. A survey crew was sent out again to collect data at any structure flagged as part of the verification field visit.

In total, there were approximately 32,058 linear feet of storm conveyance including approximately 535 linear feet of culverts and 613 structures surveyed within the three study areas. The study areas cumulatively encompass approximately 510 acres. The pipes ranged in diameter from 4 inches to 48 inches with 80% of the pipes survey between 12 inches and 24 inches as detailed in **Table 4**. The stormwater network inclusive of pipes and culverts is predominantly a combination of corrugated metal, vitrified clay, corrugated plastic, and reinforced concrete as shown in **Figure 2**. The structures collected included 97 manholes, 440 catchbasins, and 76 discharge points. The GIS data was provided to the Town to update their existing inventory within the surveyed areas.

The stormwater asset inventory developed as part of this study is intended to serve as the Town’s authoritative stormwater asset registry. The dataset should be maintained within the Town’s GIS environment and updated as capital projects are completed, development projects are reviewed, and system improvements are constructed. Ongoing maintenance of the dataset will support asset management, regulatory compliance, and future planning efforts.

Table 4. Summary of Pipe Diameter by Linear Foot

Pipe Diameter	Length of Pipe (feet)	Percent Within Total System
4 inches	250.61	1%
6 inches	701.87	2%

8 inches	1493.38	4%
10 inches	1590.88	4%
12 inches	8137.79	20%
15 inches	12162.68	30%
18 inches	7210.33	18%
24 inches	4889.05	12%
30 inches	2254.78	6%
36 inches	903.6	2%
42 inches	320.82	1%
48 inches	673.86	2%

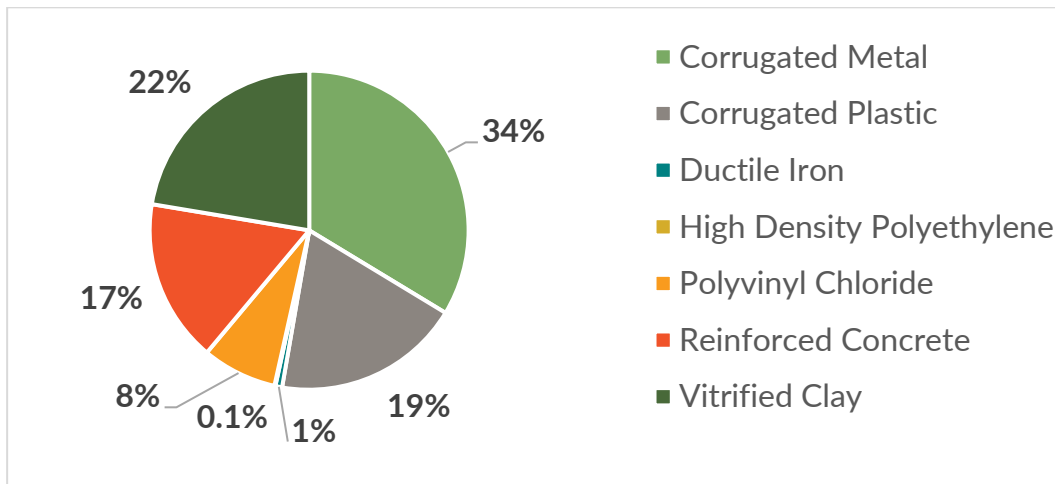


Figure 2. Pipe Material by Percentage of Linear Foot

4. Public Engagement

Public input was gathered through a survey accessible between February 12, 2024, and March 4, 2024, and public meetings on February 22, 2024, on September 24, 2025, to identify issues of concern and relate information on the stormwater management plan. The survey consisted of twelve questions to understand favorability to stormwater improvements and collect information on stormwater quality and flooding issues. The survey was published online via SurveyMonkey and advertised through the Town’s Facebook page on February 12, 2024, 2024 and via the Town website. Additionally, hard copy versions of the survey were made available at the public meeting. The survey and a summary of the results are provided in **APPENDIX H: PUBLIC ENGAGEMENT**.

There were 15 responses to the survey and 15 people overall who showed up to a meeting. Half of the respondents to the survey avoided local water due to concerns about water quality and have experienced impassable roads due to rain, ponded water on their property, or water damage in a building. There was an overall desire for stormwater management improvements in

Waynesville to reduce flooding on roadways, in parks, and on private properties. Based on the concepts listed for improving flood risk and water quality, respondent would favor the improvement of drainage infrastructure, modifying the land development ordinance, and implementing green infrastructure. There were many requests for keeping trash out of ditches and stabilizing creek beds. At the meeting, attendees asked if staffing, funding, and maintenance frequency recommendations could be included in the master report. There were also questions about incorporating land use and rainfall changes.

The areas identified as flooding concerns by residents are shown on the Stormwater Concerns Shared by the Public Figures in **APPENDIX H: PUBLIC ENGAGEMENT**. This figure also shows the concept design project locations which were presented at a public meeting on September 24, 2025. Overall, residents want to see improvements in the wellbeing of their rivers, creeks and overall environment within their community with regards to stormwater and environmental concerns.

5. Existing Conditions Hydrologic and Hydraulic Analysis

Hydrologic and hydraulic models were developed to identify potential flood prone areas within the study areas. The models were based on survey data and informed by LIDAR, SSURGO soils, and field observations.

5.1 Precipitation

Total precipitation depths for the 10-, 25-, 50- and 100-year 24-hour storms were defined based on NOAA Atlas 14 precipitation data. The precipitation distribution for the project location follows the NRCS Type-II Synthetic 24-hour Rainfall Distributions (Hershfield, 1961). For NOAA Atlas 14 precipitation data and cumulative rainfall depths for the four design storms, see **Table 5** and **APPENDIX B: REFERENCE MATERIALS**.

Table 5. Rainfall depths for select design storms (24-hour)

Return Period (year)	Precipitation Depth (Inch)
10	4.56
25	5.36
50	6.01
100	6.67

5.2 Modeled System

In developing the stormwater models, simplifications were pursued with the goal of creating manageable models that focus on an evaluation of public infrastructure. These simplifications reduce the number of pipes and structures that are evaluated for the detailed capacity analysis. Additional simplification and deviations were made in the model as needed to adequately depict and reflect flooding.

Generally, smaller pipes are lateral connections from private properties originating from downspouts or yard catchbasins. To focus the model on the publicly owned drainage infrastructure, pipes smaller than 15 inches were removed from the model unless they were identified as being along the primary infrastructure flow path within the watershed. The model included 29,966 linear feet of stormwater pipe system and 14,315 linear feet of stream.

5.3 Subcatchment Delineation

Subcatchments were delineated using survey data, 2017 QL1 LiDAR DEM, retrieved from the North Carolina Spatial Data Download, and existing drainage network to define contributing drainage areas to drainage features within the study areas.

All layers pertaining to the stormwater network were pulled from the stormwater GIS inventory, post-data validation. Subcatchment area was derived from the horizontal projection of the area within the boundaries of the subcatchment, represented in acres. The projected coordinate system used in all applications was NAD 1983 (2011) State Plain North Carolina FIPS 3200 (US Foot). *Storm Water Management Model User's Manual Version 5.1* guidance was used to set subcatchment parameters.

5.4 Infiltration

Developed by the Natural Resources Conservation Service (NRCS), formerly Soil Conservation Service (SCS), the Unit Hydrograph and Curve Number (UH-CN) is a widely accepted method for computing runoff hydrographs. Within PCSWMM this method can be utilized by applying an Alternative Runoff Method which generates a separate subcatchment layer to which different parameters can be applied instead of the standard SWMM non-linear reservoir routing method subcatchments. When the SCS dimensionless UH method is selected, the following subcatchment parameters are utilized:

- Peak Rate Factor (Kp)= Standard (483.4)
- SCS Curve Number (CN)= Composite CN based on HSG data and land use
- Initial Abstraction Method= 0.2S
- Time of concentration (tc)= NRCS TR-55 velocity method

A composite CN was determined for each subcatchment by combining the Hydrologic Soil Group (HSG) data obtained from the NRCS SSURGO (Soil Survey Geographic Database), and the existing land use as defined in the NRCS TR-55 Method. The existing land use was determined by utilizing National Agriculture Imagery Program (NAIP) from 2016. This data set informs PEARL: Planetary Computer Land Cover Mapping, an AI Accelerated Land cover Mapping Platform on the Microsoft Planetary Computer. Land cover information was obtained from this open-source software and compared to aerial imagery and analyzed using engineering judgment. Backyards in urban neighborhoods were adjusted from forested to woods-grass combination. Soils in this watershed are predominantly classified as urban land or clay loams.

For the HSG report, soils map, land use maps, and delineated subcatchment maps, see [APPENDIX B: REFERENCE MATERIALS](#). For all subcatchment associated input parameters used, see [APPENDIX D: SWMM INPUT PARAMETERS](#).

5.5 SWMM 1D Model

PC SWMM, which is based on the EPA's Storm Water Management Model (SWMM) version 5.2.3, was used to build a combined hydrologic/hydraulic model to assess the capacity of the three project areas for an existing conditions scenario. Hydraulic flow routing was performed using the Dynamic Wave approach. The conveyance system (i.e., natural streams, channels, pipes, culverts, and structures) was defined based on surveyed stormwater GIS inventory (post-data validation), FEMA cross section where available to define the stream channel and supplemented with LiDAR. The LiDAR data available through NC Emergency Management was from 2017. The Manning's N values for channel and bank materials were based on field observations when available or determined through imagery.

The following model objects were used to represent the closed system in the 1D hydraulic models:

- conduits
- junctions
- outfalls
- storage nodes
- weirs.

Conduits, junctions, and outfalls were imported into SWMM from the updated stormwater GIS inventory, post-data validation. Storage nodes with a depth-area storage curve were added to account for surface water storage and determined through GIS analysis of topographical data and survey points. Systems were modeled assuming that they were in good condition.

SWMM is a one dimensional model which assumed that water flows in a preferred linear path. It can predict overflow from the stormwater system but not where the surface flow goes. Based on the 10-Year, 24-hour design storm scenario, conduits were added to flooded junctions to simulate overland flow where water is bypassing the closed stormwater system. Cross-sections for system conduits differed between swales and streets. Swale cross-sections were assigned based on topology. Street cross-sections were assigned based on aerial imagery, differing in width and full versus half street geometry. In addition, a ponded area was assigned to nodes located in sags. Flooded areas were iteratively determined based on assumed flood depth and topographic contour area. No catchbasin restrictions were applied in this model. For all input parameters used for conduits and junctions, see [APPENDIX B: SWMM INPUT PARAMETERS](#).

5.6 Boundary Conditions

Normal depth boundary conditions were used at the terminal outfalls in the hydraulic models of the three study areas.

5.7 Data Assumptions

For junctions with no invert data, if the node lies at the catchbasin or outlet of a pipe, spot elevations from the DEM were used. An assumed invert was used in networks with drastic elevation changes to prevent unreasonable pipe slopes. Assumed inverts were used for culverts

when there was no invert data for adjacent nodes. Inverts were interpolated in areas of multiple nodes with missing invert data along a network segment based on surrounding network slope.

For conduits with no invert or outlet elevation, parameters were either assumed or interpolated based on network data and surrounding topography.

5.8 Model Results Validation

Ideally, a hydraulic model is calibrated with respect to real-world conditions using available resources such as USGS gauge data and anecdotal evidence, such as high-water marks for a major rainfall event. As there are no USGS gauges within the study area, FEMA flood hazard data was used to check model results for reasonability.

FEMA preliminary flood hazard data, specifically the 1% annual chance flood elevation (100-year peak water surface elevations) at defined cross-sections, was utilized as a best comparison to validate model results. This data was retrieved from the Effective Flood Insurance Study (FIS) report for Haywood County, NC (FIS Study Number: 37087CV000A) published on April 3, 2012. FEMA FIS reports are typically based on 1D, steady-state models using the U.S. Army Corps of Engineers’ HEC-RAS software. Major differences in model components between the FEMA preliminary model and the Town models are outlined below in **Tables 6, 7, 8, and 9**.

Table 6. Differences in Model Components between FEMA Effective and City Models

Major Model Components	Variations between Models	
	FEMA Preliminary Model	Town Models
Software	HEC-RAS	SWMM
Study Type	1D Steady	1D Unsteady
Drainage Area Resolution	Typically greater than 0.5 sq mi (320 acres) for Urban Areas	Average drainage area size equivalent to 5250 ac

Table 7. Comparison of Water Surface Elevation (WSE) between FEMA Cross-Sections and Equivalent SWMM Nodes

Distance	Equivalent SWMM Node	FEMA 100-YR WSE (ft)	SWMM 100-YR WSE (ft)	Difference (SWMM-FEMA) (ft)	FEMA 10-YR WSE (ft)	SWMM 10-YR WSE (ft)	Difference (SWMM-FEMA) (ft)	Location
Frog Level (Richland Creek)								
35180	J35180	2647.9	2651.22	3.32	2644.5	2648.25	3.75	Miller Street (Upstream)
35120	J35120	2647.78	2645.05	-2.73	2643.39	2642.68	-0.71	Miller Street (Downstream)
34206	J34206	2642.65	2641.48	-1.17	2639.56	2639.64	0.08	Depot Street (Upstream)
34139	J34139	2641.84	2638.63	-3.21	2638.44	2636.94	-1.50	Depot Street (Downstream)
32922	J32922	2630.71	2630.09	-0.62	2629.09	2628.96	-0.13	Downstream Node in Model
Shelton Branch								
7003	J15	2660.36	2659.4	-0.96	Not available in FEMA models			
5498	J5498	2653.62	2651.7	-1.92	Not available in FEMA models			
Hazelwood								
4011	J4011	2719.14	2720.37	1.23	Not available in FEMA models			Hazelwood Avenue (Upstream)
3759	CVPT0008	2718.23	2720.3	2.07	Not available in FEMA models			Downstream Node in Model
1090	J1090	2679.69	2678.9	-0.79	Not available in FEMA models			

Table 8. Comparison of Flows between FEMA Cross-Sections and Equivalent SWMM Nodes

FEMA Cross-Section	Equivalent SWMM Node	FEMA 100-YR Flow (cfs)	SWMM 100-YR Flow (cfs)	Difference (SWMM-FEMA) (cfs)	FEMA 10-YR Flow (cfs)	SWMM 10-YR Flow (cfs)	Difference (SWMM-FEMA) (cfs)
Frog Level (Richland Creek)							
35180	J35180	7900	12314	4414	4070	4810	740
34206	J34206	8020	12372	4352	4140	4964	824
Shelton Branch							
7003	J15	1360	1446	86	Not available in FEMA models		
5498	J5498	1670	1437	-233	Not available in FEMA models		
Hazelwood							
4011	J4011	730	800	70	Not available in FEMA models		
3759	CVPT0008	1240	810	-430	Not available in FEMA models		

Table 9. Drainage Area in Acres to FEMA Cross-Section in FEMA and SWMM Models

FEMA Cross-Section	FEMA	SWMM	Percent Difference
Frog Level (Richland Creek)			
35180	27980.8	27963	-0.06%
34206	28678.4	28494	-0.65%
Shelton Branch			
7003	953.6	872	-9.36%
5498	N/A	963	N/A
Hazelwood			
4011	640	616	-3.90%
3759	N/A	661	N/A

A comparison between the FEMA and the SWMM will never be an equivalent comparison based on their different methodologies. The flow in the FEMA HEC-RAS 1D model remains constant until a flow change is specified, as typical of a steady flow model. Flow changes typically occur at tributary inflows or diversion. In contrast, the SWMM model is an unsteady flow model in which water does not have a constant rate. The SWMM model is dynamic, accounting for velocity, depth, and discharge change over time. The FEMA models were last revised in April 2012 which would mean that the land use data used to develop the hydrology could be even older. Structures including pier supports are not accounted for in the SWMM model but are accounted for in the FEMA model. The FEMA model was reviewed to serve as a benchmark to evaluate if the flows and water surface elevations were of the same magnitude. The cross sections selected for review between models were the most upstream cross section within each study area and the cross sections in the FEMA HECRAS where flow rates changed.

The Frog Level model within the Richland Creek drainage area would be the most impacted by land use change with respect to flows. That model is at the downstream portion of the Town encompassing the largest drainage area and the flattest area where infill development is most probable. The percent difference in the drainage areas at these two cross sections between the models is less than 1% which is insignificant. The flow in the Frog Level SWMM model is greater than the flow reported by FEMA at both cross sections compared. Based on the relative similar scale for peak flows, we have confidence in the stormwater models for determining where the infrastructure is at capacity and where flooding may occur.

The results of the SWMM model were also reviewed to anecdotal evidence from Town staff and the public to help verify that our existing model showed issues where the Town and citizens experience them. A respondent in the survey noted that the culvert under Camelot Drive just before Georgia Avenue has had flow that flowed over the crest of the road several times in the past year. Other places of concern noted included Hazelwood Avenue, Broad Street culvert, Georgia Avenue. The drainage infrastructure at these locations reached capacity in the models. The review of the FEMA model and anecdotal evidence of flooding confirmed that the model results were reliable.

Hydrologic and hydraulic modeling results presented in this plan are intended for planning and prioritization purposes. Final pipe sizing, grades, alignments, and construction feasibility will require detailed field survey, utility coordination, and engineering design prior to implementation.

6. Identification and Assessment of Area of Concern for Infrastructure

6.1 Capacity Analysis Criteria

The focus of the analysis was to identify stormwater catchbasins and pipes that exceeded capacity based on the design storm events. Exceeding capacity refers to the maximum hydraulic grade line exceeding the rim elevation of a catchbasin or having full capacity in closed pipes. Capacity maps were developed utilizing model information and illustrated to identify infrastructure at full capacity. Junctions and conduits were rendered in specific colors based on the results from each design storm as depicted in **Figure 3**. If a stormwater structural element reaches capacity at the 10-Year storm, it is also reaching capacity for any larger storm (i.e. 25-Year Storm, 50-Year Storm). Existing Conditions Capacity Maps are provided in **APPENDIX E: EXISTING CONDITIONS CAPACITY MAPS**.



Figure 3. Capacity Map Legend

The Existing Conditions Capacity Maps show riverine inundation. These results were generated from the water surface elevation of the open channels modeled in SWMM compared to the adjacent topography. The inundation areas are the best representation of one-dimensional flow model mapping of impacts accounting for topography but are not precise given the limitations of publicly available topography and general modeling assumptions for the large area of study.

The upstream drainage area from outside the study area was included in the model to account for flow. A discussion of how the flows between the Town SWMM Existing Conditions Model and the FEMA HECRAS model are discussed in section 4.8 Model Results Validation.

A hydraulic grade line (HGL) in a closed system is the elevation water will rise to in a pipe. It is closely related to the water level, but it is not the exact same. If the HGL is above the top of the pipe, pressure flow conditions exist. Conversely, if the HGL is below the crown of the pipe, open channel flow conditions exist.

Full capacity for the pipes and culverts was determined based on those conditions in which the maximum depth to full depth reaches a ratio of 1.00. This criterion meant that some culverts or

pipes under catchbasin control were not meeting the condition even though they would likely be at full capacity if not for catchbasin control. Catchbasin control denotes that flow is controlled at the entrance by the headwater depth, cross-sectional area of the opening, and type of catchbasin. Pipes or culverts under catchbasin control typically flow partially full because water can flow through faster than it can enter. A criterion was added for assessing pipe and culvert capacity based on the number of hours at which the upstream end of the conduit was surcharged. If the upstream end of the conduit was surcharged greater than 0.01 hours, it was considered to be at full capacity. The pipes and culvert at or near capacity should be considered when looking at possible improvements needed to enhance the stormwater system capacity.

6.2 Potential Areas of Concern

Potential areas of concern (PAOC) were identified within the study areas where capacity of the system was exceeded during the 10-year storm event. Potential areas of concern are areas where the results demonstrated: roadway overtopping; areas with a concentrated number of flooded junctions and pipe capacity issues; or surface ponding issues. There are additional systems that reach capacity as observed in the maps provided in **APPENDIX E: EXISTING CONDITIONS CAPACITY MAPS** not discussed in this section. The areas identified prioritized problems that could impact public safety. Challenges to pursuing specific projects are noted in the descriptions. The forty-two identified Potential Areas of Concern for infrastructure were reviewed by the Town and considered as potential project areas for proposed conceptual improvement designs. Additional areas of concern not included in the study are listed in **APPENDIX F: TOWN OF WAYNESVILLE PUBLIC WORKS REFERENCES** as identified by Public Works staff.

Frog Level

PAOC F1 – Buffalo Lane to Richland Creek [Frog Level: D2]

PAOC F1 consists of the closed pipe network beginning on the south side of the railroad and connecting to a lateral system along Buffalo Lane which cumulatively discharges to Richland Creek. **Figure 4** and **Figure 5** show the location of the PAOC in Frog Level. The system is within the FEMA floodplain. The water surface elevation of the stream during storm events impacts the water surface elevation within the stormwater drainage network as indicated by the riverine inundation areas. There is also a large drainage area to the railroad culvert from upstream area to the south contributing flow.

PAOC F2 – Charles Street and Branner Avenue [Frog Level: E2]

The stormwater system of concern is located along Branner Avenue extending northwest down Charles Street. The system is within the FEMA floodplain. Negative slopes and alternating pipe sizes are contributing to limited system capacity resulting in roadway inundation. Upsizing and improving efficiency throughout the system would help alleviate roadway flooding.

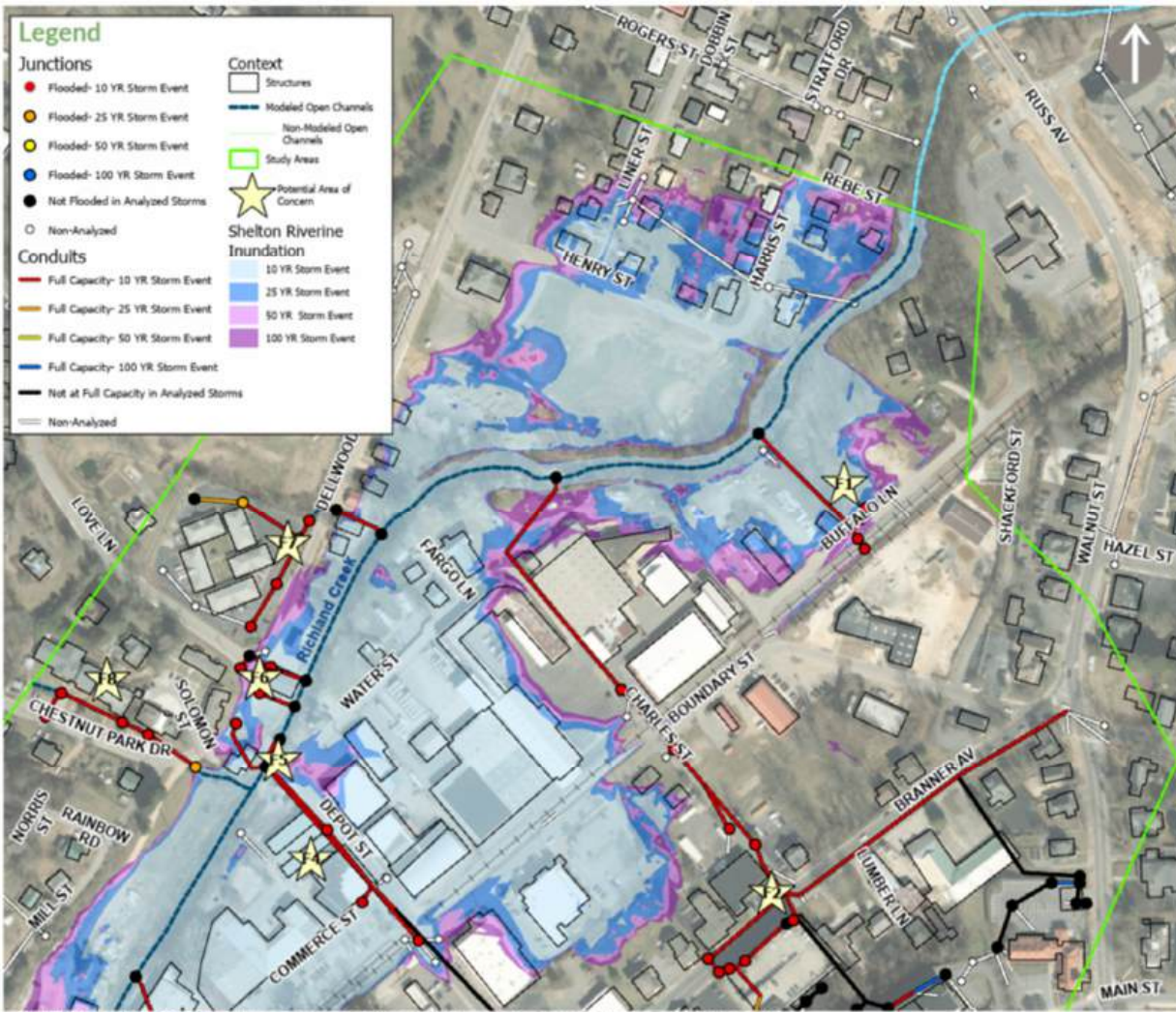


Figure 4. Frog Level PAOC North

PAOC F3 – Depot Street and North Haywood Street [Frog Level: E2]

The stormwater systems along North Haywood Street and Depot Street reach capacity during the 10-Year event. The systems combine at the intersection of North Haywood Street and Depot Street. Upsizing pipes may help alleviate capacity; however, inundation of the stream is affecting where water can go at the downstream end of the system.

PAOC F4 – Depot Street Love Lane [Frog Level: E1]

PAOC F4 refers to the stormwater network on the south side of the railroad along Boundary Street to the outfall on Richland Creek. The discharge point is upstream of the culvert where Depot Street crosses the creek. Richland Creek has riverine flooding that extends to Boundary Street encompassing the system within the FEMA floodplain. The water surface elevation of the stream affects where the water from the system can discharge. If the outfall of the system is below the water surface elevation, there may be backwater effects into the closed network. Stream flooding causes the commercial structures along Depot Street to flood.

PAOC F5 – Depot Street Culvert [Frog Level: E1]

The Depot Street culvert conveys the perennial streamflow of Richland Creek within the FEMA floodway. The culvert is undersized reaching capacity during the 10-year storm. The stream channel capacity is unable to carry the flow regardless of the culvert size.

PAOC F6 – Love Lane [Frog Level: D1]

PAOC F6 refers to the closed network from the intersection of Love Lane and Dellwood City within the FEMA floodway. Road to the outfall on Richland Creek. The water surface elevation of the stream impacts the water surface elevation and flooding within the network.

PAOC F7 – Dellwood City Road [Frog Level: D1]

PAOC F7 refers to the stormwater system originating on the private property located at 367 Dellwood City Road. The system discharges to an open channel on the west side of Dellwood City Road and is conveyed through a closed pipe system in between two residential properties to Richland Creek. Private property is included in this area because road runoff from Love Lane is contributing to ponding within the parking lot area. The system is within the FEMA defined floodplain.

PAOC F8 – Chestnut Park Drive [Frog Level: D1 & E1]

PAOC 8 refers to the system that originates on Chestnut Park Drive and runs parallel to the street through private property and across the road discharging into an open channel. The system is undersized, which is causing flooding.

PAOC F9 – Commerce Street [Frog Level: E1]

This system conveys road runoff from Commerce Street underneath an industrial building at 102 Commerce Street to Richland Creek. The network is at capacity due to the water surface elevation of the downstream stream. The building and the stormwater network are located within the FEMA floodplain.

PAOC F10 – Miller Street Culvert [Frog Level: E1]

The Miller Street roadway is overtopped in the 10-Year storm event at this culvert location within the FEMA floodway. The culvert conveys the perennial flow of Richland Creek. Upsizing the culvert crossing may help, but the capacity of the stream channel is limited.

PAOC F11 – Miller Street [Frog Level: E1]

PAOC F11 refers to the stormwater network originating in front of 174 Miller Street west along Miller Street under the railroad tracks and discharging to Richland Creek downstream of the Miller Street culvert. The water surface elevation of the stream is impacting the water surface elevation and capacity within the stormwater network. The downstream pipes are within the FEMA floodplain.

PAOC F12 – Church Street and South Haywood Street [Frog Level: F2]

PAOC F12 refers to the stormwater network on Church Street that flows into the system on South Haywood Street to the intersection with Miller Street. It also includes the stormwater system along Miller Street from Montgomery Street to South Haywood Street. Upsizing and increasing the depth of the network may help reduce capacity impacts throughout the system.

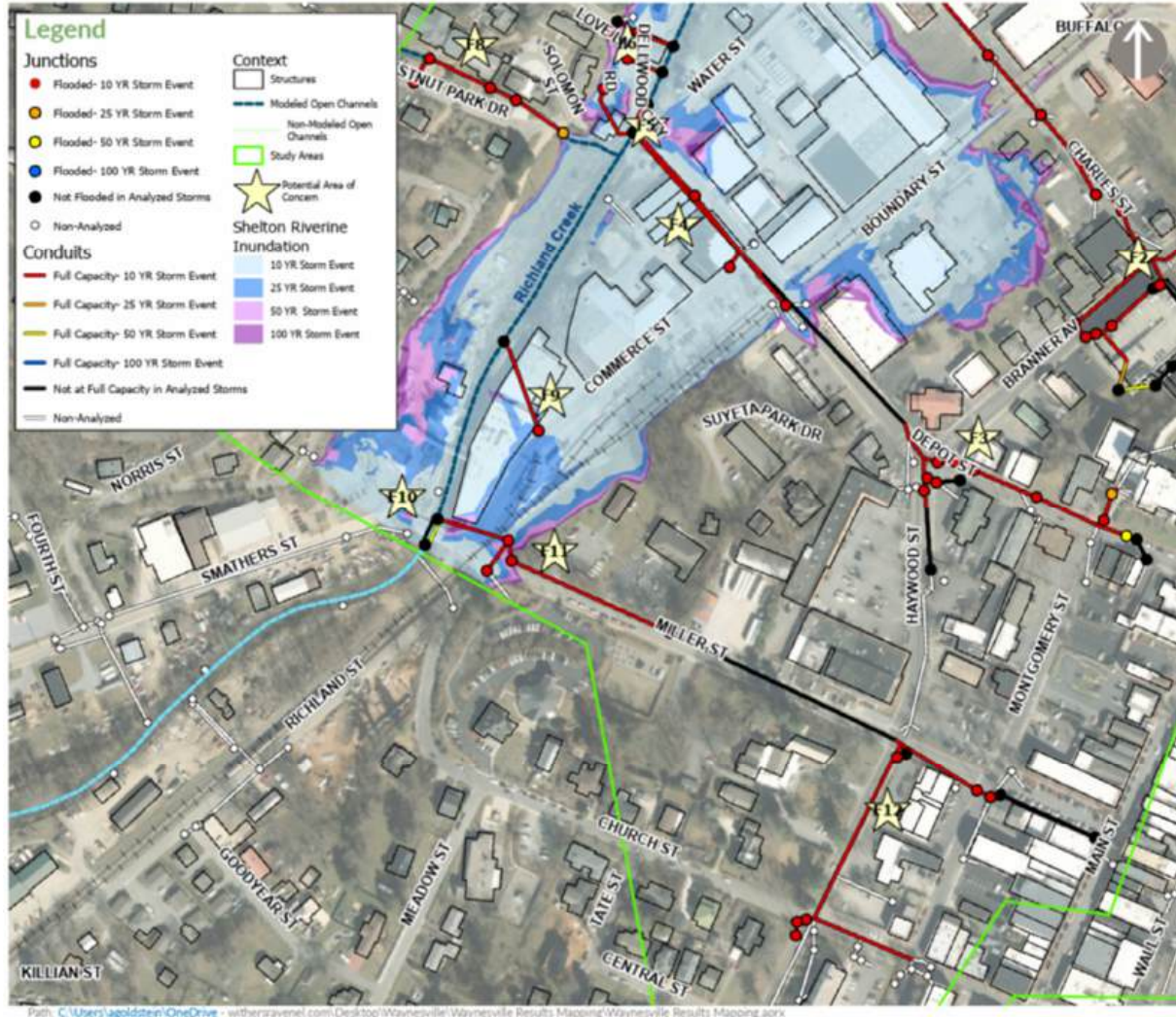


Figure 5. Frog Level PAOC South

Shelton Branch

PAOC S1- East Street at Shelton Creek [Shelton Creek: A2]

PAOC S1 refers to several sections of stormwater network that are hydraulically connected within the FEMA floodplain. It includes the stormwater network on East Street that discharges to the upstream side of the East Street Culvert, the East Street Culvert, and the system along East Street that discharges on the downstream side of the culvert. The East Street culvert conveys the perennial stream flow of Shelton Creek. The water surface elevation in the stream appears to be impacting the storm drain system in PAOC S1 and PAOC S2. **Figure 6** and **Figure 7** show the location of the PAOC in Shelton Branch.

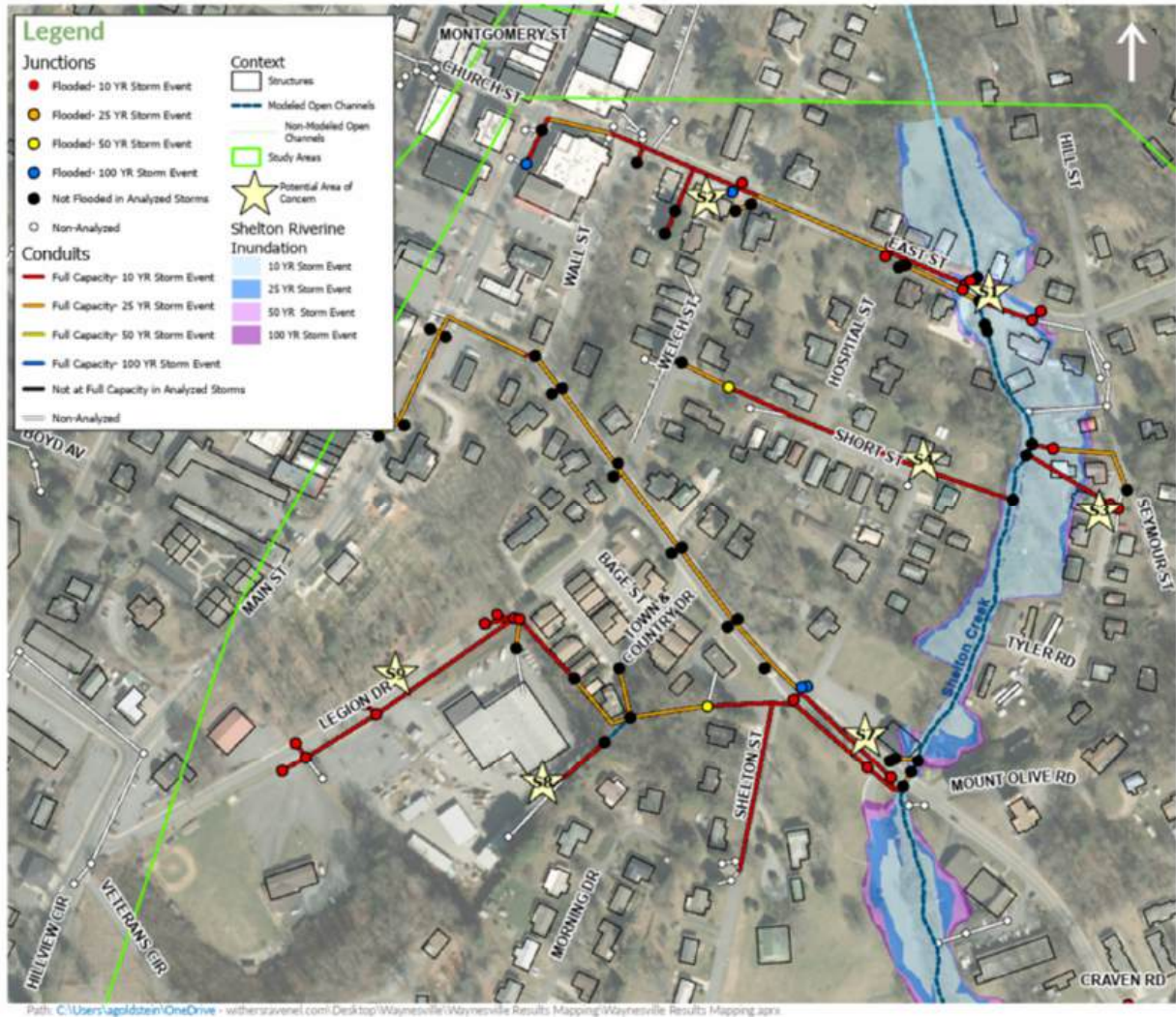


Figure 6. Shelton Branch PAOC North

PAOC S2 – East Street and Wall Street [Shelton Creek: A1]

PAOC S2 refers to the stormwater system originating from Wall Street and East Street to Welch Street and East Street. The water surface elevation within the network is contained below most of the structure rims in the 10-Year storm event.

PAOC S3- Hill Street [Shelton Creek: A2]

The stormwater system from Hill Street south of the intersection with Seymour Street to Shelton Creek is located underneath a residential structure. The water surface elevation in the stream is impacting the water surface elevation and capacity within the network. The structure and downstream stormwater system is within the FEMA floodplain.

PAOC S4 – Short Street [Shelton Creek: A1 & A2]

PAOC S4 refers to the stormwater network originating in front of 24 Short Street to an outfall on Shelton Creek. The outfall is within the FEMA floodplain. The water surface elevation within the network is contained below most of the structure rims in the 10-Year storm event.

PAOC S5 – Oakdale Road and Pigeon Street [Shelton Creek: B2]

PAOC S5 includes the stormwater network along Pigeon Street that crosses Thomas Park and Hillside Road before turning on Oakdale Road and discharging into an open channel. Runoff from Hillside Road is causing ponding on private property. Further investigations of the downstream end of the system would need to be made before design could commence due to survey uncertainties.

PAOC S6 – Craven Road and Pigeon Street [Shelton Creek: B2]

The stormwater system at the end of Craven Road crosses under Pigeon Street and outfalls into an open channel. Upsizing the pipes may help reduce system capacity impacts. There are no residences in the impacted area downstream of the outfall.

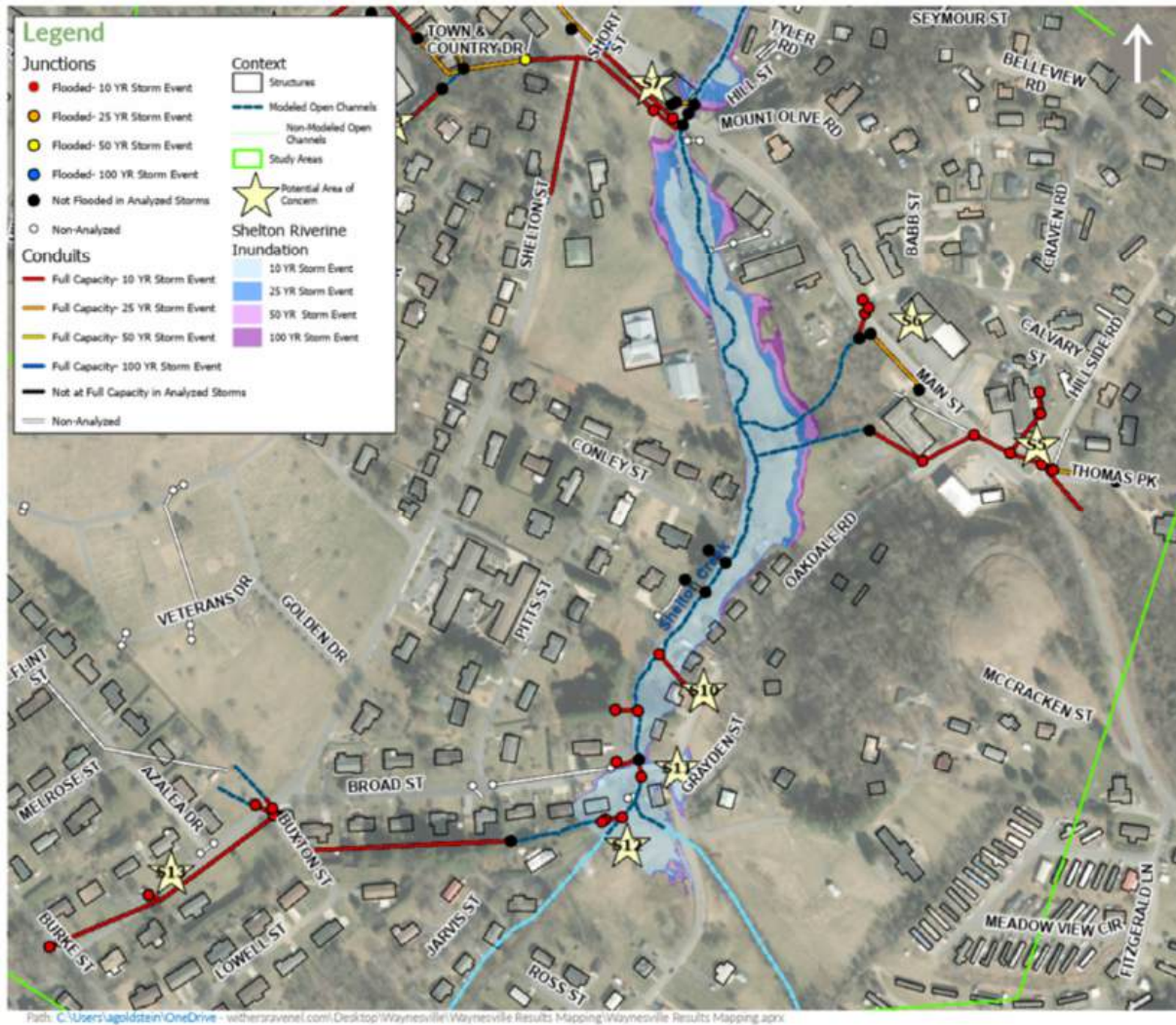


Figure 7. Shelton Branch PAOC South

PAOC S7 – Shelton Street and Pigeon Street [Shelton Creek: B1 & B2]

PAOC S7 refers to the system along Shelton Street that converges with the system along Pigeon Street and discharges into Shelton Creek. Upsizing the pipes may help address capacity throughout the system.

PAOC S8 – Town Public Works Building [Shelton Creek: B1]

The stormwater network at the rear of the Town Public Works Building at 129 Legion Drive has capacity issues and experiences ponding at the catchbasins to the system. More catchbasins and upsizing the pipes would help alleviate flooding impacts.

PAOC S9 – Legion Drive [Shelton Creek: A1 & B1]

The stormwater system is located along Legion Dr in front of the Waynesville Public Works Building. Runoff escaping the system on Legion Drive flows to the catchbasins located at the north corner of 129 Legion Dr, then overtops the curb and flows behind the homes on Town & Country Drive. Water appears to be flooding into private residential yards.

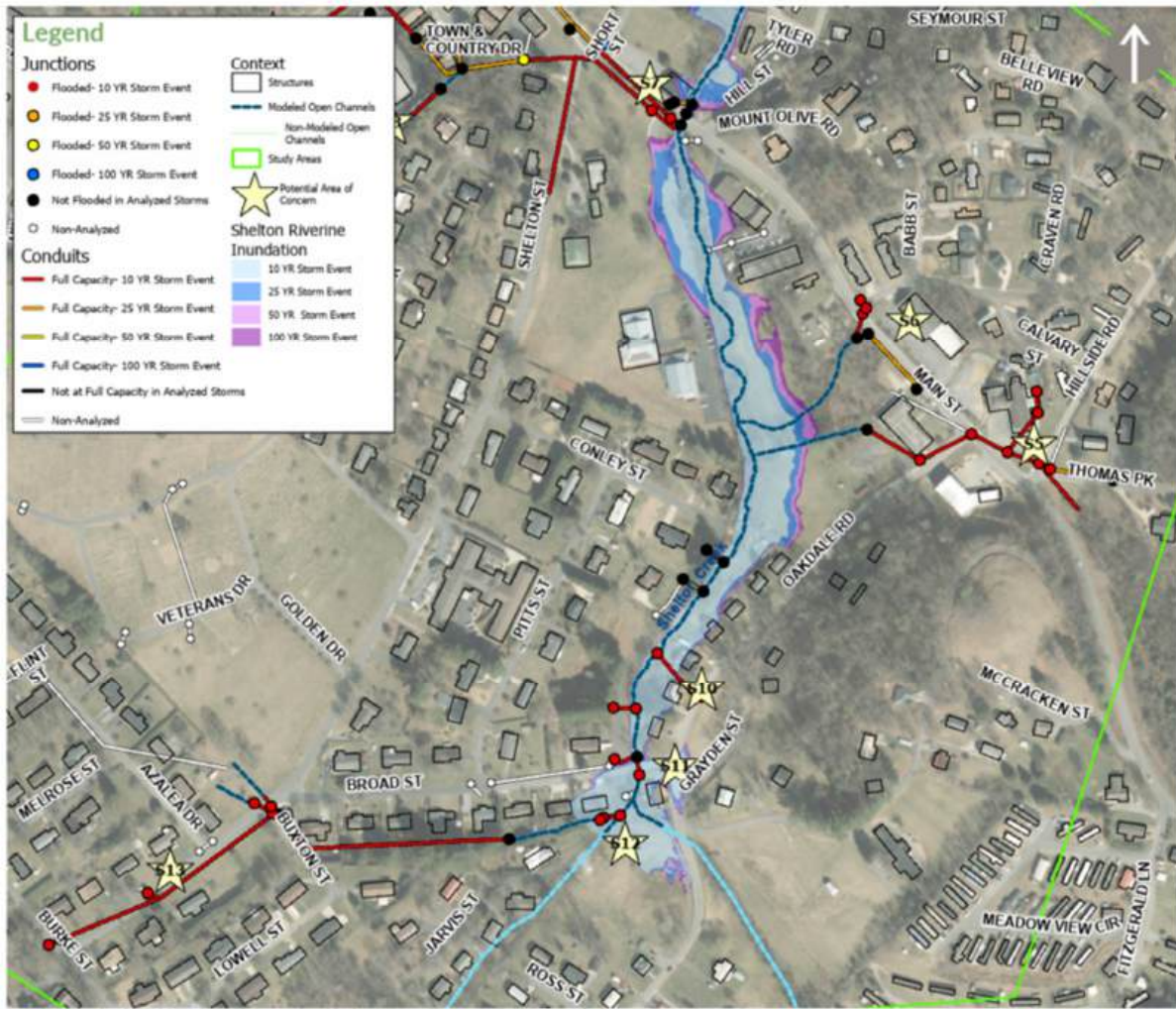


Figure 8. Shelton Branch PAOC South

PAOC S10 – Oakdale Road [Shelton Creek: C2]

The stormwater system from Oakdale Road to an outfall on Shelton Creek is undersized. A large amount of water is leading to a catchbasin on the east side of Oakdale at the low point in the road resulting in ponding around the catchbasin. There is roadway flooding on Oakdale Road.

PAOC S11 – Broad Street Culvert [Shelton Creek: C2]

The culvert below Broad Street is under capacity which results in runoff overtopping the roadway during the 10-year storm event. Additionally, the culvert appears to cause backwater flooding upstream of culvert. This area was identified in the Public Survey as a known flooding area.

PAOC S12 – Jarvis Street [Shelton Creek: C2]

This system is comprised of double pipes underneath Jarvis Street. The water surface elevation of the stream is impacting the water surface elevation and capacity within the network.

PAOC S13 – Shelton Street [Shelton Creek: C1]

PAOC S13 refers to the stormwater system located along Shelton Street from Burke Street to Buxton Street extending underneath residences south of Broad Street to an outfall into an open channel. This system is undersized which is causing ponding impacts in the area. The catchbasin and headwall on the northwest side of the intersection of Buxton Street and Shelton Street, which collect flow from open channels, both overtop onto the roadway during the 10-Year storm event.

Hazelwood

PAOC H1 – Farmers Branch Culvert [Hazelwood: G1]

The culvert conveys Farmers Branch flow within Dutch Fisher Park. The culvert is undersized and within the FEMA floodplain. **Figure 8** and **Figure 9** show the location of the PAOC in Hazelwood study area.

PAOC H2 – Dutch Fisher Culvert [Hazelwood: G1]

This culvert is located under the entry road into Dutch Fisher Park leading to the parking lot. It conveys Farmers Branch flow and is within the FEMA defined floodplain. The culvert is undersized.

PAOC H3 – Westwood Circle [Hazelwood: G1]

The stormwater system of concern originates in front of 419 Westwood Circle extending across the roadway between homes and through Dutch Fisher Park to an open channel. The system is within the FEMA floodplain. The negative pipe slopes throughout the system cause efficiency issues and may be causing ponding near homes.

PAOC H4 – Westwood Circle and Brankris Drive [Hazelwood: G1]

This stormwater system consists of the stormwater system across Westwood Circle at the intersection with Brankris Drive. The system is within the FEMA floodplain. The culvert is undersized and causing the roadway to overtop in the 10-Year storm event.

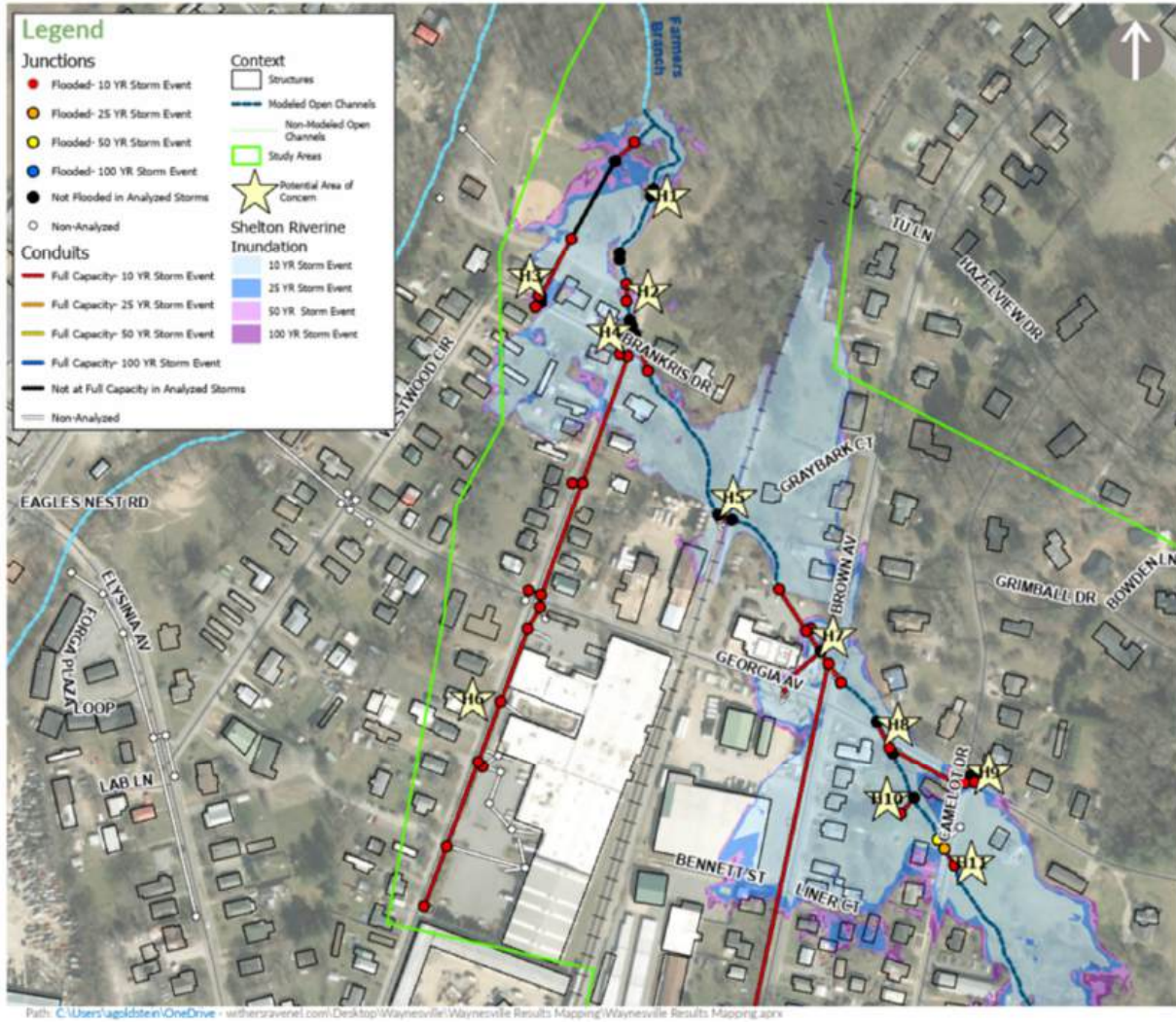


Figure 9. Hazelwood PAOC North

PAOC H5 – Railroad Culvert downstream of the Town Tax Office [Hazelwood: G1]

The railroad culvert of concern is located downstream of the Town Tax Office and Fire Station #2 building on Georgia Avenue and Brown Avenue. The culvert conveys the perennial streamflow of Farmers Branch and is within the FEMA floodplain. The size and orientation of the railroad culvert restrict flow resulting in backwater.

PAOC H6- Westwood Circle and Georgia Avenue [Hazelwood: H1 & G1]

The stormwater system originates opposite 115 Westwood Circle and extends down the street to an outfall on Farmers Branch within Dutch Fisher Park. The pipe size decreases in size as the flow moves downstream and receives more runoff leading to insufficient capacity. Upsizing the pipes and increasing efficiency of the system would alleviate roadway flooding and potential ponding in residential yards.

PAOC H7 –Town Tax Office Building and Fire Station #2 [Hazelwood: H1]

The Waynesville Hazelwood Town Office is located at the confluence of the closed system along Brown Avenue and Farmer Branch and is within the FEMA floodplain. Both contributing systems are undercapacity. As observed during the facility inspection, there is damage to the catchbasins on Brown Avenue in front of the Town Office and at the system outfall on the north side of the parking lot. During the 10-year storm event, ponding occurs along the roadway and in parking lot.

PAOC H8 – Georgia Avenue Culvert [Hazelwood: H1]

The Georgia Avenue culvert conveys the Farmers Branch flow and is within the FEMA floodplain. The culvert is undersized and the flow overtops the roadway in the 10-Year storm event and flows towards Brown Avenue. There is insufficient cover for the culvert in the right of the way such that culvert outfall rim is higher than the ground surface.

PAOC H9 – Camelot Drive and Georgia Avenue [Hazelwood: H1]

The stormwater system originates at the intersection of Camelot Drive and Georgia Avenue and extends downstream along Georgia Avenue to Farmers Branch. The system along Georgia Avenue is within the FEMA floodplain. The pipe size decreases as the system flows downstream resulting in limited capacity and backwater effects. Upsizing the pipes and increasing efficiency of the system would alleviate roadway flooding.

PAOC H10 – Residential Pipe [Hazelwood: H1]

There is a singular pipe within a residential yard that discharges to Farmers Branch. The system is within the FEMA floodplain and is impacted by stream flooding.

PAOC H11- Camelot Drive Culvert [Hazelwood: H1]

The culvert under Camelot Drive conveys Farmers Branch flow within the FEMA floodplain. The culvert is undersized, and the roadway is overtopping in the 10-Year storm event.

PAOC H12 – Brown Avenue [Hazelwood: H1 & I1]

PAOC H12 refers to the stormwater system that originates along Hazelwood Avenue between Camelot Drive and Riverbend Street. The system extends along Brown Avenue converging with the Farmers Branch flow at PAOC H7. There is roadway flooding along this system which could be mitigated by upsizing pipes and increasing depth of the system. The upstream area of the system along Hazelwood Avenue is affected by stream flooding from Browning Branch and Farmers Branch. Segments of this system are within the FEMA floodplain.

PAOC H12 – Brown Avenue [Hazelwood: H1 & I1]

PAOC H12 refers to the stormwater system that originates along Hazelwood Avenue between Camelot Drive and Riverbend Street. The system extends along Brown Avenue converging with the Farmers Branch flow at PAOC H7. There is roadway flooding along this system which could be mitigated by upsizing pipes and increasing depth of the system. The upstream area of the system along Hazelwood Avenue is affected by stream flooding from Browning Branch and Farmers Branch. Segments of this system are within the FEMA floodplain.

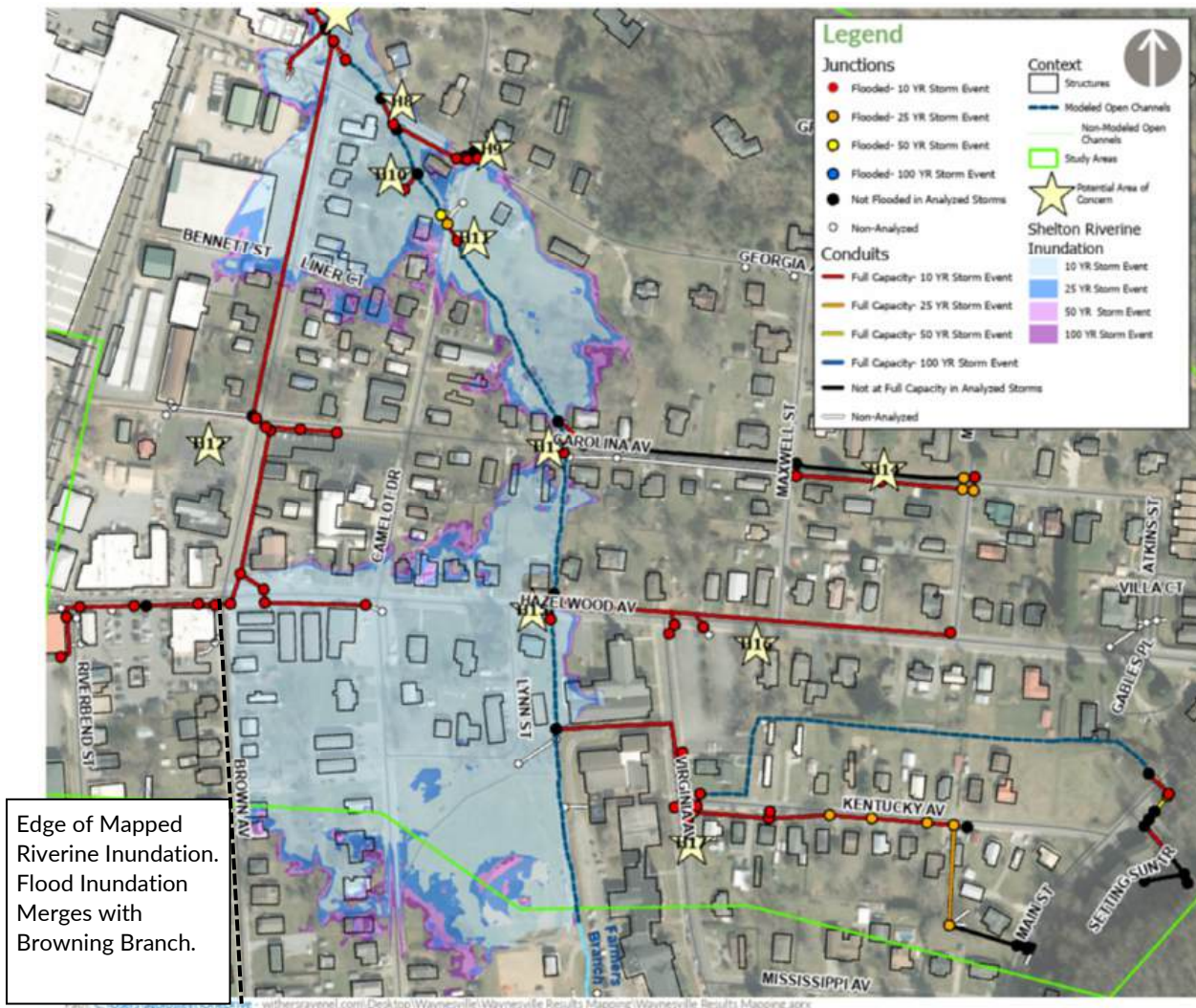


Figure 10. Hazelwood PAOC North

PAOC H13 - Carolina Avenue Culvert [Hazelwood: H1]

The culvert under Carolina Avenue conveys the Farmers Branch flow and is within the FEMA floodplain. The culvert is undersized.

PAOC H14 - Carolina Avenue [Hazelwood: H2]

PAOC H14 refers to the stormwater system along Carolina Avenue from Morgan Street to Maxwell Street. The negative pipe slopes throughout the system cause efficiency issues.

PAOC H15 - Hazelwood Avenue Culvert [Hazelwood: I1]

The culvert under Hazelwood Avenue east of Lynn Street conveys the Farmers Branch streamflow and is within the FEMA floodplain. The culvert is undersized and the channel capacity cannot contain the 10-Year storm event. There is ponding with the yards of nearby houses.

PAOC H16 – Hazelwood Avenue [Hazelwood: I1 & I2]

PAOC H16 refers to the stormwater system located along Hazelwood Avenue, between Morgan Street and the outfall on Farmers Branch. There is roadway inundation within this dense residential area. The pipes within the network are undersized.

PAOC H17 – Kentucky Avenue and Virginia Avenue [Hazelwood: I1 & I2]

The stormwater system originates on Main Street through residential yards to Kentucky Avenue connecting with Virginia Avenue and outfalls on Farmers Branch behind a church. The pipes within the network are undersized. As a result, roadway inundation is present within the dense residential area.

7. Proposed Conceptual Stormwater Infrastructure Improvement Options

Based on input from Town staff, eight project areas were selected from the potential areas of concerns identified. These project locations are shown on **Figure 10**.

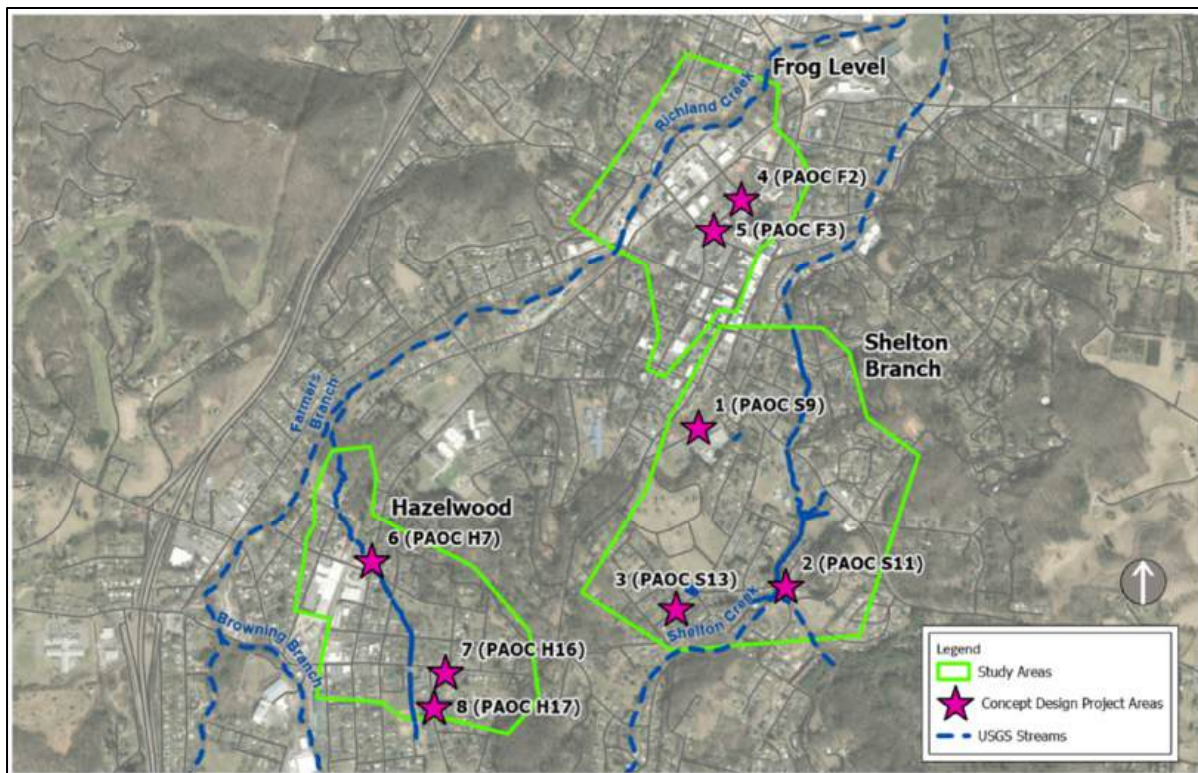


Figure 11. Conceptual Design Project Areas

The project challenges, concepts designs, benefits, and costs are discussed in this section. Opinions of probable cost are provided for planning purposes only and are subject to refinement. Final construction costs may vary due to market conditions, inflation, utility relocation requirements, right-of-way or easement acquisition, and final design decisions. Fact sheets and planning level cost opinions for each concept area can be found in **APPENDIX A: PROPOSED**

CONCEPTS & ENGINEER PROBABLE COST OPINIONS FOR CONCEPTUAL LEVEL IMPROVEMENTS.

7.1 Target Level of Service

To develop conceptual designs, the existing conditions models were modified by adjusting the hydraulic network to meet the desired level of service (LOS). Proposed projects were designed so that downstream impacts were considered and minimized. It was assumed that site constraints could limit the ability to meet these LOS when developing proposed concepts; if that was the case, concepts were designed to meet the LOS to the maximum extent possible. Site constraints include topographic limitations and constructability restraints such as minimum pipe cover. The selected LOS criteria were:

Closed Pipe System: 10-Year, 24-hour storm event hydraulic grade line (HGL) contained within pipe, pipe sizes a minimum of fifteen inch (15") internal diameter, and minimum pipe slope is 0.5% or that which produces a minimum velocity of 2.5 fps when flowing full.

Roadside Ditches within ROW: 10-Year, 24-hour contained with roadside ditch without overtopping

- NCDOT standards would supersede if working within their ROW and roadway classification required higher standard

Culverts: Convey the 50-Year, 24-hour storm event with no freeboard and headwater depth limited to 1.2 times the opening height

- If 50-year is not feasible for local roads due to topographic constraints, convey 25-year, 24-hour storm event with same parameters

- **Open Channels outside ROW:**

- Improvements to channels should only be proposed if needed to support other proposed project impacts.
- Channels should define the path for the 100-year storm event such that no principal or accessory structures are flooded
- There should be no significant change in channel carrying capacity for up to the 10-year storm event

Freeboard is the clearance between the culvert top slab and the high-water surface elevation. It serves as a safety margin to provide extra height for fluctuating water levels due to debris or storm surges to limit the road from overtopping.

7.2 Resiliency Assessment

The Town of Waynesville has an objective to build resilience into future infrastructure projects and to understand climate-related stormwater runoff and flood risks. As part of this effort, the proposed project designs were analyzed using climate adjusted rainfall depths obtained from the NC State Climate RainDROP (Rainfall Intensity Duration and Return for Observations and Projections) Tool on March 17, 2025. The tool scales localized NOAA Atlas 14 precipitation

depths using different greenhouse gas emission scenarios to create predicted climate adjusted depths. The selected climate scenario utilized for the conceptual designs was the RCP4.5- Mid Century (Mean) Precipitation projection which is included in **APPENDIX A: REFERENCE**. The RCP4.5 Mid Century (Mean) scenario reflects a change in precipitation due to increases in emissions peaking around mid-century and then declining in response to climate change mitigation policies, while accounting for mitigation strategies. The century for which the projections are considered is from 2006-2100.

As in existing conditions evaluations, the models were analyzed using four storm events: the 10-, 25-, 50-, and 100-year 24-hour storms. A comparison of the 24-hour duration rainfall depths from NOAA Atlas 14 utilized in the Existing Conditions Analysis and from RainDROP RCP4.5 utilized when analyzing the conceptual designs are shown in **Table 10**.

Table 10. Summary of Rainfall Depths (inches)

Storm Event	NOAA Atlas 14	RCP 4.5
10-Year	4.56	4.84
25-Year	5.36	5.69
50-Year	6.01	6.44
100-Year	6.67	7.14

7.3 Concept #1 - Waynesville Public Works and Legion Drive (PAOC S8/S9):

Existing Conditions

The stormwater system located along Legion Drive and at 129 Legion Drive (Waynesville Public Works Building) is composed of catchbasins and closed pipes which reach capacity beginning in the 10-year storm event. Runoff escaping the system on Legion Drive flows to the catchbasins located at the north corner of 129 Legion Drive, then overtops the curb and flows behind the homes on Town & Country Drive. Ponding is known to occur behind the Public Works building in the area of the existing catchbasins. PAOC S8 and S9 were grouped together as the systems and drainage areas interact with one another.

Proposed Conceptual Project

The conceptual design for Concept Project 1 would replace the stormwater network on Legion Drive beginning at the Waynesville Public Works Building (129 Legion Drive) employee parking lot and extending to the catchbasin located in the sump southwest of Town & Country Drive. A new system would be added along Town N Country Drive to connect with the system on Pigeon Street. The existing system on Pigeon Street between Town N Country Drive and Shelton Creek would be replaced to provide additional capacity. The outfall into Shelton Creek would be redirected to the north side of Pigeon Street. The revised layout is shown in **Figure 11**.

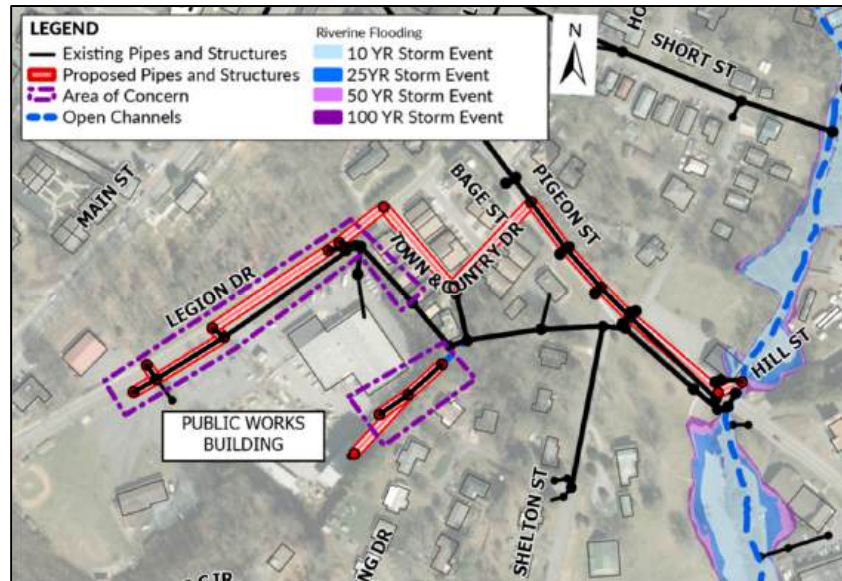


Figure 12. Concept Project Area 1 – Waynesville Public Works and Legion Drive

The design also includes replacing the stormwater system located on the southeast side of the Waynesville Public Works property. The proposed project would entail replacing catchbasins located on Legion Drive and enlarging the pipe network to 18” RCP pipes at the east end of Legion Street increasing to 36” RCP at the intersection with Town N Country Drive. At the northern corner of 129 Legion Drive, the existing system turns to the southeast and runs behind the homes located on Town N Country Dr and continues behind private homes to Shelton Street.

To bring the system into the public right-of-way (ROW), the proposed system will continue along Legion Drive and Town N Country Drive, with 36” RCP pipes, until it connects with the system located on Pigeon Street. The central line of the system along Pigeon Street would be replaced with a combination of 36” RCP and 48” RCP pipes. The outfall at Shelton Creek would be redirected farther north from the existing location to the opposite side of Pigeon Street. By redirecting the outfall to downstream of the culvert below Pigeon Street on Shelton Creek, increased flows within the new system will not add to the potential overtopping of the roadway. The existing system located along the southeast edge of 129 Legion Drive will be replaced with 24” RCP pipes to the outfall located on the edge of the property. New catchbasins and manholes are proposed along the length of the system updates. A map showing the conceptual design layout is included in [APPENDIX A: CONCEPTUAL STORMWATER PROJECT FACT SHEET AND PLANNING LEVEL COST ESTIMATES](#).

Evaluation of the upstream system that connects to the start of the proposed network on Legion Drive should be completed during detailed design to ensure sufficient capacity of the network. Implementation of this conceptual project will require further evaluation of right-of-way availability, utility conflicts, maintenance access, and construction impacts. These factors will be addressed during subsequent design phases and may influence final project limits, cost, and schedule.

This project could be split into two projects within the Capital Improvement Plan if desired by the Town by completing the work on Legion Drive and the work on 129 Legion Drive separately. The estimated opinion of probable costs based on today’s dollars for Concept Project 1 is summarized in **Table 11**.

Table 11. Concept Project 1- Opinion of Probable Cost for Waynesville Public Works and Legion Drive

Opinion of Probable Cost	
Construction Cost (Labor, Materials, and Site Work)	\$1,054,000
Engineering and Administration	\$123,000
Total (Includes 35% Contingency Cost)	\$1,589,000

Benefit

The primary benefit of this project would be the reduction of roadway inundation on Legion Drive and ponding behind the Public Works building. By increasing the size of the stormwater network, roadway inundation is reduced up to and including the 10-year event on Legion Drive and ponding is reduced up to and including the 25-year storm event behind the Public Works building. The project would relocate the storm drainage system behind the homes fronting Town & Country Drive into the right-of-way to prevent flooding in the backyards.

7.4 Concept #2 - Broad Street Culvert (PAOC S11)

Existing Conditions

The culvert below Broad Street begins to overtop the roadway during the 10-year storm event and appears to be causing backwater flooding upstream of culvert. This area was identified in the Public Survey as a known flooding area.

Proposed Conceptual Projects

The existing culvert on Shelton Creek below Broad Street would be replaced with dual 6’ Height x 7’ Width concrete box culverts. Due to topographic restrictions, including the elevation of the roadway crest and the width of the channel, the size of the proposed culvert that could be installed in this location was limited. As a result, the culvert does not meet the target level of service criteria for conveying the 50-Year, 24-Hour storm event with no freeboard and headwater depth above 1.2 times the opening height. The proposed culvert would pass the 10-Year, 24-hour storm event with 6 inches of freeboard. Limited channel grading is proposed on either side of the culvert to transition the channel flow in and out of the new culvert. The site design is shown in **Figure 12**.

Additional survey of the culvert and channel in this area is recommended during detailed design to assess project feasibility. Implementation of this conceptual project will require further evaluation of right-of-way availability, utility conflicts, maintenance access, and construction impacts. These factors will be addressed during subsequent design phases and may influence final project limits, cost, and schedule.

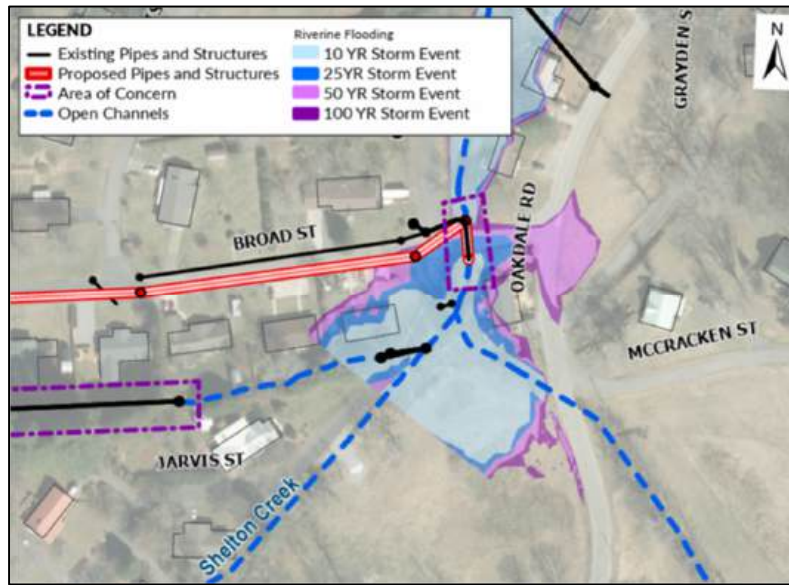


Figure 13. Concept Project Area 2 – Broad Street Culvert

The estimated opinion of probable costs based on today’s dollars for Concept Project 2 is summarized in **Table 12**. A fact sheet of the conceptual layout and detailed breakdown of the cost is included in **APPENDIX A: CONCEPTUAL STORMWATER PROJECT FACT SHEET AND PLANNING LEVEL COST ESTIMATES**.

Table 12. Concept Project 2- Opinion of Probable Cost for Broad Street Culvert

Opinion of Probable Cost	
Construction Cost (Labor, Materials, and Site Work)	\$456,000
Engineering and Administration	\$93,000
Total (Includes 35% Contingency Cost)	\$742,000

Benefit

The primary benefit of this project would be to reduce the frequency of runoff overtopping Broad Street and reduce the inundation extents upstream of the culvert. The proposed culvert passes the 10-Year design storm event with 6” of freeboard. This freeboard allowance is favorable as a margin of safety since the culvert does not meet the desired level of service for conveying the 50-year, 24-hour storm event.

7.5 Concept #3 – Burke Street and Shelton Street (PAOC F2)

Existing Conditions

The existing stormwater system located along Shelton Street from Burke Street to Buxton Street is composed of catchbasins and closed pipes which reach capacity beginning in the 10-Year storm event. The catchbasin and headwall on the northwest side of the intersection of Buxton

Street and Shelton Street, which collect flow from open channels, are overtopped with flow during the 10-Year storm event. The roadway experience inundation.

Proposed Conceptual Projects

The existing stormwater network from Burke Street, extending northeast along Shelton Street to the intersection of Lowell Street, would be replaced with 36” to 48” RCP pipes. The existing headwall and catchbasin along the northwest side of Shelton Street that collect flow from open drainage channels would be replaced and the connecting network size would increase to 30” and 36” RCP pipes. To bring the system into the Public ROW, the proposed stormwater network is rerouted from Shelton Street, along Broad Street to a proposed outfall into Shelton Creek, north of Broad Street. The system will include 48” RCP pipes and dual 42” pipes. New catchbasins and manholes are proposed along the length of the new stormwater system as shown in **Figure 13**.

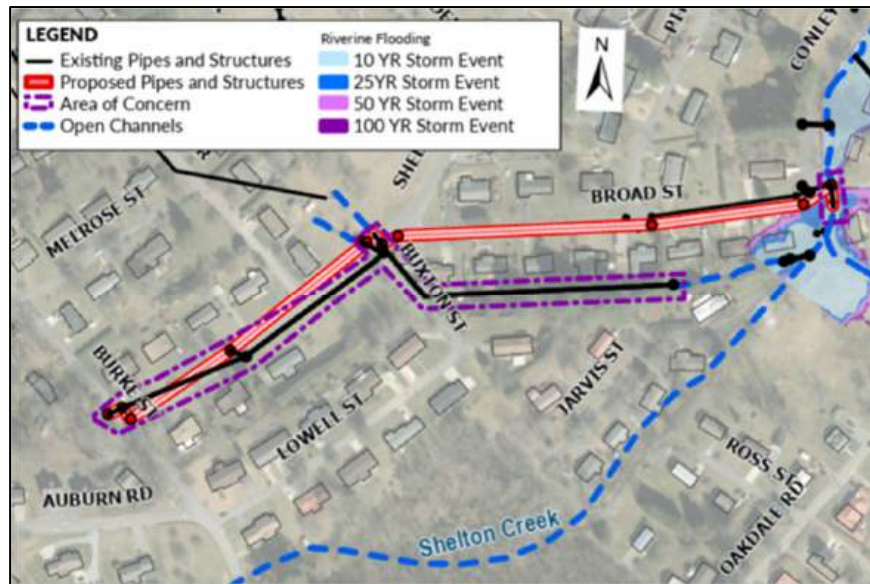


Figure 14. Concept Project Area 3 – Burke Street and Shelton Street

Implementation of this conceptual project will require further evaluation of right-of-way availability, utility conflicts, maintenance access, and construction impacts. These factors will be addressed during subsequent design phases and may influence final project limits, cost, and schedule.

The estimated opinion of probable costs based on today’s dollars for Concept Project 3 is summarized in **Table 13**. A fact sheet of the conceptual layout and detailed breakdown of the cost is included in **APPENDIX A: CONCEPTUAL STORMWATER PROJECT FACT SHEET AND PLANNING LEVEL COST ESTIMATES**.

Table 13. Concept Project 3- Opinion of Probable Cost for Burke Street and Shelton Street

Opinion of Probable Cost

Construction Cost (Labor, Materials, and Site Work)	\$1,172,000
Engineering and Administration	\$101,000
Total (Includes 35% Contingency Cost)	\$1,719,000

Benefit

The primary benefit of this project would be the reduction of roadway inundation up to and including the 25-Year storm event from the intersection of Burke Street and Shelton Street to the intersection of Buxton Street and Shelton Street. Overtopping of Shelton Street from the open channels would be reduced up to and including the 25-Year storm event. Additionally, the stormwater system would be relocated from private property underneath homes to the public right-of-way. This relocation allows for easier maintenance of the infrastructure and reduces private liability. It would mitigate flooding on property.

7.6 Concept #4 – Charles Street and Branner Avenue (PAOC F2)

Existing Conditions

The stormwater system located along Branner Avenue and extending northwest down Charles Street is composed of catchbasins and closed pipes which reach capacity beginning in the 10-Year design storm. Negative slopes and alternating pipe sizes are contributing to limited system capacity resulting in roadway inundation.

Proposed Conceptual Projects

The existing stormwater network along Branner Avenue would be replaced with 24” to 36” RCP pipes. The system along Charles Street will be replaced with a series of concrete box culverts ranging in size from 2’ H x 6’ W to 3’ H x 8’ W. Due to topographic constraints and the high water surface elevation along Richland Creek, some pipes do not meet Level of Service standards due to backwatering. To create positive drainage throughout the system, a short section of 24” RCP pipe is proposed to collect runoff from the railroad ditch on the west side of Charles Street and connect it to the box culvert system. New catchbasins and manholes are proposed along the length of the system. The extents of the proposed conceptual project are shown in **Figure 14**.

Implementation of this conceptual project will require further evaluation of right-of-way availability, utility conflicts, maintenance access, and construction impacts. These factors will be addressed during subsequent design phases and may influence final project limits, cost, and schedule.

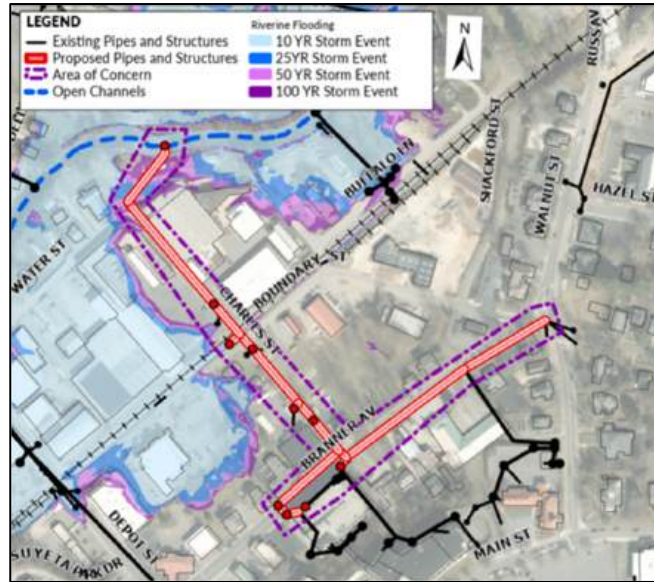


Figure 15. Concept Project Area 4 – Charles Street and Branner Avenue

The estimated opinion of probable costs based on today’s dollars for Concept Project 4 is summarized in **Table 14**. A fact sheet of the conceptual layout and detailed breakdown of the cost is included in **APPENDIX A: CONCEPTUAL STORMWATER PROJECT FACT SHEET AND PLANNING LEVEL COST ESTIMATES**.

Table 14. Concept Project 4- Opinion of Probable Cost for Charles Street and Branner Avenue

Opinion of Probable Cost	
Construction Cost (Labor, Materials, and Site Work)	\$2,894,000
Engineering and Administration	\$128,000
Total (Includes 15% Contingency Cost)	\$4,080,000

Benefit

The primary benefit of this project would be the reduction of roadway inundation up to and including the 10-Year storm event along Branner Avenue and Charles Avenue. It would replace older clay pipes.

7.7 Concept #5 – North Haywood Street and Depot Street (PAOC F3)

Existing Conditions

The stormwater system along North Haywood Street and Depot Street reaches capacity during the 10-Year event in existing condition as shown in **Figure 15**. The systems combine at the intersection of North Haywood Street and Depot Street and extend along Depot Street. This network discharges to Richland Creek upstream of the culvert where Depot Street crosses the creek. Richland Creek has riverine flooding that extends to Boundary Street. The system was

selected for conceptual design review with Town staff with the caveat that downstream conditions should not be worsened.

Site Constraints

The riverine flooding back-ups into the stormwater collection system while the system is also trying to convey stormwater from upstream sources. The creek has insufficient cross-sectional area to convey the flow. The concept design review evaluated upsizing pipes, diverting flow, storage and flap gates. The upsizing of pipes alleviates the upstream system on North Haywood Drive and the upstream end of Depot Street but results in higher levels of inundation for the downstream area. Due to low-lying grade in this area being primarily in the floodplain, there was no available location to size a stormwater detention practice with significant storage to be impactful. Adjacent stormwater networks on parallel streets were already at capacity, so diverting flow was not feasible. When modeled, flap gates did not reduce the level of flooding. The system did not present a feasible infrastructure solution.

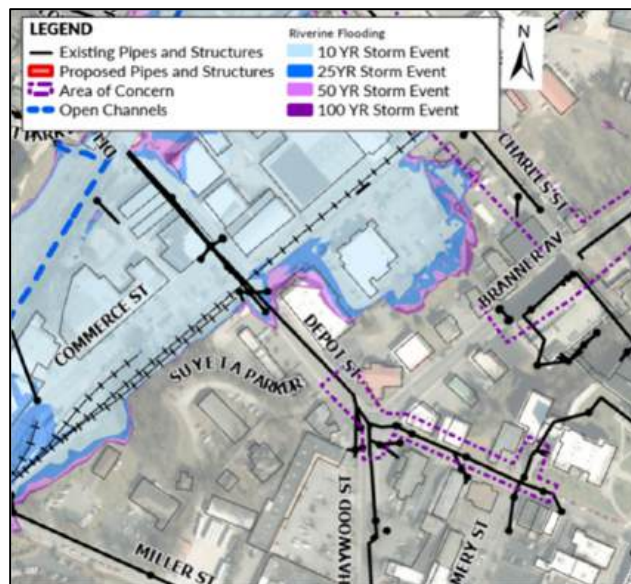


Figure 16. Concept Project Area 5 – North Haywood Street and Depot Street

Proposed Conceptual Projects

It is suggested that a long-term vision be reviewed regarding the floodplain capacity for Richland Creek. Currently, the floodplain associated with Richland Creek is developed and the stream itself is channelized. During large storm events, the stormwater flows rapidly through the channel and for large rain events, overtops the banks into adjacent roads and structures. To improve floodplain capacity, the objective is to reconnect streams with their floodplain by allowing for natural meandering. This goal is achieved by restoring and/or preserving floodplain areas by removing levees or berms to allow overbank conveyance into the floodplain. The project would require buy-outs and large-scale restoration of the land to create pools and shape the stream banks.

7.8 Concept #6 – Waynesville Hazelwood Town Office and Georgia Avenue (PAOC H7/H8)

Existing Conditions

The Waynesville Hazelwood Town Office is located at the confluence of the closed system along Brown Avenue and Farmer Branch as shown in **Figure 16**. Farmer Branch is conveyed through culverts at Georgia Avenue and Brown Avenue that are currently undersized for the 10-Year storm event. The existing culvert at Georgia Avenue does not have sufficient cover in the ROW. The top elevation of the culvert outfall is higher than the ground surface. When the culvert reaches capacity, the runoff overtops Georgia Avenue and flows down to Brown Avenue. There is existing observed damage to the catchbasins on Brown Avenue in front of the Town Office and at the system outfall on the north side of the parking lot. Farmers Branch flows northwest to a culvert under the railroad tracks. The size and orientation of the railroad culvert restrict flow resulting in backwater.

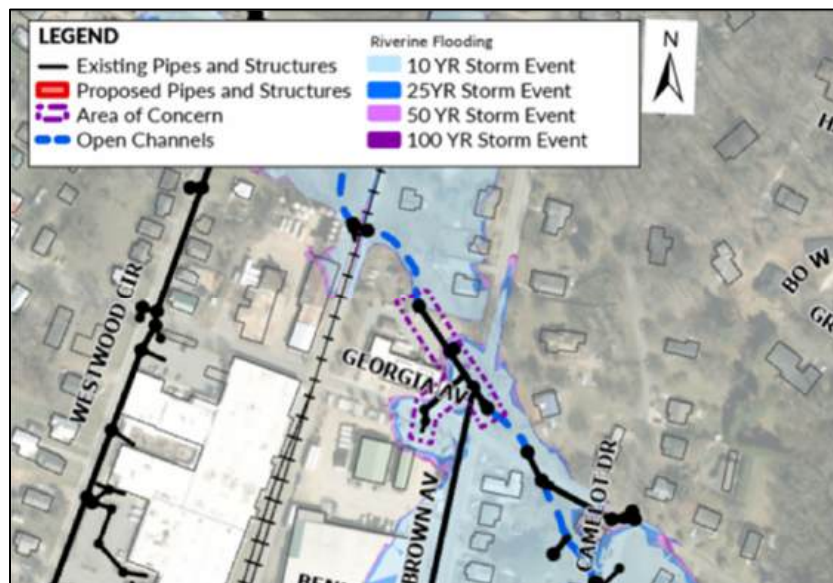


Figure 17. Concept Project Area 6 – Waynesville Hazelwood Town Office and Georgia Avenue

Site Constraints

The conceptual design analyzed several scenarios including the replacement of a single pipe with dual pipes, rerouting flow, stream grading and storage. Private property limitations and minimal grade precluded the possibility of storage and stream grading. Dual pipes would not provide sufficient capacity. Rerouting flow to Brown Avenue in the drainage area would increase capacity issues along Brown Street. All upstream issues would still require replacement of the culvert at the railroad.

Proposed Conceptual Projects

Per discussion with the Town, the decision was made to focus on flood protection strategies for the Town Office Building. Suggested building specific strategies include temporary flood barriers,

dry floodproofing, elevating critical equipment, and installing a flood alert system. Approximate unit costs and anticipated labor for each of these potential solutions are provided in **Table 15**.

Table 15. Concept Project 6- Opinion of Probable Cost for Waynesville Hazelwood Town Office and Georgia Avenue

Opinion of Probable Cost	
Flood Barrier (size dependent)	\$1,000 - \$3,000
Flood Alert System	Varies depending on type and extent of system
Dry Proofing for One Structure	\$10,000 - \$20,000
Elevating Equipment for One Appliance	\$10,000 - \$15,000

Benefit

Flood alert systems are real-time alerts based on sensors to notify the public of an impending situation such as rising floodwaters. These systems are activated by river level data or manually by emergency management. They are equipped with sirens that can be heard up to a half a mile away. These systems help with emergency planning and improve public safety by providing timely updates. Flood barriers, dry proofing, and elevating equipment are all methods for protecting existing structures from flooding damage by preventing water intrusion into a structure.

7.9 Concept #7 – Hazelwood Avenue (PAOC H16)

Existing Conditions

The stormwater system is located along Hazelwood Avenue, between Morgan Street and the outfall on Farmers Branch. The catchbasins and closed pipes within this stretch of system reach capacity beginning in the 10-Year design storm. As a result, roadway inundation is present within the dense residential area.

Proposed Conceptual Projects

The stormwater network would begin with replacing catchbasins located at the intersection of Morgan Street and Hazelwood Avenue as shown in **Figure 17**. The system extending to the west along Hazelwood would be replaced with 30” to 36” RCP pipes all the way to the outfall into Farmers Branch. Additional capacity increases would be made at the intersection of Virginia Avenue and Hazelwood Avenue with the installation of 15” and 24” RCP pipes. New catchbasins and manholes are proposed along the length of the system updates.



Figure 18. Concept Project Area 7 - Hazelwood Avenue

Implementation of this conceptual project will require further evaluation of right-of-way availability, utility conflicts, maintenance access, and construction impacts. These factors will be addressed during subsequent design phases and may influence final project limits, cost, and schedule.

Benefit

The primary benefit of this project would be the reduction of roadway inundation up to and including the 50-Year storm event along the entire length of the proposed system on Hazelwood Avenue. The estimated opinion of probable costs based on today’s dollars for Concept Project 7 is summarized in **Table 16**. A fact sheet of the conceptual layout and detailed breakdown of the cost is included in **APPENDIX A: CONCEPTUAL STORMWATER PROJECT FACT SHEET AND PLANNING LEVEL COST ESTIMATES**.

Table 16. Concept Project 7 - Opinion of Probable Cost for Hazelwood Avenue

Opinion of Probable Cost	
Construction Cost (Labor, Materials, and Site Work)	\$2,894,000
Engineering and Administration	\$128,000
Total (Includes 15% Contingency Cost)	\$4,080,000

7.10 Concept #8 – Virginia Avenue, Kentucky Avenue, and Main Street (PAOC H17)

Existing Conditions

The stormwater system originates on Main Street through residential yards to Kentucky Avenue connecting with Virginia Avenue and outfalls on Farmers Branch behind a church. The pipes within the network are undersized, reaching capacity beginning in the 10-Year design storm. As a result, roadway inundation is present within the dense residential area.

Proposed Conceptual Projects

The stormwater network would begin with replacing the catchbasin in front of 116 Kentucky Avenue and upsizing the system with 24” to 30” RCP pipes to the intersection of Virginia Avenue. The location and alignment of several structures and pipes were shifted from the existing locations to reduce the required number of proposed structures, limit the length of proposed pipe, and bring the system in the public ROW. The system upgrades would continue with 36” to 48” RCP pipes along Virginia Avenue all the way to the outfall along Farmers Branch. Additional work is proposed to replace the system below S Main Street, in front of 1102 S Main Street, with dual 18” RCP pipes. New catchbasins and manholes are proposed along the length of the system updates as shown in **Figure 18**.

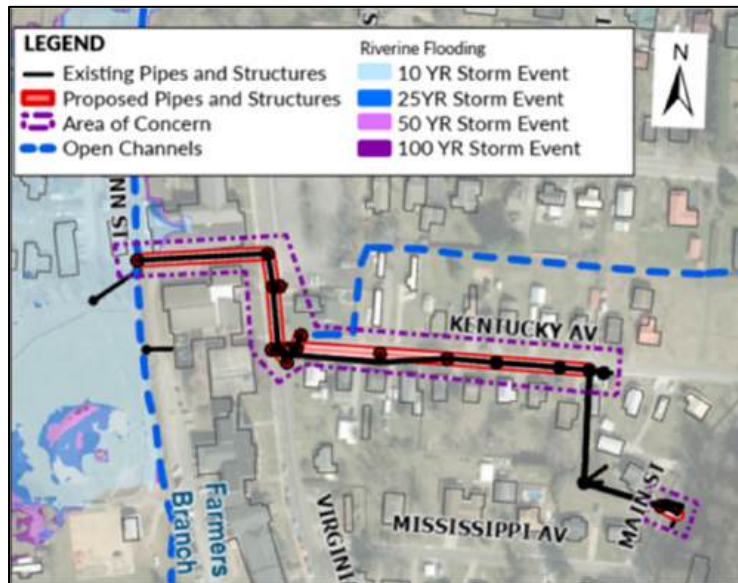


Figure 19. Concept Project Area 8

Implementation of this conceptual project will require further evaluation of right-of-way availability, utility conflicts, maintenance access, and construction impacts. These factors will be addressed during subsequent design phases and may influence final project limits, cost, and schedule.

The estimated opinion of probable costs based on today’s dollars for Concept Project 8 is summarized in **Table 17**. A fact sheet of the conceptual layout and detailed breakdown of the cost is included in **APPENDIX A: CONCEPTUAL STORMWATER PROJECT FACT SHEET AND PLANNING LEVEL COST ESTIMATES**.

Table 17. Concept Project 8- Opinion of Probable Cost

Opinion of Probable Cost	
Construction Cost (Labor and Materials)	\$598,000
Engineering and Administration	\$82,000
Total (Includes 15% Contingency Cost)	\$918,000

Benefit

The primary benefit of this project would be the reduction of roadway inundation up to and including the 25-Year storm event on Main Street, Kentucky Avenue, and Virginia Avenue.

