


CENTRAL ASHEVILLE WATERSHED RESTORATION PLAN





Submitted to:

RIVER LINK
EXPERIENCE. LEARN. CONSERVE.

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Foreword

Waters Used, Abused and Forgotten

The area of Asheville that we call the Central Asheville Watershed (see Figure 1) contains streams that over the past three centuries have been used and abused and now, for most of the community, lie forgotten. These streams have long sustained our life and commerce, they continue to do so today even in their neglected and forgotten state. Buried in pipes and large tunnels beneath our buildings, roads, and parking lots, these streams carry stormwater that runs off our property, keeping our homes, businesses, parks, and roads from flooding. They also carry all the refuse, chemicals and pathogens that are part of urban living. Perhaps we are fortunate that so much of the original streams are out of sight and out of mind. Even in the remaining reaches of these streams that see daylight and experience the open breezes and the falling rain and snow, we have pulled away. We seem to prefer these streams to deliver our runoff, and our toxic mix of refuse, to the French Broad River without our having to acknowledge the condition they are in. Will that be our legacy? Alternatively, will we respect, perhaps even celebrate, the remaining open reaches of these streams? Will we learn to view them as valuable resources, adding to our quality of life and giving our children places to enjoy and learn about water and the life that it sustains? It is our choice. Let us make it a conscious choice, not a choice by remaining uninformed and neglectful.

RiverLink has been developing plans, building coalitions, and taking action to protect and improve the French Broad River and other waters in the French Broad Basin for over 30 years. They commissioned this study to find ways to restore, to the fullest feasible extent, the streams that drain from this watershed, through the River Arts District and into the French Broad. The goals of the project go far beyond finding technical, or "engineering," measures to improve water quality, including:

- Listening to community residents,
- Identifying the purposes and achievable objectives of watershed restoration,
- Finding those who share in the mission and will "chip-in" to achieve it,
- Building an understanding of the current state of the watershed and how it is changing,
- Recommending changes in government policies, infrastructure maintenance and other measures that will lead to better water quality and ecological restoration of the streams,
- Fostering the creation of "green" jobs and social equity,

This report documents the findings and recommendations for a Central Asheville Watershed Restoration Plan (CAWRP). Its purpose is to summarize what has been learned about the watershed, its residents, challenges, and opportunities; to establish a foundation on which a useful watershed restoration program can be built; and to document ways in which communities and organizations across the watershed can collaborate to restore and protect Asheville's waters and sustain Asheville's neighborhoods.

Acknowledgements

This report was prepared for RiverLink (www.RiverLink.org) by Blue Earth Planning, Engineering and Design (www.blueearth.us) with funding provided by the North Carolina Clean Water Management Trust Fund (www.cwmtf.nc.gov) and the Community Foundation of Western North Carolina - Pigeon River Fund (https://cfwnc.org/grantseekers/pigeon-river-fund). Renee Fortner served as RiverLink's project manager. She not only provided the leadership necessary to successfully complete the project but, also, never hesitated to provide direct support for field work, obtaining input from the numerous stakeholders, and analyzing the project findings and recommendations.

Blue Earth understood this to be a more complicated project than the usual watershed restoration plan. We were fortunate to assemble a broad team of consultants to assist in developing the plan, including:

- Wildlands Engineering (www.Wildlandseng.com)
- Headwater Environmental, Inc. (www.headwaterenvironmental.com)
- Ecosystem Services Engineering (www.ecosystemservices.us)
- FrontWater, LLC (www.FrontWater.com)
- SiteworkStudios (www.siteworkstudios.com)
- Penrose Environmental Consulting (www.penrose.consulting)
- Reece Environmental Services (www.reeceenvironmental.com)

This team brought a diverse and deep level of expertise to the project and consistently demonstrated dedication to Asheville, its neighborhoods and to restoring water quality, public health and safety, and a healthy aquatic ecosystem to the watershed. It was a privilege to work with them.

The NC Department of Environmental Quality – Division of Water Resources provided substantial aid to this project by providing advice, assisting with water quality sampling, providing supplies and laboratory services, and by having a stream assessment team perform an assessment of Town Branch. Their assistance was a significant contribution to the successful completion of this restoration plan.

There are too many additional stakeholders who supported this project to properly acknowledge in this space. City departments, utilities, non-profit organizations concerned with environmental quality and social and economic equity, and many individuals devoted time to attend meetings, contribute data, respond to inquiries, assist with field assessments, review potential projects, and contribute in numerous ways. Their continued commitment will ensure that the Central Asheville Watershed Restoration Plan is not placed on a shelf but is studied, adapted, and implemented.

Blue Earth submits this report to RiverLink to document the project findings and recommendations. Any errors or omissions are the sole responsibility of Blue Earth.

Introduction

The Central Asheville Watershed Restoration Plan was undertaken to explore water quality and habitat issues within three streams that flow through this just over 2 sq. mile area, and empty into one of the most heavily used sections of the French Broad River (see Figures 1 and 2).

The watershed includes a significant portion of Asheville's central business district south of Interstate 240, west of Beaucatcher Mountain and north of the Swannanoa River. In general, the watershed is quite steep with elevations ranging from over 2500 feet on Beaucatcher Mountain to 1960 feet along the banks of the French Broad River. The watershed's central region is highly developed with an aggregate impervious percentage of nearly 45%, some areas exceeding 95%. Throughout much of this area the historical streams have been filled and drainage is achieved through an extensive, and mostly quite old, collection of pipes and tunnels. Remnants of the open channel system exists primary in the watershed's eastern uplands and its lower reaches. Figure 2 displays the significant open channel reaches in the watershed as bold blue lines. In that figure, the light blue lines show the alignment of major components of the City's storm water collection system. The pipes displayed range from 24" diameter storm sewers to 10' by 8' drainage tunnels.

Figure 3 presents the current Asheville city limits and zoning. The City contains approximately 45.3 square miles, has over 68 identified neighborhoods and 54 public parks. The study area lies near the geographic centroid bounded by the downtown central business district and Interstate 240 on the north and the Asheville-Buncombe Technical Community College campus on the south. The CAW supports a disproportionate volume of the business and economic activity and its residential neighborhoods have densities and diversities well above the City's average.

The watershed's streams include: Town Branch, Bacoate Branch, and Haith Branch (previously referred to simply as an unnamed tributary of the French Broad River). Town Branch is one of the most polluted streams in Buncombe County, based on water quality testing conducted by the Environmental Quality Institute's Volunteer Water Information Network (VWIN) Program and the French Broad RiverKeeper. Prior to this study, there was little publicly available data on water quality in the other streams within this watershed. During development of this plan, those streams and their watersheds were evaluated, and water quality monitoring initiated. This watershed study identified sources of pollution and impairment in the CAW and proposes projects and policies to address those issues.