8. Capital Improvement Plan

A Capital Improvement Plan (CIP) can reflect the Town’s plans for staffing, equipment, maintenance, and capital improvements for the next ten years. This CIP focuses on the costs related to infrastructure capital improvements within the three study areas and stormwater maintenance needs. Six projects, identified and ranked above, were incorporated into the CIP analysis. A summary of the six projects and the project’s opinion of probable costs are summarized below and in **Table 18**.

- **Project Area 1- Waynesville Public Works and Legion Drive:** Improvements focused on increasing system capacity along Legion Drive and Pigeon Street and realigning infrastructure into public right-of-way by adding new infrastructure on Town & Country Drive.
- **Project Area 2- Broad Street:** Replacement of the existing culvert on Broad Street which conveys Shelton Creek.
- **Project Area 3- Burke Street & Shelton Street:** Improvements include increasing capacity along Shelton Street and realigning the system behind home to along Broad Street to a new outfall on Shelton Creek.
- **Project Area 4- Charles Street & Branner Avenue:** Upsizing capacity along Branner Avenue through Charles Street to the outfall north of Water Street.
- **Project Area 7- Hazelwood Avenue:** Upsizing capacity along Hazelwood Avenue and cross drainage into the system from the intersection with Morgan Street to the outfall on Farmers Branch.
- **Project Area 8- Virginia Avenue, Kentucky Avenue & Main Street:** Improvements focused on increasing system capacity for the system starting on Main Street traversing behind homes along Kentucky Avenue and Virginia Avenue to the outfall on Farmers Branch.

Table 18. Summary of Probable Project Costs

	Construction Cost (Labor and Materials)	Engineering and Administration	Total (Includes 35% Miscellaneous Cost)
Concept Project 1- Waynesville Public Works and Legion Drive	\$1,054,000	\$123,000	\$1,589,000
Concept Project 2- Broad Street Culvert	\$456,000	\$93,000	\$742,000
Concept Project 3- Burke Street and Shelton Street	\$1,172,000	\$101,000	\$1,719,000

Concept Project 4- Charles Street and Branner Avenue	\$2,894,000	\$128,000	\$4,080,000
Concept Project 7- Hazelwood Avenue	\$376,000	\$78,000	\$613,000
Concept Project 8- Virginia Avenue, Kentucky Avenue, and Main Street	\$598,000	\$82,000	\$918,000

This Capital Improvement Plan (CIP) focuses on the distribution of the six project costs over 10 years. The Town budget allocates an annual maintenance budget for streets, sanitation and stormwater which amounted to \$325,000 in FY 2025. The portion of this budget that is dedicated to stormwater is nominal and insufficient to meet maintenance needs. The town staff has requested that a recommendation be made for the allocation of funds to cover the personnel costs, equipment, materials, and any contracted services to complete field work for stormwater infrastructure improvements and maintenance.

8.1 Stormwater Revenue

The Town’s budget for Fiscal Year 2024-2025 was \$200,000. In the adopted budget for FY26, the recommended stormwater budget was \$193,238. The stormwater fund was established to provide revenue to administer the EPA Municipal Separate Storm Sewer System (MS4) Program. Previously, the Town depended on the General Fund for stormwater activities. The revenue for this stormwater fund is entirely from stormwater utility fees paid by residential and commercial users.

The stormwater fund is divided into two expenditure categories - administrative and finance in the amount of \$82,090 or 42% of the fund and stormwater management totaling \$111,148 or 58% of the fund per the FY26 budget. The administration and finance amount are charges by the General Fund. The stormwater management allocation covers one full-time position for administering the MS4 permit including materials for education, travel, and contracted services which could include water quality testing.

8.2 Stormwater Program Needs

The Town is a designated Municipal Separate Storm Sewer System (MS4) designated community under permit number NCS000501. The MS4 program is a state-managed component of the federal Clean Water Act that regulates stormwater runoff to protect water quality. This is an unfunded mandate. The MS4 program consists of six minimum control measures which are broken down into best management practices (BMPs). Per permit reference 3.7.3, there is a BMP entitled MS4 Operation and Maintenance Program which states “The permittee shall provide operation and maintenance staff training on stormwater awareness and pollution prevention, perform MS4 inspections, maintain the collection system including catchbasins and conveyances; and establish specific frequencies, schedules, and standard documentation.” Maintaining the MS4 program is not only good practice but also mandated under the MS4 program.

As part of this project, an asset survey was conducted of the drainage infrastructure and outfalls within the prioritized area. The survey provides a preliminary estimation of maintenance needs for the existing system. A breakdown of the pipes within the study area by material is summarized in **Figure 19** according to their percentage of pipe length. The overall pipe length surveyed was approximately 41,00 linear feet. There were 6 materials identified within the study area – Corrugated Metal (CMP), Corrugated Plastic (CPP), Ductile Iron (DIP), High Density Polyethylene (HDPE), Polyvinyl Chlorine (PVC), and Reinforced Concrete (RCP).

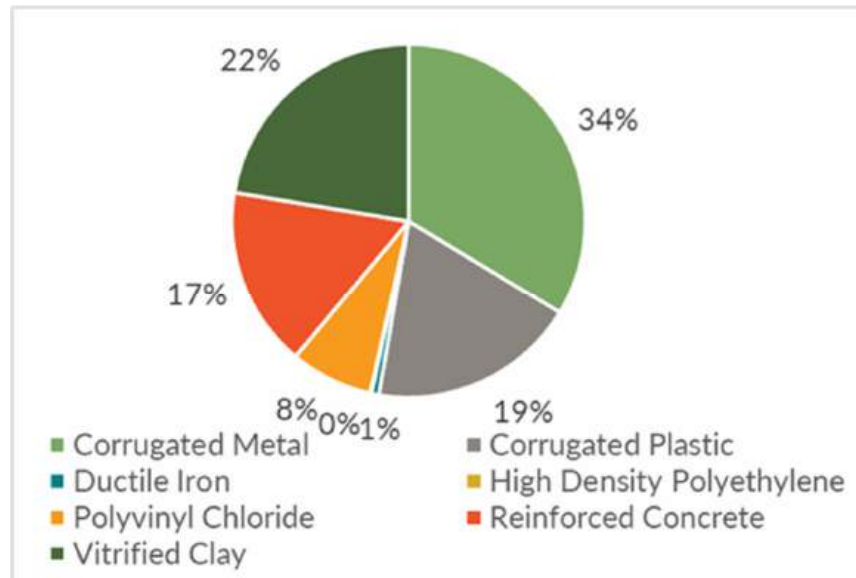


Figure 20. Percent of Pipe Length by Material in Study Area

The estimated useful life of each asset based on pipe material was determined by industry standards. Metal pipes have an average life span of 10-30 years. Plastic pipes have an average life span of 50-100 years. Concrete and ductile iron has an average lifespan of 75-100 years. Clay also has an average life span of 100 years, but they are not commonly installed anymore. Any presence of clay pipes would signify that the pipe was very old. The clay pipes constitute 22% of the system or 9,100 linear feet ranging in diameters from 4 inches to 24 inches. Although clay pipes indicate old infrastructure, these pipes may be in better condition than metal pipes. Maintenance costs for upgrading pipes will be included in this CIP as an annual lump cost to cover minor repairs. Further evaluation of drainage needs in the areas with clay pipes should be evaluated to determine if upsizing pipes may need to occur when replacing the pipes to estimate costs. The majority of clay pipes are in Frog Level neighborhood.

8.3 Estimated Timeline of Major Project Expenditures

The proposed Capital Improvement Plan (CIP) reflects the City’s capital improvements for the next ten years, beginning in Fiscal Year 2027 and ending through Fiscal Year 2036. The CIP includes estimated cost for minor stormwater system maintenance annually and proposed the addition of

a stormwater crew. This CIP is limitedly focused on the infrastructure capital improvements within the priority study area established by Town staff for the Town of Waynesville LASII Planning – Comprehensive Stormwater Master Plan.

The Public Works Department provided a list of twenty stormwater priority projects geographically located throughout Town that have been included in **APPENDIX F: TOWN OF WAYNESVILLE PUBLIC WORKS REFERENCES**. No preliminary designs or probable costs have been estimated for the projects on the public works list. This list was provided after the conceptual designs were developed. Five of the six conceptual projects in this stormwater master plan were included in the public works maintenance list.

- Concept Project 1 – Waynesville Public Works and Legion Drive (PW #11)
- Concept Project 3 – Burke Street and Shelton Street (PW #3)
- Concept Project 4 – Charles Street and Branner Avenue (PW #4)
- Concept Project 7 – Hazelwood Avenue (PW #9 for the area on Hazelwood from Riverbend Street to Brown Avenue)
- Concept Project 8 – Virginia Avenue, Kentucky Avenue, and Main Street (PW #10)

Capital improvement projects were prioritized based on input from public work staff which considered flood risk reduction, protection of public infrastructure and facilities, severity and frequency of flooding impacts, and readiness for external grant funding.

The six projects were staggered across the 10-Year CIP based on project priority determined by the Public Works. Concept Projects 2 and 3 are discharged to the same location on Shelton Creek. The culvert underneath Broad Street is proposed to occur prior to the realignment of the pipe along Broad Street. This project order will ensure that the culvert improvements are designed prior to determining the exact location of the discharge from the Broad Street system. To note, Concept Project 2 for the Broad Street Culvert is not on the public works list.

It was assumed that the Town stormwater activities and management fees would remain at \$82,090 per year and \$117,910 per year respectively. A new line item for MS4 drainage maintenance is proposed equivalent to \$208,00 for FY 2027. The expenditure would include wages and benefits for a maintenance team consisting of a stormwater crew lead and two-man crew and an allowance for minor infrastructure improvements to the system. It is assumed that the Town would utilize existing equipment for the crew. A review of equipment needs and the life cycle of equipment to assess age for replacement should be factored into future budgets.

A 3% cost escalation factor per year was applied to account for inflation through the 10-Year CIP for all the capital projects and stormwater program expenditures. The developed opinions of probable project cost were incorporated into an estimated timeline of major project expenditures in order of priority as shown in **Table 19**. Opinions of probable cost are provided for planning purposes only and are subject to refinement. Final construction costs may vary due to market conditions, inflation, utility relocation requirements, right-of-way or easement acquisition, and final design decisions. The estimated total funding amount for stormwater improvement projects

and drainage maintenance per this proposed CIP is approximately \$13,552,069. Further evaluation of the stormwater utility fee and grants should be pursued to fund the capital improvement projects outlined in this plan.

Table 19. Estimated Timeline for Stormwater Capital Improvement Projects

Project	Cumulative Costs	Budget FY 2027	Budget FY 2028	Budget FY 2029	Budget FY 2030	Budget FY 2031	Budget FY 2032	Budget FY 2033	Budget FY 2034	Budget FY 2035	Budget FY 2036
		0%	3%	6%	9%	12%	15%	18%	21%	24%	27%
% Cost Escalation Factor											
Concept Project 1- Waynesville Public Works and Legion Drive	\$1,633,880	\$93,000	\$1,540,880								
Concept Project 2- Broad Street Culvert	\$871,780		\$70,560	\$801,220							
Concept Project 7- Hazelwood Avenue	\$757,240			\$56,640	\$700,600						
Concept Project 8- Virginia Avenue, Kentucky Avenue, and Main Street	\$1,190,280				\$64,480	\$1,125,800					
Concept Project 3- Burke Street and Shelton Street	\$2,333,280					\$98,800	\$2,234,480				
Concept Project 4- Charles Street and Branner Avenue	\$5,056,260								\$118,580	\$4,937,680	
Stormwater Management	\$1,338,279	\$117,910	\$121,447	\$124,985	\$128,522	\$132,059	\$135,597	\$139,134	\$142,671	\$146,208	\$149,746
Stormwater General Fund	\$931,722	\$82,090	\$84,553	\$87,015	\$89,478	\$91,941	\$94,404	\$96,866	\$99,329	\$101,792	\$104,254
MS4 Drainage Maintenance	\$2,360,800	\$208,000	\$214,240	\$220,480	\$226,720	\$232,960	\$239,200	\$245,440	\$251,680	\$257,920	\$264,160
TOTAL	\$13,180,999	\$501,000	\$1,961,120	\$503,040	\$1,302,580	\$1,222,040	\$1,693,800	\$2,715,920	\$612,260	\$5,443,600	\$518,160

9. Growth Assessment

The growth assessment assesses the impact of future development on existing stormwater infrastructure within the three study areas. The three priority areas selected by Town staff were Shelton Branch, Hazelwood, and Frog Level. Additionally, the existing stormwater ordinance was evaluated to assess what policies could be implemented to mitigate stormwater runoff from development. The Town of Waynesville has an existing post-construction stormwater ordinance because it is permitted Phase II entity under the Clean Water Act. The current ordinance sets standards for development and redevelopment to manage stormwater runoff flow and stormwater volume.

9.1 Current Town Stormwater Regulations

The Town is a designated NPDES MS4 community. As such, the community must meet the minimum NPDES MS4 post-construction requirements codified within 15A N.C. Administrative Code 02H.1017. The Town of Waynesville’s stormwater regulations are found in the Town of Waynesville’s Appendix A Land Development Standards Section 12.5 entitled Stormwater Ordinance. The post construction requirements are applicable to new development and redevelopment projects that:

- Cumulatively disturb at least one acre of land
- Project less than one acre and that are a part of a common plan of development,
- Project less than one acre and proposing impervious surfaces greater than 24,000 square feet

Exempted from these requirements include single-family and two-family development on individual lots and all development in the Central Business District. The Central Business District per the Official Land Development Map dated June 13, 2025, extends from Richland Creek to Wall Street and from Russ Avenue to S Haywood straddling the Main Street commercial area.

The stormwater requirements for low- and high-density development are presented in **Table 20**.

Table 20. Stormwater Regulations based on Development Type per 12.5.7.B, C, D

Development Options	Density	Stormwater Management
Low Density	≤ 24% BUA or 2 dwelling units per acre for all residential and non-residential development	Capture and treat runoff from the 1-year, 1-hour storm event
High Density	> 24% BUA or > 2 dwellings units per acre	Capture and treat runoff from the 1-year, 1-hour storm event Post development peak flow rates discharged shall not exceed the predevelopment peak discharge rates for the 1-year 24-hour, 2-year 24-hour storm, and the 10-year 24-hour storm.

		<p>No one BMP shall receive runoff from an area greater than three (3) acres. However, the total drainage area from BMPs used in series (i.e., integrated) can exceed this three (3) acre maximum. *</p> <p>Storage shall be sufficient to store all excess surface runoff up to the 10-year 24-hour storm event.</p>
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*Per request of the town, a memorandum on drainage area recommendations for stormwater control measures was written and is included in **APPENDIX G: POLICY REVIEW MEMOS**.

Additionally, all projects must have the built-upon area at a minimum of thirty feet landward of all perennial and intermittent surface waters. Water quality BMPs may encroach into a required buffer as long as the encroachment does not disturb the majority of existing vegetation. The requirements for conveyance system design storms are determined according to the pipe location and contributing flow as presented in **Table 21**.

Table 21. Stormwater Conveyance Systems Design Requirements per Section 12.5.7.E

Conveyance	Storm Event Peak Flow Rate
Drainage parallel to road, including ditches, swales and pipes	2-year, 24-hour
Cross Drainage	10-year, 24-hour
Cross Drainage conveying intermittent of perennial streams	50-year, 24-hour

9.2 Land Use Comparison

The Town is limited in development based on the urban service boundary and topographic location in a valley. In reviewing the development suitability map in the Comprehensive Plan, the areas at the headwater of streams and in the higher reaches of the watershed with steep slopes are deemed lower to medium suitability. The high suitability areas are the flat areas along Richland Creek and converging streams. The existing urban core areas coincide with FEMA identified floodplains. Future land use is based on the Town’s 2035 Comprehensive Land Use Plan.

In comparing the existing and future land use maps, there are a few areas that will change land use designation when reviewing the drainage areas specific to this master plan.

- In Frog Level, the area west of Richland Creek labeled as Love Lane is currently neighborhood residential and in the future is allowed to be residential medium-high. Love Lane is currently smaller bungalow style homes on small lots. Density from this land use change would slightly decrease from 10 units/acre to 8 units/acre. The pervious area

requirements for medium residential standard requires 20% compared to neighborhood residential which requires 10%.

- In Hazelwood, the area north of Waynesville Golf Resort adjacent to Browning Branch is changing from residential low density to residential medium-high. The change in zoning for the area in Hazelwood would result in slightly higher density from 6 units/acre to 8 units/acre with smaller minimum lot sizes and less setback distances.

Future infill or higher density development would put pressure on existing stormwater infrastructure, especially in the following areas which are at capacity during the 2-year, 24-hour storm event equivalent to 3.24 inches:

- Systems discharging to Richland Creek within the Frog Level basin originating on Buffalo Lane, Branner Avenue, Depot Street, Montgomery Street, and Dellwood Street.
- Systems discharging into Farmers Branch with Hazelwood originating along Westwood Circle, Camelot Drive and East Georgia Avenue, Hazelwood Avenue and Morgan Street, and Virginia Avenue and Kentucky Avenue.
- System along Hazelwood Avenue flowing into the system along Brown Avenue towards Carolina Avenue
- Systems discharging into Shelton Branch originating at Oakdale Road and Conley Street
- System along Legion Drive by the Public Works Building, Shelton Street and Lowell Street intersection and a few isolated pipes throughout Shelton Drainage Area.

The 2-year storm event is the existing level of service requirement for closed stormwater conveyance. Some of these systems include cross-drainage pipes that do not meet the existing level of service requiring conveyance of the 10-year, 24-hour storm event.

10. Stormwater Ordinance Recommendations

The proposed concepts developed as part of this study only address flood mitigation problems in a few areas of the Town. Ordinance changes are recommended to impact future development townwide. The recommended actions are to increase protection of riparian buffer, increase the storm design standards for stormwater conveyance, and erosion and sediment control, and require projects to evaluate downstream impacts. Additionally, ensuring that floodplain standards are followed with respect to floodproofing will be essentials for mitigating risk. For each ordinance recommendation, the purpose and various options are provided to offer a suite of examples. It would be incumbent on the Town staff to refine the choices and follow regulatory requirements to present any amendments through the appropriate channels (i.e. Boards and Council) before official adoption.

10.1 Downstream Impact Analysis

Purpose: A downstream impact analysis evaluates if new development will cause any impact on flooding or channel degradation downstream of the project site. The analysis provides the Town with an estimate of the planned hydrologic and hydraulic changes and determines an appropriate mitigation strategy to the proposed changes identified.

Ordinance Suggestion: Clarify the requirements for the Uniform Watershed Analysis in Section 12.5.7.F to address downstream impacts.

- Option: Propose defining that a downstream impact assessment is determined at the confluence point where area of proposed development is less than 10% of the total drainage point. The analysis needs to demonstrate that the peak flow rate does not increase for a given storm. The impact statement shall list the infrastructure (ditches, culvert, etc.) and indicate all the adverse effects and impacts to (roads, culverts, businesses, homes, lawns, etc.) from development to the 10% point. If backwater from detention appears to be a problem, then the impact statement shall also consider potential effects on upstream properties for the 100-year, 24-hour storm. An explanation of the 10% rule and application of a downstream impact analysis is shared in a memo provided in **APPENDIX G: POLICY REVIEW MEMOS.**
- Option to limit the downstream impact only for development projects upstream of an existing or potential drainage problem and/or flooding concern. Or could limit impact assessment to high density projects.
- Option to also address development downstream of a known flooding problem to demonstrate that flows through the property can be conveyed at non-erosive velocities for a given storm.
- This recommendation would require a drainage complaint map kept up to date.

10.2 Stormwater Conveyance Standards

Purpose: The stormwater conveyance standards are proposed to ensure suitability for larger events to prevent erosion in open ditches and convey volume of runoff to the stormwater control measure (SCM). The stormwater regulations already require storage in the SCM sufficient to store all excess surface runoff up to the 10-year 24-hour storm event. Additionally, the state stormwater standards in 15A NCAC 02H Section .1000 require vegetated conveyance, curb outlet systems, and stormwater outlets to convey the peak flow or designed to prevent erosion for the peak flows from the 10-year storm event. The selection of the design storm for stormwater standards is determined by the frequency of a storm event, the possibility of damage, the level of risk one can tolerate, and cost. A discussion of design storms from comparative communities is provided in a design storm memorandum provided in **APPENDIX G: POLICY REVIEW MEMOS.**

Ordinance Suggestion: Change the design storms and clarify requirements for pipe loss calculations

- Change the required storm event for designing stormwater conveyance system to be in concurrence with the stormwater detention requirements. The stormwater detention requirement is the 10-year, 24-hour storm for high density projects. Closed pipe systems would be required to convey the 10-year, 24-hour storm. The modified requirements and additional standards are bolded in **Table 22.**

Table 22. Recommended Stormwater Conveyance Systems Design Requirements

Conveyance	Storm Event Peak Flow Rate	Additional Standards
Drainage parallel to road, including ditches, swales and pipes	10-year, 24-hour	Contain HGL within pipes, and minimum pipe slope is 0.5% or that which produces a minimum velocity of 2.5 fps and a maximum velocity of 8 fps when flowing full. If a ditch, flow should be contained inside cross-section
Cross Drainage	10-year, 24-hour	
Cross Drainage conveying intermittent or perennial streams	50-year, 24-hour	No freeboard, and headwater depth limited to 1.2 times the opening height

- Revise the required design storm intensity and depth to the NC State Climate RainDROP (Rainfall Intensity Duration and Return for Observations and Projections) RCP4.5- Mid Century (Mean) Precipitation projection instead of NOAA Atlas 14.
- Options to differentiate design storm standards for ditches than closed pipe systems.
- Clarification requirements for pipe loss calculations specifically for backflow.

10.3 Erosion and Sediment Control

Purpose: Sediment is the leading pollutant in North Carolina primarily caused by soil erosion from land disturbing activities. The current Town regulation meets the state standard requiring erosion and sedimentation control measures to be designed for the 10-year peak runoff. In areas where High Quality Waters (HQP's) are a concern, the design requirement is the 25-year storm. There are no HQW's in Waynesville or the ETJ. The tributaries to Allens Creek just outside the ETJ are classified as high quality waters. The stormwater survey conducted in an earlier phase of this project, the top concerns listed were trash in creeks, polluted streams, streambank conditions, and wildlife and fish preservation.

Ordinance Suggestion: Consider revising Mandatory Standards for Land-Disturbing Activity in Section 12.4.4 to require erosion and sediment control measures up to the maximum peak rate of runoff from the 25-year storm for high density projects.

10.4 Riparian Buffers

Purpose: Riparian buffers provide water quality, minimize danger and property danger from flooding, protect streams for erosion and sedimentation, and preserve urban wildlife corridors and plant habitats. Forested riparian buffers also provide habitat and shading of the water bodies which helps to cool down water temperatures. The required width of a vegetated setback from perennial waterbodies, perennial streams, and intermittent streams per the NPDES Post Construction standards is at least 30 feet in width. The state regulations for water supply

watersheds which are areas designated by the state to protect surface water drinking supplies require 100-foot minimum width buffers from perennial streams for high density development. Riparian buffers are critical for providing water quality treatment and dispersing flow into waterbodies.

Ordinance Suggestion: Improving protection of riparian buffers by increasing minimum width and changing allowable activities within the buffer.

- Increasing the riparian buffer with to a minimum 50 feet for intermittent and perennial streams for major subdivisions and/or high-density development.
- Recommend disallowing water quality BMPs within the buffer as permitted in Section 12.5.7.C(6).

10.5 Buildable Area Outside Floodplain

Purpose: Keep structures outside of environmentally sensitive area to protect drainageways, dwellings, and individuals

Ordinance Suggestions: Evaluate fill allowances within the floodplain

- Option: Lot must be platted to have at least 1,200 sf of buildable area outside of the flood prone area
- Option: Lots may not be proposed within flood hazard areas at all.
- Option: Lot sizes may be reduced, if practical, to avoid encroaching into flood risk areas.
- Option: Disallow stormwater control measures from being built within the floodplain.

Public work staff suggested additional ordinance revisions should the ordinance be updated. The ordinance recommendations are included in **APPENDIX F: TOWN OF WAYNESVILLE PUBLIC WORKS REFERENCES**. Recommended ordinance and design standard updates should be considered through the Town's established development ordinance update process, including coordination with Planning staff, the Planning Board, and legal counsel prior to adoption.

11. Summary

The Stormwater Master Plan including the conceptual projects and ordinance suggestions are intended for review and discussion to determine what is most practical, applicable, and timely for the Town of Waynesville. The stormwater master plan in this iteration represents three priority areas within the town boundaries: Frog Level, Shelton Branch, and Hazelwood. As shared by the Public Works department, there are additional stormwater project priority areas throughout the Town.

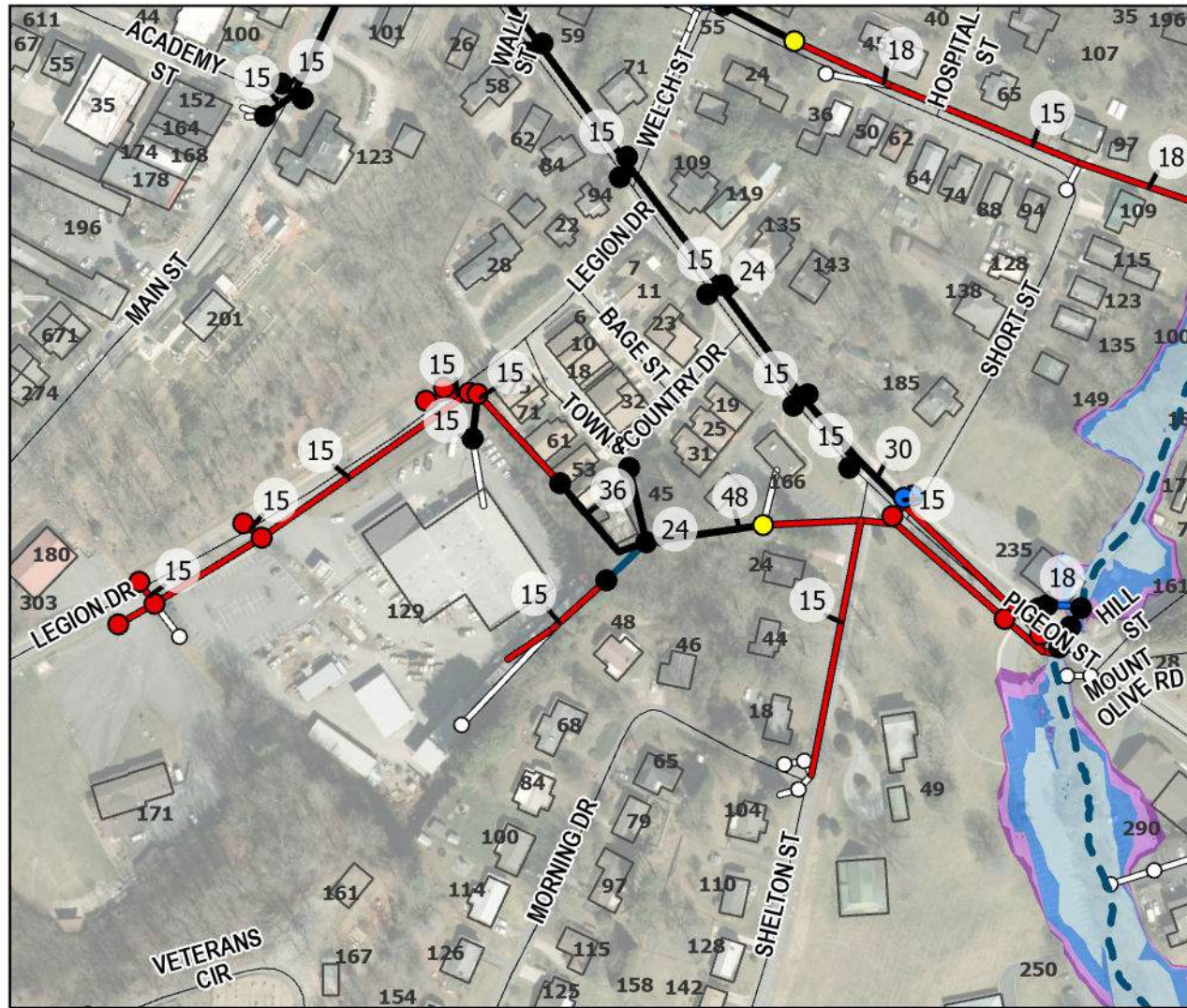
12. References

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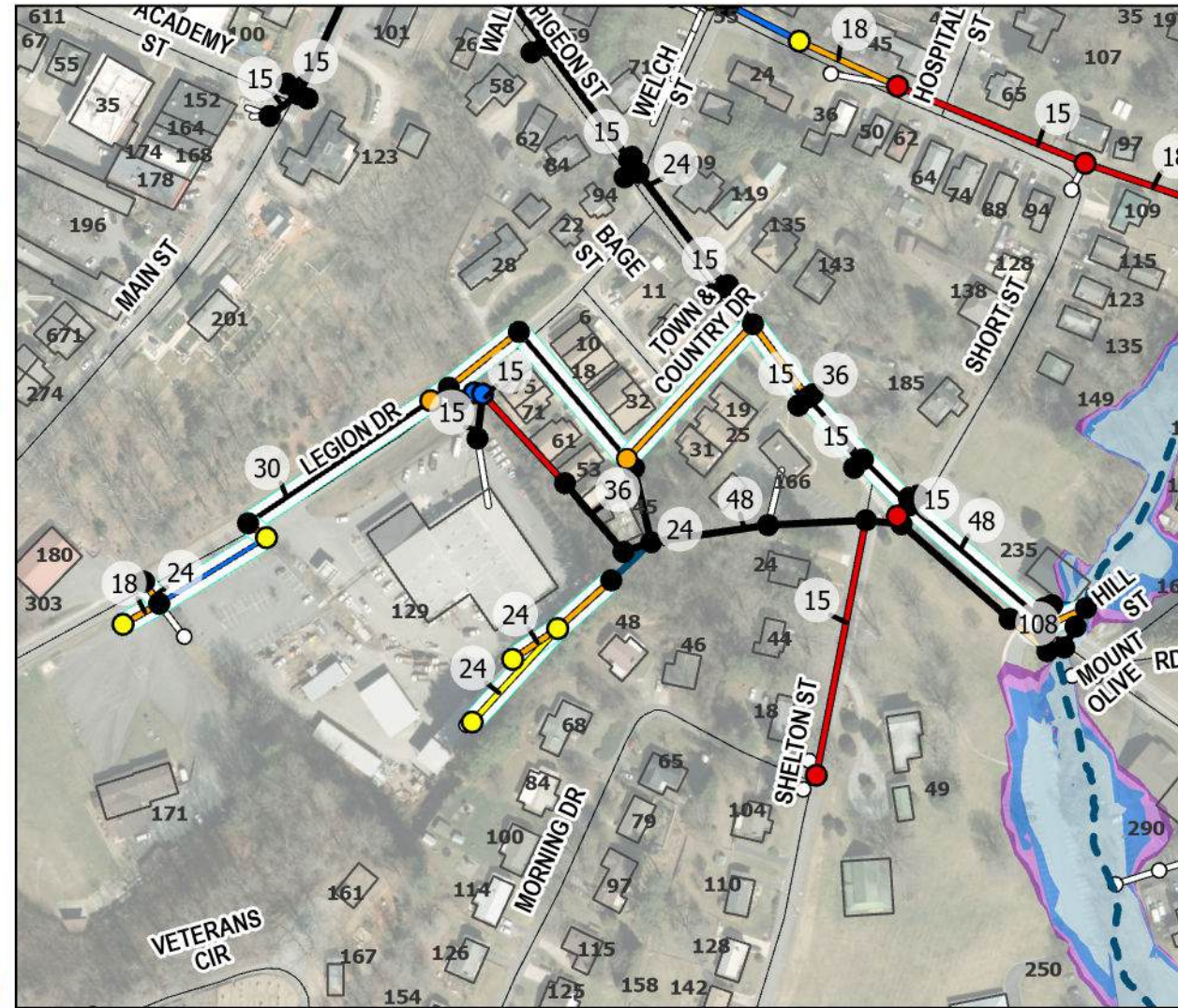
Appendix A: Conceptual Stormwater Project Fact Sheet and Planning Level Cost Estimates

EXISTING CONDITIONS



NC Collaboratory at UNCCH, Microsoft, Vantor

PROPOSED CONDITIONS



LEGEND

Junctions

- Full Capacity - 10 YR Storm Event
- Full Capacity - 25 YR Storm Event
- Full Capacity - 50 YR Storm Event
- Full Capacity - 100 YR Storm Event
- Not-Flooded in Analyzed Storms
- Non-Analyzed

Conduits

- Full Capacity - 10 YR Storm Event
- Full Capacity - 25 YR Storm Event
- Full Capacity - 50 YR Storm Event
- Full Capacity - 100 YR Storm Event
- Not-Flooded in Analyzed Storms
- Non-Analyzed

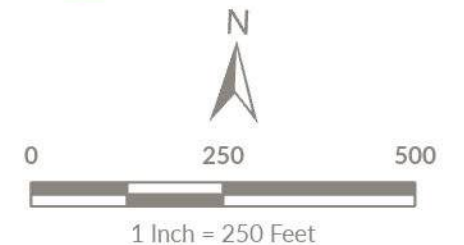
Context

- Open Channels
- Non-Modeled Open Channels
- Railroads
- Structures
- Proposed Pipes and Structures

- 123 Address
- 123 Pipe Size

Riverine Inundation

- 10 YR Storm Event
- 25 YR Storm Event
- 50 YR Storm Event
- 100 YR Storm Event



PROBLEM

The stormwater system located along Legion Dr and on 129 Legion Dr (Waynesville Public Works Building) is composed of inlets and closed pipes which reach capacity beginning in the 10-year storm event. Runoff escaping the system on Legion Drive flows to the inlets located at the north corner of 129 Legion Dr, then overtops the curb and flows behind the homes on Town & Country Dr. Ponding is known to occur behind the Public Works building in the area of the existing inlets.

SOLUTION

The conceptual design begins with replacing the inlets on Legion Dr and upsizing the network with 18" to 36" RCP pipes. At the northern corner of 129 Legion Dr, the system will be realigned to stay within the public ROW through the addition of 36" RCP pipes along Legion Dr and Town & Country Drive to Pigeon St. The central stormwater line along Pigeon St will be upsized with 36" to 48" RCP pipes, and the outfall into Shelton Creek redirected to the north of Pigeon St. The existing system located along the southeast edge of 129 Legion Dr will be replaced with 24" RCP pipes to the outfall.

BENEFITS

The primary benefit of this project would be the reduction of roadway inundation on Legion Dr and ponding behind the Public Works building. By increasing the size of the stormwater network, roadway inundation is reduced up to and including the 10-year event on Legion Dr and ponding is reduced up to and including the 25-year storm event behind the Public Works building.

OPINION OF PROBABLE PROJECT COST (as of February 2026)

Construction:	\$1,054,000
Engineering and Administration:	\$123,000
TOTAL (Includes 35% Contingency Cost):	\$1,589,000

Project Name: Waynesville Stormwater Master Plan
 City/State: Waynesville, North Carolina

Project #: 23-0734
 Date: 2/19/2026

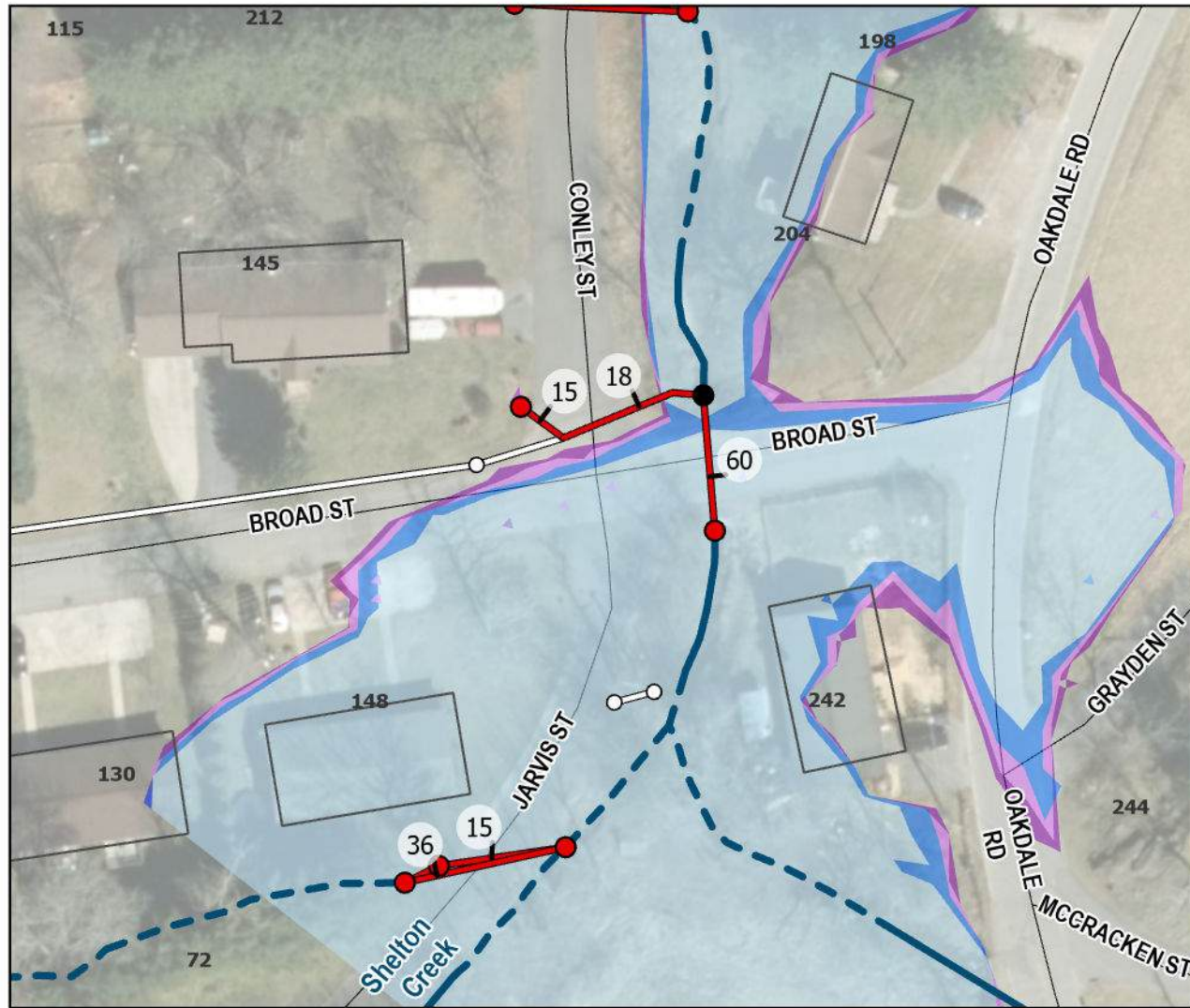
Concept Project 1
Waynesville Public Works and Legion Dr

<u>Proposed Improvements</u>				
<u>CONSTRUCTION COST</u>				
<u>Labor and Material Cost</u>				
Structure	Quantity*	Unit	Unit Price	Total
18" Reinforced Concrete Pipe	58	LF	\$ 150	\$ 9,000
24" Reinforced Concrete Pipe	389	LF	\$ 170	\$ 67,000
30" Reinforced Concrete Pipe	545	LF	\$ 180	\$ 99,000
36" Reinforced Concrete Pipe	969	LF	\$ 300	\$ 291,000
48" Reinforced Concrete Pipe	313	LF	\$ 470	\$ 148,000
Inlets/Manholes	17	EA	\$ 6,500	\$ 111,000
Headwall/Endwall	2	EA	\$ 5,000	\$ 10,000
Roadway/Asphalt Restoration	1590	SY	\$ 110	\$ 175,000
MATERIALS SUBTOTAL				\$ 910,000
<u>Site Work Costs</u>				
Based on % of Materials Cost				
Mobilization		5%	\$	46,000
Erosion Control		2%	\$	19,000
Construction Survey		2%	\$	19,000
Traffic Control		LS	\$	35,000
Utility Conflicts		LS	\$	25,000
Dewatering		0%	\$	-
SITE WORK COST SUBTOTAL				\$ 144,000
CONSTRUCTION SUBTOTAL (INCLUDES LABOR AND MATERIAL COST)				\$ 1,054,000
<u>ENGINEERING AND ADMINISTRATION COST</u>				
Based on % of Construction Cost				
Site Characterization (Survey & Geotech)		5%	\$	53,000
Design and Permitting		LS	\$	40,000
Construction Administration		LS	\$	25,000
Closeout		LS	\$	5,000
ENGINEERING & ADMINISTRATION SUBTOTAL				\$ 123,000
PROJECT TOTAL SUBTOTAL				\$ 1,177,000
Contingency		35%	\$	412,000
PROJECT TOTAL				\$ 1,589,000

Assumptions

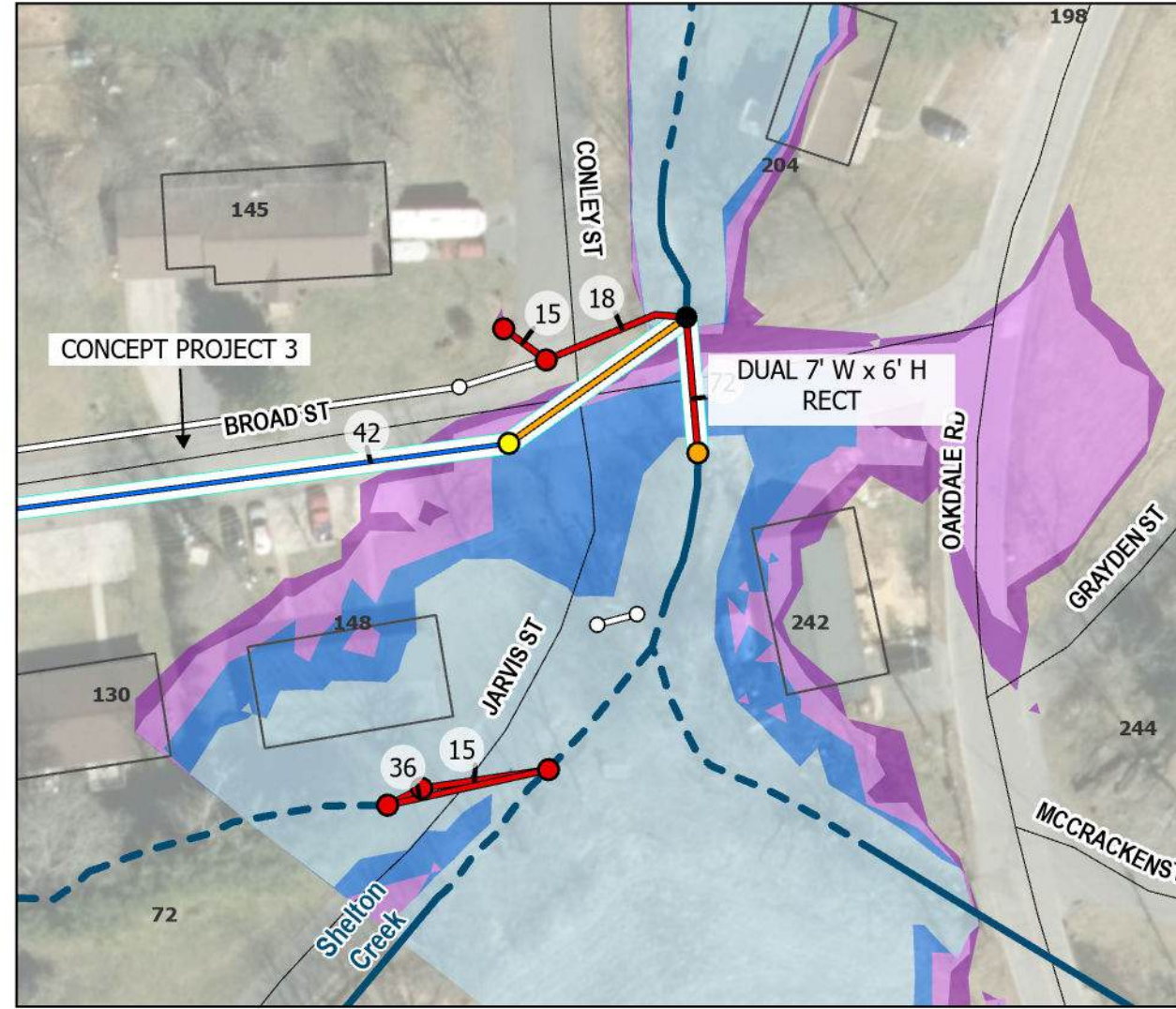
This estimate of probable cost is approximate as of February 19, 2026. Actual construction bids may vary significantly from this statement of probable costs due to timing of construction, changed conditions, land acquisition, labor rate changes, or other factors beyond the control of the estimators.

EXISTING CONDITIONS



NC Collaboratory at UNCCH, Microsoft, Vantor

PROPOSED CONDITIONS



LEGEND

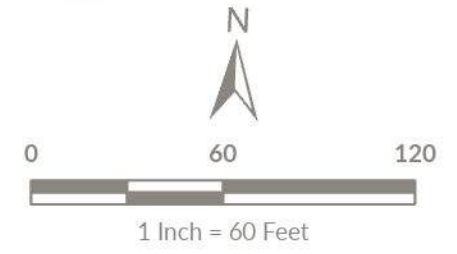
- Junctions**
- Full Capacity - 10 YR Storm Event
 - Full Capacity - 25 YR Storm Event
 - Full Capacity - 50 YR Storm Event
 - Full Capacity - 100 YR Storm Event
 - Not-Flooded in Analyzed Storms
 - Non-Analyzed

- Conduits**
- Full Capacity - 10 YR Storm Event
 - Full Capacity - 25 YR Storm Event
 - Full Capacity - 50 YR Storm Event
 - Full Capacity - 100 YR Storm Event
 - Not-Flooded in Analyzed Storms
 - Non-Analyzed

- Context**
- Open Channels
 - Non-Modeled Open Channels
 - Railroads
 - Structures
 - Proposed Pipes and Structures

- 123 Address**
- 123 Pipe Size (inches)

- Riverine Inundation**
- 10 YR Storm Event
 - 25 YR Storm Event
 - 50 YR Storm Event
 - 100 YR Storm Event



PROBLEM

The culvert below Broad St begins to overtop the roadway during the 10-year storm event and appears to be causing backwater flooding upstream of culvert. This area was identified during Public Survey as a known flooding area.

SOLUTION

The existing culvert on Shelton Creek below Broad St would be replaced with dual 6' H x 7' W concrete box culverts. Due to topographic restrictions, including the elevation of the roadway crest and the width of the channel, the size of the culvert was limited. As a result, the culvert does not meet the LOS criteria of conveying the 50-Year, 24-Hour storm event with no freeboard and headwater depth above 1.2 times the opening height.

BENEFITS

The primary benefit of this project would be to reduce the frequency of roadway overtopping of Broad St and reduce the inundation extents upstream of the culvert. The proposed culvert passes the 10-year design storm event with 6" of freeboard.

OPINION OF PROBABLE PROJECT COST (as of February 2026)

Construction:	\$456,000
Engineering and Administration:	\$93,000
TOTAL (Includes 35% Contingency Cost):	\$742,000

Project Name: Waynesville Stormwater Master Plan
 City/State: Waynesville, North Carolina

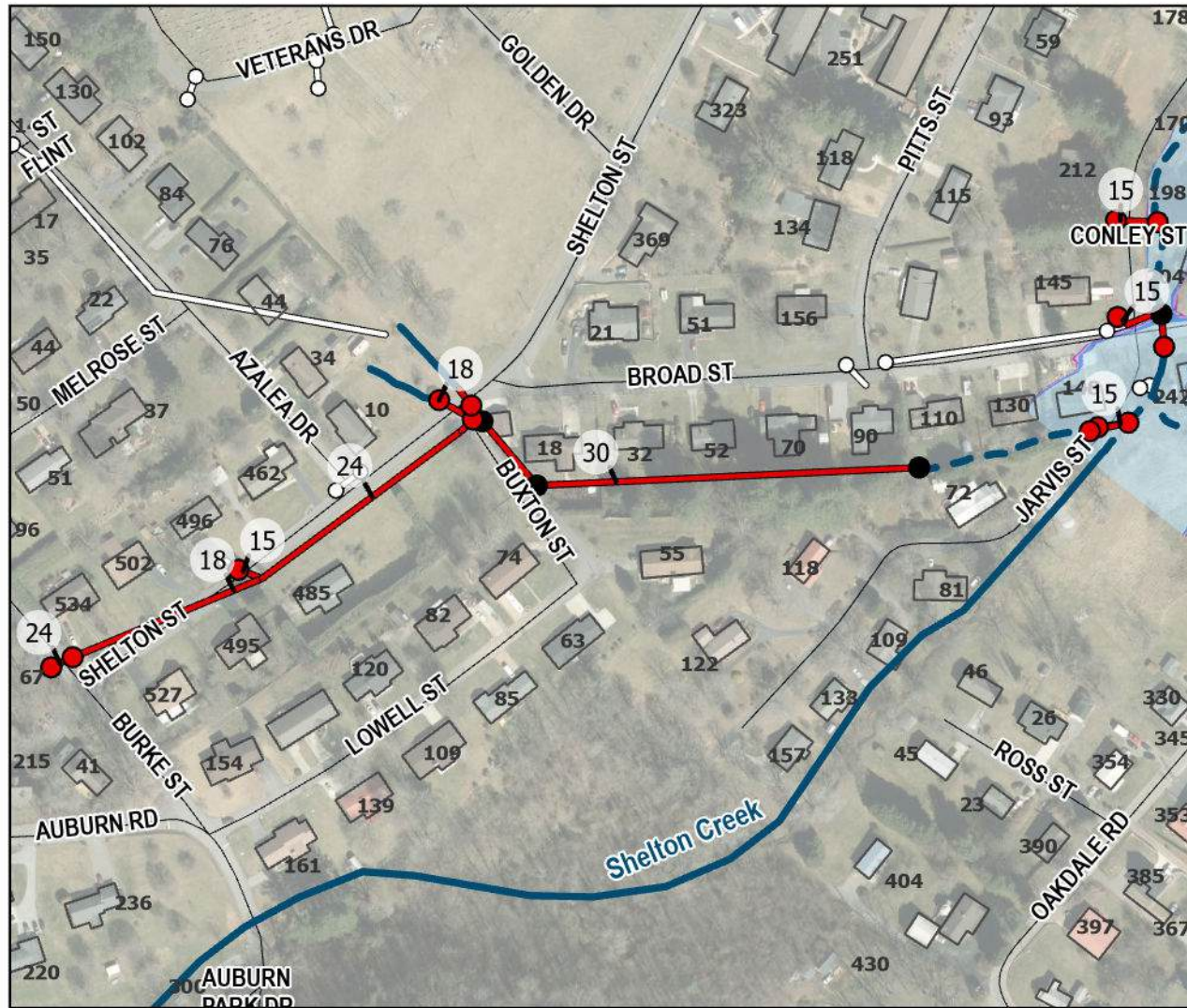
Project #: 23-0734
 Date: 2/19/2026

Concept Project 2
Broad St Culvert

<u>Proposed Improvements</u>				
<u>CONSTRUCTION COST</u>				
<u>Labor and Material Cost</u>				
Structure	Quantity*	Unit	Unit Price	Total
6'x7' Concrete Box Culvert	90	LF	\$ 2,500	\$ 225,000
Headwall/Endwall	2	EA	\$ 15,000	\$ 30,000
Channel Improvement	100	LF	\$ 350	\$ 35,000
Roadway/Asphalt Restoration	60	SY	\$ 110	\$ 7,000
MATERIALS SUBTOTAL				\$ 297,000
<u>Site Work Costs</u>				
Based on % of Materials Cost				
Mobilization		5%	\$	15,000
Erosion Control		6%	\$	18,000
Construction Survey		2%	\$	6,000
Traffic Control		LS	\$	35,000
Utility Conflicts		LS	\$	25,000
Dewatering		20%	\$	60,000
SITE WORK COST SUBTOTAL				\$ 159,000
CONSTRUCTION SUBTOTAL (INCLUDES LABOR AND MATERIAL COST)				\$ 456,000
<u>ENGINEERING AND ADMINISTRATION COST</u>				
Based on % of Construction Cost				
Site Characterization		5%	\$	23,000
Design and Permitting		LS	\$	40,000
Construction Administration		LS	\$	25,000
Closeout		LS	\$	5,000
ENGINEERING & ADMINISTRATION SUBTOTAL				\$ 93,000
PROJECT TOTAL SUBTOTAL				\$ 549,000
Contingency		35%	\$	193,000
PROJECT TOTAL				\$ 742,000

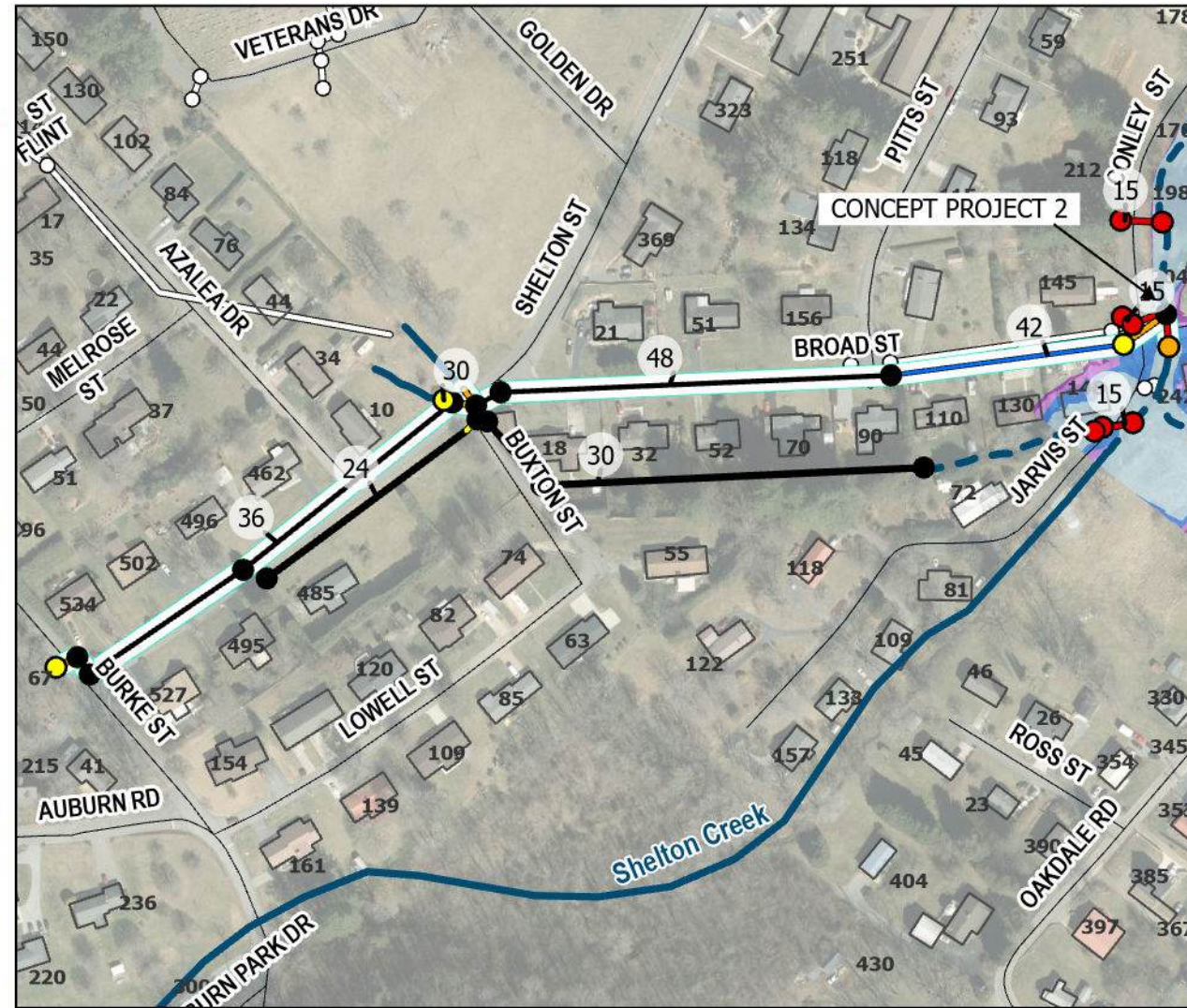
Assumptions
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EXISTING CONDITIONS



NC Collaboratory at UNCH, Microsoft, Vantor

PROPOSED CONDITIONS



LEGEND

Junctions

- Full Capacity - 10 YR Storm Event
- Full Capacity - 25 YR Storm Event
- Full Capacity - 50 YR Storm Event
- Full Capacity - 100 YR Storm Event
- Not-Flooded in Analyzed Storms
- Non-Analyzed

Conduits

- Full Capacity - 10 YR Storm Event
- Full Capacity - 25 YR Storm Event
- Full Capacity - 50 YR Storm Event
- Full Capacity - 100 YR Storm Event
- Not-Flooded in Analyzed Storms
- Non-Analyzed

Context

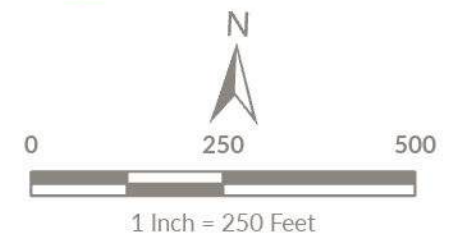
- Open Channels
- Non-Modeled Open Channels
- Railroads
- Structures
- Proposed Pipes and Structures

123 Address

12 Pipe Size (inches)

Riverine Inundation

- 10 YR Storm Event
- 25 YR Storm Event
- 50 YR Storm Event
- 100 YR Storm Event



PROBLEM

The existing stormwater system located along Shelton St from Burke St to Buxton St is composed of inlets and closed pipes which reach capacity beginning in the 10-year storm event. The inlet and headwall on the northwest side of the intersection of Buxton St and Shelton St, that collect flow from open channels, both overtop onto the roadway during the 10-year storm event.

SOLUTION

The existing stormwater network from Burke St, extending northeast along Shelton St to the intersection of Lowell St, would be replaced with 36" to 48" RCP pipes. The existing headwall and inlet along the northwest side of Shelton St that collect flow from open drainage channels would be replaced and the connecting network size would increase to 30" and 36" RCP pipes. To bring the system into the Public ROW, the proposed stormwater network is rerouted from Shelton St, along Broad St to a proposed outfall into Shelton Creek, north of Broad St. The system will include 48" RCP pipes and dual 42" pipes. New inlets and manholes are proposed along the length of the system.

BENEFITS

The primary benefit of this project would be the reduction of roadway inundation up and including the 25-year storm event from the intersection of Burke St and Shelton St to the intersection of Buxton St and Shelton St. Overtopping of Shelton St from the open channels would be reduced up to and including the 25-year storm event.

OPINION OF PROBABLE PROJECT COST (as of February 2026)

Construction:	\$1,172,000
Engineering and Administration:	\$101,000
TOTAL (Includes 35% Contingency Cost):	\$1,719,000

Project Name: Waynesville Stormwater Master Plan
 City/State: Waynesville, North Carolina

Project #: 23-0734
 Date: 2/19/2026

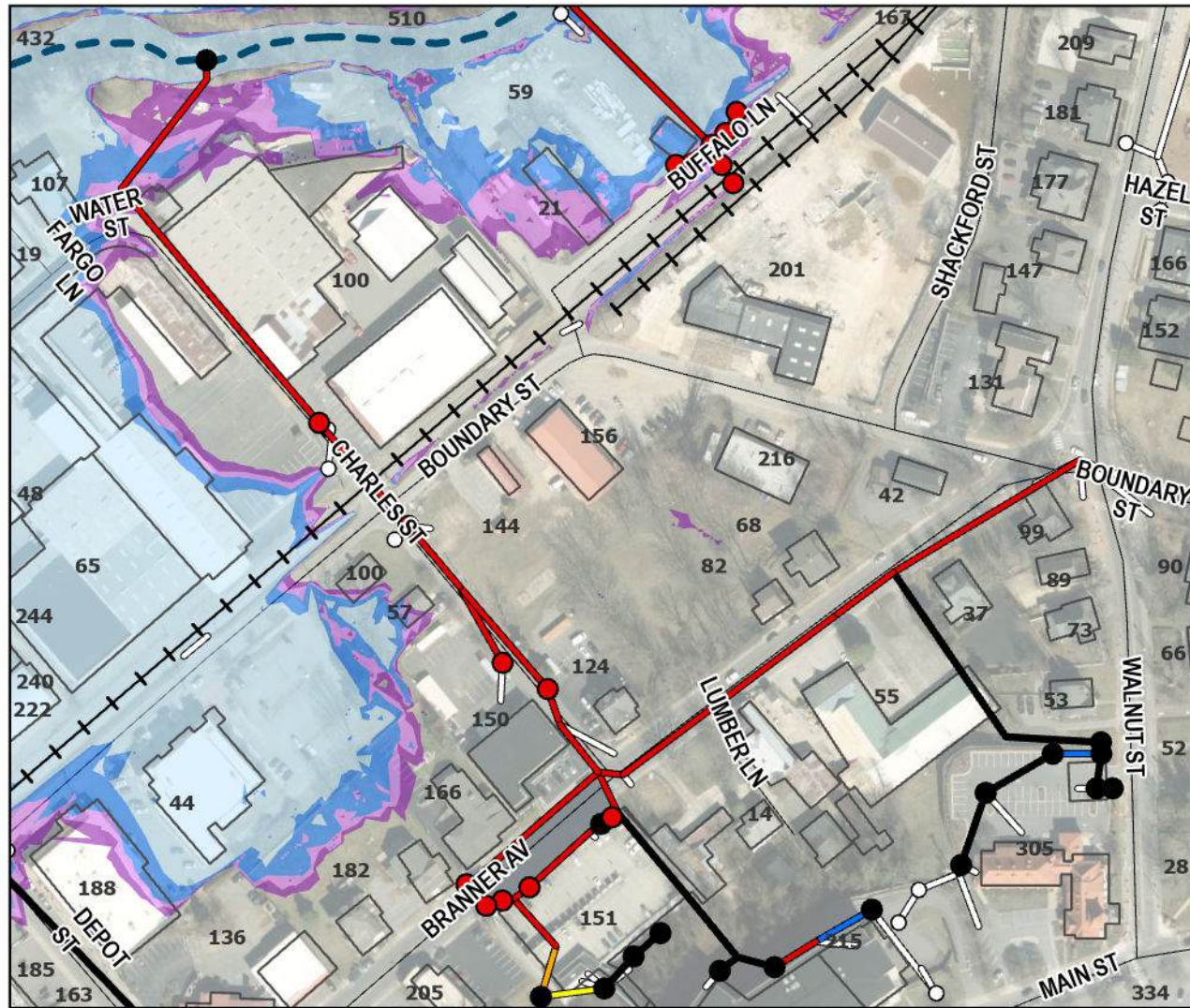
Concept Project 3
Burke St and Shelton St

<u>Proposed Improvements</u>				
<u>CONSTRUCTION COST</u>				
<u>Labor and Material Cost</u>				
Structure	Quantity*	Unit	Unit Price	Total
30" Reinforced Concrete Pipe	13	LF	\$ 180	\$ 3,000
36" Reinforced Concrete Pipe	721	LF	\$ 300	\$ 217,000
42" Reinforced Concrete Pipe	798	LF	\$ 330	\$ 264,000
48" Reinforced Concrete Pipe	615	LF	\$ 470	\$ 290,000
Inlets/Manholes	9	EA	\$ 6,500	\$ 59,000
Headwall/Endwall	3	EA	\$ 5,000	\$ 15,000
Roadway/Asphalt Restoration	1590	SY	\$ 110	\$ 175,000
MATERIALS SUBTOTAL				\$ 1,023,000
<u>Site Work Costs</u>				
Based on % of Materials Cost				
Mobilization		5%	\$	52,000
Erosion Control		2%	\$	21,000
Construction Survey		2%	\$	21,000
Traffic Control		LS	\$	30,000
Utility Conflicts		LS	\$	25,000
Dewatering		0%	\$	-
SITE WORK COST SUBTOTAL				\$ 149,000
CONSTRUCTION SUBTOTAL (INCLUDES LABOR AND MATERIAL COST)				\$ 1,172,000
<u>ENGINEERING AND ADMINISTRATION COST</u>				
Based on % of Construction Cost				
Site Characterization (Survey & Geotech)		3%	\$	36,000
Design and Permitting		LS	\$	40,000
Construction Administration		LS	\$	20,000
Closeout		LS	\$	5,000
ENGINEERING & ADMINISTRATION SUBTOTAL				\$ 101,000
PROJECT TOTAL SUBTOTAL				\$ 1,273,000
Contingency		35%	\$	446,000
PROJECT TOTAL				\$ 1,719,000

Assumptions

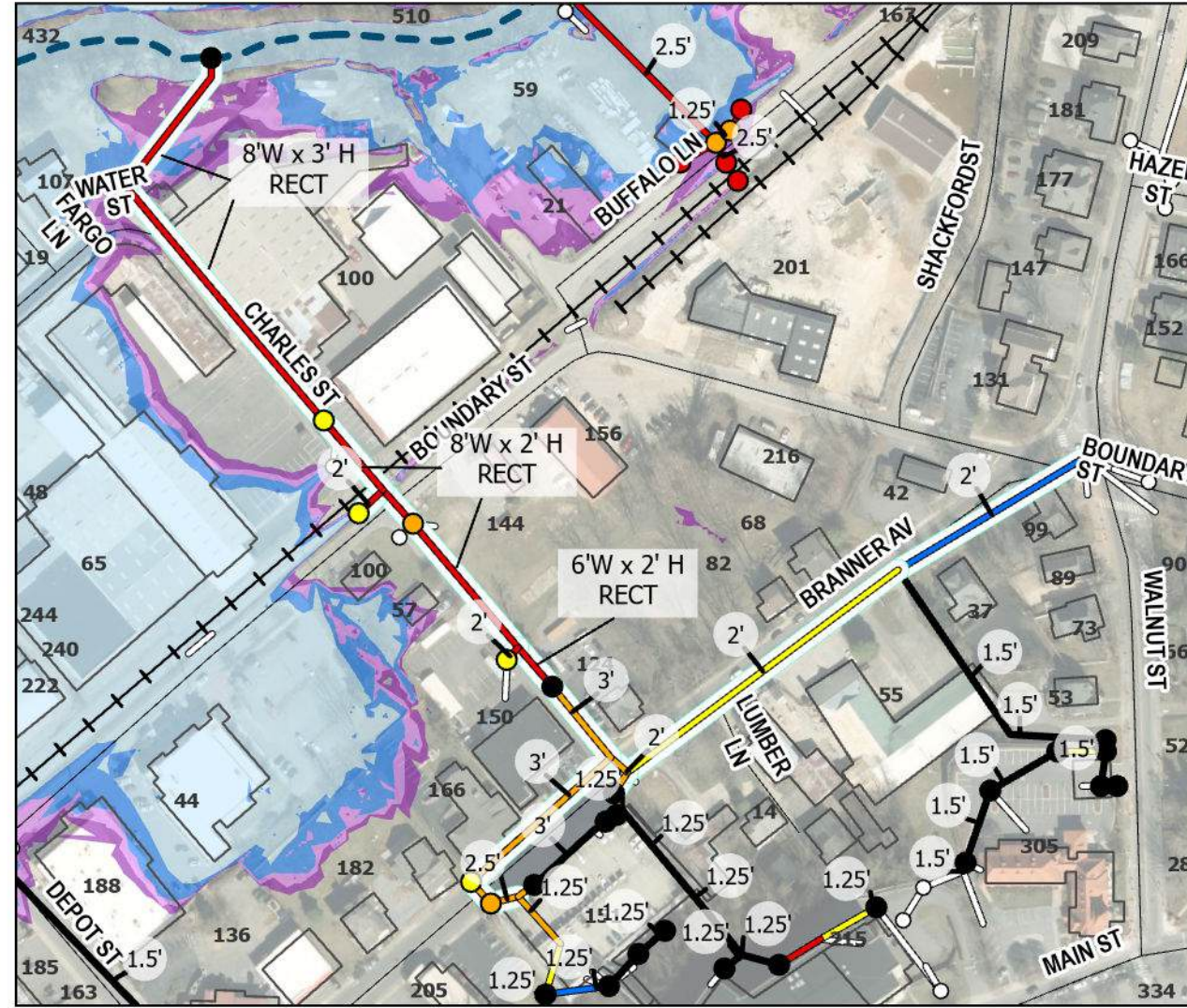
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EXISTING CONDITIONS



NC Collaboratory at UNCCH, Microsoft, Vantor

PROPOSED CONDITIONS



LEGEND

Junctions

- Full Capacity - 10 YR Storm Event
- Full Capacity - 25 YR Storm Event
- Full Capacity - 50 YR Storm Event
- Full Capacity - 100 YR Storm Event
- Not-Flooded in Analyzed Storms
- Non-Analyzed

Conduits

- Full Capacity - 10 YR Storm Event
- Full Capacity - 25 YR Storm Event
- Full Capacity - 50 YR Storm Event
- Full Capacity - 100 YR Storm Event
- Not-Flooded in Analyzed Storms
- Non-Analyzed

Context

- Open Channels
- Non-Modeled Open Channels
- Railroads
- Structures
- Proposed Pipes and Structures

123 Address

12 Pipe Size (inches)

Riverine Inundation

- 10 YR Storm Event
- 25 YR Storm Event
- 50 YR Storm Event
- 100 YR Storm Event



0 220 440



1 Inch = 220 Feet

PROBLEM

The stormwater system located along Branner Ave and extending northwest down Charles St is composed of inlets and closed pipes which reach capacity beginning in the 10-year design storm. Negative slopes and alternating pipe sizes are contributing to limited system capacity resulting in roadway inundation.

SOLUTION

The existing stormwater network along Branner Ave would be replaced with 24" to 36" RCP pipes. The system along Charles St will be replaced with a series of concrete box culverts ranging in size from 2'H x 6'W to 3' H x 8'W. Due to topographic constraints and the high water surface elevation along Richland Creek, some pipes do not meet the LOS standards due to backwatering. To create positive drainage throughout the system, a short section of 24" RCP pipe is proposed to collect runoff from the railroad ditch on the west side of Charles St and connect it to the box culvert system. New inlets and manholes are proposed along the length of the system.

BENEFITS

The primary benefit of this project would be the reduction of roadway inundation up to and including the 10-year storm event along Branner Ave and Charles Ave.

OPINION OF PROBABLE PROJECT COST (as of February 2026)

Construction:	\$2,894,000
Engineering and Administration:	\$128,000
TOTAL (Includes 15% Added Miscellaneous Cost):	\$4,080,000

Project Name: Waynesville Stormwater Master Plan
 City/State: Waynesville, North Carolina

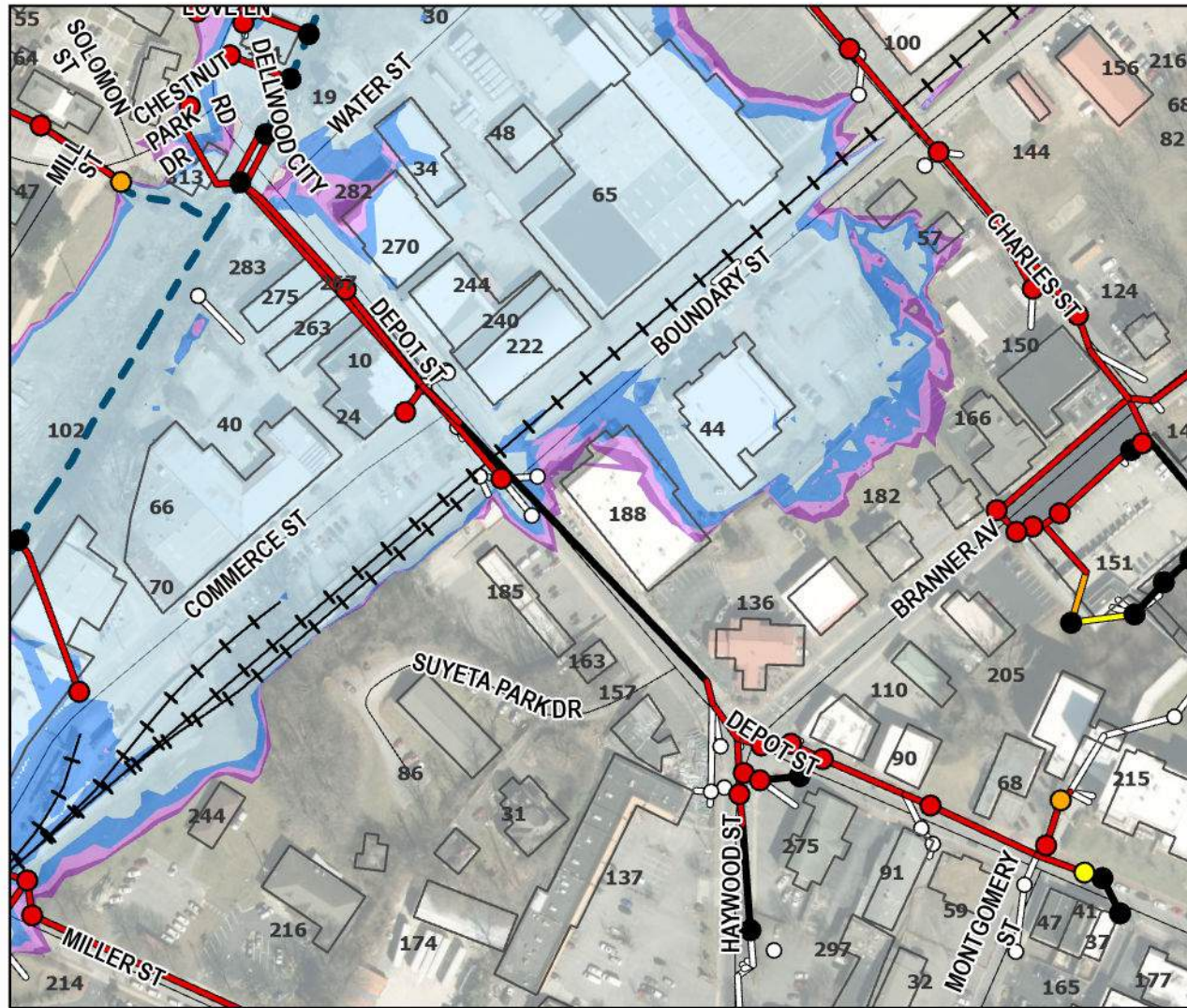
Project #: 23-0734
 Date: 2/19/2026

Concept Project 4
Charles St and Branner Ave

<u>Proposed Improvements</u>				
<u>CONSTRUCTION COST</u>				
<u>Labor and Material Cost</u>				
Structure	Quantity*	Unit	Unit Price	Total
18" Reinforced Concrete Pipe	30	LF	\$ 150	\$ 5,000
24" Reinforced Concrete Pipe	757	LF	\$ 170	\$ 129,000
30" Reinforced Concrete Pipe	34	LF	\$ 180	\$ 7,000
36" Reinforced Concrete Pipe	376	LF	\$ 300	\$ 113,000
2'x6' Concrete Box Culvert	63	LF	\$ 1,900	\$ 120,000
2'x8' Concrete Box Culvert	365	LF	\$ 2,100	\$ 767,000
3'x8' Concrete Box Culvert	545	LF	\$ 2,200	\$ 1,199,000
Custom Concrete Junction Box	6	EA	\$ 10,000	\$ 60,000
Inlets/Manholes	11	EA	\$ 6,501	\$ 72,000
Headwall/Endwall	1	EA	\$ 15,000	\$ 15,000
Roadway/Asphalt Restoration	2100	SY	\$ 110	\$ 231,000
MATERIALS SUBTOTAL				\$ 2,718,000
<u>Site Work Costs</u>				
Based on % of Materials Cost				
Mobilization		2%	\$	55,000
Erosion Control		1%	\$	28,000
Construction Survey		1%	\$	28,000
Traffic Control		LS	\$	35,000
Utility Conflicts		LS	\$	30,000
Dewatering		0%	\$	-
SITE WORK COST SUBTOTAL				\$ 176,000
CONSTRUCTION SUBTOTAL (INCLUDES LABOR AND MATERIAL COST)				\$ 2,894,000
<u>ENGINEERING AND ADMINISTRATION COST</u>				
Based on % of Construction Cost				
Site Characterization		2%	\$	58,000
Design and Permitting		LS	\$	40,000
Construction Administration		LS	\$	25,000
Closeout		LS	\$	5,000
ENGINEERING & ADMINISTRATION SUBTOTAL				\$ 128,000
PROJECT TOTAL SUBTOTAL				\$ 3,022,000
Contingency		35%	\$	1,058,000
PROJECT TOTAL				\$ 4,080,000

Assumptions
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EXISTING CONDITIONS



NC Collaboratory at UNCCH, Microsoft, Vantor

LEGEND

Junctions

- Full Capacity - 10 YR Storm Event
- Full Capacity - 25 YR Storm Event
- Full Capacity - 50 YR Storm Event
- Full Capacity - 100 YR Storm Event
- Not-Flooded in Analyzed Storms
- Non-Analyzed

Conduits

- Full Capacity - 10 YR Storm Event
- Full Capacity - 25 YR Storm Event
- Full Capacity - 50 YR Storm Event
- Full Capacity - 100 YR Storm Event
- Not-Flooded in Analyzed Storms
- Non-Analyzed

Context

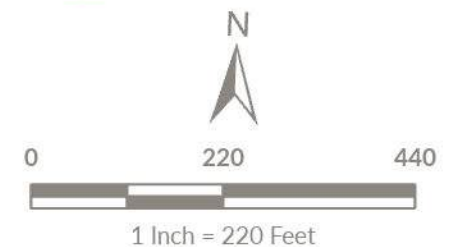
- Open Channels
- Non-Modeled Open Channels
- Railroads
- Structures
- Proposed Pipes and Structures

123 Address

- 12 Pipe Size (inches)

Riverine Inundation

- 10 YR Storm Event
- 25 YR Storm Event
- 50 YR Storm Event
- 100 YR Storm Event



PROBLEM

The stormwater system along North Haywood Street and Depot Street reaches capacity during the 10-Year event in existing condition. The systems combine at the intersection of North Haywood Street and Depot Street and conveyed along Depot Street. This network discharges to Richland Creek upstream of the culvert where Depot Street crosses the creek. Richland Creek has riverine flooding that extends to Boundary Street. The system was selected for conceptual design review with Town staff with the caveat that downstream conditions should not be worsened.

SITE CONSTRAINTS

The riverine flooding back-ups into the stormwater collection system while the system is also trying to convey stormwater from upstream sources. The creek has insufficient cross-sectional area to convey the flow. The concept design review evaluated upsizing pipes, diverting flow, storage and flap gates. The upsizing of pipes alleviates the upstream system on N Haywood Drive and the upstream end of Depot Street but results in higher levels of inundation for the downstream area. Due to low-lying grade in this area being primarily in the floodplain, there was no available location to size a stormwater detention practice with significant storage to be impactful. Adjacent stormwater networks on parallel streets were already at capacity so diverting flow was not feasible. When modeled, flap gates did not reduce the level of flooding. The system did not present a feasible infrastructure solution. It is suggested that a long-term vision be reviewed regarding the floodplain capacity for Richland Creek.

PROBLEM

The Waynesville Hazelwood Town Office is located at the confluence of the closed system along Brown Avenue and Farmer Branch. Farmer Branch is conveyed through culverts at Georgia Avenue and Brown Avenue that are currently undersized for the 10-Year storm event. The existing culvert at Georgia Avenue does not have sufficient cover in the ROW. The top elevation of culvert outlet is higher than the ground surface. When the culvert reaches capacity, the runoff overtops Georgia Avenue and flows down to Brown Avenue. There is existing observed damage to the inlets on Brown Avenue in front of the Town Office and at the system outfall on the north side of the parking lot. Farmers Branch flows northwest to a culvert under the railroad tracks. The size and orientation of the railroad culvert restrict flow resulting in backwater.

SITE CONSTRAINTS

The conceptual design analyzed several scenarios including the replacement of a single pipe with dual pipes, rerouting flow, stream grading and storage. Private property limitations and minimal grade precluded the possibility of storage and stream grading. Dual pipes would not provide enough capacity. Rerouting would increase capacity issues along Brown Street. All upstream issues would still require replacement of the culvert at the railroad.

SOLUTION

Per discussion with the Town, the decision was made to focus on flood protection strategies for the Town Office Building. Suggested building specific strategies include temporary flood barriers, dry floodproofing, elevating critical equipment, and installing a flood alert system. Approximate unit costs and anticipated labor for each of these potential solutions is included below.

Flood Barrier: \$1,000 - \$3,000 per door (size dependent)

Flood Alert System:

- Materials - \$75 per site
- Installation - 2.5 labor hours per site
- Monthly Inspection/Storm Validations - 0.5 labor hours per site per visit

Dry Floodproofing: \$10,000 - \$20,000

Elevating Equipment: \$10,000 - \$15,000



Image obtained from FEMA NFIP Technical Bulletin 3

Flood Barrier



Images obtained from U.S. Department of Homeland Security, Low Cost Flood Sensors: Urban Installation Guidebook



Flood Alert System

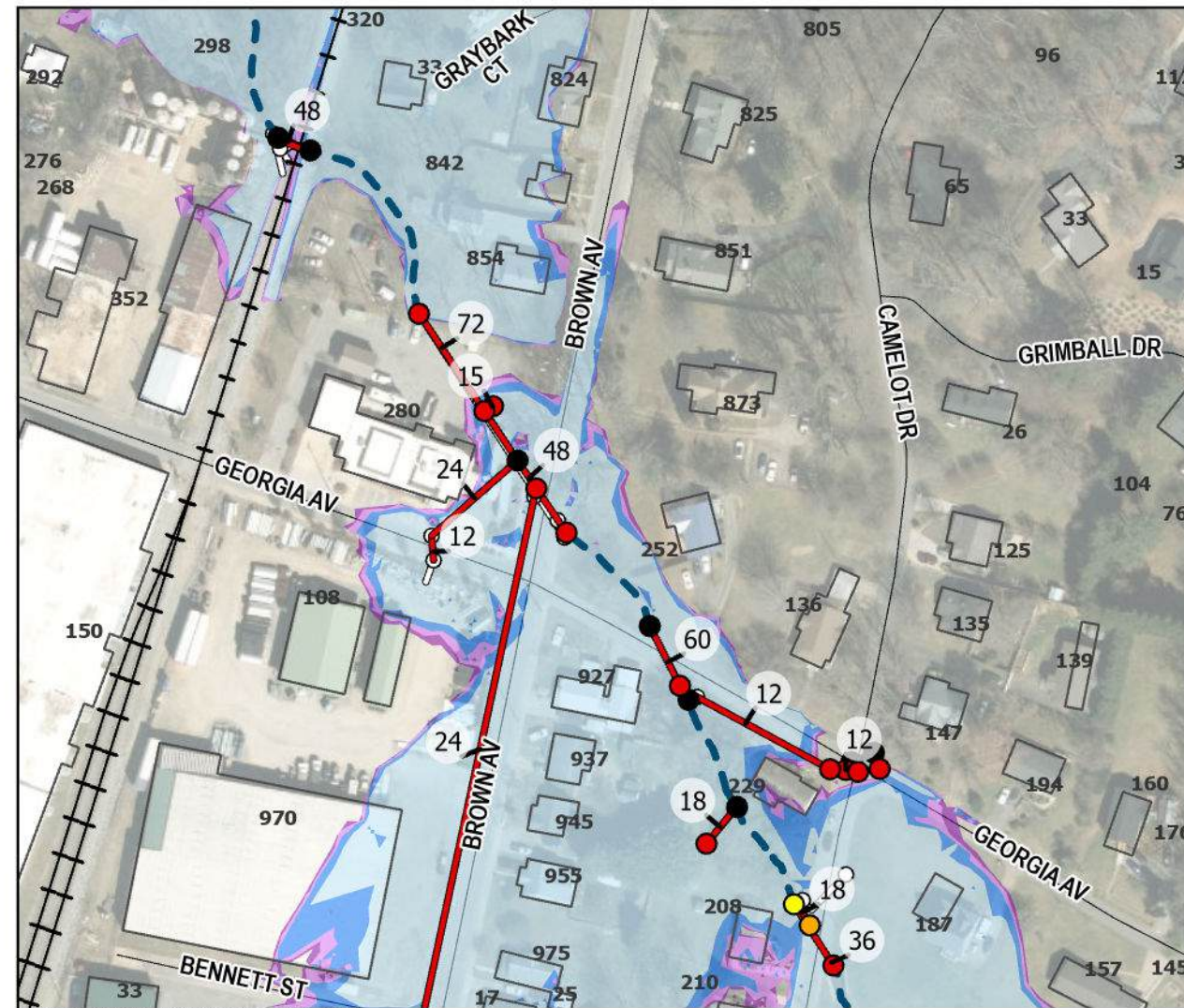


Images obtained from FEMA P-348, Edition 2



Elevated Equipment

EXISTING CONDITIONS



NC Collaboratory at UNCCH, Microsoft, Vantor

LEGEND

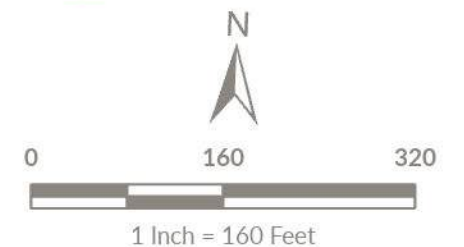
- Junctions**
- Full Capacity - 10 YR Storm Event
 - Full Capacity - 25 YR Storm Event
 - Full Capacity - 50 YR Storm Event
 - Full Capacity - 100 YR Storm Event
 - Not-Flooded in Analyzed Storms
 - Non-Analyzed

- Conduits**
- Full Capacity - 10 YR Storm Event
 - Full Capacity - 25 YR Storm Event
 - Full Capacity - 50 YR Storm Event
 - Full Capacity - 100 YR Storm Event
 - Not-Flooded in Analyzed Storms
 - Non-Analyzed

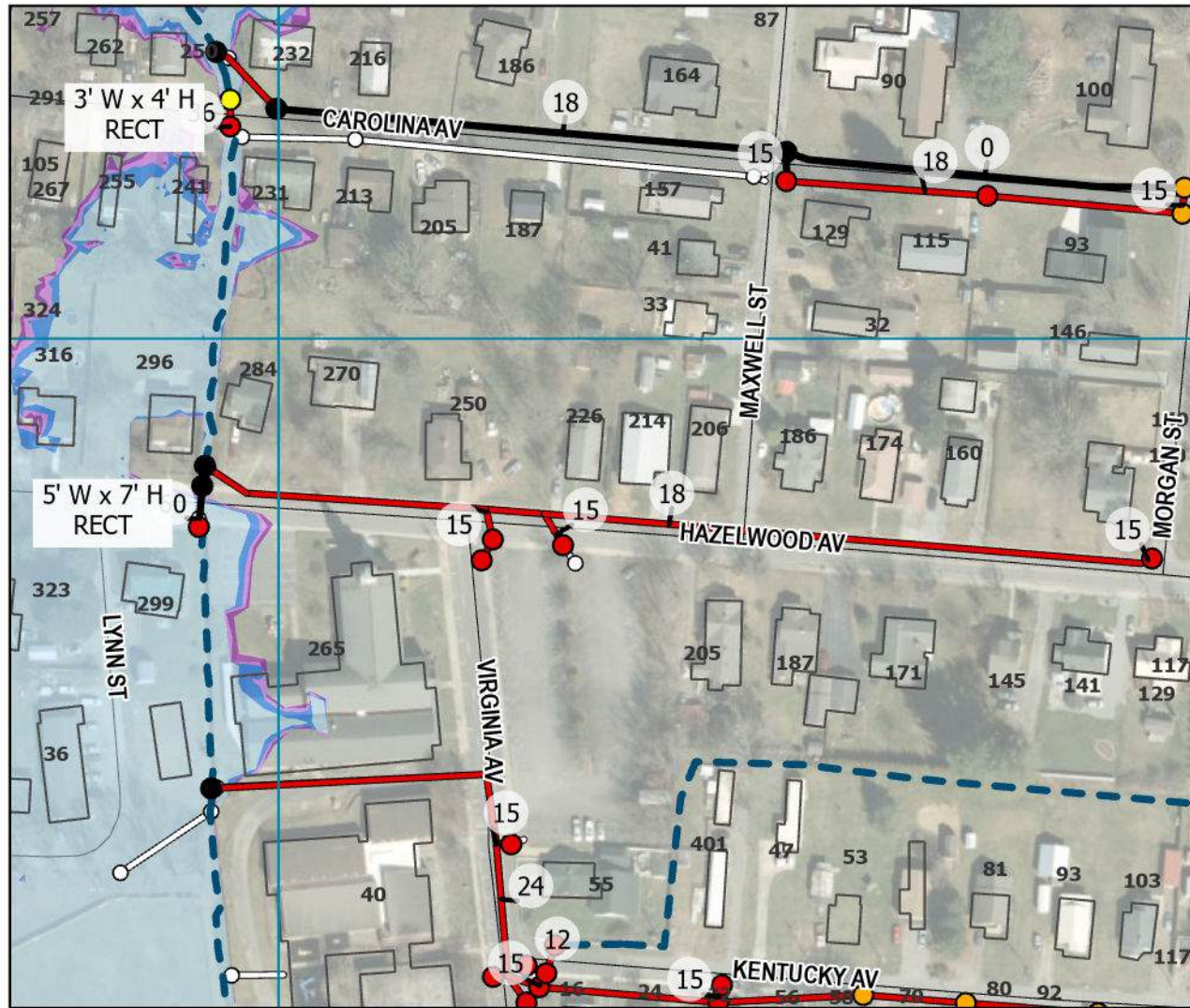
- Context**
- Open Channels
 - Non-Modeled Open Channels
 - Railroads
 - Structures
 - Proposed Pipes and Structures

- 123 Address**
- Pipe Size (inches)

- Riverine Inundation**
- 10 YR Storm Event
 - 25 YR Storm Event
 - 50 YR Storm Event
 - 100 YR Storm Event

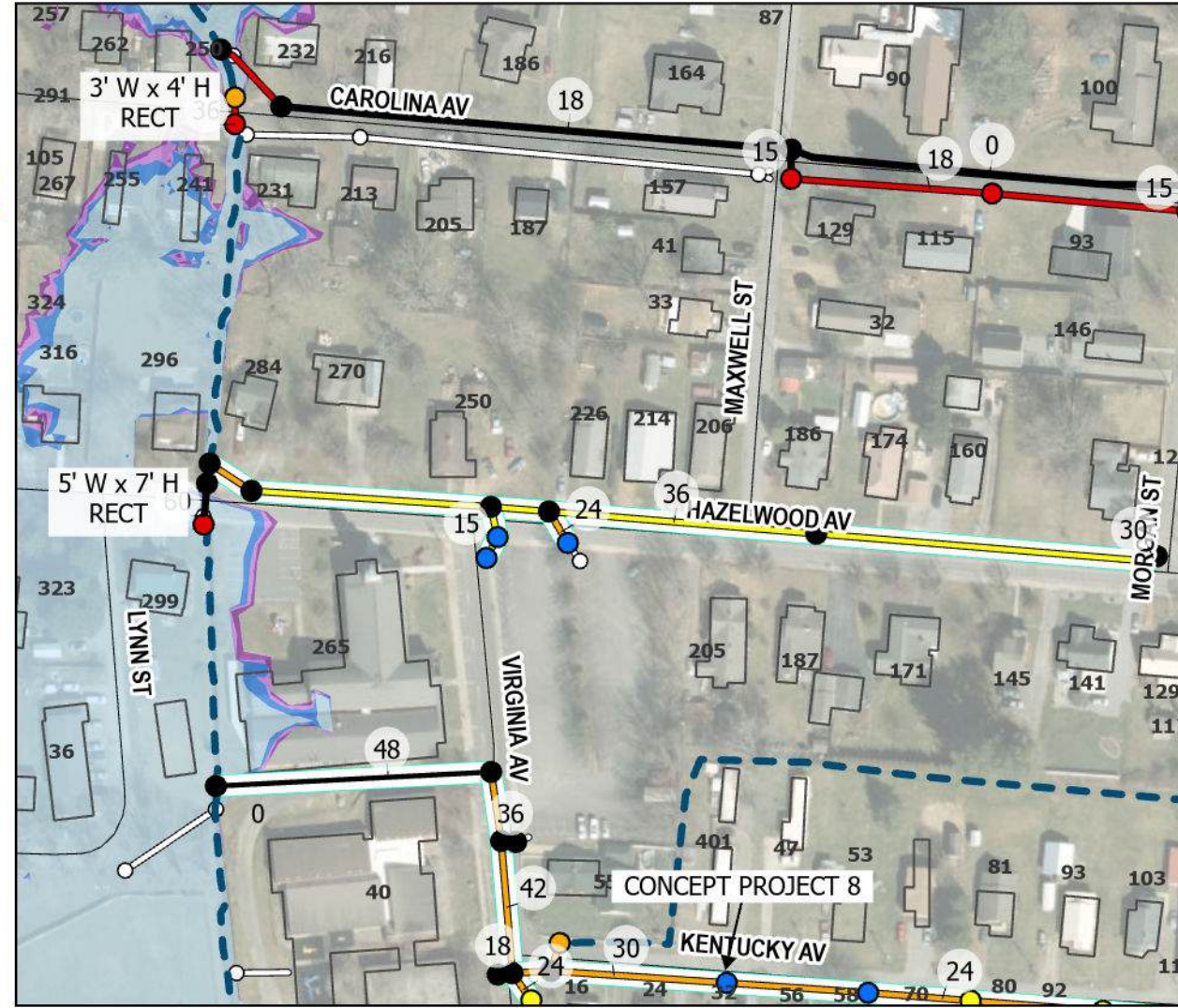


EXISTING CONDITIONS



NC Collaboratory at UNCC, Microsoft, Vantor

PROPOSED CONDITIONS



LEGEND

Junctions

- Full Capacity - 10 YR Storm Event
- Full Capacity - 25 YR Storm Event
- Full Capacity - 50 YR Storm Event
- Full Capacity - 100 YR Storm Event
- Not-Flooded in Analyzed Storms
- Non-Analyzed

Conduits

- Full Capacity - 10 YR Storm Event
- Full Capacity - 25 YR Storm Event
- Full Capacity - 50 YR Storm Event
- Full Capacity - 100 YR Storm Event
- Not-Flooded in Analyzed Storms
- Non-Analyzed

Context

- Open Channels
- Non-Modeled Open Channels
- Railroads
- Structures
- Proposed Pipes and Structures

123 Address

12 Pipe Size (inches)

Riverine Inundation

- 10 YR Storm Event
- 25 YR Storm Event
- 50 YR Storm Event
- 100 YR Storm Event



0 160 320



1 Inch = 160 Feet

PROBLEM

The stormwater system located along Hazlewood Ave, between Morgan St and the outfall on Farmers Branch, is composed of inlets and closed pipes which reach capacity beginning in the 10-year design storm. As a result, roadway inundation is present within the dense residential area.

SOLUTION

The stormwater network would begin with replacing inlets located at the intersection of Morgan St and Hazelwood Ave. The system extending to the west along Hazelwood would be replaced with 30" to 36" RCP pipes all the way to the outfall into Farmers Branch. Additional capacity increases would be made at the intersection of Virginia Ave and Hazelwood Ave with the installation of 15" and 24" RCP pipes. New inlets and manholes are proposed along the length of the system updates.

BENEFITS

The primary benefit of this project would be the reduction of roadway inundation up to and including the 50-year storm event along the entire length of the proposed system on Hazelwood Ave.

OPINION OF PROBABLE PROJECT COST (as of February 2026)

Construction:	\$376,000
Engineering and Administration:	\$78,000
TOTAL (Includes 35% Contingency Cost):	\$613,000

Project Name: Waynesville Stormwater Master Plan
 City/State: Waynesville, North Carolina

Project #: 23-0734
 Date: 2/19/2026

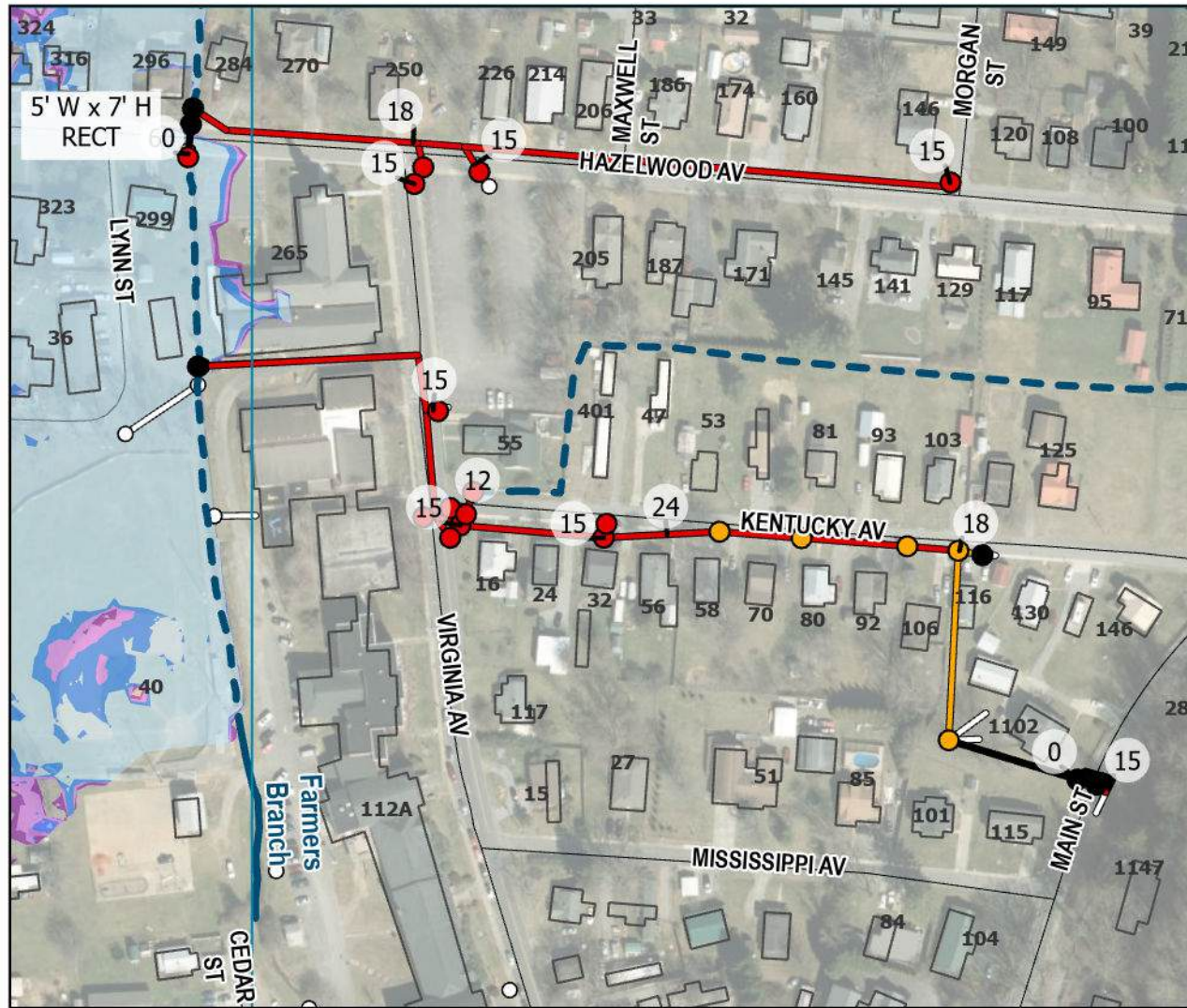
Concept Project 7
Hazelwood Ave

<u>Proposed Improvements</u>				
<u>CONSTRUCTION COST</u>				
<u>Labor and Material Cost</u>				
Structure	Quantity*	Unit	Unit Price	Total
15" Reinforced Concrete Pipe	49	LF	\$ 110	\$ 6,000
24" Reinforced Concrete Pipe	32	LF	\$ 170	\$ 6,000
30" Reinforced Concrete Pipe	11	LF	\$ 180	\$ 2,000
36" Reinforced Concrete Pipe	833	LF	\$ 180	\$ 150,000
Inlets/Manholes	9	EA	\$ 6,500	\$ 59,000
Headwall/Endwall	1	EA	\$ 6,500	\$ 7,000
Roadway/Asphalt Restoration	680	SY	\$ 110	\$ 75,000
MATERIALS SUBTOTAL				\$ 305,000
<u>Site Work Costs</u>				
Based on % of Materials Cost				
Mobilization		5%	\$	16,000
Erosion Control		3%	\$	10,000
Construction Survey		3%	\$	10,000
Traffic Control		LS	\$	20,000
Utility Conflicts		LS	\$	15,000
Dewatering		0%	\$	-
SITE WORK COST SUBTOTAL				\$ 71,000
CONSTRUCTION SUBTOTAL (INCLUDES LABOR AND MATERIAL COST)				\$ 376,000
<u>ENGINEERING AND ADMINISTRATION COST</u>				
Based on % of Construction Cost				
Site Characterization		2%	\$	8,000
Design and Permitting		LS	\$	40,000
Construction Administration		LS	\$	25,000
Closeout		LS	\$	5,000
ENGINEERING & ADMINISTRATION SUBTOTAL				\$ 78,000
PROJECT TOTAL SUBTOTAL				\$ 454,000
Contingency		35%	\$	159,000
PROJECT TOTAL				\$ 613,000

Assumptions

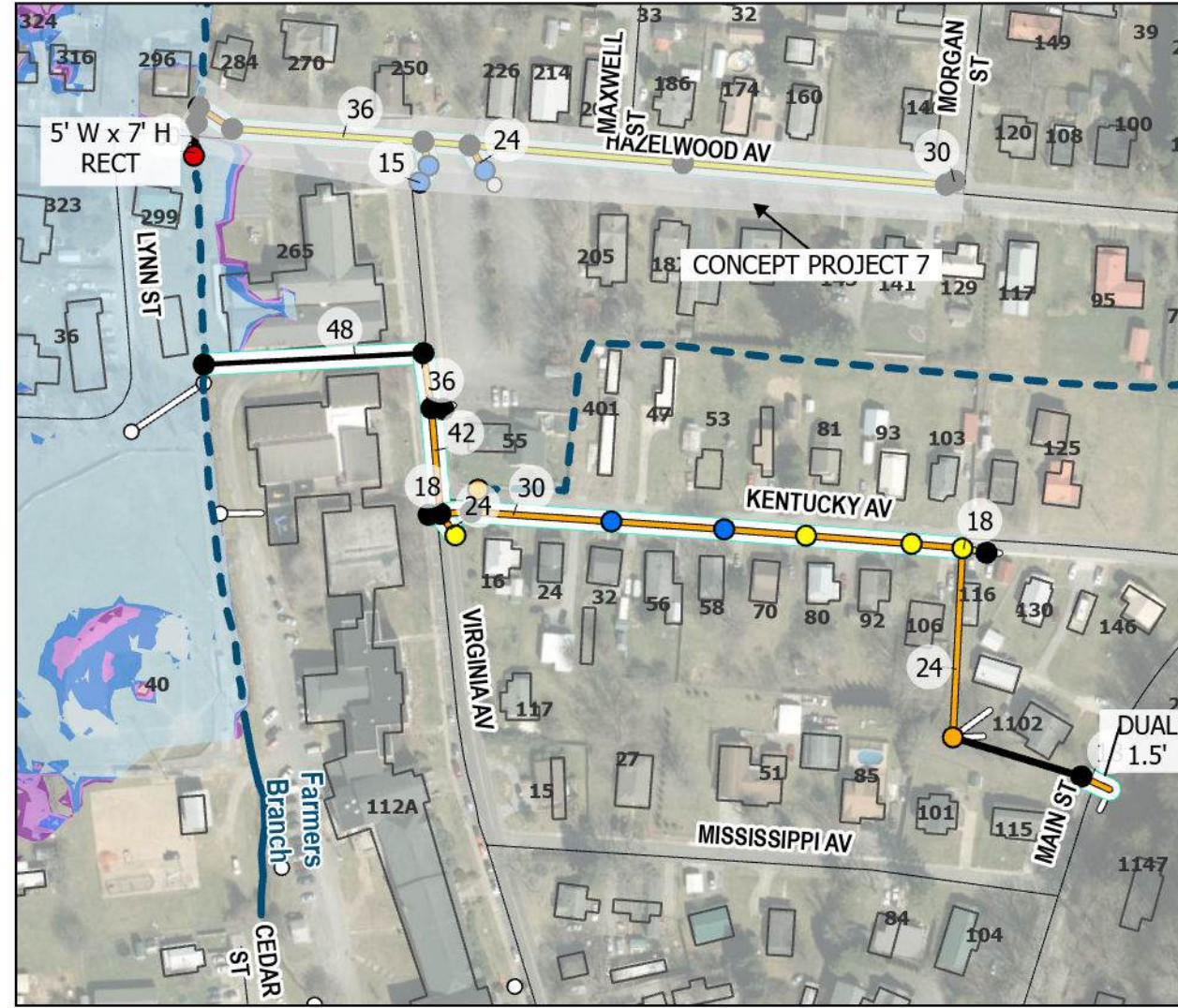
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EXISTING CONDITIONS



NC Collaboratory at UNCCH, Microsoft, Vantor

PROPOSED CONDITIONS



LEGEND

Junctions

- Full Capacity - 10 YR Storm Event
- Full Capacity - 25 YR Storm Event
- Full Capacity - 50 YR Storm Event
- Full Capacity - 100 YR Storm Event
- Not-Flooded in Analyzed Storms
- Non-Analyzed

Conduits

- Full Capacity - 10 YR Storm Event
- Full Capacity - 25 YR Storm Event
- Full Capacity - 50 YR Storm Event
- Full Capacity - 100 YR Storm Event
- Not-Flooded in Analyzed Storms
- Non-Analyzed

Context

- Open Channels
- Non-Modeled Open Channels
- Railroads
- Structures
- Proposed Pipes and Structures

123 Address

12 Pipe Size (inches)

Riverine Inundation

- 10 YR Storm Event
- 25 YR Storm Event
- 50 YR Storm Event
- 100 YR Storm Event



0 200 400



1 Inch = 200 Feet

PROBLEM

The stormwater system starting on Main St, extending to Kentucky Ave and Virginia Ave, is composed of inlets and closed pipes which reach capacity beginning in the 10-year design storm. As a result roadway inundation is present within the dense residential area.

SOLUTION

The stormwater network would begin with replacing the inlet in front of 116 Kentucky Ave and upsizing the system with 24" to 30" RCP pipes to the intersection of Virginia Ave. The location and alignment of several structures and pipes were shifted from the existing locations to reduce the required number of proposed structures, limit the length of proposed pipe, and bring the system in the public ROW. The system upgrades would continue with 36" to 48" RCP pipes along Virginia Ave all the way to the outfall along Farmers Branch. Additional work is proposed to replace the system below S Main St, in front of 1102 S Main St, with dual 18" RCP pipes. New inlets and manholes are proposed along the length of the system updates.

BENEFITS

The primary benefit of this project would be the reduction of roadway inundation up to and including the 25-year storm event on Main St, Kentucky Ave, and Virginia Ave.

OPINION OF PROBABLE PROJECT COST (as of February 2026)

Construction:	\$598,000
Engineering and Administration:	\$82,000
TOTAL (Includes 35% Contingency Cost):	\$918,000

Project Name: Waynesville Stormwater Master Plan
 City/State: Waynesville, North Carolina

Project #: 23-0734
 Date: 2/19/2026

Concept Project 8

Virginia Ave, Kentucky Ave & Main St

<u>Proposed Improvements</u>				
<u>CONSTRUCTION COST</u>				
<u>Labor and Material Cost</u>				
Structure	Quantity*	Unit	Unit Price	Total
18" Reinforced Concrete Pipe	83	LF	\$ 150	\$ 13,000
24" Reinforced Concrete Pipe	421	LF	\$ 170	\$ 72,000
30" Reinforced Concrete Pipe	183	LF	\$ 180	\$ 33,000
36" Reinforced Concrete Pipe	34	LF	\$ 180	\$ 7,000
42" Reinforced Concrete Pipe	118	LF	\$ 330	\$ 39,000
48" Reinforced Concrete Pipe	302	LF	\$ 470	\$ 142,000
Inlets/Manholes	15	EA	\$ 6,500	\$ 98,000
Headwall/Endwall	1	EA	\$ 6,500	\$ 7,000
Roadway/Asphalt Restoration	850	SY	\$ 110	\$ 94,000
MATERIALS SUBTOTAL				\$ 505,000
<u>Site Work Costs</u>				
Based on % of Materials Cost				
Mobilization		5%	\$	26,000
Erosion Control		3%	\$	16,000
Construction Survey		2%	\$	11,000
Traffic Control		LS	\$	25,000
Utility Conflicts		LS	\$	15,000
Dewatering		0%	\$	-
SITE WORK COST SUBTOTAL				\$ 93,000
CONSTRUCTION SUBTOTAL (INCLUDES LABOR AND MATERIAL COST)				\$ 598,000
<u>ENGINEERING AND ADMINISTRATION COST</u>				
Based on % of Construction Cost				
Site Characterization		2%	\$	12,000
Design and Permitting		LS	\$	40,000
Construction Administration		LS	\$	25,000
Closeout		LS	\$	5,000
ENGINEERING & ADMINISTRATION SUBTOTAL				\$ 82,000
PROJECT TOTAL SUBTOTAL				\$ 680,000
Contingency		35%	\$	238,000
PROJECT TOTAL				\$ 918,000

Assumptions
 This estimate of probable cost is approximate as of February 19, 2026. Actual construction bids may vary significantly from this statement of probable costs due to timing of construction, changed conditions, land acquisition, labor rate changes, or other factors beyond the control of the estimators.

Appendix B: Reference Materials

- ◆ FEMA Floodplain Map
- ◆ Rainfall Data
- ◆ Soils Data
- ◆ Land Use Map
- ◆ Subcatchment Maps
- ◆ FEMA Cross Sections



The digital Flood Insurance Rate Map (FIRM) was produced through a unique cooperative partnership between the State of North Carolina and the Federal Emergency Management Agency (FEMA). The State of North Carolina has implemented a Big Data approach to floodplain management to decrease the costs associated with flooding. This is demonstrated by the State's commitment to the Big Data approach to floodplain management. As a result of the effort, the State of North Carolina has joined a Cooperative Technical State agreement with FEMA to produce and maintain this digital FIRM.

FLOOD HAZARD INFORMATION

SEE FIS REPORT FOR ZONE DESCRIPTIONS AND INDEX MAP
 THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT [HTTP://FRIS.NC.GOV/FRIS](http://fris.nc.gov/fris)

- SPECIAL FLOOD HAZARD AREAS**
 - Without Base Flood Elevation (BFE) Zone A, A99
 - With BFE or Depth Zone AE, AO, AH, VE, AR
 - Regulatory Floodway
 - 0.2% Annual Chance Flood Hazard, Areas of Depth Less Than One Foot or With Drainage Areas of Less Than One Square Mile Zone X
 - Future Conditions 1% Annual Chance Flood Hazard Zone X
 - Area with Reduced Flood Risk due to Levee See Notes Zone X
 - Areas Determined to be Outside the 0.2% Annual Chance Floodplain Zone X
- OTHER AREAS OF FLOOD HAZARD**
- OTHER AREAS**
- GENERAL STRUCTURES**
 - Channel, Culvert, or Storm Sewer
 - Accredited or Provisionally Accredited Levee, Dike, or Floodwall
 - North Carolina Geodetic Survey bench mark BMS510
 - National Geodetic Survey bench mark BMS510
 - Cross Sections with 1% Annual Chance Water Surface Elevation (BFE)
 - Coastal Transect
 - Coastal Transect Baseline
 - Profile Baseline
 - Hydrographic Feature
 - Limit of Study
 - Jurisdiction Boundary
- OTHER FEATURES**

NOTES TO USERS

For information and questions about this map, available products associated with this FIRM including historic versions of the BFE, file or order products of the National Flood Insurance Program in general, please call the FEMA Map Information Exchange at 1-877-FEMA-MAP (477-3662) or visit the FEMA Map Service Center website at www.fema.gov. An accompanying Flood Insurance Study report Letter of Map Revision (LOMR) or Letter of Map Amendment (LOMA) covering portions of this map and digital versions of this FIRM are also available. Visit the North Carolina Floodplain Mapping Program website at <http://www.ncfloodmaps.com> or contact the FEMA Map Service Center.

Communities planning and/or preparing FEMA panels must obtain a current copy of the adjacent panel as well as the current FIRM data. These may be obtained directly from the Map Service Center at the number listed above.

For community and countywide map data refer to the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in the community, contact your insurance agent or call the National Flood Insurance Program at 1-800-368-5847.

Base map information shown on this FIRM was produced in digital format by the North Carolina Floodplain Mapping Program (NCFMPP). The source of this information can be determined from the metadata available in the USFIRM0001 metadata and in the Technical Support Data Notebook (TSND).

ACCREDITED LEVEE NOTES TO USERS: If an accredited levee note appears on this panel check with your local community to obtain more information, such as the estimated level of protection provided (which may exceed the regulatory flood risk level) and Emergency Action Plan, on the levee system(s) shown on providing protection. To mitigate flood risk in residential areas, property owners and residents are encouraged to consider flood insurance and floodproofing or other protective measures. For more information on flood insurance, interested parties should visit the FEMA Website at <http://www.fema.gov/nationalfloodinsurance>.

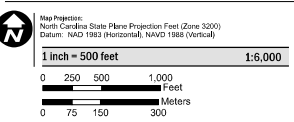
INDIVIDUALLY ACCREDITED LEVEE NOTES TO USERS: If a provisionally Accredited Levee (PAL) note appears on this panel, check with your local community to obtain more information, such as the estimated level of protection provided (which may exceed the regulatory flood risk level) and Emergency Action Plan, on the levee system(s) shown on providing protection. To maintain accreditation, the levee owner or community is required to submit the data and documentation necessary to comply with Section 65.12 requirements of the FIRM regulations. If the community or owner does not provide the necessary data and documentation of the data and documentation provided includes the base elevation does not comply with Section 65.12 requirements, FEMA will mark the flood hazard and risk information for this area to reflect consideration of the levee system. To mitigate flood risk in residential areas, property owners and residents are encouraged to consider flood insurance and floodproofing or other protective measures. For more information on flood insurance, interested parties should visit the FEMA Website at <http://www.fema.gov/nationalfloodinsurance>.

LIMIT OF MODERATE WAVE ACTION NOTES TO USERS: For some coastal flooding areas the AE Zone category has been divided by a Limit of Moderate Wave Action (LMWA). The LMWA represents the approximate landward limit of the 1% flood breaking waves. The effects of wave hazards between the VE Zone and the LMWA, or between the LMWA and the LMWA for areas where VE zones are not identified, will be similar to, but less severe than those in the VE Zone.

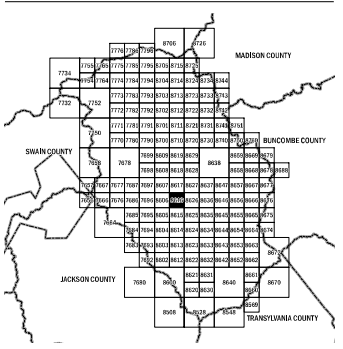
COASTAL BARRIER RESOURCES SYSTEM (CBRS) NOTE
 This map may include approximate boundaries of the CBRS for informational purposes only. Flood insurance is not available with CBRS as it is for structures that are newly built or substantially improved on or after the date of the map on the map. For more information see <http://www.fema.gov/nationalfloodinsurance>, contact the FEMA Flood or visit the U.S. Fish and Wildlife Service Customer Service Center at 1-800-344-6842.

Legend:
 - Limit of Moderate Wave Action (LMWA)
 - CBRS Area
 - Otherwise Protected Area

SCALE



PANEL LOCATOR



FEMA National Flood Insurance Program

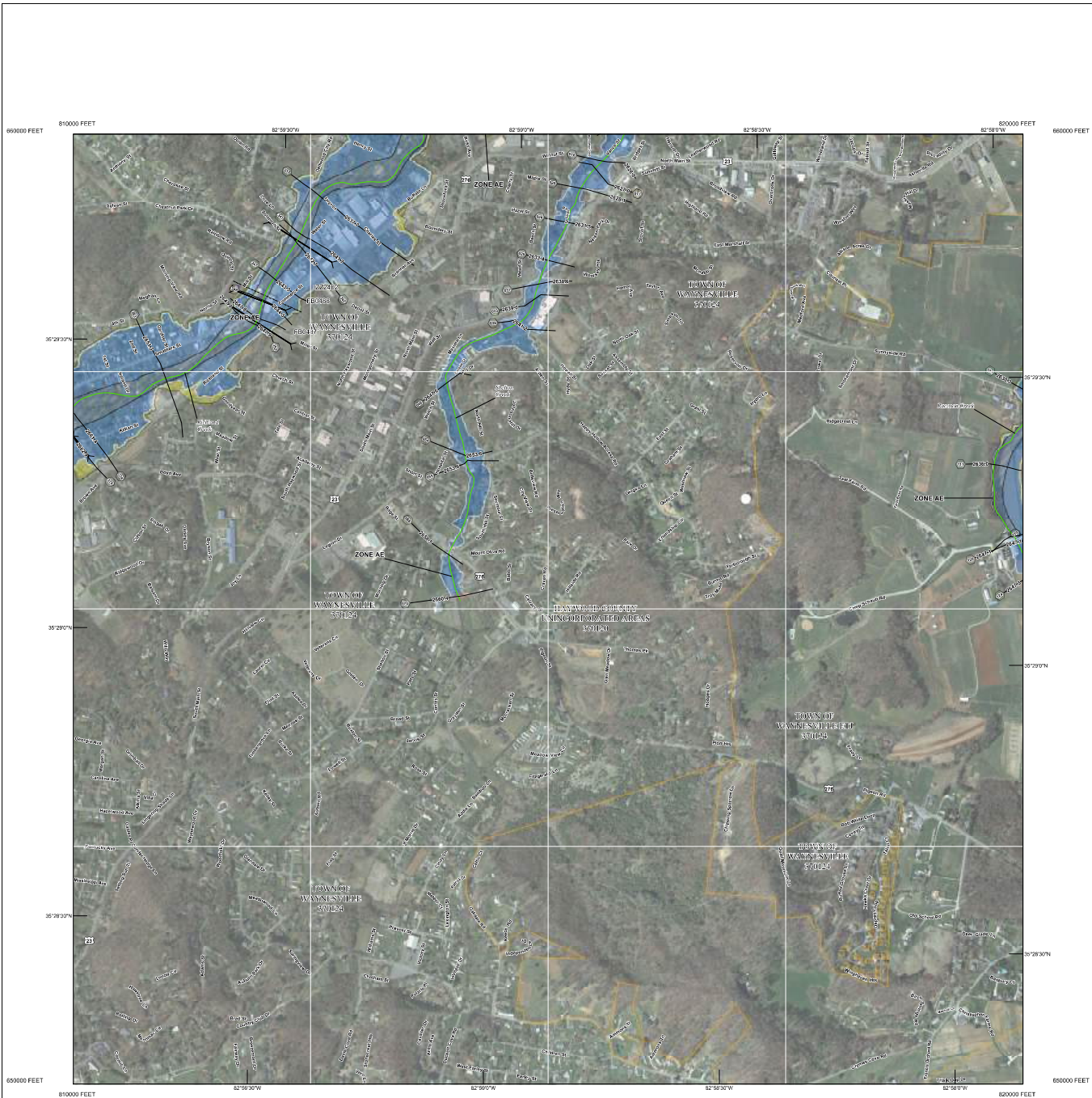
NORTH CAROLINA FLOODPLAIN MAPPING PROGRAM NATIONAL FLOOD INSURANCE PROGRAM FLOOD INSURANCE RATE MAP NORTH CAROLINA

PANEL 8616

Panel Contains:

COMMUNITY	QD	PANEL	SUFFIX
HAYWOOD COUNTY	370150	8616	J
MAIZE VALLEY TOWN OF	370150	8616	J
WAYNESVILLE TOWN OF	370154	8616	J

MAP NUMBER: 3700861600J
 MAP REVISED: 4/3/2012



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SPECIAL FLOOD HAZARD AREAS	Without Base Flood Elevation (BFE) Zone A, X, V, VE
	With BFE or Depth Zone AE, AO, AH, VE, AR
OTHER AREAS OF FLOOD HAZARD	Regulatory Floodway
	0.2% Annual Chance Flood Hazard, Areas of Depth Less Than One Foot or With Drainage Areas of Less Than One Square Mile Zone X
	Future Conditions 1% Annual Chance Flood Hazard Zone X
OTHER AREAS	Area with Reduced Flood Risk due to Levee See Notes Zone X
	Areas Determined to be Outside the 0.2% Annual Chance Floodplain Zone X
GENERAL STRUCTURES	Channel, Culvert, or Storm Sewer
	Accredited or Provisionally Accredited Levee, Dike, or Floodwall
	North Carolina Geodetic Survey bench mark
	National Geodetic Survey bench mark Contractor Est. NCFPM Survey bench mark
OTHER FEATURES	Cross Sections with 1% Annual Chance Water Surface Elevation (BFE)
	Coastal Transect
	Coastal Transect Baseline
	Profile Baseline
	Hydrographic Feature
Limit of Study	
Jurisdiction Boundary	

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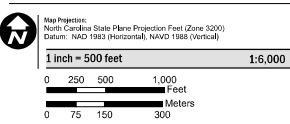
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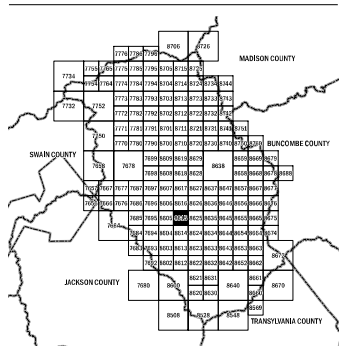
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CBRS Area **Otherwise Protected Area**

SCALE



PANEL LOCATOR



FEMA
National Flood Insurance Program

NORTH CAROLINA FLOODPLAIN MAPPING PROGRAM
NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP
NORTH CAROLINA

PANEL 8615

Panel Contains:

COMMUNITY	QD	PANEL SUFFIX
HAYWOOD COUNTY	370120	8615 J
WAYNESVILLE, TOWN OF	370124	8615 J

MAP NUMBER
3700861500J
MAP REVISED
4/3/2012



NOAA Atlas 14, Volume 2, Version 3
Location name: Waynesville, North Carolina, USA*
Latitude: 35.4812°, Longitude: -82.994°
Elevation: 2815 ft**
 * source: ESRI Maps
 ** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

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

NOAA, National Weather Service, Silver Spring, Maryland

[PF_tabular](#) | [PF_graphical](#) | [Maps & aeriels](#)

PF tabular

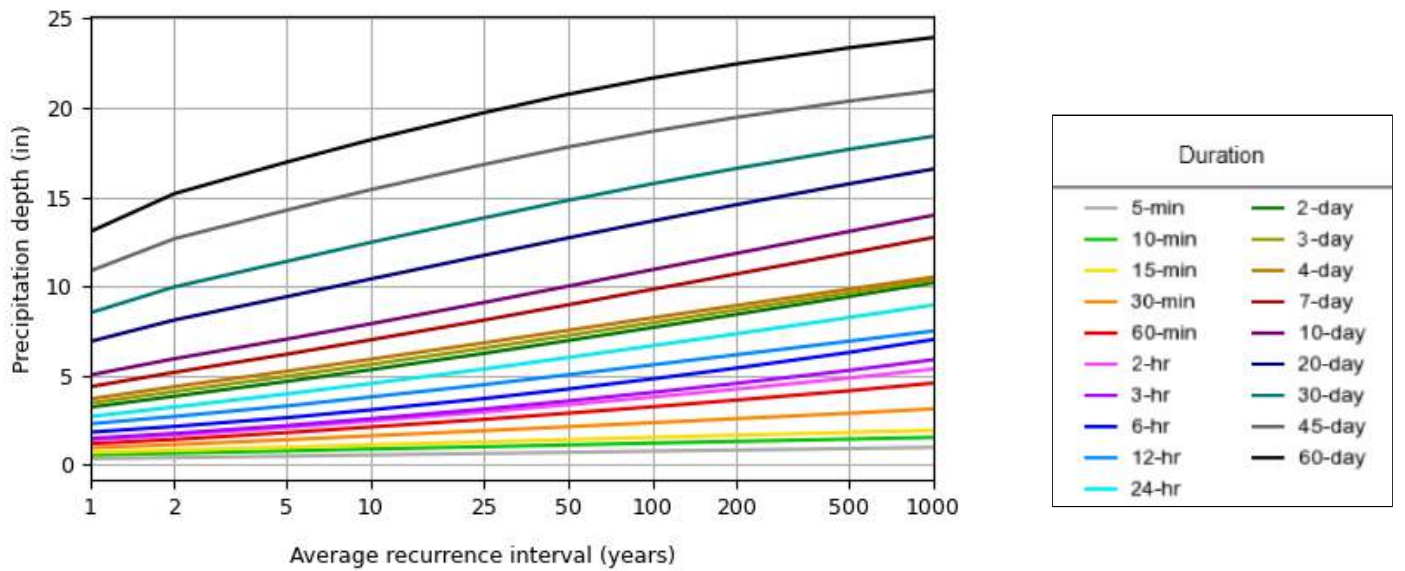
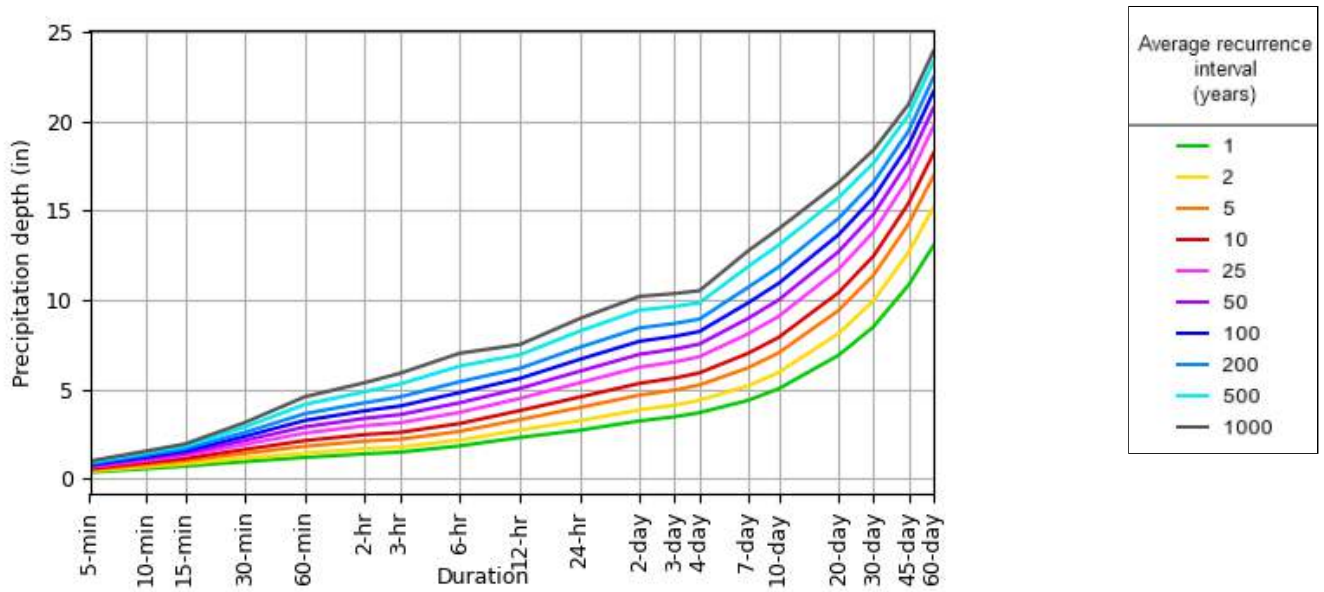
PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.347 (0.314-0.385)	0.409 (0.370-0.455)	0.490 (0.441-0.544)	0.556 (0.500-0.617)	0.639 (0.571-0.708)	0.703 (0.625-0.781)	0.768 (0.678-0.854)	0.831 (0.728-0.929)	0.913 (0.790-1.03)	0.980 (0.839-1.11)
10-min	0.554 (0.501-0.615)	0.655 (0.591-0.728)	0.784 (0.707-0.871)	0.890 (0.800-0.987)	1.02 (0.910-1.13)	1.12 (0.995-1.24)	1.22 (1.08-1.36)	1.32 (1.15-1.47)	1.44 (1.25-1.62)	1.54 (1.32-1.75)
15-min	0.693 (0.626-0.769)	0.823 (0.743-0.915)	0.992 (0.894-1.10)	1.12 (1.01-1.25)	1.29 (1.15-1.43)	1.42 (1.26-1.57)	1.54 (1.36-1.72)	1.66 (1.46-1.86)	1.82 (1.57-2.04)	1.94 (1.66-2.19)
30-min	0.950 (0.858-1.06)	1.14 (1.03-1.26)	1.41 (1.27-1.56)	1.63 (1.47-1.81)	1.91 (1.71-2.12)	2.14 (1.90-2.37)	2.36 (2.09-2.63)	2.59 (2.27-2.89)	2.89 (2.50-3.25)	3.14 (2.69-3.55)
60-min	1.18 (1.07-1.32)	1.43 (1.29-1.58)	1.81 (1.63-2.01)	2.12 (1.91-2.36)	2.54 (2.28-2.82)	2.89 (2.57-3.21)	3.25 (2.87-3.62)	3.63 (3.18-4.06)	4.15 (3.59-4.66)	4.58 (3.92-5.18)
2-hr	1.38 (1.26-1.53)	1.66 (1.51-1.84)	2.10 (1.90-2.31)	2.46 (2.22-2.72)	2.96 (2.65-3.26)	3.37 (3.00-3.72)	3.80 (3.35-4.20)	4.24 (3.72-4.71)	4.86 (4.20-5.43)	5.37 (4.58-6.04)
3-hr	1.48 (1.34-1.64)	1.76 (1.60-1.95)	2.20 (2.00-2.43)	2.58 (2.34-2.85)	3.12 (2.80-3.44)	3.58 (3.19-3.94)	4.06 (3.58-4.48)	4.57 (3.99-5.07)	5.29 (4.55-5.91)	5.89 (5.00-6.63)
6-hr	1.83 (1.68-2.01)	2.15 (1.97-2.36)	2.64 (2.41-2.90)	3.08 (2.80-3.37)	3.71 (3.35-4.05)	4.24 (3.80-4.64)	4.82 (4.27-5.28)	5.42 (4.76-5.97)	6.30 (5.43-6.97)	7.02 (5.96-7.82)
12-hr	2.30 (2.12-2.50)	2.71 (2.50-2.96)	3.30 (3.04-3.59)	3.80 (3.50-4.14)	4.48 (4.10-4.87)	5.04 (4.60-5.48)	5.60 (5.07-6.10)	6.17 (5.55-6.74)	6.92 (6.17-7.61)	7.50 (6.64-8.30)
24-hr	2.70 (2.54-2.89)	3.24 (3.04-3.46)	3.97 (3.73-4.24)	4.56 (4.27-4.86)	5.36 (5.02-5.70)	6.01 (5.60-6.38)	6.67 (6.20-7.08)	7.34 (6.80-7.79)	8.25 (7.59-8.75)	8.96 (8.19-9.50)
2-day	3.23 (3.04-3.43)	3.84 (3.63-4.08)	4.67 (4.40-4.96)	5.33 (5.02-5.66)	6.24 (5.84-6.60)	6.96 (6.50-7.36)	7.69 (7.15-8.14)	8.44 (7.81-8.93)	9.43 (8.67-9.99)	10.2 (9.33-10.8)
3-day	3.46 (3.27-3.67)	4.11 (3.89-4.36)	4.96 (4.68-5.26)	5.62 (5.31-5.96)	6.53 (6.14-6.91)	7.24 (6.79-7.66)	7.96 (7.44-8.42)	8.68 (8.08-9.19)	9.64 (8.92-10.2)	10.4 (9.54-11.0)
4-day	3.69 (3.49-3.91)	4.38 (4.15-4.64)	5.24 (4.96-5.55)	5.92 (5.60-6.26)	6.82 (6.43-7.22)	7.53 (7.08-7.96)	8.23 (7.72-8.71)	8.93 (8.35-9.45)	9.84 (9.16-10.4)	10.5 (9.75-11.2)
7-day	4.37 (4.14-4.63)	5.18 (4.90-5.49)	6.19 (5.85-6.55)	7.00 (6.62-7.40)	8.10 (7.62-8.55)	8.96 (8.41-9.45)	9.83 (9.20-10.4)	10.7 (9.98-11.3)	11.9 (11.0-12.5)	12.7 (11.8-13.5)
10-day	5.03 (4.75-5.33)	5.94 (5.62-6.30)	7.04 (6.65-7.46)	7.90 (7.46-8.37)	9.08 (8.55-9.61)	10.0 (9.39-10.6)	10.9 (10.2-11.6)	11.8 (11.0-12.6)	13.1 (12.1-13.9)	14.0 (12.9-14.9)
20-day	6.90 (6.58-7.26)	8.12 (7.72-8.54)	9.41 (8.95-9.90)	10.4 (9.89-11.0)	11.7 (11.1-12.3)	12.7 (12.0-13.4)	13.7 (12.9-14.4)	14.6 (13.7-15.3)	15.7 (14.7-16.6)	16.6 (15.5-17.5)
30-day	8.51 (8.13-8.89)	9.97 (9.53-10.4)	11.4 (10.9-11.9)	12.5 (11.9-13.0)	13.8 (13.2-14.5)	14.8 (14.1-15.5)	15.7 (15.0-16.5)	16.6 (15.8-17.4)	17.7 (16.7-18.6)	18.4 (17.4-19.4)
45-day	10.8 (10.4-11.3)	12.7 (12.2-13.2)	14.3 (13.7-14.9)	15.4 (14.8-16.0)	16.8 (16.1-17.5)	17.8 (17.0-18.5)	18.7 (17.8-19.4)	19.5 (18.6-20.3)	20.4 (19.4-21.2)	21.0 (19.9-21.9)
60-day	13.0 (12.6-13.6)	15.2 (14.6-15.8)	17.0 (16.3-17.7)	18.2 (17.5-19.0)	19.7 (19.0-20.5)	20.8 (20.0-21.6)	21.7 (20.8-22.6)	22.5 (21.6-23.4)	23.4 (22.4-24.4)	23.9 (22.9-25.0)

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

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PF graphical

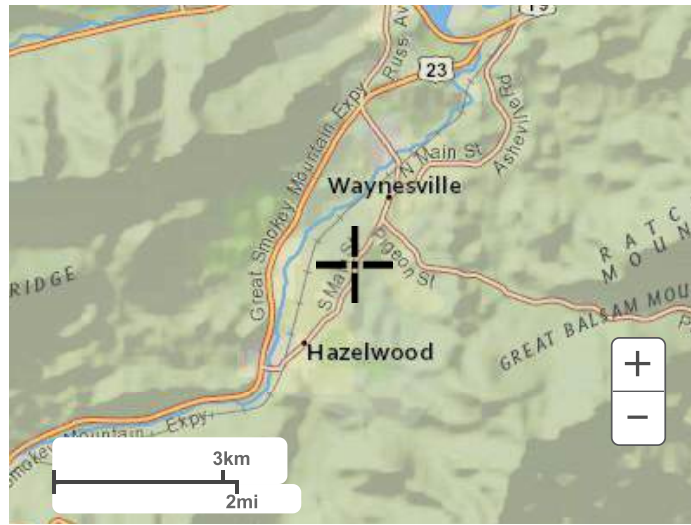
PDS-based depth-duration-frequency (DDF) curves Latitude: 35.4812°, Longitude: -82.9940°



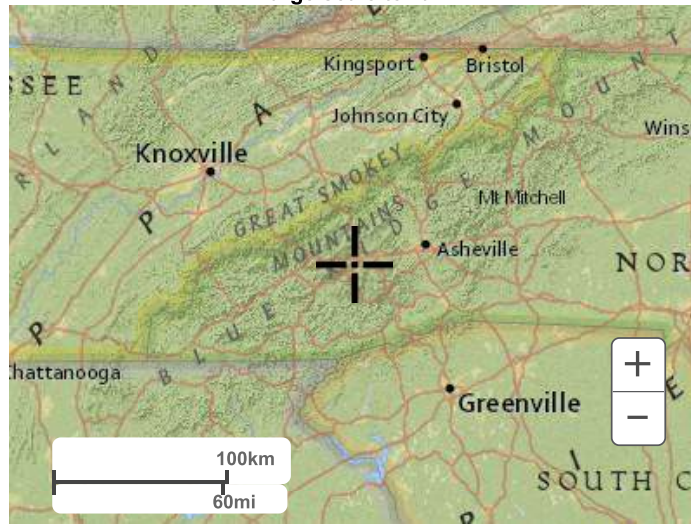
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Maps & aerials

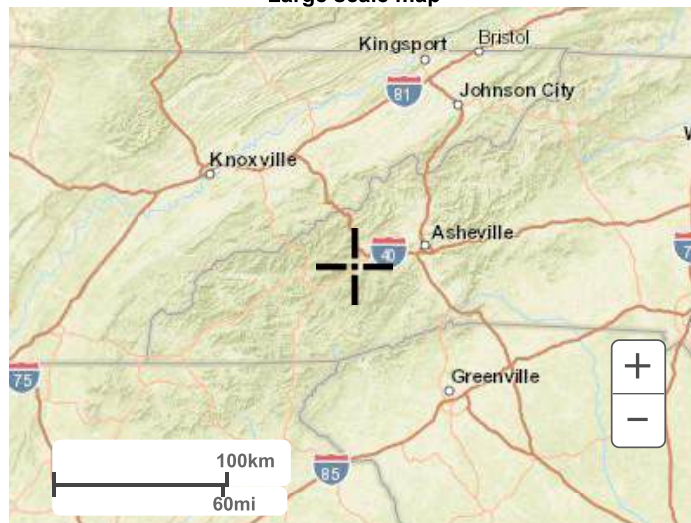
Small scale terrain



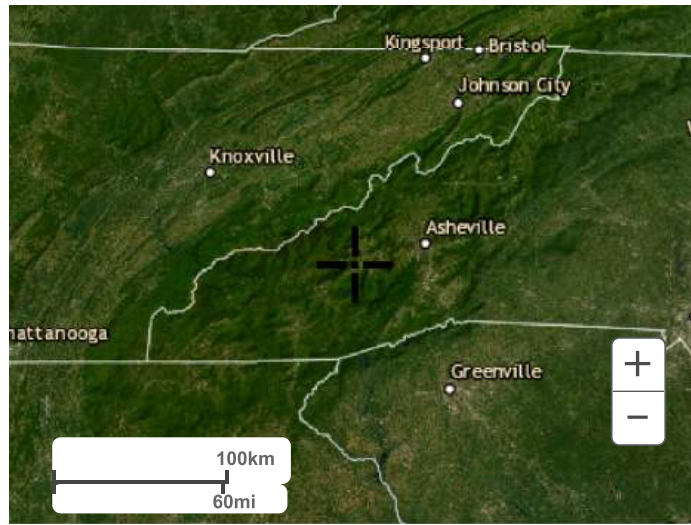
Large scale terrain



Large scale map



Large scale aerial



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[National Weather Service](#)
[National Water Center](#)
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

[Disclaimer](#)

RainDROP Tool

Rainfall Intensity, Duration and Return for Observations and Projections Tool for North Carolina

Maps - IDF Precip Depth & Intensity

Map 1 Dataset:

Atlas 14

Map 1 Return Period:

2 Year

Map 1 Duration:

1-hour Precip Depth (in)

Selected Coords: 35.4906°N, -82.9879°E:

Grid Point Coords: 35.4906°N, -82.9879°E:

Grid Point Value: 1.420 in

Data Min (in or in/hr):

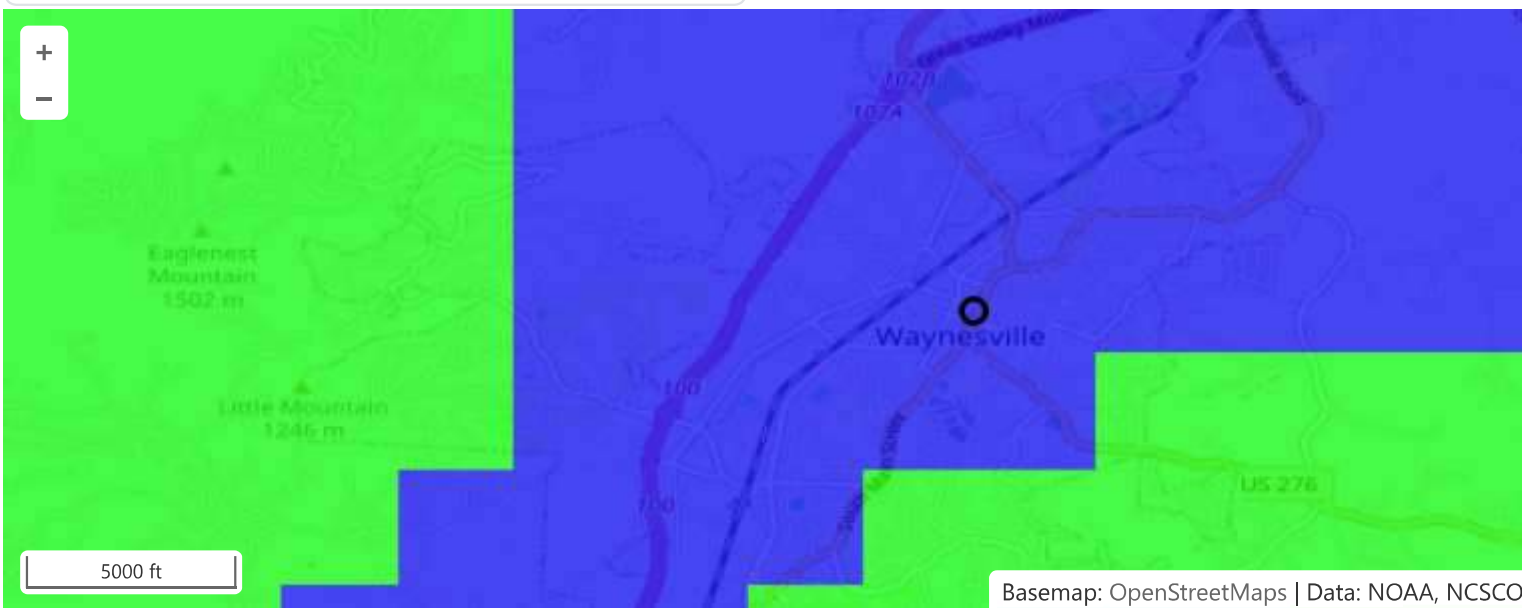
1.2

Data Max (in or in/hr):

2.4

Legend (inches or in/hr)

- 1.20" - 1.32"
- 1.33" - 1.44"
- 1.45" - 1.56"
- 1.57" - 1.68"
- 1.69" - 1.80"
- 1.81" - 1.92"
- 1.93" - 2.04"
- 2.05" - 2.16"
- 2.17" - 2.28"
- 2.29" - 2.40"



Map 2 Dataset:

RCP4.5 Mid Century (Mean)

Map 2 Return Period:

2 Year

Map 2 Duration:

1-hour Precip Depth (in)

Selected Coords: 35.4906°N, -82.9879°E:

Grid Point Coords: 35.4906°N, -82.9879°E:

Grid Point Value: 1.491 in



RainDROP Tool Supported By:



Table - IDF by Dataset

Lat (°N): Use the map or enter below

Lon (°E): Use the map or enter below

Update the table below by clicking on 'Update Table Location'

35.4906

-82.9879

Update Table Location

Datasets

- Atlas 14
- RCP4.5 Mid Century (Mean)
- RCP4.5 Mid Century (90 Pctl)
- RCP4.5 End of Century (Mean)
- RCP4.5 End of Century (90 Pctl)
- RCP8.5 Mid Century (Mean)

Durations

- 1-hour Precip Depth (in)
- 2-hour Precip Depth (in)
- 3-hour Precip Depth (in)
- 6-hour Precip Depth (in)
- 12-hour Precip Depth (in)
- 24-hour Precip Depth (in)
- 1-hour Precip Intensity (in/hr)
- 2-hour Precip Intensity (in/hr)

- RCP8.5 Mid Century (90 Pctl)
- RCP8.5 End of Century (90 Pctl)
- RCP8.5 End of Century (Mean)

- 3-hour Precip Intensity (in/hr)
- 6-hour Precip Intensity (in/hr)
- 12-hour Precip Intensity (in/hr)
- 24-hour Precip Intensity (in/hr)

Precip Depth (in) and Intensity (in/hr) estimates for 35.49166°N, -82.991684°E:

(This is the nearest grid point to your selected location of 35.4906°N, -82.9879°E)

Note: Intensity is calculated by precip depth (inches) divided by duration (hours)

Dataset	Duration	ARI	ARI	ARI	ARI	ARI	ARI	ARI	ARI
		2 yr	5 yr	10 yr	25 yr	50 yr	100 yr	500 yr	1000 yr
RCP4.5 Mid Century (Mean)	24-hour Depth (in)	3.35	4.18	4.84	5.69	6.44	7.14	9.06	9.91



Table - IDF by Dataset

Lat (°N): Use the map or enter below

Lon (°E): Use the map or enter below

Update the table below by clicking on 'Update Table Location'

[Update Table Location](#)

Datasets

- Atlas 14
- RCP4.5 Mid Century (Mean)
- RCP4.5 Mid Century (90 Pctl)
- RCP4.5 End of Century (Mean)
- RCP4.5 End of Century (90 Pctl)
- RCP8.5 Mid Century (Mean)
- RCP8.5 Mid Century (90 Pctl)
- RCP8.5 End of Century (Mean)
- RCP8.5 End of Century (90 Pctl)

Durations

- 1-hour Precip Depth (in)
- 2-hour Precip Depth (in)
- 3-hour Precip Depth (in)
- 6-hour Precip Depth (in)
- 12-hour Precip Depth (in)
- 24-hour Precip Depth (in)
- 1-hour Precip Intensity (in/hr)
- 2-hour Precip Intensity (in/hr)
- 3-hour Precip Intensity (in/hr)
- 6-hour Precip Intensity (in/hr)
- 12-hour Precip Intensity (in/hr)
- 24-hour Precip Intensity (in/hr)

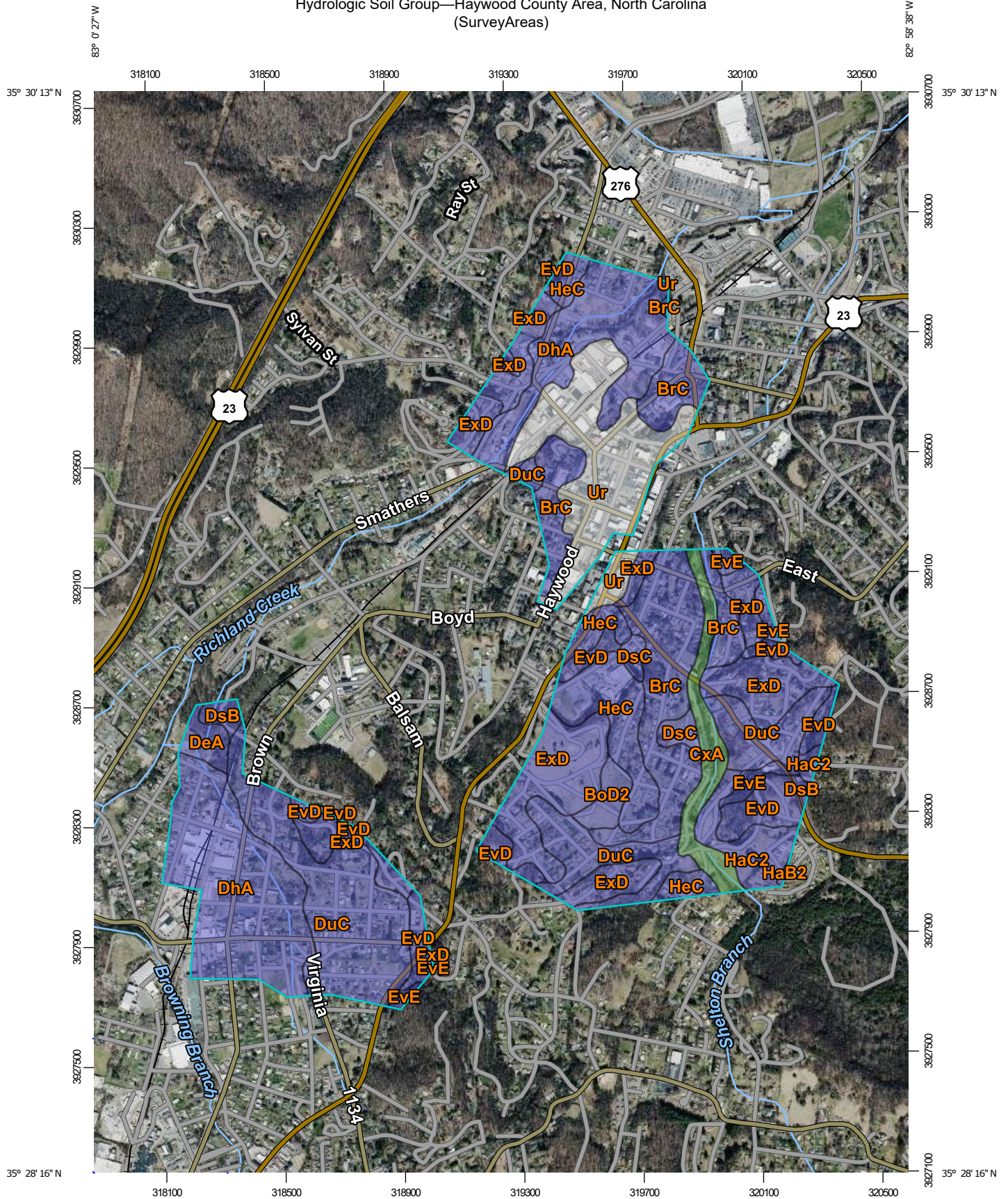
Precip Depth (in) and Intensity (in/hr) estimates for 35.49166°N, -82.991684°E:

(This is the nearest grid point to your selected location of 35.4906°N, -82.9879°E)

Note: Intensity is calculated by precip depth (inches) divided by duration (hours)

Dataset	Duration	ARI 2 yr	ARI 5 yr	ARI 10 yr	ARI 25 yr	ARI 50 yr	ARI 100 yr	ARI 500 yr	ARI 1000 yr
RCP4.5 Mid Century (Mean)	24-hour Depth (in)	3.35	4.18	4.84	5.69	6.44	7.14	9.06	9.91

Hydrologic Soil Group—Haywood County Area, North Carolina
(SurveyAreas)



Map Scale: 1:17,600 if printed on A portrait (8.5" x 11") sheet.




Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84




MAP LEGEND

Area of Interest (AOI)









 Area of Interest (AOI)

Soils

Soil Rating Polygons





 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available

Soil Rating Lines


 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available

Soil Rating Points






 A
 A/D
 B
 B/D

 C
 C/D
 D
 Not rated or not available


Water Features

 Streams and Canals

Transportation

 Rails
 Interstate Highways
 US Routes
 Major Roads
 Local Roads

Background

 Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:12,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
 Web Soil Survey URL:
 Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Haywood County Area, North Carolina
 Survey Area Data: Version 27, Aug 27, 2025

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 11, 2025—Mar 12, 2025

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
BoD2	Braddock clay loam, 15 to 30 percent slopes, eroded, stony	B	5.9	1.2%
BrC	Braddock-Urban land complex, 2 to 15 percent slopes	B	68.1	13.4%
CxA	Cullowhee-Nikwasi complex, 0 to 2 percent slopes, frequently flooded	A/D	17.8	3.5%
DeA	Dellwood cobbly sandy loam, 0 to 3 percent slopes, occasionally flooded	B	5.2	1.0%
DhA	Dellwood-Urban land complex, 0 to 3 percent slopes, occasionally flooded	B	100.4	19.7%
DsB	Dillsboro loam, 2 to 8 percent slopes	B	3.8	0.7%
DsC	Dillsboro loam, 8 to 15 percent slopes	B	5.4	1.1%
DuC	Dillsboro-Urban land complex, 2 to 15 percent slopes	B	93.9	18.4%
EvD	Evard-Cowee complex, 15 to 30 percent slopes	B	27.2	5.3%
EvE	Evard-Cowee complex, 30 to 50 percent slopes	B	7.1	1.4%
ExD	Evard-Cowee-Urban land complex, 15 to 30 percent slopes	B	69.9	13.7%
HaB2	Hayesville clay loam, 2 to 8 percent slopes, eroded	B	0.3	0.1%
HaC2	Hayesville clay loam, 8 to 15 percent slopes, eroded	B	14.9	2.9%
HeC	Hayesville-Urban land complex, 2 to 15 percent slopes	B	34.4	6.8%
Ur	Urban land		55.0	10.8%
Totals for Area of Interest			509.3	100.0%

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

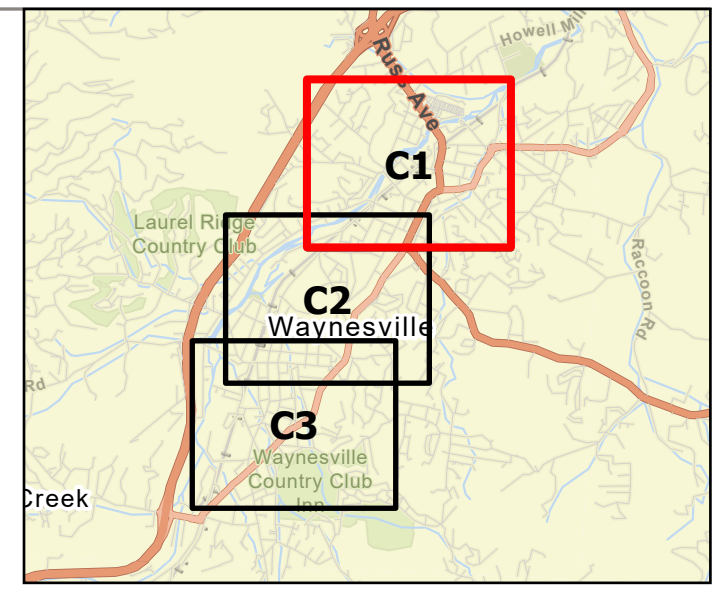
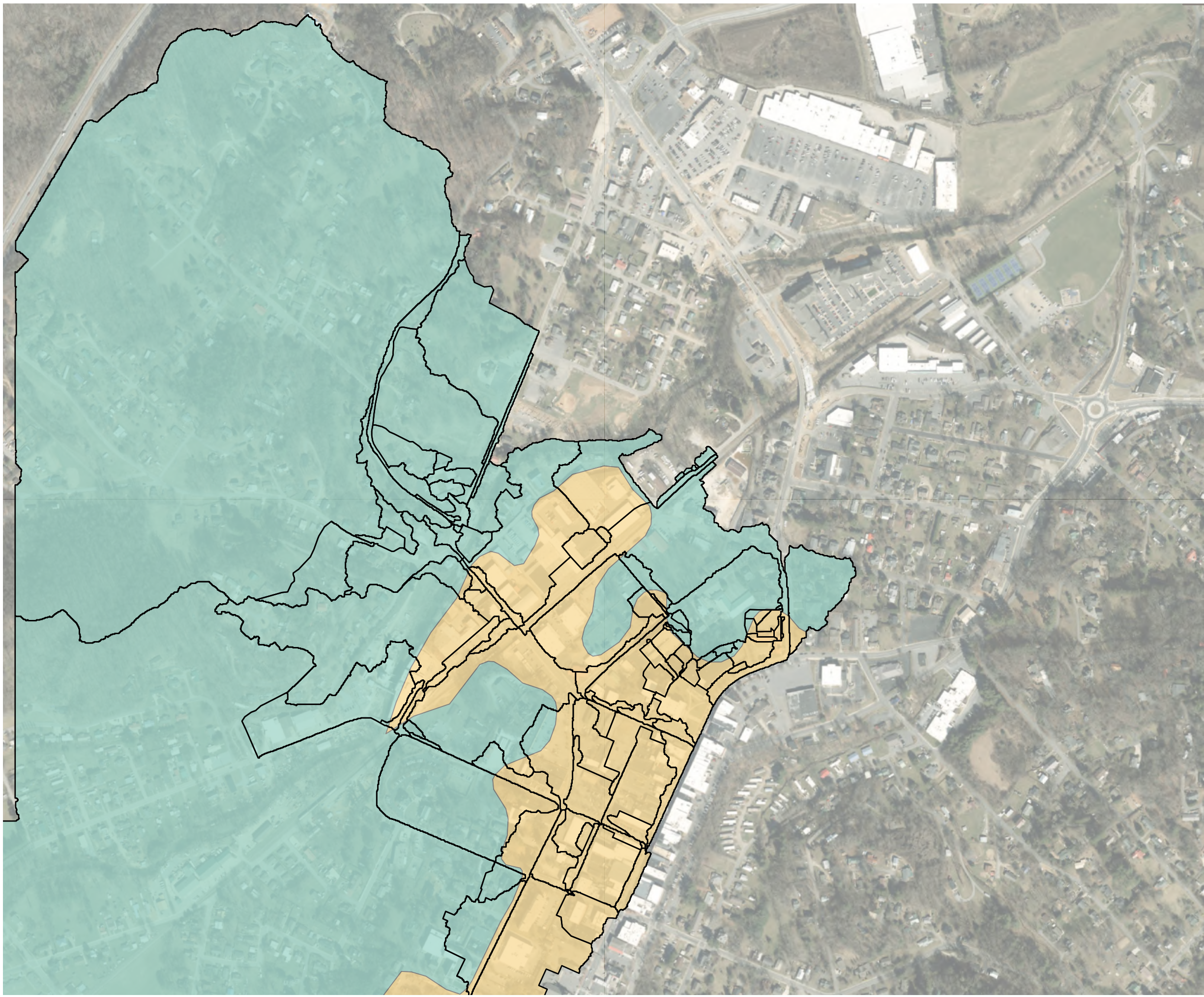
If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher



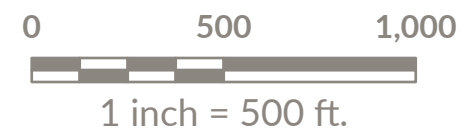
Legend

 Frog Level Drainage Areas

Hydrologic Soil Group

 B

 D



Frog Level: C1

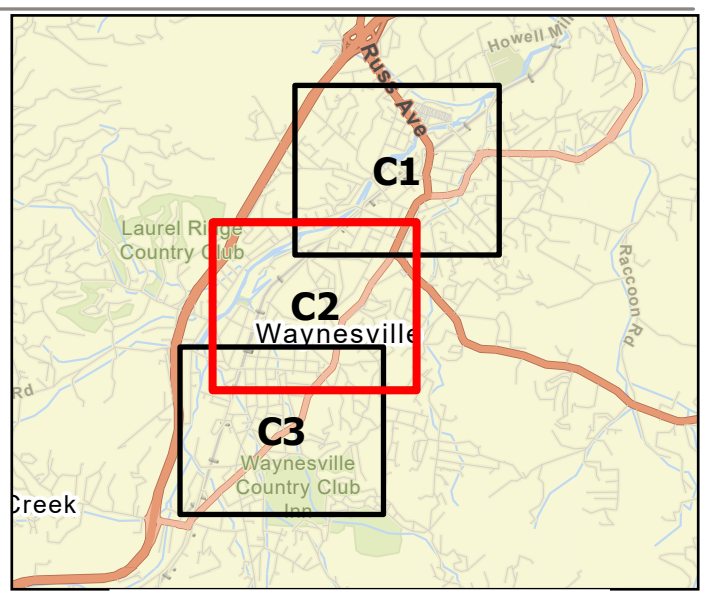
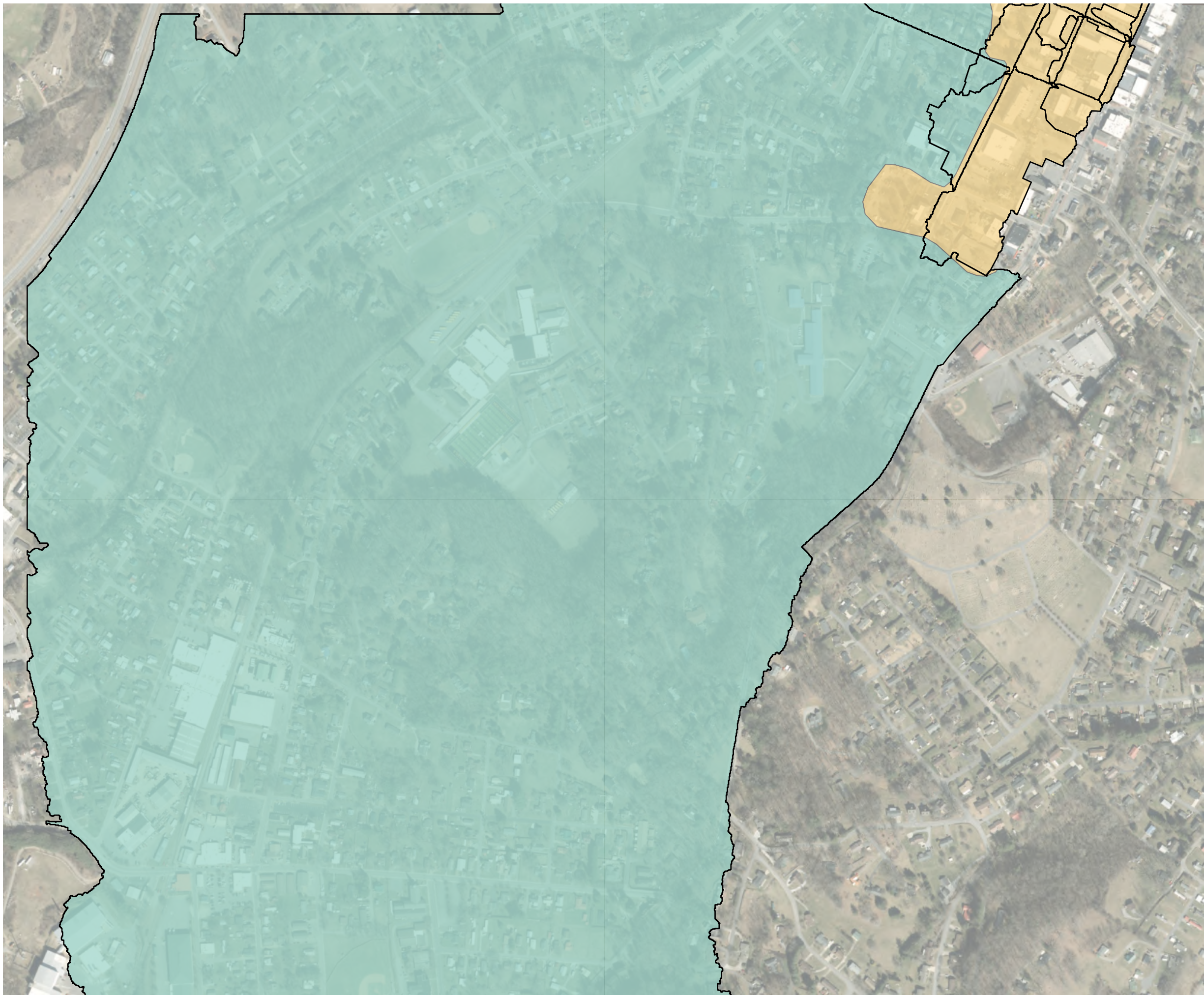
Hydrologic Soil Groups Waynesville, NC



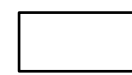
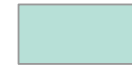

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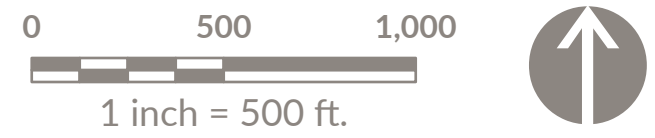
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Legend

-  Frog Level Drainage Areas
- Hydrologic Soil Group**
-  B
-  D



Frog Level: C2

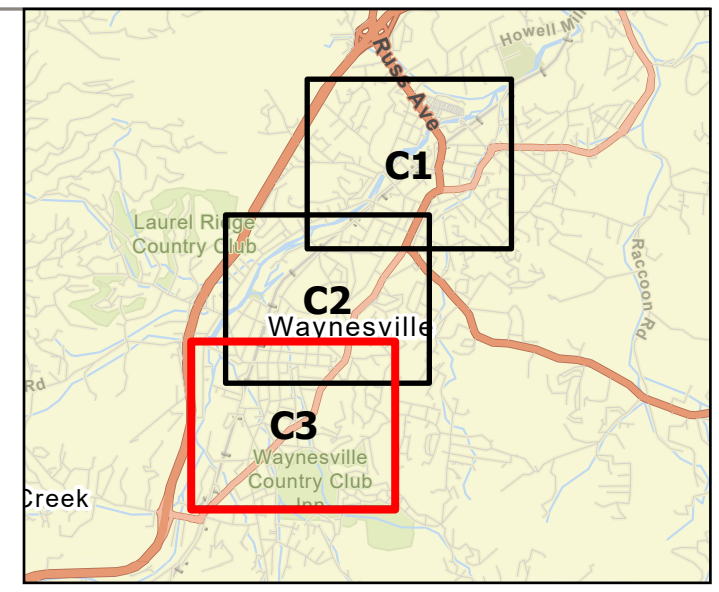
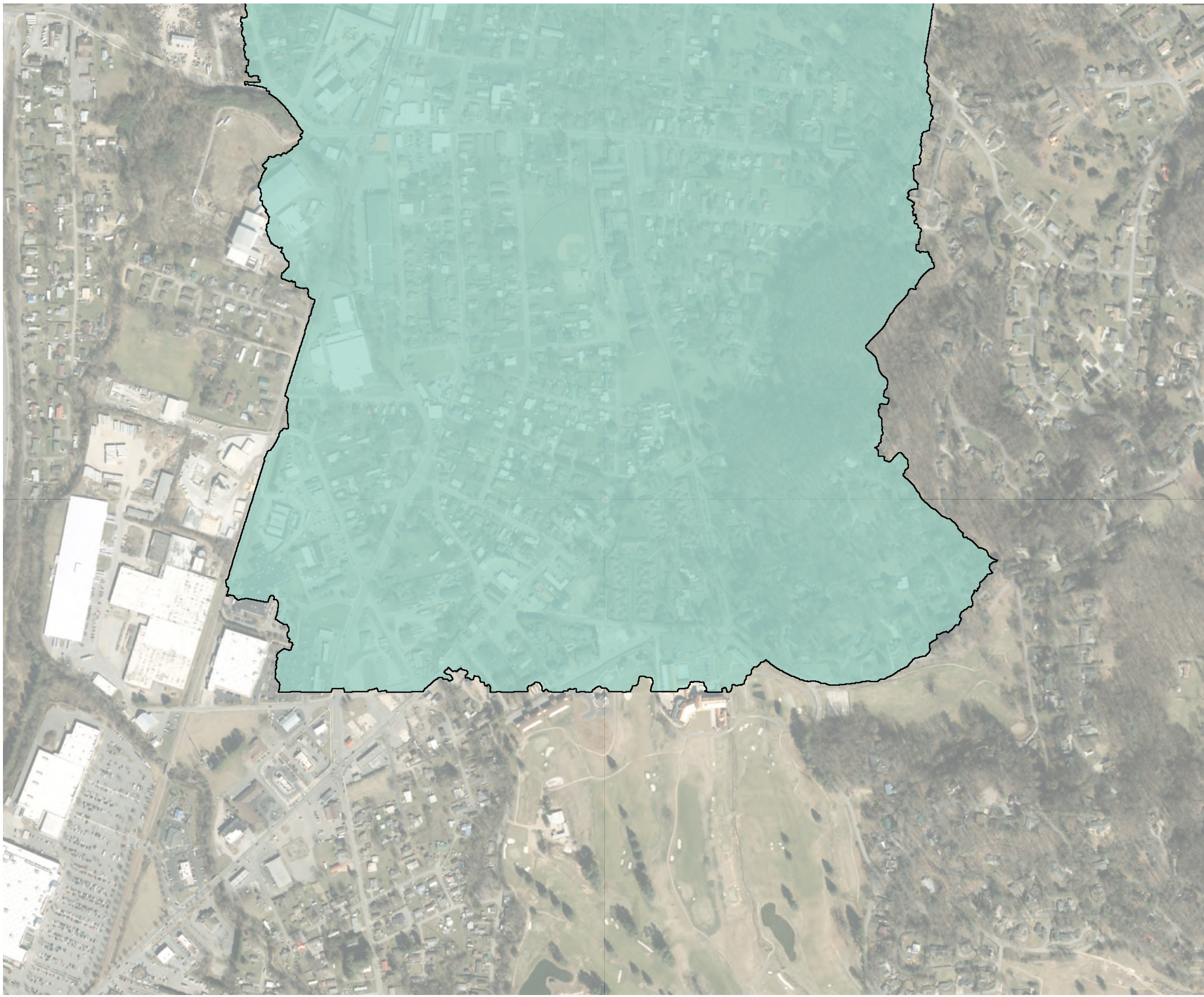
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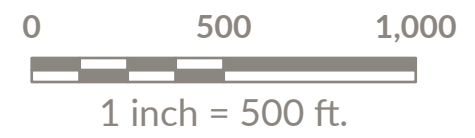
Legend

 Frog Level Drainage Areas

Hydrologic Soil Group

 B

 D



Frog Level: C3

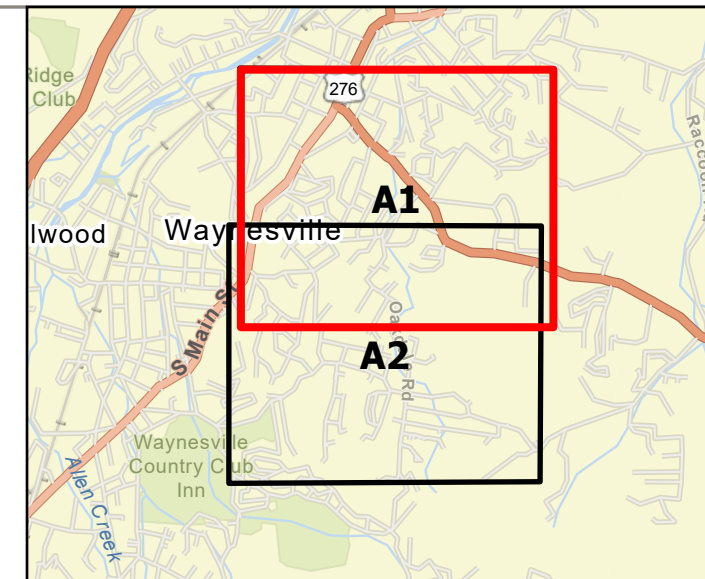
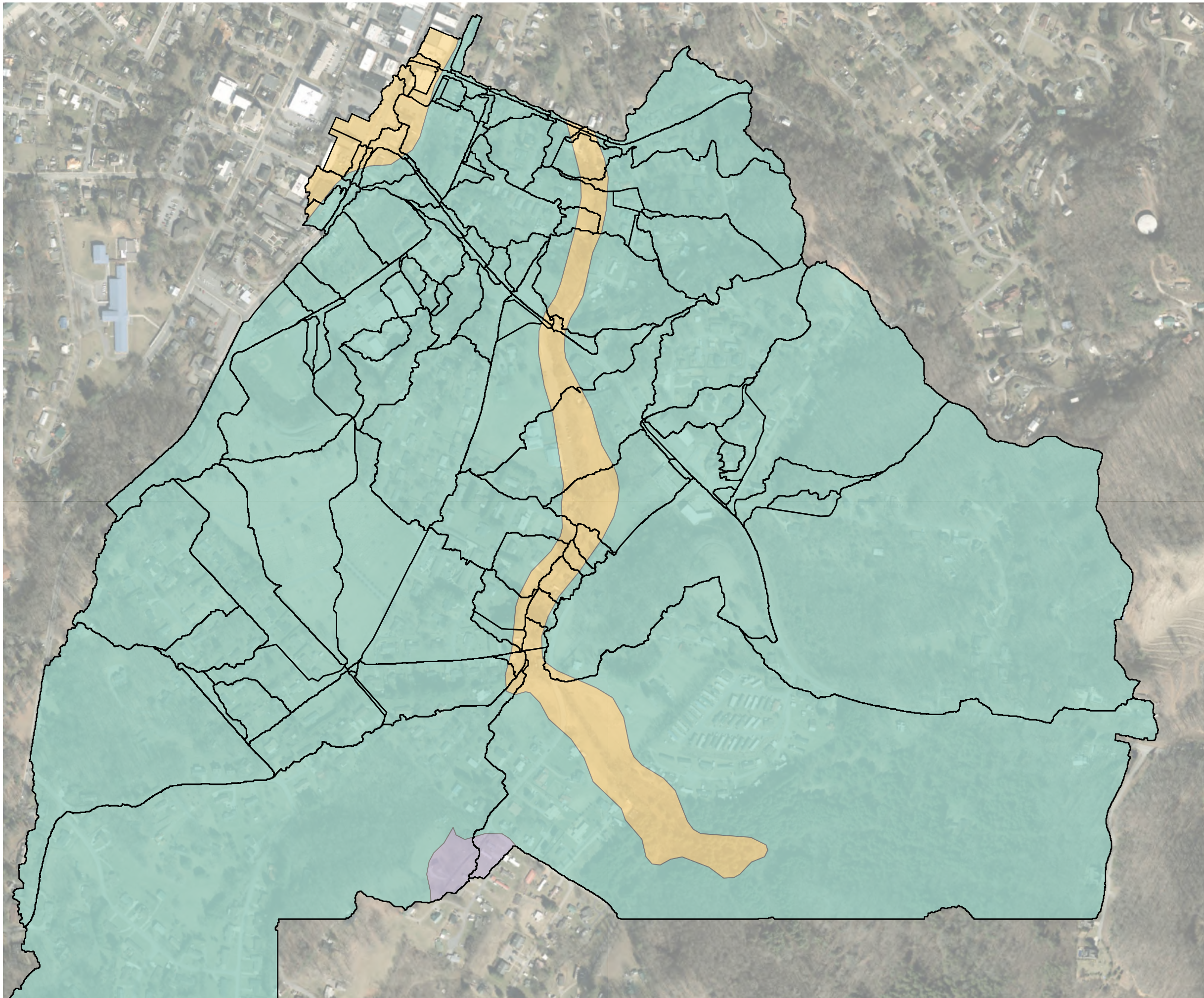
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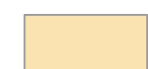
Legend

 Shelton Drainage Areas

Hydrologic Soil Group

 B

 C

 D



1 inch = 500 ft.



Shelton Branch: A1

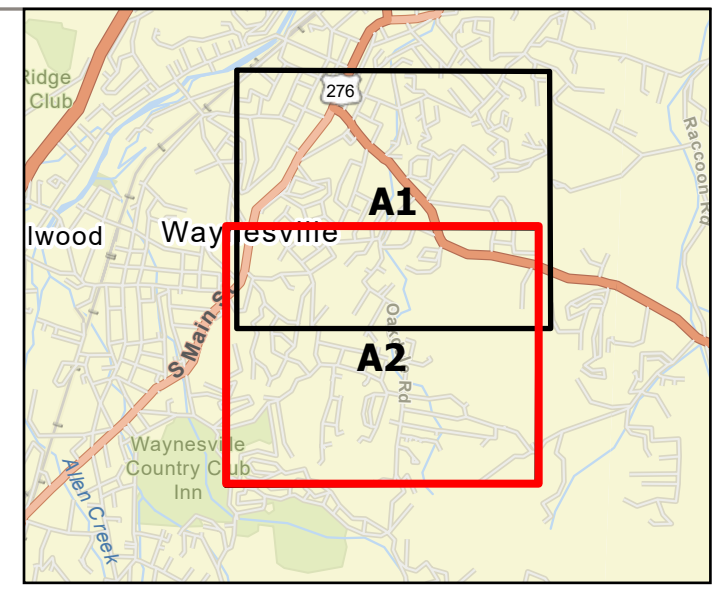
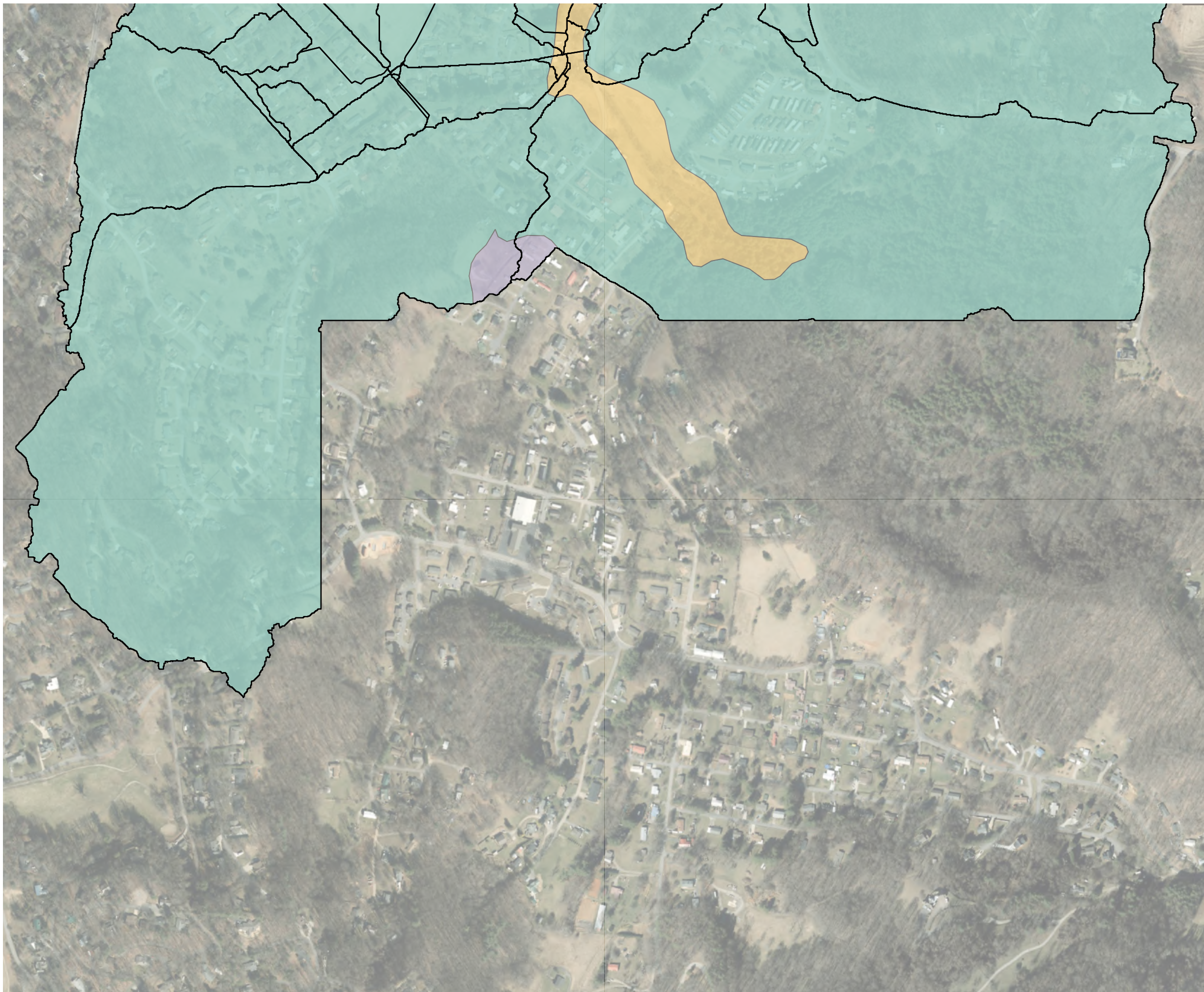
Hydrologic Soil Groups Waynesville, NC



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Legend

 Shelton Drainage Areas

Hydrologic Soil Group

 B

 C

 D



1 inch = 500 ft.



Shelton Branch: A2

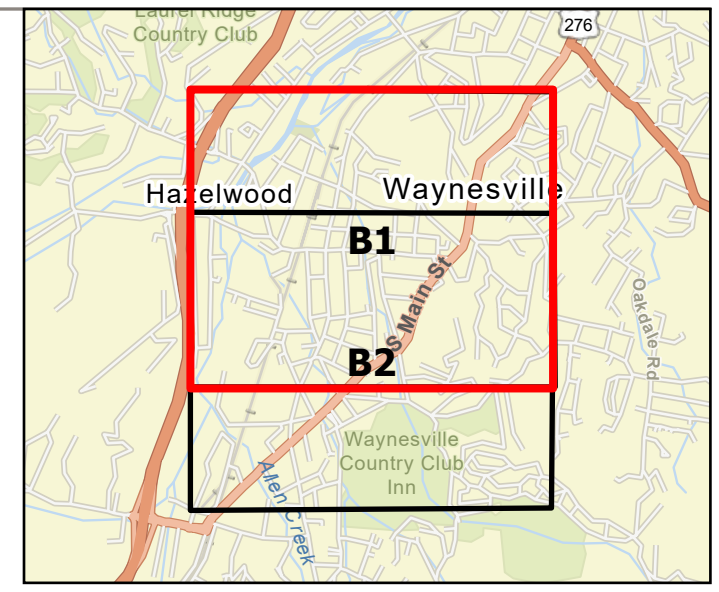
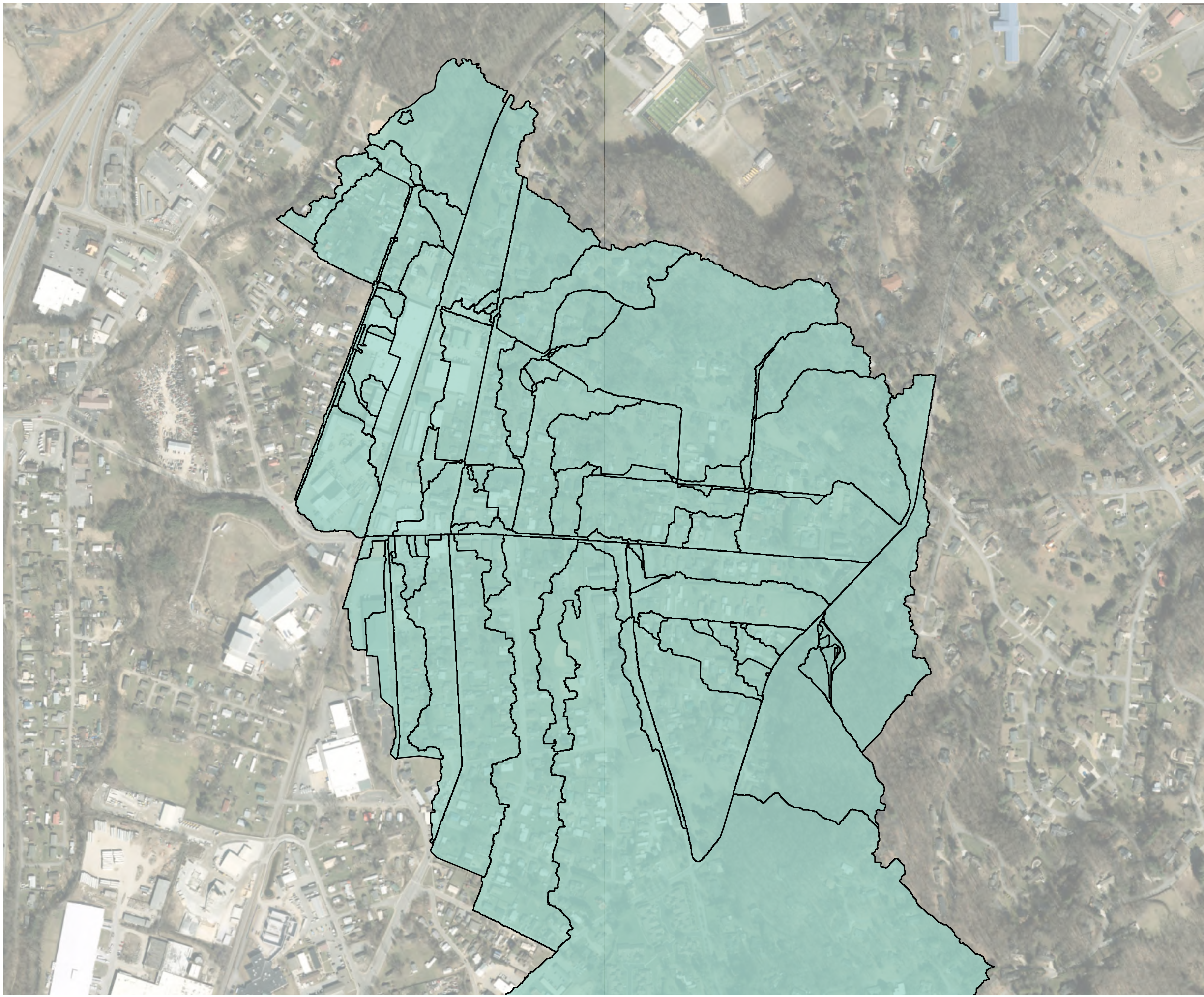
Hydrologic Soil Groups Waynesville, NC




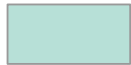
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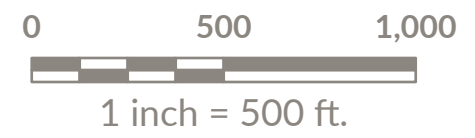
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Legend

-  Hazelwood Drainage Areas
- Hydrologic Soil Group
-  B



Hazelwood: B1

Hydrologic Soil Groups

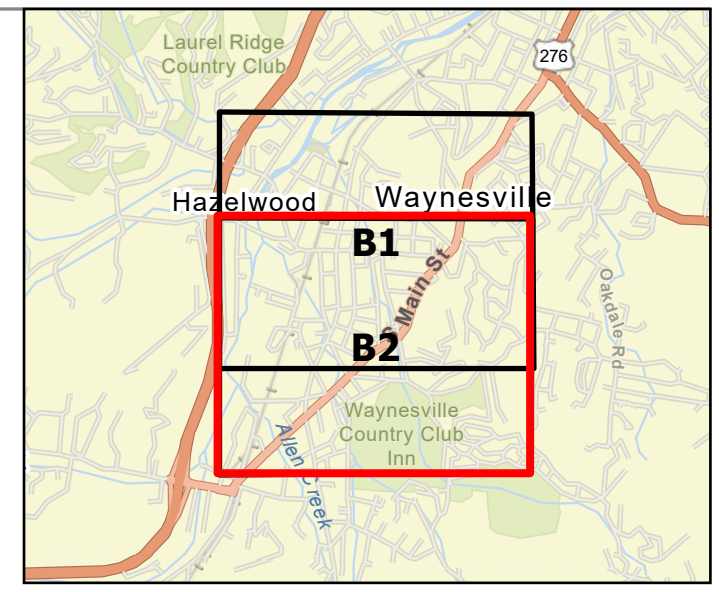
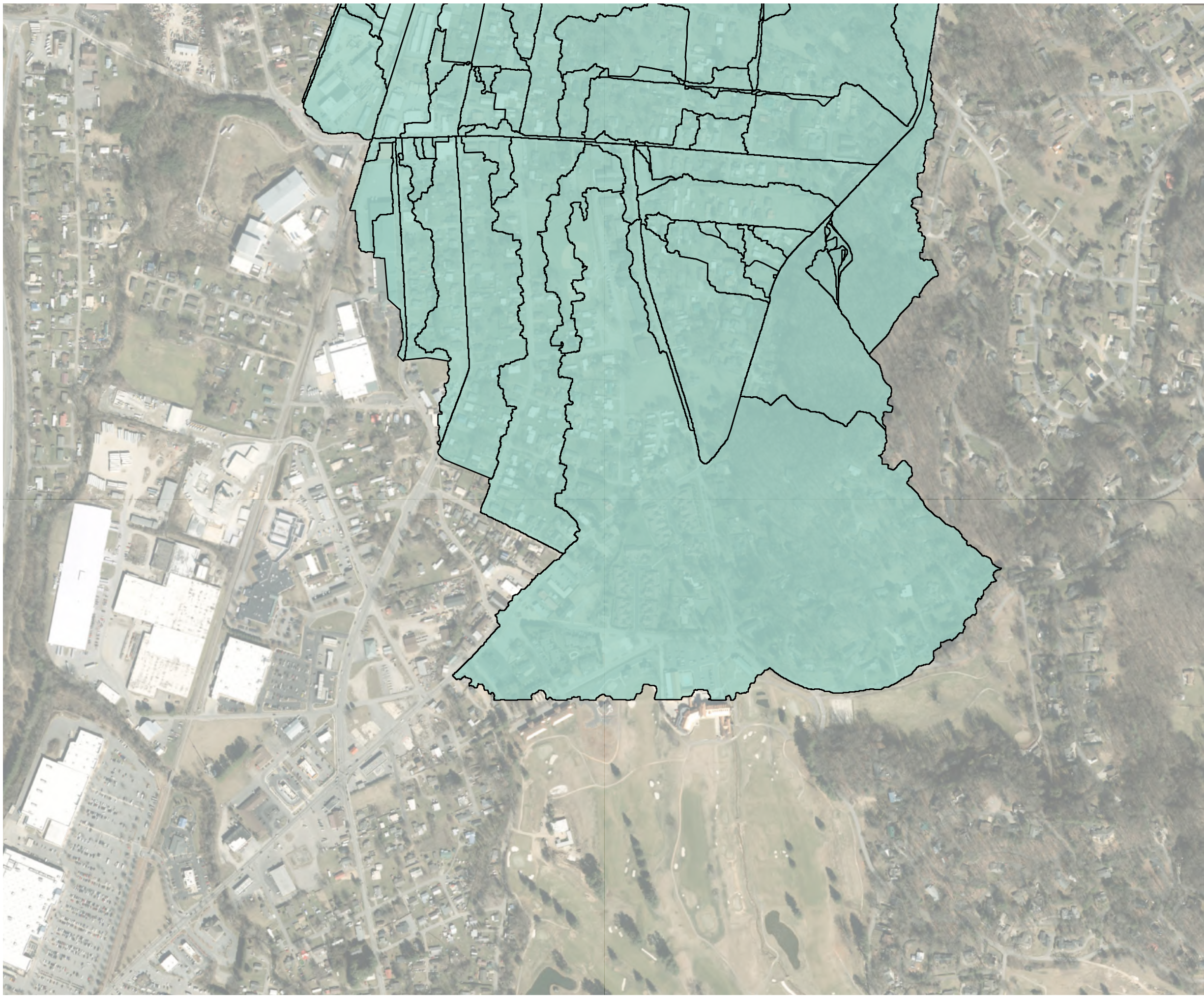
Waynesville, NC



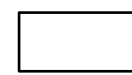
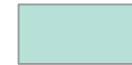
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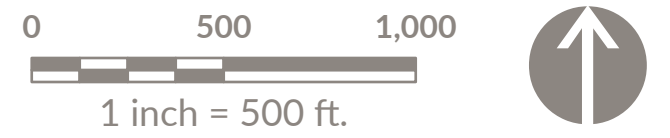
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Legend

-  Hazelwood Drainage Areas
- Hydrologic Soil Group
 -  B



Hazelwood: B2

Hydrologic Soil Groups

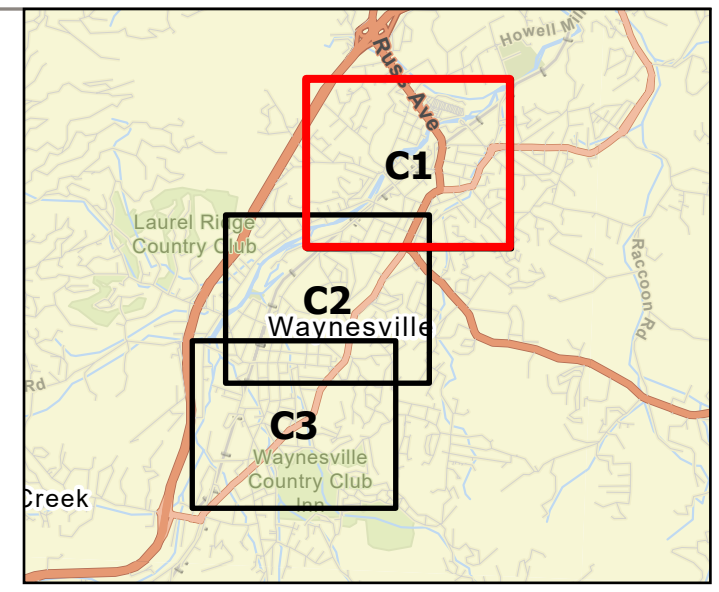
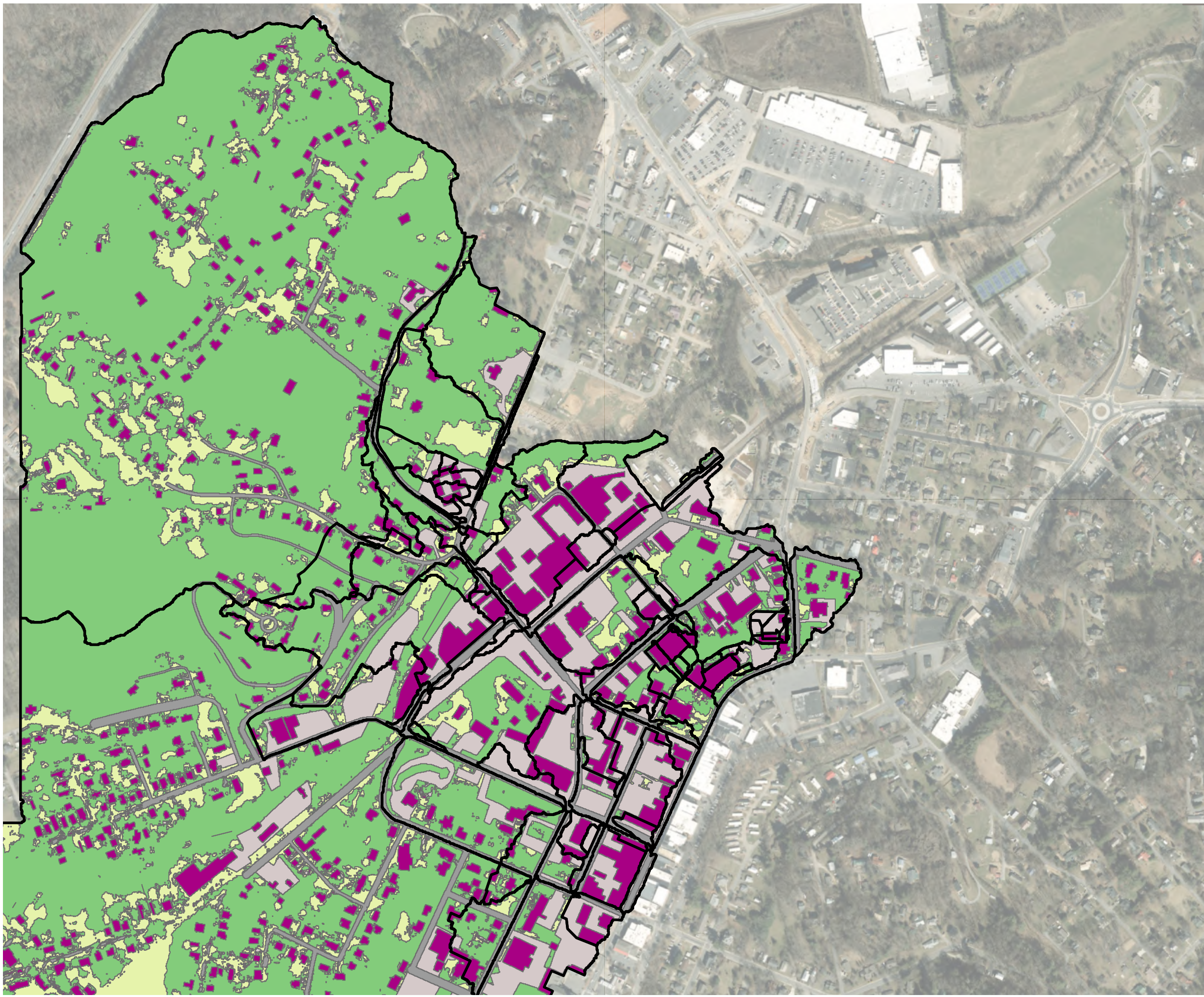
Waynesville, NC







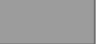


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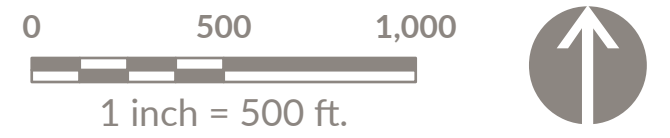
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Legend

-  Frog Level Drainage Areas
- Land Use**
-  Buildings
-  Open Space
-  Parking Lots/Impervious
-  Roadways
-  Woods
-  Woods-Grass Combination - Good Condition



Frog Level: C1

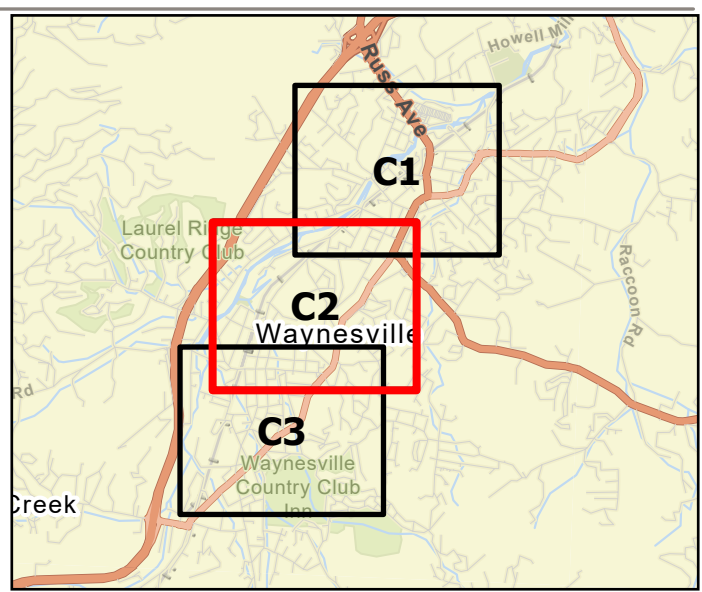
Land Use Waynesville, NC










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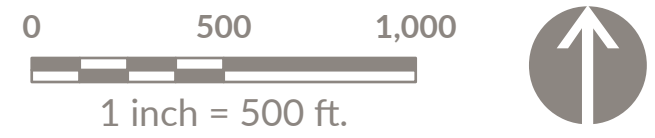
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Legend

-  Frog Level Drainage Areas
- Land Use**
-  Buildings
-  Open Space
-  Parking Lots/Impervious
-  Roadways
-  Woods
-  Woods-Grass Combination - Good Condition



Frog Level: C2

Land Use

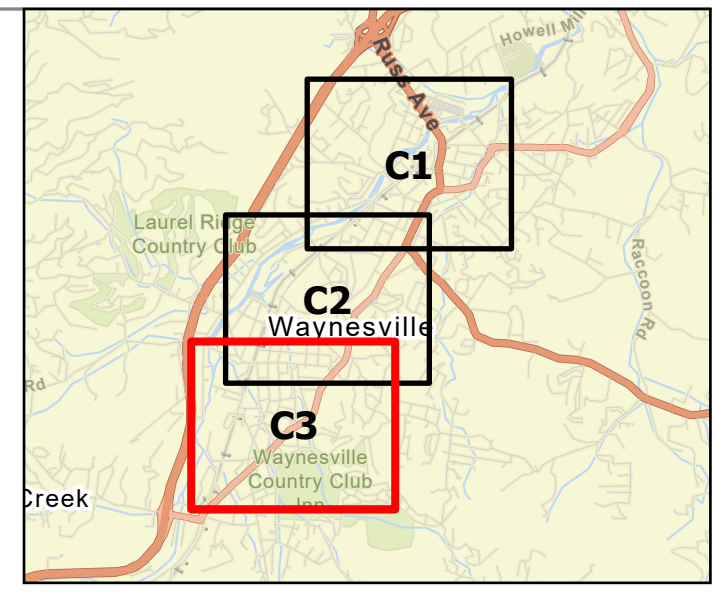
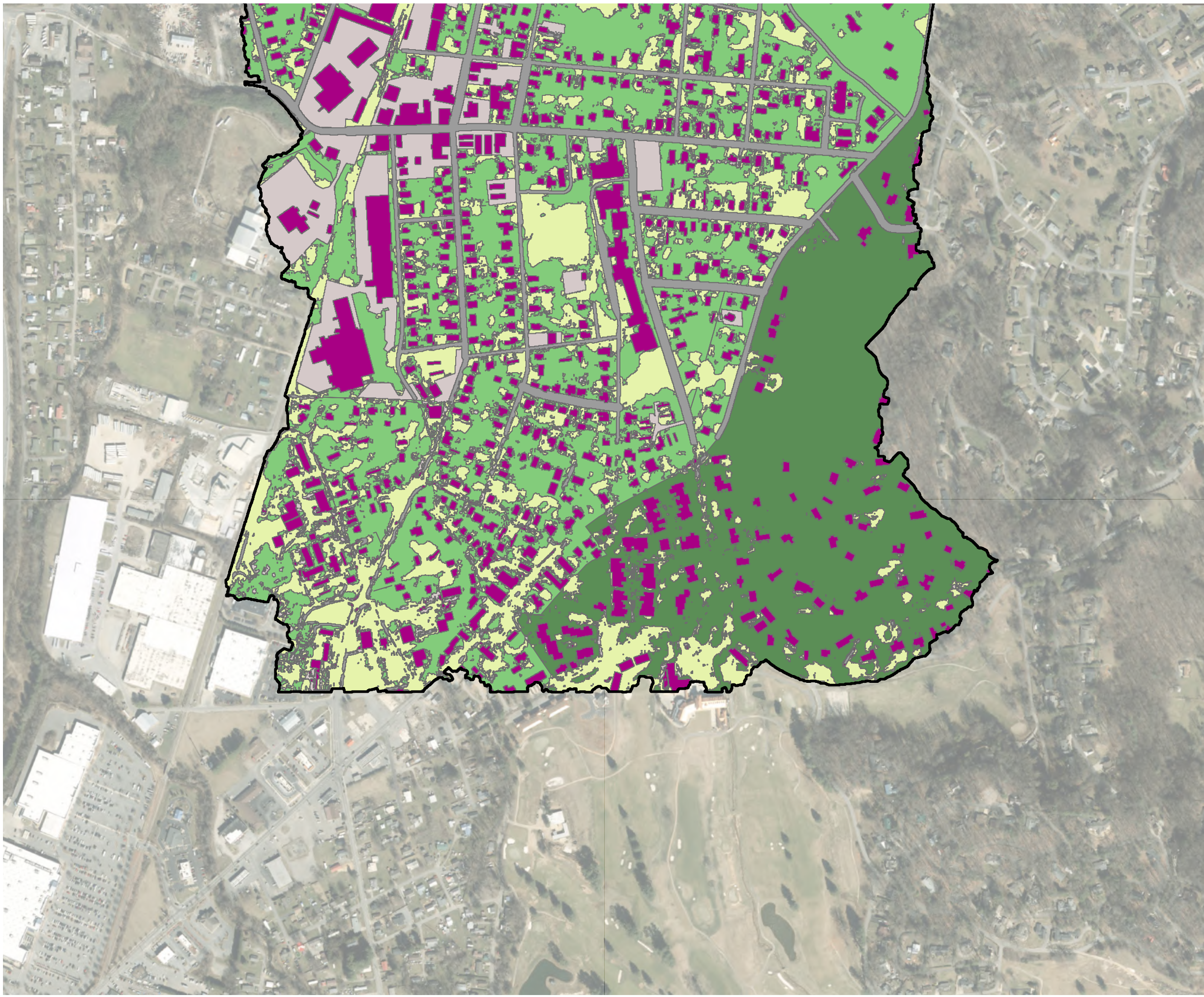
Waynesville, NC







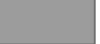




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Legend

-  Frog Level Drainage Areas
 - Land Use**
 -  Buildings
 -  Open Space
 -  Parking Lots/Impervious
 -  Roadways
 -  Woods
 -  Woods-Grass Combination - Good Condition
- 0 500 1,000

 1 inch = 500 ft. 