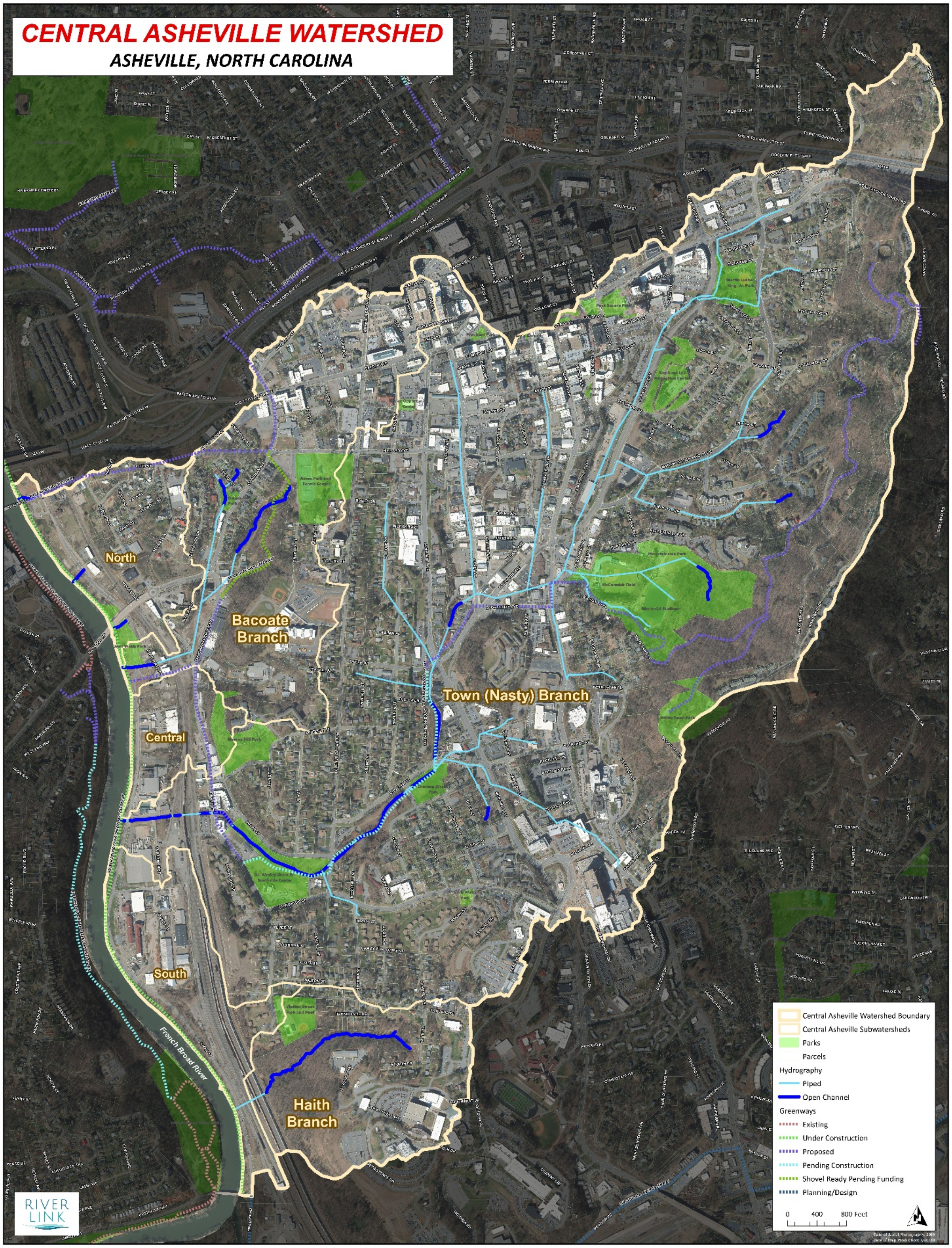


Figure 1 The Central Asheville Watershed, Asheville NC

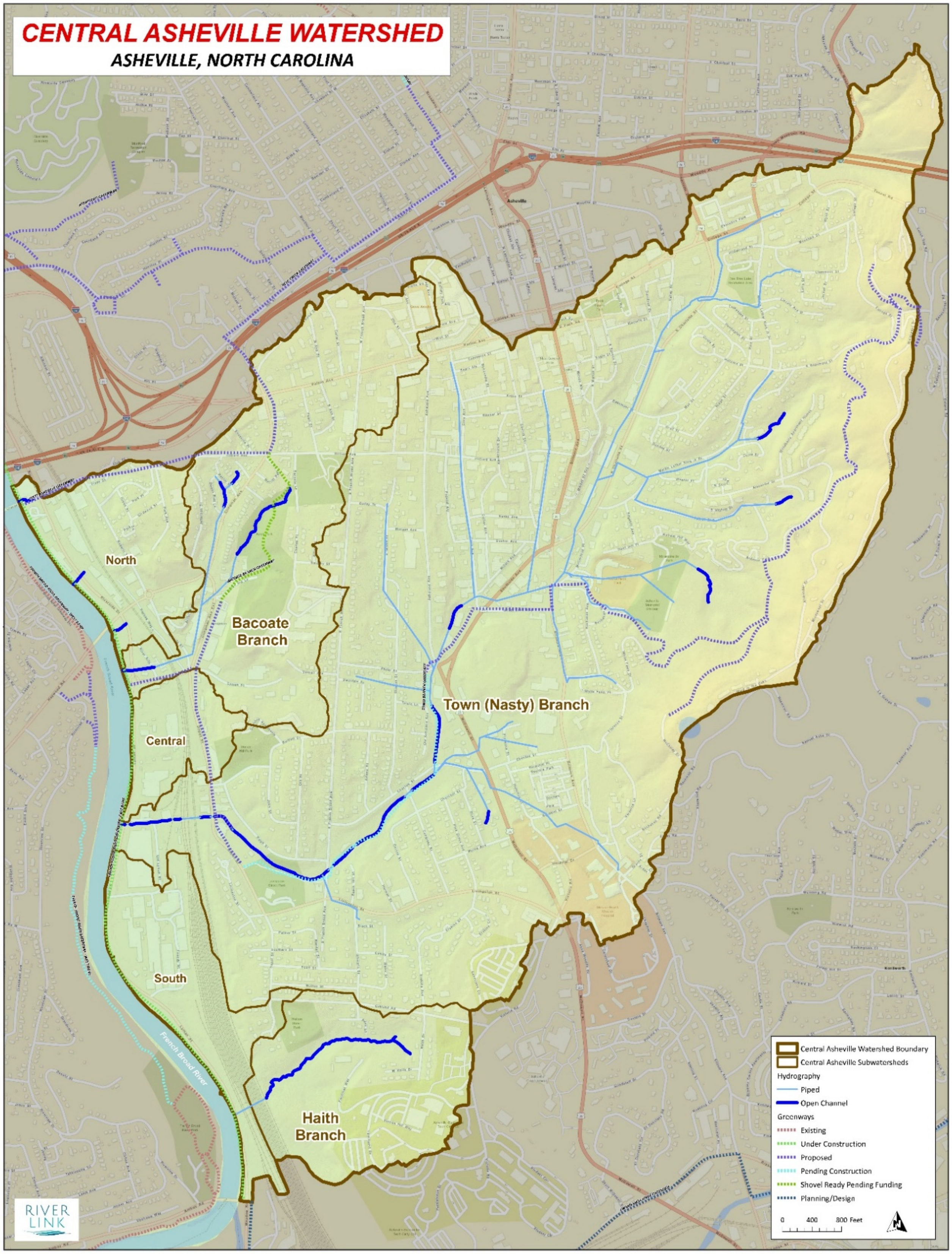


Figure 2 Central Asheville Watershed depicting existing open channel reaches of its streams.

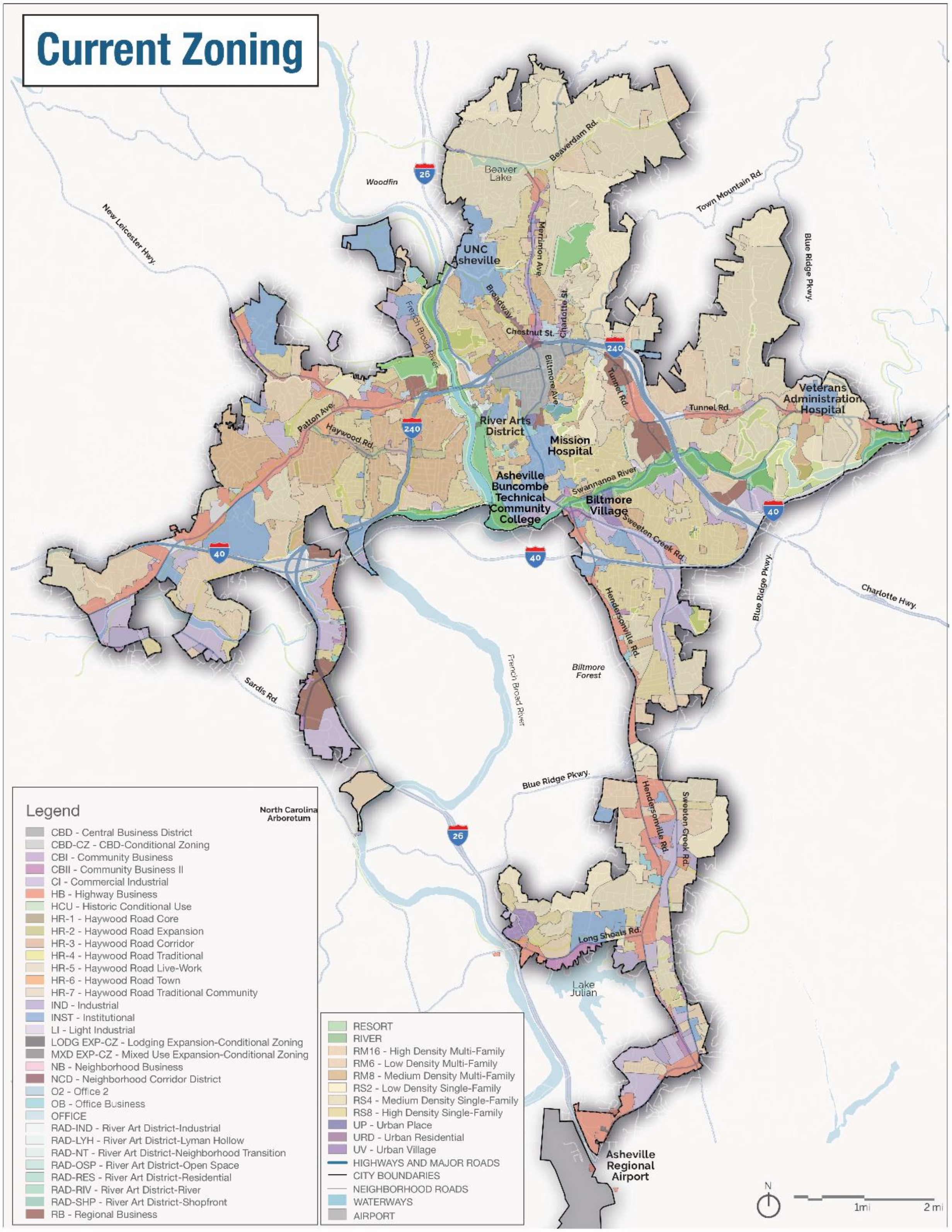


Figure 3 Current City of Asheville Limits and Zoning

Restoration Goals

During this project, adopting appropriate restoration goals was discussed in depth. At the onset, it was understood that the streams in the watershed were impaired for human contact and for the health of the aquatic ecosystems. Additional problems in the watershed included:

- Flooding in the French Broad Floodplain and in the yards and streets in the upper reaches of the watershed.
- The legacy of discrimination and underserved neighborhoods that presents barriers to bringing communities together for a common cause of environmental restoration and progressing towards social and economic equity.
- Erosion that is damaging property and putting large volumes of sediments into the watershed's streams and, ultimately, into the French Broad.
- The frequent occurrence of illicit discharges into the stormwater collection system and the area waterways.
- The fact that continued growth of the City of Asheville, with much of that growth occurring in the watershed, will increase the environmental stressors daily thus making restoration increasingly difficult unless fundamental change occurs.

It is essential that restoration goals be practical, achievable, and urban stream restoration has been shown to be difficult. However, that is not an excuse for refusing to address the issues. Successful restoration cannot be promised but a path toward it must be plotted. That is the purpose of this plan and of adopting the following eight CAWRP Restoration Goals:

1. Implement cost-effective stormwater management measures that reduce pollution, improve public safety, and add aesthetic value to the watershed's communities.

2. In the face of continued Asheville growth, reduce the delivery of pollutants, particularly bacteria and toxic substances, from the CAW to the French Broad River.

3. Reduce streambank and slope erosion throughout the watershed and, particularly, address the severe erosion occurring in the Haith Branch subwatershed.

4. Support Asheville's efforts to prevent street and structure flooding and provide a 25-year level of service for its streets and stormwater system.

5. Increase public awareness of illicit discharges resulting in improved detection, investigation, and enforcement of pollution prevention regulations.

6. Serve as a catalyst for the development of public policies and practices that improve water quality and public safety.

7. Increase public awareness and appreciation of the stream reaches within the watershed that remain above ground.

8. Support development of a restoration and preservation plan for the unique environmental qualities of the Haith Branch subwatershed.

Nine-Element Plan

The project funders directed RiverLink to produce a plan that addressed all the components of a US Environmental Protection Agency Nine-Element Watershed Planning Framework, summarized below.

Nine-Element Plan	
Element 1:	Identify causes of impairment and pollutant sources
Element 2:	Estimate load reductions from implementation measures
Element 3:	Describe the non-point source management areas needed to achieve load reductions
Element 4:	Evaluate assistance needs, costs, and partnerships
Element 5:	Develop and implement education and outreach elements
Element 6:	Develop an implementation schedule
Element 7:	Develop a schedule of measurable milestones
Element 8:	Develop monitoring criteria
Element 9:	Establish a monitoring program

Figure 4 Elements of a Watershed Restoration Plan

The project was structured to fulfill those requirements and to provide tools that will facilitate the implementation of the recommended projects and policies. One of those tools is an interactive StoryMap that can be used to explore the project's findings and recommendations. See: https://bit.ly/3ib96X7

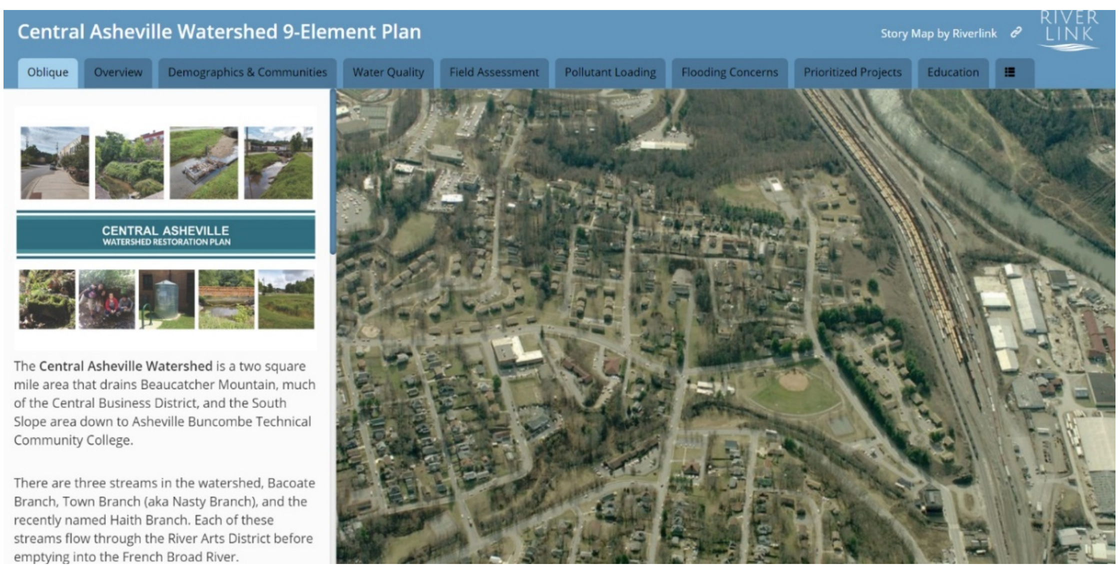


Figure 5 CAWRP Interactive StoryMap

That StoryMap, and the applications that support it, will be used to report and track the implementation of the plan over the coming years. While this document will become outdated, the StoryMap is intended to provide for the continuous updating, adaption, and documentation of progress towards the CAWRP restoration goals.

Current State of the Watershed

The first component of a nine-element plan requires the identification of causes of water impairment and the sources of the pollutants. The second component requires an estimate of the pollutant load reductions that are necessary to remove the impairments. This section characterizes the Central Asheville Watershed (CAW), identifies sources of impairments, and documents the assessments necessary to formulate projects and policies to address those repairments.

Land Cover and Use

The CAW is a steep, urban watershed. Large portions of the watershed are highly impervious, have compacted soils and are served by a dense stormwater sewer system. Figure 6 and the following table presents the areas of parcels in the watershed by current land use category. Each category represents an aggregation of parcel land use codes from the City's parcel database.

Area (%)	Land Use Category
2.6%	Unknown
4.5%	HD Residential
17.4%	Mixed & MD Residential
5.4%	LD Residential
19.1%	Services - Food, Medical, Auto, Other
32.2%	Commercial & Services - Financial, etc.
0.3%	Roads and Pavement not otherwise accounted
5.4%	Vacant - Natural Area
9.5%	Vacant
3.6%	Manufacturing/Storage

In aggregate the watershed is over 44% impervious, with some areas exceeding 95% impervious cover. Figure 6 presents the distribution of land uses in the watershed and Figure 7 presents the average impervious percentage and the average land slope of each catchment. Items of note about the watershed include:

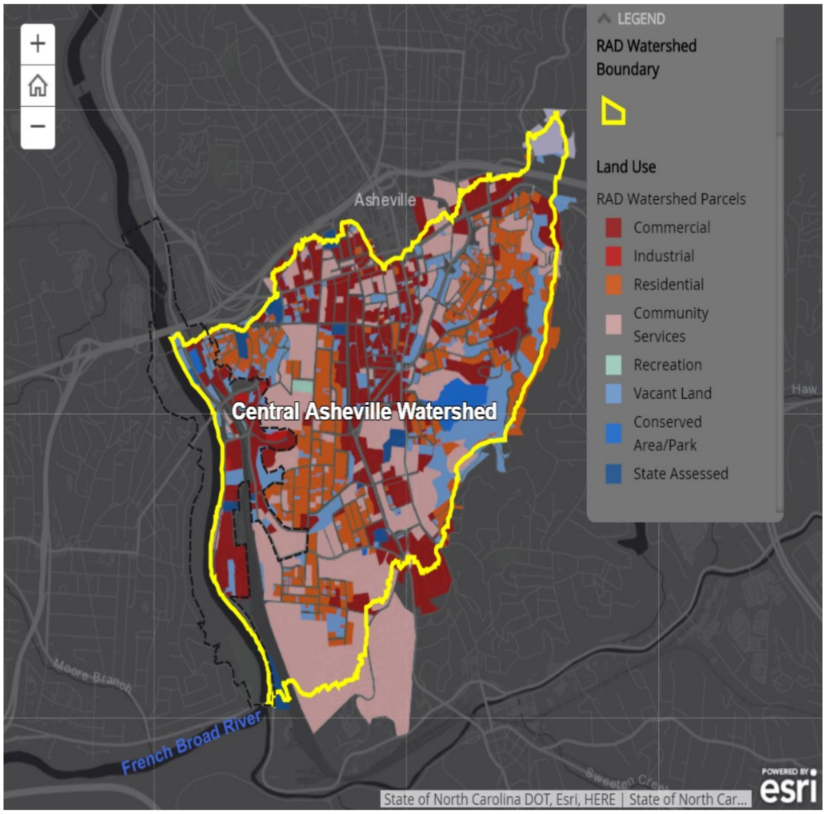


Figure 6 Land use by parcel in the CAW. The City's Interactive Zoning Map may be viewed at: https://arcgis.ashevillenc.gov/ZoningMap/

- The northern-most areas of the watershed are comprised of Asheville's central business district (CBD), a highly impervious area with relatively little open space where drainage is served by a dense system of stormwater inlets and pipes.
- The highly impervious areas extend downslope from the CBD along the Coxe, Biltmore Avenue and McDowell Street corridors, less so down South French Broad and Clingman Avenues. (See StoryMap: [https://bit.ly/3ib96X7)](https://bit.ly/3ib96X7)
- The steepest areas of the watershed lie along its northeastern edge, the western slopes of Beaucatcher Mountain. Much of this area is undeveloped and, through public ownership, protected from development.
- The western boundary of the watershed lies entirely within the floodplain of the French Broad River. This area has a centuries-long history of industrial use and resultant contamination. The area is now referred to as the River Arts District and is recognized as an Innovation District and major destination of Asheville tourism. A major portion of this area is occupied by the Norfolk and Southern railroad yard.
- The southern-most area of the watershed contains many of the buildings and parking areas of Asheville-Buncombe Technical Community College (A-B Tech) but also has a highly pervious, largely wooded area that is quite unique in this highly urbanized watershed. That wooded area is an important recreational and educational resource to A-B Tech and others.

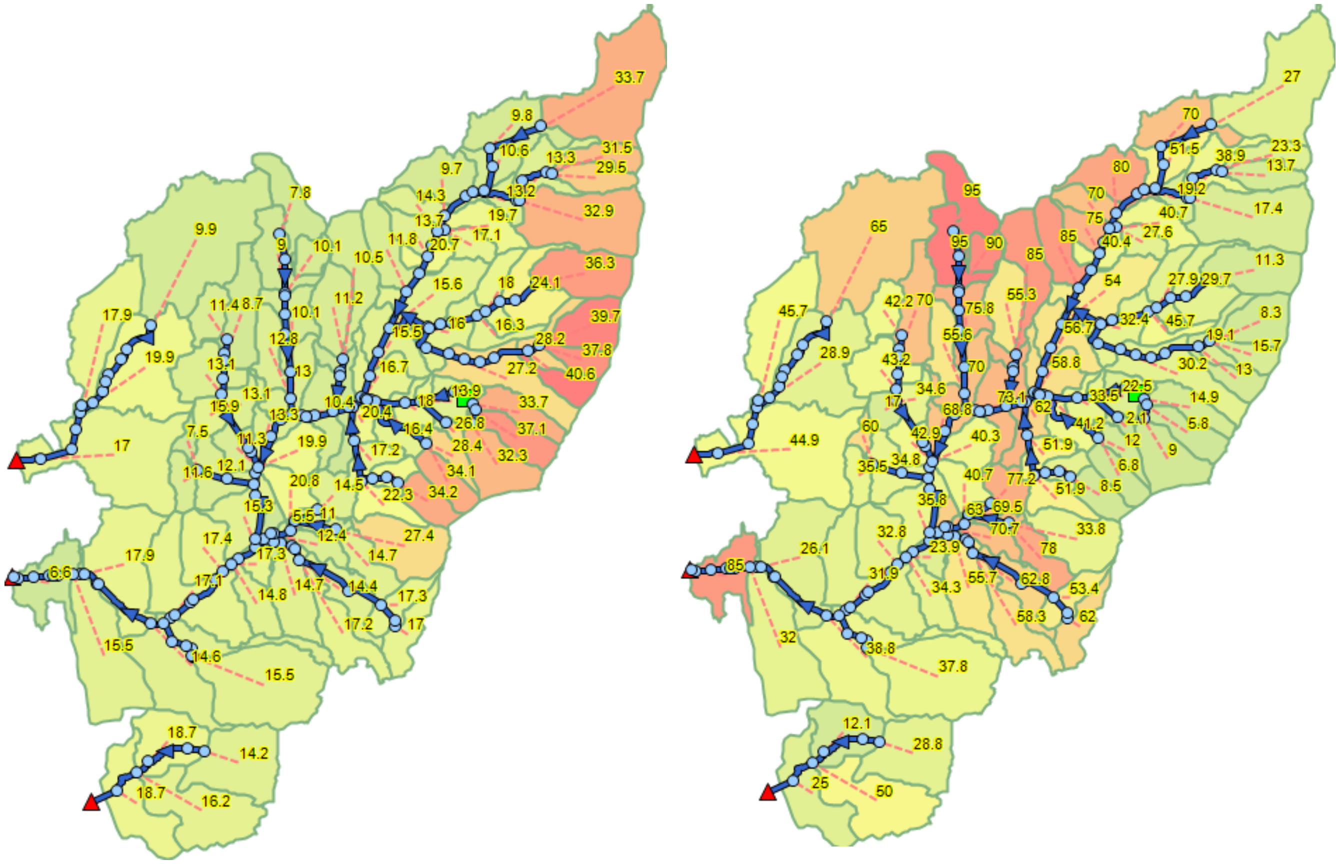


Figure 7 CAW catchment slope (%) (left) and impervious percentage (right). Note that the blue lines and circles on this map represents the larger pipes of the City's stormwater system and the watershed's streams.

Demographics and Community Conditions

At 2¼ square miles, the Central Asheville Watershed makes up just under 5% of the City of Asheville's incorporated area, but its estimated 2019 population of 6,672 is over 7% of the municipal population and includes a disproportionate amount of Asheville's diversity. Furthermore, while Asheville's population is estimated to have grown a substantial 13.6% since 2010, the 2019 population estimates for the watershed reflect even more rapid growth of 21.6% during the same period. (Source: ESRI)

Population Distribution

The map at right shows the varied population distribution within the watershed at the block level, based on 2010 counts from the US Census. Among the blocks with population—many blocks are unpopulated—the density ranges from less than one person per acre (lightest blue) to over 190 people per acre (deepest purple). The black dots provide another way of understanding the residency pattern, as they represent structures with addresses as of 2019. To be sure, not all buildings shown have residential occupants, but the arrangement of dots in the populated blocks gives a sense of the constellation of development. Overlapping dots can indicate structures with multiple units or addresses, like an apartment complex. (Source: City of Asheville GIS)

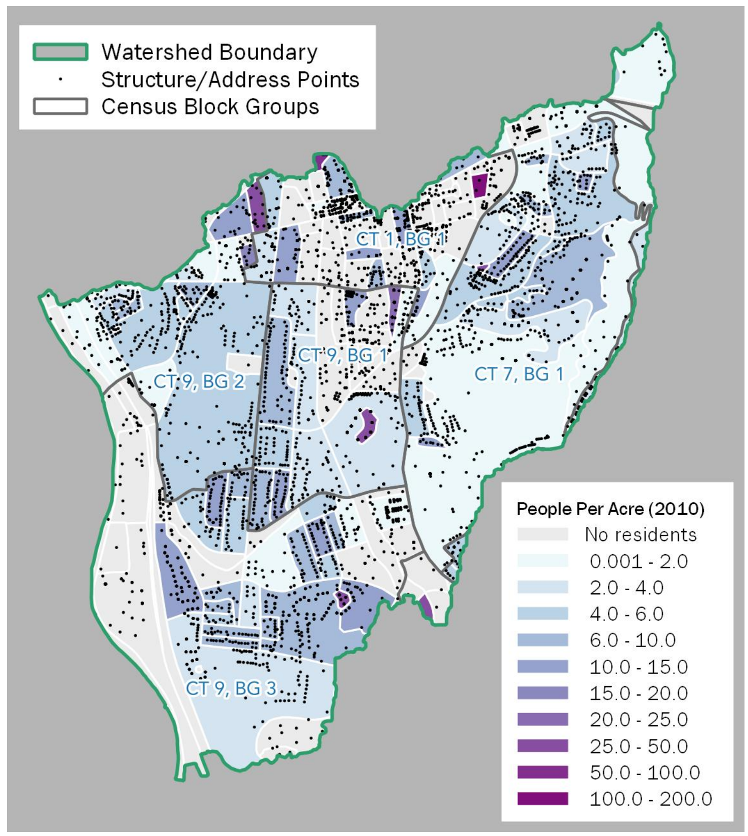


Figure 8 Population density in the watershed

Also included on the map are labels for the five major census block groups included in the watershed, with boundaries in gray and labels in blue. While the watershed does overlap with other block groups, the five shown with labels on the map have all or most of their area and population in the watershed and were the base units for some of the demographic analysis to follow.