Frog Level: C3

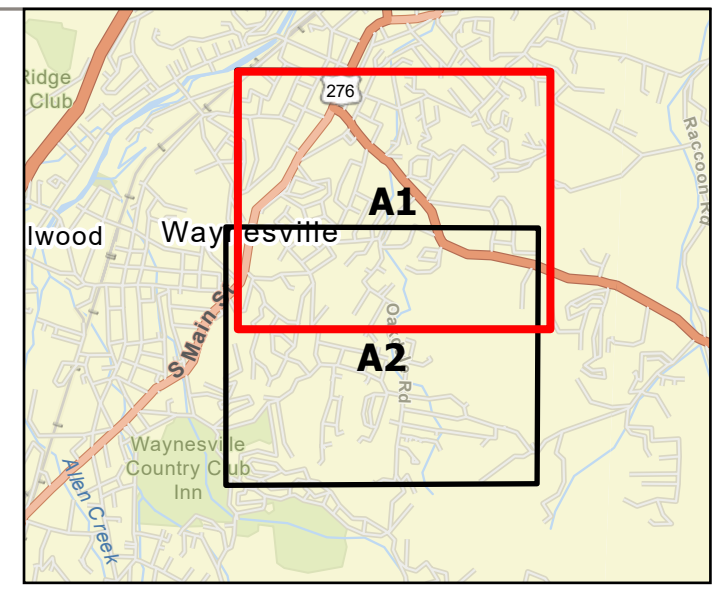
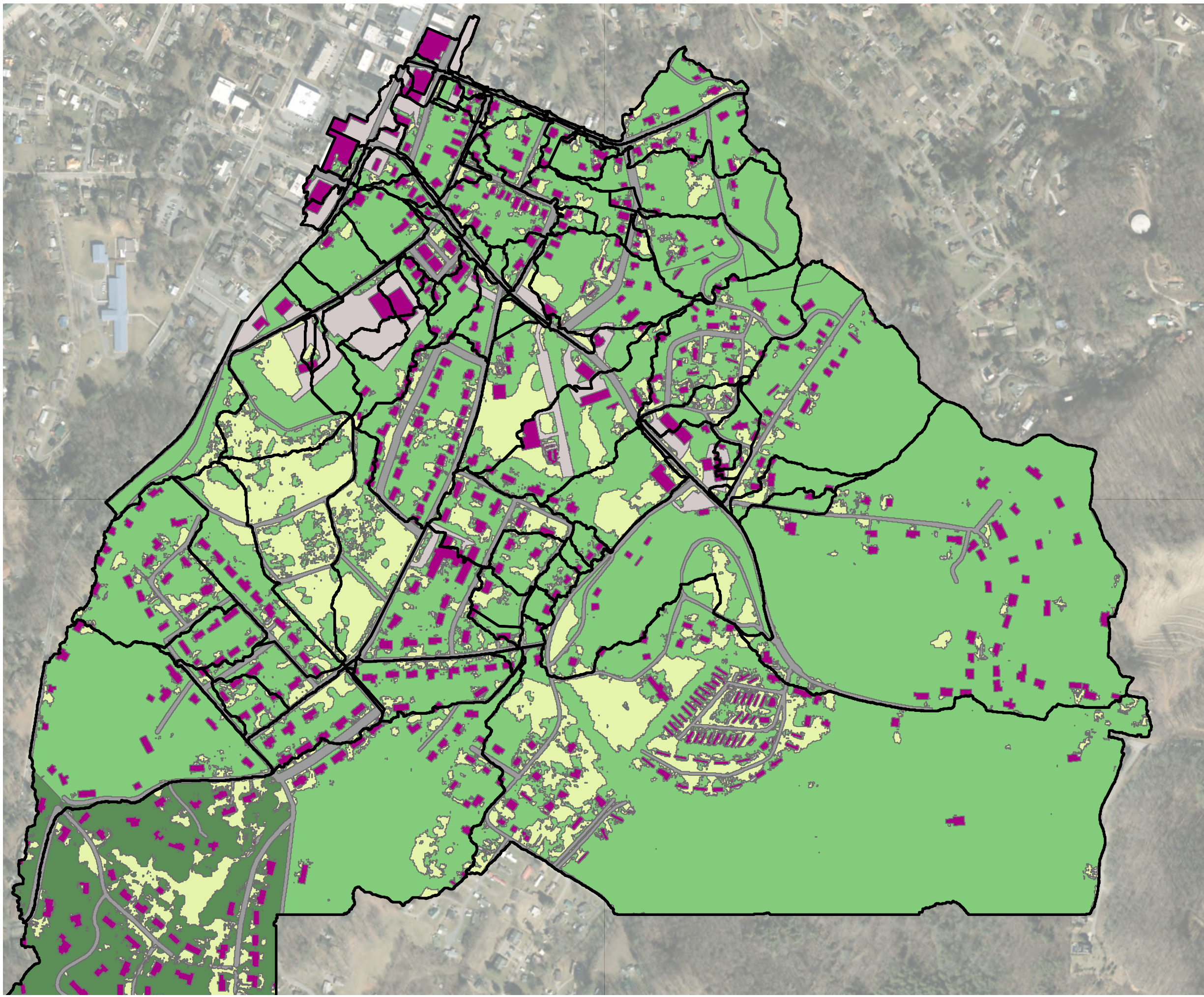
Land Use Waynesville, NC







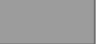


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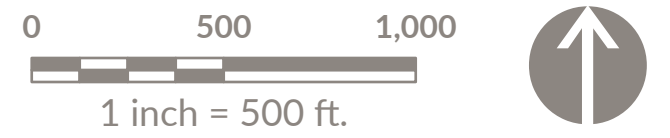
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Legend

-  Shelton Drainage Areas
- Land Use**
-  Buildings
-  Open Space
-  Parking Lots/Impervious
-  Roadways
-  Woods
-  Woods-Grass Combination - Good Condition



Shelton Branch: A1

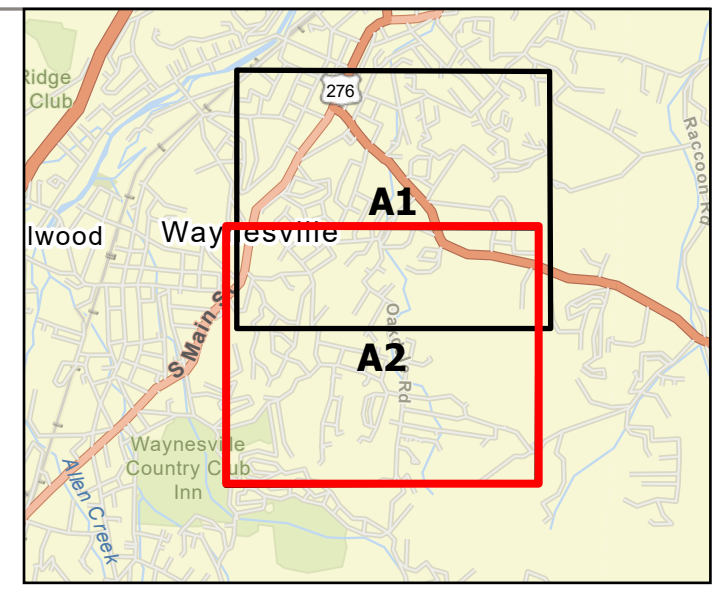
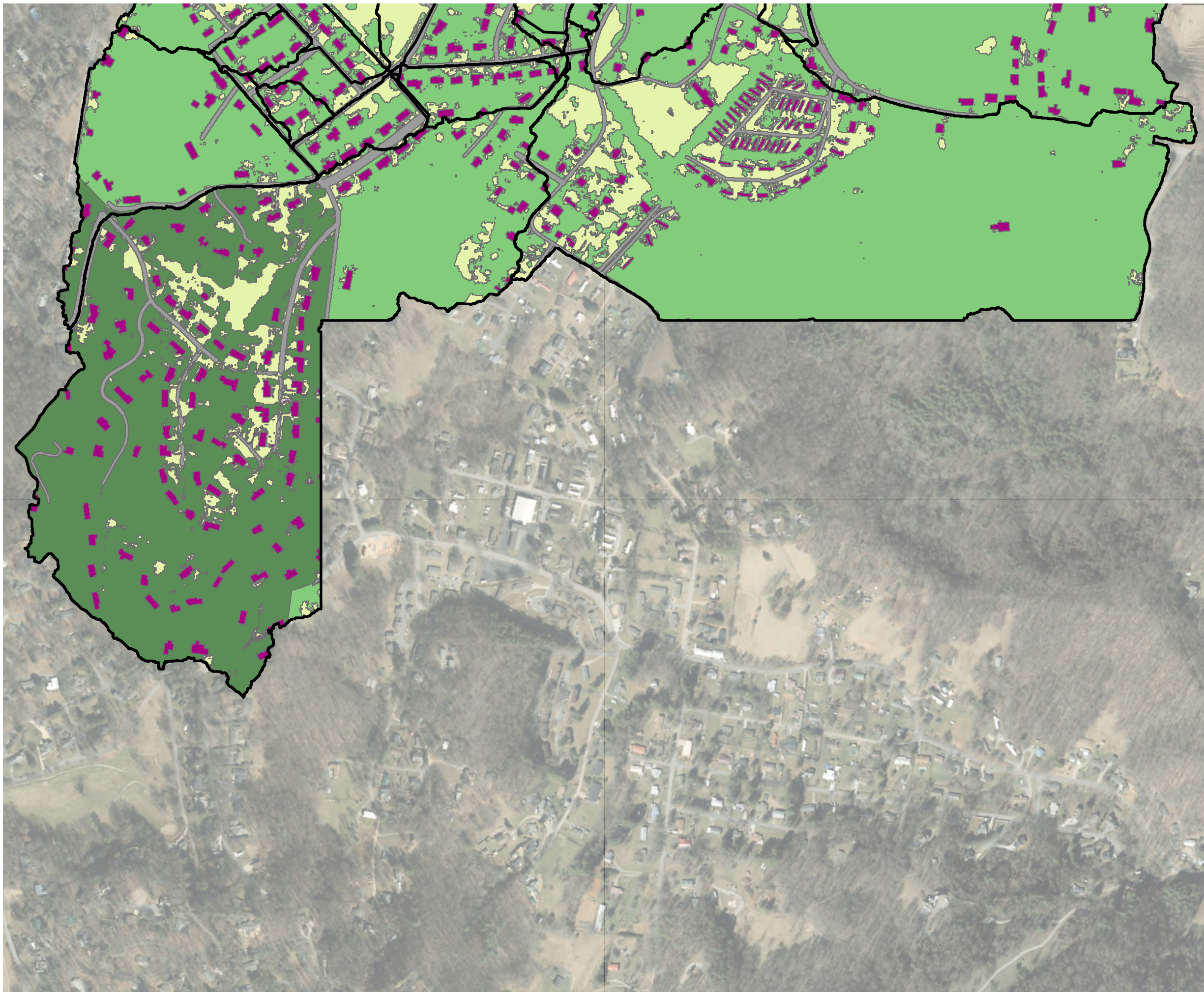
Land Use Waynesville, NC







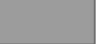


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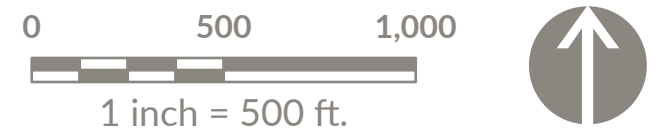
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Legend

-  Shelton Drainage Areas
- Land Use**
-  Buildings
-  Open Space
-  Parking Lots/Impervious
-  Roadways
-  Woods
-  Woods-Glass Combination - Good Condition



Shelton Branch: A2

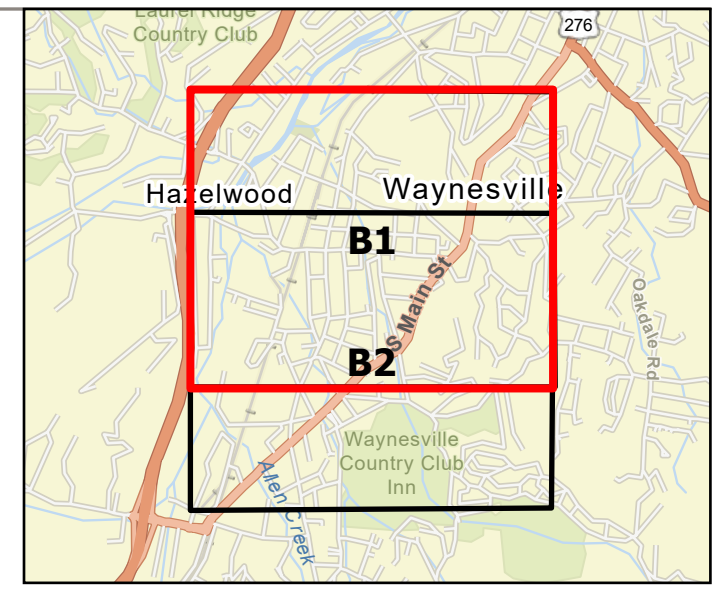
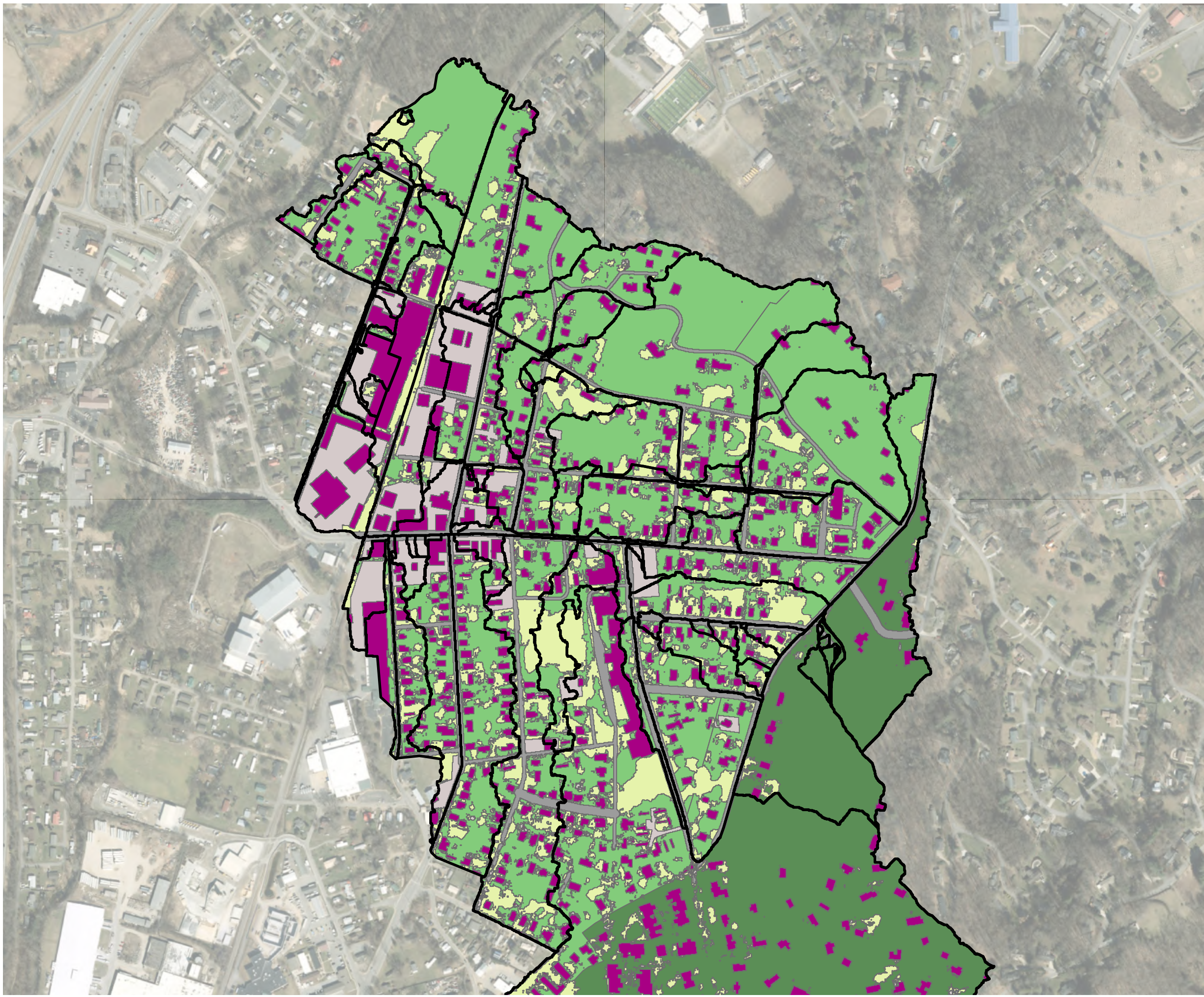
**Land Use
Waynesville, NC**







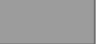


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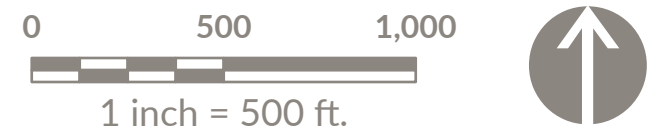
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Legend

-  Hazelwood Drainage Areas
- Land Use**
-  Buildings
-  Open Space
-  Parking Lots/Impervious
-  Roadways
-  Woods
-  Woods-Grass Combination - Good Condition



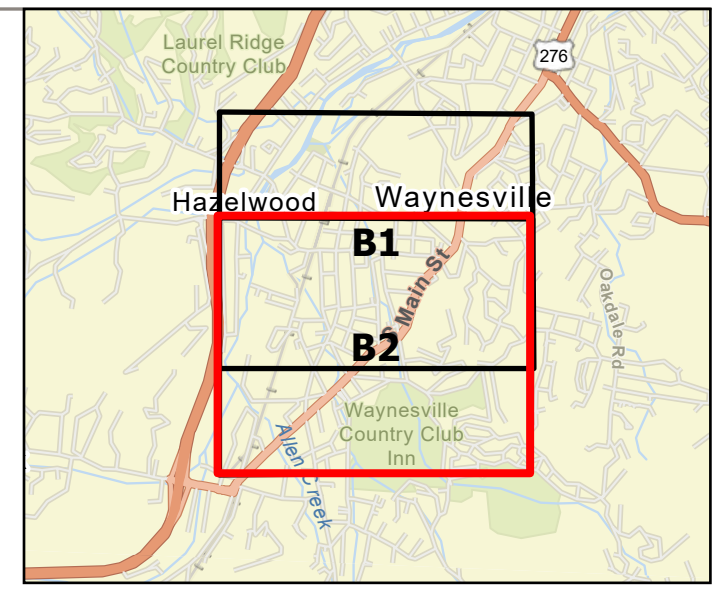
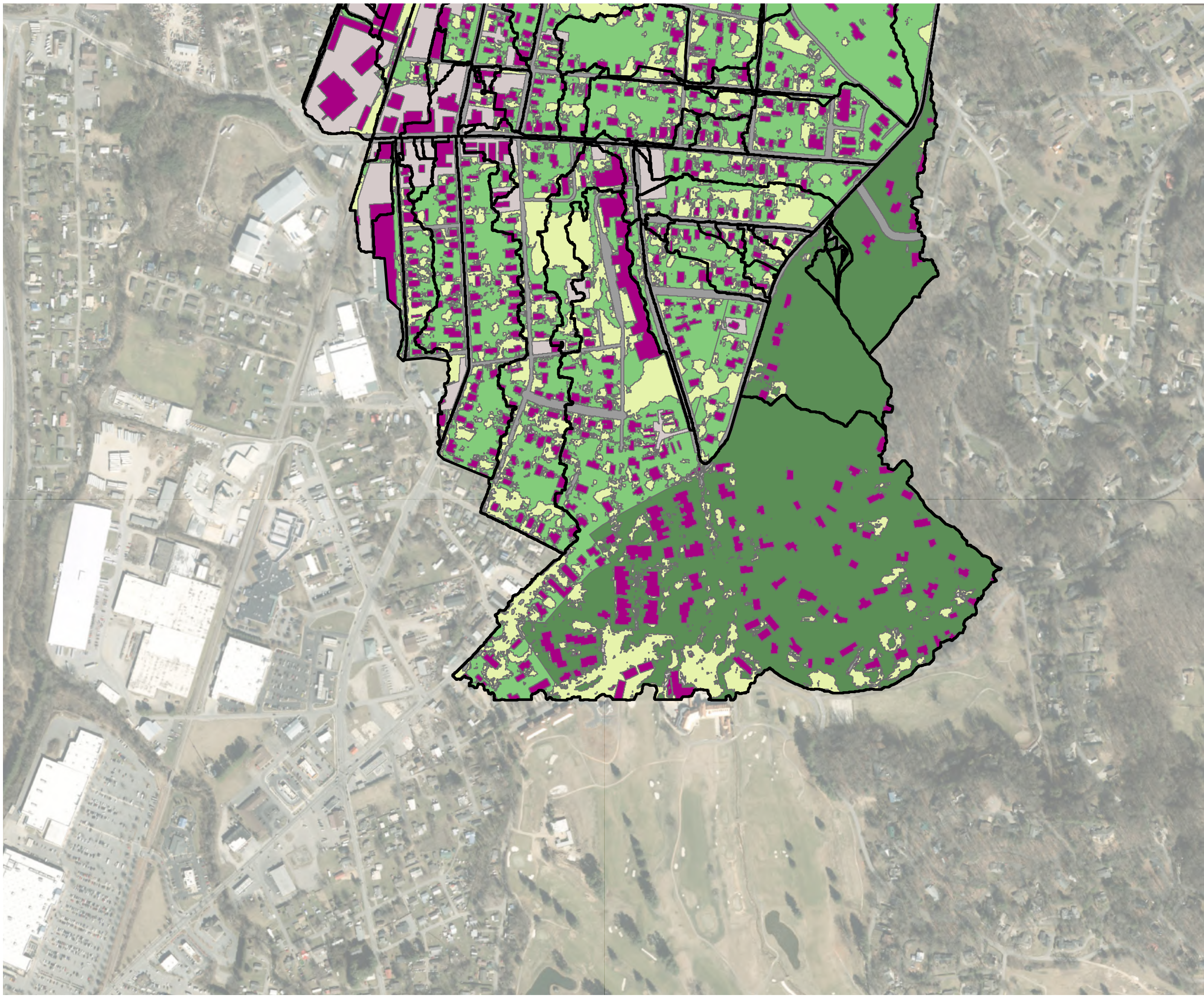
Hazelwood: B1
Land Use
Waynesville, NC












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Legend

-  Hazelwood Drainage Areas
 - Land Use**
 -  Buildings
 -  Open Space
 -  Parking Lots/Impervious
 -  Roadways
 -  Woods
 -  Woods-Grass Combination - Good Condition
- 0 500 1,000

 1 inch = 500 ft. 

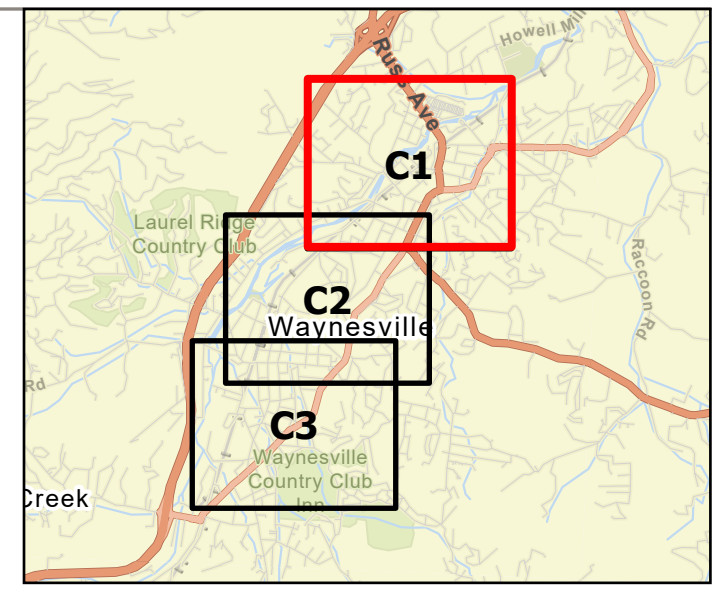
Hazelwood: B2
 Land Use
 Waynesville, NC



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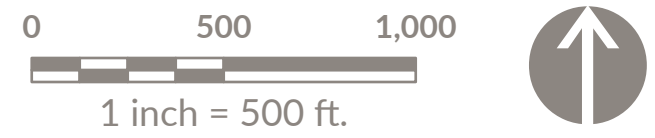
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Legend

- Existing Junctions
- Existing Conduits
- ▭ Study Areas
- ▭ Frog Level Drainage Areas
- - - Open Channels



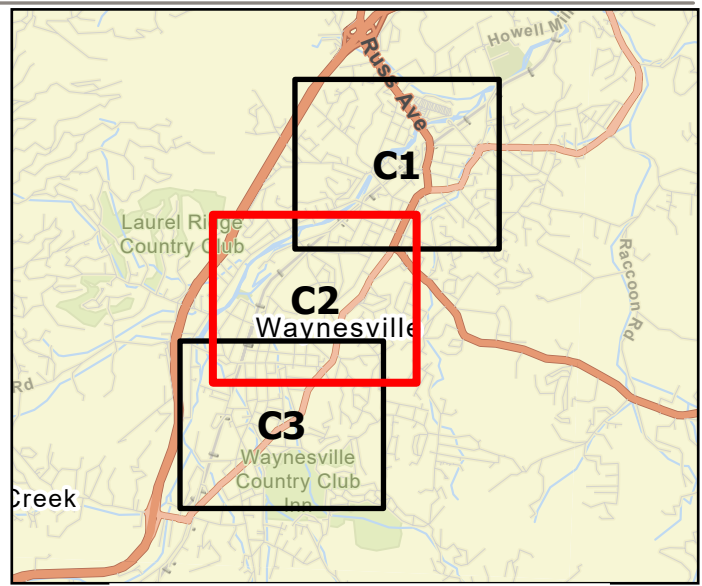
Frog Level: C1 Drainage Areas Waynesville, NC








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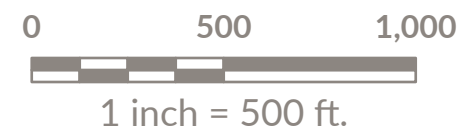
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Legend

-  Existing Junctions
-  Existing Conduits
-  Study Areas
-  Frog Level Drainage Areas
-  Open Channels



Frog Level: C2

Drainage Areas

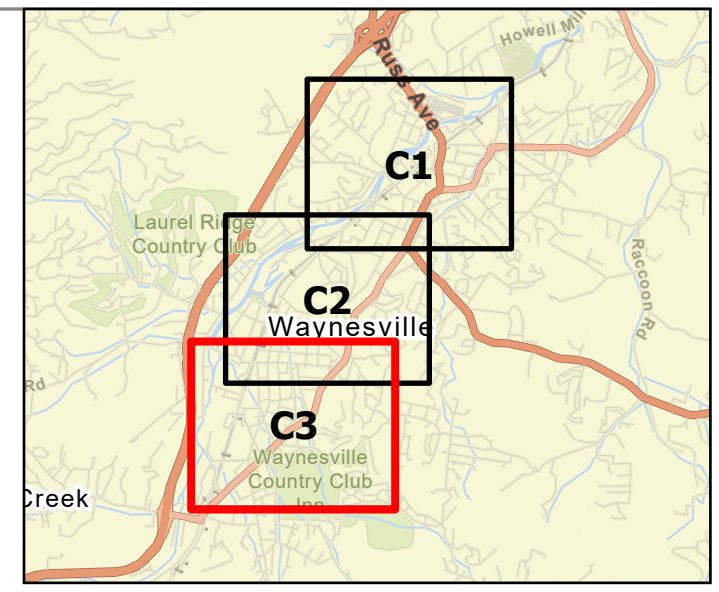
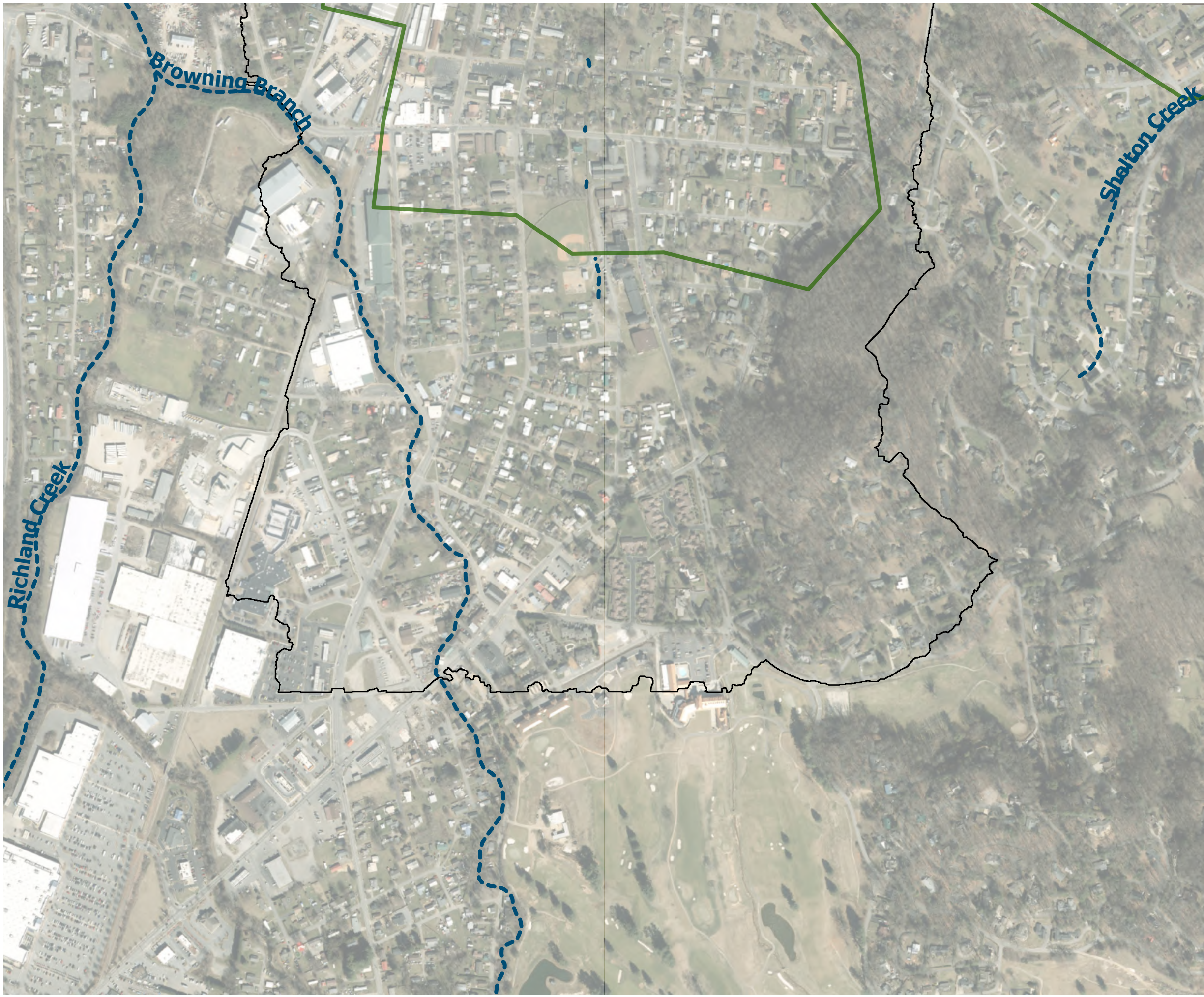
Waynesville, NC








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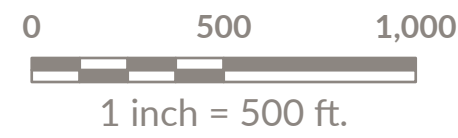
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Legend

-  Existing Junctions
-  Existing Conduits
-  Study Areas
-  Frog Level Drainage Areas
-  Open Channels



Frog Level: C3

Drainage Areas

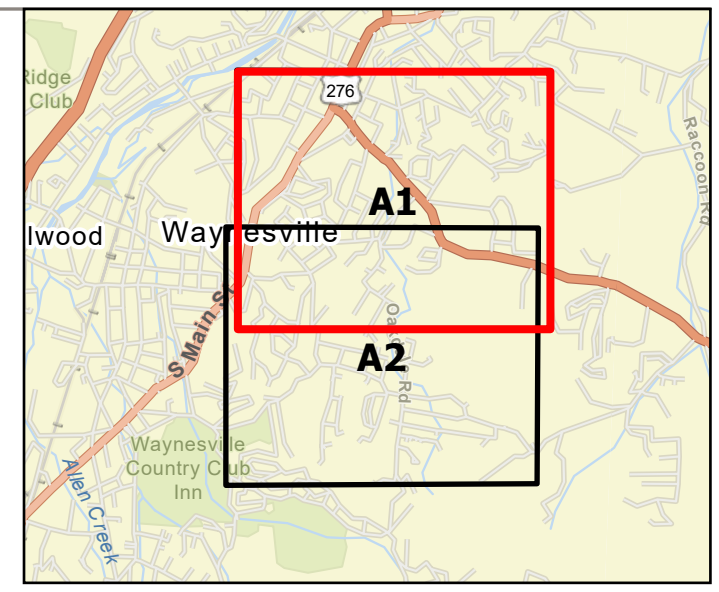
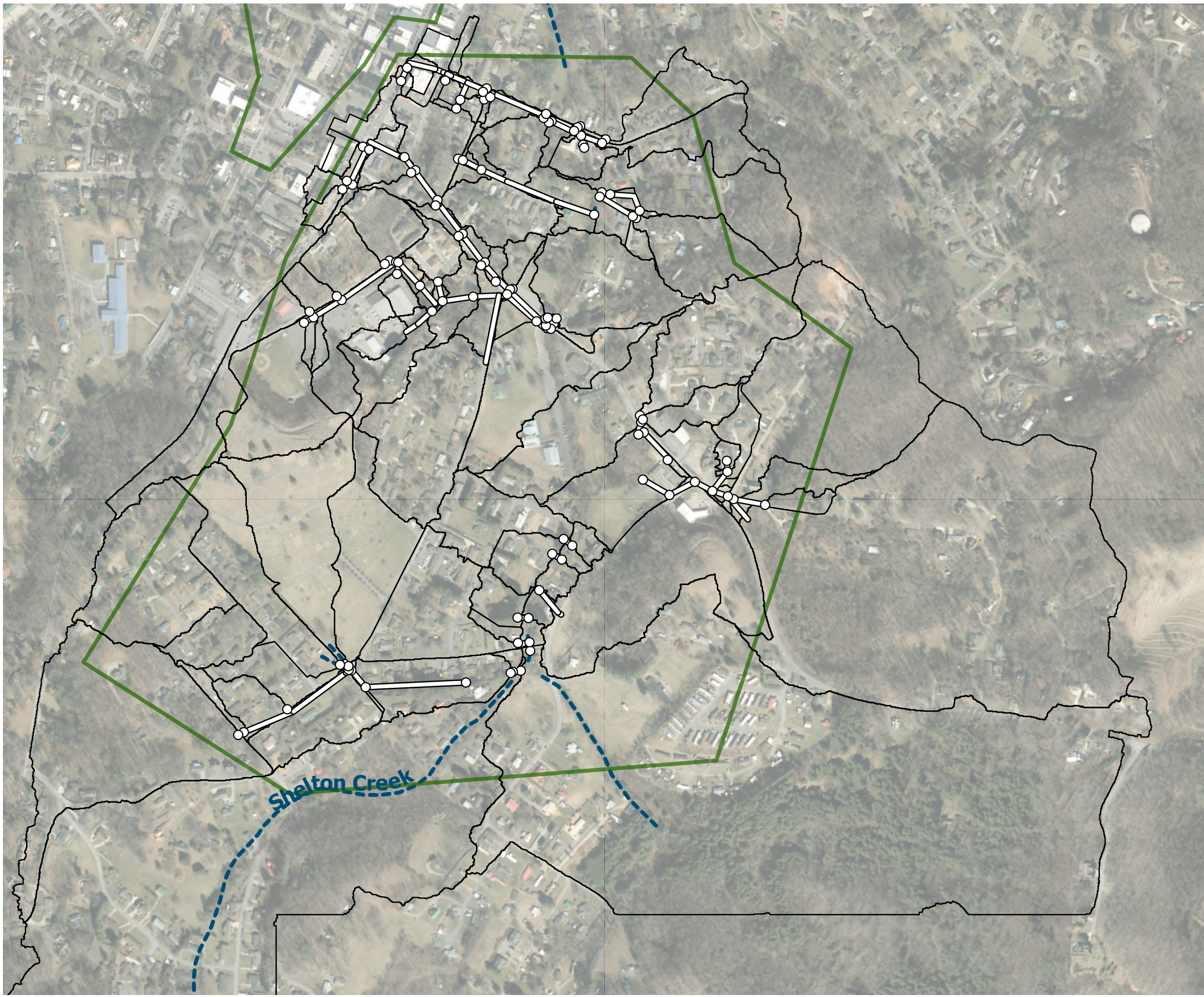
Waynesville, NC



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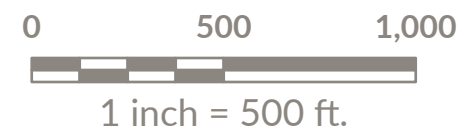
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Legend

- Existing Junctions
- Existing Conduits
- ▭ Study Areas
- ▭ Shelton Drainage Areas
- - - Open Channels



Shelton Branch: A1

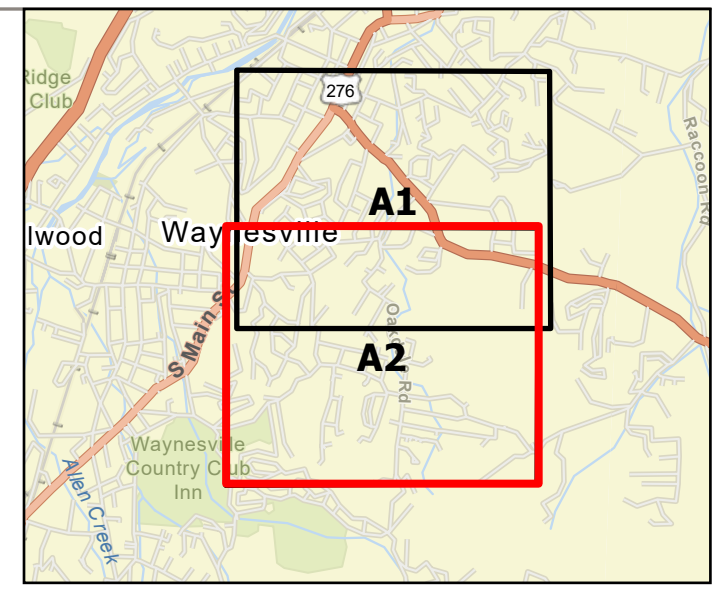
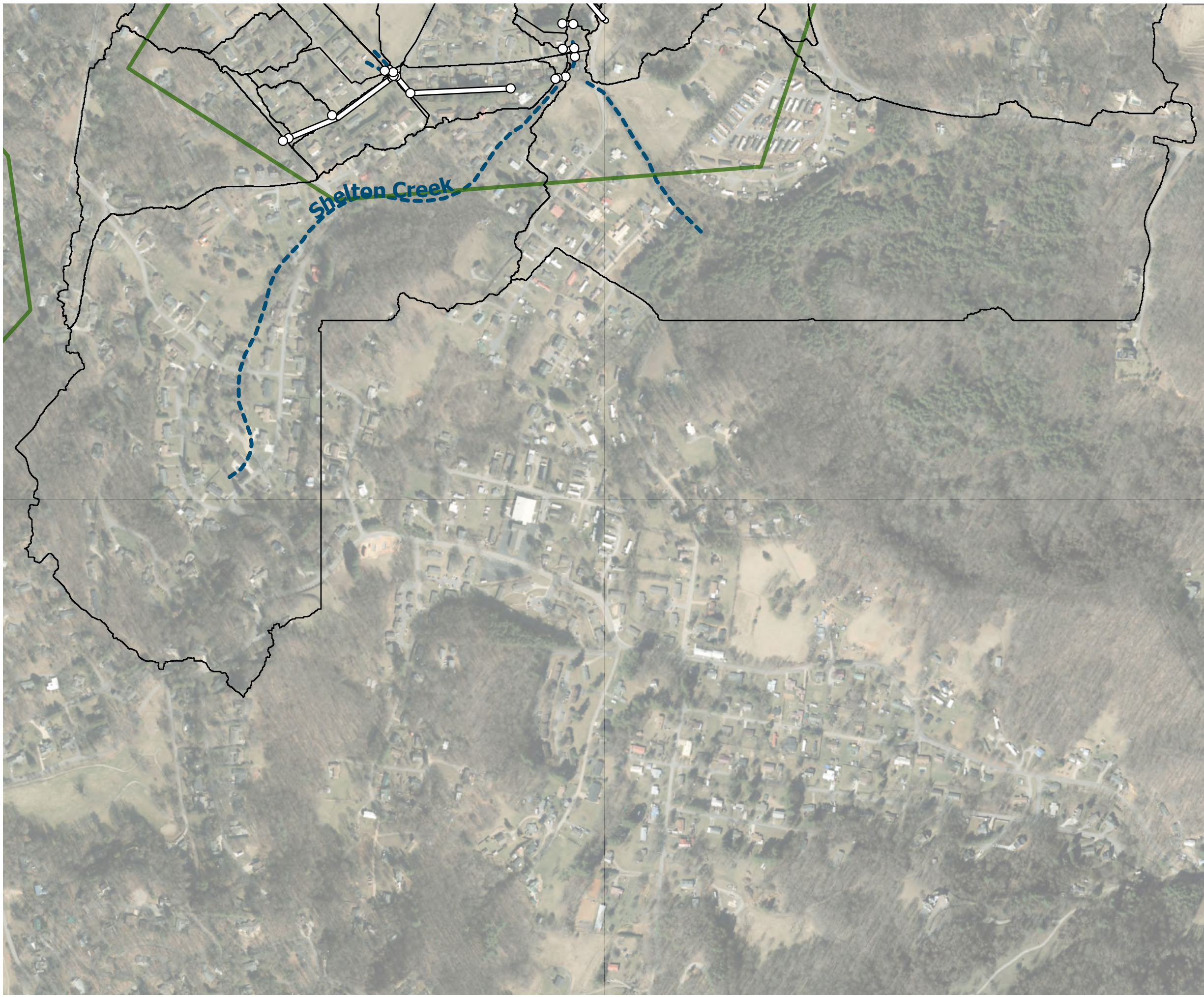
Drainage Areas Waynesville, NC








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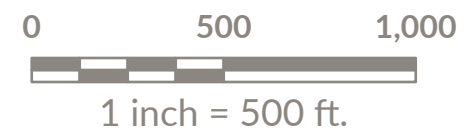
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Legend

-  Existing Junctions
-  Existing Conduits
-  Study Areas
-  Shelton Drainage Areas
-  Open Channels



Shelton Branch: A1

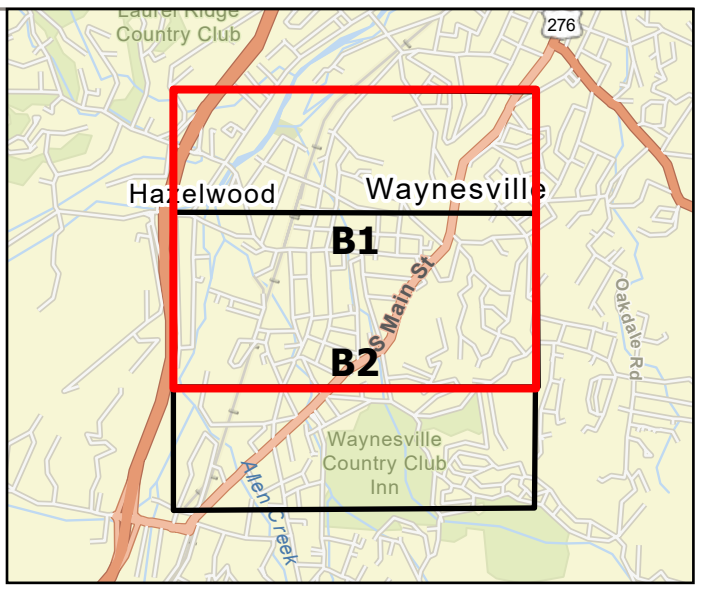
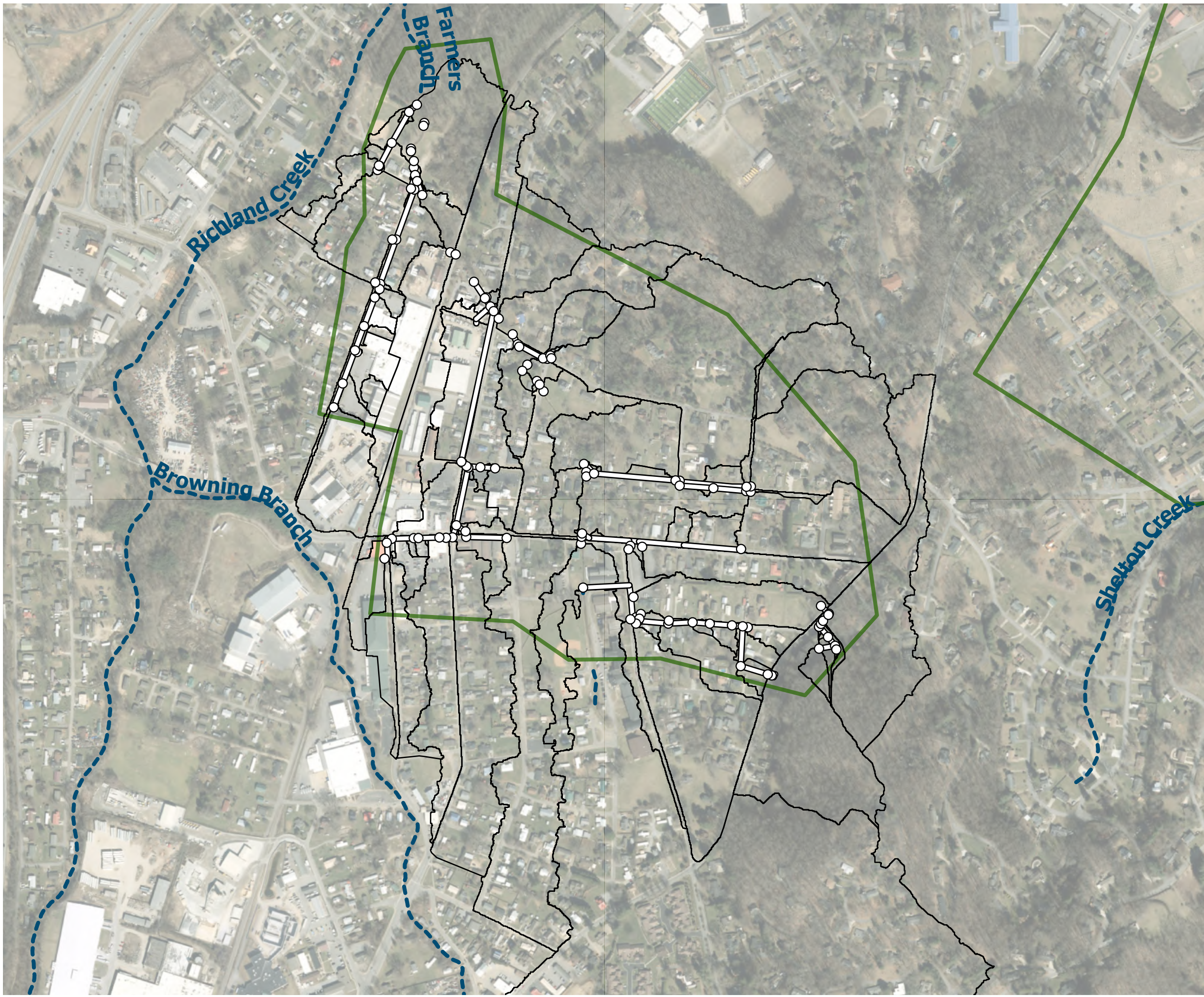
Drainage Areas
Waynesville, NC








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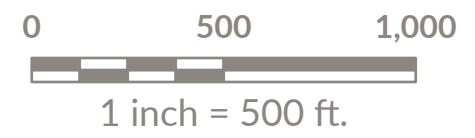
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Legend

-  Existing Junctions
-  Existing Conduits
-  Study Areas
-  Hazelwood Drainage Areas
-  Open Channels



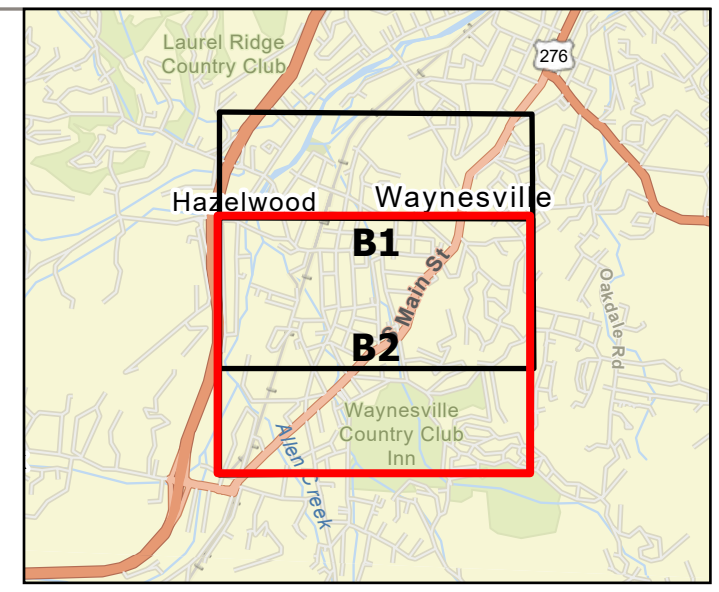
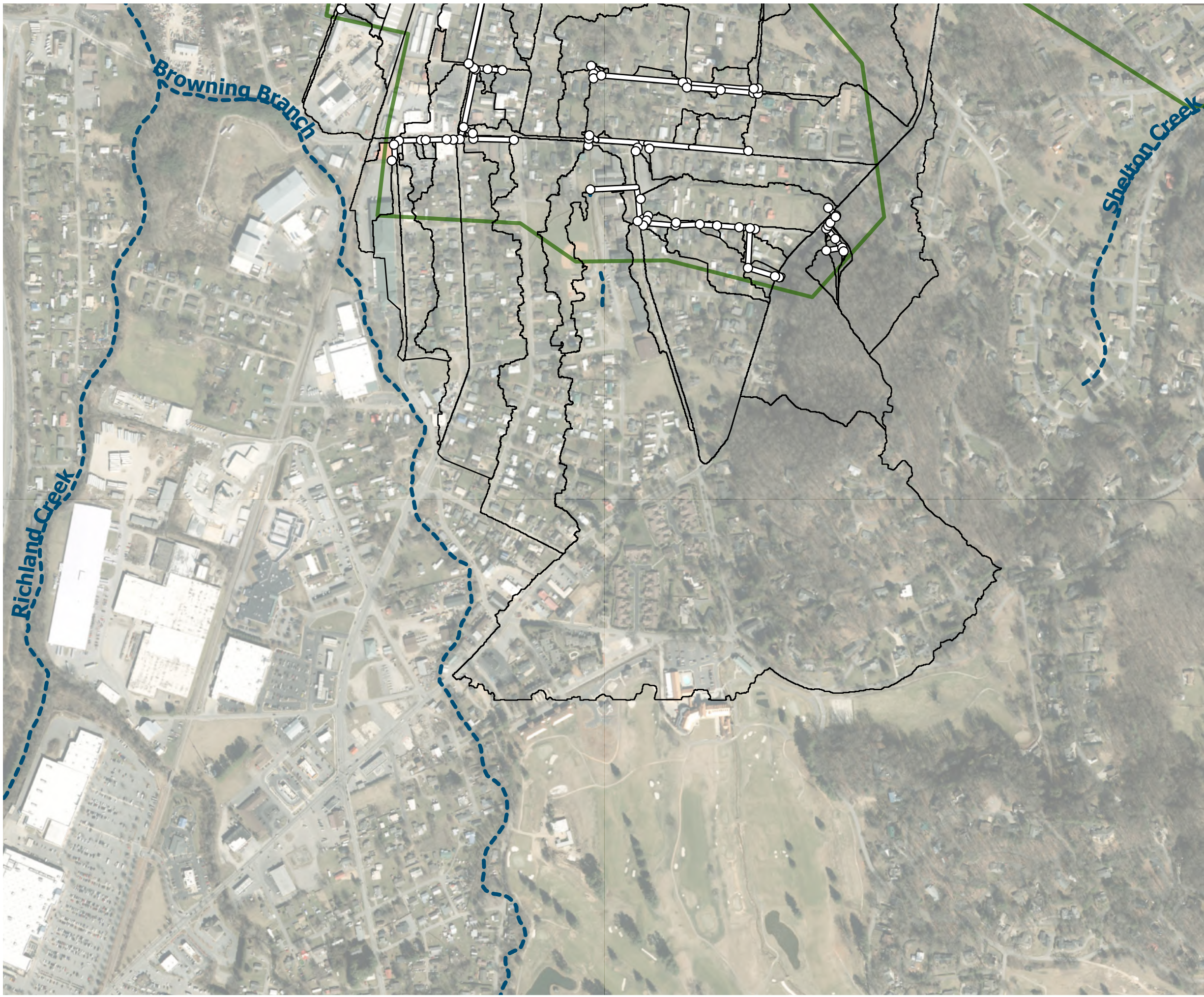
Hazelwood: B1 Drainage Areas Waynesville, NC








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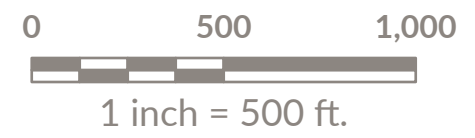
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Legend

-  Existing Junctions
-  Existing Conduits
-  Study Areas
-  Hazelwood Drainage Areas
-  Open Channels



Hazelwood: B2

Drainage Areas

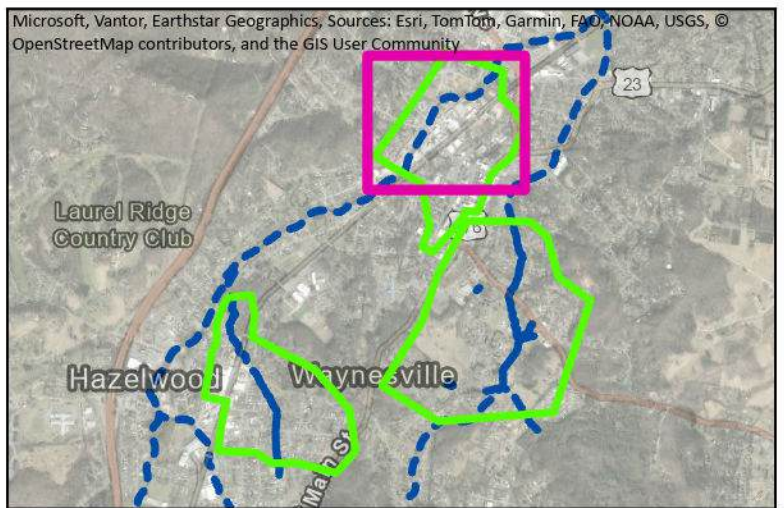
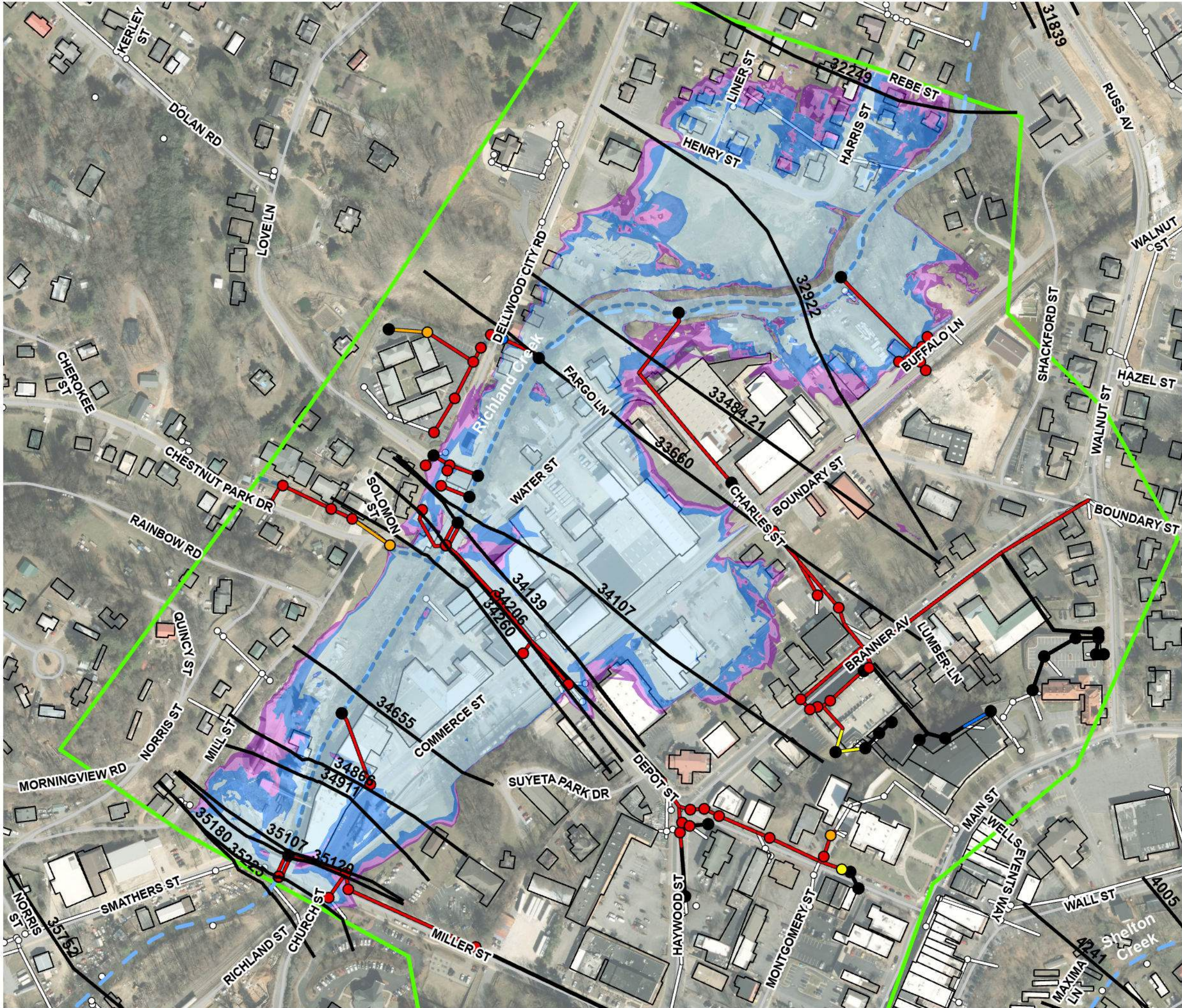
Waynesville, NC



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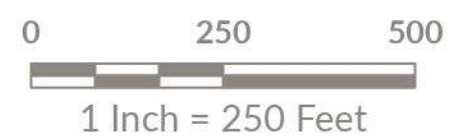
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Legend

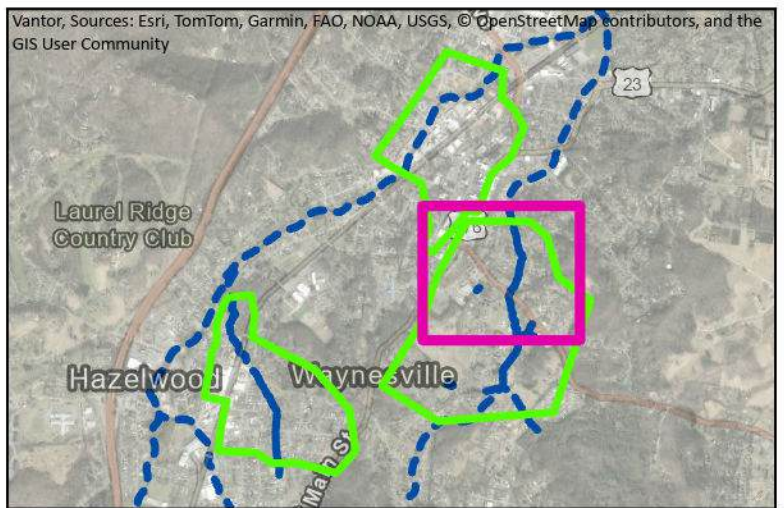
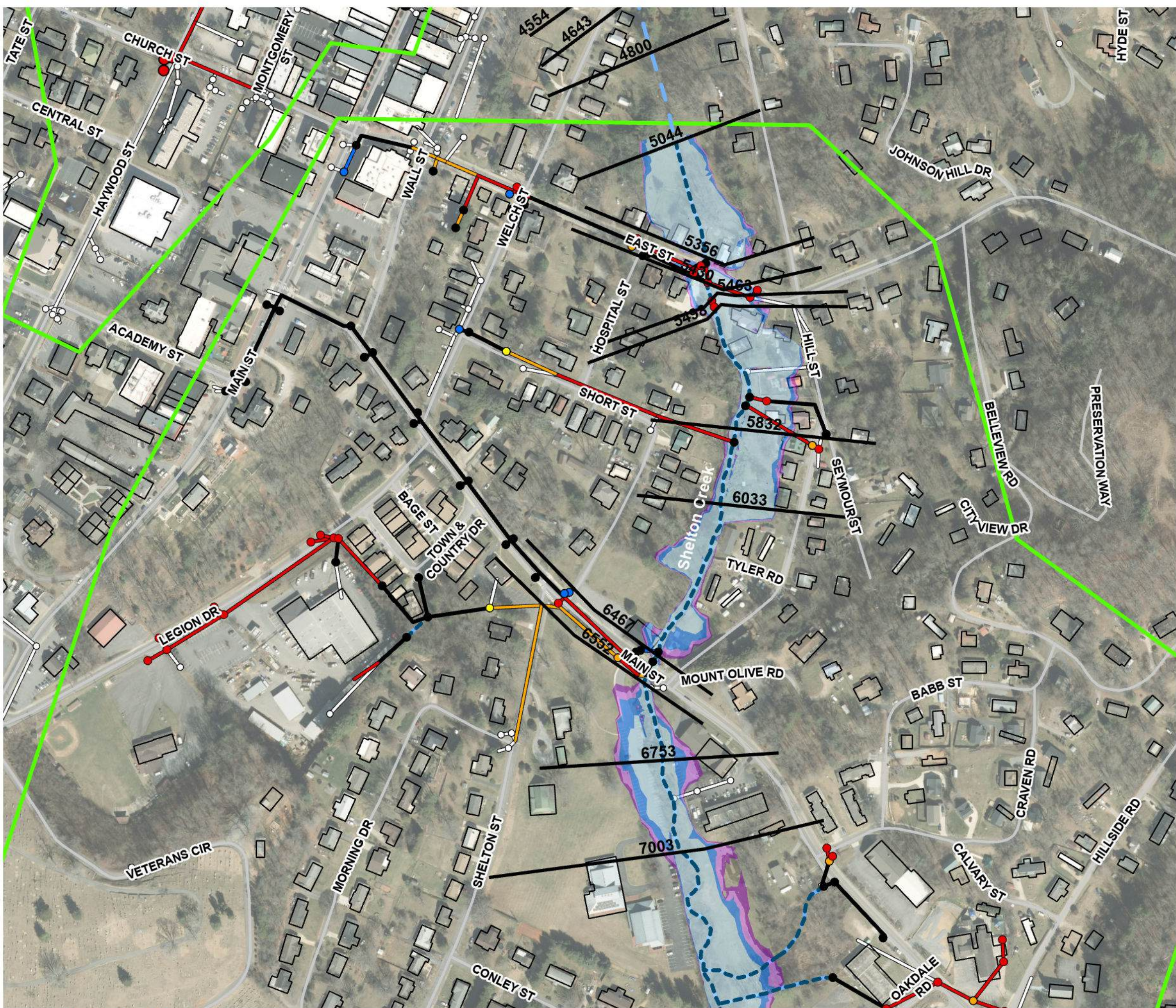
- Junctions**
 - Flooded- 10 YR Storm Event
 - Flooded- 25 YR Storm Event
 - Flooded- 50 YR Storm Event
 - Flooded- 100 YR Storm Event
 - Not Flooded in Analyzed Storms
 - Non-Analyzed
- Conduits**
 - Full Capacity- 10 YR Storm Event
 - Full Capacity- 25 YR Storm Event
 - Full Capacity- 100 YR Storm Event
 - Not at Full Capacity in Analyzed Storms
 - Non-Analyzed
- Context**
 - ▭ Structures
 - Modeled Open Channels
 - Non-Modeled Open Channels
 - ▭ Study Areas
- Riverine Inundation**
 - 10 YR Storm Event
 - 25 YR Storm Event
 - 50 YR Storm Event
 - 100 YR Storm Event
 - FEMA Stream Station



Frog Level
FEMA Cross Sections
Waynesville, NC

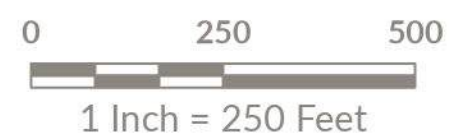
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Legend

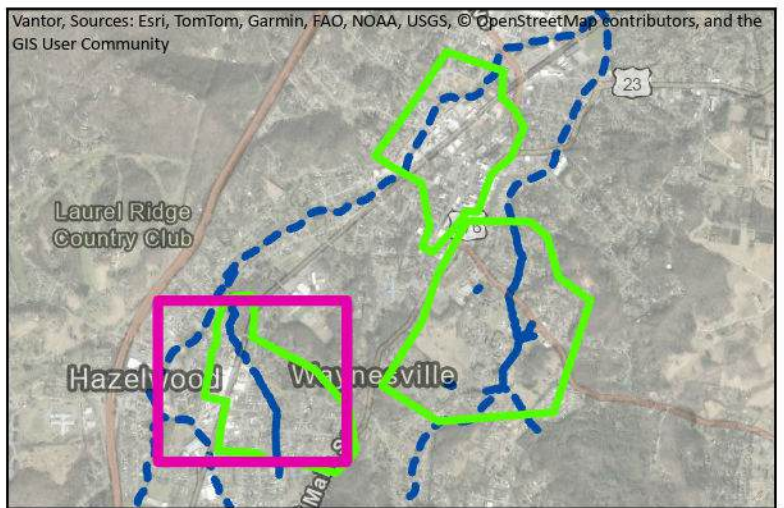
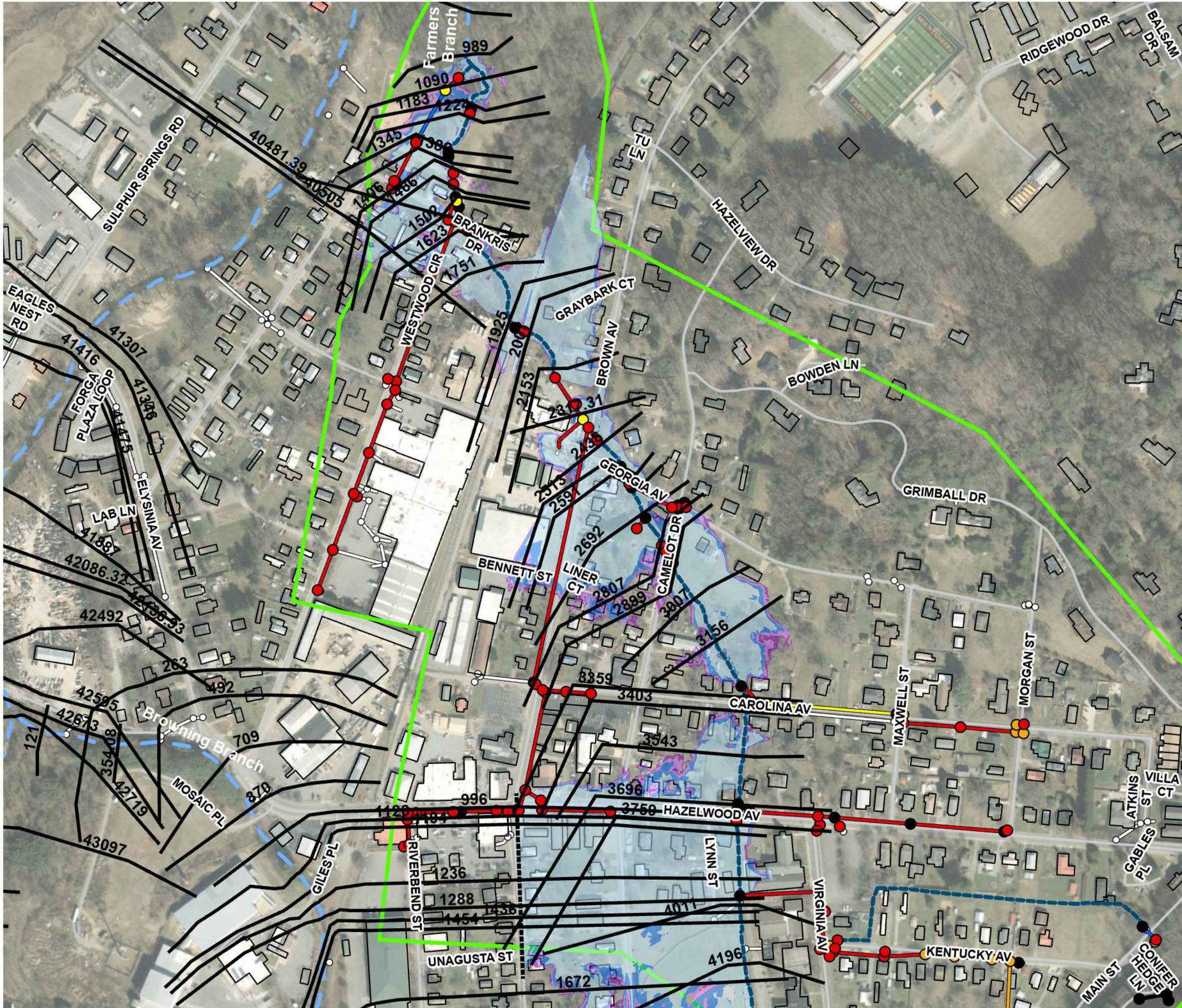
- Junctions**
 - Flooded- 10 YR Storm Event
 - Flooded- 25 YR Storm Event
 - Flooded- 50 YR Storm Event
 - Flooded- 100 YR Storm Event
 - Not Flooded in Analyzed Storms
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 - Full Capacity- 100 YR Storm Event
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 - Non-Analyzed
- Context**
 - Structures
 - Modeled Open Channels
 - Non-Modeled Open Channels
 - Study Areas
- Riverine Inundation**
 - 10 YR Storm Event
 - 25 YR Storm Event
 - 50 YR Storm Event
 - 100 YR Storm Event
 - FEMA Stream Station



**Shelton Branch
FEMA Cross Sections
Waynesville, NC**

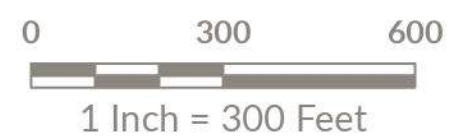
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Legend

- Junctions**
 - Flooded- 10 YR Storm Event
 - Flooded- 25 YR Storm Event
 - Flooded- 50 YR Storm Event
 - Flooded- 100 YR Storm Event
 - Not Flooded in Analyzed Storms
 - Non-Analyzed
- Conduits**
 - Full Capacity- 10 YR Storm Event
 - Full Capacity- 25 YR Storm Event
 - Full Capacity- 100 YR Storm Event
 - Not at Full Capacity in Analyzed Storms
 - Non-Analyzed
- Context**
 - Structures
 - Modeled Open Channels
 - Non-Modeled Open Channels
 - Study Areas
- Riverine Inundation**
 - 10 YR Storm Event
 - 25 YR Storm Event
 - 50 YR Storm Event
 - 100 YR Storm Event
 - FEMA Stream Station



**Hazelwood
FEMA Cross Sections
Waynesville, NC**

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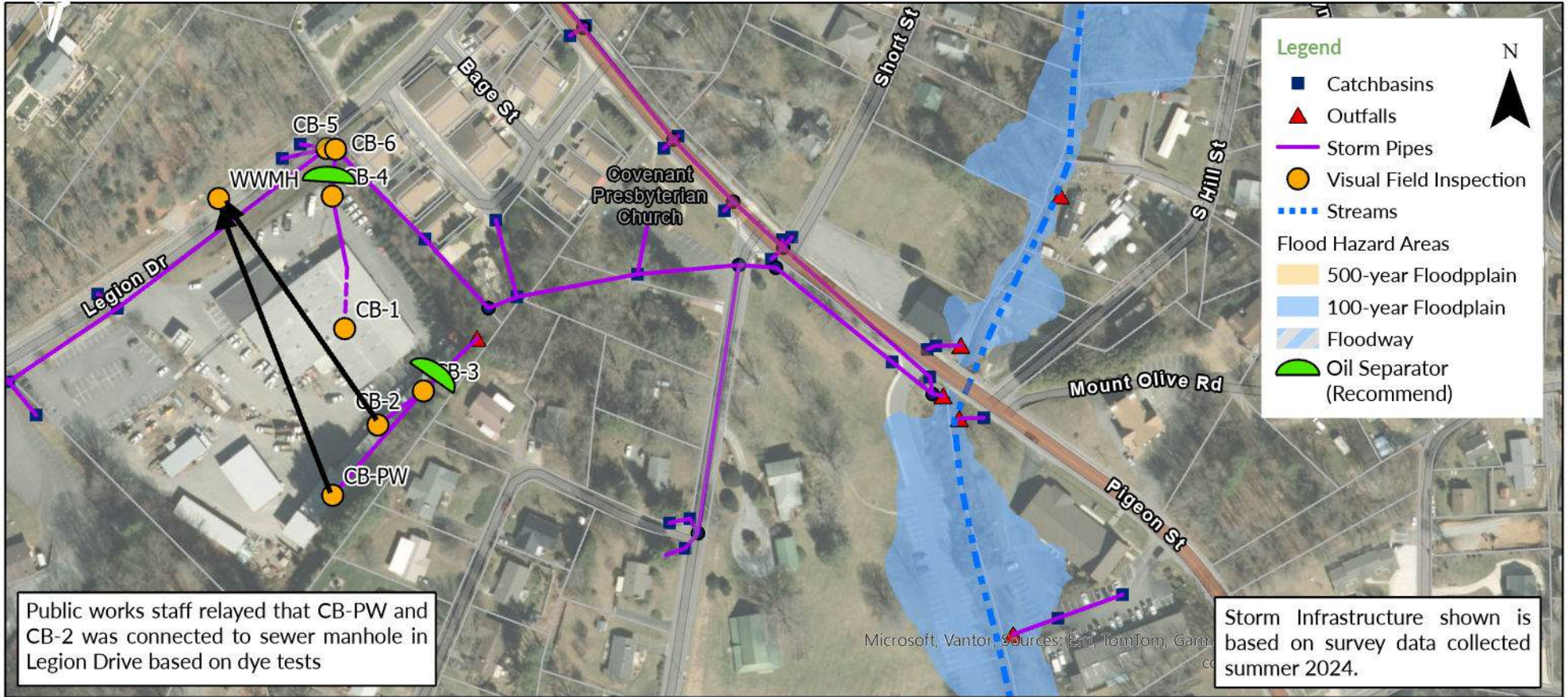
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Appendix C: Town Facility Investigation

Guidance for Visual Inspection

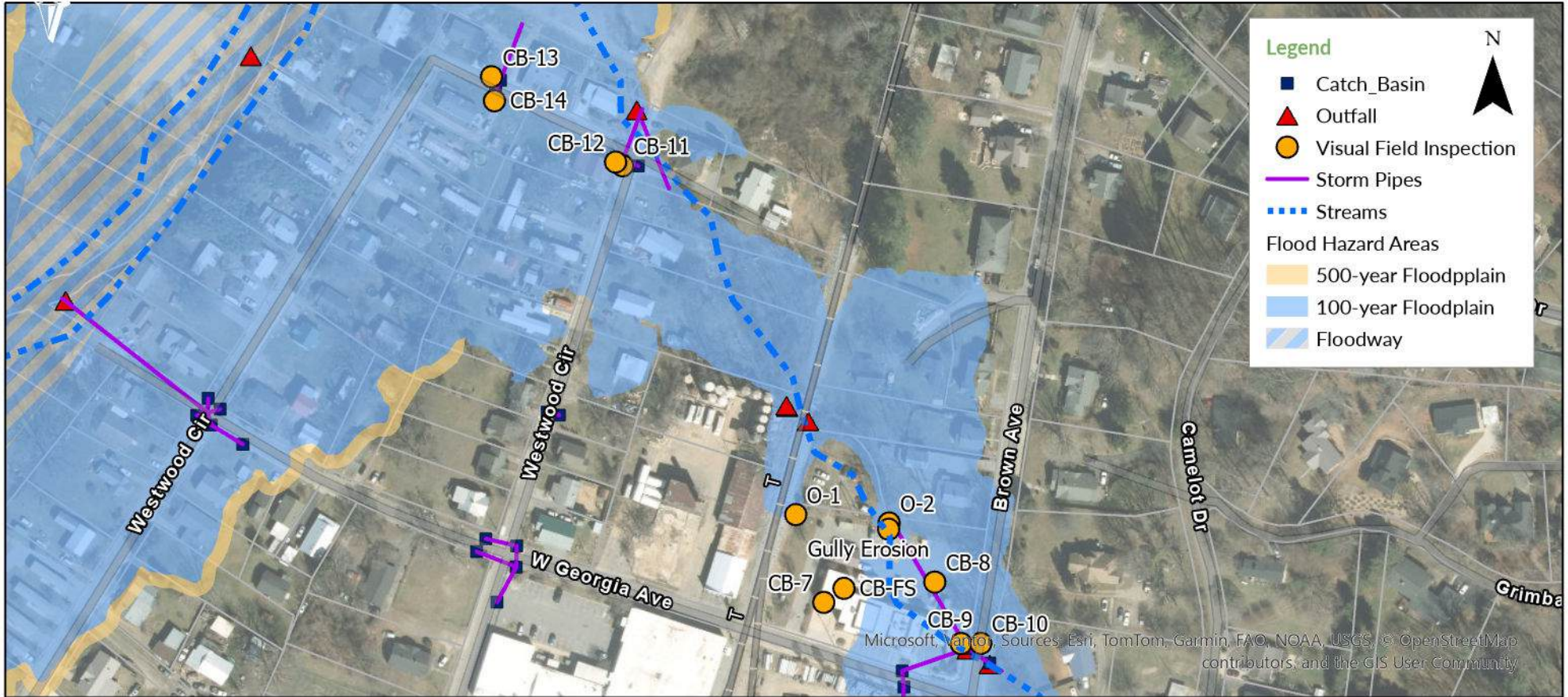
	Infrastructure Condition	Obstruction	Pipe Capacity	Vegetative Cover	Vegetative Condition	Erosion (Bed, Rill, or Gully)	Drainage Area Condition
Pass	Good condition	Free of sediment/debris	Free of sediment and debris	Good >75%	Plants alive and in good condition	None	Stabilized, pavement integrity
Minor	Few cracks or isolated deterioration that doesn't impact infrastructure function	<6" Sediment	Nominal loss of pipe capacity	<65% vegetative cover (Isolated bare spots)	Considerable weeding needed	<3"	Isolated spots that generate sediment
Moderate	Moderate flaws in structural integrity resulting in infrastructure not functioning properly	Debris blocking at least 1/3 opening	Significant loss of pipe capacity	<50% vegetative cover	Some plants are dead or diseased or some invasives	3-6"	Fair to poor condition, risk for sediment, grass clippings, etc.
Severe	Damage that impairs , grout has separated or cracked wider than 1/2" and >1' at joint of inlet/outlet pipe	Complete blockage	clogged with sediment or debris	<35% vegetative cover	Significant plant mortality, invasives	>6"	Exposed soils, erosion

Waynesville - Public Works



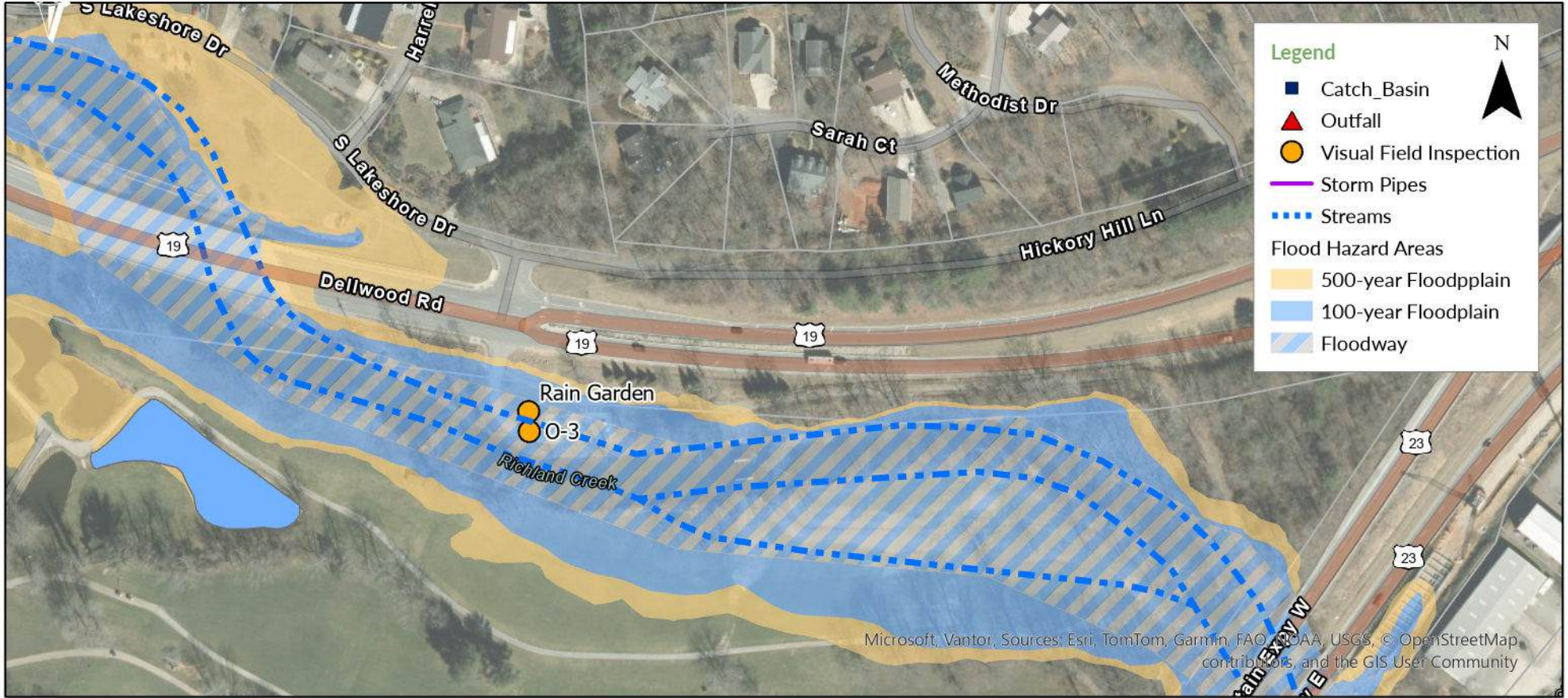
Name	Infrastructure Condition	Notes	Repair
CB-1	Pass	Trash truck bay. FilterSock, Possible need for oil separator	Yes
CB-2	Pass	FilterSock. 3" standing water. Sediment accumulation around inlet	Yes
CB-3	Pass	FilterSock. Inlet covered w/ trash & sediment. 30" standing water.	Yes
CB-4	Pass	FilterSock. 4" standing water	Yes
CB-5	Pass	Receives street drainage and connects into adjacent structure	No
CB-6	Pass	Sediment deposition at inlet. 1" standing water	No
CB-PW	Pass	FilterSock	Yes
WWMH	N/A	Sanitary sewer manhole	No

Waynesville - Fire Station 2



Name	Infrastructure Condition	Notes	Repair
CB-FS	Pass	Interior floor drain backups. Check if connects to O-2.	Yes
CB-7	Pass	Interior floor drain backups. Check if connects to O-2.	Yes
CB-8	Minor	Told that parking lot floods and may lack pipe capacity	Yes
CB-9	Pass	Connected directly to stream	No
CB-10	Severe	Missing curb along road edge	Yes
CB-11	Pass	Structure and pipe completely clogged,	Yes
CB-12	Pass	Functioning	No
CB-13	Pass	Inlet pipe shows moderate sedimentation	Yes
CB-14	Pass	Heavy sedimentation in structure	Yes
O-2	Pass	Minor sediment deposition in pipe. Moderate bank erosion	No
Gully Erosion	N/A	Erosion downstream of parking lot above culvert	Yes
O-1	Minor	Concrete lined swale is slowly disintegrating	No

Waynesville - Greenway Rain Garden



Name	Infrastructure Condition	Notes	Repair
O-3	Moderate		Yes
Rain Garden	Moderate	Town reported plants have died three times	Yes

Infrastructure Condition Rating Table

ID	Name	Property	Infrastructure Condition	Notes	Cover	Obstruction
1	CB-1	Public Works	Pass	Trash truck bay. FilterSock, Possible need for oil separator	Yes	Minor
2	CB-2	Public Works	Pass	FilterSock. 3" standing water. Sediment accumulation around inlet	Yes	Moderate
3	CB-3	Public Works	Pass	FilterSock. Inlet covered w/ trash & sediment. 30" standing water.	Yes	Severe
4	CB-4	Public Works	Pass	FilterSock. 4" standing water	Yes	Minor
5	CB-5	Public Works	Pass	Receives street drainage and connects into adjacent structure	Yes	Minor
6	CB-6	Public Works	Pass	Sediment deposition at inlet. 1" standing water	Yes	Minor
7	CB-FS	Fire Station 2	Pass	Interior floor drain backups. Check if connects to O-2.	No	Pass
8	CB-7	Fire Station 2	Pass	Interior floor drain backups. Check if connects to O-2.	No	Pass
9	CB-8	Fire Station 2	Minor	Told that parking lot floods and may lack pipe capacity	Yes	Pass
10	CB-9	Fire Station 2	Pass	Connected directly to stream	Yes	Minor
11	CB-10	Fire Station 2	Severe	Missing curb along road edge	Yes	Moderate
12	CB-11	Dutch Fischer Park	Pass	Structure and pipe completely clogged,	Yes	Pass
13	CB-12	Dutch Fischer Park	Pass	Functioning	Yes	Minor
14	CB-13	Dutch Fischer Park	Pass	Inlet pipe shows moderate sedimentation	Yes	Moderate
15	CB-14	Dutch Fischer Park	Pass	Heavy sedimentation in structure	Yes	Minor
16	CB-PW	Public Works	Pass	FilterSock	Yes	Moderate
17	O-1	Fire Station 2	Minor	Concrete lined swale is slowly disintegrating	N/A	Pass
18	O-2	Fire Station 2	Pass	Minor sediment deposition in pipe. Moderate bank erosion	N/A	N/A
19	O-3	Waynesville Greenway Park	Moderate	Pipe opening has been compressed reducing inflow capacity	No	Moderate
20	Rain Garden	Waynesville Greenway Park	Moderate	Town reported plants have died three times	N/A	Moderate
21	WWMH	Public Works	N/A	Sanitary sewer manhole	N/A	N/A
22	Erosion	Fire Station 2	N/A	Erosion downstream of parking lot above culvert	N/A	N/A
23	Potential SCM Along Greenway			Standing Water, site is in floodplain, amend soils and add vegetation		

Waynesville Facility Investigation Photo Log

Public Works Facility



Public Works #1 – Floor Drain inside garage



Public Works #2 – Floor Drain by eyewash station



Public Works #3 – External Clean out Access



Public Works #4– Bay Inlet



Public Works #5 – Bay Inlet



Public Works #6– Bay Inlet



Public Works #7– Parking Lot Inlet

Fire Station 2 and Finance Building



Fire Station #1– Parking Bay Inlet 1



Fire Station #2– Parking Bay Inlet 2



Fire Station #3– Parking Lot Inlet



Fire Station #4– Outlet to Railroad Ditch



Fire Station #5– Pipe outlet on north side of parking lot



Fire Station #6– Gully erosion adjacent to pipe



Fire Station #7– Brown Street inlet on west side



Fire Station #8– Brown St inlet on east side missing curb

Hazelwood Neighborhood



Hazelwood #1– Inlet and paved ditch on Westwood Circle



Hazelwood #2– Inlet on Westwood Circle with debris



Hazelwood #3– Inlet on Westwood Circle that collects grass clippings



Hazelwood #4– Inlet on Westwood Circle

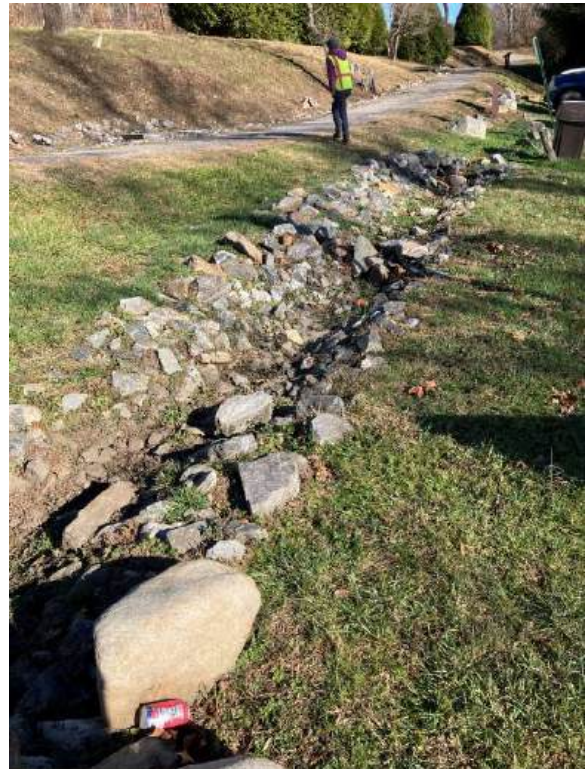
Greenway Rain Garden by Lake Junaluska



Greenway Rain Garden #1 – Vegetation



Greenway Rain Garden #2 – Outflow Channel



Greenway Rain Garden #3 – Pre-treatment Swale



Greenway Rain Garden #4 – Compromised Culvert underneath driveway

Richland Creek Greenway



Richland Creek Greenway #1 – Ponded Water



Richland Creek Greenway #2 – Riparian Buffer

Appendix D: SWMM Input Parameters

Shelton Branch				
Subcatchments				
Name	Outlet	Area (ac)	Time of Concentration (min)	Curve Number
0	J5430	0.131	10	84
7253	SWDI0244	0.545	10	79
7255	SWDI0246	4.065	10	71
7256	OF137	0.022	10	86
7257	SWDI0248	0.223	10	82
7258	SWMH0014	6.937	10	72
7260	SWDI0254	1.851	10	63
7261	SWDI0255	0.766	10	65
7262	SWDI0331	0.51	10	87
7263	SWDI0332	2.502	10	64
7264	SWDI0333	3.428	10	81
7265	SWDI0334	0.025	10	77
7266	SWDI0335	0.702	10	98
7267	SWDI0336	1.437	10	82
7268	SWDI0337	0.209	10	65
7269	SWDI0338	1.586	10	69
7271	SWDI0340	0.121	10	86
7272	SWDI0341	2.402	10	61
7273	SWDI0343	0.21	10	83
7274	SWDI0344	0.145	10	87
7275	SWDI0345	0.443	10	98
7276	SWDI0346	0.041	10	98
7277	SWDI0347	0.877	10	77
7278	SWDI0348	0.1	10	97
7279	SWDI0349	0.684	10	72
7280	SWDI0350	0.638	10	89
7281	SWDI0351	0.005	10	90
7282	SWDI0352	3.181	10	74
7283	SWDI0353	0.137	10	85
7284	SWDI0354	0.122	10	76
7285	SWMH0012	0.298	10	76
7287	SWDI0357	4.77	10	64
7288	SWDI0358	0.4	10	77
7292	J5356	0.1	10	97
7293	SWDI0365	0.5	10	75
72931	J14	1.2	10	74
7294	SWDI0364	0.1	10	94
7296	SWDI0366	3.2	10	69
7297	SWDI0367	3.6	10	67
7298	SWDI0368	0.0	10	85
7299	SWMH0012	2.1	10	67
7300	SWDI0370	0.6	10	70
7301	SWDI0371	0.2	10	95
7302	SWDI0372	0.3	10	75
7303	SWDI0373	0.1	10	89
7304	SWDI0374	0.1	10	96
7305	SWDI0375	0.2	10	98
7307	SWMH0076	0.6	10	94
7308	SWDI0378	1.2	10	98
7309	SWMH0029	0.1	10	92
7310	SWMH0029	0.4	10	98
7311	SWMH0031	0.7	10	98
7312	SWDI0984	0.3	10	70
7313	SWMH0091	9.2	10.361	72
7315	SWDI1014	0.1	10	79
7316	SWMH0015	0.4	10	96
7318	SWDI1081	0.1	10	69
73181	SWDI1082	0.3	10	77
7320	SWDI1083	0.1	10	69
7321	SWDI1084	0.5	10	90
7322	SWDI1129	0.2	10	79
7323	SWDI1130	0.6	10	97
7324	SWDI1131	0.6	10	98
7325	SWDI1132	0.2	10	87
7326	SWDI1133	0.3	10	73
7327	SWDI1134	0.1	10	85
7328	SWDI1135	0.1	10	83
7329	SWDI1136	0.8	10	73
7330	SWDI1137	0.4	10	69
7331	SWDI1138	1.4	10	72
7335	SWDI1142	0.3	10	76
73351	J5832	2.1	10.38	70
7336	SWDI1144	0.3	10	84
7337	SWDI1145	6.8	10	64
7338	SWDI1146	5.2	10	70
7339	SWDI1147	0.9	10	61
7340	SWDI1148	0.4	10	73
7342	SWDI1150	1.7	10	68
7343	SWDI1151	0.1	10	96
7344	SWDI1152	0.0	10	91
7345	SWDI1153	7.0	10	64
7346	SWDI1197	4.4	11.56	73
7347	SWDI1198	2.0	10	69
7348	SWDI1199	0.4	10	80
7349	SWDI1200	1.2	10	68
7350	SWDI1201	0.2	10	73
7351	SWDI1202	0.1	10	95
7352	SWDI1203	1.9	10.36	81
7353	SWDI1204	8.2	10	67
7358	SWDI1254	0.1	10	71
7361	SWDI1263	55.5	11.76	61
7362	SWDI1267	1.7	10	72
7364	SWDI1269	19.7	10	63
7365	SWDI1153	2.3	10	71

Shelton Branch				
Subcatchments				
Name	Outlet	Area (ac)	Time of Concentration (min)	Curve Number
7366	SWD1271	0.4	10	73
7367	SWD1272	13.8	11.093	65
7374	SWD1284	2.7	10	68
7375	SWD1285	1.0	10	96
7377	J16	7.2	10	70
7381	OF123	0.6	10	76
7386	J18	0.6	10	76
7397	J23	4.5	10	67
7406	CVPT0001	1.4	10	67
7412	J1	9.7	12	63
7425	J22	0.4	10	83
7429	J21	0.5	10	77
7432	SWD1139	0.6	10	59
74321	J6753	7.8	10	70
7433	J6467	0.3	10	83
7434	J7003	8.2	10	73
7435	J20	0.7	10	78
7436	J19	0.3	10	76
7440	J13	5.1	12.06	69
7443	J17	7.7	10	63
7478	SWMH0090	0.3	10	70
7481	SWMH0104	17.4	10	62
7486	SWMH0011	3.8	10	69
R1	SWDP0037	19.5	18.573	66
R2	J24	559.2	56	69
R3	J4	109.2	36	66

Shelton Branch					
Junctions					
Name	Tag	Description	Invert Elev. (ft)	Rim Elev. (ft)	Depth (ft)
CVPT0001		Bell	2666.494	2667.744	1.25
J1	StormNet		2700.593	2702.593	2
J10			2664.058	2666.703	2.645
J11			2671.935	2680.183	8.248
J12			2667.899	2670.899	3
J13			2657.467	2659.157	1.69
J14			2643.897	2677.07	33.173
J15	StormNet		2652.484	2670.484	18
J16			2648.592	2682.071	33.479
J17			2645.238	2669.045	23.807
J18			2658.186	2664.97	6.784
J19			2658.775	2666.66	7.885
J2	StormNet		2686.64	2692.458	5.818
J20			2659.596	2665.326	5.73
J21			2660.867	2664.417	3.55
J22			2662.118	2669.021	6.903
J23			2668.02	2671.048	3.028
J24			2665.6	2672	6.4
J25			2665.343	2668.039	2.696
J26			2686.154	2686.787	0.633
J27			2676.7	2676.7	0
J28			2706.015	2706.015	0
J29			2689.219	2689.219	0
J3	StormNet		2683.92	2698.325	14.405
J30			2720.387	2720.387	0
J31			2680.291	2680.36	0.069
J32			2650.5	2674.063	23.563
J4			2667.437	2670.437	3
J5	StormNet		2662.458	2670.872	8.414
J5356		River: Shelton Creek Reach: Reach-1 Transect: 5356	2643.25	2672.48	29.23
J5430		River: Shelton Creek Reach: Reach-1 Transect: 5430	2643.5	2677.42	33.92
J5463		River: Shelton Creek Reach: Reach-1 Transect: 5463	2643.25	2677.69	34.44
J5498		River: Shelton Creek Reach: Reach-1 Transect: 5498	2643.5	2679.45	35.95
J5832		River: Shelton Creek Reach: Reach-1 Transect: 5832	2646.43	2690.09	43.66
J6			2663.089	2673.089	10
J6033		River: Shelton Creek Reach: Reach-1 Transect: 6033	2647.62	2681.59	33.97
J6467		River: Shelton Creek Reach: Reach-1 Transect: 6467	2650.75	2683.14	32.39
J6552		River: Shelton Creek Reach: Reach-1 Transect: 6552	2651	2676.48	25.48
J6753		River: Shelton Creek Reach: Reach-1 Transect: 6753	2651.74	2683.49	31.75
J7			2677.825	2685.649	7.824
J7003		River: Shelton Creek Reach: Reach-1 Transect: 7003	2653.85	2701.06	47.21
J8	StormNet		2645.812	2649.851	4.039
J9	StormNet		2656.748	2676.748	20
OF121		Standard Outlet	2645.64	2666.636	20.996
OF1221			2645.86	2688.009	42.149
OF123		Standard Outlet	2646.54	2666.54	20
OF1251			2650.547	2683.039	32.492
OF133	StormNet	Standard Outlet	2659.343	2666.6	7.257
OF134	StormNet	Standard Outlet	2659.995	2663.324	3.329
OF135		Cut	2661.9	2665.712	3.812
OF136	StormNet	Standard Outlet	2662.24	2670.872	8.632
OF137	StormNet	Standard Outlet	2665.281	2666.972	1.691
OF138		Standard Outlet, cut	2665.577	2668.577	3
SWDI0244		Grate Inlet	2708.703	2712.753	4.05
SWDI0248		Grate Inlet	2666.993	2668.943	1.95
SWDI0254		Grate Inlet	2690.73	2694.23	3.5
SWDI0255		Grate Inlet	2706.737	2708.687	1.95
SWDI0331		Grate Inlet	2711.389	2713.439	2.05
SWDI0332		Combo Inlet	2697.466	2699.366	1.9
SWDI0333		Combo Inlet	2695.292	2698.742	3.45
SWDI0334		Grate Inlet	2692.071	2698.121	6.05
SWDI0335		Grate Inlet	2706.383	2712.083	5.7
SWDI0336		Grate Inlet	2680.334	2683.434	3.1
SWDI0337		Grate Inlet	2671.091	2678.391	7.3
SWDI0338		Grate Inlet	2663.362	2670.062	6.7
SWDI0340		Combo Inlet	2654.415	2660.515	6.1
SWDI0341		Combo Inlet	2695.826	2699.526	3.7
SWDI0343		Combo Inlet	2749.053	2750.753	1.7
SWDI0344		Grate Inlet	2748.32	2750.32	2
SWDI0345		Combo Inlet	2727.81	2732.21	4.4
SWDI0346		Combo Inlet	2720.671	2724.371	3.7
SWDI0347		Combo Inlet	2722.501	2724.651	2.15
SWDI0348		Combo Inlet	2706.158	2708.658	2.5
SWDI0349		Combo Inlet	2703.773	2707.273	3.5
SWDI0350		Grate Inlet	2657.336	2659.786	2.45
SWDI0351		Grate Inlet	2656.188	2660.588	4.4
SWDI0352		Combo Inlet	2689.932	2691.732	1.8
SWDI0353		Combo Inlet	2688.537	2691.837	3.3
SWDI0354		Grate Inlet	2682.667	2685.467	2.8
SWDI0357		Grate Inlet	2652.391	2655.491	3.1
SWDI0358		Grate Inlet	2651.057	2655.357	4.3
SWDI0364		Combo Inlet	2645.447	2649.297	3.85
SWDI0365		Combo Inlet	2647.14	2649.39	2.25
SWDI0366		Combo Inlet	2648.009	2650.209	2.2
SWDI0367		Combo Inlet	2647.392	2649.592	2.2
SWDI0368		Combo Inlet	2650.858	2652.958	2.1
SWDI0369		Combo Inlet	2650.634	2654.034	3.4
SWDI0370		Combo Inlet	2652.67	2656.32	3.65
SWDI0371		Combo Inlet	2652.647	2656.197	3.55
SWDI0372		Combo Inlet	2688.521	2693.271	4.75
SWDI0373		Combo Inlet	2687.752	2690.052	2.3
SWDI0374		Combo Inlet	2690.762	2692.862	2.1
SWDI0375		Combo Inlet	2735.281	2737.931	2.65
SWDI0378		Combo Inlet	2737.386	2739.786	2.4

Shelton Branch					
Junctions					
Name	Tag	Description	Invert Elev. (ft)	Rim Elev. (ft)	Depth (ft)
SWDI0984		Combo Inlet	2674.664	2677.414	2.75
SWDI1014		Combo Inlet	2679.923	2682.723	2.8
SWDI1081		Combo Inlet	2715.841	2721.791	5.95
SWDI1082		Combo Inlet	2701.254	2706.404	5.15
SWDI1083		Combo Inlet	2702.279	2707.479	5.2
SWDI1084		Combo Inlet	2689.412	2694.362	4.95
SWDI1129		Grate Inlet	2759.966	2762.166	2.2
SWDI1130		Grate Inlet	2759.326	2761.776	2.45
SWDI1131		Grate Inlet	2762.583	2764.683	2.1
SWDI1132		Combo Inlet	2687.247	2690.597	3.35
SWDI1133		Combo Inlet	2688.384	2691.034	2.65
SWDI1134		Combo Inlet	2674.494	2677.394	2.9
SWDI1135		Combo Inlet	2667.901	2669.801	1.9
SWDI1136		Combo Inlet	2662.689	2665.489	2.8
SWDI1137		Combo Inlet	2663.4	2665.4	2
SWDI1138		Combo Inlet	2662.014	2665.614	3.6
SWDI1139		Slabtop	2652.927	2660.527	7.6
SWDI1142		Grate Inlet	2646.924	2649.324	2.4
SWDI1144		Grate Inlet	2717.705	2721.355	3.65
SWDI1145		Grate Inlet	2720.29	2724.24	3.95
SWDI1146		Grate Inlet	2720.218	2722.668	2.45
SWDI1147		Combo Inlet	2712.09	2714.49	2.4
SWDI1148		Grate Inlet	2690.047	2695.347	5.3
SWDI1150		Combo Inlet	2701.183	2703.933	2.75
SWDI1151		Grate Inlet	2686.961	2692.111	5.15
SWDI1152		Grate Inlet	2688.816	2691.916	3.1
SWDI1197		Grate Inlet	2669.974	2672.874	2.9
SWDI1198		Grate Inlet	2669.33	2672.38	3.05
SWDI1199		Grate Inlet	2688.236	2690.486	2.25
SWDI1200		Grate Inlet	2688.008	2691.008	3
SWDI1201		Slabtop	2680.435	2689.935	9.5
SWDI1202		Combo Inlet	2678.136	2681.786	3.65
SWDI1203		Grate Inlet	2677.47	2680.42	2.95
SWDI1204		Combo Inlet	2677.931	2680.631	2.7
SWDI1254		Pipe	2656.604	2658.1	1.496
SWDI1267		Pipe	2678.794	2680.294	1.5
SWDI1269		Pipe	2709.48	2711.88	2.4
SWDI1270		Pipe	2688.502	2691.7	3.198
SWDI1271		Pipe	2668.469	2669.719	1.25
SWDP0014		Standard Outlet	2671.575	2674.075	2.5
SWDP0015		Standard Outlet	2665.895	2668.895	3
SWDP0023	StormNet		2658.4	2666.7	8.3
SWDP0024		Standard Outlet, cut	2674.883	2678.609	3.726
SWDP0037			2691.6	2697.6	6
SWDP0045		Standard Outlet	2708.396	2709.646	1.25
SWMH0011	MH		2666	2676.211	10.211
SWMH0012	MH		2674.238	2681.087	6.849
SWMH0013	MH		2664.949	2670.384	5.435
SWMH0014	MH	OTH	2667.676	2671.26	3.584
SWMH0015	MH	OTH	2710.797	2714.584	3.787
SWMH0028	MH	STD	2732.224	2737.324	5.1
SWMH0029	MH	STD	2719.966	2724.666	4.7
SWMH0030	MH	STD	2715.106	2720.106	5
SWMH0031	MH	STD	2713.449	2717.399	3.95
SWMH0032	MH	STD	2699.112	2704.912	5.8
SWMH0033	MH	STD	2688.464	2693.964	5.5
SWMH0034	MH	STD	2686.074	2689.724	3.65
SWMH0035	MH	STD	2651.395	2656.245	4.85
SWMH0036	MH	STD	2649.436	2654.336	4.9
SWMH0074	MH	STD	2746.863	2750.863	4
SWMH0075	MH	STD	2757.472	2762.372	4.9
SWMH0076	MH	STD	2745.759	2749.059	3.3
SWMH0077	MH	STD	2728.865	2733.965	5.1
SWMH0078	MH	STD	2720.371	2724.621	4.25
SWMH0079	MH	STD	2704.472	2708.922	4.45
SWMH0080	MH	STD	2686.735	2691.035	4.3
SWMH0081	MH	STD	2673.899	2677.899	4
SWMH0082	MH	STD	2666.66	2670.31	3.65
SWMH0083	MH	STD	2659.849	2665.749	5.9
SWMH0084	MH	STD	2658.912	2665.812	6.9
SWMH0085	MH	STD	2660.62	2668.57	7.95
SWMH0086	MH	STD	2652.543	2661.643	9.1
SWMH0090	MH	STD	2674.628	2682.228	7.6
SWMH0091	MH	STD	2683.461	2686.911	3.45
SWMH0092	MH	STD	2697.633	2703.733	6.1
SWMH0104		DRP	2681.798	2694.098	12.3
SWMH0105	MH	STD	2679.728	2682.978	3.25
SWMH0113	MH	STD	2701.505	2707.155	5.65

Shelton Branch

Conduits

Name	Inlet Node	Outlet Node	Tag	Length (ft)	Roughness	Inlet Elev. (ft)	Outlet Elev. (ft)	Entry Loss Coeff.	Exit Loss Coeff.	Cross-Section	Geom1 (ft)	Barrels	Slope (ft/ft)
C1	J1	SWDI1153	Open_Channel	119.641	0.01	2700.593	2688.929	0	0	IRREGULAR	0	1	0.09796
C10	OF1221	OF121	Open_Channel	25.406	0.01	2645.86	2645.64	0	0	IRREGULAR	0	1	0.00866
C11	J11	J12		162.234	0.024	2671.935	2667.899	0.5	1	CIRCULAR	3	1	0.02489
C12	J5	OF136	highchord	20	0.016	2670.872	2670.872	0	0	IRREGULAR	0	1	0
C12_1	J12	J10	Open_Channel	110.114	0.01	2667.899	2664.058	0	0	IRREGULAR	0	1	0.0349
C12_2	J10	J13	Open_Channel	198.022	0.01	2664.058	2658.4	0	0	IRREGULAR	0	1	0.02858
C13	SWDI0364	J5356		14.629	0.022	2645.447	2644.734	0.5	1	CIRCULAR	1.5	1	0.0488
C14	SWDI0244	SWDI1150	overland	274.187	0.016	2712.753	2703.933	0	0	STREET	0	1	0.03218
C15	SWDI1150	SWDI1153	overland	396.834	0.016	2703.933	2691.329	0	0	STREET	0	1	0.03178
C16	SWDI1153	SWDI1152	overland	20	0.016	2691.95	2691.916	0	0	IRREGULAR	0	1	0.0017
C17	SWDI1152	J5	overland	969.898	0.016	2692.1	2670.872	0	0	STREET	0	1	0.02189
C18	SWDI0246	SWDI1151	overland	10	0.016	2692.111	2692.111	0	0	IRREGULAR	0	1	0
C19	SWDI1151	SWDI1152	overland	24.224	0.016	2692.111	2691.916	0	0	IRREGULAR	0	1	0.00805
C2	J9	J7003	Open_Channel	323.64	0.01	2696.748	2653.85	0	0	IRREGULAR	0	1	0.00895
C20	SWDI0248	SWDP0015	overland	10	0.035	2669.7	2668.895	0	0	IRREGULAR	0	1	0.08076
C21	SWDP0015	OF138	overland	20	0.016	2670.2	2668.577	0	0	IRREGULAR	0	1	0.08142
C23	SWDI0254	SWMH0104	overland	32.999	0.016	2694.23	2693.6	0	0	IRREGULAR	0	1	0.01909
C24	SWDI1271	OF136	overland	30	0.016	2671.2	2670	0	0	IRREGULAR	0	1	0.04003
C25	SWDI1014	SWDI1202	overland	194	0.016	2682.723	2681.786	0	0	STREET	0	1	0.00483
C26	SWDI1202	SWDP0024	overland	18	0.045	2681.786	2678.609	0	0	IRREGULAR	0	1	0.17932
C27	SWDI1147	SWDI0341	overland	305.863	0.016	2714.49	2699.526	0	0	STREET	0	1	0.04898
C28	SWDI0331	SWDI0333	overland	351.779	0.016	2713.439	2698.742	0	0	STREET	0	1	0.04182
C29	SWDI0335	SWDI0333	overland	37	0.03	2712.78	2698.742	0	0	RECT_OPEN	0.1	1	0.41007
C3	SWDI1146	SWDI1147	overland	165.841	0.016	2722.668	2714.49	0	0	STREET	0	1	0.04937
C3_1	OF133	J19	Open_Channel	56.021	0.01	2659.343	2658.775	0	0	IRREGULAR	0	1	0.01014
C3_2	J19	SWDP0023	Open_Channel	37.013	0.01	2658.775	2658.4	0	0	IRREGULAR	0	1	0.01013
C30	SWDI0334	SWDI1148	overland	168.94	0.01	2699	2695.347	0	0	IRREGULAR	0	1	0.02163
C31	SWDI0333	SWDI0334	overland	11.814	0.016	2698.742	2698.121	0	0	IRREGULAR	0	1	0.05264
C32	SWDI0332	SWDI0333	overland	25	0.016	2699.366	2698.742	0	0	IRREGULAR	0	1	0.02497
C33	SWDI0341	SWDI0332	overland	30.884	0.016	2699.526	2699.366	0	0	STREET	0	1	0.00518
C34	SWMH0091	SWDI1138	overland	406.956	0.016	2686.911	2665.614	0	0	STREET	0	1	0.0524
C35	SWDI0337	SWDI0338	overland	164.147	0.05	2678.391	2670.062	0	0	IRREGULAR	0	1	0.05081
C36	SWDI1263	SWMH0104	overland	80	0.02	2698	2694.098	0	0	IRREGULAR	0	1	0.04883
C37	SWDI1138	SWDI0340	overland	263.622	0.016	2665.614	2660.515	0	0	STREET	0	1	0.01935
C38	SWDI1135	SWDI1138	overland	90.079	0.016	2669.801	2665.614	0	0	STREET	0	1	0.04653
C39	SWDI1137	SWDI0350	overland	235.417	0.016	2665.4	2659.786	0	0	STREET	0	1	0.02385
C4	SWDI1145	SWDI1144	overland	57.9	0.016	2725	2721.355	0	0	IRREGULAR	0	1	0.06308
C4_1	OF134	J20	Open_Channel	126.706	0.01	2659.995	2659.596	0	0	IRREGULAR	0	1	0.00315
C4_2	J20	OF133	Open_Channel	80.6	0.01	2659.596	2659.343	0	0	IRREGULAR	0	1	0.00314
C40	SWDI1136	SWDI1137	overland	13.72	0.016	2665.489	2665.4	0	0	STREET	0	1	0.00649
C41	SWDI1134	SWDI1135	overland	116.105	0.016	2677.394	2669.801	0	0	STREET	0	1	0.06554
C42	SWDI0984	SWDI1137	overland	196.503	0.016	2677.414	2665.4	0	0	STREET	0	1	0.06125
C43	SWDI0351	OF1251	overland	47.045	0.03	2660.7	2654	0	0	IRREGULAR	0	1	0.14388
C44	SWDI0350	SWDI0351	overland	12.336	0.016	2657.336	2656.188	0	0	IRREGULAR	0	1	0.09347
C45	SWDI0340	J6552	overland	20	0.03	2660.515	2659	0	0	RECT_OPEN	0.2	1	0.07597
C46	SWDI1139	J6753	overland	316.637	0.016	2660.527	2657	0	0	STREET	0	1	0.01114
C47	SWDI1132	SWDI0984	overland	192.07	0.016	2690.597	2677.414	0	0	STREET	0	1	0.0688
C48	SWDI1133	SWDI1134	overland	195.49	0.016	2691.034	2677.394	0	0	STREET	0	1	0.06994
C49	SWDI0349	SWDI1133	overland	203.087	0.016	2707.273	2691.034	0	0	STREET	0	1	0.08022
C5	SWDI1144	SWDI0331	overland	180.686	0.016	2721.355	2713.439	0	0	STREET	0	1	0.04385
C5_1	OF135	J21	Open_Channel	93.455	0.01	2661.9	2660.867	0	0	IRREGULAR	0	1	0.01105
C5_2	J21	OF134	Open_Channel	78.901	0.01	2660.867	2659.995	0	0	IRREGULAR	0	1	0.01105
C50	SWDI0348	SWDI1132	overland	222.663	0.016	2708.658	2690.597	0	0	STREET	0	1	0.08138
C51	SWDI0346	SWDI0348	overland	196.759	0.016	2724.371	2708.658	0	0	STREET	0	1	0.08011
C52	SWDI0347	SWDI0349	overland	216.709	0.016	2724.651	2707.273	0	0	STREET	0	1	0.08045
C53	SWDI0345	SWDI0346	overland	90.449	0.016	2732.21	2724.371	0	0	STREET	0	1	0.08699
C54	SWDI0344	SWDI0347	overland	265.841	0.016	2750.32	2724.651	0	0	STREET	0	1	0.09701
C55	SWDI0343	SWDI0378	overland	433.744	0.016	2750.753	2739.786	0	0	STREET	0	1	0.02529
C56	SWDI1130	SWDI0343	overland	200.213	0.016	2761.776	2750.753	0	0	STREET	0	1	0.05514
C57	SWDI1129	SWDI0344	overland	206.147	0.016	2762.166	2750.32	0	0	STREET	0	1	0.05756
C58	SWDI1131	SWDI1130	overland	50.535	0.016	2764.683	2761.776	0	0	STREET	0	1	0.05762
C59	SWDI0353	SWDI0354	overland	110.086	0.016	2691.837	2685.467	0	0	STREET	0	1	0.05796
C6	J24	J25	Open_Channel	106.994	0.01	2665.6	2665.343	0	0	IRREGULAR	0	1	0.0024
C6_1	OF136	J22	Open_Channel	47.765	0.01	2662.24	2662.118	0	0	IRREGULAR	0	1	0.00255
C6_2	J22	OF135	Open_Channel	85.406	0.01	2662.118	2661.9	0	0	IRREGULAR	0	1	0.00255
C60	SWDI0352	SWDI0353	overland	15	0.016	2692.6	2691.837	0	0	IRREGULAR	0	1	0.05093
C61	SWDI0354	SWMH0012	overland	150.148	0.016	2685.467	2681.087	0	0	STREET	0	1	0.02918
C62	SWMH0012	J27	overland	281.894	0.016	2681.087	2676.7	0	0	STREET	0	1	0.01556
C63	J27	OF121	overland	377.311	0.04	2676.7	2651	0	0	IRREGULAR	0	1	0.06827
C64	SWDI0378	SWDI0375	overland	76.98	0.016	2739.786	2737.931	0	0	STREET	0	1	0.0241
C65	SWDI0375	SWMH0029	overland	157.216	0.016	2737.931	2724.666	0	0	STREET	0	1	0.08468
C66	SWDI0373	J29	overland	10.217	0.016	2690.052	2689.219	0	0	STREET	0	1	0.0818
C66_1	SWMH0029	J30	overland	41.22	0.016	2724.666	2720.387	0	0	STREET	0	1	0.10437
C66_2	J30	SWMH0031	overland	28.78	0.016	2720.387	2717.399	0	0	STREET	0	1	0.10439
C67	SWMH0031	SWDI0374	overland	223	0.016	2717.399	2692.862	0	0	STREET	0	1	0.11107
C68	SWDI1082	J28	overland	89	0.016	2706.404	2706.015	0	0	IRREGULAR	0	1	0.00437
C68_2	J28	SWDI1084	overland	106.228	0.016	2706.015	2694.362	0	0	STREET	0	1	0.11036
C68_4	SWMH0031	J28	overland	103.772	0.016	2717.399	2706.015	0	0	STREET	0	1	0.11037
C69	SWDI0372	SWDI0373	overland	34.943	0.016	2693.271	2690.052	0	0	STREET	0	1	0.09251
C69_1	SWDI1084	J29	overland	47.182	0.016	2694.362	2689.219	0	0	STREET	0	1	0.10966
C69_2	J29	SWDI0370	overland	301.825	0.016	2689.219	2656.32	0	0	STREET	0	1	0.10965
C7	SWDI1269	SWDI0244	overland	15	0.016	2713.5	2713.5	0	0	IRREGULAR	0	1	0
C7_1	OF138	J25	Open_Channel	54.823	0.01	2665.577	2665.343	0	0	IRREGULAR	0	1	0.00427
C7_2	J25	OF137	Open_Channel	14.435	0.01	2665.343	2665.281	0	0	IRREGULAR	0	1	0.00443
C70	SWDI0374	SWDI0371	overland	342.811	0.016	2692.862	2656.197	0	0	STREET	0	1	0.10757
C71	SWDI1083	SWDI1082	overland	47.0	0.016	2707.48	2706.404	0	0	IRREGULAR	0	1	0.023
C72	SWDI1081	J30	overland	57.2	0.016	2721.79	2720.39	0	0	STREET	0	1	0.025
C73	SWDI0370	SWDI0368	overland	46.6	0.016	2656.32	2652.96	0	0	STREET	0	1	0.072
C74	SWDI0368	SWDI0365	overland	130.0	0.016	2652.96	2649.39	0	0	STREET	0	1	0.027
C75	SWDI0371	SWDI0364	overland	181.4	0.016	2656.20	2649.30	0	0	STREET	0	1	0.038
C76	SWDI0365	J5430	overland	42.0	0.016	2649.39	2649.12	0	0	STREET	0	1	0.007
C77	SWDI0364	J5356	overland	17.0	0.016	2649.30	2649.01	0	0	STREET	0	1	0.017
C78	SWDI0364	J5356	overland	5.0	0.016	2650.00	2649.90	0	0	IRREGULAR	0	1	0.020
C79	SWDI0365	J5430	overland	5.0	0.016	2650.00	2649.90	0	0	IRREGULAR	0	1	0.020

Shelton Branch													
Conduits													
Name	Inlet Node	Outlet Node	Tag	Length (ft)	Roughness	Inlet Elev. (ft)	Outlet Elev. (ft)	Entry Loss Coeff.	Exit Loss Coeff.	Cross-Section	Geom1 (ft)	Barrels	Slope (ft/ft)
C8	J5	OF136	EDIT	50.2	0.024	2662.46	2662.24	0	0	CIRCULAR	5	1	0.004
C80	SWDI0367	J5430	overland	109.0	0.016	2649.59	2649.12	0	0	STREET	0	1	0.004
C81	SWDI0366	J5356	overland	147.0	0.016	2650.21	2649.01	0	0	STREET	0	1	0.008
C82	SWDI1203	J31	overland	39.6	0.016	2680.42	2680.36	0	0	STREET	0	1	0.002
C82_1	SWDI1204	J31	overland	10.2	0.016	2680.63	2680.29	0	0	STREET	0	1	0.034
C82_2	J31	J15	overland	369.8	0.016	2680.29	2667.90	0	0	STREET	0	1	0.034
C83	SWDI1267	SWDI1203	overland	19.3	0.016	2680.50	2680.42	0	0	STREET	0	1	0.004
C84	SWDI0357	SWDI0358	overland	19.4	0.016	2655.88	2655.36	0	0	IRREGULAR	0	1	0.027
C85	J11	SWDI1272	overland	867.7	0.016	2680.18	2668.92	0	0	STREET	0	1	0.013
C85_1	SWDI0358	J32	overland	119.9	0.02	2655.36	2650.50	0	0	IRREGULAR	0	1	0.041
C85_2	J32	OF1221	overland	105.0	0.04	2650.50	2650.00	0	0	IRREGULAR	0	1	0.005
C85_3	SWDI1254	SWDI1142	overland	212.9	0.035	2658.10	2649.32	0	0	IRREGULAR	0	1	0.041
C85_4	SWDI1142	OF121	overland	42.1	0.04	2649.32	2649.00	0	0	IRREGULAR	0	1	0.008
C86	SWMH0104	SWDI1201	overland	75.0	0.02	2684.50	2689.00	0	0	IRREGULAR	0	1	0.074
C87	J26	SWDI1203	overland	447.3	0.01	2686.15	2680.42	0	0	STREET	0	1	0.013
C87_1	SWDI1201	J26	overland	80.9	0.01	2689.00	2686.15	0	0	STREET	0	1	0.035
C87_2	J26	J11	overland	172.3	0.01	2686.15	2680.18	0	0	STREET	0	1	0.035
C88	SWDI1272	J21	overland	217.7	0.01	2670.75	2665.00	0	0	IRREGULAR	0	1	0.026
C9	OF123	J5832	Open_Channel	35.8	0.01	2646.54	2646.43	0	0	IRREGULAR	0	1	0.003
CJ5356	J5356	J5044	Open_Channel	325.5	0.01	2643.25	2641.75	0	0	IRREGULAR	0	1	0.005
CJ5430	J5430	J5356	Bridge	40.0	0.049	2643.50	2643.25	0	0	CUSTOM	4.5	1	0.006
CJ5430_HC	J5430	J5356	highchord	40.0	0.016	2650.00	2650.00	0	0	IRREGULAR	0	1	0.000
CJ5463	J5463	J5430	Open_Channel	50.4	0.01	2643.25	2643.50	0	0	IRREGULAR	0	1	-0.005
CJ5498	J5498	J5463	Bridge	18.0	0.048	2643.50	2643.25	0	0	CUSTOM	5.5	1	0.014
CJ5498_HC	J5498	J5463	highchord	18.0	0.024	2650.00	2650.00	0	0	IRREGULAR	0	1	0.000
CJ5832_1	J5832	OF1221	Open_Channel	68.3	0.01	2646.43	2645.86	0	0	IRREGULAR	0	1	0.008
CJ5832_2	OF121	J17	Open_Channel	49.0	0.01	2645.64	2645.24	0	0	IRREGULAR	0	1	0.008
CJ5832_4	J14	J5498	Open_Channel	48.4	0.01	2643.90	2643.50	0	0	IRREGULAR	0	1	0.008
CJ5832_5	J17	J14	Open_Channel	163.1	0.01	2645.24	2643.90	0	0	IRREGULAR	0	1	0.008
CJ6033_1	J6033	OF123	Open_Channel	168.8	0.01	2647.62	2646.54	0	0	IRREGULAR	0	1	0.006
CJ6467_1	J6467	OF1251	Open_Channel	29.8	0.01	2680.75	2680.55	0	0	IRREGULAR	0	1	0.007
CJ6467_3	OF1251	J16	Open_Channel	290.0	0.01	2650.55	2648.59	0	0	IRREGULAR	0	1	0.007
CJ6467_4	J16	J6033	Open_Channel	144.1	0.01	2648.59	2647.62	0	0	IRREGULAR	0	1	0.007
CJ6552	J6552	J6467	Bridge	28.0	0.048	2651.00	2650.75	0	0	CUSTOM	9	1	0.009
CJ6552_HC	J6552	J6467	highchord	28.0	0.016	2662.00	2662.00	0	0	IRREGULAR	0	1	0.000
CJ6753	J6753	J6552	Open_Channel	243.8	0.01	2651.74	2651.00	0	0	IRREGULAR	0	1	0.003
CJ7003_1	J7003	J15	Open_Channel	201.1	0.01	2653.85	2652.48	0	0	IRREGULAR	0	1	0.007
CJ7003_2	J15	J6753	Open_Channel	103.4	0.01	2652.48	2651.74	0	0	IRREGULAR	0	1	0.007
CULV0007	CVPT0001	OF135	Culvert	46.1	0.024	2666.49	2665.71	0.5	1	CIRCULAR	1.25	1	0.017
SSGM1578	SWDI1285	SWDI1284		75.9	0.022	2710.65	2710.26	0.5	0.42	CIRCULAR	1.25	1	0.005
SSGM1579	SWDI1284	SWDP0045		100.1	0.024	2708.41	2708.40	0.5	1	CIRCULAR	1.25	1	0.000
SSGM1605	SWDI1270	SWDI1151		53.8	0.022	2688.50	2687.56	0.7	0.42	CIRCULAR	1.5	1	0.017
SSGM1606	SWDI1152	J2		26.9	0.024	2688.82	2687.00	0.5	0.42	CIRCULAR	1.25	1	0.068
SSGM1607	SWDI1151	J2		13.8	0.024	2686.96	2686.64	0.5	0.7	CIRCULAR	2	1	0.023
SSGM1608	J2	J3		116.9	0.024	2686.64	2683.92	0.5	0.83	CIRCULAR	2.5	1	0.023
SWG0310	SWDI1289	SWDI0244		33.0	0.024	2709.48	2708.75	0.5	0.42	CIRCULAR	2	1	0.022
SWG0314	SWDI0248	OF138		39.7	0.024	2666.99	2666.44	0.5	1	CIRCULAR	1.25	1	0.014
SWG0407	SWMH0090	SWDI0337		40.8	0.024	2674.63	2671.89	0.5	0.42	CIRCULAR	4	1	0.067
SWG0408	SWDI0336	SWDI0337		106.0	0.024	2680.33	2672.59	0.5	1	CIRCULAR	2	1	0.073
SWG0409	SWDI0337	SWDI0338		164.1	0.024	2671.09	2663.46	0.5	0.42	CIRCULAR	4	1	0.047
SWG0410	SWDI0341	SWDI0333		61.2	0.024	2695.83	2696.84	0.5	0.42	CIRCULAR	1.25	1	-0.017
SWG0411	SWDI0332	SWDI0333		35.8	0.024	2697.47	2695.34	0.5	0.42	CIRCULAR	1.25	1	0.059
SWG0412	SWDI0333	SWDI0334		11.8	0.024	2695.29	2693.92	0	0.7	CIRCULAR	1.25	1	0.117
SWG0413	SWDI0335	SWDI0334		62.4	0.024	2706.38	2695.77	0.5	1	CIRCULAR	1.25	1	0.173
SWG0414	SWDI0350	SWDI0351		12.3	0.024	2657.34	2656.79	0.5	0.42	CIRCULAR	1.5	1	0.044
SWG0415	SWDI0351	OF1251		33.5	0.024	2656.19	2654.15	0.5	1	CIRCULAR	1.5	1	0.061
SWG0416	SWDI0343	SWMH0074		22.6	0.013	2749.05	2747.01	0.5	1	CIRCULAR	1.25	1	0.091
SWG0417	SWDI0344	SWMH0074		15.4	0.013	2748.32	2747.46	0.5	1	CIRCULAR	1.25	1	0.056
SWG0418	SWMH0074	SWMH0076		35.5	0.013	2746.86	2746.26	0.5	0	CIRCULAR	1.5	1	0.017
SWG0419	SWDI0353	SWDI0354		110.1	0.013	2688.54	2682.82	0.5	0.42	CIRCULAR	1.5	1	0.052
SWG0420	SWDI0354	SWMH0012		150.1	0.013	2682.67	2674.24	0.5	0.42	CIRCULAR	1.5	1	0.056
SWG0422	SWMH0012	SWMH0011		281.9	0.013	2674.24	2666.00	0.5	0.42	CIRCULAR	1.25	1	0.029
SWG0424	SWMH0011	OF123		211.5	0.024	2666.00	2646.54	0.5	1	CIRCULAR	1.5	1	0.092
SWG0425	SWDI0357	SWDI0358		19.4	0.013	2652.39	2651.11	0.5	0.42	CIRCULAR	1.25	1	0.066
SWG0426	SWDI0366	SWDI0367		26.8	0.013	2648.01	2647.54	0.5	1	CIRCULAR	1.25	1	0.017
SWG0428	SWDI0378	SWDI0375		77.0	0.013	2737.39	2736.18	0.5	0.42	CIRCULAR	1.25	1	0.016
SWG0430	SWDI0375	SWMH0028		28.4	0.013	2735.28	2733.82	0.5	1	CIRCULAR	1.25	1	0.051
SWG0431	SWMH0029	SWMH0030		46.6	0.013	2719.97	2715.26	0.5	0.42	CIRCULAR	1.25	1	0.102
SWG0432	SWMH0030	SWMH0031		23.0	0.013	2715.11	2713.50	0.5	0.42	CIRCULAR	1.25	1	0.070
SWG0433	SWMH0035	SWMH0036		26.6	0.013	2651.40	2650.54	0.5	0.42	CIRCULAR	1.5	1	0.032
SWG0434	SWMH0036	J8		143.3	0.013	2649.44	2645.81	0.5	1	CIRCULAR	2	1	0.025
SWG0437	SWDI0372	SWDI0373		34.9	0.013	2688.52	2687.75	0.5	0.7	CIRCULAR	1.25	1	0.022
SWG0438	SWDI0369	SWMH0036		23.4	0.013	2650.63	2649.94	0.5	1	CIRCULAR	1.25	1	0.030
SWG1073	SWMH0028	SWMH0029		138.8	0.013	2732.22	2720.27	0.5	0.42	CIRCULAR	1.25	1	0.087
SWG1075	SWDI1081	SWMH0031		36.0	0.013	2715.84	2713.60	0.5	1	CIRCULAR	1.25	1	0.062
SWG1076	SWMH0015	SWMH0032		94.9	0.013	2710.80	2699.16	0.5	0.42	CIRCULAR	1.25	1	0.124
SWG1078	SWDI1082	SWMH0032		98.0	0.013	2701.25	2699.81	0.5	1	CIRCULAR	1.25	1	0.015
SWG1079	SWDI1083	SWDI1082		51.0	0.013	2702.28	2701.30	0.5	0.42	CIRCULAR	1.25	1	0.019
SWG1080	SWDI0374	SWMH0033		12.8	0.013	2690.76	2690.66	0.5	1	CIRCULAR	1.25	1	0.008
SWG1081	SWMH0032	SWMH0033		104.2	0.013	2699.11	2688.51	0.5	0.42	CIRCULAR	1.25	1	0.102
SWG1082	SWMH0033	SWMH0034		39.1	0.013	2688.46	2686.12	0.5	0.42	CIRCULAR	1.25	1	0.060
SWG1083	SWMH0034	SWMH0035		309.3	0.013	2686.07	2651.65	0.5	0.42	CIRCULAR	1.5	1	0.112
SWG1084	SWDI0370	SWMH0035		15.4	0.013	2652.67	2652.00	0.5	0.83	CIRCULAR	1.25	1	0.044
SWG1085	SWDI0368	J5430		168.4	0.013	2650.86	2644.48	0.5	1	CIRCULAR	1.25	1	0.038
SWG1086	SWDI0365	J8		12.2	0.013	2647.14	2645.81	0.5	0.42	CIRCULAR	1.25	1	0.110
SWG1087	J8	SWDI0364		14.4	0.013	2645.81	2645.50	0.5	0.42	CIRCULAR	2	1	0.022
SWG1188	SWDI0367	J5430		109.0	0.013	2647.39	2645.41	0.5	1	CIRCULAR	1.5	1	0.018
SWG1192	SWDI1130	SWMH0075		22.7	0.013	2759.33	2758.82	0.5	1	CIRCULAR	1.25	1	0.022
SWG1193	SWMH0075	SWMH0074		209.5	0.013	2757.47	2747.21	0.5	0.42	CIRCULAR	1.25	1	0.049
SWG1196	SWMH0076	SWMH0077		183.4	0.013	2745.76	2728.92	0.5	0.7	CIRCULAR	1.5	1	0.092
SWG1198	SWMH0077	SWDI0345		17.7	0.013	2728.87	2728.06	0.5	0.83	CIRCULAR	1.5	1	0.046
SWG1199	SWDI0347	SWMH0078		21.4	0.013	2722.50	2721.27	0.5	1	CIRCULAR	1.25	1	0.057
SWG1200	SWDI0345	SWMH0078		90.7	0.013	2727.81	2720.62	0.5	0.42	CIRCULAR	1.5	1	0.080
SWG1201	SWMH0078	SWMH0079		196.7	0.013	2720.37	2704.62	0.5	0.42	CIRCULAR	2	1	0.080
SWG1202	SWDI0348	SWMH0079		5.4	0.013	2706.16	2705.37	0.5	1	CIRCULAR	1.25	1	0.146

Shelton Branch													
Conduits													
Name	Inlet Node	Outlet Node	Tag	Length (ft)	Roughness	Inlet Elev. (ft)	Outlet Elev. (ft)	Entry Loss Coeff.	Exit Loss Coeff.	Cross-Section	Geom1 (ft)	Barrels	Slope (ft/ft)
SWGM1203	SWDI0349	SWMH0113		20.6	0.013	2703.77	2702.76	0.5	1	CIRCULAR	1.25	1	0.050
SWGM1204	SWDI1133	SWMH0080		20.7	0.013	2688.38	2686.84	0.5	1	CIRCULAR	1.25	1	0.075
SWGM1205	SWMH0113	SWMH0080		199.6	0.013	2701.51	2687.19	0.5	0.42	CIRCULAR	2	1	0.072
SWGM1206	SWDI1134	SWMH0081		17.1	0.013	2674.49	2673.95	0.5	1	CIRCULAR	1.25	1	0.032
SWGM1207	SWMH0080	SWMH0081		191.2	0.013	2686.74	2674.10	0.5	0.42	CIRCULAR	2	1	0.066
SWGM1208	SWDI1135	SWMH0082		17.0	0.013	2667.90	2666.71	0.5	1	CIRCULAR	1.25	1	0.070
SWGM1209	SWMH0081	SWMH0082		115.1	0.013	2673.90	2666.71	0.5	0.42	CIRCULAR	2	1	0.063
SWGM1210	SWMH0085	SWMH0084		49.8	0.024	2660.62	2658.96	0.5	0.7	CIRCULAR	4	1	0.033
SWGM1211	SWMH0084	SWDI1139		199.7	0.024	2658.91	2653.03	0.5	0.42	CIRCULAR	4	1	0.029
SWGM1212	SWDI1138	SWMH0083		22.1	0.013	2662.01	2661.35	0.5	1	CIRCULAR	1.25	1	0.030
SWGM1213	SWDI1136	SWMH0083		18.2	0.013	2662.69	2660.35	0.5	1	CIRCULAR	1.25	1	0.130
SWGM1214	SWMH0083	SWDI0340		260.8	0.013	2659.85	2655.67	0.5	0.7	CIRCULAR	2.5	1	0.016
SWGM1220	SWDI0352	SWDI0353		26.4	0.013	2689.93	2689.09	0.5	0.42	CIRCULAR	1.5	1	0.032
SWGM1227	SWDI1254	SWDI1142		209.7	0.024	2656.60	2646.97	0.5	0.42	CIRCULAR	1.25	1	0.046
SWGM1228	SWDI0358	OF1221		202.0	0.013	2651.06	2646.76	0.5	1	CIRCULAR	1.25	1	0.021
SWGM1231	SWDI1145	SWDI1144		57.9	0.024	2720.29	2717.86	0.5	0.42	CIRCULAR	1.25	1	0.042
SWGM1233	SWDI1144	SWDI0331		175.0	0.024	2717.71	2711.44	0.5	0.42	CIRCULAR	1.25	1	0.036
SWGM1234	SWDI0331	SWDI0333		351.8	0.024	2711.39	2695.34	0.5	0.7	CIRCULAR	1.25	1	0.046
SWGM1237	SWDI0338	SWMH0085		136.1	0.024	2663.36	2660.67	0.5	0.42	CIRCULAR	4	1	0.020
SWGM1239	SWDI1148	SWMH0090		125.2	0.024	2690.05	2674.73	0.5	1	CIRCULAR	3	1	0.123
SWGM1240	SWDI0334	SWDI1148		168.9	0.024	2692.07	2690.10	0.5	0.42	CIRCULAR	1.25	1	0.012
SWGM1242	SWMH0091	SWMH0085		361.0	0.013	2683.46	2664.07	0.5	1	CIRCULAR	1.25	1	0.054
SWGM1246	SWDI1150	SWMH0092		35.0	0.022	2701.18	2700.78	0.5	0.83	CIRCULAR	1.25	1	0.011
SWGM1247	SWDI0244	SWMH0092		285.0	0.022	2708.70	2698.28	0.5	0.42	CIRCULAR	1.5	1	0.037
SWGM1248	SWMH0092	SWDI0246		345.3	0.024	2697.63	2688.44	0.5	0.42	CIRCULAR	2	1	0.027
SWGM1249	SWDI0246	SWDI1151		21.8	0.022	2688.39	2687.01	0.5	0.83	CIRCULAR	2	1	0.063
SWGM1251	SWDI1153	SWDI1152		28.0	0.024	2688.93	2688.87	0.5	0.42	CIRCULAR	1.25	1	0.002
SWGM1255	J3	SWDP0014		531.9	0.024	2683.92	2671.58	0.5	1	CIRCULAR	2.5	1	0.023
SWGM1259	SWDI1271	SWMH0014		17.6	0.024	2668.47	2667.68	0.9	0.83	CIRCULAR	1.25	1	0.045
SWGM1260	SWMH0014	OF136		39.4	0.024	2667.68	2665.90	0.5	1	CIRCULAR	1.5	1	0.045
SWGM1261	SWDP0015	SWDI0248		12.6	0.024	2667.28	2667.04	0.7	0.42	CIRCULAR	1.25	1	0.018
SWGM1262	SWDP0015	OF138		50.8	0.024	2665.90	2665.58	0.7	1	CIRCULAR	3	1	0.006
SWGM1361	SWDI1197	SWDP0023		41.4	0.024	2669.97	2666.70	0.5	1	CIRCULAR	1.5	1	0.079
SWGM1362	SWDI1198	OF133		49.3	0.024	2669.33	2666.60	0.5	1	CIRCULAR	1.25	1	0.055
SWGM1366	SWDI1272	SWMH0013		19.9	0.024	2665.33	2664.95	0.5	0.42	CIRCULAR	1.25	1	0.019
SWGM1367	SWMH0013	OF134		149.2	0.022	2664.95	2662.07	0.5	1	CIRCULAR	1.25	1	0.019
SWGM1369	SWDI0255	SWDI0254		170.1	0.024	2706.74	2691.53	0.5	0.42	CIRCULAR	1.25	1	0.090
SWGM1370	SWDI0254	SWMH0104		33.0	0.013	2690.73	2690.10	0.5	0.42	CIRCULAR	1	1	0.019
SWGM1372	SWDI1263	SWMH0104		161.5	0.024	2688.72	2684.60	0.5	0.7	CIRCULAR	3	1	0.026
SWGM1373	SWDI1202	SWDP0024		30.8	0.024	2678.14	2677.36	0.5	1	CIRCULAR	1.5	1	0.025
SWGM1374	SWMH0105	SWDI1202		193.4	0.024	2679.73	2678.19	0.5	1	CIRCULAR	1.25	1	0.008
SWGM1375	SWDI1203	SWDP0024		67.5	0.024	2677.47	2674.88	0.5	1	CIRCULAR	1.5	1	0.038
SWGM1376	SWDI1204	SWDI1203		35.2	0.024	2677.93	2677.77	0.5	0.7	CIRCULAR	1.25	1	0.005
SWGM1377	SWDI1200	SWDI1201		129.4	0.022	2688.01	2684.84	0.5	1	CIRCULAR	1.25	1	0.025
SWGM1378	SWMH0104	SWDI1201		86.7	0.024	2681.80	2680.54	0.5	0.42	CIRCULAR	3	1	0.015
SWGM1461	SWDI1142	OF121		45.9	0.024	2646.92	2646.64	0.5	1	CIRCULAR	1.25	1	0.006
SWGM1466	SWDI0371	SWMH0035		13.1	0.013	2652.65	2651.60	0.5	1	CIRCULAR	1.25	1	0.081
SWGM1467	SWDI0373	SWMH0034		23.2	0.013	2687.75	2686.12	0.5	1	CIRCULAR	1.25	1	0.070
SWGM1468	SWDI1084	SWMH0033		15.3	0.013	2689.41	2688.86	0.5	0.83	CIRCULAR	1.25	1	0.036
SWGM1473	SWDI0340	SWMH0086		23.2	0.013	2654.42	2653.34	0.5	1	CIRCULAR	2.5	1	0.046
SWGM1474	SWDI1137	SWMH0083		10.6	0.013	2663.40	2662.35	0.5	0.7	CIRCULAR	1.25	1	0.099
SWGM1475	SWMH0082	SWMH0083		90.8	0.013	2666.66	2660.15	0.5	0.42	CIRCULAR	2.5	1	0.072
SWGM1476	SWMH0086	J6552		14.4	0.024	2652.54	2652.22	0.5	1	CIRCULAR	4	1	0.022
SWGM1477	SWDI0984	SWMH0081		8.0	0.013	2674.66	2674.05	0.5	1	CIRCULAR	1.25	1	0.077
SWGM1478	SWDI1132	SWMH0080		4.4	0.013	2687.25	2686.94	0.5	1	CIRCULAR	1.25	1	0.071
SWGM1479	SWDI0346	SWMH0078		4.0	0.013	2720.67	2720.62	0.5	1	CIRCULAR	1.25	1	0.013
SWGM1480	SWMH0079	SWMH0113		22.8	0.013	2704.47	2701.61	0.5	0.42	CIRCULAR	2	1	0.127
SWGM1481	SWDI1131	SWMH0075		50.6	0.013	2762.58	2759.42	0.5	0.7	CIRCULAR	1.25	1	0.063
SWGM1482	SWDI1129	SWMH0075		13.4	0.013	2759.97	2759.07	0.5	1	CIRCULAR	1.25	1	0.067
SWGM1483	SWDI1146	SWDI1144		37.0	0.024	2720.22	2719.16	0.5	1	CIRCULAR	1.25	1	0.029
SWGM1484	SWDI1147	SWDI0331		32.5	0.024	2712.09	2711.44	0.5	1	CIRCULAR	1.25	1	0.020
SWGM1487	SWDI1267	SWDI1203		15.7	0.024	2678.79	2677.72	0.7	0.42	CIRCULAR	1.5	1	0.069
SWGM1514	SWDI1139	SWMH0086		68.9	0.024	2652.93	2652.74	0.5	0.7	CIRCULAR	4	1	0.003
SWGM1518_1	SWDI1201	J7		104.9	0.024	2680.44	2677.83	0.5	0.83	CIRCULAR	3	1	0.025
SWGM1518_2	J7	J11		236.7	0.024	2677.83	2671.94	0.5	0.83	CIRCULAR	3	1	0.025
SWGM1519	SWDI1199	SWDI1200		58.0	0.022	2688.24	2688.06	0.5	0.7	CIRCULAR	1.25	1	0.003
SWGM1529	SWDI1014	SWMH0105		7.4	0.024	2679.92	2679.83	0.5	1	CIRCULAR	1.25	1	0.013
SWGM1551	SWMH0031	SWMH0015		21.5	0.013	2713.45	2710.80	0.5	0.42	CIRCULAR	1.25	1	0.124
SWOD0766	OF137	J5	Open_Channel	60.8	0.01	2665.28	2662.46	0	0	IRREGULAR	0	1	0.046
SWOD0800_1	SWDP0014	J23	Open_Channel	144.0	0.01	2671.58	2668.02	0	0	IRREGULAR	0	1	0.025
SWOD0800_2	J23	SWDP0015	Open_Channel	102.4	0.01	2668.02	2665.90	0	0	IRREGULAR	0	1	0.021
SWOD0843	J4	OF138	Open_Channel	55.9	0.01	2667.44	2665.58	0	0	IRREGULAR	0	1	0.033
SWOD0883_2	J13	J9	Open_Channel	97.8	0.01	2657.47	2656.75	0	0	IRREGULAR	0	1	0.007
SWOD0883_3	SWDP0023	J18	Open_Channel	71.3	0.01	2658.40	2658.19	0	0	IRREGULAR	0	1	0.003
SWOD0883_4	J18	J13	Open_Channel	239.5	0.01	2658.19	2657.47	0	0	IRREGULAR	0	1	0.003
SWOD0909	SWDP0037	SWDI1270	Open_Channel	106.4	0.01	2691.60	2688.50	0	0	IRREGULAR	0	1	0.029
SWOD0995_1	SWDP0024	J6	Open_Channel	229.2	0.01	2674.88	2663.09	0	0	IRREGULAR	0	1	0.052
SWOD0995_2	J6	J9	Open_Channel	215.0	0.01	2663.09	2656.75	0	0	IRREGULAR	0	1	0.030
SWOD1048	SWDP0045	SWDI0337	Open_Channel	76.7	0.01	2708.40	2678.39	0	0	IRREGULAR	0	1	0.425

Frog Level				
Subcatchments				
Name	Outlet	Area (ac)	Time of Concentration (min)	Curve Number
0	SWDI0466	0.316	10	98
2553	SWDI0387	2.538	19.123	76
2558	SWDI0392	2.466	10	98
2559	SWDI0393	0.292	10	96
2560	SWDI0394	2.431	10	92
2561	SWDI0395	0.079	10	98
2562	SWDI0397	7.711	10	76
2563	SWDI0398	0.113	10	69
2564	SWDI0399	0.22	10	98
2565	SWMH0020	2.257	10	97
2567	SWDI0402	0.448	10	98
2568	SWDI0403	0.014	10	98
25691	SWDI0441	0.43	10	85
25692	SWDI1022	1.831	10	92
25693	SWDI1103	0.178	10	87
25694	SWMH0046	1.311	10	87
2570	SWMH0048	0.579	10	94
2572	SWDI0442	0.281	10	90
2573	SWDI0443	0.134	10	84
2574	SWDI0444	0.167	10	79
2575	SWMH0072	2.883	10	78
2576	SWDI0446	0.526	10	79
2577	SWMH0109	6.879	10	65
2578	SWDI0465	0.323	10	91
2580	SWDI0467	1.481	10	67
2581	SWDI0468	0.1	10	98
2583	OF342	0.492	10	75
25831	SWDI0470	0.258	10	98
2584	SWDI0471	0.029	10	97
2585	SWDI0472	2.213	14.04	66
2589	SWDI1000	0.119	10	94
2590	SWDI1237	0.337	10	77
25901	SWDI1236	2.7	10	73
2599	SWDI1073	0.6	10	70
2600	SWDI1085	0.2	10	98
2603	SWDI1088	0.7	10	98
2604	SWDI1089	1.0	10	92
2605	SWMH0016	0.2	10	98
2607	SWDI1093	1.3	10	96
2608	SWDI1094	1.3	10	97
2609	SWDI1095	0.3	10	98
2612	SWDI1098	0.0	10	93
2613	SWDI1099	0.1	10	91
2614	SWDI1100	0.2	10	95
2615	SWMH0018	1.1	10	98
26151	SWMH0045	2.5	10	97
2620	SWDI1106	0.3	10	86
2621	SWDI1107	0.8	10	98
2623	SWDI1109	0.1	10	93
2624	SWDI1111	0.2	10	82
2626	SWDI1112	0.1	10	78
2627	SWDI1113	0.2	10	94
2628	SWDI1114	0.0	10	93
2629	SWDI1115	0.0	10	93
2630	SWDI1117	0.6	10	98
2631	SWDI1118	0.0	10	97
2632	SWDI1119	0.4	10	98
2633	SWDI0446	5.0	11.44	87
2634	J5	0.1	10	98
2635	J5	0.6	11.52	98
26351	J10	7.4	19.1	88
26371	SWDI1123	0.2	10	95
26372	SWDI1124	0.1	10	98
26373	SWDI1125	0.2	10	97
26374	SWDI1126	0.1	10	95
26375	SWDI1127	0.0	10	91
26376	SWMH0061	4.2	10	82
2641	SWDI1128	0.0	10	65
2642	SWDI1212	8.6	10	82
2646	SWMH0019	0.3	10	98
2647	SWDI1214	0.5	10	98
2648	SWDI1214	0.3	10	98
2649	J13	11.0	15.27	76
26491	SWDI1216	0.6	10	98
2651	SWDI1219	0.2	10	96
2661	SWDI1230	0.1	10	97
26611	SWDI1229	0.4	10	98
2663	SWDI1273	6.1	10	62
26631	SWDI1231	1.2	10	67
2664	SWDI1234	1.7	10	78
2667	SWDI1235	0.4	10	82
2670	SWDI1238	0.6	10	71
2673	SWDI1241	0.0	10	84
2674	SWDI1242	0.0	10	96
2675	SWDI1243	0.3	10	98
2677	SWDI1265	0.0	10	79
2678	SWDI1266	8.5	10.28	84
2683	SWMH0007	8.7	10	93
2684	SWMH0027	1.3	10	98
2700	SWMH0059	0.1	10	65
27001	SWMH0054	0.4	10	98
2712	J6	3.7	10	87
2737	J34911	5.1	10	85
2738	J34260	0.7	10	67

Frog Level**Subcatchments**

Name	Outlet	Area (ac)	Time of Concentration (min)	Curve Number
2743	J12	1.3	10	68
2752	SWDP0031	0.1	10	82
2813	SWMH0049	0.5	10	98
R1	J35180	27962.7	229	59
R2	J11	459.7	48	63

Frog Level						
Junctions						
Name	Tag	Description	Invert Elev. (ft)	Rim Elev. (ft)	Depth (ft)	
J1	StormNet		2714.211	2717.97	3.759	
J10			2625.676	2653.567	27.891	
J11			2648.67	2655.67	7	
J12			2627.485	2650.395	22.91	
J13			2628.762	2660.117	31.355	
J14			2697.2	2698.516	1.316	
J15			2636.5	2638.007	1.507	
J16			2635.022	2635.6	0.578	
J17			2630.7	2631.474	0.774	
J18			2617.243	2639.673	22.43	
J19			2627.534	2627.534	0	
J2	StormNet		2658.297	2662.926	4.629	
J20			2647.1	2647.1	0	
J21			2629.79	2631.223	1.433	
J22			2635.8	2637.403	1.603	
J3	StormNet		2658.164	2662.363	4.199	
J32922		River: RichlandCreek Reach: DTL Transect: 32922	2620	2642.43	22.43	
J34107		River: RichlandCreek Reach: DTL Transect: 34107	2627.65	2658.85	31.2	
J34139		River: RichlandCreek Reach: DTL Transect: 34139	2628.29	2649.48	21.19	
J34206		River: RichlandCreek Reach: DTL Transect: 34206	2628.84	2649.58	20.74	
J34260		River: RichlandCreek Reach: DTL Transect: 34260	2628.61	2652.64	24.03	
J34655		River: RichlandCreek Reach: DTL Transect: 34655	2629	2671.84	42.84	
J34866		River: RichlandCreek Reach: DTL Transect: 34866	2631.55	2663.59	32.04	
J34911		River: RichlandCreek Reach: DTL Transect: 34911	2631.62	2660.04	28.42	
J35107		River: RichlandCreek Reach: DTL Transect: 35107	2633.27	2675.16	41.89	
J35120		River: RichlandCreek Reach: DTL Transect: 35120	2632.95	2675.7	42.75	
J35180		River: RichlandCreek Reach: DTL Transect: 35180	2631.93	2675.29	43.36	
J4	StormNet		2657.977	2661.982	4.005	
J5	StormNet		2626.145	2632.837	6.692	
J6			2621.726	2645.817	24.091	
J7	StormNet		2643	2647.499	4.499	
J8	StormNet		2694.76	2701.778	7.018	
J9	StormNet		2697.046	2701.556	4.51	
OF079		Standard Outlet	2629.814	2669.205	39.391	
OF342		Standard Outlet	2627.628	2646.447	18.819	
OF343		Standard Outlet	2627.596	2640.566	12.97	
OF344		River: RichlandCreek Reach: DTL Transect: 33660	2627.41	2656.97	29.56	
OF347		Standard Outlet	2623.182	2648.674	25.492	
OF349		Standard Outlet	2619.007	2641.437	22.43	
SWDI0387		Grate Inlet	2716.722	2719.022	2.3	
SWDI0392		Grate Inlet	2701.43	2704.63	3.2	
SWDI0393		Combo Inlet	2700.52	2703.52	3	
SWDI0394		Grate Inlet	2659.671	2666.471	6.8	
SWDI0395		Grate Inlet	2640.663	2645.763	5.1	
SWDI0397		Grate Inlet	2641.9	2644.05	2.15	
SWDI0398		Slabtop	2637.465	2642.665	5.2	
SWDI0399		Grate Inlet	2639.443	2640.843	1.4	
SWDI0402		Grate Inlet	2726.277	2728.927	2.65	
SWDI0403		Grate Inlet	2723.937	2727.537	3.6	
SWDI0441		Grate Inlet	2647.831	2652.231	4.4	
SWDI0442		Grate Inlet	2648.728	2656.028	7.3	
SWDI0443		Grate Inlet	2650.44	2653.64	3.2	
SWDI0444		Grate Inlet	2650.773	2652.823	2.05	
SWDI0446		Grate Inlet	2627.861	2632.811	4.95	
SWDI0465		Combo Inlet	2631.867	2636.367	4.5	
SWDI0466		Grate Inlet	2634.911	2637.311	2.4	
SWDI0467		Combo Inlet	2635.079	2638.179	3.1	
SWDI0468		Combo Inlet	2633.094	2638.094	5	
SWDI0470		Combo Inlet	2630.849	2635.899	5.05	
SWDI0471		Combo Inlet	2633.312	2635.812	2.5	
SWDI0472		Grate Inlet	2651.692	2653.692	2	
SWDI1000		Grate Inlet	2647.675	2649.325	1.65	
SWDI1022		Grate Inlet	2642.941	2646.241	3.3	
SWDI1073		Combo Inlet	2715.581	2717.781	2.2	
SWDI1085		Grate Inlet	2704.32	2706.07	1.75	
SWDI1088		Combo Inlet	2693.914	2697.314	3.4	
SWDI1089		Combo Inlet	2694.952	2697.352	2.4	
SWDI1093		Grate Inlet	2667.541	2670.641	3.1	
SWDI1094		Combo Inlet	2659.448	2661.648	2.2	
SWDI1095		Combo Inlet	2661.848	2664.948	3.1	
SWDI1098		Combo Inlet	2659.699	2662.499	2.8	
SWDI1099		Combo Inlet	2661.615	2666.515	4.9	
SWDI1100		Combo Inlet	2674.712	2679.612	4.9	
SWDI1103		Grate Inlet	2691.114	2694.864	3.75	
SWDI1106		Combo Inlet	2695.028	2699.128	4.1	
SWDI1107		Combo Inlet	2701.274	2704.374	3.1	
SWDI1109		Combo Inlet	2688.871	2693.121	4.25	
SWDI1111		Grate Inlet	2692.28	2695.43	3.15	
SWDI1112		Grate Inlet	2691.469	2696.319	4.85	
SWDI1113		Combo Inlet	2690.961	2696.311	5.35	
SWDI1114		Grate Inlet	2644.796	2649.196	4.4	
SWDI1115		Grate Inlet	2643.415	2647.955	4.54	
SWDI1117		Grate Inlet	2641.596	2645.996	4.4	
SWDI1118		Grate Inlet	2630.227	2638.627	8.4	
SWDI1119		Grate Inlet	2632.014	2634.864	2.85	
SWDI1123		Combo Inlet	2686.504	2692.154	5.65	
SWDI1124		Combo Inlet	2683.339	2688.439	5.1	
SWDI1125		Combo Inlet	2679.497	2687.047	7.55	
SWDI1126		Combo Inlet	2684.469	2688.719	4.25	
SWDI1127		Combo Inlet	2684.828	2688.228	3.4	
SWDI1128		Grate Inlet	2679.258	2684.358	5.1	
SWDI1212		Grate Inlet	2634.876	2637.876	3	
SWDI1216		Grate Inlet	2634.909	2636.409	1.5	
SWDI1219		Grate Inlet	2632.417	2636.817	4.4	

Frog Level

Junctions

Name	Tag	Description	Invert Elev. (ft)	Rim Elev. (ft)	Depth (ft)
SWDI1229		Grate Inlet	2634.223	2636.973	2.75
SWDI1230		Grate Inlet	2636.999	2641.499	4.5
SWDI1231		Grate Inlet	2639.172	2642.272	3.1
SWDI1234		Grate Inlet	2635.624	2638.724	3.1
SWDI1235		Grate Inlet	2633.718	2635.968	2.25
SWDI1236		Combo Inlet	2635.381	2637.781	2.4
SWDI1237		Grate Inlet	2642.808	2649.208	6.4
SWDI1238		Grate Inlet	2640.622	2644.872	4.25
SWDI1241		Grate Inlet	2623.367	2628.667	5.3
SWDI1242		Grate Inlet	2624.947	2628.447	3.5
SWDI1243		Grate Inlet	2623.994	2628.094	4.1
SWDI1265		Pipe	2625.47	2627.47	2
SWDI1266		Pipe	2628.195	2630.195	2
SWDI1273		Pipe	2632.208	2633.708	1.5
SWDI1274		Pipe	2646.326	2653	6.674
SWDP0026		Standard Outlet	2633.903	2635.153	1.25
SWDP0028		Standard Outlet	2636.922	2640.422	3.5
SWDP0031		Standard Outlet	2625.458	2626.708	1.25
SWMH0007	MH	STD	2713.036	2718.236	5.2
SWMH0016	MH	OTH	2698.497	2702.145	3.648
SWMH0018	MH	OTH	2671.604	2676.754	5.15
SWMH0019	MH	OTH	2635.28	2636.786	1.506
SWMH0020	MH	OTH	2653.243	2656.542	3.299
SWMH0025	MH	OTH	2707.92	2712.64	4.72
SWMH0027	MH	STD	2716.885	2721.885	5
SWMH0037	MH	STD	2692.052	2697.252	5.2
SWMH0038	MH	STD	2692.002	2696.802	4.8
SWMH0039	MH	STD	2637.227	2643.277	6.05
SWMH0044	MH	STD	2651.508	2654.308	2.8
SWMH0045	MH	STD	2689.11	2694.06	4.95
SWMH0046	MH	STD	2695.725	2703.075	7.35
SWMH0048	MH	STD	2688.952	2694.052	5.1
SWMH0049	MH	STD	2691.55	2697.65	6.1
SWMH0050	MH	STD	2690.103	2696.853	6.75
SWMH0051	MH	STD	2658.661	2665.111	6.45
SWMH0052	MH	STD	2646.022	2651.222	5.2
SWMH0053	MH	STD	2639.089	2649.889	10.8
SWMH0054	MH	STD	2644.469	2649.969	5.5
SWMH0055	MH	STD	2642.931	2648.381	5.45
SWMH0056	MH	STD	2645.606	2652.231	6.625
SWMH0057	MH	STD	2641.489	2646.539	5.05
SWMH0059	MH	STD	2645.8	2651.45	5.65
SWMH0061	MH	DRP	2633.944	2642.694	8.75
SWMH0062	MH	STD	2628.59	2633.89	5.3
SWMH0063	MH	STD	2625.133	2633.283	8.15
SWMH0064	MH	STD	2627.215	2632.515	5.3
SWMH0065	MH	STD	2626.254	2631.604	5.35
SWMH0069	MH	STD	2674.062	2676.962	2.9
SWMH0070	MH	STD	2652.058	2656.858	4.8
SWMH0071	MH	STD	2650.901	2655.901	5
SWMH0072	MH	OTH	2655.8	2662.044	6.244
SWMH0106	MH	STD	2658.949	2664.099	5.15
SWMH0107	MH	STD	2657.812	2662.312	4.5
SWMH0108	MH	STD	2656.528	2660.628	4.1
SWMH0109	MH	DRP	2631.787	2637.187	5.4
SWMH0110	MH	STD	2634.917	2639.517	4.6

Frog Level

Conduits

Name	Inlet Node	Outlet Node	Tag	Length (ft)	Roughness	Inlet Elev. (ft)	Outlet Elev. (ft)	Entry Loss Coeff.	Exit Loss Coeff.	Cross-Section	Geom1 (ft)	Barrels	Slope (ft/ft)
C1	SWMH0027	SWMH0007	overland	221.271	0.01	2721.885	2718.236	0	0	STREET	0	1	0.01649
C10	SWDI0397	SWDI0399	overland	321.667	0.01	2644.25	2640.843	0	0	STREET	0	1	0.01059
C11	SWDI0399	SWDI1216	overland	525.516	0.01	2640.843	2636.409	0	0	STREET	0	1	0.00844
C12	SWDI1098	SWDI1022	overland	386.289	0.01	2662.499	2646.241	0	0	STREET	0	1	0.04212
C13	SWDI1100	SWDI1099	overland	145.709	0.01	2679.612	2662.499	0	0	STREET	0	1	0.11826
C14	SWDI1094	SWMH0020	overland	65	0.016	2662.4	2659.58	0	0	IRREGULAR	0	1	0.04343
C15	SWMH0020	SWDI1212	overland	391.343	0.01	2659.58	2637.876	0	0	STREET	0	1	0.05555
C16	SWDI1103	SWDI1100	overland	154.472	0.01	2694.864	2679.612	0	0	STREET	0	1	0.09922
C17	SWDI1099	SWDI1098	overland	47.567	0.01	2666.515	2662.499	0	0	STREET	0	1	0.08473
C18	SWDI1022	SWDI1117	overland	30	0.016	2647	2645.996	0	0	IRREGULAR	0	1	0.03349
C18_1	SWDI1117	J16	overland	413.797	0.045	2646.5	2635.022	0	0	IRREGULAR	0	1	0.02775
C18_2	J16	SWDI0446	overland	148.938	0.01	2635.022	2632.622	0	0	STREET	0	1	0.01612
C19	SWDI1234	SWDI0468	overland	140	0.01	2638.724	2637	0	0	STREET	0	1	0.01232
C2	SWDI0387	SWDI1073	overland	31.45	0.01	2719.022	2717.781	0	0	STREET	0	1	0.03949
C20	SWDI0466	SWMH0109	overland	162	0.01	2637.8	2637.187	0	0	STREET	0	1	0.00378
C21	SWDI1119	SWDI0446	overland	202	0.01	2634.864	2632.622	0	0	IRREGULAR	0	1	0.0111
C22	SWDI1243	SWDI1241	overland	20	0.01	2628.8	2628.667	0	0	IRREGULAR	0	1	0.00665
C22_1	SWDI0446	J17	overland	323.357	0.01	2632.811	2630.7	0	0	IRREGULAR	0	1	0.00653
C22_3	J17	J21	overland	60.706	0.01	2630.7	2630.208	0	0	IRREGULAR	0	1	0.0081
C22_4	J21	SWDI1266	overland	248.621	0.01	2629.79	2628.195	0	0	IRREGULAR	0	1	0.00642
C23	SWDI1118	SWDI0446	overland	262	0.01	2638.627	2632.811	0	0	IRREGULAR	0	1	0.0222
C24	SWDI1265	J19	overland	50	0.01	2628.3	2627.534	0	0	IRREGULAR	0	1	0.01532
C24_1	SWDP0031	J19	overland	22.135	0.01	2627.7	2627.534	0	0	IRREGULAR	0	1	0.0075
C24_2	J19	J18	overland	403.803	0.01	2627.534	2624.5	0	0	IRREGULAR	0	1	0.00751
C25	SWDI1242	SWDP0031	overland	29.162	0.01	2628.447	2626.708	0	0	IRREGULAR	0	1	0.05974
C26	SWDI1274	SWDI1237	overland	140.036	0.01	2653	2649.208	0	0	IRREGULAR	0	1	0.02709
C27	SWDI0472	SWDP0028	overland	334.982	0.01	2635.692	2640.422	0	0	IRREGULAR	0	1	0.03965
C27_1	SWDI1237	J20	overland	55.792	0.01	2649.208	2647.1	0	0	IRREGULAR	0	1	0.03781
C27_2	J20	SWDI1236	overland	246.627	0.01	2647.1	2637.781	0	0	IRREGULAR	0	1	0.03781
C28	SWDI1235	OF342	overland	50	0.01	2636.2	2634	0	0	IRREGULAR	0	1	0.04404
C29	SWDI1115	SWDI1022	overland	57.507	0.01	2647.955	2646.241	0	0	STREET	0	1	0.02982
C30	SWDI1214	J10	overland	894.614	0.01	2637	2630	0	0	IRREGULAR	0	1	0.00782
C31	SWDI1219	SWDI1214	overland	400	0.01	2636.817	2636.316	0	0	STREET	0	1	0.00125
C32	SWDI1266	SWDI1243	overland	10	0.01	2631.6	2628.094	0	0	RECT_OPEN	0.5	1	0.37436
C33	SWDI0470	OF343	overland	75	0.02	2635.899	2634	0	0	IRREGULAR	0	1	0.02533
C33_1	SWDI1212	J22	overland	70.872	0.01	2637.8	2635.8	0	0	IRREGULAR	0	1	0.02823
C33_2	J22	J21	overland	926.121	0.01	2635.8	2629.79	0	0	IRREGULAR	0	1	0.00649
C34	SWMH0072	OF1	overland	104.683	0.016	2662.044	2658	0	0	STREET	0	1	0.03866
C4	SWDI0392	SWDI0393	overland	31.804	0.016	2704.63	2703.52	0	0	IRREGULAR	0	1	0.03492
C5	SWDI1089	J14	overland	33.196	0.01	2697.352	2697.2	0	0	STREET	0	1	0.00458
C5_1	SWDI1073	J14	overland	412.1	0.01	2717.781	2697.2	0	0	STREET	0	1	0.05
C5_2	J14	SWDI0397	overland	910.803	0.01	2697.2	2644.05	0	0	STREET	0	1	0.05845
C6	SWMH0007	SWDI1089	overland	381.111	0.01	2718.236	2697.352	0	0	STREET	0	1	0.05488
C7	SWDI0394	SWDI0395	overland	364.738	0.01	2666.471	2645.763	0	0	STREET	0	1	0.05687
C8	SWDI0395	SWDI0398	overland	50.831	0.035	2645.763	2642	0	0	IRREGULAR	0	1	0.07423
C9	SWDI1216	SWDI1214	overland	43.24	0.01	2636.409	2636.196	0	0	STREET	0	1	0.00493
C9_1	SWDI0398	J15	overland	719.794	0.01	2642.665	2636.5	0	0	IRREGULAR	0	1	0.00857
C9_2	J15	SWDI1212	overland	20.206	0.02	2638.007	2637.876	0	0	IRREGULAR	0	1	0.00648
CJ32922_1	J32922	OF349	Open_Channel	124.301	0.01	2620	2619.007	0	0	IRREGULAR	0	1	0.00799
CJ32922_3	OF349	J18	Open_Channel	220.792	0.01	2619.007	2617.243	0	0	IRREGULAR	0	1	0.00799
CJ32922_4	J18	J32249	Open_Channel	343.408	0.01	2617.243	2614.5	0	0	IRREGULAR	0	1	0.00799
CJ33660_2	OF344	J10	Open_Channel	174.18	0.01	2627.41	2625.676	0	0	IRREGULAR	0	1	0.00996
CJ33660_3	OF347	J6	Open_Channel	146.261	0.01	2623.182	2621.726	0	0	IRREGULAR	0	1	0.00996
CJ33660_4	J6	J32922	Open_Channel	173.41	0.01	2621.726	2620	0	0	IRREGULAR	0	1	0.00995
CJ33660_5	J10	OF347	Open_Channel	250.49	0.01	2625.876	2623.182	0	0	IRREGULAR	0	1	0.00996
CJ34107_1	OF343	J12	Open_Channel	207.464	0.01	2627.596	2627.485	0	0	IRREGULAR	0	1	0.00054
CJ34107_3	J34107	OF342	Open_Channel	41.481	0.01	2627.65	2627.628	0	0	IRREGULAR	0	1	0.00053
CJ34107_4	OF342	OF343	Open_Channel	59.801	0.01	2627.628	2627.596	0	0	IRREGULAR	0	1	0.00054
CJ34107_5	J12	OF344	Open_Channel	138.764	0.01	2627.485	2627.41	0	0	IRREGULAR	0	1	0.00054
CJ34139	J34139	J34107	Open_Channel	32.16	0.01	2628.29	2627.65	0	0	IRREGULAR	0	1	0.0199
CJ34206_1	J34206	J34139	Bridge	66.46	0.05	2628.84	2628.29	0.5	1	CUSTOM	9.66	1	0.00828
CJ34206_2	J34206	J34139	Bridge	66.46	0.05	2629.16	2628.93	0.5	1	CUSTOM	9.944	1	0.00346
CJ34206_HC	J34206	J34139	highchord	39.2	0.01	2638	2638	0	0	IRREGULAR	0	1	0
CJ34260	J34260	J34206	Open_Channel	54.7	0.01	2628.61	2628.84	0	0	IRREGULAR	0	1	-0.0042
CJ34655_1	J34655	J13	Open_Channel	240.963	0.01	2629	2628.762	0	0	IRREGULAR	0	1	0.00099
CJ34655_2	J13	J34260	Open_Channel	153.677	0.01	2628.762	2628.61	0	0	IRREGULAR	0	1	0.00099
CJ34866_1	J34866	OF079	Open_Channel	143.38	0.01	2631.55	2629.814	0	0	IRREGULAR	0	1	0.01211
CJ34866_2	OF079	J34655	Open_Channel	67.27	0.01	2629.814	2629	0	0	IRREGULAR	0	1	0.0121
CJ34911	J34911	J34866	Open_Channel	44.98	0.01	2631.62	2631.55	0	0	IRREGULAR	0	1	0.00156
CJ35107	J35107	J34911	Open_Channel	196.26	0.01	2633.27	2631.62	0	0	IRREGULAR	0	1	0.00841
CJ35120	J35120	J35107	Open_Channel	12.59	0.01	2632.95	2633.27	0	0	IRREGULAR	0	1	-0.02543
CJ35180_1	J35180	J35120	Bridge	60.64	0.05	2632.99	2635	0.5	1	CUSTOM	10.85	1	-0.03316
CJ35180_2	J35180	J35120	Bridge	60.64	0.05	2632.008	2632.95	0.5	1	CUSTOM	11.662	1	-0.01554
CJ35180_HC	J35180	J35120	highchord	60.64	0.01	2646	2646	0	0	IRREGULAR	0	1	0
SWG0446	SWDI0392	SWDI0393	overland	31.804	0.013	2701.43	2700.62	0.5	0.42	CIRCULAR	1.5	1	0.02548
SWG0447	SWMH0038	SWDI0394	overland	524.763	0.024	2692.002	2659.721	0.5	0.42	CIRCULAR	2.5	1	0.06163
SWG0448	SWDI0394	SWDI0395	overland	364.738	0.024	2659.721	2640.713	0.5	0.83	CIRCULAR	2.5	1	0.05205
SWG0449	SWDI0395	SWDI0398	overland	43.153	0.024	2640.663	2638.515	0.5	1	CIRCULAR	2.5	1	0.04984
SWG0450	SWDI0397	SWDI0398	overland	78.483	0.024	2641.9	2638.665	0.5	1	CIRCULAR	1.25	1	0.04125
SWG0452	SWDI0402	SWDI0403	overland	33.766	0.022	2726.277	2724.487	0.5	0.83	CIRCULAR	1.25	1	0.05309
SWG0495	SWDI0444	SWDI0443	overland	43.331	0.022	2650.773	2650.54	0.5	0.42	CIRCULAR	1.25	1	0.00538
SWG0496	SWDI0443	SWDI0442	overland	53.188	0.022	2650.44	2648.778	0.5	0.7	CIRCULAR	1.25	1	0.03126
SWG0514	SWDI0467	SWDI0468	overland	33.166	0.013	2635.079	2633.144	0.5	1	CIRCULAR	1.5	1	0.05844
SWG0516	SWDI0471	SWDI0470	overland	15.343	0.013	2633.312	2632.999	0.5	1	CIRCULAR	1.5	1	0.0204
SWG0517	SWDI0470	OF343	overland	68.678	0.013	2630.849	2628.566	0.5	1	CIRCULAR	2	1	0.03326
SWG1061	SWDI0387	SWDI1073	overland	29.0	0.022	2716.72	2715.63	0.5	1	CIRCULAR	1.25	1	0.038
SWG1062	J1	SWMH0007	overland	16.9	0.013	2714.21	2713.24	0.5	0.83	CIRCULAR	1	1	0.058
SWG1067	SWMH0027	SWMH0007	overland	221.3	0.013	2716.89	2713.09	0.5	1	CIRCULAR	1	1	0.017
SWG1088	SWDI0403	SWDI1085	overland	215.9	0.022	2723.94	2704.37	0.5	0.7	CIRCULAR	1.25	1	0.091
SWG1089	SWDI1085	SWDI0392	overland	21.5	0.01	2704.32	2702.93	0.5	0.7	CIRCULAR	1	1	0.065
SWG1094	SWDI1089	SWDI1088	overland	18.7	0.013	2694.95	2694.41	0.5	1	CIRCULAR	1.5	1	0.029
SWG1096	SWDI1088	SWMH0037	overland	23.8	0.013	2693.91	2692.50	0.5	0.7	CIRCULAR	1.5	1	0.060
SWG1097	SWMH0037	SWMH0038	overland	11.9	0.024	2692.05	2692.00	0.5	0.42	CIRCULAR	2.5	1	0.004
SWG1098	SWMH0016	SWMH0037	overland	143.3	0.013								