Diversity

Much as the watershed contains pronounced differences in terrain in close proximity, it also represents a remarkable amount of the city's human diversity and dynamism. The watershed includes both pancake-flat floodplains and 40+% slopes, both the bulk of the downtown central business zone and undeveloped tracts as big as 30 acres, both new luxury condo/hotel buildings and at least 40% of the City's aging public housing sites. It is home to landmark educational institutions, the bustling new South Slope Brewery District, as well as most of Asheville's historically under-resourced neighborhoods: 84% of the watershed overlaps with recently designated Federal Opportunity Zone areas composed of five lower income census tracts that did not benefit equitably in the recovery from the 2008 recession and are likely disproportionately impacted by the current recession .

Comparing the five major block groups in the watershed to the group of all 54 block groups which lie all or mostly in Asheville highlights how some of the watershed's demographic characteristics stand out. In the figures to the right, the bars shown in blue represent block groups in the watershed, while those in orange represent those that lie outside.

While the Census Bureau's American Community Survey lists Asheville's entire population as roughly 18% People of Color, the percentages in the watershed are generally much higher. The graphic at right shows that: four of the city's six most diverse block groups are in the watershed; two of those four are majority People of Color; and the other two more are more than 40% People of Color. Even the least diverse block group in the watershed (Census Tract 1, Block Group 1) is more diverse than the city average.

Income

When it comes to measures of income, the block groups in the watershed again fall disproportionately on one side of the chart. The graph at right ranks block groups based on the percentage of households below the poverty level. The two poorest block groups (based on this measure) are in the watershed, and two others fall well within the quintile with the most poverty. The much lower percentage for the fifth block group may partly be related to the large number of people living in "group quarters," i.e., not households, as will be discussed below.

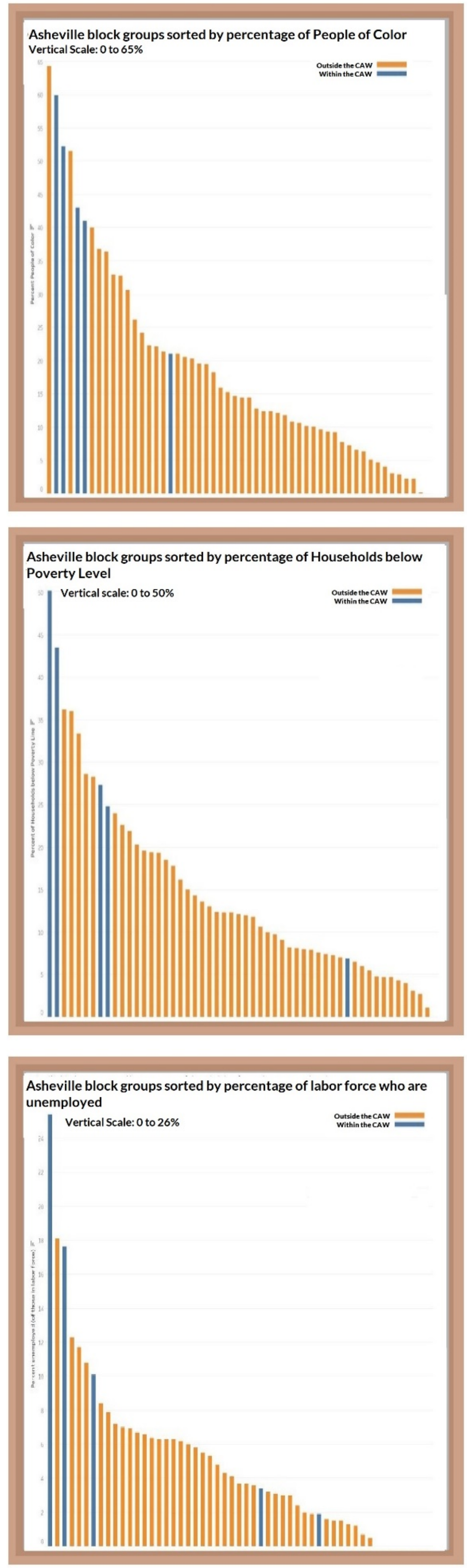


Figure 9 Demographic statistics

Employment

Measures of unemployment show a similar, though not quite as lopsided distribution. The graphic at right, based on the percentage of those in the labor force who are unemployed, shows that three of the watershed block groups are among the seven block groups with the most elevated levels of unemployment. The tallest bar, Census Tract 9, Block Group 2 provides the city's most significant outlier, with a rate more than seven percentage points higher than the next highest level.

The American Community Survey also reveals that the four block groups outside of Census Tract 1 have distinctly higher percentages of people living in rented homes as compared to the city average (49%). Those four block groups have rates ranging from 57% to 71% living in rented homes; Census Tract 1, Block Group 1, which overlaps with the downtown core, has a rate of 36%.

Ownership

As mentioned above, many of Asheville's noteworthy public institutions are in this watershed: City Hall, the County Courthouse Complex, the Veach-Baley Federal Complex, Asheville-Buncombe Technical Community College, and Asheville Middle School, to name just a few. In fact, of the real property area (excluding rights-of-way) in the watershed, roughly one-third is owned by public entities.

Figure 10 represents the extent of public ownership. In addition, there are substantial areas of the watershed owned by Norfolk Southern Railroad, as well as public-service entities like the electrical utility and the Mission Hospital system. (Source for parcel attributes: Buncombe County Property Records)

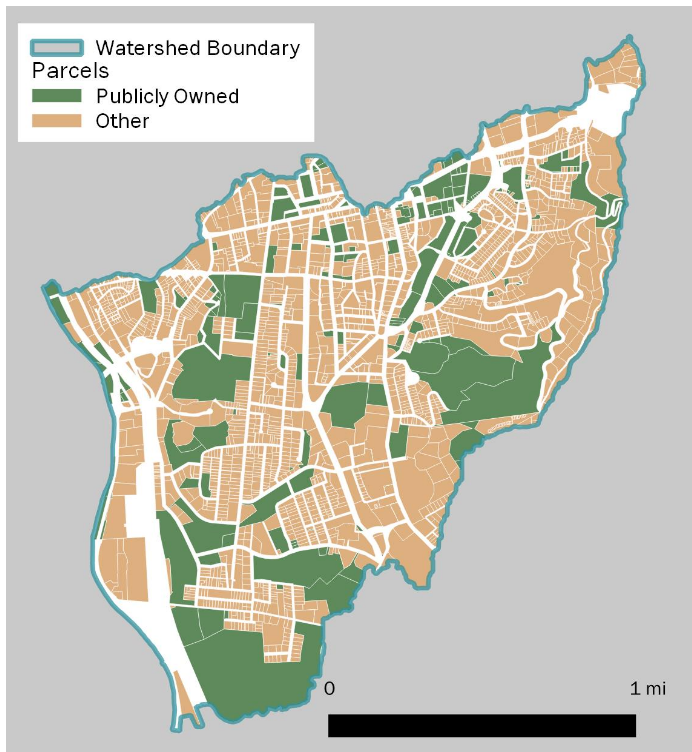


Figure 10 Public and private land ownership

Property Values

Property values within the watershed vary widely as well. The average assessed value of properties coded as "improved" single-family residential properties (excluding condos) is $230,000, but values range from $62,000 to $1.53 million.

Figure 11 shows all non-exempt property in the watershed (not just single-family residential), with dots for each parcel to indicate tax value range. It is difficult to represent the values of stacked condos in this manner, but the map still shows the general trend of lower values in the Southside (southwest), South French Broad (west of the watershed's center), and East End-Valley Street (northeast) neighborhoods, and higher values downtown (north central), near Beaucatcher Ridge (eastern margin), and adjoining the Hospital campus (south central).

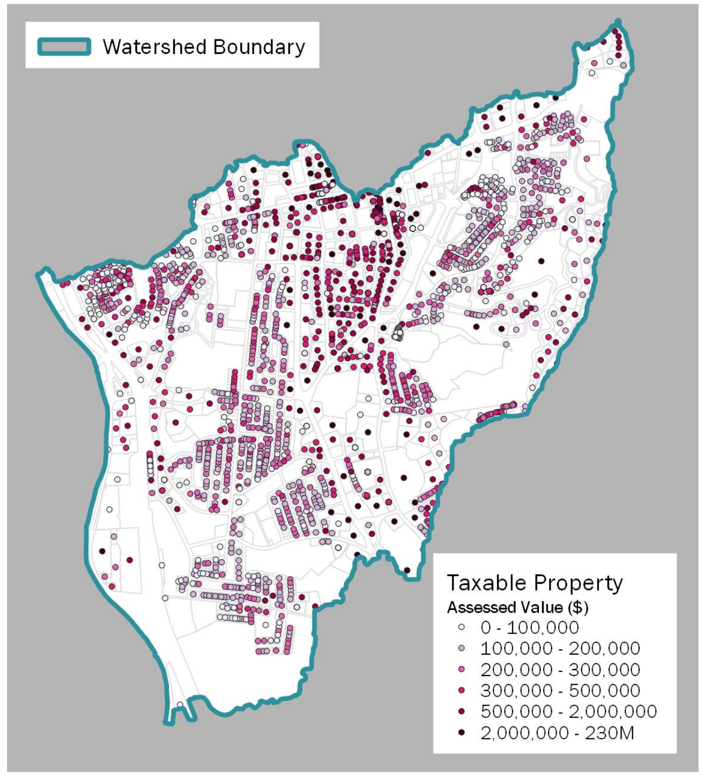


Figure 11 Assessed property values.

Urban Renewal

A discussion of the community conditions in this watershed would not be complete without an explanation of the profound destructive legacy of the 20th century redevelopment program called urban renewal. Sarah Judson, a historian at the University of North Carolina Asheville, has identified Asheville's urban renewal project as "the largest in the Southeast," and stated that "beginning in the late 1950s, the [programs] fundamentally transformed the footprint of the city." (See Judson's article: "'I Am a Nasty Branch Kid': Women's Memories of Place in the Era of Asheville's Urban Renewal," *The North Carolina Historical Review*, Vol. 91, No. 3, p. 329.) Many of the projects, purportedly to improve transportation infrastructure, reduce blight, and improve the housing stock, eviscerated the cores of predominantly African American communities. Hundreds of homes inhabited by Black families were destroyed as were businesses owned and/or operated by Black residents.

The Southside and East End-Valley Street neighborhoods, both around the banks of what was then called Nasty Branch (now called Town Branch), were some of the most deeply affected. Judson states, "The creek functioned as a pathway through the city as it linked together several African American neighborhoods … [and] … represented an ecological connection among black Asheville residents that transcended the mapping of city planners." Comparison of the images below showing an identical extent of Southside from 1951 (left) and 1975 (right) reveals just a fraction of the extensive demolition in the vicinity of Nasty Branch.

Figure 12 Changes in the vicinity of Nasty (now Town) Branch, 1951 - 1975

Though the urban renewal projects ended decades ago, negative effects endure, stemming from the disruption and destruction of livelihoods, of homeownership, and of community identity. Among the consequences is a persistent mistrust among the populations that remained about government and non-profit initiatives aiming to “improve” neighborhoods.

While this current century has seen Asheville emerge as a major regional destination with a thriving tourism economy and a booming housing market, these trends portend still more displacement for yet another generation of lower-income, predominantly Black residents. Gentrification of other diverse Asheville neighborhoods, such as Montford, has been evident going back before the turn of the last century, and the acceleration of the disruption in neighborhoods like the ones in this watershed have moved advocates and equity-minded agencies to seek ways to slow or reverse the momentum.

Impacts on the Watershed Restoration Plan

The history of discrimination, of urban renewal, and the on-going lack of social and economic equity in Asheville’s communities necessarily impacts planning for watershed restoration. This project’s public outreach was met with skepticism about another set of “experts” making recommendations about neighborhoods in which they do not live. The entire notion of improving environmental conditions raises concerns about gentrification and displacement of current residents and businesses. Like many urban restoration projects, legitimate questions were raised about what “improvement” means and if that improvement addresses the communities’ priorities. For example, a project that benefits aquatic ecosystems but has a negative impact upon community health and safety is not an improvement. Projects that present clear opportunities for job training and the creation of “green jobs” may be preferable to projects that engage a contractor from outside the impacted community.

RiverLink's charge to the restoration technical team was to consider the above concerns at each step of the project, particularly in the location and conceptualization of proposed projects meant to accomplish the restoration goals. The recommended projects, and the entire restoration plan, are supposed to contribute to social and economic equity and to address specific needs of underserved communities. This topic is further addressed later in this report where the recommended projects and policies are presented.

Sanitary Sewer System

There are over 950 miles of sanitary sewer lines operated by the Municipal Sewerage District of Buncombe County (MSD), many miles of those lines are in the CAW. Figure 13 displays the location of the MSD lines in the watershed. By necessity, the sanitary sewer collection system follows the valleys from the upper reaches of the watershed to a large sewer main lying along the banks of the French Broad River. The proximity of the sewers to our streams, both above and below ground, means that any leakage or spillage in the system usually has an immediate impact upon the stream's water quality, particularly bacterial loads carried by the stream. Later in this report is documentation of dry- and wet-weather e. coli and fecal coliform concentrations in the three primary streams in the watershed with each stream showing high levels of bacteria. Often a primary contributor to bacterial contamination in urban streams, particularly during periods of dry weather and low stream flows, is the sanitary sewer system. Urban stormwater runoff is a primary contributor during wet periods.

Figure 13 also illustrates the reported sanitary sewer overflows (SSOs) and the locations of sewer odor complaints investigated by MSD since April 2017. As measured against similar sized sewersheds in other North Carolina communities, there have been a relatively small number of SSO and odor complaint incidents. However, the concentration of the SSOs immediately adjacent to Town Branch and the French Broad River is a cause for concern.

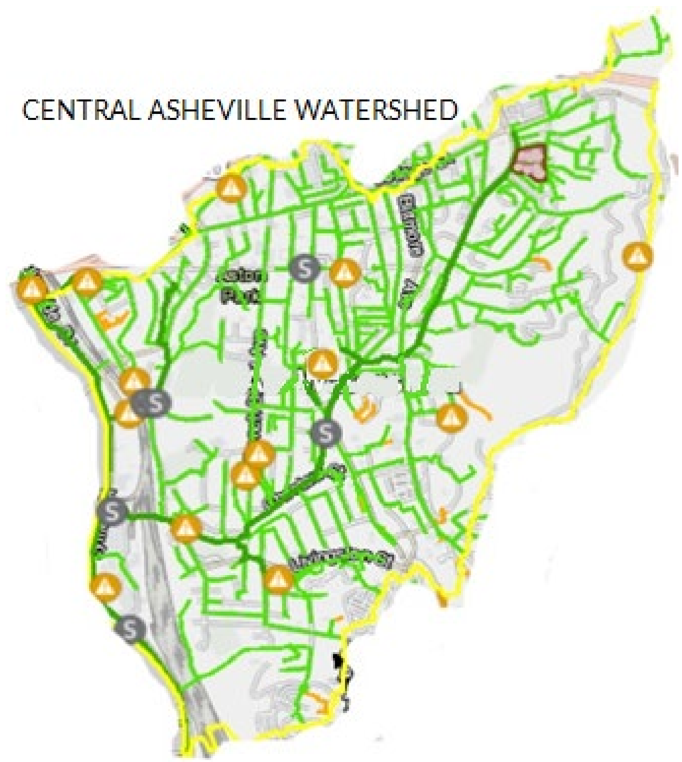


Figure 13 MSD Sanitary lines in the CAW and reports of SSO (denoted by an S) and Odor problems (denoted with triangles) in the past three years.