Frog Level

Conduits

Name	Inlet Node	Outlet Node	Tag	Length (ft)	Roughness	Inlet Elev. (ft)	Outlet Elev. (ft)	Entry Loss Coeff.	Exit Loss Coeff.	Cross-Section	Geom1 (ft)	Barrels	Slope (ft/ft)
SWGMI099	SWMH0025	SWMH0037		309.4	0.013	2707.92	2692.55	0.5	1	CIRCULAR	1.25	1	0.050
SWGMI102	SWDI0398	SWMH0039		63.2	0.012	2637.47	2637.28	0.5	0.42	CIRCULAR	2.5	1	0.003
SWGMI103	SWMH0039	J35120		72.2	0.024	2637.23	2635.27	0.5	1	CIRCULAR	2.5	1	0.027
SWGMI114	SWDI1095	SWDI1094		48.7	0.013	2661.85	2659.65	0.5	0.7	CIRCULAR	1.25	1	0.045
SWGMI119	SWDI1099	SWDI1098		43.1	0.013	2661.62	2659.75	0.5	0.7	CIRCULAR	1.5	1	0.043
SWGMI120	SWMH0018	SWDI1099		109.5	0.013	2671.60	2661.72	0.5	0.42	CIRCULAR	1.25	1	0.091
SWGMI123	SWMH0045	SWDI1100		143.8	0.013	2689.11	2674.81	0.5	0.42	CIRCULAR	1.25	1	0.100
SWGMI124	SWDI1103	SWMH0045		16.4	0.022	2691.11	2689.86	0.5	1	CIRCULAR	1	1	0.077
SWGMI125	J8	SWDI1103		58.0	0.022	2694.76	2691.16	0.5	0.7	CIRCULAR	1	1	0.062
SWGMI126	SWMH0046	J8		15.3	0.022	2695.73	2694.76	0.5	0.7	CIRCULAR	1.25	1	0.063
SWGMI131	SWDI1106	SWMH0045		61.7	0.022	2695.03	2689.81	0.5	0.42	CIRCULAR	1.25	1	0.085
SWGMI132	SWDI1107	J9		48.2	0.022	2701.27	2697.05	0.5	0.83	CIRCULAR	1.25	1	0.088
SWGMI133	J9	SWDI1106		23.0	0.013	2697.05	2695.08	0.5	0.42	CIRCULAR	1.25	1	0.086
SWGMI136	SWMH0048	SWDI1109		11.1	0.022	2688.95	2688.92	0.5	0.42	CIRCULAR	1.5	1	0.003
SWGMI140	SWDI1111	SWMH0049		78.6	0.022	2692.28	2691.75	0.5	0.42	CIRCULAR	1.25	1	0.007
SWGMI142	SWMH0049	SWDI1112		59.5	0.022	2691.55	2691.52	0.5	0.83	CIRCULAR	1.25	1	0.001
SWGMI143	SWDI1113	SWMH0050		27.2	0.022	2690.96	2690.20	0.5	1	CIRCULAR	1.25	1	0.028
SWGMI145	SWMH0050	SWMH0051		90.6	0.01	2690.10	2658.96	0.5	0.42	CIRCULAR	1.25	1	0.366
SWGMI146	SWMH0051	SWMH0052		138.2	0.01	2658.66	2646.12	0.5	0.42	CIRCULAR	1.25	1	0.091
SWGMI147	SWDI1000	SWMH0052		8.9	0.01	2647.68	2646.12	0.5	1	CIRCULAR	1.25	1	0.178
SWGMI148	SWMH0052	SWMH0053		55.4	0.01	2646.02	2642.39	0.5	0.42	CIRCULAR	1.25	1	0.066
SWGMI149	SWDI1114	SWMH0054		17.1	0.022	2644.80	2644.47	0.5	0.42	CIRCULAR	3	1	0.019
SWGMI151	SWMH0054	SWDI1115		99.9	0.022	2644.47	2643.56	0.5	0.42	CIRCULAR	3	1	0.009
SWGMI155	SWMH0056	SWMH0055		77.8	0.01	2645.61	2643.18	0.5	0.83	CIRCULAR	1.25	1	0.031
SWGMI157	SWDI0442	SWDI0441		78.2	0.022	2648.73	2647.93	0.5	1	CIRCULAR	1.25	1	0.010
SWGMI158	SWDI0441	SWMH0056		64.7	0.01	2647.83	2645.61	0.5	0.83	CIRCULAR	1.25	1	0.034
SWGMI159	J7	SWDI1022		20.8	0.01	2643.00	2643.34	0.5	1	CIRCULAR	1.25	1	-0.016
SWGMI160	SWMH0055	J7		13.7	0.022	2642.93	2643.00	0.5	0.42	CIRCULAR	1.25	1	-0.005
SWGMI161	SWDI1022	SWDI1117		35.9	0.013	2642.94	2641.70	0.5	1	CIRCULAR	1	1	0.035
SWGMI162	SWMH0057	SWMH0053		207.6	0.013	2641.49	2639.14	0.5	1	CIRCULAR	1	1	0.011
SWGMI164	SWMH0059	SWMH0053		30.5	0.013	2645.80	2644.69	0.5	0.83	CIRCULAR	1.25	1	0.037
SWGMI166	SWMH0061	SWDI1118		46.0	0.013	2633.94	2630.43	0.5	0.42	CIRCULAR	1.5	1	0.077
SWGMI168	SWDI1119	SWMH0062		106.9	0.022	2632.01	2630.29	0.5	0.42	CIRCULAR	1.25	1	0.016
SWGMI169	SWDI1118	SWMH0062		165.3	0.013	2630.23	2628.64	0.5	0.42	CIRCULAR	1.5	1	0.010
SWGMI170	SWMH0062	SWDI0446		97.0	0.013	2628.59	2628.16	0.5	0.42	CIRCULAR	1.5	1	0.004
SWGMI173	SWDI0466	SWMH0063		23.4	0.013	2627.86	2625.18	0.5	0.42	CIRCULAR	1.5	1	0.115
SWGMI174	J5	SWMH0064		151.8	0.013	2626.15	2627.27	0.5	0.42	CIRCULAR	1.5	1	-0.007
SWGMI177	SWMH0064	SWMH0065		223.0	0.013	2627.22	2626.30	0.5	1	CIRCULAR	2	1	0.004
SWGMI178	SWMH0065	OF347		169.5	0.013	2626.25	2625.36	0.5	1	CIRCULAR	2	1	0.005
SWGMI179	SWDI1109	SWDI1123		93.1	0.022	2688.87	2686.60	0.5	0.7	CIRCULAR	1.5	1	0.024
SWGMI180	SWDI1123	SWDI1124		94.9	0.022	2686.50	2683.39	0.5	0.7	CIRCULAR	1.5	1	0.033
SWGMI182	SWDI1126	SWDI1125		43.0	0.022	2684.47	2683.15	0.5	0.42	CIRCULAR	1.5	1	0.031
SWGMI184	SWDI1128	SWMH0069		116.6	0.022	2679.26	2674.16	0.5	0.83	CIRCULAR	1.5	1	0.044
SWGMI185	SWMH0071	SWMH0059		328.3	0.013	2650.90	2645.95	0.5	0.7	CIRCULAR	1.25	1	0.015
SWGMI186	SWMH0069	SWMH0070		243.5	0.022	2674.06	2652.86	0.5	1	CIRCULAR	1.5	1	0.087
SWGMI187	SWMH0072	SWMH0070		266.1	0.013	2655.80	2652.11	0.5	0.42	CIRCULAR	1.25	1	0.014
SWGMI183	SWDI1093	SWMH0106		130.3	0.013	2667.54	2659.90	0.5	0.42	CIRCULAR	1.25	1	0.059
SWGMI184	SWDI1094	J3		21.7	0.022	2659.45	2658.16	0.5	0.42	CIRCULAR	1.25	1	0.059
SWGMI185	SWMH0106	J2		36.7	0.013	2658.95	2658.30	0.5	0.42	CIRCULAR	1.25	1	0.018
SWGMI186	J2	SWMH0107		27.3	0.013	2658.30	2658.11	0.5	0.42	CIRCULAR	1.25	1	0.007
SWGMI187	J3	SWMH0107		5.9	0.013	2658.16	2658.11	0.5	1	CIRCULAR	1.25	1	0.009
SWGMI188	SWMH0107	SWMH0108		40.8	0.013	2657.81	2656.58	0.5	0.7	CIRCULAR	1.25	1	0.030
SWGMI189	SWDI1098	J4		36.2	0.022	2659.70	2657.98	0.5	0.42	CIRCULAR	1.25	1	0.048
SWGMI190	J4	SWMH0108		30.5	0.013	2657.98	2656.58	0.5	0.7	CIRCULAR	1.5	1	0.046
SWGMI192	SWMH0108	SWMH0020		52.7	0.022	2656.53	2653.24	0.5	0.42	CIRCULAR	1.5	1	0.062
SWGMI193	SWMH0020	SWMH0044		27.9	0.013	2653.24	2651.56	0.5	0.7	CIRCULAR	1.25	1	0.061
SWGMI197	SWDI1212	SWDI1214		147.8	0.013	2634.88	2633.60	0.5	0.42	CIRCULAR	1.5	1	0.009
SWGMI199	SWDI1216	SWDI1214		38.0	0.022	2634.91	2634.10	0.5	1	CIRCULAR	1.25	1	0.021
SWGMI1401	SWMH0044	SWMH0019		438.0	0.013	2651.51	2635.28	0.5	0.42	CIRCULAR	1.5	1	0.037
SWGMI1403	SWDI1214	J34206		301.8	0.024	2633.40	2630.49	0.5	1	CIRCULAR	1.5	1	0.010
SWGMI1404	SWDI1214	SWDI1219		151.6	0.013	2632.97	2632.47	0.5	0.42	CIRCULAR	2	1	0.003
SWGMI1409	SWDI0465	OF344		91.4	0.024	2631.87	2628.39	0.5	1	CIRCULAR	1.5	1	0.038
SWGMI1410	SWDI1230	SWDI1229		142.3	0.024	2637.00	2634.27	0.5	1	CIRCULAR	1.25	1	0.019
SWGMI1413	SWDI0466	SWDI1229		106.8	0.024	2634.91	2634.27	0.5	0.42	CIRCULAR	1.25	1	0.006
SWGMI1414	SWDI0468	SWDI0470		49.1	0.013	2633.09	2630.90	0.5	0.42	CIRCULAR	2	1	0.045
SWGMI1416	SWDI1235	OF342		64.6	0.022	2633.72	2632.39	0.5	1	CIRCULAR	1.25	1	0.021
SWGMI1417	SWMH0110	J34206		80.8	0.013	2634.92	2631.15	0.5	1	CIRCULAR	1.5	1	0.047
SWGMI1418	SWDI0472	SWDI1274		56.1	0.024	2651.69	2649.96	0.5	1	CIRCULAR	1.25	1	0.031
SWGMI1419	SWDI1274	SWDI1237		140.0	0.024	2646.33	2642.86	0.5	0.42	CIRCULAR	3.5	1	0.025
SWGMI1420	SWDI1238	SWDP0028		120.1	0.024	2640.62	2636.92	0.5	1	CIRCULAR	3.5	1	0.031
SWGMI1425	SWDI1286	SWDI1243		26.3	0.024	2628.20	2625.39	0.5	0.42	CIRCULAR	2	1	0.107
SWGMI1426	SWDI1243	SWDI1241		27.5	0.024	2623.99	2623.57	0.5	0.42	CIRCULAR	2.5	1	0.016
SWGMI1427	SWDP0031	SWDI1242		29.2	0.013	2625.46	2625.05	0.5	0.42	CIRCULAR	1.25	1	0.014
SWGMI1428	SWDI1265	SWDI1241		49.5	0.013	2625.47	2623.97	0.5	1	CIRCULAR	2	1	0.030
SWGMI1429	SWDI1241	OF349		240.8	0.024	2623.37	2622.31	0.5	1	CIRCULAR	2.5	1	0.004
SWGMI1432	SWDI0399	OF079		178.7	0.024	2639.44	2633.10	0.5	1	CIRCULAR	1.25	1	0.036
SWGMI1435	SWDI1073	J1		19.7	0.022	2715.58	2714.21	0.5	0.42	CIRCULAR	1.25	1	0.070
SWGMI1442	SWDI1236	SWMH0110		25.7	0.013	2635.38	2635.02	0.5	0.83	CIRCULAR	1.5	1	0.014
SWGMI1444	SWDI1219	J34206		151.0	0.013	2632.42	2630.95	0.5	1	CIRCULAR	2	1	0.010
SWGMI1446	SWDI1242	SWDI1241		22.8	0.013	2624.95	2624.17	0.5	1	CIRCULAR	1.25	1	0.034
SWGMI1447	SWMH0063	J5		143.5	0.013	2625.13	2626.15	0.5	0.42	CIRCULAR	1.5	1	-0.007
SWGMI1449	SWMH0053	SWMH0061		74.8	0.013	2639.09	2634.64	0.5	0.42	CIRCULAR	1	1	0.060
SWGMI1450	SWDI1115	SWMH0055		24.1	0.022	2643.42	2643.28	0.5	0.7	CIRCULAR	3	1	0.006
SWGMI1451	SWDI1117	SWMH0057		4.5	0.013	2641.60	2641.59	0.5	0.7	CIRCULAR	1	1	0.002
SWGMI1452	SWDI1112	SWMH0050		47.1	0.022	2691.47	2690.15	0.5	0.7	CIRCULAR	1.25	1	0.028
SWGMI1454	SWDI1125	SWDI1128		13.8	0.022	2679.50	2679.36	0.5	1	CIRCULAR	1.5	1	0.010
SWGMI1455	SWDI1124	SWDI1125		59.4	0.022	2683.34	2682.45	0.5	1	CIRCULAR	1.5	1	0.015
SWGMI1456	SWMH0070	SWMH0071		84.9	0.013	2652.06	2650.95	0.5	0.42	CIRCULAR	1.25	1	0.013
SWGMI1457	SWMH0109	SWDI0465		24.2	0.024	2631.79	2631.97	0.5	0.42	CIRCULAR	1.5	1	-0.007
SWGMI1458	SWDI1273	SWMH0109		8.6	0.024	2632.21	2631.84	0.7	0.42	CIRCULAR	1.5	1	0.043
SWGMI1459	SWDI1229	SWDP0026		41.7	0.024	2634.22	2633.90	0.5	1	CIRCULAR	1.25	1	0.008
SWGMI1469	SWDI1231	SWDI1230		100.9	0.024	2639.17	2637.05	0.5	0.7	CIRCULAR	1.25	1	0.021
SWGMI1470	SWDI1234	SWDI0466		103.7	0.024	2635.62	2634.96	0.5</					

Frog Level

Conduits

Name	Inlet Node	Outlet Node	Tag	Length (ft)	Roughness	Inlet Elev. (ft)	Outlet Elev. (ft)	Entry Loss Coeff.	Exit Loss Coeff.	Cross-Section	Geom1 (ft)	Barrels	Slope (ft/ft)
SWGM1552	SWDI0393	SWMH0016		45.0	0.013	2700.52	2698.50	0.5	0.42	CIRCULAR	1.5	1	0.045
SWGM1558	SWDI1100	SWMH0018		34.1	0.013	2674.71	2671.60	0.5	0.42	CIRCULAR	1.25	1	0.092
SWGM1559	SWMH0019	SWDI1214		62.5	0.013	2635.28	2632.97	0.5	1	CIRCULAR	1.5	1	0.037
SWGM1565	SWMH0007	SWMH0025		99.7	0.013	2713.04	2707.92	0.5	0.42	CIRCULAR	1.25	1	0.051
SWOD0846	J11	SWDI1274	Open_Channel	61.6	0.01	2648.67	2646.33	0	0	IRREGULAR	0	1	0.038
SWOD0961	SWDP0026	SWDI1273	Open_Channel	42.5	0.01	2633.90	2632.21	0	0	IRREGULAR	0	1	0.040
SWOD0962	SWDP0028	J34260	Open_Channel	103.9	0.01	2636.92	2628.61	0	0	IRREGULAR	0	1	0.080

Hazelwood				
Subcatchments				
Name	Outlet	Area (ac)	Time of Concentration (min)	Curve Number
8584	SWD0132	0.369	10	75
8585	SWD0133	0.628	10	76
8586	CVPT0008	0.829	10	80
8588	SWD0136	13.716	28.881	71
8589	SWD0137	9.892	21.459	69
8590	SWD0138	2.962	11.146	75
8591	SWD0139	0.077	10	98
8592	SWD0140	1.123	10	89
8593	SWMH0101	0.144	10	89
85931	SWD0141	0.475	10	93
8594	SWD0142	5.444	12.118	77
8597	SWD0145	0.06	10	98
8598	SWMH0103	0.198	10	91
8599	SWD0149	0.04	10	98
8600	SWD0150	0.22	10	96
8601	SWD0151	1.599	10	98
8604	SWD0154	3.584	11.749	89
8605	SWD0155	0.302	10	98
8606	SWD0156	4.118	10	66
8607	J2438	2.442	20.627	79
8608	SWD0158	0.044	10	80
8609	SWD0159	0.01	10	63
8612	SWD0162	0.564	10	77
8613	SWD0163	0.016	10	84
8614	SWD0164	0.1	10	68
8616	SWD0166	0.04	10	89
8617	SWD0167	0.331	10	98
8618	SWD0168	0.518	10	96
8619	SWD0169	0.394	10	98
8621	SWD0171	0.008	10	81
8622	SWD0172	0.08	10	98
8623	SWD0173	1.738	10	67
8624	SWD0174	0.0	10	98
8625	SWD0175	4.2	11.904	67
8626	SWD0176	0.0	10	92
8632	SWD0991	0.0	10	95
8633	SU1	1.8	10	93
8634	SWD1154	0.5	10	69
8635	SWD1155	0.0	10	80
8636	SWD1156	0.7	10	69
8637	SWD1157	0.2	10	80
8638	SWD1158	2.2	10	68
8640	SWD1160	0.3	10	85
8641	SWD1161	9.1	13.715	70
8642	SWD1162	1.2	10	80
8643	SWD1163	4.8	10	69
8645	SWD1165	0.1	10	98
8646	SWD1166	0.5	10	96
8647	SWD1167	4.3	10	71
8649	SWD1169	8.3	12.28	71
8654	SWD1176	0.2	10	98
8656	SWD1178	0.0	10	91
8657	SWD1179	0.2	10	71
8658	SWD1180	10.3	43.399	63
8659	SWD1181	0.2	10	79
8660	SWD1182	0.1	10	83
8661	SWD1183	0.4	10	78
8664	SWD1187	4.2	16.105	70
8666	SWD1189	1.0	10	89
8667	SWD1190	0.6	10	87
8671	SWD1194	0.7	10	73
8672	SWD1195	0.1	10	60
8673	SWD1196	0.2	10	76
8675	SWD1257	0.1	10	69
8676	SWD1258	1.1	10	88
8677	SWD1259	1.5	10	76
8678	SWD1287	1.2	10	97
8684	SWD1293	0.7	10	90
8685	SWD1294	0.5	10	88
8686	SWD1295	4.7	10.946	94
8688	SWD1297	0.5	10	55
8690	SWD1299	0.0	10	55
8691	SWD1300	0.1	10	63
8692	SWD1301	0.0	10	81
86931	SWD1302	0.2	10	61
8694	SWD1303	0.0	10	55
8696	CVPT0002	3.8	10	65
8698	CVPT0008	4.1	12.886	70
8699	J2438	5.1	10	66
8701	CVPT0014	9.2	12.086	61
8705	CVPT0023	0.9	10	60
87051	J1925	4.3	18.157	83
8708	J2007	10.3	20.243	77
8709	CVPT0004	0.1	10	61
8735	J3156	5.0	10	64
8739	J3543	4.7	14.262	67
8752	SWMH0093	9.7	10	58
8759	SWMH0097	0.0	10	98
8760	SWMH0098	0.5	10	76
8761	SWMH0099	1.1	10	72
8767	SWMH0102	1.7	21.987	86
8773	J16	1.2	10	67
8777	J19	0.4	10	67
8789	J17	0.1	10	98

Hazelwood				
Subcatchments				
Name	Outlet	Area (ac)	Time of Concentration (min)	Curve Number
8790	SWDP0041	0.2	10	98
8794	J20	6.7	10	59
Hazelwood	J4394	615.7	83	66
R1	SWDI1256	22.2	13.225	63
R2	SWDI1298	0.2	10	56
R3	SWDI0144	0.8	10	98

Hazelwood					
Junctions					
Name	Tag	Description	Invert Elev. (ft)	Rim Elev. (ft)	Depth (ft)
CVPT0002			2696.33	2701.33	5
CVPT0004		Cut	2677.123	2681.623	4.5
CVPT0005		Cut	2695.607	2700.607	5
CVPT0008		Cut	2711.964	2718.59	6.626
CVPT0010		Cut	2682.798	2688.898	6.1
CVPT0011		Cut	2712.386	2718.94	6.554
CVPT0014		Head Wall	2756.065	2758.065	2
CVPT0016		Head Wall	2753	2755	2
CVPT0022		Cut	2678.658	2683.158	4.5
CVPT0023		Cut	2680.312	2684.812	4.5
CVPT0024			2675.8	2680.3	4.5
J1			2748.303	2750.303	2
J10	Created		2697.849	2706.197	8.348
J1090		River: Farmers Branch Reach: Reach-1 Transect: 1090	2673.11	2684.56	11.45
J11	StormNet	River: Farmers Branch Reach: Reach-1 Transect: 1183	2696.43	2709.99	13.56
J1183		River: Farmers Branch Reach: Reach-1 Transect: 1224	2673.05	2684.4	11.35
J12			2672.629	2686.061	13.432
J1224		River: Farmers Branch Reach: Reach-1 Transect: 1345	2673.1	2685.1	12
J13	Created	River: Farmers Branch Reach: Reach-1 Transect: 1386	2678.943	2688.242	9.299
J1345			2676.05	2684.91	8.86
J1386			2676.1	2684.94	8.84
J14		Standard Outlet	2734.415	2736.415	2
J15			2730.161	2733.194	3.033
J16		River: Farmers Branch Reach: Reach-1 Transect: 1751	2704.709	2718.699	13.99
J17	StormNet		2689.994	2697.44	7.446
J1751			2685.28	2693.03	7.75
J18		River: Farmers Branch Reach: Reach-1 Transect: 1925	2730.2	2731.825	1.625
J19	StormNet		2698.232	2706.58	8.348
J1925			2684.9	2698.73	13.83
J2	StormNet	River: Farmers Branch Reach: Reach-1 Transect: 2007	2677.823	2681.778	3.955
J20	StormNet		2673.874	2685.05	11.176
J2007		River: Farmers Branch Reach: Reach-1 Transect: 2438	2685	2702.86	17.86
J21			2724.352	2725.112	0.76
J2438			2693.5	2697.5	4
J2692		River: Farmers Branch Reach: Reach-1 Transect: 2692	2697.51	2700.061	2.551
J2807		River: Farmers Branch Reach: Reach-1 Transect: 2807	2698.72	2702.87	4.15
J2899		River: Farmers Branch Reach: Reach-1 Transect: 2899	2699	2703.15	4.15
J3			2730.524	2730.524	0
J3007		River: Farmers Branch Reach: Reach-1 Transect: 3007	2701.12	2706.71	5.59
J3156		River: Farmers Branch Reach: Reach-1 Transect: 3156	2703.92	2716.633	12.713
J3359		River: Farmers Branch Reach: Reach-1 Transect: 3359	2704.85	2708.36	3.51
J3403		River: Farmers Branch Reach: Reach-1 Transect: 3403	2705	2708.51	3.51
J3543		River: Farmers Branch Reach: Reach-1 Transect: 3543	2708.25	2721.51	13.26
J4	StormNet		2702.231	2703.989	1.758
J4011		River: Farmers Branch Reach: Reach-1 Transect: 4011	2716	2730.85	14.85
J4196		River: Farmers Branch Reach: Reach-1 Transect: 4196	2718.48	2733.83	15.35
J4394		River: Farmers Branch Reach: Reach-1 Transect: 4394	2721.4	2736.41	15.01
J5	StormNet		2702.88	2704.431	1.551
J6	StormNet		2702.661	2704.29	1.629
J7	StormNet		2725.647	2731.226	5.579
J8	StormNet		2729.263	2733.666	4.403
J9	StormNet		2754.638	2757.802	3.164
OF266		KW_added outlet junction name updated to match gis	2715.984	2730.144	14.16
OF286		Standard Outlet	2674.955	2676.955	2
SWDI0132		Grate Inlet	2734.297	2739.897	5.6
SWDI0133		Grate Inlet	2739.16	2742.66	3.5
SWDI0136		Combo Inlet	2711.292	2713.192	1.9
SWDI0137		Grate Inlet	2709.196	2712.696	3.5
SWDI0138		Grate Inlet	2712.268	2713.668	1.4
SWDI0139		Grate Inlet	2709.024	2711.524	2.5
SWDI0140		Grate Inlet	2710.133	2712.333	2.2
SWDI0141		Grate Inlet	2709.64	2712.14	2.5
SWDI0142		Grate Inlet	2710.721	2712.921	2.2
SWDI0144		Grate Inlet	2711.325	2713.325	2
SWDI0145		Grate Inlet	2710.9	2712.9	2
SWDI0149		Grate Inlet	2704.965	2707.615	2.65
SWDI0150		Grate Inlet	2705.368	2707.318	1.95
SWDI0151		Grate Inlet	2704.624	2706.924	2.3
SWDI0156			2691.369	2697.302	5.933
SWDI0158		Grate Inlet	2701.69	2703.54	1.85
SWDI0159		Grate Inlet	2704.187	2705.737	1.55
SWDI0162		Grate Inlet	2730.082	2732.582	2.5
SWDI0163		Grate Inlet	2728.137	2732.637	4.5
SWDI0164		Grate Inlet	2730.61	2732.81	2.2
SWDI0166		Grate Inlet	2690.998	2692.798	1.8
SWDI0167		Grate Inlet	2691.655	2693.455	1.8
SWDI0168		Grate Inlet	2692.75	2694.25	1.5
SWDI0169		Grate Inlet	2691.5	2692.8	1.3
SWDI0171		Grate Inlet	2686.549	2688.149	1.6
SWDI0172		Grate Inlet	2687.131	2688.531	1.4
SWDI0173		Grate Inlet	2681.756	2683.756	2
SWDI0174		Grate Inlet	2681.555	2683.405	1.85
SWDI0175		Grate Inlet	2680.019	2681.319	1.3
SWDI0176		Grate Inlet	2676.225	2681.175	4.95
SWDI0991		Grate Inlet	2736.747	2742.047	5.3
SWDI1008		Grate Inlet	2713.422	2714.872	1.45
SWDI1154		Grate Inlet	2740.912	2744.912	4
SWDI1155		Grate Inlet	2753.517	2756.617	3.1
SWDI1156		Grate Inlet	2735.999	2741.299	5.3
SWDI1157		Grate Inlet	2732.015	2738.515	6.5
SWDI1158		Grate Inlet	2730.356	2733.906	3.55
SWDI1159		Grate Inlet	2728.87	2729.97	1.1
SWDI1160		Grate Inlet	2725.848	2730.948	5.1
SWDI1161		Grate Inlet	2728.648	2731.048	2.4

Hazelwood					
Junctions					
Name	Tag	Description	Invert Elev. (ft)	Rim Elev. (ft)	Depth (ft)
SWD1162		Grate Inlet	2726.761	2730.711	3.95
SWD1163		Grate Inlet	2724.171	2728.771	4.6
SWD1165		Grate Inlet	2723.075	2725.775	2.7
SWD1166		Combo Inlet	2723.199	2725.449	2.25
SWD1167		Combo Inlet	2723.915	2726.465	2.55
SWD1169		Grate Inlet	2733.486	2736.686	3.2
SWD1174			2712.454	2713.954	1.5
SWD1176		Grate Inlet	2711.38	2713.53	2.15
SWD1178		Grate Inlet	2733.872	2738.922	5.05
SWD1179		Grate Inlet	2734.074	2739.274	5.2
SWD1180		Grate Inlet	2734.719	2739.469	4.75
SWD1181		Grate Inlet	2733.673	2738.973	5.3
SWD1182		Grate Inlet	2731.885	2734.835	2.95
SWD1183		Grate Inlet	2706.611	2710.561	3.95
SWD1187		Grate Inlet	2701.668	2703.268	1.6
SWD1189		Grate Inlet	2705.098	2707.298	2.2
SWD1190		Grate Inlet	2702.271	2707.571	5.3
SWD1192		Grate Inlet	2692.682	2696.032	3.35
SWD1194		Grate Inlet	2675.668	2679.268	3.6
SWD1195		Grate Inlet	2675.002	2678.552	3.55
SWD1196		Combo Inlet	2692.938	2696.288	3.35
SWD1256		Pipe	2703.415	2704.665	1.25
SWD1257		Pipe	2698.691	2700.191	1.5
SWD1258		Pipe	2706.24	2708.14	1.9
SWD1259		Pipe	2679.714	2680.964	1.25
SWD1287		Combo Inlet	2695.037	2698.537	3.5
SWD1293		Combo Inlet	2693.969	2697.819	3.85
SWD1294		Combo Inlet	2696.434	2700.134	3.7
SWD1295		Combo Inlet	2698.165	2701.765	3.6
SWD1297		Grate Inlet	2779.568	2782.818	3.25
SWD1298		Grate Inlet	2774.357	2777.657	3.3
SWD1299		Grate Inlet	2777.186	2780.136	2.95
SWD1300		Grate Inlet	2756.136	2771.386	15.25
SWD1301		Grate Inlet	2756.406	2764.006	7.6
SWD1302		Combo Inlet	2756.833	2764.033	7.2
SWD1303		Combo Inlet	2756.921	2764.271	7.35
SWDP0016		KW_Added point name matches gis	2710.771	2725.023	14.252
SWDP0041			2687.575	2696.22	8.645
SWDP0047			2678.995	2685.032	6.037
SWDP0048	Standard_Outlet		2756.973	2758.973	2
SWMH0094	MH	STD	2725.214	2731.164	5.95
SWMH0095	MH	STD	2722.84	2729.39	6.55
SWMH0096	MH	STD	2722.425	2728.625	6.2
SWMH0097	MH	STD	2721.138	2726.188	5.05
SWMH0098	MH	STD	2722.053	2726.953	4.9
SWMH0099	MH	STD	2725.81	2731.66	5.85
SWMH0100	MH	STD	2732.024	2737.474	5.45
SWMH0101	MH	STD	2715.303	2720.553	5.25
SWMH0102	MH	STD	2713.296	2715.146	1.85
SWMH0103	MH	STD	2712.269	2714.019	1.75
SWMH0112	MH	STD	2756.826	2765.226	8.4

Hazelwood

Conduits

Name	Inlet Node	Outlet Node	Tag	Length (ft)	Roughness	Inlet Elev. (ft)	Outlet Elev. (ft)	Entry Loss Coeff.	Exit Loss Coeff.	Cross-Section	Geom1 (ft)	Barrels	Slope (ft/ft)
C1	SWDI1256	SWDI0158	Overland	44.414	0.01	2704.665	2703.54	0	0	IRREGULAR	0	1	0.02534
C10	SWDI1196	SWDI0168	Overland	161.942	0.01	2696.288	2694.25	0	0	STREET	0	1	0.01259
C11	SWDI0168	SWDI0167	Overland	56.257	0.01	2694.25	2693.455	0	0	STREET	0	1	0.01413
C12	SWDI0167	SWDI0166	Overland	28.478	0.01	2693.455	2692.798	0	0	IRREGULAR	0	1	0.02308
C13	SWDI0169	SWDI0172	Overland	244.504	0.01	2692.8	2688.531	0	0	STREET	0	1	0.01746
C14	SWDI1192	CVPT0010	overland	90	0.01	2696.032	2695.6	0	0	IRREGULAR	0	1	0.0048
C15	SWDI0132	SWDI1157	Overland	91.467	0.01	2739.897	2738.515	0	0	STREET	0	1	0.01511
C16	SWDI1160	J3		400	0.01	2725.848	2730.524	0	0	CIRCULAR	1	1	-0.01169
C16_1	SWDI1161	J3	Overland	33.011	0.01	2731.048	2730.524	0	0	IRREGULAR	0	1	0.01588
C16_2	J3	SWDI1163	Overland	110.533	0.01	2730.524	2728.771	0	0	IRREGULAR	0	1	0.01586
C17	SWDI1159	SWDI1163	Overland	103.565	0.01	2729.97	2728.771	0	0	IRREGULAR	0	1	0.01158
C18	SWDI1163	SWDI1166	Overland	254.13	0.01	2728.771	2725.449	0	0	IRREGULAR	0	1	0.01307
C19	SWDI0133	SWDI0991	Overland	27.173	0.01	2742.66	2742.047	0	0	STREET	0	1	0.02256
C19_1	SWDI1169	J18	Overland	357.301	0.01	2736.686	2730.2	0	0	STREET	0	1	0.01816
C19_2	J18	SWDP0016	Overland	499.897	0.01	2730.2	2725.023	0	0	STREET	0	1	0.01036
C2	SWDI0175	SWDI1259	Overland	23.936	0.01	2681.319	2680.964	0	0	IRREGULAR	0	1	0.01483
C20	SWDI1162	J21	Overland	393.801	0.01	2730.711	2725.112	0	0	STREET	0	1	0.01422
C20_1	SWDI1166	J21	Overland	42.708	0.01	2725.449	2725.112	0	0	STREET	0	1	0.00789
C20_2	J21	CVPT0008	Overland	224.292	0.01	2725.112	2718.59	0	0	STREET	0	1	0.02909
C21	SWDI1167	SWDI1165	Overland	62.679	0.01	2726.465	2725.775	0	0	STREET	0	1	0.01101
C22	SWDI1180	SWDI1178	Overland	35.68	0.01	2739.469	2738.922	0	0	IRREGULAR	0	1	0.01533
C23	SWDI1178	SWDI1182	Overland	174.329	0.01	2738.922	2734.835	0	0	STREET	0	1	0.02345
C24	SWDI1182	SWDI0164	Overland	179.228	0.01	2734.835	2732.81	0	0	STREET	0	1	0.0113
C25	SWDI0164	J18	Overland	316.545	0.01	2732.81	2730.2	0	0	STREET	0	1	0.00825
C26	SWDI1008	SWDI1174	Overland	92.537	0.01	2714.872	2713.954	0	0	STREET	0	1	0.00992
C27	SWDI0144	SWDI1176	Overland	24.509	0.01	2713.325	2713.53	0	0	STREET	0	1	-0.00836
C28	SWDI0138	SWDI0144	Overland	72.831	0.01	2713.668	2713.325	0	0	STREET	0	1	0.00471
C29	SWDI0145	SWDI0142	Overland	35.27	0.01	2712.9	2712.921	0	0	STREET	0	1	-0.0006
C3	SWDI1194	SWDI1195	Overland	187.497	0.01	2679.268	2678.552	0	0	IRREGULAR	0	1	0.00382
C30	SWDI1176	SWDI0145	Overland	111.164	0.01	2713.53	2712.9	0	0	STREET	0	1	0.00567
C31	SWDI1174	SWDI0138	Overland	38.438	0.01	2713.954	2713.668	0	0	IRREGULAR	0	1	0.00744
C32	SWDI0136	SWDI0140	Overland	214.511	0.01	2713.192	2712.333	0	0	STREET	0	1	0.004
C33	SWDI0137	SWDI0140	Overland	72.555	0.01	2712.696	2712.333	0	0	STREET	0	1	0.005
C34	SWDI0140	SWDI0141	Overland	29.626	0.01	2712.333	2712.14	0	0	IRREGULAR	0	1	0.00651
C35	SWDI0141	SWDI0139	Overland	63.815	0.01	2712.14	2711.524	0	0	IRREGULAR	0	1	0.00965
C36	SWDI0139	SWDI1189	Overland	312.029	0.01	2711.524	2707.298	0	0	STREET	0	1	0.01354
C37	SWDI1258	SWDI0150	Overland	78.315	0.01	2708.14	2707.318	0	0	STREET	0	1	0.0105
C38	SWDI0150	SWDI1189	Overland	73.291	0.01	2707.318	2707.298	0	0	STREET	0	1	0.00027
C39	SWDI1189	J2438	Overland	800.496	0.01	2707.298	2697.5	0	0	STREET	0	1	0.01224
C4	SWDI1259	SWDI0176	Overland	5.047	0.01	2680.964	2681.175	0	0	IRREGULAR	0	1	-0.04184
C40	SWDI0151	SWDI0154	Overland	807.15	0.01	2706.924	2695.893	0	0	STREET	0	1	0.01367
C41	SWDI0156	SWDI1192	overland	80	0.01	2697.302	2696.032	0	0	IRREGULAR	0	1	0.01588
C42	SWDI0155	SWDI1192	overland	30	0.01	2697.5	2696.5	0	0	IRREGULAR	0	1	0.03335
C43	SWDI0154	SWDI0155	overland	400	0.01	2693.393	2693.292	0	0	CIRCULAR	1	1	0.00025
C44	SWDI0154	SWDI0155	overland	1	0.016	2696.2	2696.2	0	0	IRREGULAR	0	1	0
C45	SWMH0093	SWDI1155		5	0.01	2758.3	2756.617	0	0	IRREGULAR	0	1	0.35746
C46	SWDI1156	SWDI0132	Overland	117.916	0.01	2741.299	2739.897	0	0	STREET	0	1	0.01189
C47	SWDI0991	SWDI1156	Overland	76.058	0.01	2742.047	2741.299	0	0	STREET	0	1	0.00984
C48	SWDI1154	SWDI0991	Overland	225.878	0.01	2745.2	2742.047	0	0	IRREGULAR	0	1	0.01396
C49	SWDI1158	SWDI1160	Overland	158	0.01	2733.906	2730.948	0	0	STREET	0	1	0.01872
C5	SWDI0176	SWDI1194	Overland	158.787	0.01	2681.175	2679.268	0	0	IRREGULAR	0	1	0.01201
C50	SWDI1157	SWDI1158	Overland	126	0.01	2738.515	2733.906	0	0	STREET	0	1	0.0366
C51	SWDI1160	J3	overland	5	0.01	2730.948	2730.524	0	0	STREET	0	1	0.08511
C52	SU1	SWDI1008	Overland	5	0.01	2714.872	2714.872	0	0	IRREGULAR	0	1	0
C53	SWDI0142	SWDI0137	Overland	20	0.01	2713.2	2712.696	0	0	IRREGULAR	0	1	0.02521
C54	SWDI1181	SWDI0162		356	0.01	2738.973	2732.582	0	0	STREET	0	1	0.01796
C55	SWDI1179	SWDI1169	Overland	325.719	0.01	2739.274	2736.686	0	0	STREET	0	1	0.00795
C56	SWDI0166	SWDI0171	Overland	251.432	0.01	2692.798	2688.149	0	0	STREET	0	1	0.01849
C57	SWDI0174	SWDI0175	Overland	202.594	0.01	2683.405	2681.319	0	0	IRREGULAR	0	1	0.0103
C58	SWDI0173	SWDI0174	Overland	18.555	0.01	2683.9	2683.405	0	0	IRREGULAR	0	1	0.02669
C59	SWDI0171	SWDI0173	Overland	281.934	0.01	2688.149	2683.756	0	0	STREET	0	1	0.01558
C6	SWDI1295	SWDI1294	Overland	134.974	0.01	2701.765	2700.134	0	0	STREET	0	1	0.01208
C60	SWDI1187	J2807	Overland	10	0.01	2703.5	2702.87	0	0	IRREGULAR	0	1	0.06313
C61	SWDI1257	J2692	Overland	65.121	0.01	2700.191	2698	0	0	IRREGULAR	0	1	0.03366
C7	SWDI1294	SWDI1293	Overland	187.156	0.01	2700.134	2697.819	0	0	STREET	0	1	0.01237
C8	SWDI1293	SWDI1196	Overland	136.962	0.01	2697.819	2696.288	0	0	STREET	0	1	0.01118
C9	SWDI1287	SWDI1196	Overland	143.681	0.01	2698.537	2696.288	0	0	STREET	0	1	0.01565
CJ1090_1	J1090	J12	Open_Channel	57.902	0.01	2673.11	2672.629	0	0	IRREGULAR	0	1	0.00831
CJ1090_2	J12	J989	Open_Channel	39.114	0.01	2672.629	2672.26	0	0	IRREGULAR	0	1	0.00943
CJ1183	J1183	J1090	Open_Channel	131.403	0.01	2673.05	2673.11	0	0	IRREGULAR	0	1	-0.00046
CJ1224	J1224	J1183		10	0.024	2673.1	2673.05	0.9	1	ARCH	5	1	0.005
CJ1224_HC	J1224	J1183	HC	10	0.024	2679.093	2679.043	0	0	IRREGULAR	0	1	0.005
CJ1345_1	J1345	J20	Open_Channel	104.803	0.01	2676.05	2673.874	0	0	IRREGULAR	0	1	0.02077
CJ1345_2	J20	J1224	Open_Channel	37.292	0.01	2673.874	2673.1	0	0	IRREGULAR	0	1	0.02076
CJ1386	J1386	J1345		10	0.024	2676.1	2676.05	0.9	1	ARCH	5	1	0.005
CJ1386_HC	J1386	J1345	HC	10	0.024	2679.94	2679.89	0	0	IRREGULAR	0	1	0.005
CJ1406	CVPT0024	J1386	Open_Channel	54.38	0.01	2675.8	2676.1	0	0	IRREGULAR	0	1	-0.00552
CJ1466_HC	CVPT0004	CVPT0024	HC	40	0.024	2681.623	2680.3	0	0	IRREGULAR	0	1	0.03309
CJ1502_1	CVPT0022	J13	Open_Channel	3.796	0.01	2679.29	2678.943	0	0	IRREGULAR	0	1	0.0918
CJ1502_2	J13	CVPT0004	Open_Channel	32.204	0.01	2678.943	2677.123	0	0	IRREGULAR	0	1	0.05661
CJ1623_HC	CVPT0023	HC		102	0.024	2683.7	2683.19	0	0	IRREGULAR	0	1	0.005
CJ1751	J1751	CVPT0023	Open_Channel	141.018	0.01	2685.28	2680.312	0	0	IRREGULAR	0	1	0.03525
CJ1925	J1925	J1751	Open_Channel	212.944	0.01	2684.9	2685.28	0	0	IRREGULAR	0	1	-0.00178
CJ2007	J2007	J1925		210	0.013	2685	2684.9	0.2	1	CIRCULAR	4	1	0.00048
CJ2007_2	J2007	J1925		210	0.024	2687	2686.9	0.9	1	CIRCULAR	4	1	0.00048
CJ2007_HC	J2007	J1925	HC	210.0	0.013	2692.05	2691.95	0	0	IRREGULAR	0	1	0.000
CJ2153	CVPT0010	J2007	Open_Channel	194.2	0.01	2682.80	2685.00	0	0	IRREGULAR	0	1	-0.011
CJ2438	J2438	SWDI0156		49.9	0.013	2693.50	2691.37	0.4	0.42	RECT_CLOSED	4	1	0.043
CJ2438_HC	J2438	SWDI0156	HC	30.0	0.024	2697.50	2697.30	0	0	IRREGULAR	0	1	0.007
CJ2513	CVPT0005	J2438	Open_Channel	114.1	0.01	2695.61	2693.50	0	0	IRREGULAR	0	1	0.018
CJ2591_HC	CVPT0002	CVPT0005	HC	58.0	0.024	2701.33	2700.61	0	0	IRREGULAR	0	1	0.012
CJ2692_1	J2692	J11	Open_Channel	88.5	0.01	2697.51	2696.43	0	0	IRREGULAR	0	1	0.012
CJ2692_2	J11	CVPT0002	Open_Channel	15.3	0.01	2696.43	2696.33	0	0	IRREGULAR	0	1	0.007
CJ2807_2	J10	J2692	Open_Channel	17.1	0.01	2697.85	2697.51	0	0	IRREGULAR	0	1	0.020

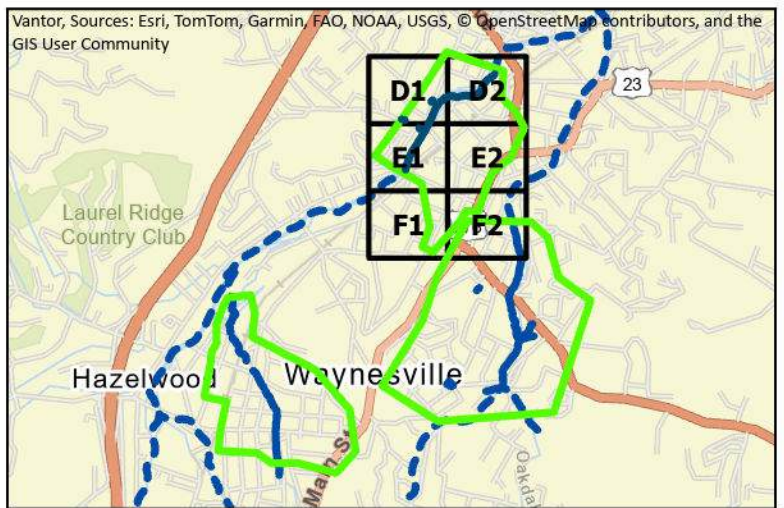
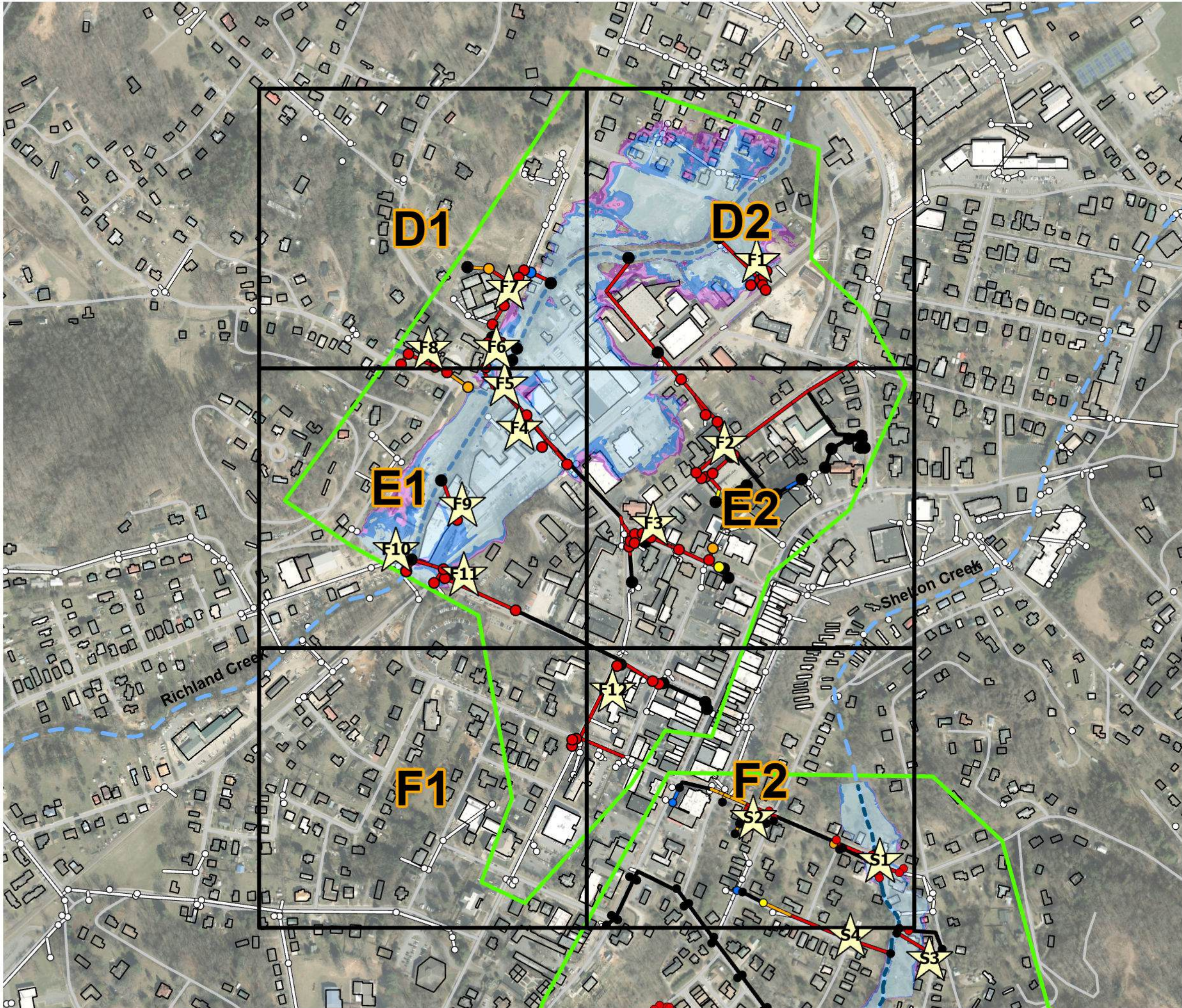
Hazelwood													
Conduits													
Name	Inlet Node	Outlet Node	Tag	Length (ft)	Roughness	Inlet Elev. (ft)	Outlet Elev. (ft)	Entry Loss Coeff.	Exit Loss Coeff.	Cross-Section	Geom1 (ft)	Barrels	Slope (ft/ft)
CJ2807_3	J2807	J19	Open_Channel	57.3	0.01	2698.72	2698.23	0	0	IRREGULAR	0	1	0.009
CJ2807_4	J19	J10	Open_Channel	45.0	0.01	2698.23	2697.85	0	0	IRREGULAR	0	1	0.009
CJ2899	J2899	J2807		56.0	0.024	2699.00	2698.72	0.5	1	ARCH	3	2	0.005
CJ2899_HC	J2899	J2807	HC	56.0	0.024	2703.15	2702.87	0	0	IRREGULAR	0	1	0.005
CJ3007	J3007	J2899	Open_Channel	133.2	0.01	2701.12	2699.00	0	0	IRREGULAR	0	1	0.016
CJ3156	J3156	J3007	Open_Channel	152.4	0.01	2703.92	2701.12	0	0	IRREGULAR	0	1	0.018
CJ3359_1	J3359	J16	Open_Channel	44.6	0.01	2704.85	2704.71	0	0	IRREGULAR	0	1	0.003
CJ3359_2	J16	J3156	Open_Channel	163.2	0.01	2704.71	2703.92	0	0	IRREGULAR	0	1	0.005
CJ3403	J3403	J3359		30.0	0.024	2705.00	2704.85	0.5	1	ARCH	3	2	0.005
CJ3403_HC	J3403	J3359	HC	30.0	0.024	2708.51	2708.36	0	0	IRREGULAR	0	1	0.005
CJ3543	J3543	J3403	Open_Channel	153.7	0.01	2708.25	2705.00	0	0	IRREGULAR	0	1	0.021
CJ3696_1	CVPT0011	SWDP0016	Open_Channel	20.1	0.01	2712.39	2710.77	0	0	IRREGULAR	0	1	0.081
CJ3696_2	SWDP0016	J3543	Open_Channel	154.3	0.01	2710.77	2708.25	0	0	IRREGULAR	0	1	0.016
CJ3759_HC	CVPT0008	CVPT0011	HC	32.0	0.013	2718.59	2718.94	0	0	IRREGULAR	0	1	-0.011
CJ4011_1	J4011	OF266	Open_Channel	30.1	0.01	2716.00	2715.98	0	0	IRREGULAR	0	1	0.001
CJ4011_2	OF266	CVPT0008	Open_Channel	234.9	0.01	2715.98	2711.96	0	0	IRREGULAR	0	1	0.017
CJ4196	J4196	J4011	Open_Channel	186.1	0.01	2718.48	2716.00	0	0	IRREGULAR	0	1	0.013
CJ4394	J4394	J4196	Open_Channel	198.2	0.01	2721.40	2718.48	0	0	IRREGULAR	0	1	0.015
CULV0003	CVPT0002	CVPT0005	Culvert	59.6	0.024	2696.33	2695.61	0.5	1	CIRCULAR	5	1	0.012
CULV0004	CVPT0008	CVPT0011	Culvert	36.6	0.013	2711.96	2712.39	0.4	1	RECT_CLOSED	5	1	-0.012
CULV0005_2	SWDP0041	CVPT0010	Culvert	111.9	0.024	2687.58	2682.80	0.9	1	CIRCULAR	6	1	0.043
CULV0005_4	J17	SWDP0041	Culvert	56.7	0.024	2689.99	2687.58	0.5	0.42	RECT_CLOSED	4	1	0.043
CULV0005_5	SWDI0156	J17	Culvert	32.2	0.024	2691.37	2689.99	0.5	0.42	RECT_CLOSED	4	1	0.043
CULV0006_1	CVPT0023	SWDP0047	Culvert	78.5	0.024	2680.31	2679.00	0.5	0.42	CIRCULAR	4.5	1	0.017
CULV0006_2	SWDP0047	CVPT0022	Culvert	20.1	0.024	2679.00	2678.66	0.5	1	CIRCULAR	4.5	1	0.017
CULV0008	CVPT0004	CVPT0024		34.2	0.024	2677.12	2675.80	0.9	1	CIRCULAR	4.5	1	0.039
CULV0009	CVPT0014	CVPT0016	Culvert	58.6	0.013	2756.07	2753.00	0.5	1	CIRCULAR	2	1	0.052
SSGM1586	SWDI1287	SWDI1293		14.0	0.022	2695.04	2693.97	0.5	1	CIRCULAR	1.25	1	0.077
SSGM1587	SWDI1293	SWDI1196		137.0	0.022	2693.97	2692.94	0.5	0.42	CIRCULAR	2	1	0.008
SSGM1589	SWDI1294	SWDI1293		187.2	0.022	2696.43	2693.97	0.5	0.42	CIRCULAR	2	1	0.013
SSGM1591	SWDI1295	SWDI1294		135.0	0.022	2698.17	2696.43	0.5	0.42	CIRCULAR	2	1	0.013
SSGM1592	SWDI0173	SWDP0047		43.8	0.024	2681.76	2679.00	0.5	0.7	CIRCULAR	1.25	1	0.063
SSGM1593	SWDI1297	SWDI1298		86.1	0.024	2779.57	2774.36	0.5	1	CIRCULAR	1.5	1	0.061
SSGM1594	SWDI1299	SWDI1298		20.5	0.024	2777.19	2774.66	0.5	0.42	CIRCULAR	1.5	1	0.124
SSGM1595	SWDI1298	SWDI1300		59.9	0.024	2774.41	2766.19	0.5	0.42	CIRCULAR	1.5	1	0.138
SSGM1596	SWDI1300	SWMH0112		61.2	0.024	2756.14	2756.83	0.5	0.42	CIRCULAR	3	1	-0.011
SSGM1597	SWMH0112	SWDI1301		10.9	0.024	2760.93	2759.51	0.5	1	CIRCULAR	1.5	1	0.131
SSGM1598A	SWDI1302	SWDI1303		19.5	0.024	2756.83	2756.97	0.5	0.42	CIRCULAR	2	1	-0.007
SSGM1598B	SWDI1301	SWDI1302		18.4	0.024	2756.41	2756.93	0.5	0.42	CIRCULAR	2	1	-0.029
SSGM1612	SWDI1303	SWDP0048		42.5	0.013	2756.92	2756.97	0.5	1	CIRCULAR	2	1	-0.001
SWG00081	J6	J4		11.1	0.024	2702.66	2702.23	0.5	0.42	CIRCULAR	1	1	0.039
SWG00225	SWDI0169	SWDI0166		26.8	0.024	2691.50	2691.05	0.5	1	CIRCULAR	1.25	1	0.017
SWG00226	SWDI0168	SWDI0167		51.3	0.024	2692.75	2691.71	0.5	0.7	CIRCULAR	1.25	1	0.020
SWG00227	SWDI0167	SWDI0166		27.6	0.024	2691.66	2691.05	0.5	0.42	CIRCULAR	1.25	1	0.022
SWG00228	SWDI0154	SWDI0155		21.8	0.024	2693.39	2693.39	0.5	0.83	CIRCULAR	1.5	1	0.000
SWG00229	SWDI0139	SWDI0149		312.0	0.013	2709.02	2705.02	0.5	1	CIRCULAR	1.5	1	0.013
SWG00231	SWDI0136	SWDI0140		214.5	0.024	2711.29	2710.28	0.5	1	CIRCULAR	1.25	1	0.005
SWG00233	SWDI0140	SWDI0141		29.6	0.013	2710.13	2709.67	0.5	0.83	CIRCULAR	1.25	1	0.016
SWG00234	SWDI0138	SWDI0144		72.8	0.024	2712.27	2711.68	0.5	0.42	CIRCULAR	1.25	1	0.008
SWG00235	SWDI0145	SWDI0142		35.3	0.024	2710.90	2710.82	0.5	0.42	CIRCULAR	1.25	1	0.002
SWG00236	SWDI0141	SWDI0139		58.3	0.013	2709.64	2709.07	0.5	1	CIRCULAR	1.25	1	0.010
SWG01265	SWMH0093	J9		13.6	0.024	2755.34	2754.64	0.5	0.7	CIRCULAR	1.25	1	0.052
SWG01266	J9	SWDI1155		21.8	0.022	2754.64	2753.62	0.5	0.42	CIRCULAR	1.5	1	0.047
SWG01267	SWDI1155	SWDI1154		149.8	0.022	2753.52	2740.96	0.5	1	CIRCULAR	2	1	0.084
SWG01269	SWDI1154	SWDI0991		211.0	0.022	2740.91	2738.70	0.5	1	CIRCULAR	2	1	0.011
SWG01270	SWDI0133	SWDI0991		27.2	0.022	2739.16	2736.95	0.5	0.42	CIRCULAR	1.5	1	0.082
SWG01273	SWDI0991	SWDI1156		57.0	0.022	2736.75	2736.10	0.5	0.42	CIRCULAR	2	1	0.011
SWG01274	SWDI1156	SWDI0132		117.9	0.022	2736.00	2734.35	0.5	0.42	CIRCULAR	2	1	0.014
SWG01275	SWDI0132	SWDI1157		91.5	0.022	2734.30	2732.07	0.5	0.42	CIRCULAR	2	1	0.024
SWG01276	SWDI1157	J8		129.0	0.022	2732.02	2729.26	0.5	0.42	CIRCULAR	2	1	0.021
SWG01277	SWDI1158	J8		15.7	0.022	2730.36	2729.26	0.5	1	CIRCULAR	1.25	1	0.070
SWG01278	SWDI1159	SWDI1160		26.0	0.022	2728.87	2728.40	0.5	0.42	CIRCULAR	1	1	0.018
SWG01279	SWDI1160	J7		13.9	0.022	2725.85	2725.65	0.5	1	CIRCULAR	1.25	1	0.015
SWG01280	J8	J7		160.0	0.022	2729.26	2725.65	0.5	0.42	CIRCULAR	2	1	0.023
SWG01281	SWDI1161	SWMH0094		29.3	0.022	2728.65	2725.41	0.5	0.7	CIRCULAR	1.25	1	0.111
SWG01282	SWDI1162	SWMH0094		13.1	0.022	2726.76	2725.91	0.5	1	CIRCULAR	1.25	1	0.065
SWG01283	SWDI1163	SWMH0095		13.3	0.022	2724.17	2722.99	0.5	1	CIRCULAR	1.25	1	0.089
SWG01285	SWMH0094	SWMH0095		118.1	0.022	2725.21	2722.94	0.5	0.42	CIRCULAR	2	1	0.019
SWG01286	SWMH0095	SWMH0096		62.0	0.022	2722.84	2722.48	0.5	1	CIRCULAR	2	1	0.006
SWG01287	SWMH0096	OF266		240.1	0.022	2722.43	2715.98	0.5	1	CIRCULAR	2	1	0.027
SWG01289	SWDI1166	SWDI1165		21.0	0.022	2723.20	2723.18	0.5	0.7	CIRCULAR	1.25	1	0.001
SWG01290	SWDI1165	SWMH0097		27.5	0.022	2723.08	2722.39	0.5	1	CIRCULAR	1.25	1	0.025
SWG01292	SWDI1167	SWMH0098		32.6	0.022	2723.92	2723.55	0.5	0.83	CIRCULAR	1.25	1	0.011
SWG01293	SWMH0098	SWMH0097		51.9	0.022	2722.05	2721.19	0.5	0.42	CIRCULAR	1.5	1	0.017
SWG01294	SWMH0099	SWMH0098		238.4	0.022	2725.81	2723.10	0.5	0.42	CIRCULAR	1.5	1	0.011
SWG01295	SWDI1169	SWMH0100		10.7	0.022	2733.49	2732.92	0.5	0.7	CIRCULAR	1.25	1	0.053
SWG01296	SWMH0100	SWMH0099		294.2	0.022	2732.02	2725.96	0.5	0.42	CIRCULAR	1.5	1	0.021
SWG01297	SWMH0097	SWMH0101		213.5	0.022	2721.14	2715.35	0.5	0.7	CIRCULAR	1.5	1	0.027
SWG01303	SWDI1008	SWMH0102		19.1	0.024	2713.42	2713.35	0.5	0.42	CIRCULAR	1.25	1	0.004
SWG01306	SWDI1174	SWMH0103		2.5	0.01	2712.45	2712.27	0.5	1	CIRCULAR	1	1	0.074
SWG01308	SWMH0103	SWDI0138		25.8	0.01	2712.27	2712.27	0.5	0.42	CIRCULAR	0.667	1	0.000
SWG01310	SWDI1176	SWDI0145		111.2	0.024	2711.38	2710.95	0.5	0.42	CIRCULAR	1.25	1	0.004
SWG01311	SWDI0142	SWDI0137		34.3	0.01	2710.72	2710.40	0.5	1	CIRCULAR	0.667	1	0.009
SWG01312	SWDI0139	SWDI0139		67.1	0.024	2709.20	2709.12	0.5	0.42	CIRCULAR	1.25	1	0.001
SWG01314	SWDI1180	SWDI1179		28.5	0.022	2734.72	2734.17	0.5	1	CIRCULAR	1.25	1	0.019
SWG01315	SWDI1182	SWDI0164		179.2	0.022	2731.89	2730.66	0.5	1	CIRCULAR	1.5	1	0.007
SWG01316	SWDI0164	SWDI0162		26.0	0.024	2730.61	2731.23	0.5	1	CIRCULAR	1.25	1	-0.024
SWG01317	SWDI0163	SWDI1183		433.2	0.022	2728.14	2708.16	0.5	0.7	CIRCULAR	1.5	1	0.046
SWG01323	SWDI0159	J5		21.8	0.024	2704.19	2702.88	0.5	0.42	CIRCULAR	1.25	1	0.060
SWG01324	SWDI1256	J6		19.4	0.013	2703.42	2702.66	0.5	0.42	CIRCULAR	1.25	1	0.039
SWG01325	J5	SWDI0158		19.8	0.01	2702.88	2701.79	0.5	0.83	CIRCULAR	0.833	1	0.055
SWG01326	J4	SWDI0158		13.9	0.01	2702.23	2701.74	0.5	0.7	CIRCULAR	0.833	1	0.035
SWG01327	SWDI0158	J11		134.7	0.024	2701.69	2696.43	0.5	1	CIRCULAR	1	1	0.039
SWG01328	SWDI1257	J10		39.5	0.024	2698.69	2698.90						

Hazelwood

Conduits

Name	Inlet Node	Outlet Node	Tag	Length (ft)	Roughness	Inlet Elev. (ft)	Outlet Elev. (ft)	Entry Loss Coeff.	Exit Loss Coeff.	Cross-Section	Geom1 (ft)	Barrels	Slope (ft/ft)
SWG1331	SWDI1258	SWDI0150		78.3	0.024	2706.24	2705.42	0.5	0.42	CIRCULAR	1.25	1	0.011
SWG1332	SWDI0150	SWDI1189		73.3	0.024	2705.37	2705.30	0.5	0.7	CIRCULAR	1.25	1	0.001
SWG1333	SWDI0149	SWDI1189		11.7	0.013	2704.97	2705.15	0.5	0.42	CIRCULAR	1.5	1	-0.016
SWG1334	SWDI1189	SWDI0151		28.3	0.024	2705.10	2704.72	0.5	0.42	CIRCULAR	1.5	1	0.013
SWG1337	SWDI0151	SWDI1190		8.3	0.013	2704.62	2702.67	0.5	0.83	CIRCULAR	1.5	1	0.242
SWG1339	SWDI0155	I17		101.1	0.024	2693.29	2689.99	0.5	1	CIRCULAR	2	1	0.033
SWG1340	SWDI1192	SWDP0041		7.5	0.022	2692.68	2687.58	0.5	1	CIRCULAR	1.25	1	0.939
SWG1343	SWDI0166	SWDI0171		249.9	0.024	2691.00	2686.60	0.5	0.42	CIRCULAR	1.25	1	0.018
SWG1344	SWDI0171	SWDI0173		281.5	0.024	2686.55	2681.81	0.5	0.42	CIRCULAR	1.25	1	0.017
SWG1346	SWDI0174	J13		70.1	0.022	2681.56	2679.59	0.5	1	CIRCULAR	1.5	1	0.028
SWG1347	SWDI1259	SWDI0176		5.0	0.022	2679.71	2679.48	0.5	1	CIRCULAR	1.25	1	0.047
SWG1348	SWDI0176	SWDI1194		138.2	0.022	2676.23	2675.72	0.5	0.42	CIRCULAR	2	1	0.004
SWG1349	SWDI0175	J2		15.9	0.013	2680.02	2677.82	0.5	0.83	CIRCULAR	1.5	1	0.139
SWG1350	J2	SWDI0176		11.6	0.022	2677.82	2679.23	0.5	0.7	CIRCULAR	1.5	1	-0.122
SWG1351	SWDI1194	SWDI1195		187.5	0.022	2675.67	2677.05	0.5	0.42	CIRCULAR	2	1	-0.007
SWG1355	SWDI1196	SWDI0168		161.9	0.022	2692.94	2692.75	0.5	0.42	CIRCULAR	1.5	1	0.001
SWG1358	SWDI1190	SWDI0156		808.3	0.024	2702.27	2691.37	0.5	0.83	CIRCULAR	2	1	0.013
SWG1439	SWDI0162	SWDI0163		21.9	0.024	2730.08	2728.19	0.5	0.42	CIRCULAR	1.25	1	0.087
SWG1489	SWDI1183	J16		62.1	0.022	2706.61	2705.92	0.5	1	CIRCULAR	1.5	1	0.011
SWG1490	SWDI1181	SWDI1178		23.1	0.022	2733.67	2733.92	0.5	1	CIRCULAR	1.25	1	-0.011
SWG1491	SWDI1178	SWDI1182		174.3	0.022	2733.87	2731.94	0.5	0.42	CIRCULAR	1.5	1	0.011
SWG1492	SWDI1179	SWDI1178		24.0	0.022	2734.07	2733.87	0.5	0.42	CIRCULAR	1.25	1	0.008
SWG1493	SWDI1195	OF286		56.5	0.022	2675.00	2674.96	0.5	1	CIRCULAR	2	1	0.001
SWG1495	SWDI0144	SWDI1176		24.5	0.024	2711.33	2711.43	0.5	0.42	CIRCULAR	1.25	1	-0.004
SWG1496	SWMH0101	SWDP0016		41.0	0.022	2715.30	2713.20	0.5	1	CIRCULAR	1.5	1	0.051
SWG1520	SWDI0172	SWDI0171		20.4	0.024	2687.13	2686.60	0.5	1	CIRCULAR	1.25	1	0.026
SWG1549	J7	SWMH0094		29.8	0.022	2725.65	2725.26	0.5	1	CIRCULAR	2	1	0.013
SWG1563	SWMH0102	SWMH0103		97.1	0.01	2713.30	2712.27	0.5	0.42	CIRCULAR	1.25	1	0.011
SWOD1010	OF286	J12	Open_Channel	51.7	0.01	2674.96	2672.63	0	0	IRREGULAR	0	1	0.045
SWOD1034_1	CVPT0016	J1	Open_Channel	238.8	0.01	2753.00	2748.30	0	1	IRREGULAR	0	1	0.020
SWOD1034_2	J14	J15	Open_Channel	205.5	0.01	2734.42	2730.16	0	1	IRREGULAR	0	1	0.021
SWOD1034_3	J1	J14	Open_Channel	625.1	0.01	2748.30	2734.42	0	1	IRREGULAR	0	1	0.022
SWOD1034_5	J15	SWDI1159	Open_Channel	59.8	0.01	2730.16	2728.87	0	0.5	IRREGULAR	0	1	0.022
SWOD1035	SWDP0048	CVPT0014	Open_Channel	6.5	0.01	2756.97	2756.07	0.5	0.5	IRREGULAR	0	1	0.141

Appendix E: Existing Conditions Capacity Maps



Legend

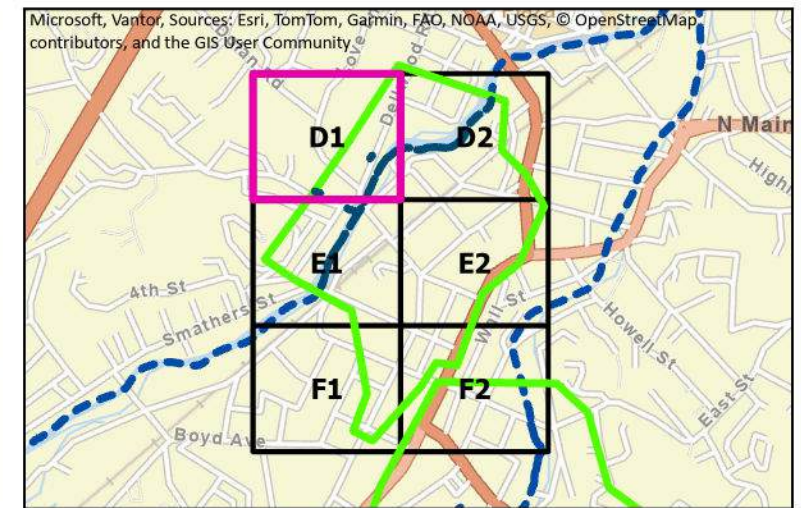
- | | |
|---|---------------------------------|
| Junctions | Context |
| ● Flooded- 10 YR Storm Event | □ Structures |
| ● Flooded- 25 YR Storm Event | - - - Modeled Open Channels |
| ● Flooded- 50 YR Storm Event | - - - Non-Modeled Open Channels |
| ● Flooded- 100 YR Storm Event | □ Study Areas |
| ● Not Flooded in Analyzed Storms | ★ Potential Area of Concern |
| ○ Non-Analyzed | |
| Conduits | Riverine Inundation |
| — Full Capacity- 10 YR Storm Event | □ 10 YR Storm Event |
| — Full Capacity- 25 YR Storm Event | □ 25 YR Storm Event |
| — Full Capacity- 50 YR Storm Event | □ 50 YR Storm Event |
| — Full Capacity- 100 YR Storm Event | □ 100 YR Storm Event |
| — Not at Full Capacity in Analyzed Storms | |
| — Non-Analyzed | |



Frog Level Index Map
Existing Conditions Capacity Analysis
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Legend

Junctions <ul style="list-style-type: none"> ● Flooded- 10 YR Storm Event ● Flooded- 25 YR Storm Event ● Flooded- 50 YR Storm Event ● Flooded- 100 YR Storm Event ● Not Flooded in Analyzed Storms ○ Non-Analyzed 	Context <ul style="list-style-type: none"> Structures Modeled Open Channels Non-Modeled Open Channels Study Areas 321 Address ★ Potential Area of Concern
Conduits <ul style="list-style-type: none"> Full Capacity- 10 YR Storm Event Full Capacity- 25 YR Storm Event Full Capacity- 50 YR Storm Event Full Capacity- 100 YR Storm Event Not at Full Capacity in Analyzed Storms Non-Analyzed 	Shelton Riverine Inundation <ul style="list-style-type: none"> 10 YR Storm Event 25 YR Storm Event 50 YR Storm Event 100 YR Storm Event

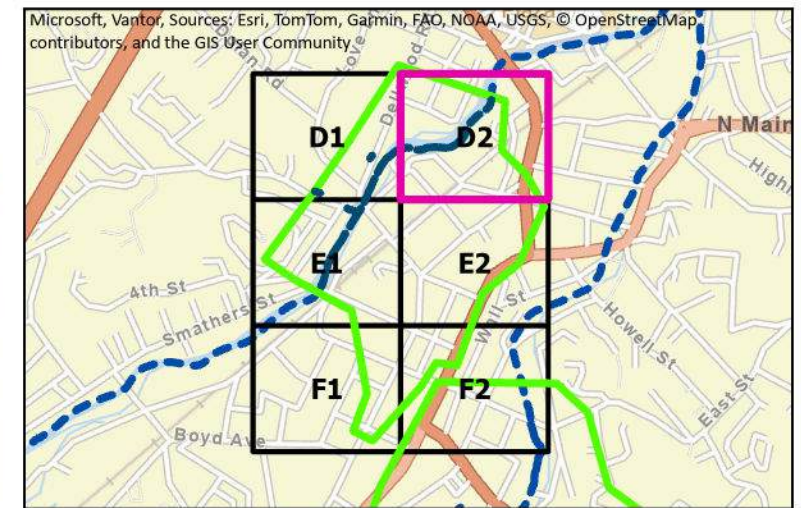
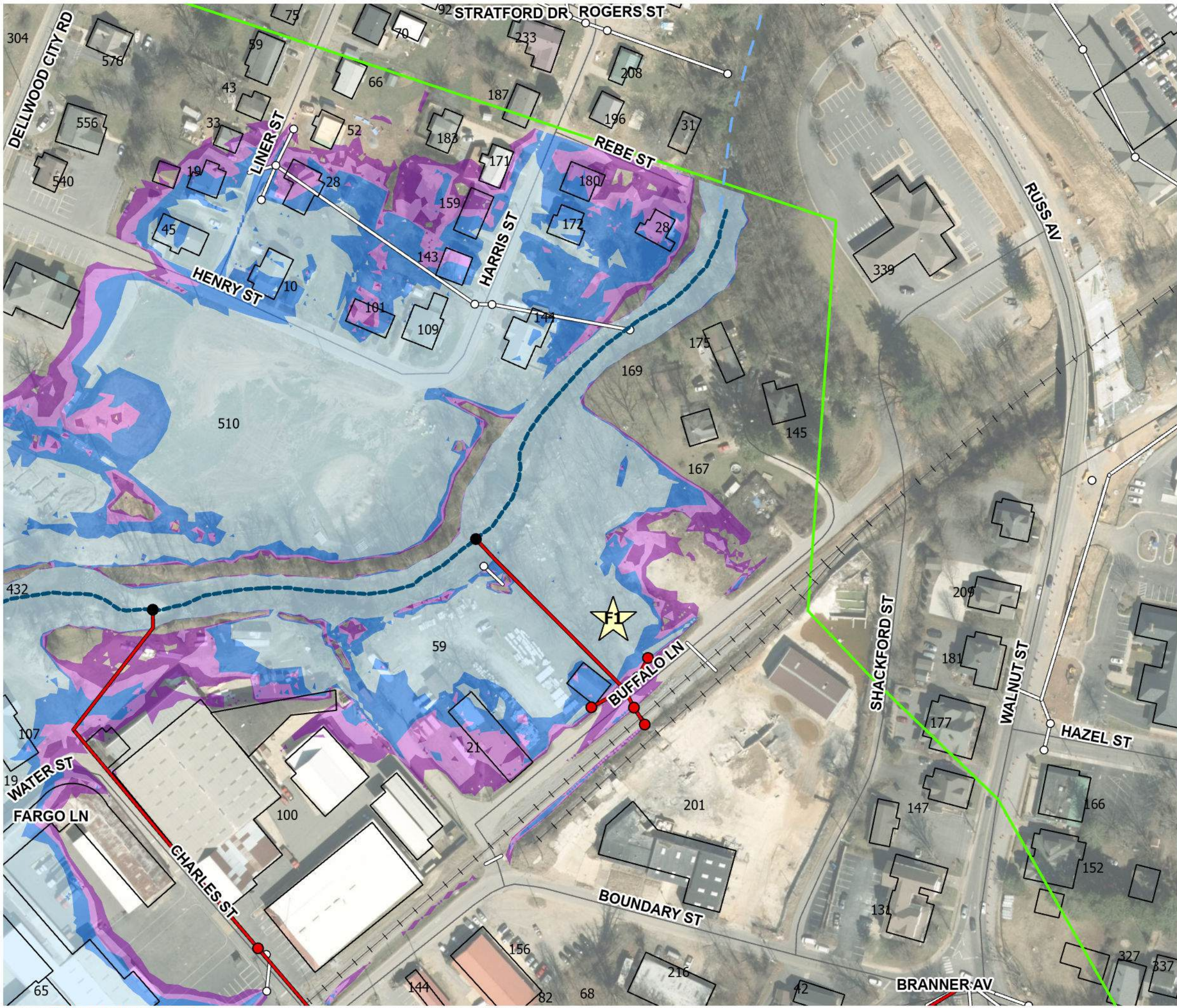
0 125 250
1 Inch = 125 Feet

Frog Level: D1

Existing Conditions Capacity Analysis Waynesville, NC

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Legend

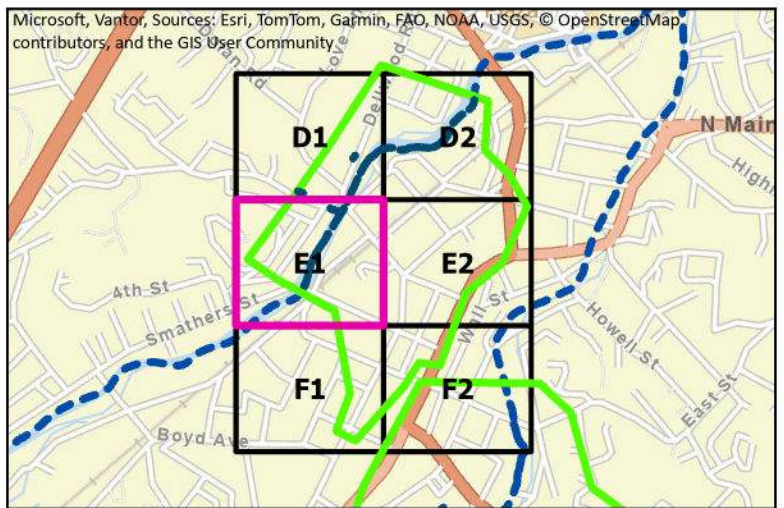
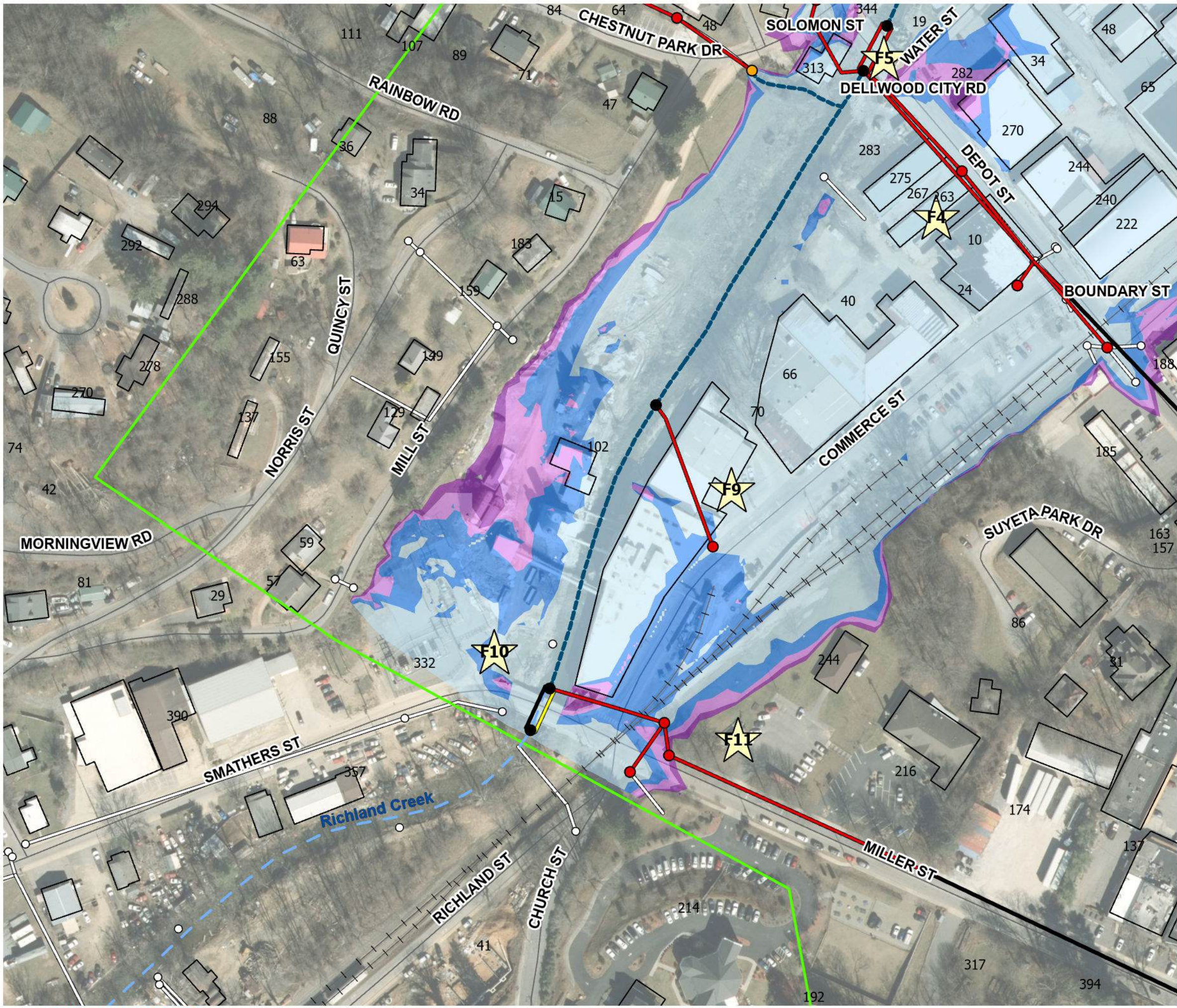
Junctions	Context
● Flooded- 10 YR Storm Event	□ Structures
● Flooded- 25 YR Storm Event	— Modeled Open Channels
● Flooded- 50 YR Storm Event	- - - Non-Modeled Open Channels
● Flooded- 100 YR Storm Event	□ Study Areas
● Not Flooded in Analyzed Storms	321 Address
○ Non-Analyzed	★ Potential Area of Concern
Conduits	Shelton Riverine Inundation
— Full Capacity- 10 YR Storm Event	10 YR Storm Event
— Full Capacity- 25 YR Storm Event	25 YR Storm Event
— Full Capacity- 50 YR Storm Event	50 YR Storm Event
— Full Capacity- 100 YR Storm Event	100 YR Storm Event
— Not at Full Capacity in Analyzed Storms	
— Non-Analyzed	

0 125 250
1 Inch = 125 Feet

Frog Level: D2
Existing Conditions Capacity Analysis
Waynesville, NC

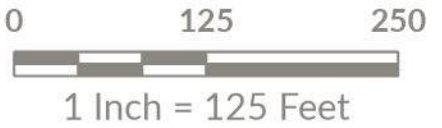
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Legend

- | | |
|---|------------------------------------|
| Junctions | Context |
| ● Flooded- 10 YR Storm Event | □ Structures |
| ● Flooded- 25 YR Storm Event | — Modeled Open Channels |
| ● Flooded- 50 YR Storm Event | — Non-Modeled Open Channels |
| ● Flooded- 100 YR Storm Event | □ Study Areas |
| ● Not Flooded in Analyzed Storms | 321 Address |
| ○ Non-Analyzed | ★ Potential Area of Concern |
| Conduits | Shelton Riverine Inundation |
| — Full Capacity- 10 YR Storm Event | 10 YR Storm Event |
| — Full Capacity- 25 YR Storm Event | 25 YR Storm Event |
| — Full Capacity- 50 YR Storm Event | 50 YR Storm Event |
| — Full Capacity- 100 YR Storm Event | 100 YR Storm Event |
| — Not at Full Capacity in Analyzed Storms | |
| — Non-Analyzed | |

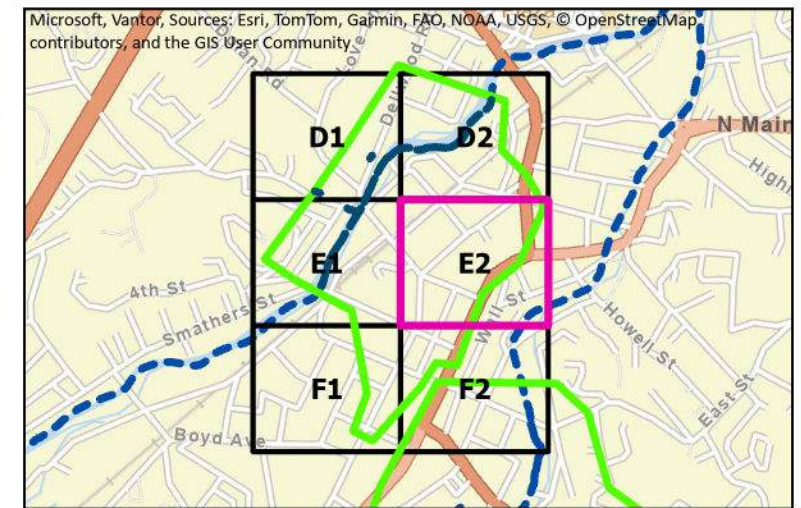
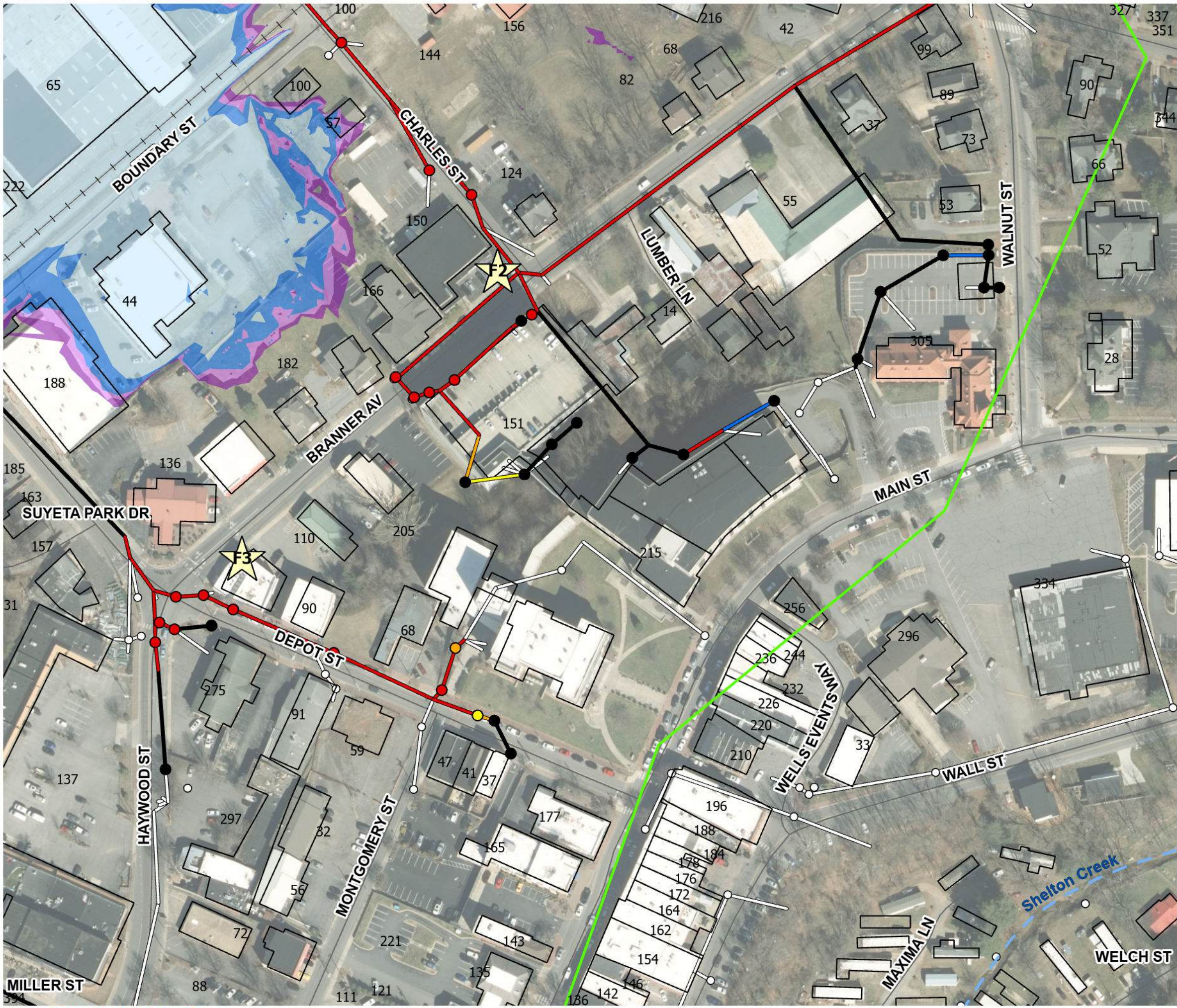


Frog Level: E1

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Legend

Junctions	Context
● Flooded- 10 YR Storm Event	▭ Structures
● Flooded- 25 YR Storm Event	— Modeled Open Channels
● Flooded- 50 YR Storm Event	- - - Non-Modeled Open Channels
● Flooded- 100 YR Storm Event	▭ Study Areas
● Not Flooded in Analyzed Storms	321 Address
○ Non-Analyzed	★ Potential Area of Concern
Conduits	Shelton Riverine Inundation
— Full Capacity- 10 YR Storm Event	10 YR Storm Event
— Full Capacity- 25 YR Storm Event	25 YR Storm Event
— Full Capacity- 50 YR Storm Event	50 YR Storm Event
— Full Capacity- 100 YR Storm Event	100 YR Storm Event
— Not at Full Capacity in Analyzed Storms	
— Non-Analyzed	

0 125 250
1 Inch = 125 Feet

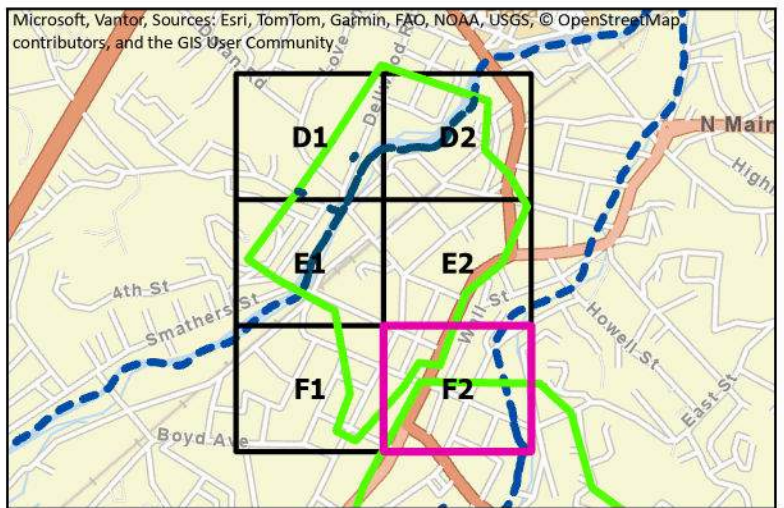
Frog Level: E2

Existing Conditions Capacity Analysis

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Legend

- | | |
|---|------------------------------------|
| Junctions | Context |
| ● Flooded- 10 YR Storm Event | □ Structures |
| ● Flooded- 25 YR Storm Event | — Modeled Open Channels |
| ● Flooded- 50 YR Storm Event | — Non-Modeled Open Channels |
| ● Flooded- 100 YR Storm Event | □ Study Areas |
| ● Not Flooded in Analyzed Storms | 321 Address |
| ○ Non-Analyzed | ★ Potential Area of Concern |
| Conduits | Shelton Riverine Inundation |
| — Full Capacity- 10 YR Storm Event | □ 10 YR Storm Event |
| — Full Capacity- 25 YR Storm Event | □ 25 YR Storm Event |
| — Full Capacity- 50 YR Storm Event | □ 50 YR Storm Event |
| — Full Capacity- 100 YR Storm Event | □ 100 YR Storm Event |
| — Not at Full Capacity in Analyzed Storms | |
| — Non-Analyzed | |

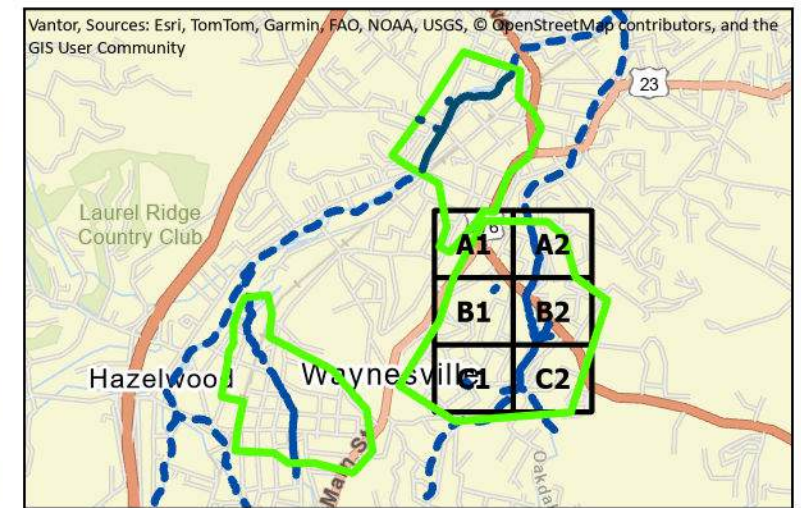
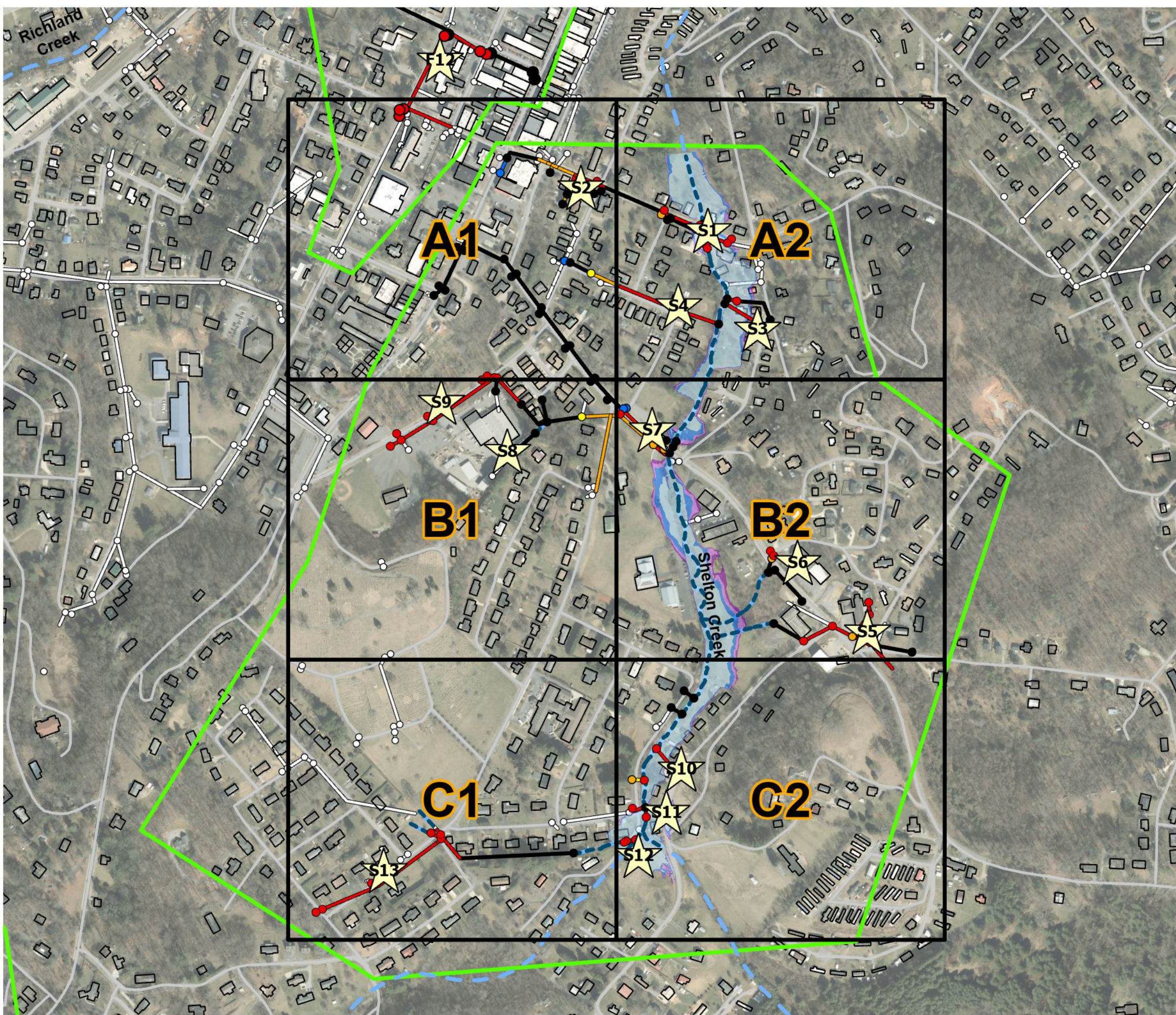


Frog Level: F2

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Legend

Junctions	Context
● Flooded- 10 YR Storm Event	□ Structures
● Flooded- 25 YR Storm Event	--- Modeled Open Channels
● Flooded- 50 YR Storm Event	--- Non-Modeled Open Channels
● Flooded- 100 YR Storm Event	□ Study Areas
● Not Flooded in Analyzed Storms	★ Potential Area of Concern
○ Non-Analyzed	
Conduits	Riverine Inundation
— Full Capacity- 10 YR Storm Event	□ 10 YR Storm Event
— Full Capacity- 25 YR Storm Event	□ 25 YR Storm Event
— Full Capacity- 50 YR Storm Event	□ 50 YR Storm Event
— Full Capacity- 100 YR Storm Event	□ 100 YR Storm Event
— Not at Full Capacity in Analyzed Storms	
— Non-Analyzed	

0 450 900
1 Inch = 450 Feet

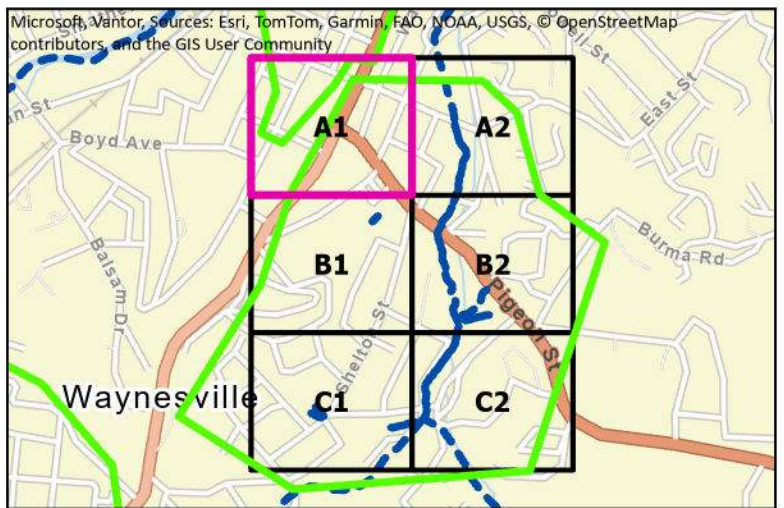
Shelton Branch Index Map

Existing Conditions Capacity Analysis

Waynesville, NC

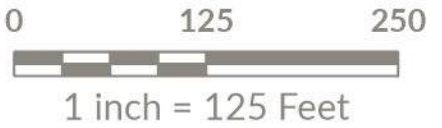


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Legend

- | | |
|---|--|
| <p>Junctions</p> <ul style="list-style-type: none"> ● Flooded- 10 YR Storm Event ● Flooded- 25 YR Storm Event ● Flooded- 50 YR Storm Event ● Flooded- 100 YR Storm Event ● Not Flooded in Analyzed Storms ○ Non-Analyzed <p>Conduits</p> <ul style="list-style-type: none"> — Full Capacity- 10 YR Storm Event — Full Capacity- 25 YR Storm Event — Full Capacity- 50 YR Storm Event — Full Capacity- 100 YR Storm Event — Not at Full Capacity in Analyzed Storms — Non-Analyzed | <p>Context</p> <ul style="list-style-type: none"> □ Structures — Modeled Open Channels — Non-Modeled Open Channels □ Study Areas ★ Potential Area of Concern <p>Shelton Riverine Inundation</p> <ul style="list-style-type: none"> □ 10 YR Storm Event □ 25 YR Storm Event □ 50 YR Storm Event □ 100 YR Storm Event |
|---|--|