Excessive amounts of fats, oils and grease (FOG) in the sanitary sewer system creates problems in the collection system and at the waste treatment plant. Many SSOs are caused by improper disposal of fats, oils and grease into the sanitary system. MSD runs a FOG education, permitting and enforcement program. Figure 14 depicts parcels with FOG permits. Details of the program can be found at: https://www.msdbc.org/fog.php

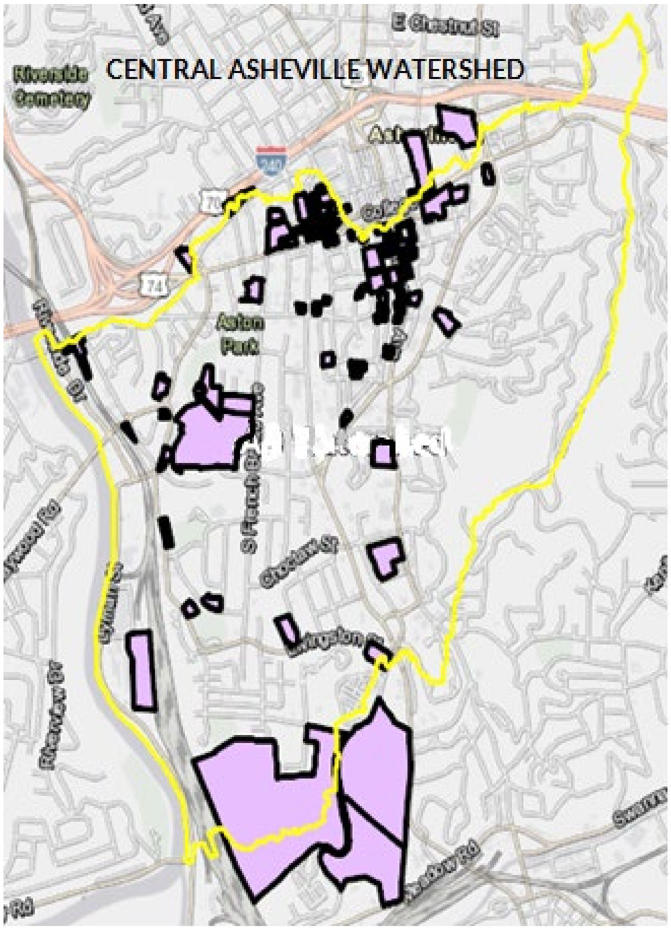
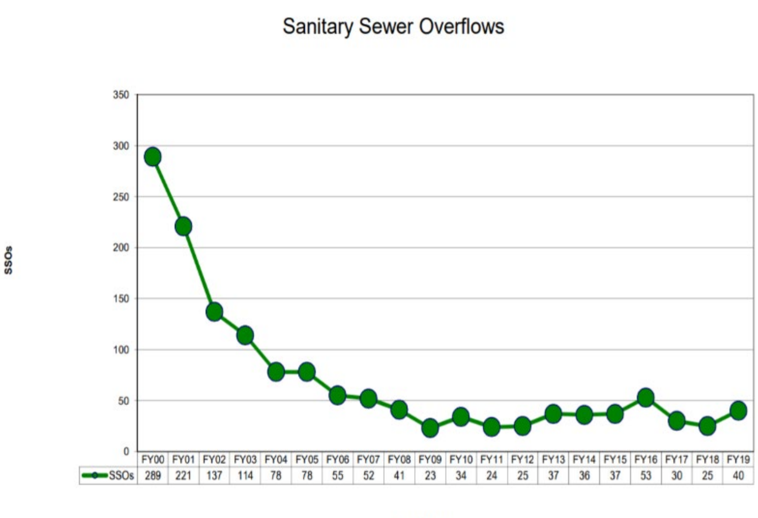


Figure 14 Parcels with active FOG permits in the CAW.

During this assessment, field teams made observations of the crossings of sanitary sewer lines across open channels and the areas along the creek banks where sanitary sewers are buried. Since most of the stormwater system is enclosed in pipes and large dimension tunnels, direct observations were not made of many of the areas of potential leakage and maintenance problems.

Often the most cost-effective means of improving water quality in urban streams is to increase the investment in the facilities, maintenance, enforcement, and education programs of its sanitary utilities. This is particularly true where water quality impairment is the result of bacterial contamination. This project's assessment concludes that this will be the case in the CAW.

The 2019 MSD performance report ([http://www.msdbc.org/documents/SPAR2019.pdf)](http://www.msdbc.org/documents/SPAR2019.pdf) reports on many aspects of the sewer system. That report illustrates the reductions in SSOs that MSD has achieved in recent years (see figure below). No sewer leakage was observed during field assessments but some of the stream crossings and lines that lie parallel to Haith Branch were observed to be subject to damage by stream bank erosion. As noted above, there are many sanitary line crossings of the City's stormwater collection system. The restoration team was unable to obtain City permission to observe those crossings or to obtain water quality samples to be analyzed for bacteria from the City's system. This issue is addressed in the recommended projects and policies section of this report.



Flooding in the Watershed

The lower region of the CAW lies in the floodplain of the French Broad River. The figure to the right shows the current effective regulatory floodway, 100-year flood fringe and the 500-year flood fringe. Flooding along the French Broad and Swannanoa rivers in 1916, 1944 and 2004 caused extensive damage in the City and in the watershed. The Land of Sky Regional Council of Governments cooperated with the National Environmental Modeling & Analysis Center (NEMAC) to develop a regional assessment of flood hazards (https://landofsky.acceladapt.com/). The geographic unit encompassing the CAW estimated 8.6% of commercial properties in the area were exposed to flood hazards within the FEMA regulator floodplain. Other categories of flood hazard included: 0.5% of residential properties, 10.56% of natural or protected properties and 20.75% of government-owned and critical facilities.

Figure 15 French Broad River Floodplain

In addition, to flooding in the French Broad floodplain, street and some structure flooding occur frequently throughout the watershed. During the development of the Asheville Stormwater Utility 10-year Capital Improvement Plan (CIP)[1] street flooding issues were identified along Patton Avenue near the top of Bacoate and Town Branches, around McCormick Place, near the intersection of Coxe Avenue and Short Coxe Avenue and elsewhere throughout the watershed. An EPA Storm Water Management Model (SWMM) developed following the CIP indicates that most of the Town Branch stormwater system below Biltmore Avenue does not meet the City's design criteria

[1] https://cdn.ymaws.com/www.ncsafewater.org/resource/collection/64DA0538-C557-46CE-A432-36630C9C0D98/3-W_T_09.10-Nick_Dierkes-Capital_Improvements.pdf

of avoiding significant street flooding during the 25-year (4% annual probability) event. To date, none of the proposed capital improvement projects to be funded under the 10-year plan will allow the City to meet its criteria.

Due to the steep slope of the watershed and its "flashy" flooding characteristics, many street flooding incidents occur and recede before they are reported, and street closures occur.

During this project's field investigations, residents identified additional areas where flooding and sediment deposition frequently present problems. Some of these are: the vicinity of Haywood Road and Roberts Street, along Knoxville Place, at Lyman Street Extension, along River Arts Place, and elsewhere. The resultant street flooding may be the result of stormwater inlet or other system maintenance issues or due to inadequate capacity of the storm sewer system. The City's 10-year Stormwater CIP includes several improvements to the storm sewer system within the CAW, including improvements above McCormick Field, near the intersection of Coxe Avenue and Southside Avenue, and improvements in the vicinity of Carter and Ann Streets. These proposed projects focus primarily on addressing the capacity of the storm sewer system to avoid street flooding to the City's standard. One of the proposed projects, a detention basin on a tributary to Town Branch would provide both stormwater quantity control and some degree of water quality treatment.