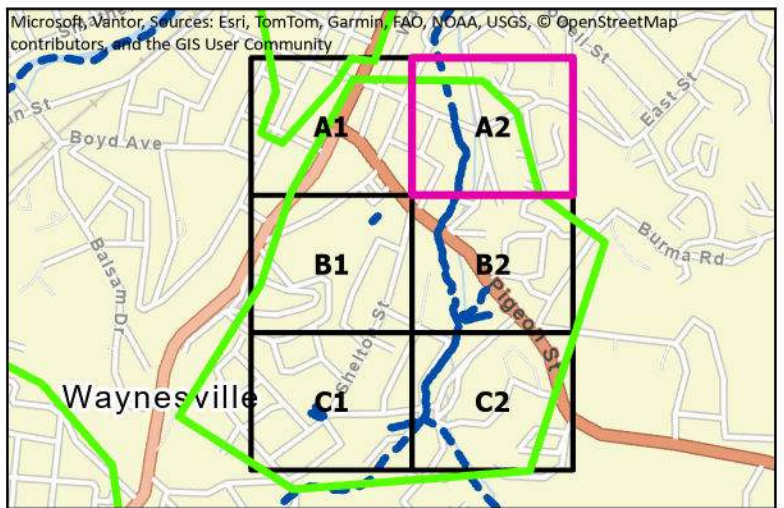
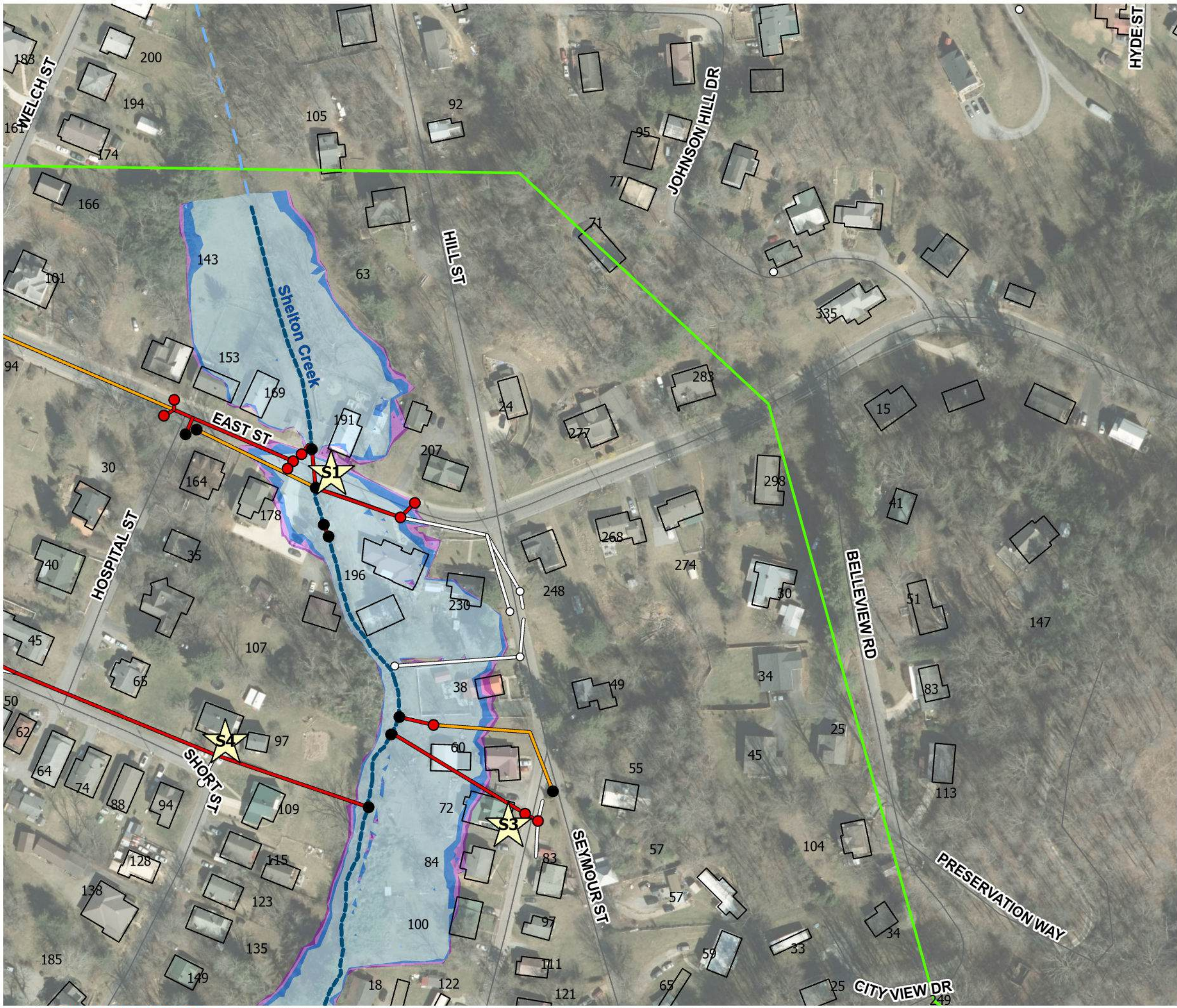
Shelton Branch: A1

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Legend

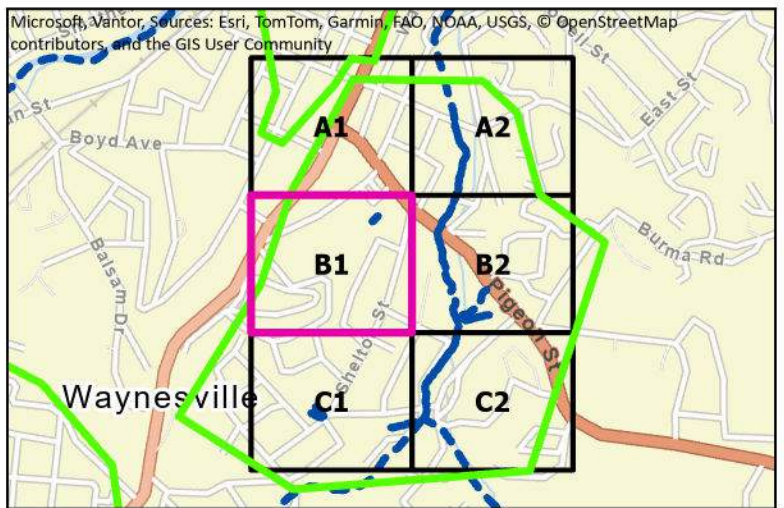
- | | |
|--|---|
| <p>Junctions</p> <ul style="list-style-type: none"> ● Flooded- 10 YR Storm Event ● Flooded- 25 YR Storm Event ● Flooded- 50 YR Storm Event ● Flooded- 100 YR Storm Event ● Not Flooded in Analyzed Storms ○ Non-Analyzed <p>Conduits</p> <ul style="list-style-type: none"> — Full Capacity- 10 YR Storm Event — Full Capacity- 25 YR Storm Event — Full Capacity- 50 YR Storm Event — Full Capacity- 100 YR Storm Event — Not at Full Capacity in Analyzed Storms — Non-Analyzed | <p>Context</p> <ul style="list-style-type: none"> Structures — Modeled Open Channels — Non-Modeled Open Channels Study Areas ★ Potential Area of Concern <p>Shelton Riverine Inundation</p> <ul style="list-style-type: none"> 10 YR Storm Event 25 YR Storm Event 50 YR Storm Event 100 YR Storm Event |
|--|---|
- 0 125 250
1 inch = 125 Feet

Shelton Branch: A2

Existing Conditions Capacity Analysis Waynesville, NC

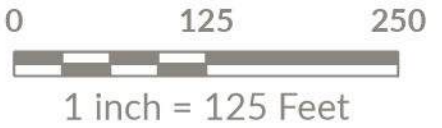
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Legend

- | | |
|---|------------------------------------|
| Junctions | Context |
| ● Flooded- 10 YR Storm Event | □ Structures |
| ● Flooded- 25 YR Storm Event | — Modeled Open Channels |
| ● Flooded- 50 YR Storm Event | — Non-Modeled Open Channels |
| ● Flooded- 100 YR Storm Event | □ Study Areas |
| ● Not Flooded in Analyzed Storms | ★ Potential Area of Concern |
| ○ Non-Analyzed | |
| Conduits | Shelton Riverine Inundation |
| — Full Capacity- 10 YR Storm Event | □ 10 YR Storm Event |
| — Full Capacity- 25 YR Storm Event | □ 25 YR Storm Event |
| — Full Capacity- 50 YR Storm Event | □ 50 YR Storm Event |
| — Full Capacity- 100 YR Storm Event | □ 100 YR Storm Event |
| — Not at Full Capacity in Analyzed Storms | |
| — Non-Analyzed | |

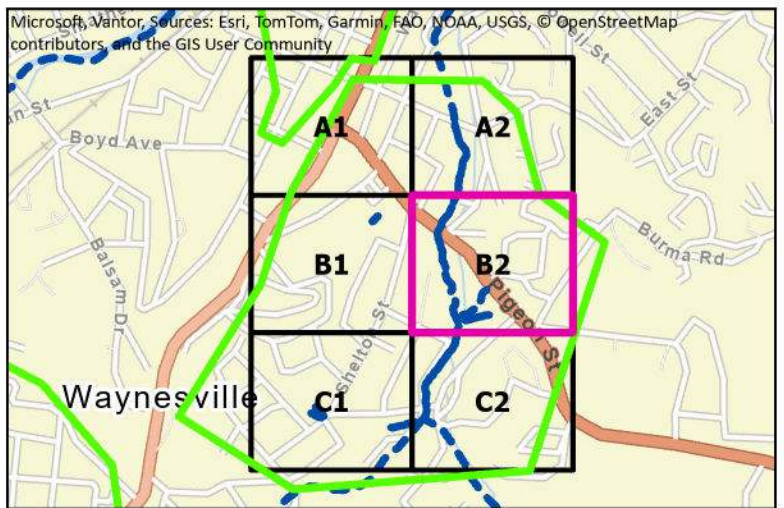
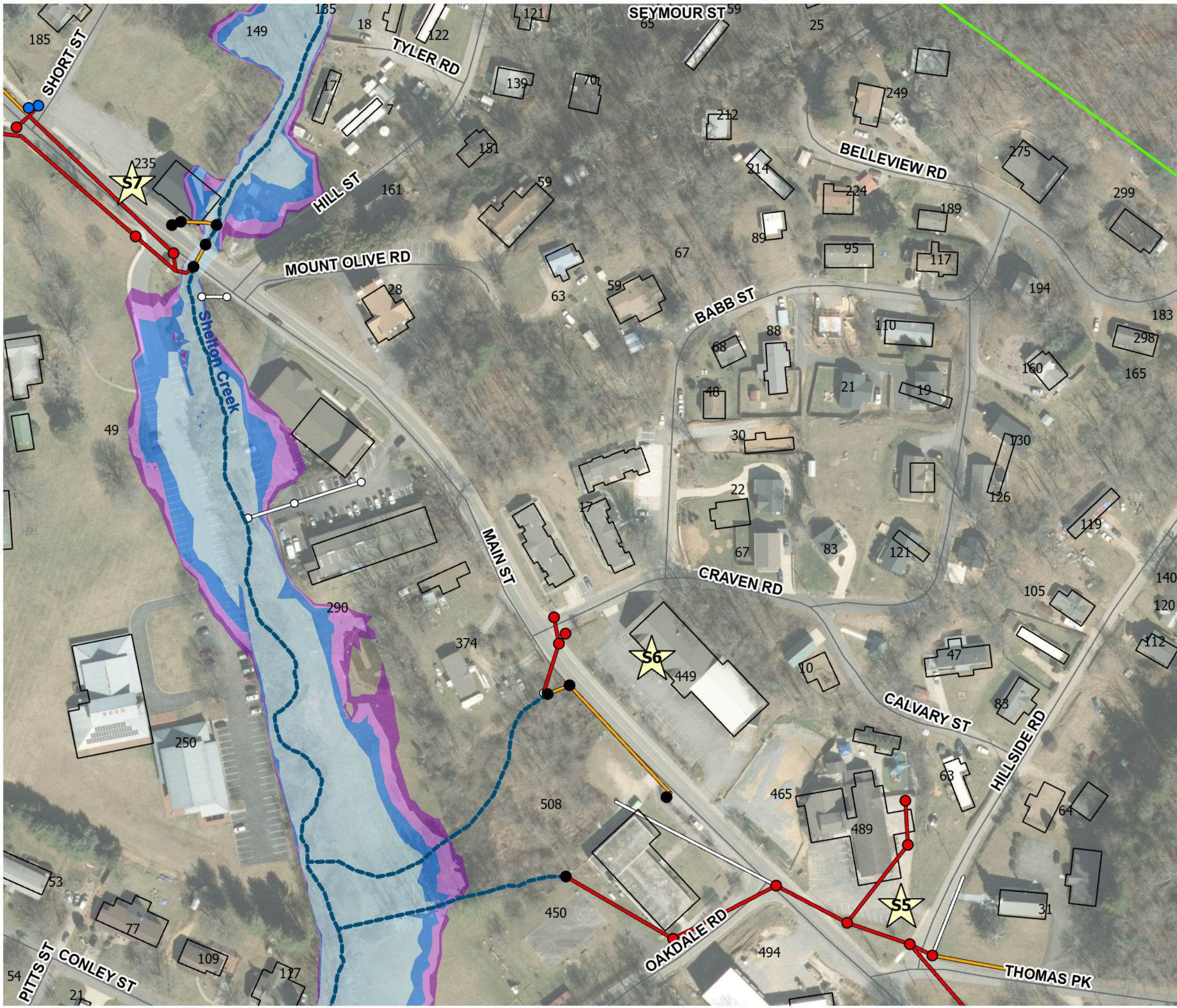


Shelton Branch: B1

Existing Conditions Capacity Analysis Waynesville, NC



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Legend

- | | |
|---|------------------------------------|
| Junctions | Context |
| ● Flooded- 10 YR Storm Event | □ Structures |
| ● Flooded- 25 YR Storm Event | — Modeled Open Channels |
| ● Flooded- 50 YR Storm Event | — Non-Modeled Open Channels |
| ● Flooded- 100 YR Storm Event | □ Study Areas |
| ● Not Flooded in Analyzed Storms | ★ Potential Area of Concern |
| ○ Non-Analyzed | |
| Conduits | Shelton Riverine Inundation |
| — Full Capacity- 10 YR Storm Event | ■ 10 YR Storm Event |
| — Full Capacity- 25 YR Storm Event | ■ 25 YR Storm Event |
| — Full Capacity- 50 YR Storm Event | ■ 50 YR Storm Event |
| — Full Capacity- 100 YR Storm Event | ■ 100 YR Storm Event |
| — Not at Full Capacity in Analyzed Storms | |
| — Non-Analyzed | |
- 0 125 250
1 inch = 125 Feet

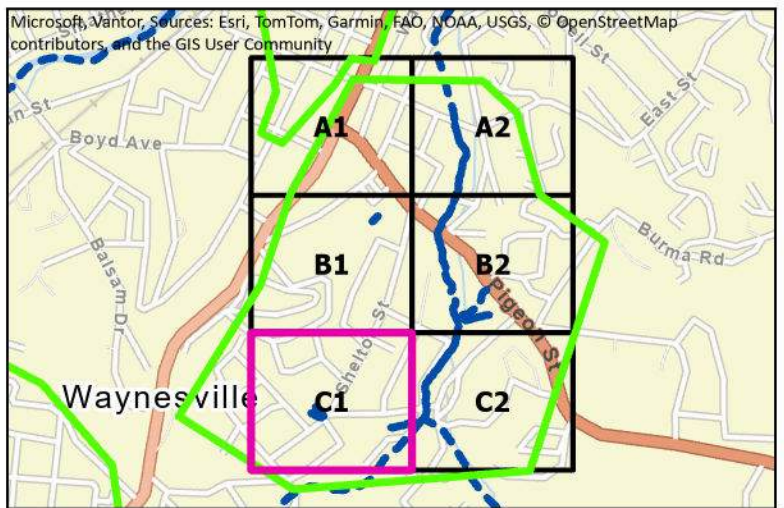
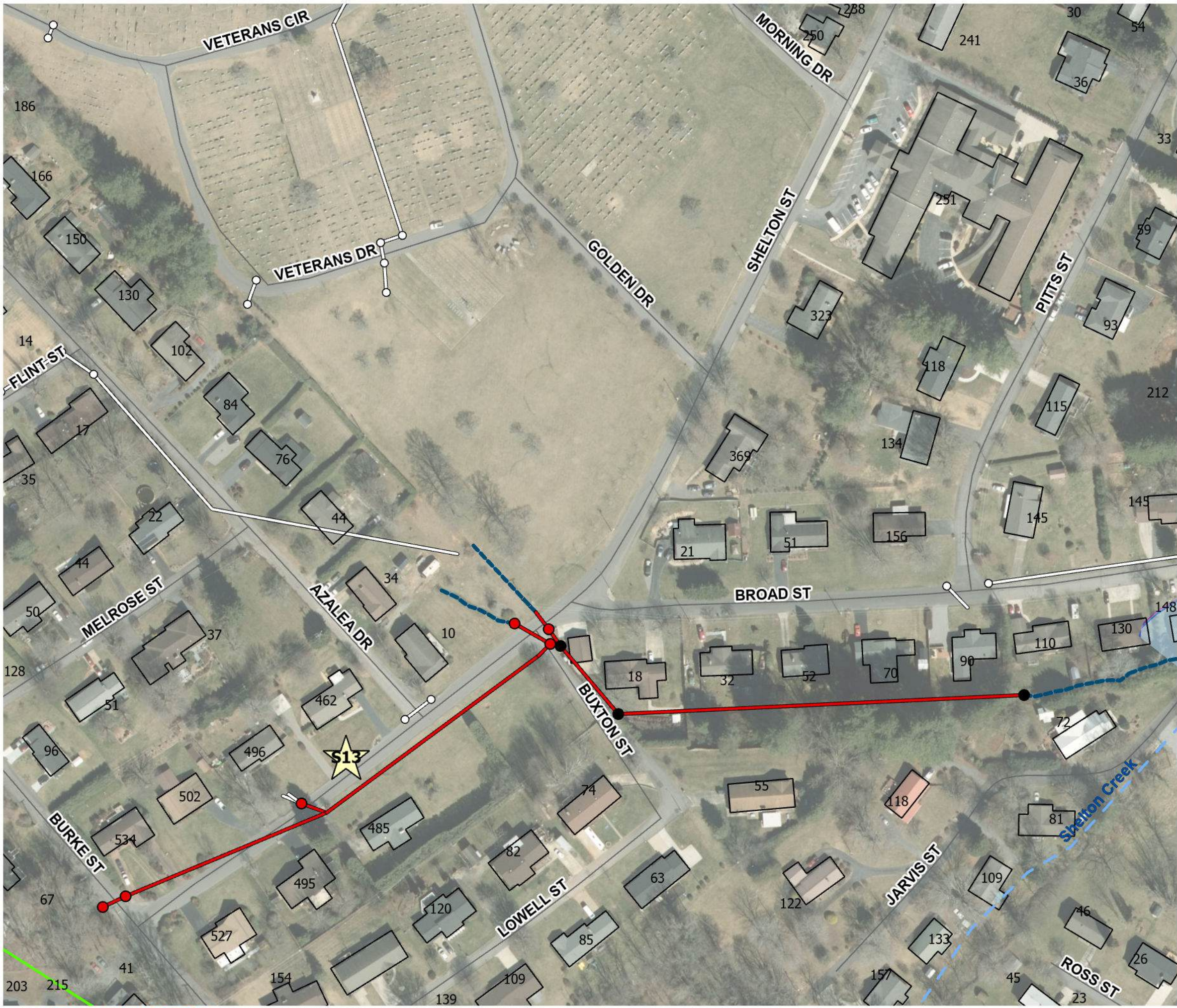
Shelton Branch: B2

Existing Conditions Capacity Analysis Waynesville, NC



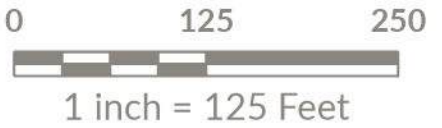
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Legend

- | | |
|---|---|
| Junctions
<ul style="list-style-type: none"> ● Flooded- 10 YR Storm Event ● Flooded- 25 YR Storm Event ● Flooded- 50 YR Storm Event ● Flooded- 100 YR Storm Event ● Not Flooded in Analyzed Storms ○ Non-Analyzed | Context
<ul style="list-style-type: none"> Structures Modeled Open Channels Non-Modeled Open Channels Study Areas ★ Potential Area of Concern |
| Conduits
<ul style="list-style-type: none"> Full Capacity- 10 YR Storm Event Full Capacity- 25 YR Storm Event Full Capacity- 50 YR Storm Event Full Capacity- 100 YR Storm Event Not at Full Capacity in Analyzed Storms Non-Analyzed | Shelton Riverine Inundation
<ul style="list-style-type: none"> 10 YR Storm Event 25 YR Storm Event 50 YR Storm Event 100 YR Storm Event |

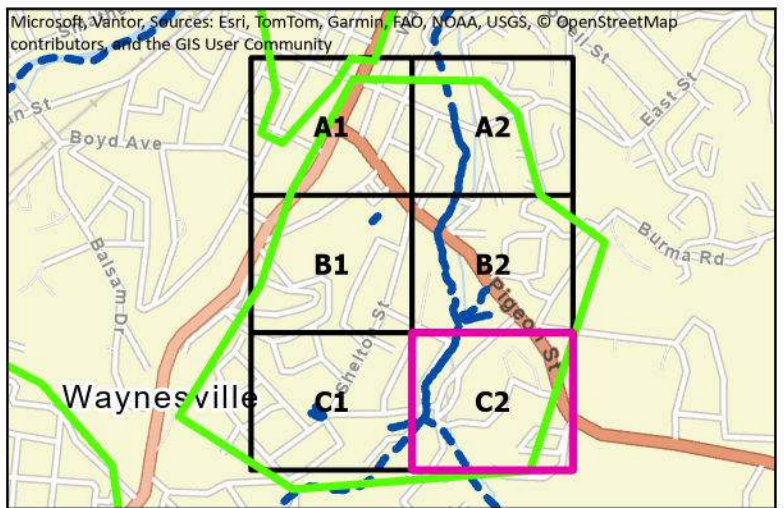
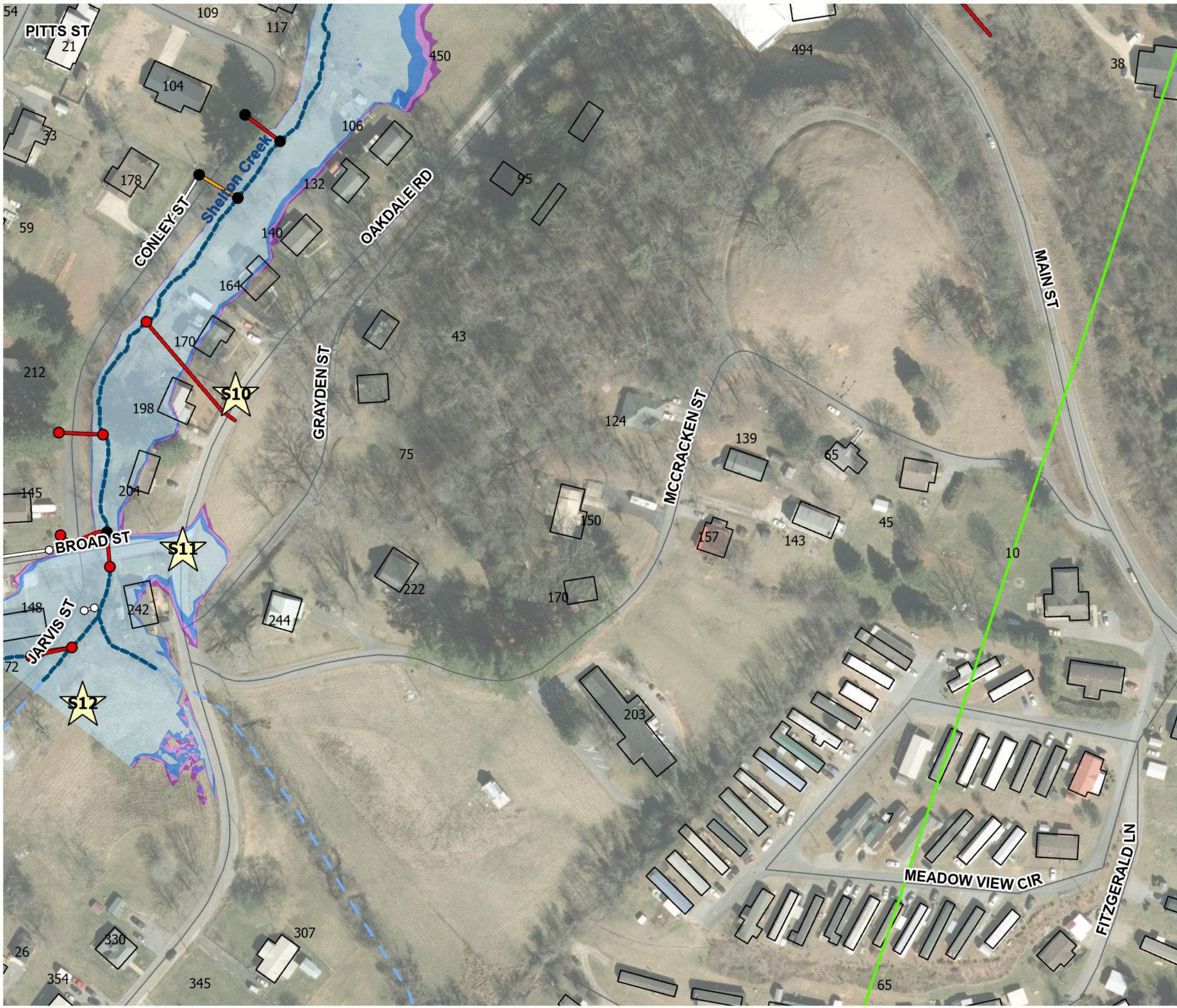


Shelton Branch: C1

Existing Conditions Capacity Analysis Waynesville, NC

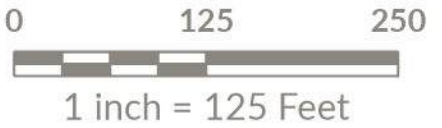


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Legend

- | | |
|---|------------------------------------|
| Junctions | Context |
| ● Flooded- 10 YR Storm Event | □ Structures |
| ● Flooded- 25 YR Storm Event | — Modeled Open Channels |
| ● Flooded- 50 YR Storm Event | — Non-Modeled Open Channels |
| ● Flooded- 100 YR Storm Event | □ Study Areas |
| ● Not Flooded in Analyzed Storms | ★ Potential Area of Concern |
| ○ Non-Analyzed | Shelton Riverine Inundation |
| Conduits | ■ 10 YR Storm Event |
| — Full Capacity- 10 YR Storm Event | ■ 25 YR Storm Event |
| — Full Capacity- 25 YR Storm Event | ■ 50 YR Storm Event |
| — Full Capacity- 50 YR Storm Event | ■ 100 YR Storm Event |
| — Full Capacity- 100 YR Storm Event | |
| — Not at Full Capacity in Analyzed Storms | |
| — Non-Analyzed | |

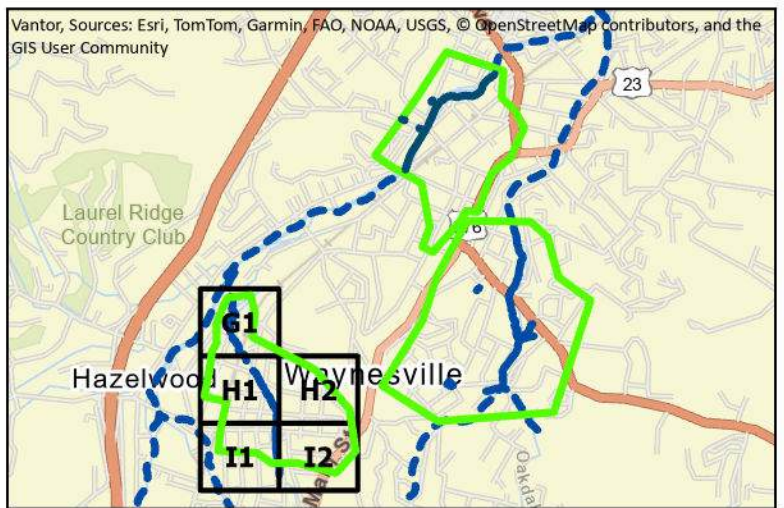
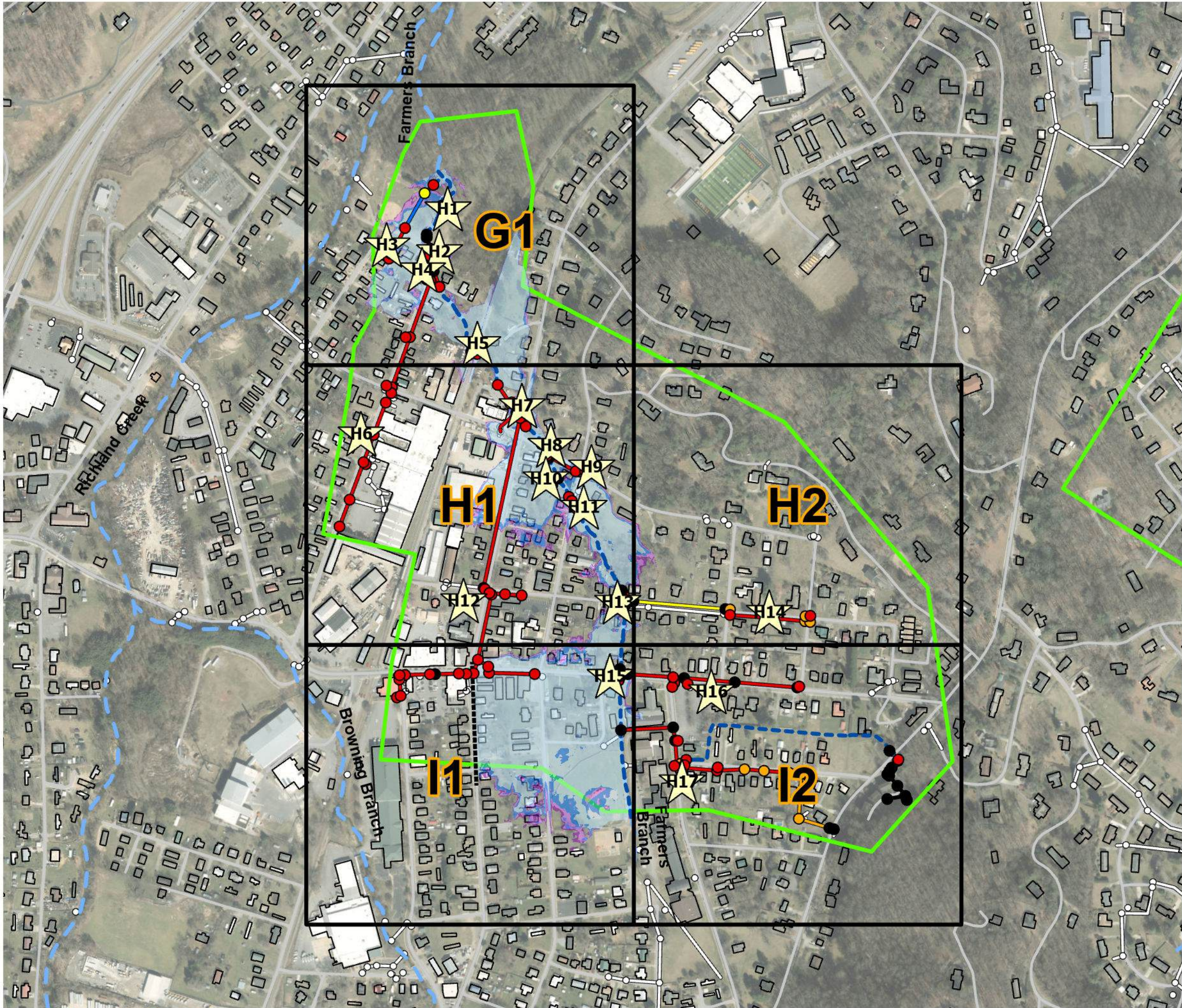


Shelton Branch: C2

Existing Conditions Capacity Analysis Waynesville, NC

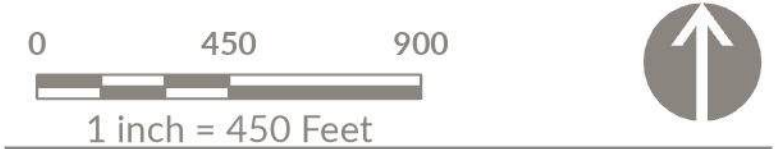


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Legend

- | | |
|---|---------------------------------|
| Junctions | Context |
| ● Flooded- 10 YR Storm Event | ▭ Structures |
| ● Flooded- 25 YR Storm Event | - - - Modeled Open Channels |
| ● Flooded- 50 YR Storm Event | - - - Non-Modeled Open Channels |
| ● Flooded- 100 YR Storm Event | ▭ Study Areas |
| ● Not Flooded in Analyzed Storms | ★ Potential Area of Concern |
| ○ Non-Analyzed | |
| Conduits | Riverine Inundation |
| — Full Capacity- 10 YR Storm Event | ▭ 10 YR Storm Event |
| — Full Capacity- 25 YR Storm Event | ▭ 25 YR Storm Event |
| — Full Capacity- 50 YR Storm Event | ▭ 50 YR Storm Event |
| — Full Capacity- 100 YR Storm Event | ▭ 100 YR Storm Event |
| — Not at Full Capacity in Analyzed Storms | |
| — Non-Analyzed | |



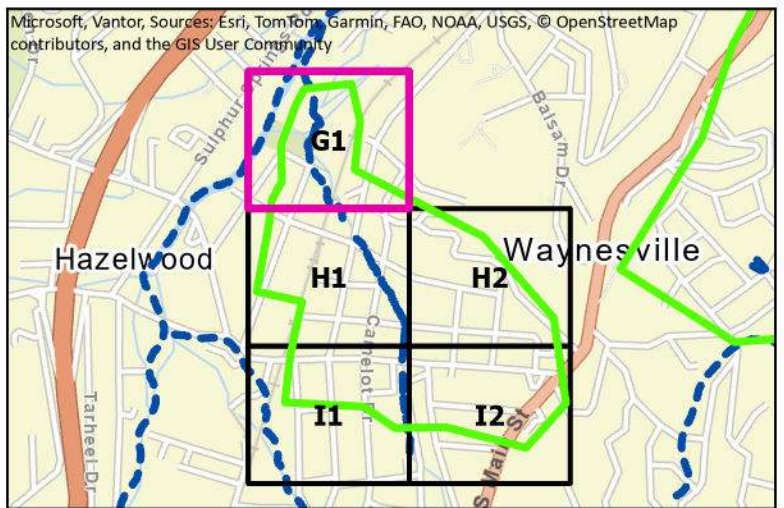
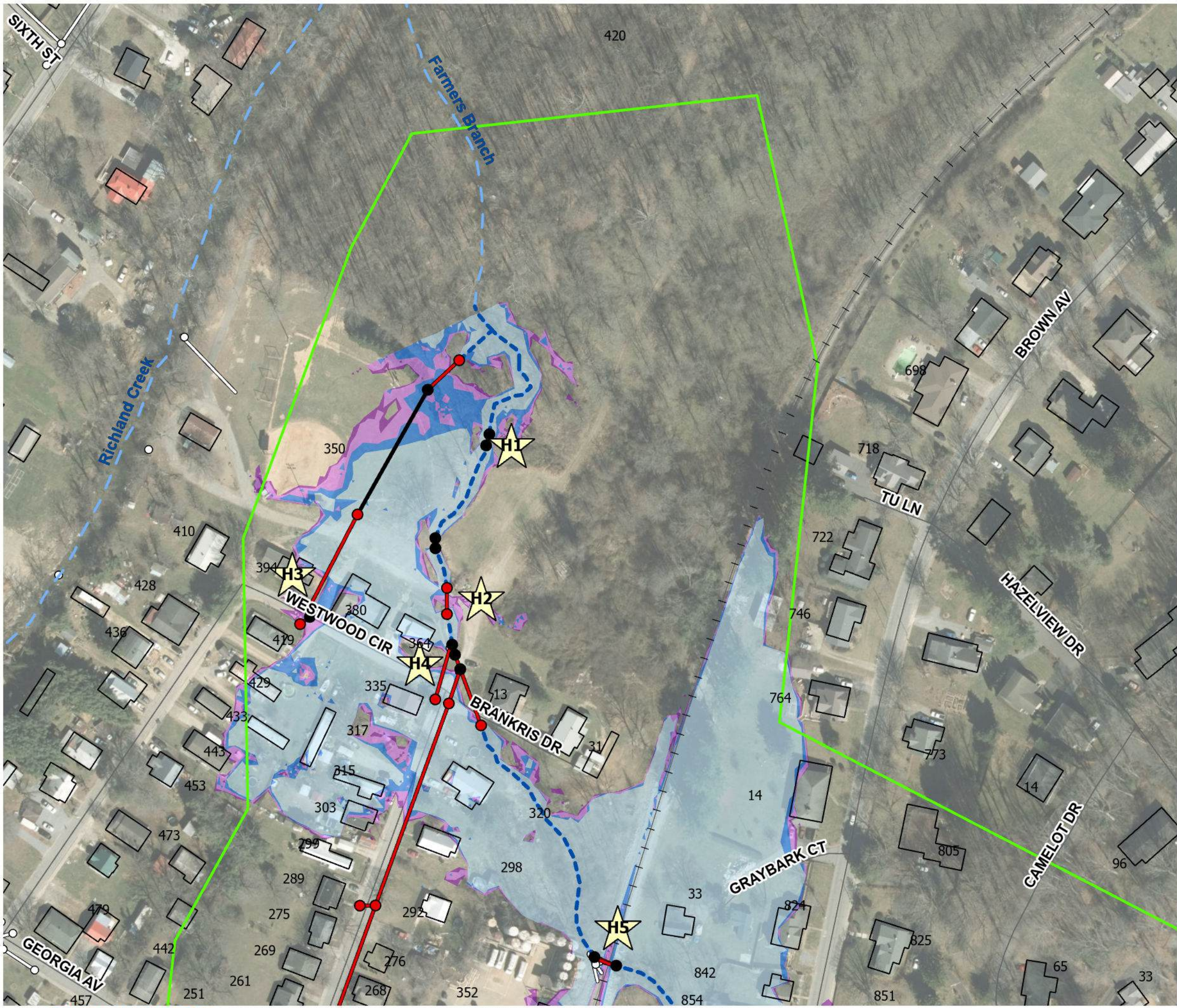
Hazelwood Index Map

Existing Conditions Capacity Analysis

Waynesville, NC



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Legend

Junctions	Context
● Flooded- 10 YR Storm Event	□ Structures
● Flooded- 25 YR Storm Event	— Modeled Open Channels
● Flooded- 50 YR Storm Event	— Non-Modeled Open Channels
● Flooded- 100 YR Storm Event	□ Study Areas
● Not Flooded in Analyzed Storms	★ Potential Area of Concern
○ Non-Analyzed	
Conduits	Shelton Riverine Inundation
— Full Capacity- 10 YR Storm Event	□ 10 YR Storm Event
— Full Capacity- 25 YR Storm Event	□ 25 YR Storm Event
— Full Capacity- 50 YR Storm Event	□ 50 YR Storm Event
— Full Capacity- 100 YR Storm Event	□ 100 YR Storm Event
— Not at Full Capacity in Analyzed Storms	
— Non-Analyzed	

0 125 250
1 inch = 125 Feet

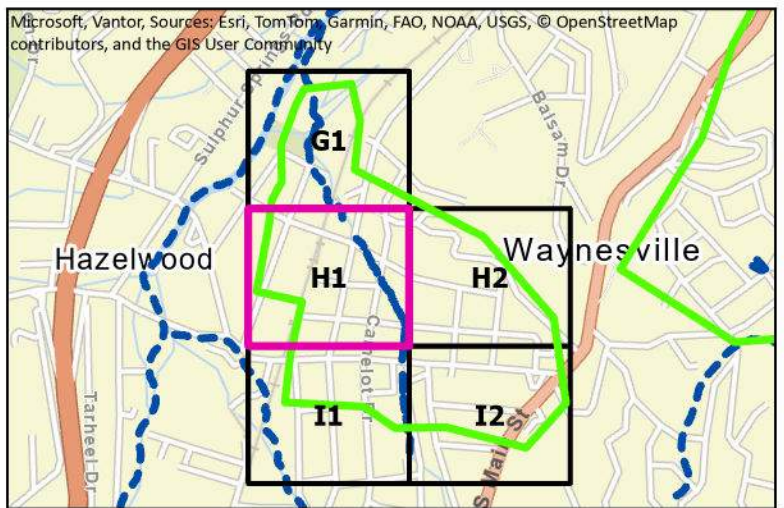
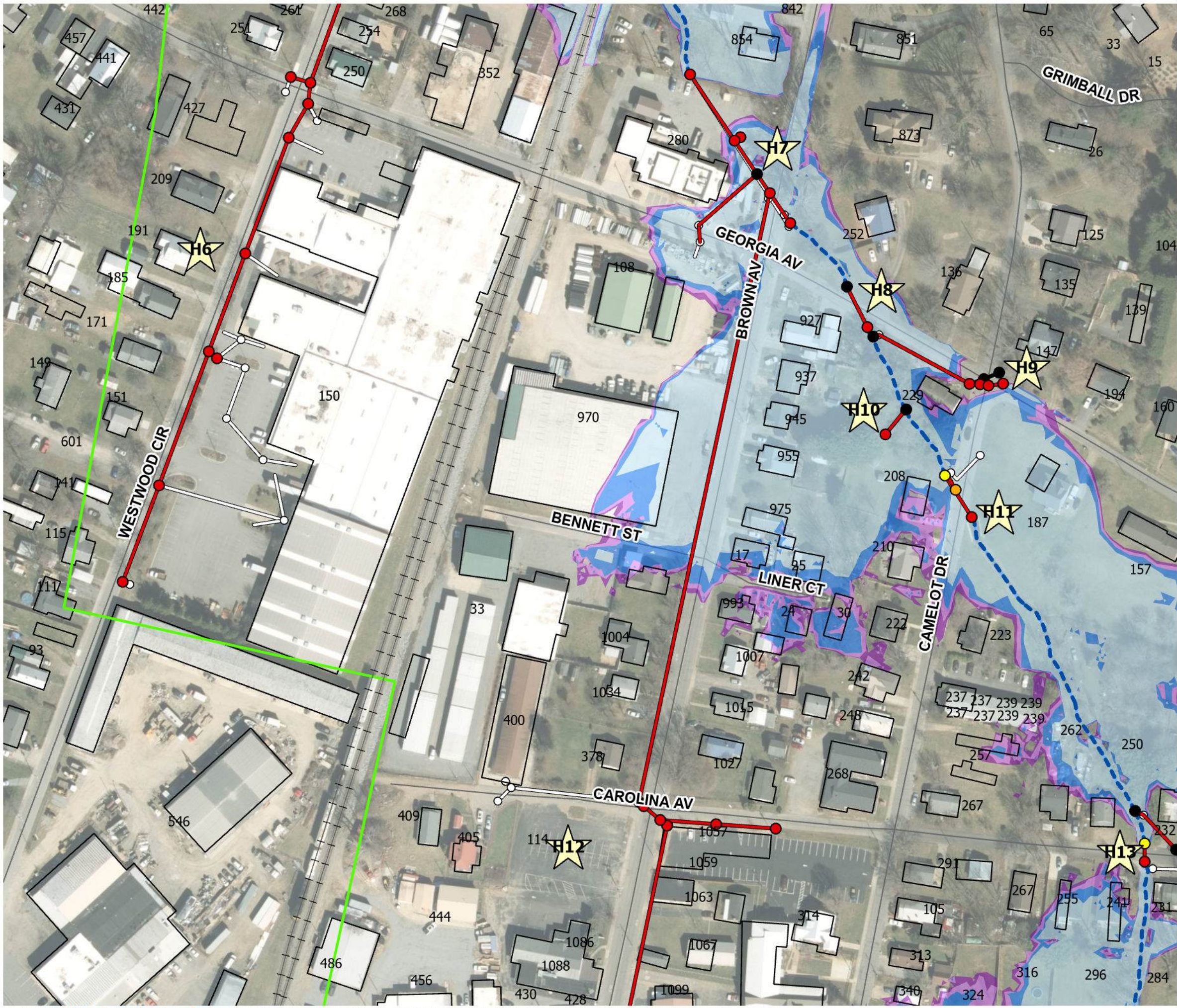
Hazelwood: G1

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Legend

Junctions	Context
● Flooded- 10 YR Storm Event	□ Structures
● Flooded- 25 YR Storm Event	— Modeled Open Channels
● Flooded- 50 YR Storm Event	— Non-Modeled Open Channels
● Flooded- 100 YR Storm Event	□ Study Areas
● Not Flooded in Analyzed Storms	★ Potential Area of Concern
○ Non-Analyzed	Shelton Riverine Inundation
Conduits	■ 10 YR Storm Event
— Full Capacity- 10 YR Storm Event	■ 25 YR Storm Event
— Full Capacity- 25 YR Storm Event	■ 50 YR Storm Event
— Full Capacity- 50 YR Storm Event	■ 100 YR Storm Event
— Full Capacity- 100 YR Storm Event	
— Not at Full Capacity in Analyzed Storms	
— Non-Analyzed	

0 125 250
1 inch = 125 Feet

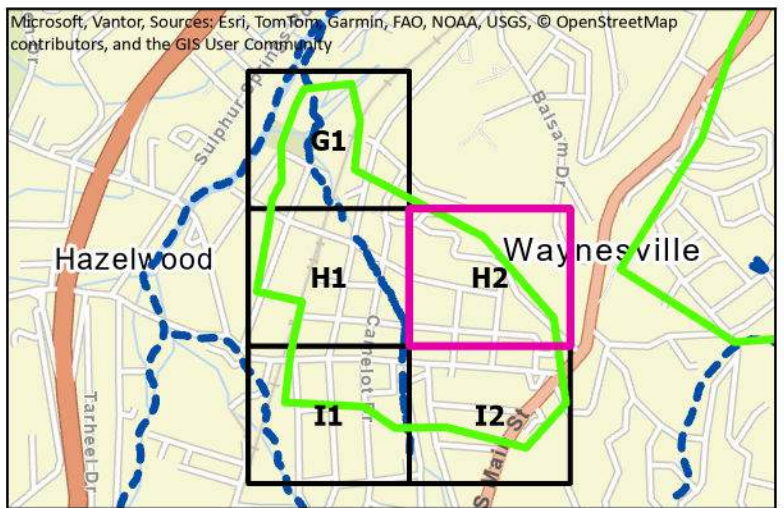
Hazelwood: H1

Existing Conditions Capacity Analysis

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Legend

<p>Junctions</p> <ul style="list-style-type: none"> ● Flooded- 10 YR Storm Event ● Flooded- 25 YR Storm Event ● Flooded- 50 YR Storm Event ● Flooded- 100 YR Storm Event ● Not Flooded in Analyzed Storms ○ Non-Analyzed <p>Conduits</p> <ul style="list-style-type: none"> — Full Capacity- 10 YR Storm Event — Full Capacity- 25 YR Storm Event — Full Capacity- 50 YR Storm Event — Full Capacity- 100 YR Storm Event — Not at Full Capacity in Analyzed Storms — Non-Analyzed 	<p>Context</p> <ul style="list-style-type: none"> Structures — Modeled Open Channels — Non-Modeled Open Channels Study Areas ★ Potential Area of Concern <p>Shelton Riverine Inundation</p> <ul style="list-style-type: none"> 10 YR Storm Event 25 YR Storm Event 50 YR Storm Event 100 YR Storm Event
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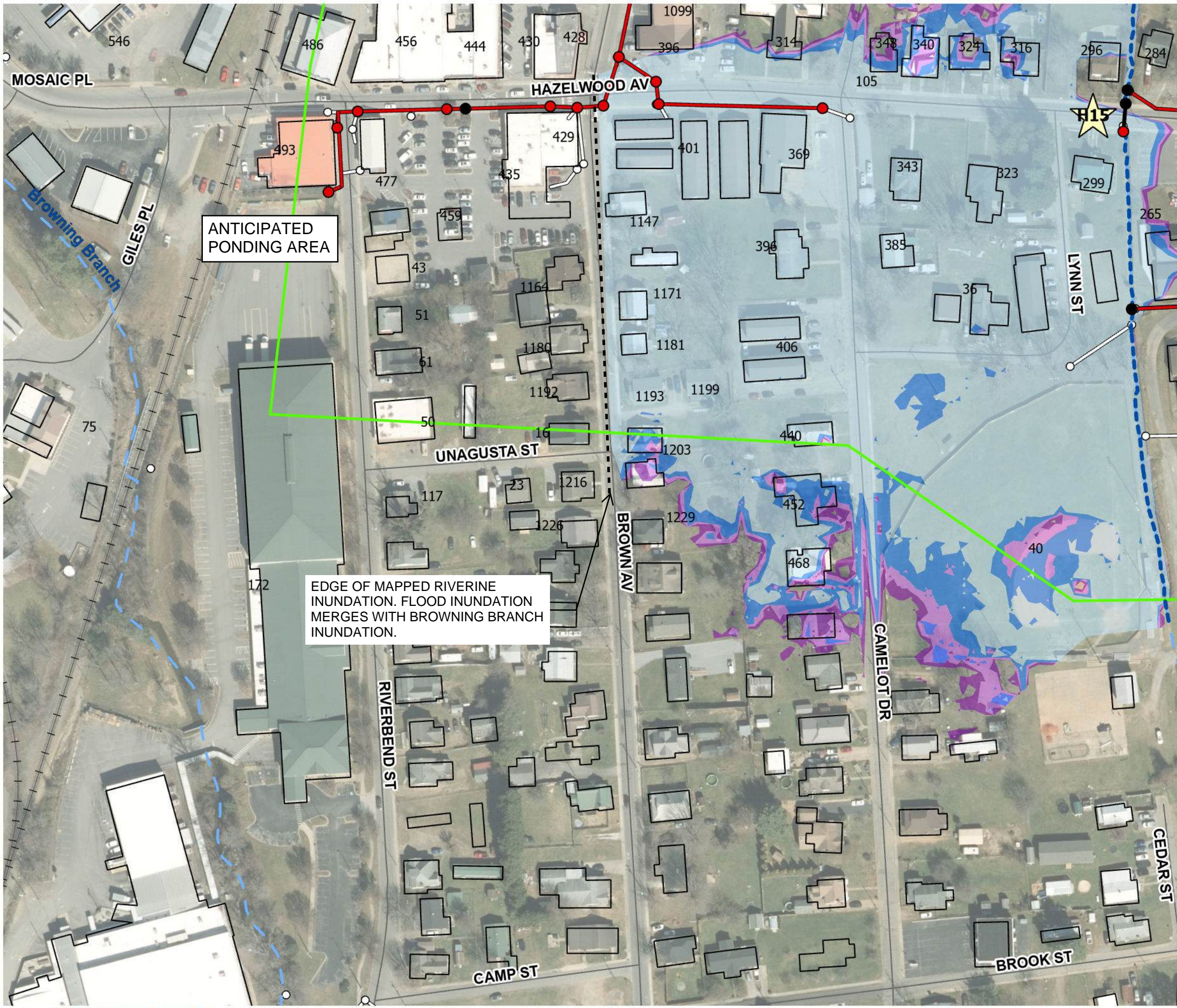
0 125 250
1 inch = 125 Feet

Hazelwood: H2

Existing Conditions Capacity Analysis Waynesville, NC

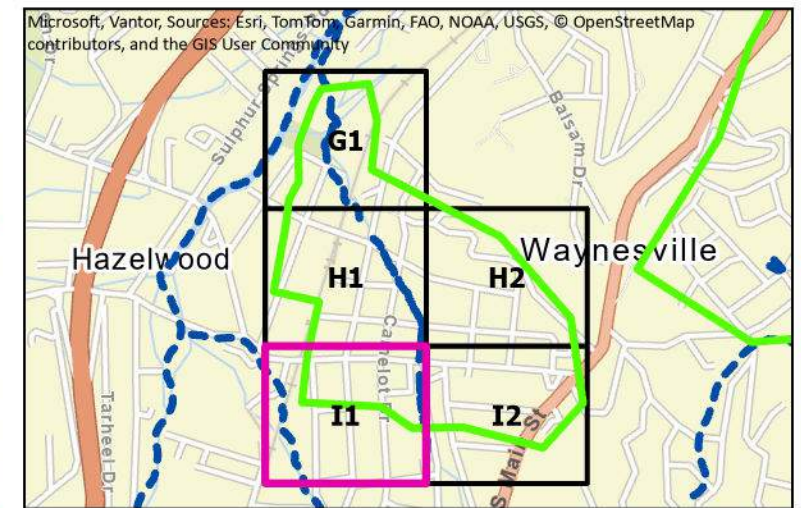
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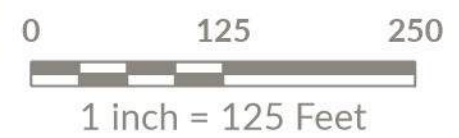
ANTICIPATED PONDING AREA

EDGE OF MAPPED RIVERINE INUNDATION. FLOOD INUNDATION MERGES WITH BROWNING BRANCH INUNDATION.



Legend

- | | |
|---|------------------------------------|
| Junctions | Context |
| ● Flooded- 10 YR Storm Event | □ Structures |
| ● Flooded- 25 YR Storm Event | — Modeled Open Channels |
| ● Flooded- 50 YR Storm Event | — Non-Modeled Open Channels |
| ● Flooded- 100 YR Storm Event | □ Study Areas |
| ● Not Flooded in Analyzed Storms | ★ Potential Area of Concern |
| ○ Non-Analyzed | Shelton Riverine Inundation |
| Conduits | □ 10 YR Storm Event |
| — Full Capacity- 10 YR Storm Event | □ 25 YR Storm Event |
| — Full Capacity- 25 YR Storm Event | □ 50 YR Storm Event |
| — Full Capacity- 50 YR Storm Event | □ 100 YR Storm Event |
| — Full Capacity- 100 YR Storm Event | |
| — Not at Full Capacity in Analyzed Storms | |
| — Non-Analyzed | |

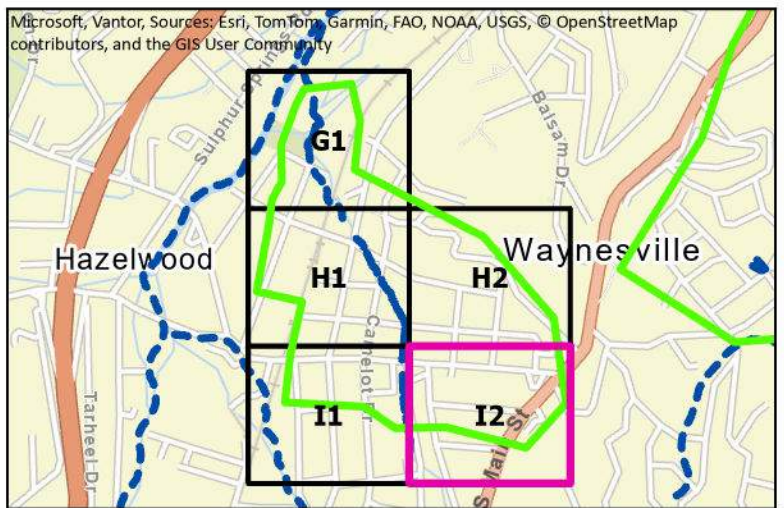


Hazelwood: I1

Existing Conditions Capacity Analysis Waynesville, NC



201 South Tryon Street Suite #800 Charlotte NC, 28202
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 license #: F-1479
 www.withersravenel.com



Legend

Junctions	Context
● Flooded- 10 YR Storm Event	□ Structures
● Flooded- 25 YR Storm Event	— Modeled Open Channels
● Flooded- 50 YR Storm Event	— Non-Modeled Open Channels
● Flooded- 100 YR Storm Event	□ Study Areas
● Not Flooded in Analyzed Storms	★ Potential Area of Concern
○ Non-Analyzed	Shelton Riverine Inundation
Conduits	□ 10 YR Storm Event
— Full Capacity- 10 YR Storm Event	□ 25 YR Storm Event
— Full Capacity- 25 YR Storm Event	□ 50 YR Storm Event
— Full Capacity- 50 YR Storm Event	□ 100 YR Storm Event
— Full Capacity- 100 YR Storm Event	
— Not at Full Capacity in Analyzed Storms	
— Non-Analyzed	

0 125 250
1 inch = 125 Feet

Hazelwood: I2

Existing Conditions Capacity Analysis Waynesville, NC

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Appendix F: Town of Waynesville Public Works References

PW Staff Stormwater Priorities

1. Sulphur Springs Road and Sixth Street
 - Pipe is old concrete pipe and metal pipe that is deteriorating and needs upsized repairs have been made over the years but pipe is completely failing and needs replaced from 1196 Sulphur springs road to Richland creek behind 1125 Sulphur Springs road with new catch basin boxes and grates to stop flooding in peoples homes and it is a safety hazard to motorists on Sulphur springs road the pipe has been inspected with a camera
2. Bradley street
 - Pipe is failing causing huge sink holes in the yard at 24 Dee Ann drive and Dee Ann Drive is collapsing making a liability for the town if someone gets injured it needs completely replaced with plastic double wall pipe have had several complaints from property owners about sink holes
3. Broad Street Culvert
 - Pipe has been inspected and is collapsing in several places and caused a huge sinkhole in a yard at 18 Broad Street. It currently runs under several houses on Broad Street causing an issue if it collapses. It needs to be moved out from under the houses and into the road with catch basins installed to prevent flooding on property and in houses
4. Goodyear Street
 - Water is flooding property, and the roadway pipe needs to be redirected away from the property at 23 Goodyear Street and upsized to hold more water
5. Buffalo Lane and Boundary Street
 - Ditch needs cleaned out and regarded pipes are failing and backing up causing standing water in the roadway at intersection pipe needs replaced and upsized to hold the amount of water flowing into catch basin and add some catch basins along branner avenue to keep the water out of the road
6. Charles Street and Branner Avenue
 - Bank has slid off multiple times at 124 branner avenue and had to go add rock to stabilize pipe needs inspected to find the leakage but is very old clay and concrete pipe so I would upgrade the pipe to plastic and upsize
7. N Haywood and Depot
 - The pipe is starting to deteriorate. It is clay and concrete pipes that needs a double grate installed at the intersection of depot and north main instead of a single have replaced small sections of this pipe but needs all of it replaced
8. Auburn Park

- Multiple complaints of flooding around 270 Auburn Park. Drive from runoff need to add catch basins and upsize the pipe from country club drive down Springview Drive to Auburn Park to catch all the water and need to upsize the pipe

9. Hazelwood Avenue

- Pipe stops up with debris easily. It is metal clay and concrete pipes. We have replaced one section with a double metal pipe to stop flooding in one section, but pipe needs upsized and more of a downward slope to make water run more effectively from riverbend street to brown avenue

10. Virginia Avenue, Kentucky Avenue, and Main Street

- Kentucky Avenue was replaced approximately 4 years ago with 24-inch double wall plastic and catch basins were added from the side street behind hazelwood Baptist church to the end of Kentucky avenue
- Virginia needs to be upgraded and catch basins added to meet the new pipe coming from Kentucky avenue
- Main street runs into Kentucky avenue in this area pipe needs upgraded to match Kentucky avenue

11. Waynesville Public Works and Legion Drive

- Pipes have been added in places around public works building needs upsized and ran away from the property at town and country, so it doesn't continue to flood

12. Burke Street and Shelton Street

- Pipe has been replaced from Buxton Street to 485 Shelton Street with 24-inch plastic double wall pipe it is concrete pipe from there to the intersection of burke and Shelton Street it needs replaced with matching pipe to the manhole at 485 Shelton Street and catch basins added along the street

13. Children street

- Have had several complaints of sinkholes in this area pipe is old clay pipe and is collapsing it needs replaced and upsized from the open ditch at 110 children street to the creek at 94 Children Street

14. Border street

- The pipe is too small and is an old clay pipe that repaired a short section approximately 3 years ago but still is standing water in roadway when it rains pipe needs upgraded to plastic and upsized from the catch basin beside Zaxby's to Richland creek

15. Railroad street

- A pipe is collapsing at the railroad crossing. It is a metal pipe, and the bottom of the pipe is deteriorating and causing the road to sink

16. Brook Street

- The pipe at the corner of 134 Brook Street that runs into the creek is deteriorating and starts to separate and cause sinkholes

17. Dolan Road

- The pipe at 224 Dolan Road the culvert head has been washed out and the ground under the sidewalk is gone it is clay pipe there is a manhole directly across the street in a field that is washed out around and the pipe runs into a ditch in the same field the pipe needs replaced with plastic pipe and upsized to prevent any future washouts and the manhole can be removed and straight pipe this into the ditch

18. Assembly street

- The pipe that comes through the property of 427 assembly street is collapsed and causing sinkholes across the property and around a manhole we have repaired the road where is caved in but never fixed the pipe it needs replaced and upsized with plastic pipe to make sure the road doesn't collapse again

19. Waynesville Hazelwood Town Office and Georgia Avenue

- Currently replacing the 72-inch culvert that runs through the parking lot of the office and replacing and upsizing the pipe from Georgia avenue to the 72-inch pipe with a 24-inch plastic pipe and adding a new catch basin

20. Scenic circle

- Below 394 Scenic circle there is a pipe that crosses the road with a creek in it is a metal pipe the bottom is completely rotten, and water is running around the pipe and coming out of the bank below it instead of coming out the pipe it needs replaced and upsized

21. Plaza

- Pipe is failing and needs to be upsized

22. Blueberry Dr

- Pipe is starting to fail. Lot flooding is visible.

23. Locust Dr (Catch Basin)

- Starting to Collapse

24. Chestnut Park Retirement Home

- Pipe is failing and needs to be upsized. Washing out of the bank is visible

25. Lansing Road

- Pipe is failing and needs to be upsized. Undermining roadway and washing out of the bank is visible.

PW Staff Suggested Ordinance Revisions

- Structures proposed to be located within the pavement area shall be outside the vehicle wheel path when possible
- Stormwater service connections shall be permitted only for projects connecting to a County maintained roadway system for which positive drainage to a point of positive outfall exists. The permitting of the stormwater connection may require construction of all necessary conveyance facilities and establishment of any easements necessary for the operation and maintenance of the drainage facilities.
- Onsite stormwater inlets shall include a 2-foot slump at the base to prevent sedimentation downstream.
- All discharge structures shall include a baffle system to encourage discharge from the center of the water column rather than the top or bottom. The baffle system shall include a skimmer or other approved mechanism suitable for preventing oil and grease from discharging from retention and detention areas, as required. Any required baffle systems shall be designed to not impact the discharge structure's hydraulic capacity.
- All discharge to the County right-of-way up to the 25-year, 24-hour storm shall be through an approved, onsite control structure with a piped connection to either an adjacent storm sewer or roadside drainage ditch. (Berm height)
- Unless the permittee provides satisfactory evidence of a specific allocation of discharge from the lot in the County-approved design of an existing roadway drainage system, the following onsite storage requirements and discharge limits shall apply:
 - i. The peak discharge rate from the 3-year, 24-hour storm shall not exceed the existing peak discharge to the right-of-way. The peak discharge shall be based upon the total site area and shall be based upon an assumed tailwater elevation equal to the static water surface elevation (i.e. elevation at zero inflow) in the roadway storm sewer at the point of connection;
 - ii. The peak discharge rate for the 25-year, 24-hour storm shall not exceed the lesser of the existing peak discharge from the total side area for the same storm or the allowable peak discharge rate established by the agency with jurisdiction over the receiving water body providing outfall to the County roadway drainage system. The discharge rate shall be based upon a tailwater elevation equal to the static water surface elevation (i.e. elevation at zero inflow) in the roadway storm sewer at the point of connection;

- iii. The onsite peak elevation due to a 3-year, 24-hour storm shall be no higher than the design hydraulic grade line elevation of the roadway system for the same storm, at the point of connection;
- iv. Where design information is not available, the design hydraulic grade line shall be assumed to be 1-foot below the inlet (grate or throat) elevation of the inlet structure immediately upstream from the point of connection;
- v. The proposed stormwater management system shall be designed to recover the runoff volume generated by the 25-year, 24-hour storm event within 5 days after the cessation of the storm event.

Appendix G: Policy Review Memos

- ◆ Drainage Area to a Stormwater Control Measure
- ◆ Downstream Impact Analysis
- ◆ Design Storm Review

Memorandum

To: Olga Grooman, Elizabeth Teague
CC: Amanda Hollingsworth, Haley Valdez
From: Alisha Goldstein
Date: December 11, 2025
Project: Town of Waynesville Stormwater Planning LASII (23-0734)
Subject: Downstream Impact Assessment

This memorandum provides information on downstream impact analysis.

Purpose: A downstream impact analysis evaluates if new development will cause any impact on flooding or channel degradation downstream of the project site. The reason for this analysis is to determine the timing of the flow peaks and the total increase in volume of runoff. The analysis provides the Town an estimate of the planned hydrologic and hydraulic changes that will result from the proposed changes and assists in the determination of an appropriate mitigation strategy. The criteria for evaluation in a downstream impact analysis include:

- Stream channel protection to non-erosively convey the 24-hour detention of the 1-year storm
- Convey the 100-year storm without increasing floodplain at the site and downstream
- Maintain a non-erosive velocity at the discharge point and downstream

Ordinance Suggestion: Clarify the requirements for the Uniform Watershed Analysis in Section 12.5.7.F to address downstream impacts.

- Downstream impact assessment to a confluence point where the area of proposed development is less than 10% of the total drainage area at the confluence point demonstrating that the peak flow rate or flow volume does not increase for a given storm.
- The impact statement shall list the infrastructure (ditches, culvert, etc.) and indicate any potential adverse effects and impacts (roads, culverts, businesses, homes, lawns, etc.) from the development to the 10% point. If backwater from detention appears to be a problem, then the impact statement shall also consider potential effects on upstream properties for the 100-year, 24-hour storm.

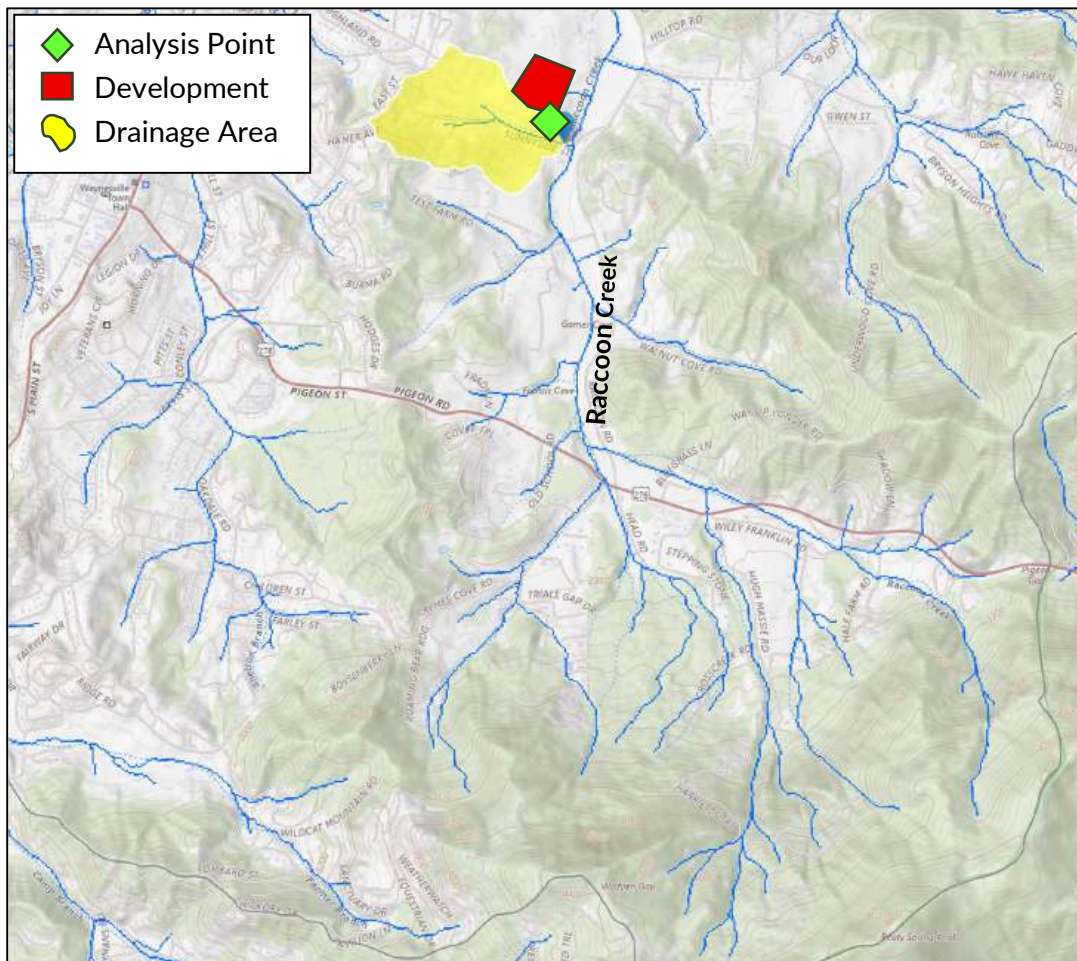
Since the current requirements are for the 2 year, 24-hour and 25 year, 24-hour peak flows, the downstream impact would be most applicable for evaluating the 100-year, 24-hour storm event. It would be at the discretion of Town staff to require this analysis. Considerations for requiring a downstream analysis could be historic flooding, when the site is redirecting runoff to a new discharge point, or if peak flows increase more than 10% for the 100-year, 24-hour storm event.

Steps to Perform a Downstream Assessment

- 1) Determine downstream limit of assessment
 - a. A point downstream where drainage from the proposed site development or redevelopment represents less than ten percent of the total watershed area draining to that point (typically referred to as the 10% guideline).

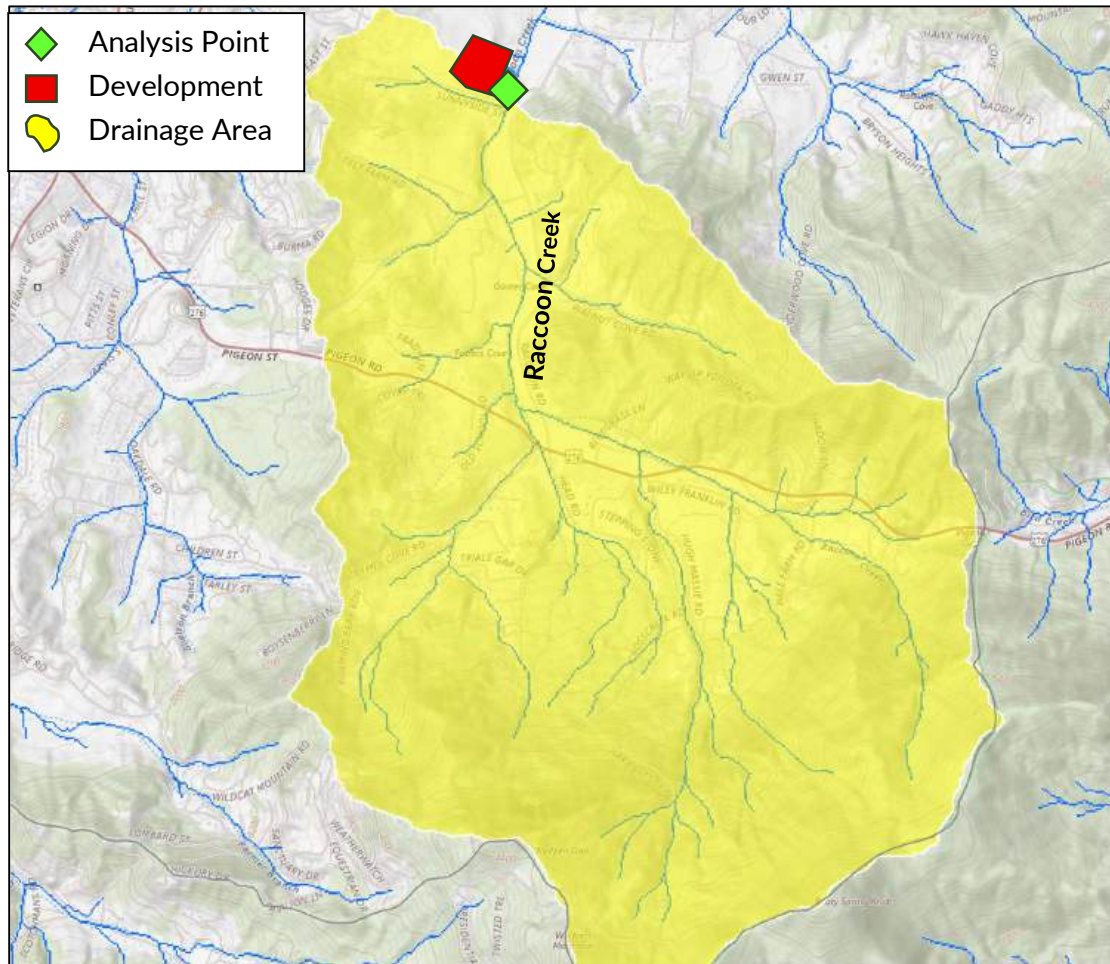
- b. A point downstream where drainage from the development or redevelopment site enters a FEMA established floodway.
- c. A point where the Stormwater Director knows of no existing Stormwater problems that the proposed development or redevelopment is likely to exacerbate downstream of known flooding issues.
- d. A point where there are no public road crossings or other public infrastructure that may be adversely impacted by an increase in runoff from the proposed development or redevelopment.

Example 1 - Point of Analysis on a Tributary



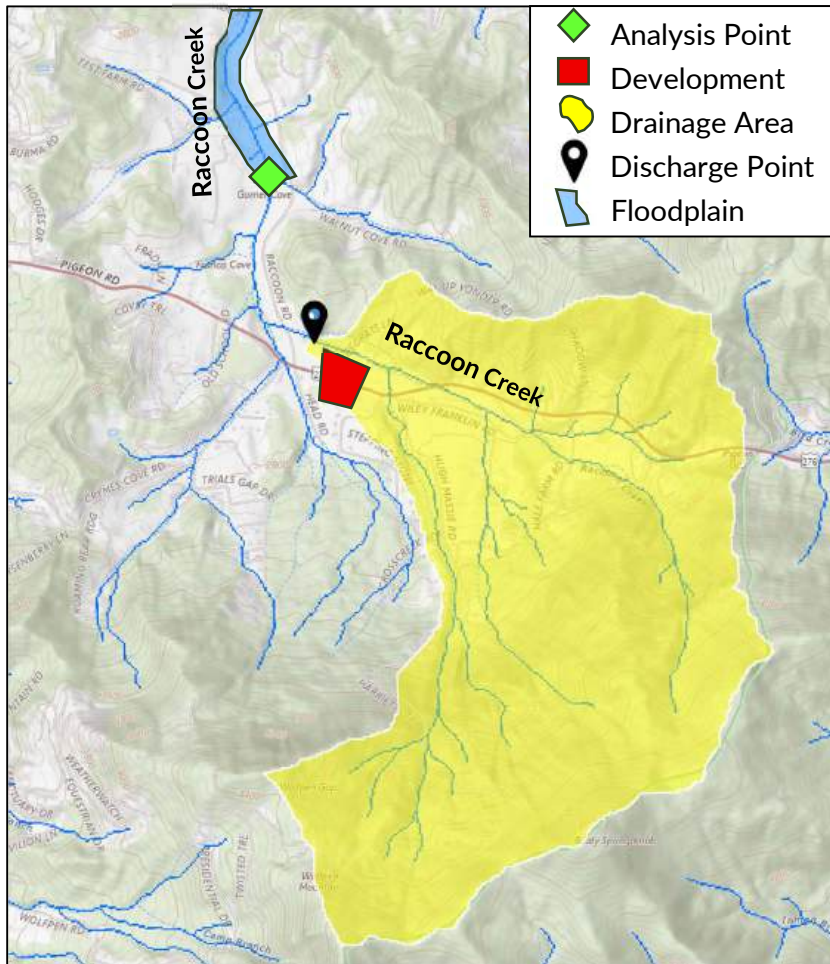
Proposed development is 58 acres. The 10% rule requires the project look at a minimum of 580 acres of drainage area or at the nearest downstream confluence with another waterbody. The analysis point on the tributary is **NOT** an appropriate point of analysis. The contributing drainage area to the discharge point is 96 acres which is less than 10% of the watershed.

Example 2 - Point of Analysis on a River (Raccoon Creek)



For the same project as shown in Example 1, the point of analysis was selected to be on Raccoon Creek. The drainage area to this analysis point is 2579 acre. This analysis point is acceptable since the proposed development of 58 acres is less than 10% of the drainage area.

Example 3 – Point of Analysis at a Floodplain



A 50 acre development project is planned for the upstream portion of the Raccoon Creek watershed. The drainage area to the project discharge point is 1069 acre. The discharge point from the project on Raccoon Creek would be an appropriate point of analysis. Based on downstream concerns, the analysis point for the impact assessment was determined to be where the FEMA floodplain is mapped downstream of Walnut Cove Road.

- 2) Data collection
 - a. Ste land use for post-development should be based on future land use to represent change from existing to proposed conditions
 - b. Off-site undeveloped areas should be considered as full build-out for both the pre- and post-development analyses.
- 3) Hydrologic Analysis
 - a. Watershed hydrology
 - b. Site hydrology

- 4) Post-Development Downstream Impact Assessment
 - a. Analyze capacity of all existing constraint points along the drainage path, such as existing floodplain, storm drainage systems, culverts, bridges, tributary confluences, or channels to convey post-development flows and/or velocities
 - b. Evaluate water surface elevation within the floodplain relative to the existing flood heights as well as potential impact to structures
 - c. Evaluate if the extent of the 100-year floodplain has changed
 - d. Review the time of the inflection point of the site hydrograph occurs before the time of the peak for the upstream hydrograph

- 5) Determine if and what action may be required for the proposed development
 - a. Reduce water surface elevation and/or velocity using channel or conveyance improvements
 - b. Design on-site structural controls to maintain pre-development flows or reduce velocity
 - c. Work with the town to determine other acceptable approaches
 - d. If there are no peak flows or velocity increases downstream, then the control of the flood protection volume can be waived by the local authority

Memorandum

To: Olga Grooman, Elizabeth Teague
CC: Amanda Hollingsworth, Haley Valdez
From: Alisha Goldstein
Date: December 11, 2025
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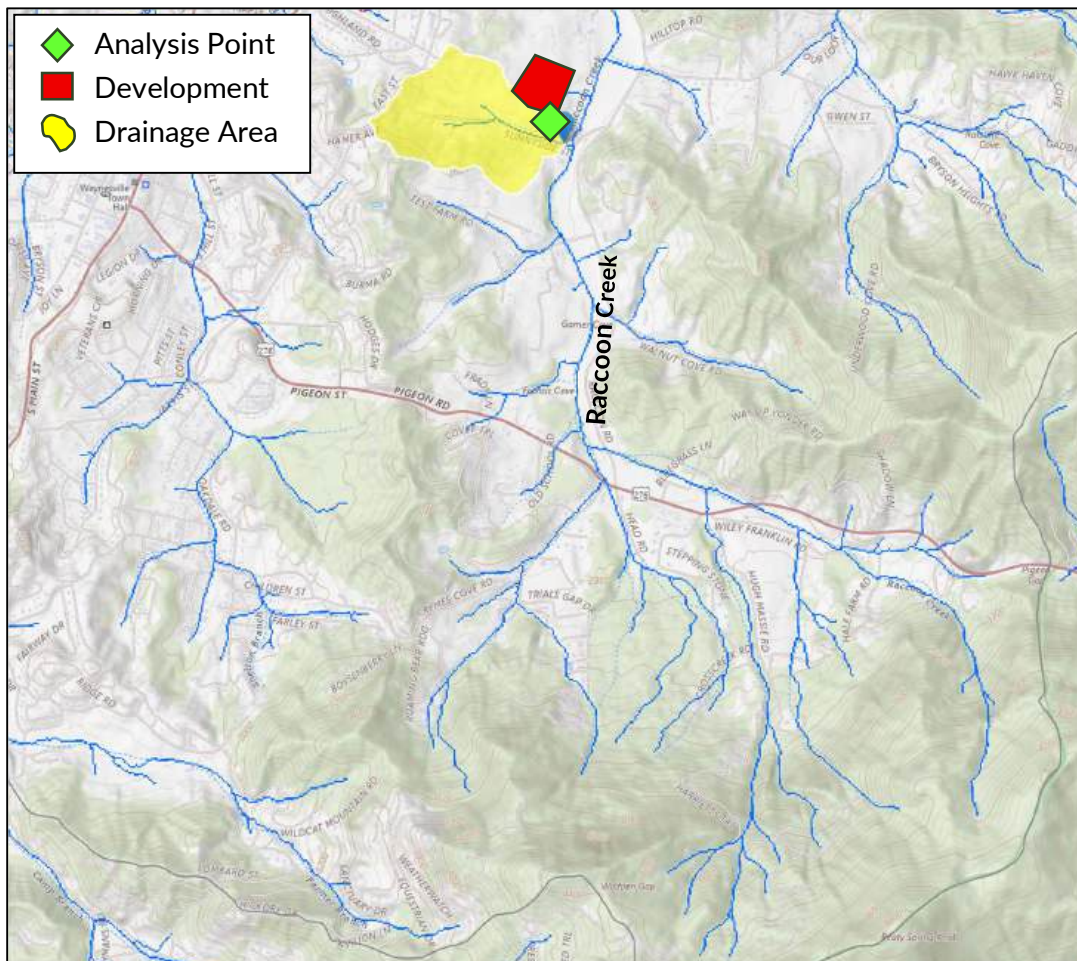
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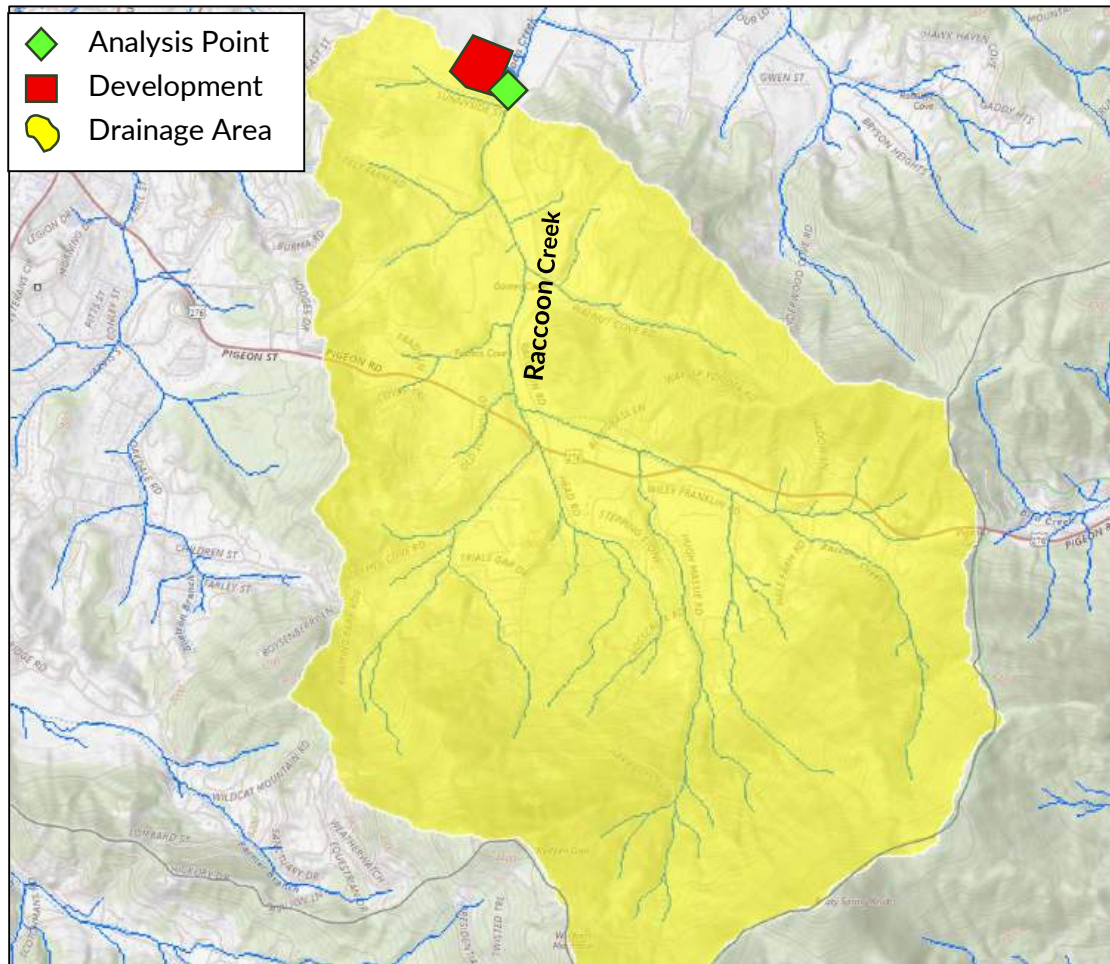
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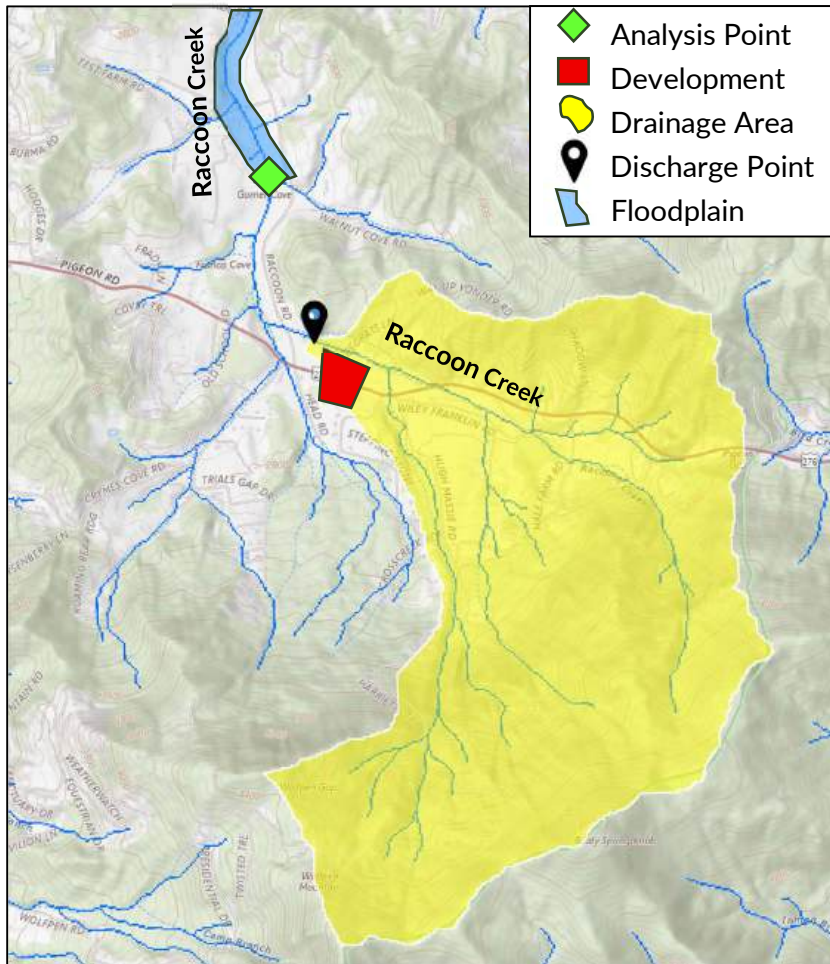
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Memorandum

To: Olga Grooman, Elizabeth Teague
CC: Amanda Hollingsworth
From: Alisha Goldstein
Date: November 4, 2024
Project: Town of Waynesville Stormwater Planning LASII (23-0734)
Subject: Stormwater Regulatory Review

This memorandum provides information on recommended stormwater management regulations specifically design storms through a comparative peer city evaluation and other zoning considerations. The Town of Waynesville's post-construction stormwater management ordinances are in Section 12.5 of the Land Development Standards within the Code of Ordinances. The current stormwater standards are addressed in three sections: stormwater control measures, water quantity, and stormwater conveyance systems.

A comparative peer community review analysis was compiled of stormwater regulations. The communities were selected based on specific characteristics. The Town of Cary and the Town of Chapel Hill have regulations for addressing the 100-year storm event. The City of Hendersonville is in the same geographic region and the Town of Hillsborough has a similar population size to Waynesville. The regulations for each municipality including Waynesville are presented in Table 1. There are some differences between the municipalities as identified below:

- The Towns of Hillsborough and Chapel Hill have lower area thresholds (less than an acre) for stormwater regulation applicability.
- The Town of Chapel Hill requires new conditional zoning and major special use permits that post development peak flow shall not exceed pre development peak flow for 1-year, 2 year, 25-year, and 100-year, 24-hour storm events.
- The Town of Cary requires a downstream impact analysis for each discharge point evaluating the 2-year, 5-year, 10-year, and 100-year peak discharges between pre and post development conditions and mitigation measures depending on analysis.
- For stormwater conveyances systems, many communities require 25-year, 24-hour storm for roadway culvert on arterial roads and the 50-year, 24-hour storm for culverts on thoroughfares. The Town of Chapel Hill requires bridge and/or box culverts for stream crossings be designed to pass the 100-year, 24-hour storm event.
- To encourage green infrastructure, some communities have grant programs, public-private partnerships, or have adopted low impact design standards to ease implementation.
- Riparian buffers vary between municipality due to local watershed overlay or state regulations.

In addition to reviewing post-construction stormwater management regulations from comparative communities, opportunities to address the impacts of climate change beyond stormwater regulations were identified. Part of enhancing a community's resiliency is not simply via regulation of new development but also protection of existing natural resources and topography. The Town has implemented tree protection and steep slopes ordinances. Other regulatory options include:

- Expanding stream buffer protections by increasing riparian buffer or specifying that buffers must remain in natural undisturbed forest vegetation;
- Enacting watershed protection or conservation district overlays;
- Reducing the land disturbance threshold for stormwater requirements;
- Offer incentives for voluntary adoption of increased volume retention or reduction in peak flows for specific design storms;
- Revising parking minimum, setting parking maximums, or allowing for shared parking lots to reduce impervious area;
- Reducing the maximum impervious surface allowed on residential and commercial lots; or
- Prevent stormwater control measures from being built in a riparian buffer or floodplain.

Adapting to the changing climate requires a multi-prong approach to address the sources of increased runoff and management of an appropriate design storm. It is apparent that a few municipalities in NC are beginning to regulate the 100-year peak discharge rates from new development as demonstrated by the Towns of Cary and Chapel Hill. Other approaches to consider for design storm standards are designing for a shorter duration storm or using climate adjusted historic design flows. The latter approach will be evaluated in this stormwater planning study.

Shorter duration storms would equate to using a 6-hour storm instead of a 24-hour storm event. The accepted methodology for an appropriate storm duration is for selected storm duration should be as long at the time of concentration. The time of concentration refers to the duration for the runoff from the furthest point of the drainage system discharges to the point of interest. The 24-hour storm represents a reasonable and common time frame for design purposes.

In determining an appropriate design standard, there are two risk management approaches that one can take: fail-safe or safe-to fail. Fail-safe are engineered not to fail. A safe-to fail approach acknowledges that some disruptions are likely due to the magnitude of hazards. This approach acknowledges that not all storms can be managed. There are questions that need to be asked with this approach. If a system fails or is compromised, who or what is at risk? What is the consequence of failure? With that risk, how can be flood damage be prevented or lessened? These questions should be taken into consideration when considering regulation to determine the impact of the regulation.

Regardless of the approach adapted, it is important to remember that design criteria are not static and need to be routinely reviewed to evaluate performance. Also, as standards are revised, it is important to assess the impact on staff resources. If the threshold for disturbance area is lowered, the number of plan reviews may increase. More design criteria requirements may translate into longer plan review times. Plan review fees may need to be increases and more staff added based on the selection of regulatory requirements. Higher design standards will require more land devoted to stormwater control measures and impact development patterns.

Beyond regulatory approaches for new development, the Town should consider implanting a stormwater utility fee to implement capital improvement projects that target flooding. A regional approach for flooding will be beneficial Townwide and have a measurable impact greater than one-off developments that would be impacted by changes in the design storm standards. Many older neighborhoods were not designed with stormwater retention as a consideration. New regulatory standards may lessen impact from any upstream development but will not relieve any current flooding issues.

Table 1 - Peer Communities Regulation Comparison

	Town Waynesville	Town of Cary	City of Hendersonville	Town of Hillsborough	Town of Chapel Hill
		Addresses 100-year storm flows	Comparative mountain community	Similar population size	Addresses 100-year storm flows
Regulations	NPDES MS4 Phase II	NPDES MS4 Phase II, Cape Fear Basin and Neuse, Jordan Lake, Water-Supply Watershed	NPDES MS4 Phase II	NPDES MS4 Phase II, Falls Lake Rules	NPDES MS4 Phase II, Jordan Lake Rules, Watershed Protection District
Applicability	<ul style="list-style-type: none"> - Cumulatively disturb one (1) acre or more. - Projects of less than one acre and that are a part of a larger common plan of development or sale, even though multiple, separate, or distinct activities take place at different times on different schedules. - Projects of less than one acre and that have a proposed increased impervious surface on completion of greater than 24,000 square feet. <p>Exceptions: (1) Single-family and two-family developments on individual lots. (2) All development in the Central Business District (CBD) zone.</p>	<p>Any activity that, alone or as part of a larger common plan of development or sale, disturbs</p> <ul style="list-style-type: none"> - greater than one (1) acre of land in order to establish, expand, or modify a single-unit or duplex residential development or a recreational facility. - greater than one (1) acre of land in order to establish, expand, or modify a single-unit or duplex residential development or a recreational facility. <p>Any redevelopment alone or as part of a larger common plan of development or sale in order to establish, expand, or modify a multifamily residential development or a commercial, industrial or institutional facility that increases built upon area and has an existing Stormwater Management Plan is subject to this rule regardless of disturbed area.</p>	<p>All development or redevelopment which disturbs one acre or more of ground area.</p>	<ul style="list-style-type: none"> - Add 10,000 sf or more of impervious surface. - Disturb 10,000 sf or more of land for the purpose of development. - Disturb 1/2 acre or more for single lot residential projects (not part of a larger project). - Disturb 1/2 acre or more for recreational facilities on a single lot. 	<p>- This section shall apply to all new development and redevelopment projects for which a zoning compliance permit is required.</p> <p>Exceptions: (1) Individual single-family and two-family development and redevelopments that do not disturb more than twenty thousand (20,000) square feet of land area (2) All development in the Central Business District (CBD) zone.</p>
Stormwater Control Measures	<p>Structural SCMs shall control and treat the 1-year, 1-hour storm event.</p> <p>Runoff volume drawdown shall be a minimum of 24 hours, but not more than 120 hours.</p> <p>SCMs shall be designed to achieve a minimum 85% annual removal of TSS.</p> <p>Post development peak flow shall not exceed pre development peak flow for 1-year 24 hour storm event.</p> <p>No one BMP shall receive runoff from an area greater than three (3) acres.</p>	<p>Control and treat the difference between the pre-development and post development conditions for the 1-year, 24-hour storm.</p> <p>Runoff volume drawdown shall be a minimum of 24 hours, but not more than 120 hours.</p> <p>SCMs shall be designed to achieve a minimum 85% annual removal of TSS.</p>	<p>All stormwater treatment measures shall treat either:</p> <ul style="list-style-type: none"> - the runoff volume from the disturbed area calculated utilizing the 1-year, 1-hour design storm rainfall depth; or - the difference in stormwater runoff volume between the pre- and post-development conditions for the 1-year, 24-hour storm; whichever is greater. <p>Runoff volume drawdown time shall be a minimum of 48 hours, but not more than 120 hours.</p> <p>SCMs shall be designed to achieve a minimum 85% annual removal of TSS</p>	<p>Control and treat runoff from all surfaces generated from first inch of rain.</p> <p>Runoff volume drawdown time shall be a minimum of 48 hours, but not more than 120 hours.</p> <p>SCMs shall be designed to achieve a minimum 85% annual removal of TSS.</p>	<p>Runoff volume drawdown time shall be a minimum of 48 hours, but not more than 120 hours.</p> <p>SCMs shall be designed to achieve a minimum 85% annual removal of TSS and sized for the first inch of precipitation.</p>
Water Quantity Design Requirements	<p>Storage shall be sufficient to store all excess surface runoff for the 10-year, 24-hour storm event.</p> <p>Post development peak flow shall not exceed pre development peak flow for 2-year and 25-year, 24-hour storm events.</p> <p>The temporary storage capacity shall be restored within 72 hours.</p> <p>The emergency overflow outlet must be designed to safely pass the 50-year, 24-hour storm event peak discharge.</p>	<p>No net increase in peak stormwater runoff flow leaving a development from pre-development conditions for the one (1)-year design storm.</p> <p>Exception: Developments with less than ten (10) percent net increase in peak flow of the one (1)-year design storm are not required to control peak flow for the one (1)-year storm from the site.</p>	<p>Discharge stormwater at a rate equal to or less than the pre-development discharge rate for both the 2-year, 24-hour storm and the 10-year, 24-hour storm with the ability to pass the 25-year, 24-hour storm.</p>	<p>No net increase in peak flow for the 1-year design storm.</p>	<p>Storage shall be sufficient to store all excess surface runoff for the 10-year, 24-hour storm event. The stormwater runoff volume leaving the site post-development shall not exceed the stormwater runoff volume leaving the site pre-development for the 2-year, 24-hour storm event .</p> <p>Post development peak flow shall not exceed pre development peak flow for 1-year, 2 year, and 25-year, 24-hour storm events.</p> <p>For new conditional zoning and major special use permits, Post development peak flow shall not exceed pre development peak flow for 1-year, 2 year, 25-year, and 100-year, 24-hour storm events.</p>
Stormwater Conveyance Systems Design Requirements	<p>Stormwater collection systems (drainage parallel to road, including ditches, swales and pipes) shall be designed to pass the peak flows from the 2-year, 24-hour storm event.</p> <p>Cross drainage systems that do not convey intermittent or perennial streams shall be designed to pass the peak flow rates from the 10-year, 24-hour storm event.</p> <p>Cross drainage systems conveying intermittent or perennial streams, shall be designed pass peak flow rates for the 50-year, 24-hour storm event.</p>	<p>Stormwater collection systems shall be designed based on the 2-year storm for side ditches, the 10-year storm for street drainage pipe sizing, the 25-year storm for cross-street drainage, and the 100-year storm for floodplain areas.</p> <p>Roadway culverts shall be designed to convey the 25-year, 24-hour design storm.</p>	<p>Stormwater collection systems (drainage parallel to road, including ditches and pipes) shall be designed to pass the peak flows from the 10-year, 24-hour design storm.</p> <p>Roadway culverts shall be designed to convey the 25-year, 24-hour design storm.</p>	<p>Stormwater collection systems (drainage parallel to road, including ditches and pipes) shall be designed to pass the peak flows from the 10-year, 24-hour design storm.</p> <p>Culverts for minor arterials, collectors, and local roads shall be designed to convey the 25-year, 24-hour design storm. Culverts for major arterials shall be designed to convey the 50-year, 24-hour design storm.</p>	<p>Stormwater collection systems (drainage parallel to road, including ditches and pipes) shall be designed to pass the peak flows from the 10-year, 24-hour design storm. For subdivision streets, the driveway and culvert shall be designed such that the flow from the 25-year storm shall not encroach onto the roadway pavement. If a thoroughfare road, the design storm is the 50-year.</p> <p>Arterial and collector roadway stormwater collections shall be designed to convey the 25-year design storm.</p> <p>Bridge/box culvert for stream crossings shall be designed to pass the 100-year, 24-hour storm event.</p>
Green Stormwater Infrastructure	<p>All Low Density Project sites must employ LID practices to analyze the infiltration capacity and natural drainages of the site and develop a system of controls which mimic the existing natural hydrology and which cumulatively capture and treat the runoff from the 1-year 1-hour storm event.</p>	<p>Grant program that provides reimbursement of up to \$5,000 to property owners who wish to install eligible GSI devices on their property and are willing to maintain the measure for at least 5 years.</p>	<p>The Stormwater Division has a goal to install at least one new rain garden a year moving forward.</p> <p>Established a community partnership program with a private entity that provides rain barrels at a discounted price to residents.</p>		<p>Low impact design options are encouraged. Descriptions and standard details of approved integrated management practices/best management practices are included in the town design manual.</p>
Surface Water Buffer for perennial and intermittent waters	<p>Built-upon area at a minimum of thirty (30) feet landward of all perennial and intermittent surface waters.</p>	<p>Cumulative 100-foot buffer for all United States Geological Survey (USGS) mapped intermittent and perennial streams in both the Neuse and Jordan Lake watersheds.</p>	<p>30-foot buffer to all watercourses depicted as a solid blue line on the most recent USGS map.</p>	<p>50-foot buffer of all perennial and intermittent streams.</p>	<p>50-foot buffer of all perennial and intermittent streams as required by Jordan Buffer rules.</p> <p>Resource Conservation District overlay district applies a 150-foot corridor to perennial streams with different uses allowed in the streamside, managed, and upland zones which are equally 50-feet.</p>
Other Regulations		<p>The Downstream Impact Analysis shall calculate the pre- and post-development discharges for each discharge point from the area subject to the development plan. If the calculated post-development discharge is greater than the calculated pre-development discharge for the 2-year, 5-year, 10-year, and 100-year peak discharges at any discharge point, then one of the options below shall be required.</p> <p>(1) Provide onsite detention to fully mitigate each storm event to calculated pre-development discharge; or</p> <p>(2) Provide an engineering model demonstrating no adverse impacts from the development on downstream properties and infrastructure.</p>			<p>100-year, 24-hour storm peak elevation of post-developent runoff shall not exceed the top dam bankment for retention and detention systems.</p>

Appendix H: Public Engagement

- ◆ Public Meeting Notes from February 22, 2024
- ◆ Public Presentation on February 22, 2024
- ◆ Map of Public Concerns collected from Survey and Public Meeting during First Quarter of 2024
- ◆ Results from the Waynesville Stormwater Survey
- ◆ Waynesville Stormwater Survey
- ◆ Public Meeting Notes from September 24, 2025
- ◆ Public Presentation on September 24, 2025

WAYNESVILLE PUBLIC MEETING NOTES

Date: 2/22/2024

Project: 23-0734 Town of Waynesville LASII Comprehensive Stormwater Master Plan

DISCUSSION ITEMS

What stormwater management recommendations will be made with respect to staffing and funding?

Will there be maintenance recommendations including scheduling?

Richland Creek

- ▶ Resident's property adjoins Autumn Nursing Home downstream
- ▶ Problem goes back to 1998
- ▶ Creek was rerouted and has a 90-degree turn
- ▶ Erosion undermining property
- ▶ Flooding
- ▶ Culvert under Hyatt Creek road needs more capacity

Will the analysis consider land use changes?

COMMENTS

What measure can be taken to protect riparian zones where development has already occurred (e.g. Richland Creek; potential acquisition of properties along waterways, etc.) **Water Pollution**

How can you mitigate large floodwater events that originate in the headwaters of the streams flowing through town? These will have huge impacts upon the town, coming from what is commonly considered to be "small" streams. **Flooding**

What specific green infrastructure mitigation is recommended? **Flooding, Water Pollution**

What measures need to be taken in the County to reduce sedimentation on private property (which arrives in town's waterways)? **Water Pollution**

What are most acquisitions for City to protect waterways? **Flooding, Water Pollution**

What can be done by the City to remove junkyards adjacent to Creeks? **Flooding, Water Pollution**

What opportunities exist with future in-fill development on S Main? **Flooding, Water Pollution**

What storm management measures are planned with DOT reconfiguration of Russ Ave? **Flooding**

Stormwater Master Plan

Town of Waynesville

February 22, 2024



Celebrating 40 Years!



WithersRavenel

Our People. Your Success.



Introductions and Contact Information

WithersRavenel

- Amanda Hollingsworth, PE, CFM
 - Project Manager
- Alisha Goldstein, PE
 - Assistant Project Manager
- Allison Alexander
 - Client Experience Manager

Town of Waynesville

- Olga Grooman, MPA, CZO, CFM
 - Land Use Administrator
 - (828) 356-1172
- Elizabeth Teague, AICP, CTP
 - Development Services Director



Survey

<https://www.surveymonkey.com/r/NZDYTLY>

QR code



Waynesville Stormwater Survey

Thank you for participating in our short questionnaire. Your feedback is important.

The Town of Waynesville is in the process of creating a stormwater master plan. Your input today will identify the goals and action items required to improve the Town's stormwater management practices.

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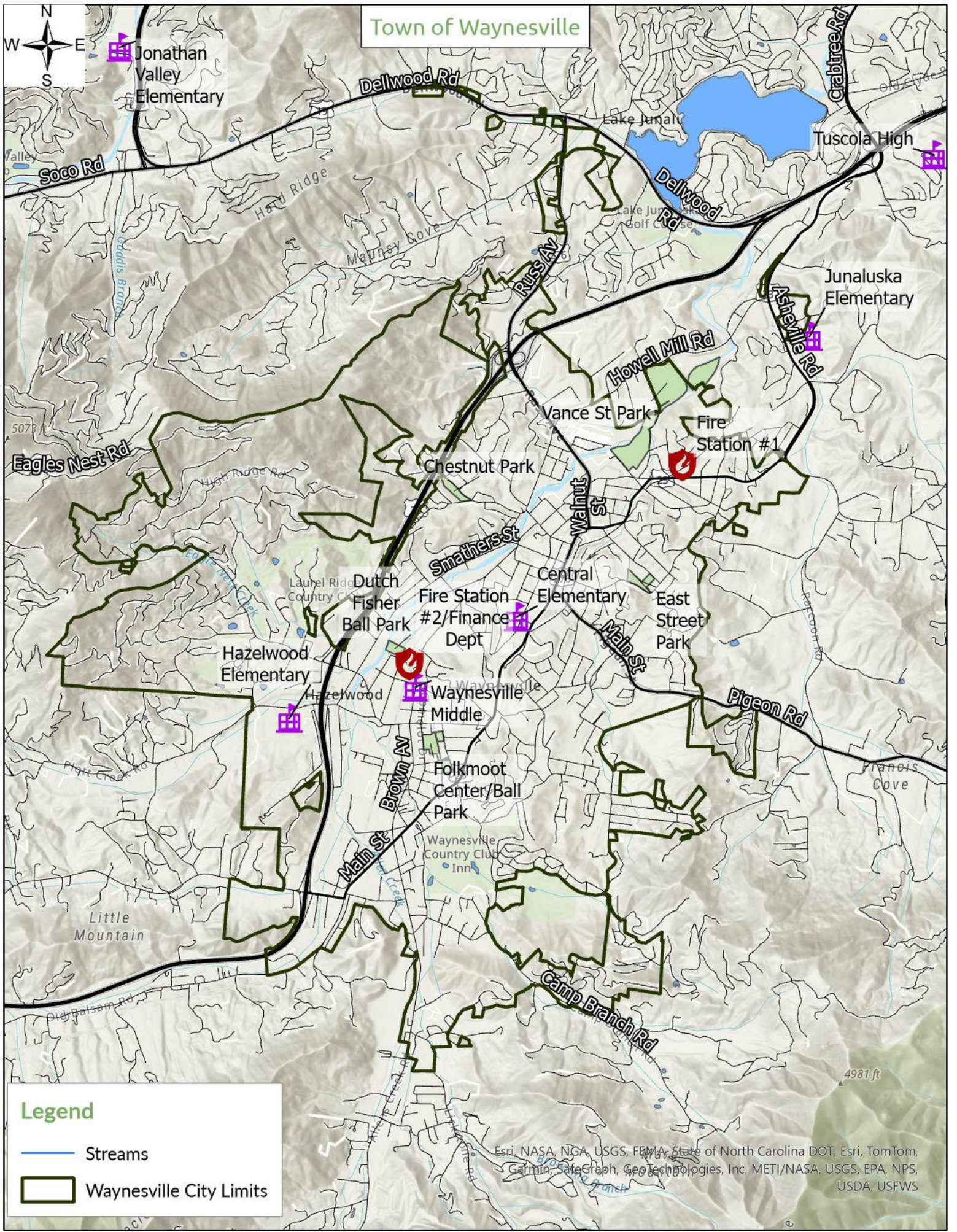
Breakout Activity

Mark with Stickers on the Maps the following concerns:



- Home/Business
- Water Pollution Concern
- Flooding Concern
- Maintenance Concern



Town of Waynesville

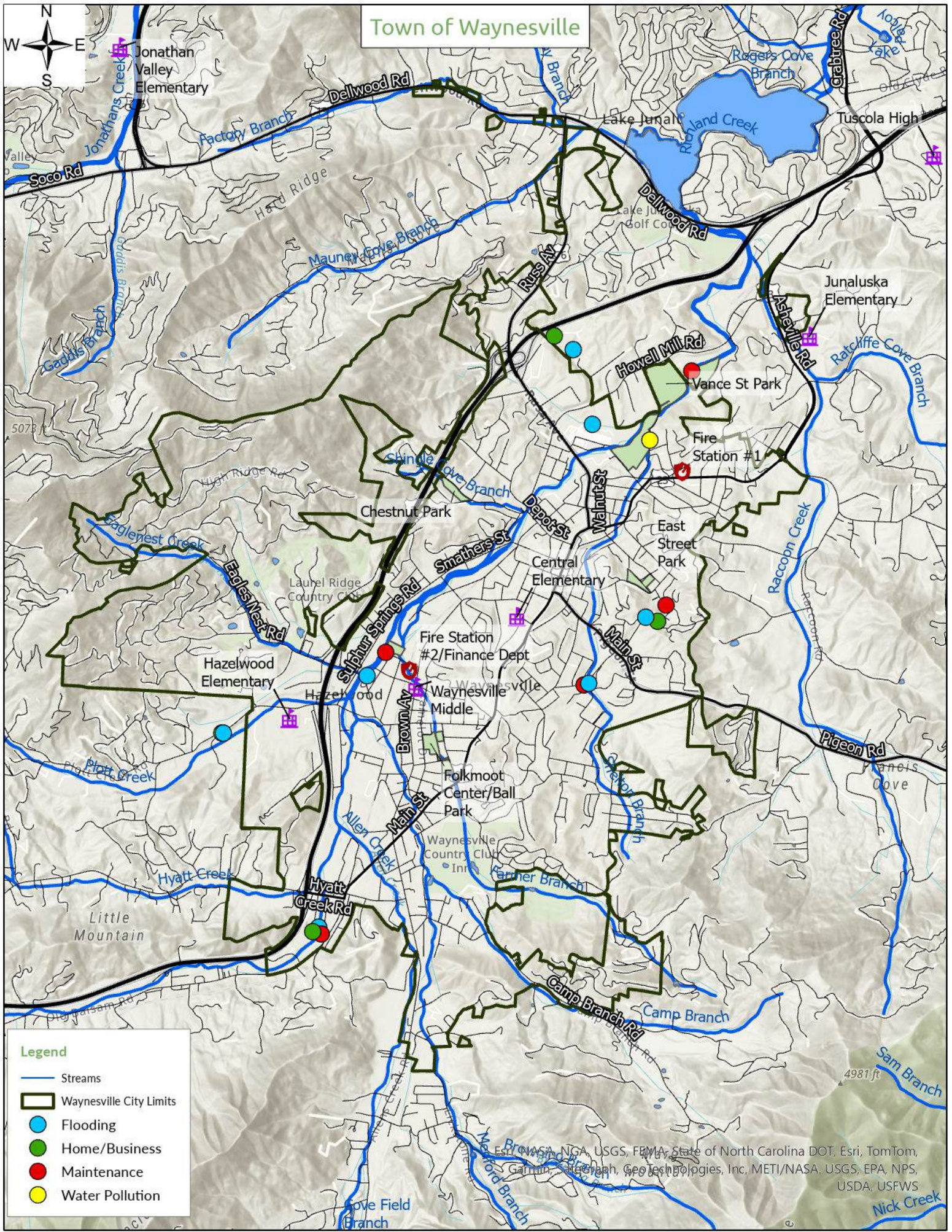


Legend

-  Streams
-  Waynesville City Limits

Esri, NASA, NGA, USGS, FEMA, State of North Carolina DOT, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, USDA, USFWS

Town of Waynesville

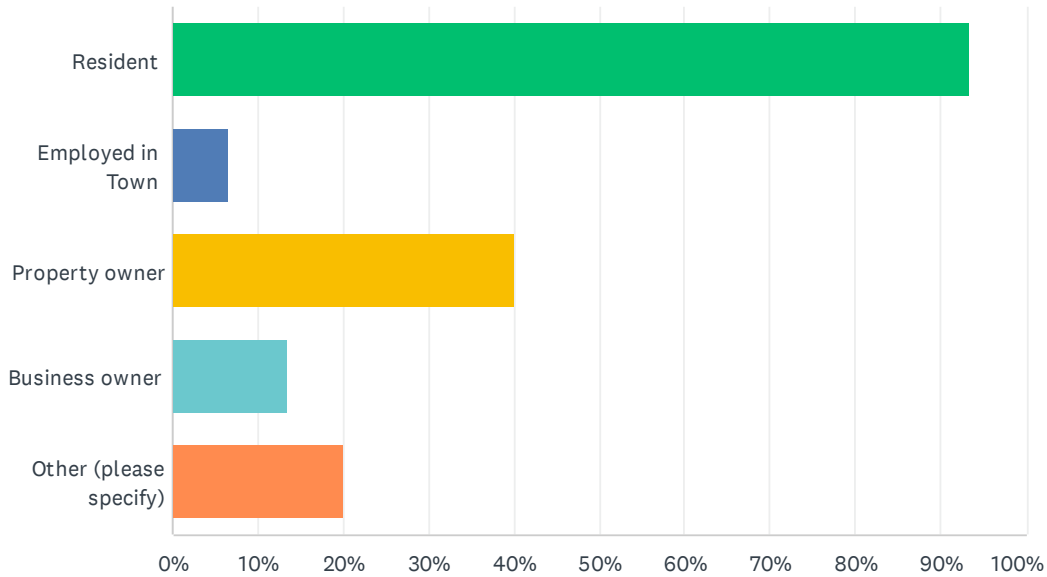


Legend

- Streams
- Waynesville City Limits
- Flooding
- Home/Business
- Maintenance
- Water Pollution

Q1 Check all the statements that best describe your status with the Town of Waynesville. I am a:

Answered: 15 Skipped: 0

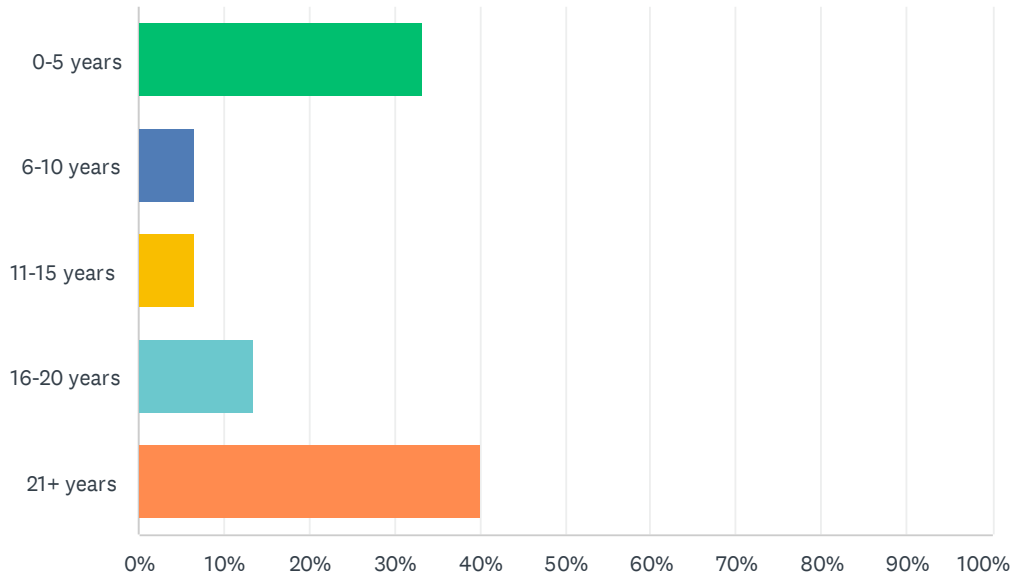


ANSWER CHOICES	RESPONSES
Resident	93.33% 14
Employed in Town	6.67% 1
Property owner	40.00% 6
Business owner	13.33% 2
Other (please specify)	20.00% 3
Total Respondents: 15	

#	OTHER (PLEASE SPECIFY)	DATE
1	Member of Waynesville Environmental Sustainability Board	2/26/2024 8:51 AM
2	I live in Barbers Orchard	2/23/2024 8:50 AM
3	Live in Ratcliffe Cove	2/22/2024 6:51 PM

Q2 If you answered that you are a resident of Waynesville. How long have you lived in Waynesville?

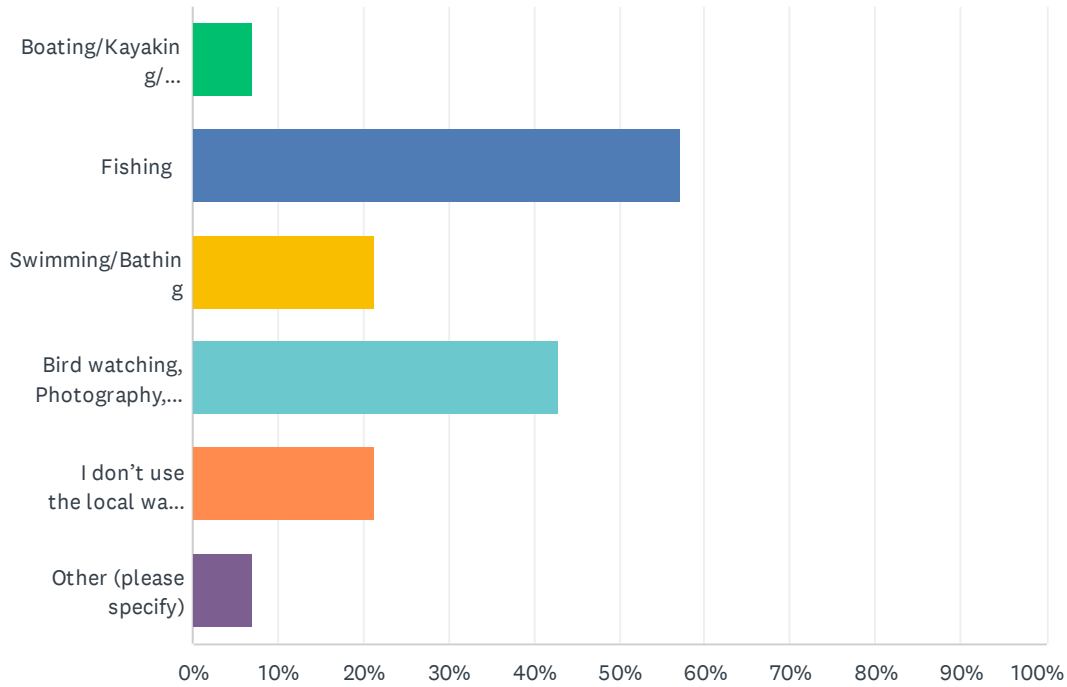
Answered: 15 Skipped: 0



ANSWER CHOICES	RESPONSES	
0-5 years	33.33%	5
6-10 years	6.67%	1
11-15 years	6.67%	1
16-20 years	13.33%	2
21+ years	40.00%	6
TOTAL		15

Q3 Do you use local bodies of water for recreational uses? If so, which of the following are applicable:

Answered: 14 Skipped: 1



ANSWER CHOICES	RESPONSES
Boating/Kayaking/ Canoeing/Paddleboarding/Tubing	7.14% 1
Fishing	57.14% 8
Swimming/Bathing	21.43% 3
Bird watching, Photography, or other water related naturalist hobby	42.86% 6
I don't use the local water bodies for recreational purposes.	21.43% 3
Other (please specify)	7.14% 1
Total Respondents: 14	

#	OTHER (PLEASE SPECIFY)	DATE
1	Gardening	2/23/2024 8:50 AM

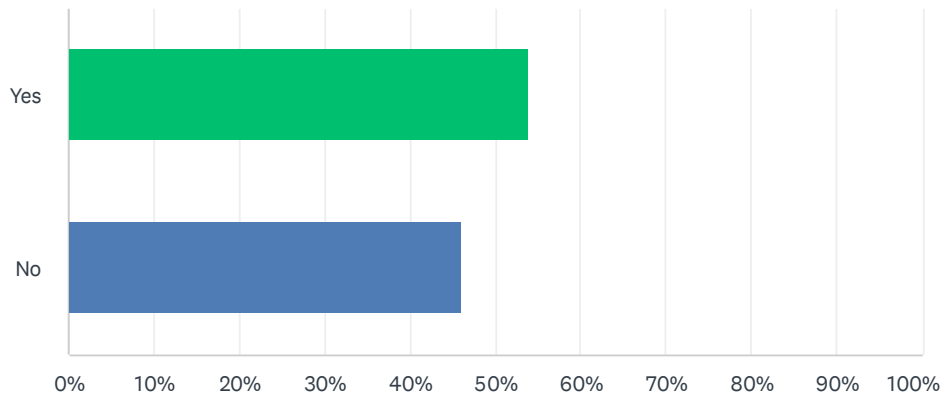
Q4 Name water bodies that you use for the purposes you specified above:

Answered: 11 Skipped: 4

#	RESPONSES	DATE
1	Swimming - Big Creek in Smoky Mountains National Park Walking - Lake Junalaska	2/26/2024 8:51 AM
2	Pigeon River	2/23/2024 12:56 PM
3	Pigeon River	2/23/2024 12:02 PM
4	Lake Junaluska, Pigeon River, Lake Logan.	2/23/2024 11:33 AM
5	Jonathan's creek	2/23/2024 8:50 AM
6	Jonathon Creek and Richland Creek	2/22/2024 11:01 PM
7	Richland Creek, Allen Creek, Lake J	2/22/2024 6:51 PM
8	Pigeon River, Richland Creek, Johnathan Creek, Shelton Branch.	2/22/2024 11:24 AM
9	East and West fork of the Pigeon river	2/13/2024 6:24 AM
10	Lake Junaluska and J Creek	2/13/2024 12:15 AM
11	Richland Creek Allen's creek	2/12/2024 1:41 PM

Q5 Do you ever avoid local water due to concerns about water quality?

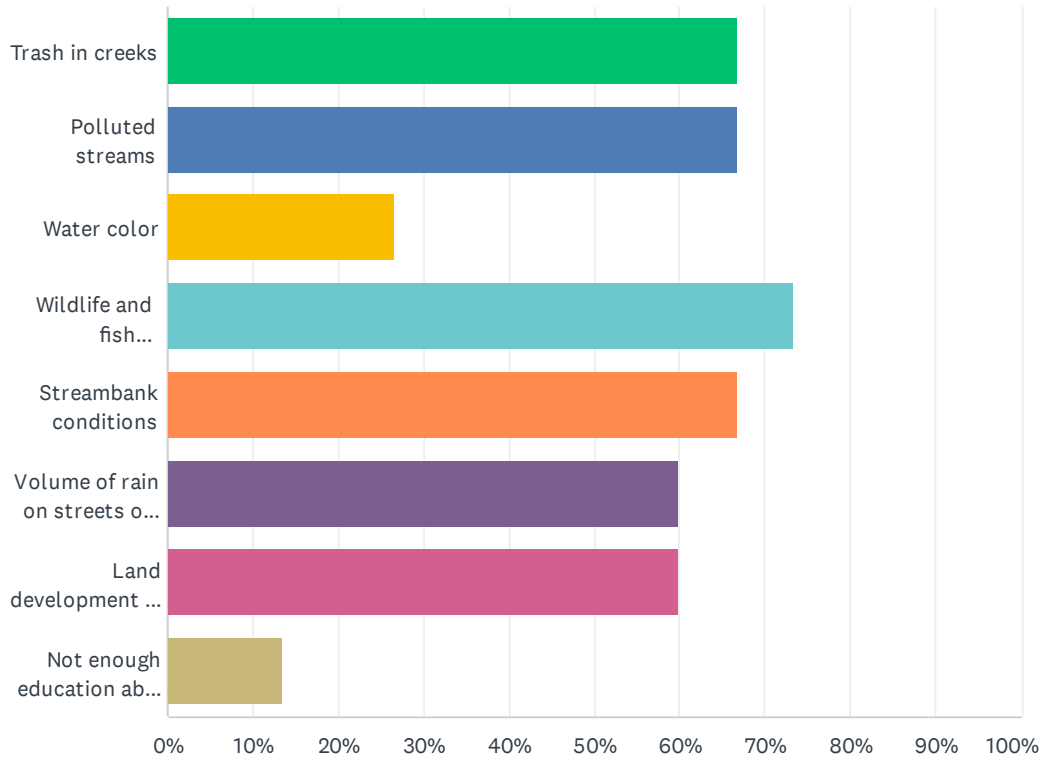
Answered: 13 Skipped: 2



ANSWER CHOICES	RESPONSES	
Yes	53.85%	7
No	46.15%	6
TOTAL		13

Q6 Check all the statements that concern you.

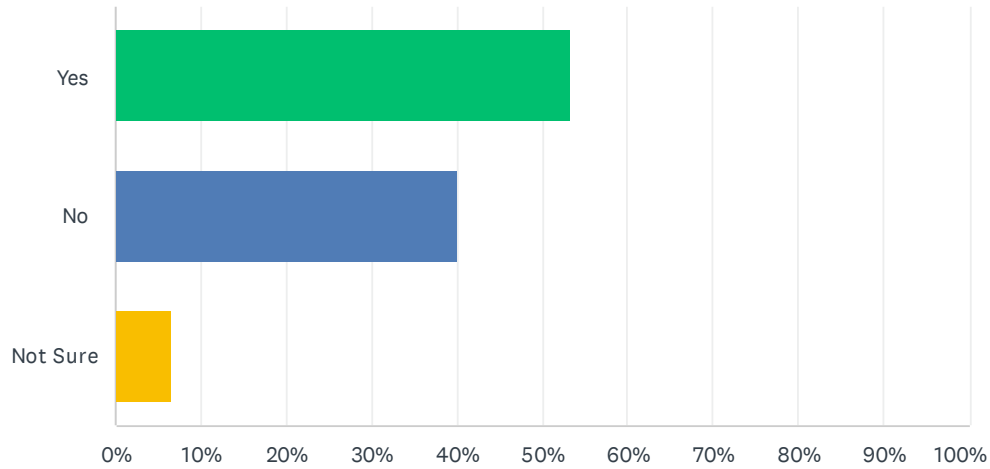
Answered: 15 Skipped: 0



ANSWER CHOICES	RESPONSES	
Trash in creeks	66.67%	10
Polluted streams	66.67%	10
Water color	26.67%	4
Wildlife and fish preservation	73.33%	11
Streambank conditions	66.67%	10
Volume of rain on streets or property	60.00%	9
Land development or population growth	60.00%	9
Not enough education about stormwater	13.33%	2
Total Respondents: 15		

Q7 Have you experienced impassable roads due to rain, ponded water on your property, or water damage in a building?

Answered: 15 Skipped: 0



ANSWER CHOICES	RESPONSES	
Yes	53.33%	8
No	40.00%	6
Not Sure	6.67%	1
TOTAL		15

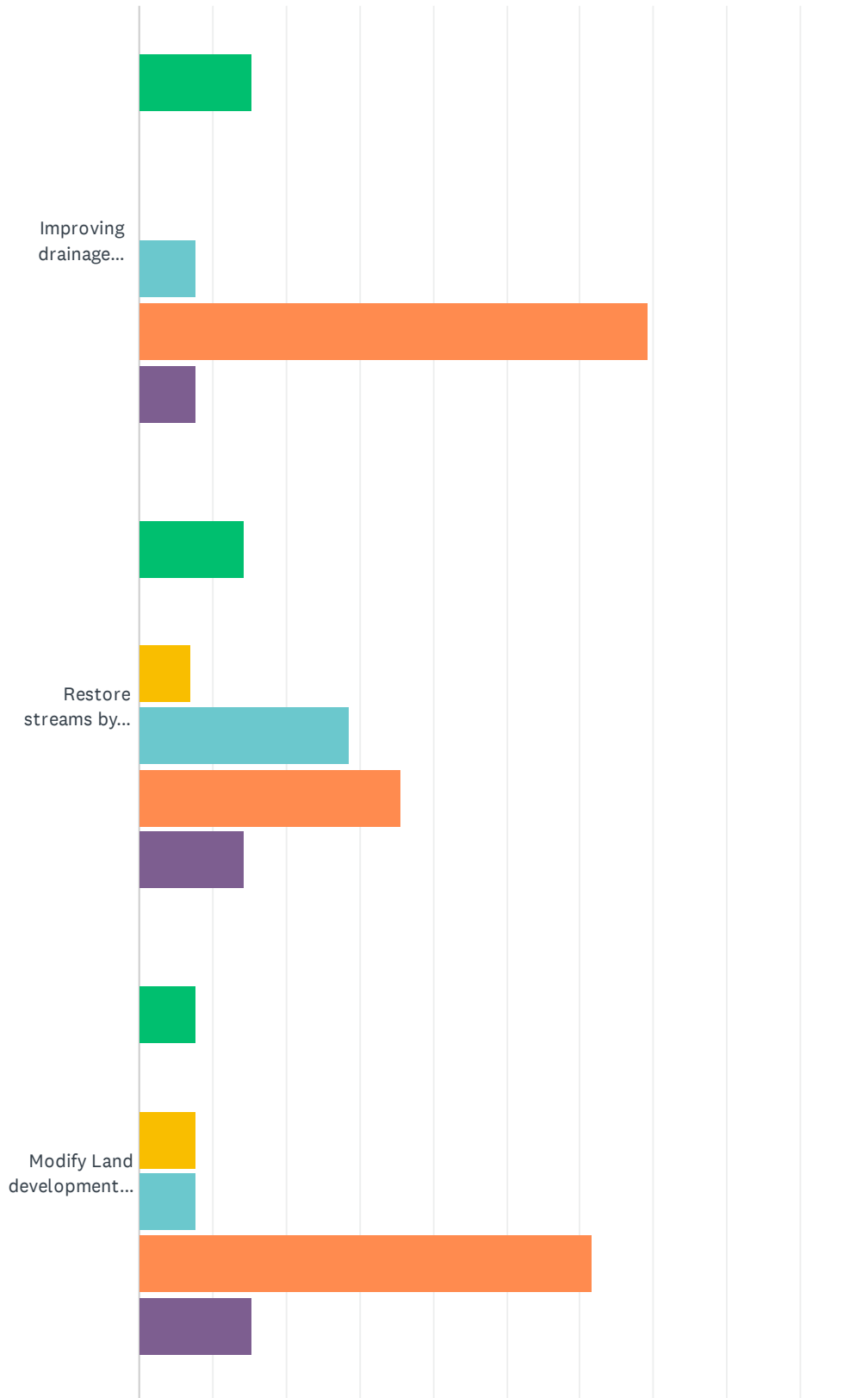
Q8 To the best of your knowledge, which areas have been impassable, accumulated rain in large volumes for days, or have experienced flood damage? Please be specific: include street names, intersections, neighborhood names, building names, etc.

Answered: 10 Skipped: 5

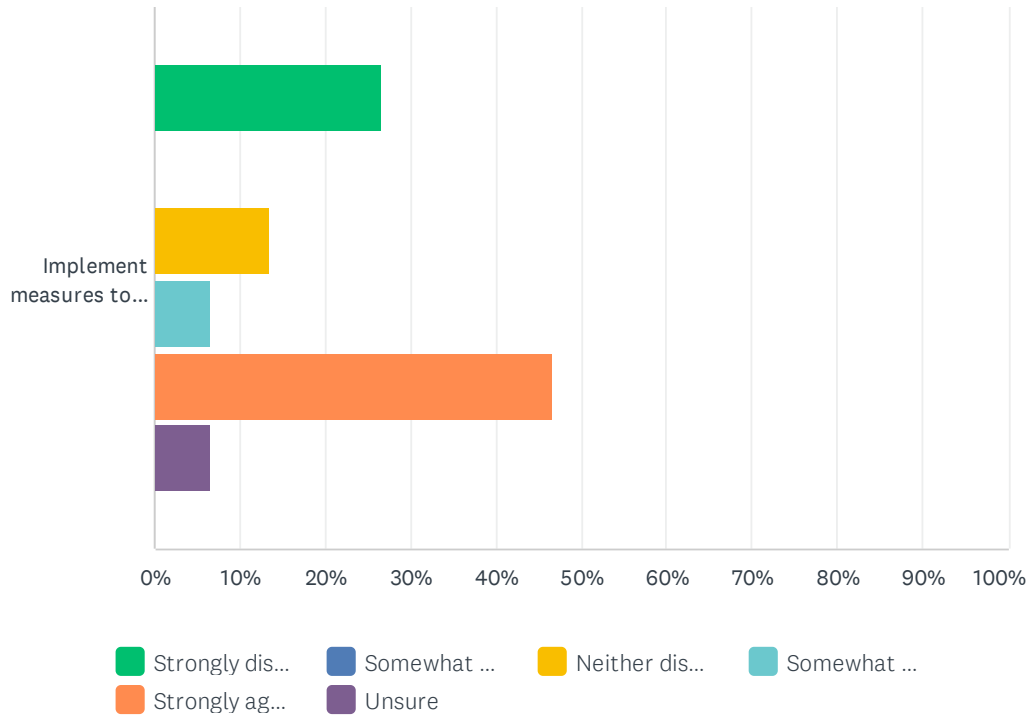
#	RESPONSES	DATE
1	My backyard turns into a 2 foot deep pool when there are heavy rains. Shelton Creek runs through the back of my property.	2/23/2024 12:56 PM
2	Camelot Drive, just before Georgia where a small creek run under the road, but has flooded over Camelot a few times in the past 5 years.	2/23/2024 12:02 PM
3	The intersection of Sulphur springs and 5th street.	2/23/2024 11:33 AM
4	Hazelwood Avenue and many other streets in the central area of the former town of Hazelwood. Stephanie Lane in the ThomasPark subdivision.	2/22/2024 11:01 PM
5	Little lane and brindle st-private residence and out buildings. Only one way in and one way out. Richland creek- both sides of creek flood properties	2/22/2024 6:53 PM
6	Waynesville Plaza	2/22/2024 6:51 PM
7	Shelton Branch on Oakdale Rd and Broad St.	2/22/2024 11:24 AM
8	Flooding occurs basement corner lot of Oakdale Road and Broad Street; runoff from street causing bank instability.	2/22/2024 10:57 AM
9	Willow rd between Farmers branch and the intersection of Longview rd.	2/13/2024 6:24 AM
10	Sulpher springs Georgia avenue	2/12/2024 1:41 PM

Q9 On the scale below, indicate your favorability towards each concept which can help reduce flooding risk and/or improve water quality.

Answered: 15 Skipped: 0



Waynesville Stormwater Survey



	STRONGLY DISAGREE	SOMEWHAT DISAGREE	NEITHER DISAGREE NOR AGREE	SOMEWHAT AGREE	STRONGLY AGREE	UNSURE	TOTAL	WEIGHTED AVERAGE
Improving drainage infrastructure	15.38% 2	0.00% 0	0.00% 0	7.69% 1	69.23% 9	7.69% 1	13	4.38
Restore streams by providing increased capacity for floodwater	14.29% 2	0.00% 0	7.14% 1	28.57% 4	35.71% 5	14.29% 2	14	4.14
Modify Land development ordinances	7.69% 1	0.00% 0	7.69% 1	7.69% 1	61.54% 8	15.38% 2	13	4.62
Implement measures to collect and treat stormwater such as rain gardens and permeable pavement	26.67% 4	0.00% 0	13.33% 2	6.67% 1	46.67% 7	6.67% 1	15	3.67

Q10 In your opinion, what could be done to improve stormwater management in the community

Answered: 12 Skipped: 3

#	RESPONSES	DATE
1	Expand and implement green infrastructure throughout community. Convert parking to more permeable surface everywhere possible.	2/26/2024 8:51 AM
2	Clean up the banks of Shelton Creek running from Pigeon Rd to East Street and help keep the water from pooling in my backyard and getting into my basement.	2/23/2024 12:56 PM
3	Increase water detention code for new construction, increase tree and shrub requirements to help absorb ground water, help homeowners with ways to collect and distribute rain water	2/23/2024 12:02 PM
4	Neighbors need to keep trash out of gulleys	2/23/2024 8:50 AM
5	Grind down old asphalt streets before repaving them. Many streets in town have been replaced so many times they are higher than the residents driveways and almost as high as the curbs along roads. Keep all storm drains clear of leaves and debris.	2/22/2024 11:01 PM
6	Stabilize creek beds Clean out ditches, culverts, and big box under streets	2/22/2024 6:53 PM
7	The DOT and the Town of Waynesville should work better together on all projects	2/22/2024 6:51 PM
8	Improve maintenance of roadways to better control runoff, causing erosion to stream banks.....leading to flooding issues. Better strategic planning regarding new developments. Just because there is empty land, does not mean we should build on it. Consider water issues first.	2/22/2024 11:24 AM
9	Better managing growth areas. As growth occurs, nothing is being done to improve drainage.	2/22/2024 10:57 AM
10	Stop golfers on Waynesville CC golf course from using Farmers branch as a toilet.	2/13/2024 6:24 AM
11	Clean the gutters, the gutters and storm drains are always filled with trash and debris. The leaves create a bed on the drains that then collects the soil run off which then blocks proper drainage. Leading to underperforming storm drains. Drive any of the main roads and you will see this problem. The streets are not properly draining the water, which leads to water sitting on the road causing pools that can cause accidents.	2/12/2024 9:37 PM
12	Upgrade the infrastructure replace some pipes that are old or to small	2/12/2024 1:41 PM

Q11 If you would like to stay connected with us as this project progresses, provide your name and email address below.

Answered: 11 Skipped: 4

ANSWER CHOICES	RESPONSES	
Name	100.00%	11
Company	0.00%	0
Address	0.00%	0
Address 2	0.00%	0
City/Town	0.00%	0
State/Province	0.00%	0
ZIP/Postal Code	0.00%	0
Country	0.00%	0
Email Address	100.00%	11
Phone Number	0.00%	0

#	NAME	DATE
1	Paul Carlson	2/26/2024 8:51 AM
2	Chris Scott	2/23/2024 12:56 PM
3	Thomas W Hale	2/23/2024 12:02 PM
4	Zach Misch	2/23/2024 11:33 AM
5	Joan Lio	2/23/2024 8:50 AM
6	Toby Hayes	2/22/2024 11:01 PM
7	Jean migliarini	2/22/2024 6:53 PM
8	Rick Boyd	2/22/2024 6:51 PM
9	Ralph Michael	2/22/2024 11:24 AM
10	Kristy	2/22/2024 10:57 AM
11	Christian	2/12/2024 9:37 PM

#	COMPANY	DATE
	There are no responses.	

#	ADDRESS	DATE
	There are no responses.	

#	ADDRESS 2	DATE
	There are no responses.	

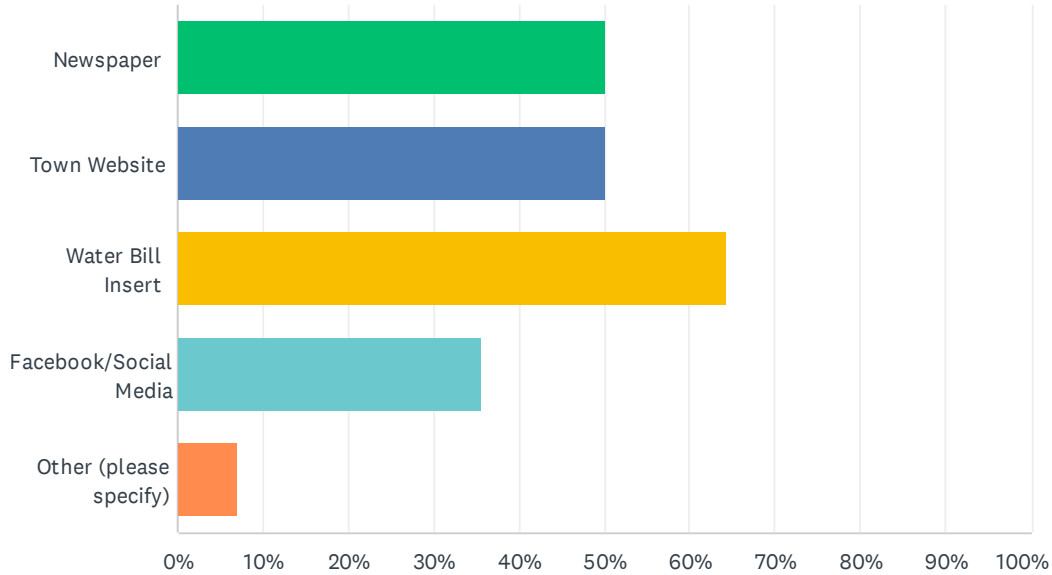
#	CITY/TOWN	DATE
	There are no responses.	

Waynesville Stormwater Survey

#	STATE/PROVINCE	DATE
	There are no responses.	
#	ZIP/POSTAL CODE	DATE
	There are no responses.	
#	COUNTRY	DATE
	There are no responses.	
#	EMAIL ADDRESS	DATE
1	carlsonforestry@gmail.com	2/26/2024 8:51 AM
2	wm2k@yahoo.com	2/23/2024 12:56 PM
3	tomandpat.hale@gmail.com	2/23/2024 12:02 PM
4	zach.misch@gmail.com	2/23/2024 11:33 AM
5	JoanLio@Yahoo.com	2/23/2024 8:50 AM
6	hayes28786@gmail.com	2/22/2024 11:01 PM
7	jeanmig05@yahoo.com	2/22/2024 6:53 PM
8	wrb2112@gmail.com	2/22/2024 6:51 PM
9	kr1779@msn.com	2/22/2024 11:24 AM
10	kristymichael4@gmail.com	2/22/2024 10:57 AM
11	ctwebb02@gmail.com	2/12/2024 9:37 PM
#	PHONE NUMBER	DATE
	There are no responses.	

Q12 Which is the following would be the information source you would look to for information about water quality and/or flooding?

Answered: 14 Skipped: 1



ANSWER CHOICES	RESPONSES
Newspaper	50.00% 7
Town Website	50.00% 7
Water Bill Insert	64.29% 9
Facebook/Social Media	35.71% 5
Other (please specify)	7.14% 1
Total Respondents: 14	

#	OTHER (PLEASE SPECIFY)	DATE
1	Email updates	2/22/2024 11:01 PM



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1. Check all the statements that best describe your status with the Town of Waynesville. I am a:

- Resident
- Employed in Town
- Property owner
- Business owner
- Other (please specify)

2. If you answered that you are a resident of Waynesville. How long have you lived in Waynesville?

- 0-5 years
- 6-10 years
- 11-15 years
- 16-20 years
- 21+ years

3. Do you use local bodies of water for recreational uses? If so, which of the following are applicable:

- Boating/Kayaking/ Canoeing/Paddleboarding/Tubing
- Fishing
- Swimming/Bathing
- Bird watching, Photography, or other water related naturalist hobby
- I don't use the local water bodies for recreational purposes.
- Other (please specify)

4. Name water bodies that you use for the purposes you specified above:

5. Do you ever avoid local water due to concerns about water quality?

Yes

No

6. Check all the statements that concern you.

Trash in creeks

Polluted streams

Water color

Wildlife and fish preservation

Streambank conditions

Volume of rain on streets or property

Land development or population growth

Not enough education about stormwater

7. Have you experienced impassable roads due to rain, ponded water on your property, or water damage in a building?

Yes

No

Not Sure

8. To the best of your knowledge, which areas have been impassable, accumulated rain in large volumes for days, or have experienced flood damage? Please be specific: include

street names, intersections, neighborhood names, building names, etc.

9. On the scale below, indicate your favorability towards each concept which can help reduce flooding risk and/or improve water quality.

	Strongly disagree	Somewhat disagree	Neither disagree nor agree	Somewhat agree	Strongly agree	Unsure
Improving drainage infrastructure	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Restore streams by providing increased capacity for floodwater	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Modify Land development ordinances	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Implement measures to collect and treat stormwater such as rain gardens and permeable pavement	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

10. In your opinion, what could be done to improve stormwater management in the community

11. If you would like to stay connected with us as this project progresses, provide your name and email address below.

Name

Email Address

12. Which of the following would be the information source you would look to for information about water quality and/or flooding?

- Newspaper
- Town Website
- Water Bill Insert
- Facebook/Social Media
- Other (please specify)

Done

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WAYNESVILLE PUBLIC MEETING NOTES

Date: 9/24/2025

Project: 23-0734 Town of Waynesville LASII Comprehensive Stormwater Master Plan

DISCUSSION

Presented on project development thus far explaining selection of study areas, existing condition study, concept design, and alternative strategies including green infrastructure and flood alert systems.

COMMENTS

What can be done with Waynesville Plaza off Russ Avenue which gets flooded?

Staff conveyed that the property is grandfathered into old rules and is not required to make any updates to the property. If the property were to make substantial improvements equivalent to 50% of the accessed value, then it would be required to comply with the floodplain ordinance.

Will the analysis consider land use and rainfall changes?

Yes, the concept design accounted for changing rainfall. The adjusted rainfall was taken from the NC RainDROP Tool which reflects emission scenarios and mitigation measures. The models take into account land use and will point out areas in which additional impervious area would add volume to the stormwater network.

Staff member expressed preference to protect headwaters streams and have a land conservation fund to buy properties.

Staff member requested that internal funding needs be accounted for in the Capital Improvement Plan. Overall, there needs to be a plan for funding maintenance crews and capital projects.

Staff member explained the concept of compensatory storage as a potential modification of the floodplain ordinance. Compensatory storage is the practice of offsetting new fill in the floodplain by excavating an additional floodable area to replace the lost flood storage area. The implementation of this practice would garner points for the National Flood Insurance Program (NFIP) community rating system (CRS) program. It was explained to the public that higher point values lessen the cost for homeowner insurance. The Town has done a cost-benefit analysis on implementing additional measures and a staff position to raise their CRS rating which has not demonstrated enough value.

Stormwater Master Plan

Town of Waynesville

September 24th, 2025



WithersRavenel

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Introductions and Contact Information

WithersRavenel

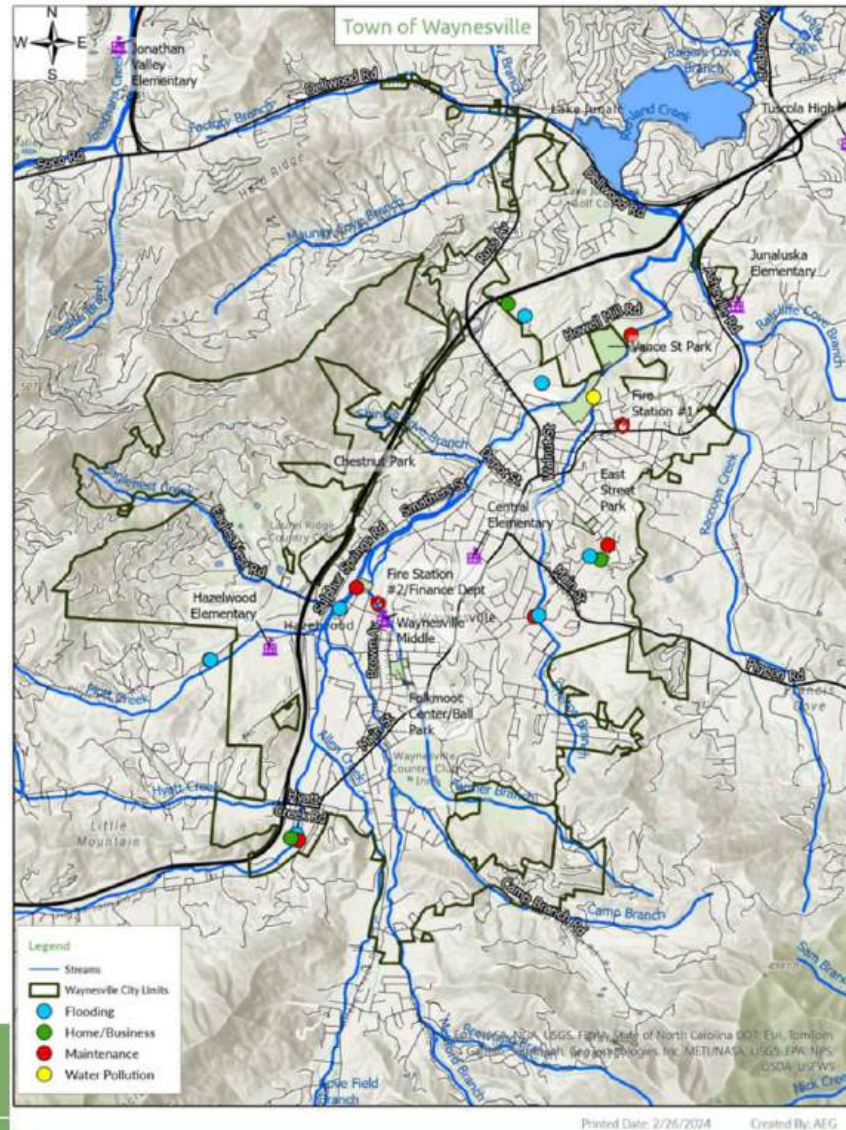
- Alisha Goldstein, PE
 - Assistant Project Manager
- Haley Valdez, PE, CFM
 - Assistant Project Manager

Town of Waynesville

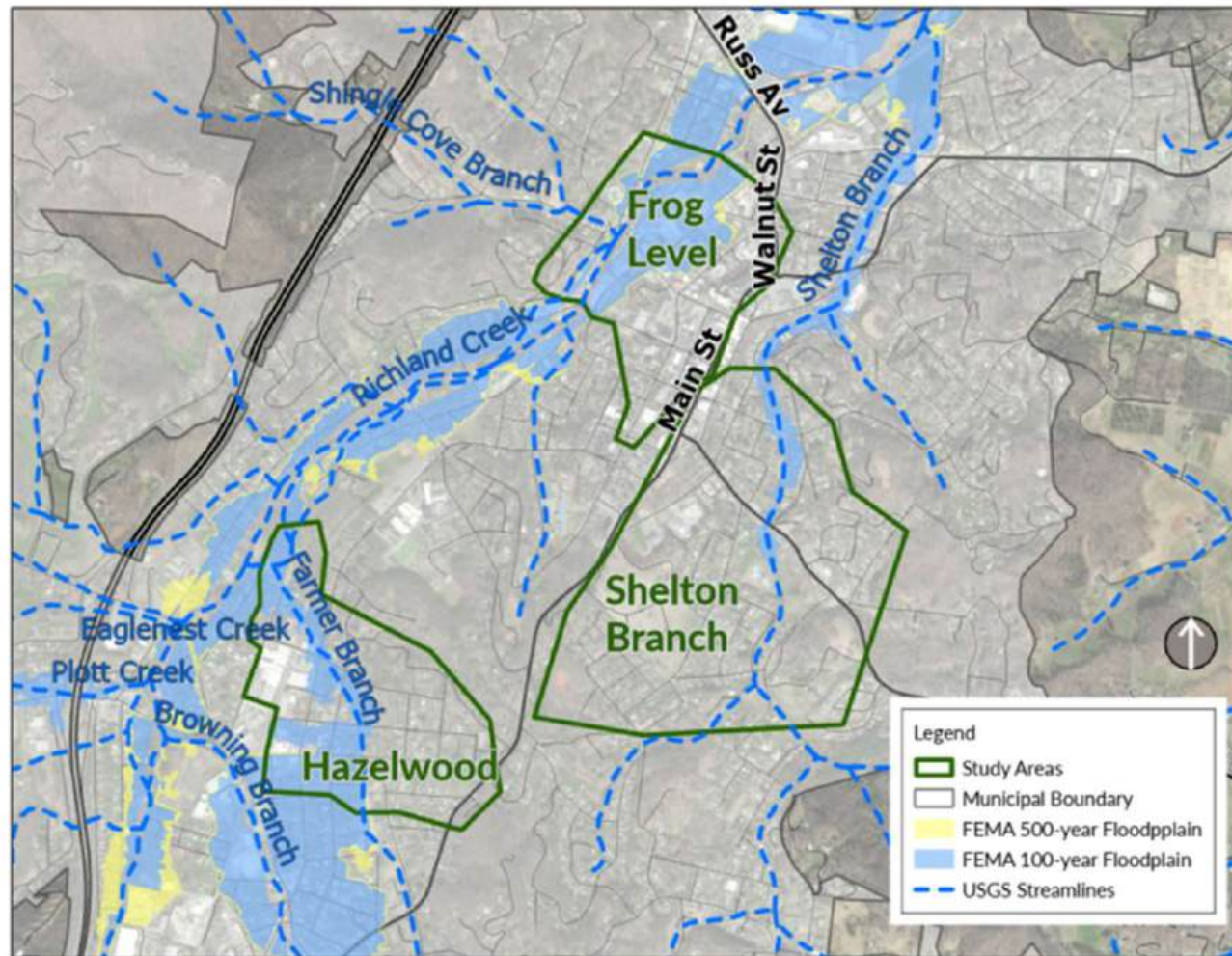
- Olga Grooman, MPA, CZO, CFM, CISEC, SCM I&M
 - Assistant Development Services Director
 - (828) 356-1172
- Elizabeth Teague, AICP, CTP
 - Development Services Director

Public Concerns

(February 22, 2024)



Study Areas



Printed Date: 9/11/2025

Created By: AGS

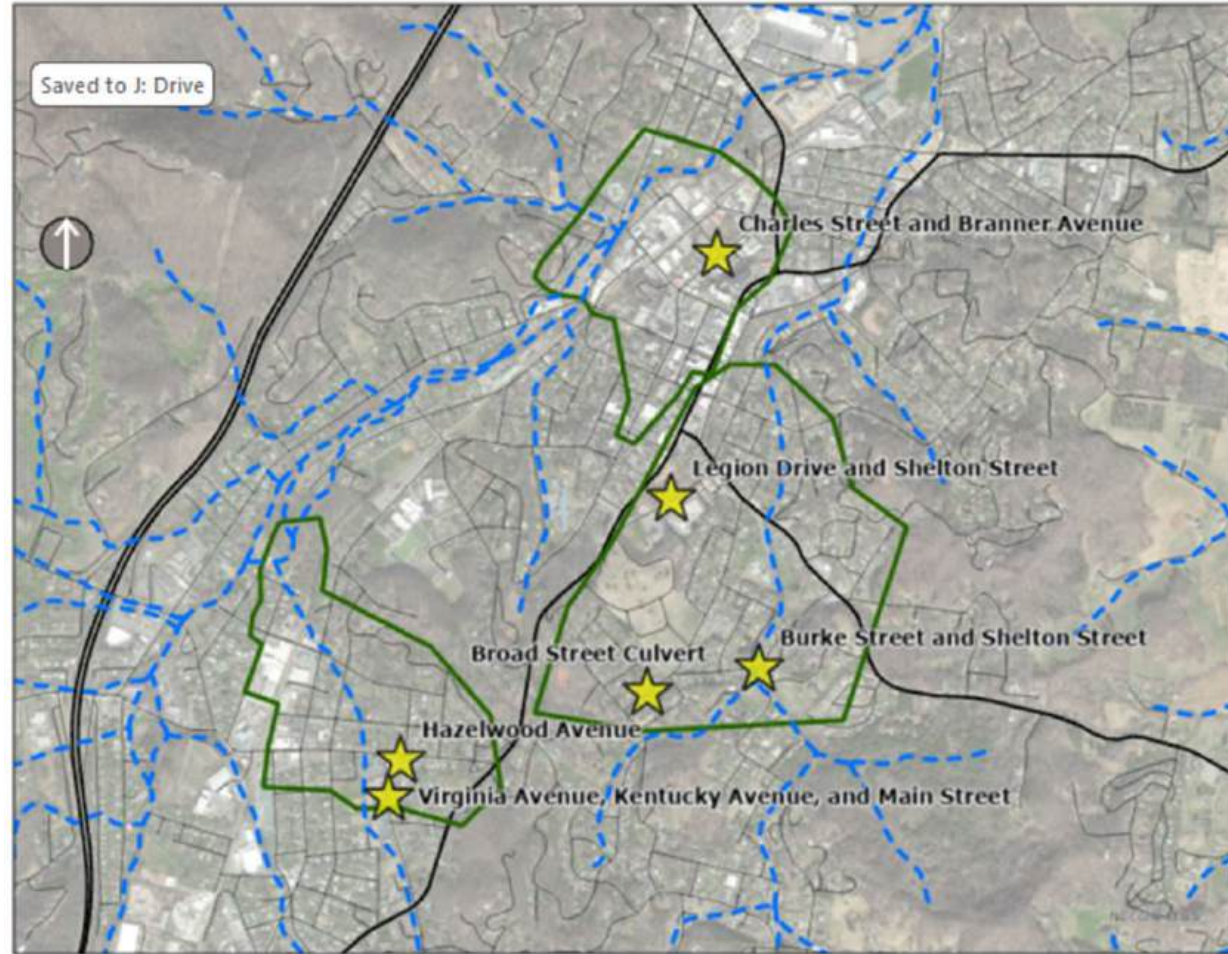
Existing Conditions



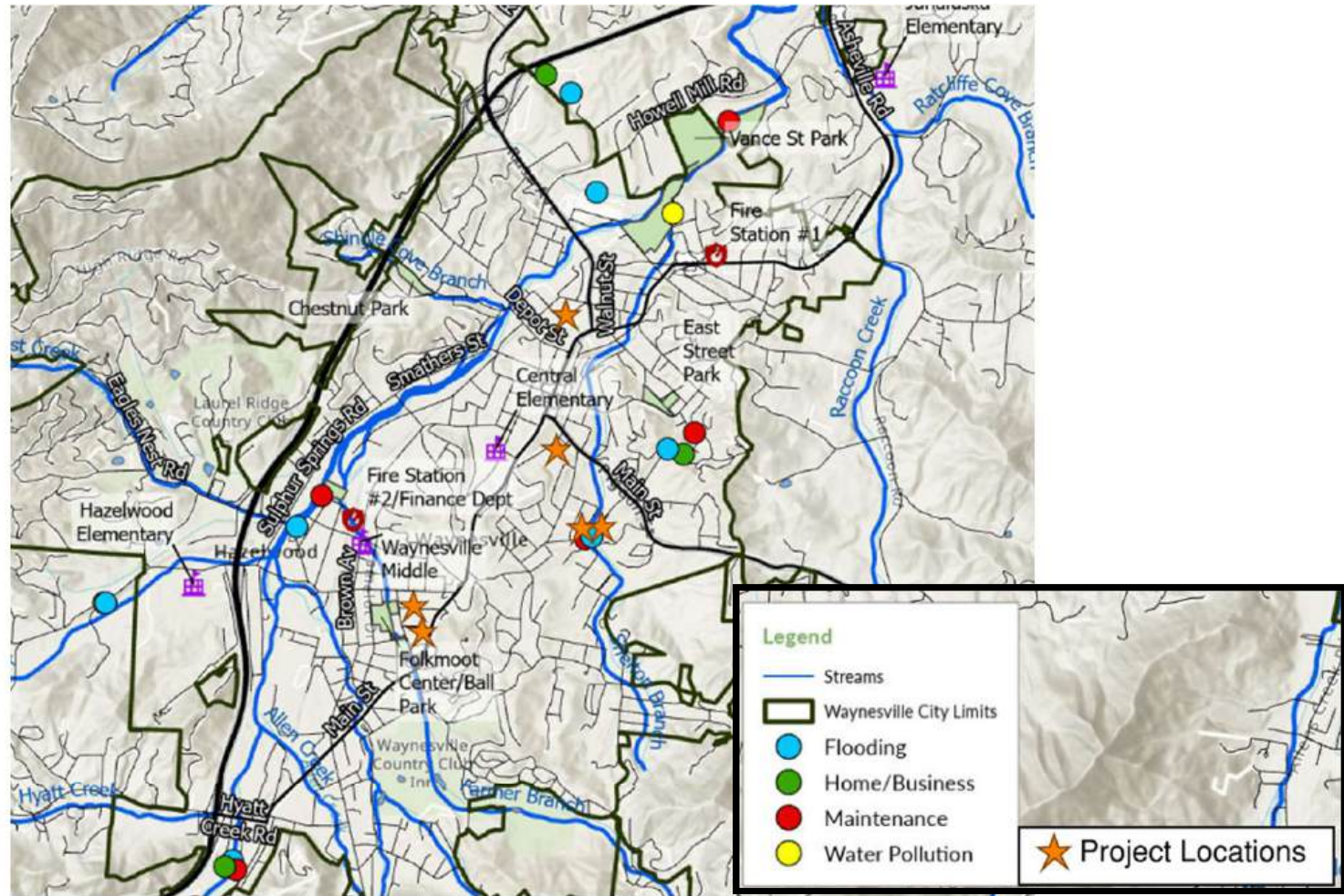
Timeline

- Identified 42 areas of concern
- Presented to Town Council on February 11, 2025
- Designed concept plans for 6 areas with town input

Concept Projects



Public Concerns



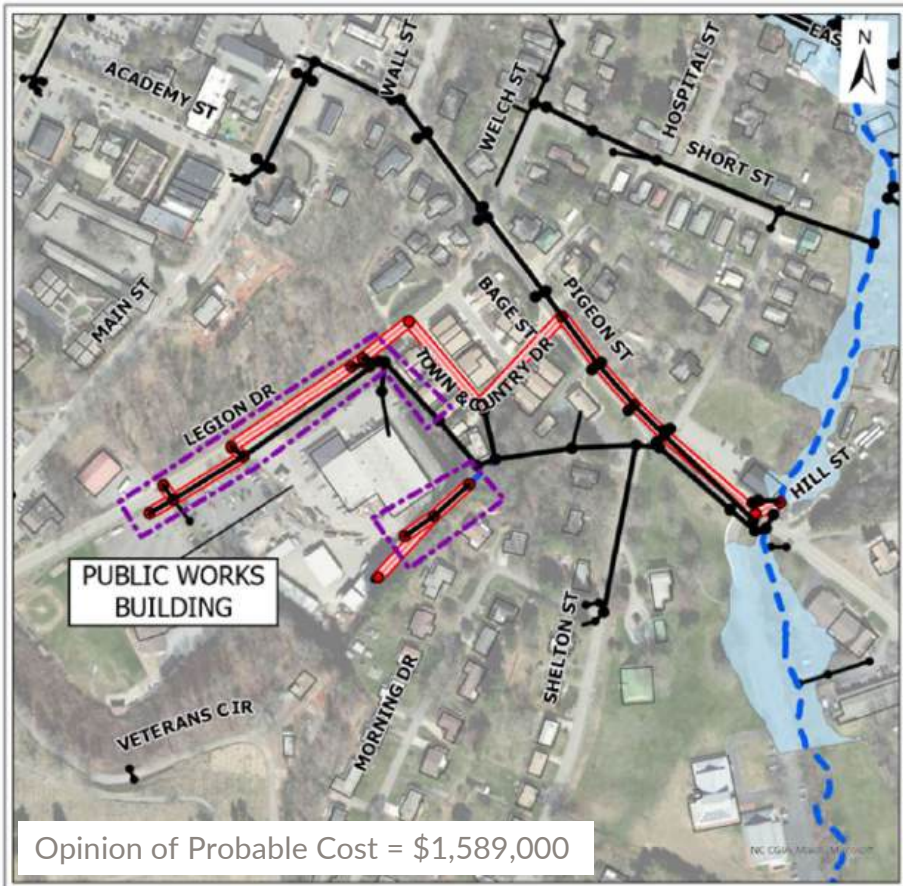
Rainfall Depths (inches)

NC State Climate RaInDROP Tool.

Storm Event	NOAA Atlas 14 (utilized in Existing Conditions)	RCP 4.5 (utilized in concept designs)
10-Year	4.56	4.84
25-Year	5.36	5.69
50-Year	6.01	6.44
100-Year	6.67	7.14

Discussion Items

- Concept design plans
- Flood alert system
- Green infrastructure



Opinion of Probable Cost = \$1,589,000

PROBLEM

- Limited capacity of the system
- Roadway flooding on Legion
- Ponding behind Public Works

SOLUTION

- Upsizing pipes
- Replacing structures
- Realigning pipes to within ROW

BENEFITS

- Reduction of roadway flooding
- Reduction of ponding
- Infrastructure in ROW

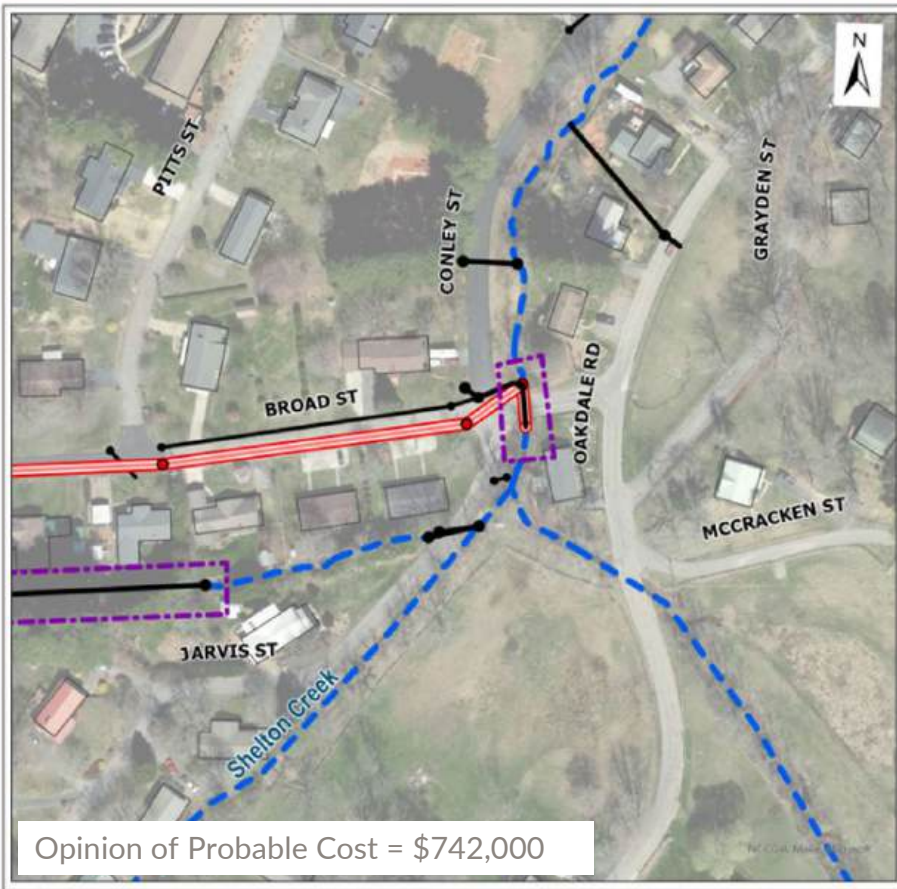
LEGEND

- Existing Pipes
- Inlets/Manhole
- - - Open Channels/Streams
- Railroads
- 100-year FEMA Floodplain
- 500-year FEMA Floodplain
- Structures
- Area of Concern
- Proposed Pipes and Structures

Legion Drive & Shelton Street

Waynesville LASII Stormwater Master Plan





Opinion of Probable Cost = \$742,000

PROBLEM

- Roadway flooding
- Backwater impacts
- Publicly identified flooding

SOLUTION

- Upsizing to dual culverts to fit channel width and roadway

BENEFITS

- Reduction of roadway flooding on Oakdale Road
- Positive Drainage

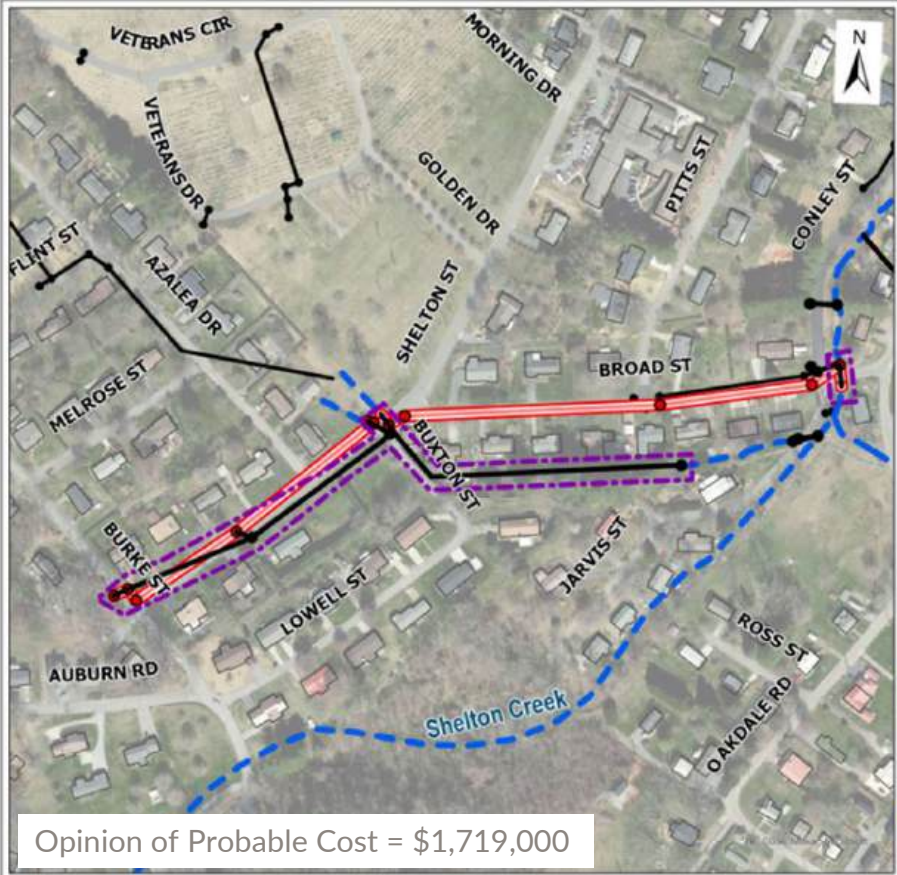
LEGEND

- Existing Pipes
- Inlets/Manhole
- Open Channels/Streams
- Railroads
- 100-year FEMA Floodplain
- 500-year FEMA Floodplain
- Structures
- ▭ Area of Concern
- Proposed Pipes and Structures

Broad Street Culvert

Waynesville LASII Stormwater Master Plan





PROBLEM

- Limited capacity of the system
- Roadway flooding
- Pipe underneath homes

SOLUTION

- Upsizing pipes
- Replace structures
- Reroute system to Broad Street

BENEFITS

- Reduction of roadway flooding along Shelton Street
- Easier maintenance of pipe in ROW

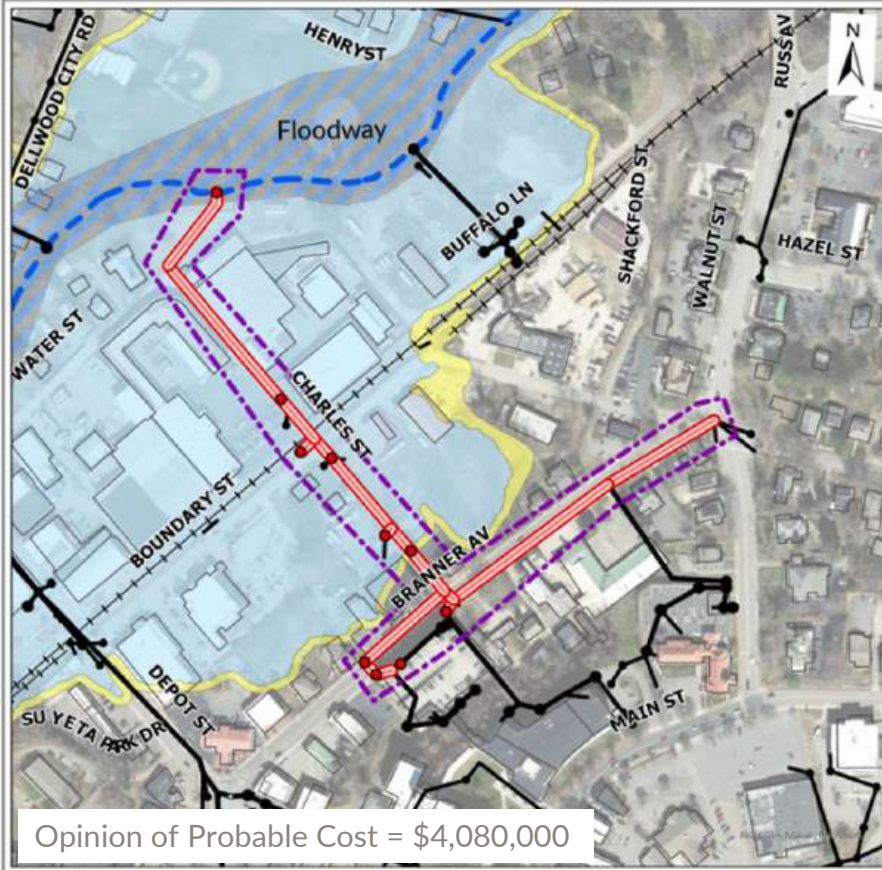
LEGEND

— Existing Pipes	100-year FEMA Floodplain
● Inlets/Manhole	500-year FEMA Floodplain
— Open Channels/Streams	Structures
— Railroads	Area of Concern
	Proposed Pipes and Structures

Burke Street & Shelton Street

Waynesville LASII Stormwater Master Plan





PROBLEM

- Limited capacity of the system
- Roadway flooding
- Negative pipe slopes
- Old clay pipes

SOLUTION

- Upsizing pipes
- Replacing structures

BENEFITS

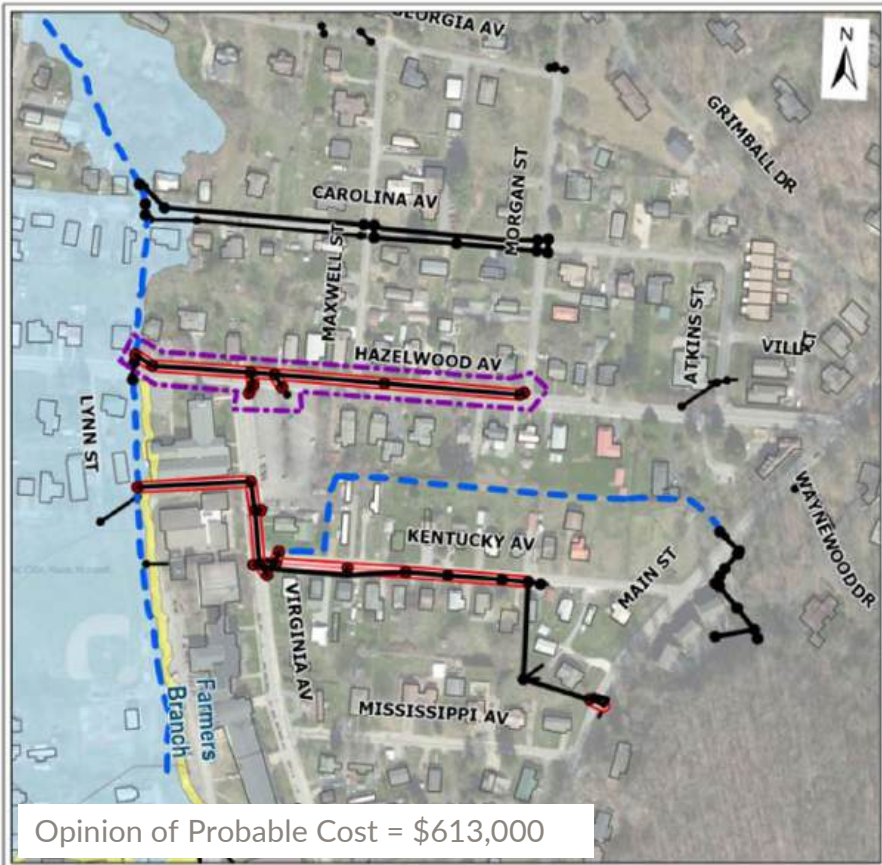
- Reduction of roadway flooding on Branner Avenue and Charles Avenue
- Positive Drainage

LEGEND

100-year FEMA Floodplain	500-year FEMA Floodplain
Existing Pipes	Structures
Inlets/Manhole	Area of Concern
Open Channels/Streams	Proposed Pipes and Structures
Railroads	

Charles Street & Branner Avenue Waynesville LASII Stormwater Master Plan





PROBLEM

- Limited capacity of the system
- Roadway flooding

SOLUTION

- Upsizing pipes
- Replacing inlets along Hazelwood and at intersection with Virginia Avenue

BENEFITS

- Reduction of roadway flooding

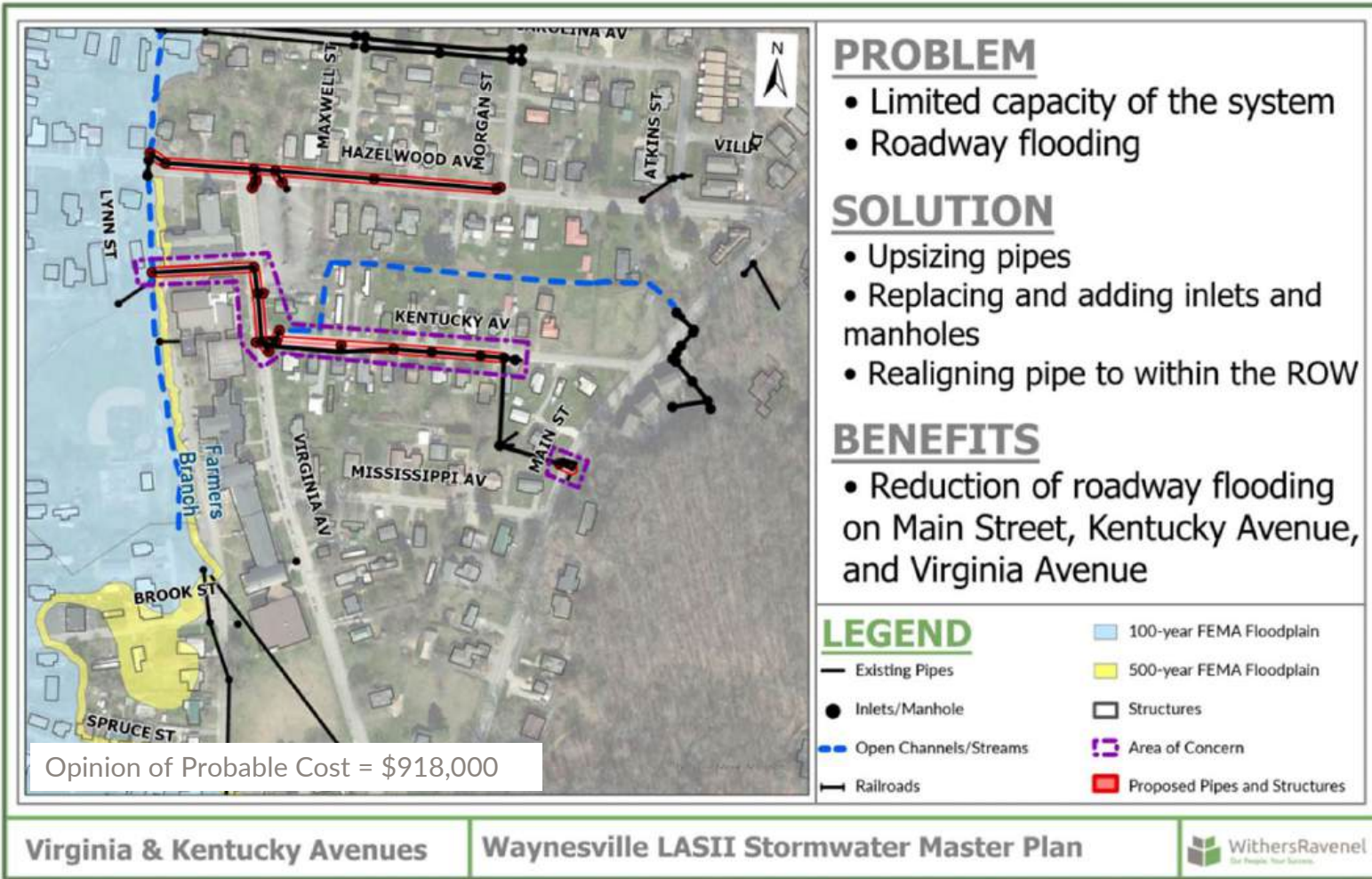
LEGEND

- Existing Pipes
- Inlets/Manhole
- Open Channels/Streams
- Railroads
- 100-year FEMA Floodplain
- 500-year FEMA Floodplain
- Structures
- Area of Concern
- Proposed Pipes and Structures

Hazelwood Avenue

Waynesville LASII Stormwater Master Plan





PROBLEM

- Limited capacity of the system
- Roadway flooding

SOLUTION

- Upsizing pipes
- Replacing and adding inlets and manholes
- Realigning pipe to within the ROW

BENEFITS

- Reduction of roadway flooding on Main Street, Kentucky Avenue, and Virginia Avenue

LEGEND

— Existing Pipes	100-year FEMA Floodplain
● Inlets/Manhole	500-year FEMA Floodplain
— Open Channels/Streams	Structures
— Railroads	Area of Concern
	Proposed Pipes and Structures

Virginia & Kentucky Avenues

Waynesville LASII Stormwater Master Plan





Photo by Laura Hackett from BPR (August 28, 2025)



Photo from The Mountaineer (August 6, 2025)

South Haywood County Example

- Began install summer 2025 and expected to be completed in early 2026
- 18 outdoor warning sirens placed in flood-prone areas
- Activated by river level data or manually by emergency management
- Generally heard up to half a mile away

PROBLEM

- Predicting flooding with respect to timing and impact
- Inadequate flood warning

SOLUTION

- Real-time alerts using sensors
- Regional system or specific locations
- Local coordination or integrate statewide

BENEFITS

- Emergency planning
- Improve public safety

EXAMPLES

Structural Practices

- Rain gardens
- Pervious pavement
- Downspout disconnect
- Bioswales



Photo of the Haywood Arts County cistern and rain garden from The Mountaineer (December 10, 2022)

Site Design and Layout

- Ordinance
- Design Manuals



Photo of the Peterson Street Linear Bioretention Area in Raleigh, NC

New land use adopted in Waynesville 2035 Comprehensive Land Use Plan



Residential Conservation

Best suited for low density residential development that is clustered or of a conservation design. Generally these areas contain steep slopes and / or working agricultural lands. These areas may have narrow streets and may or may not to be connected to water and sewer utilities. Low Impact Development (LID) techniques should be encouraged to reduce stormwater runoff and development should be clustered away from resources.

PROBLEM

- Limited infiltration in urban areas
- Localized ponding

SOLUTION

- Disconnect impervious surfaces
- Protect and/or restore natural hydrology

BENEFITS

- Integrated with traffic calming
- Mitigate urban heat island
- Adds resiliency

CONSIDERATIONS

- Maintenance
- Public safety
- Density of practices

Green Infrastructure

Waynesville LASII Stormwater Master Plan

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Next Steps

- Capital Improvement Plan
- Ordinance Recommendations
- Stormwater Master Plan

To note, there are other stormwater projects that the Town has identified.

Appendix I: Town Comments on Draft Stormwater Master Plan

Olga's Comments:

1. **Executive Summary:** project areas 5-6 do not have rough estimates.
2. **Introduction:** add language that floodplain runs through many urbanized, densely developed, older areas of the town with old infrastructure.
3. **Section 2.1- Public Works, 1st paragraph:** add language that during the audit in 2025, staff were informed that the facility needs its separate NPDES permit and should conduct a periodic water testing at the outfall to ensure no illicit discharges are going into the middle drain. The facility since then has secured the permit. Laura secured NPDES permit for the public works facility.
4. **Discuss 8.1, 2nd paragraph**
5. FEMA is currently updating the preliminary floodplain maps for the County.
6. Discuss ordinance suggestions 10.4 and 10.5.
7. Talk about the raingarden- the Town plans to get rid of it.
8. Page numbers are missing.

Goldstein, Alisha

From: Elizabeth Teague <eteague@waynesvillenc.gov>
Sent: Wednesday, February 11, 2026 2:46 PM
To: Olga Grooman; Goldstein, Alisha
Subject: [EXTERNAL] Stormwater Plan comments

CAUTION: This email originated from outside of WithersRavenel. Do not click links or open attachments unless you recognize the sender and know the content is safe.

My comments:

Glossary - Add note with links at end:

Other definitions can be found in the [Stormwater Design Manual | NC DEQ](#), and the Town of Waynesville Land Development Standards, Chapter 17, [Ordinances and Permits | The Town of Waynesville, NC](#)

- 1.1: 2nd paragraph – add “**the Richland Creek Watershed**”
- 2.2: Update last paragraph based on recent repair work and pipe installation after Helene damage (?)
- 2.4 End of 1st paragraph... “**This culvert should be replaced, and the rain garden removed.**” Then strike last paragraph.
- 6.2 Add sentence at end of paragraph. “**Additional areas of concern not included in the study are listed in Appendix F as identified by Public Works staff.**”
- 7.2 What is the recommendation on the design storm? Keep the same as now or adjust? (Address in Section 10?)
- 10.5 Correct: 2nd paragraph...**Ordinance Suggestions: Evaluate fill allowances within the floodplain**

Thank you-
ET

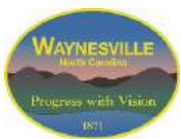
Elizabeth Teague, AICP, CTP | Development Services Director

Town of Waynesville, NC
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Stormwater Master Plan – Director Recommended Revisions and Inserted Language

Prepared by: Ricky Bourne, Director of Public Works

Date: February 9, 2026

This document provides specific, implementation-focused feedback on the Stormwater Master Plan along with recommended replacement or supplemental language. Suggested text is written to be inserted directly into the plan and identifies where each revision should occur. These revisions are intended to strengthen clarity, defensibility, and long-term municipal usability.

1. Executive Summary – Decision Framing

Location in Plan: Executive Summary (Page 5)

Issue: The Executive Summary summarizes technical work completed but does not clearly frame how the plan should be used by Town leadership for capital planning and funding decisions.

Recommended Insert (add near end of Executive Summary):

“This Stormwater Master Plan is intended to serve as the Town of Waynesville’s primary stormwater capital planning and grant-support document for the next 10 to 15 years. The conceptual projects identified herein provide a framework for prioritizing future design, pursuing external funding, and reducing flood risk to public infrastructure, private property, and critical facilities.”

2. Stormwater GIS Inventory and Asset Ownership

Location in Plan: Section 3 – Stormwater Asset Inventory & GIS Data Characterization

Issue: The plan does not explicitly state how the GIS inventory will be maintained or used beyond this study.

Recommended Insert (new subsection at end of Section 3):

“The stormwater asset inventory developed as part of this study is intended to serve as the Town’s authoritative stormwater asset registry. The dataset should be maintained within the Town’s GIS environment and updated as capital projects are completed, development projects are reviewed, and system improvements are constructed. Ongoing maintenance of the dataset will support asset management, regulatory compliance, and future planning efforts.”

3. Modeling Limitations and Intended Use

Location in Plan: Section 5 – Existing Conditions Hydrologic and Hydraulic Analysis

Issue: While modeling assumptions are described, the planning-level intent should be reinforced.

Recommended Insert (end of Section 5):

“Hydrologic and hydraulic modeling results presented in this plan are intended for planning and prioritization purposes. Final pipe sizing, grades, alignments, and construction feasibility will require detailed field survey, utility coordination, and engineering design prior to implementation.”

4. Concept Project Implementation Considerations

Location in Plan: Sections 7.4 – 7.10 (Concept Projects)

Issue: Concept projects focus primarily on hydraulic performance without explicitly addressing implementation considerations.

Recommended Insert (standard paragraph to add to each concept project):

“Implementation of this conceptual project will require further evaluation of right-of-way availability, utility conflicts, maintenance access, and construction impacts. These factors will be addressed during subsequent design phases and may influence final project limits, cost, and schedule.”

5. Cost Opinions and Risk Disclosure

Location in Plan: Sections 6.2 and 7 (Cost Tables)

Issue: Cost opinions are appropriate but should more clearly identify risk factors.

Recommended Insert (preceding cost tables):

“Opinions of probable cost are provided for planning purposes only and are subject to refinement. Final construction costs may vary due to market conditions, inflation, utility relocation requirements, right-of-way or easement acquisition, and final design decisions.”

6. Capital Improvement Plan – Policy Alignment

Location in Plan: Section 8 – Capital Improvement Plan

Issue: CIP prioritization criteria should be more explicitly stated.

Recommended Insert (opening paragraph of Section 8):

“Capital improvement projects were prioritized based on flood risk reduction, protection of public infrastructure and facilities, severity and frequency of flooding impacts, and readiness for external grant funding.”

7. Ordinance and Design Standards – Implementation Path

Location in Plan: Section 10 – Stormwater Conveyance Standards

Issue: Ordinance recommendations lack implementation guidance.

Recommended Insert (end of Section 10):

“Recommended ordinance and design standard updates should be considered through the Town’s established development ordinance update process, including coordination with Planning staff, the Planning Board, and legal counsel prior to adoption.”

Laura Yonkers Comments on Stormwater Master Plan

2.1 Recommend installation of an oil/water separator upstream of the outfall. Additionally, recommend verification that only one outfall exists, consistent with DEQ guidance. The northeast catch basin location is questionable and should be confirmed as either connected to the storm sewer system or discharging to the adjacent ditch.

5. All new and proposed flood modeling should be submitted to FEMA for flood map updates. Future projects should be required to include flood modeling, with results provided in a format acceptable to FEMA. Recommend that future flood modeling include 10-year storm analysis, consistent with Table 7.

7. Cost estimates appear low. The proposed pipe systems are designed to convey a 10-year, 24-hour storm; however, clarification is needed regarding proposed roadway elevations. What elevations are the roads being raised to, if any? These projects will likely require full roadway reconstruction. Based on existing roadway elevations, determine whether raising the roadways is necessary to meet design criteria.

8.3 Land and easement acquisition costs should be included in proposed and future projects and reflected in the stormwater fee.

10. If we are updating the **Ordinance**, please consider the following:

- Structures proposed to be located within the pavement area shall be outside the vehicle wheel path when possible

- Stormwater service connections shall be permitted only for projects connecting to a County maintained roadway system for which positive drainage to a point of positive outfall exists. The permitting of the stormwater connection may require construction of all necessary conveyance facilities and establishment of any easements necessary for the operation and maintenance of the drainage facilities.

-Onsite stormwater inlets shall include a 2-foot slump at the base to prevent sedimentation downstream.

- All discharge structures, shall include a baffle system to encourage discharge from the center of the water column rather than the top or bottom. The baffle system shall include a skimmer or other approved mechanism suitable for preventing oil and grease from discharging from retention and detention areas, as required. Any required baffle systems shall be designed so as to not impact the discharge structure's hydraulic capacity.

-All discharge to the County right-of-way up to the 25-year | 24-hour storm shall be through an approved, onsite control structure with a piped connection to either an adjacent storm sewer or roadside drainage ditch. (Berm height)

-Unless the permittee provides satisfactory evidence of a specific allocation of discharge from the lot in the County-approved design of an existing roadway drainage system, the following onsite storage requirements and discharge limits shall apply:

- i. The peak discharge rate from the 3-year I 24-hour storm shall not exceed the existing peak discharge to the right-of-way. The peak discharge shall be based upon the total site area and shall be based upon an assumed tailwater elevation equal to the static water surface elevation (i.e. elevation at zero inflow) in the roadway storm sewer at the point of connection;
- ii. The peak discharge rate for the 25-year I 24 hour storm shall not exceed the lesser of the existing peak discharge from the total side area for the same storm or the allowable peak discharge rate established by the agency with jurisdiction over the receiving water body providing outfall to the County roadway drainage system. The discharge rate shall be based upon a tailwater elevation equal to the static water surface elevation (i.e. elevation at zero inflow) in the roadway storm sewer at the point of connection;
- iii. The onsite peak elevation due to a 3-year I 24-hour storm shall be no higher than the design hydraulic grade line elevation of the roadway system for the same storm, at the point of connection. iv. Where design information is not available, the design hydraulic grade line shall be assumed to be 1-foot below the inlet (grate or throat) elevation of the inlet structure immediately upstream from the point of connection;
- v. The proposed stormwater management system shall be designed to recover the runoff volume generated by the 25-year I 24 hour storm event within 5 days after the cessation of the storm event.

Table 22 – “produces a minimum velocity of 2.5fps an a maximum velocity of 8 fps when flowing full.

Concept project 1 – shows pipes that are currently thought to be tied to sewer, upgraded and tied to stormwater. No BMPs proposed.

PW Staff Stormwater Priorities (after Appendix F) –

21. Plaza – Pipe is failing and needs to be upsized.
22. Blueberry Dr – Pipe is starting to fail. Lot flooding is visible.
23. Locust Dr (Catch Basin) – Starting to Collapse
24. Chestnut Park Retirement Home – Pipe is failing and needs to be upsized. Washing out of the bank is visible.
25. Lansing Road - Pipe is failing and needs to be upsized. Undermining roadway and washing out of the bank is visible.