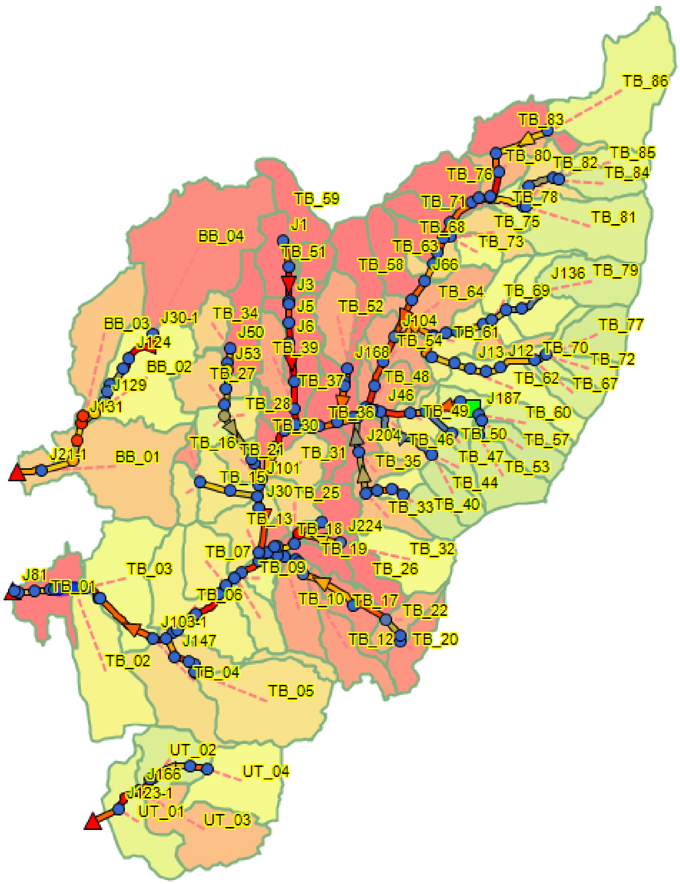


Figure 16 The CAW Storm Water Management Model

As previously noted, during development of the 10-year CIP, a hydrologic model of the upper reaches of the Town Branch catchment was developed. During this project that model was extended to cover the three primarily streams in the CAW. The EPA Storm Water Management Model (SWMM) represents the hydrologic flow routing of open channel and pipe conveyances in the CAW. The modeled tributaries include Town Branch, Bacoate Branch and Haith Branch See the table below for individual tributary drainage areas. Rainfall inputs to the model for various events were derived from NOAA Atlas 14 design storms (24 hour).

The model contains three free flowing outfall nodes that represent the three major tributaries' confluences with the French Broad River. These were used for reporting peak flows and generating hydrographs. The peak flow and flooded node results from the model do not account for the backwater conditions arising from the French Broad River. Junctions were set to allow ponding when the system capacity is exceeded.

Infiltration in the model was calculated using standard curve numbers for Hydrologic Soil Groups A and B, with adjustment for compaction that is typical of urban soils. Percent imperviousness of catchments was determined by area-weighting an impervious surface dataset with the model catchment boundaries. That unpublished dataset was provided by the City of Asheville GIS department and only includes building footprints, some residential driveways, and some parking lots. From Michael Cole (COA, GIS Coordinator): “Note that this data doesn't include impervious area existing in ROWs (City or NCDOT streets, or Railway ROW), and some features were derived using automated feature extraction and, as such, will not have an indication of the type of, or constituent material of the feature (building rooftop, driveway, etc). Also, there will likely be inaccuracies and/or omissions per the age of the imagery (2015).” Primary and secondary road right-of-way areas and additional obvious impervious surfaces (I.e. parking lots, rock outcroppings, etc.) were manually added to the impervious dataset before area-weighting was conducted. Imperviousness for highly urban catchments (areas in heart of downtown Asheville) was manually estimated based on aerial imagery. These catchments had between 70-95 % imperviousness.

The following table presents a summary of the expected number of flooding locations in the constructed stormwater conveyance system for various frequency storm events. It should be noted that the model only represents the major components of the stormwater system and that flooding to various degrees may occur at additional locations. In addition, the model only considers the design system capacity. Flooding often occurs due to maintenance problems including clogging of street inlets and the formulation of debris dams in streams, at the entrance of bridges and culverts and elsewhere. Haith Branch is not included in the table because it has only a small constructed stormwater system.

Event	Bacoate Branch		Town Branch	
	# of Nodes Flooding	**# Nodes Flooding more than 10,000 feet^3**	**# of Nodes Flooding**	**# Nodes Flooding more than 10,000 feet^3**
Annual	4	2	2	2
2-Year	5	4	5	2
5-Year	5	5	11	3
10-Year	7	7	17	5
25-Year	7	7	28	12
50-Year	7	7	40	17
100-Year	7	7	49	24

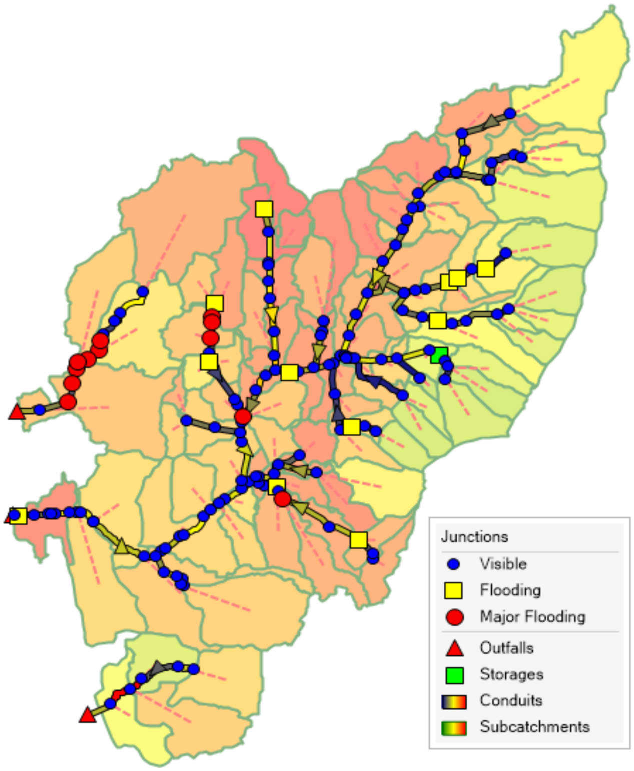


Figure 17 Flooding in the watershed for the 10-year

Figure 17 shows locations where the model indicates likelihood of minor and major street (and other) flooding for the 10-year (10% annual probability) event.

Note that the square and circles in the figure denote areas where the City's stormwater system does not have the capacity to convey all the stormwater. The model assumes that all water that discharges out of a stormwater inlet due to the system surcharging and water that would have entered an inlet if the system was not surcharged, ponds in the area of the inlet until it can reenter the system. Depending upon local topography, that may not be what occurs at each source of flooding. Thus, areas downstream of the displayed nodes may experience flooding because of the uncontrolled water running down streets and through properties.

Figure 18 shows locations in the storm sewer system where the current storm sewer system, current watershed conditions and current climate data indicate that the system does not meet the City's criteria to have the capacity to prevent street flooding in the 25-year (4% annual probability) event. In the figure the color of the catchments represents the percentage of rainfall that runs off from that area (scale: green-yellow-red). The yellow boxes indicate areas where relatively minor flooding occurs, and the red circles represent areas where at least 10,000 cubic feet of water is either discharged from the storm sewers or cannot enter the system at a street or other inlet.

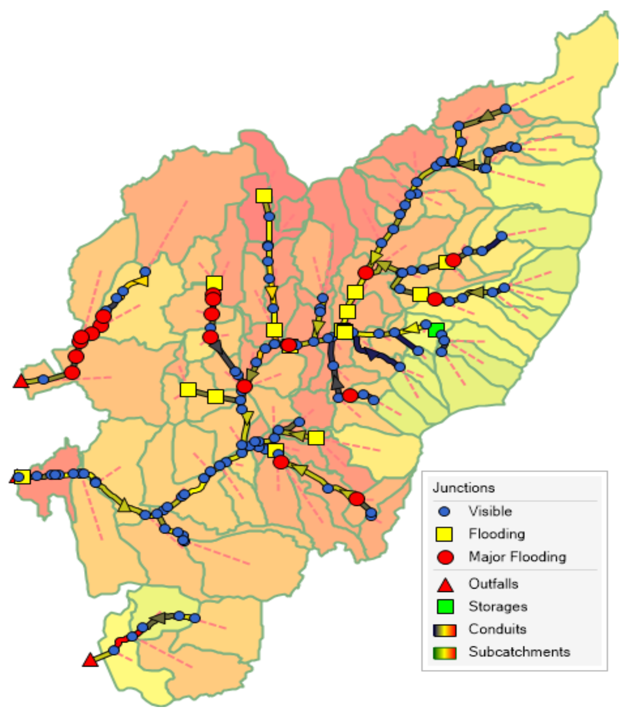


Figure 18 Flooding in the watershed for the 25-year

The following tables summarize the subwatersheds included in the model and the peak discharges to the French Broad river for storm events of various frequencies. Note that the tabulated discharges accounts only for water contained in the City's stormwater system, not water flowing down the streets and through properties. The area of the three major tributaries represent just over 89% of the entire study area.

Subwatershed	Drainage Area (acres)	Percentage of Total CAW	Impervious Area (%)	Pervious Area (%)
Haith Branch	91.1	6.3	31	69
Bacoate Branch	174.5	12.0	51	49
Town Branch	1030.9	71.0	44	56
Total Watershed	1452	------	48	52

Subwatershed	Peak Discharge (cfs) to French Broad River by Storm Recurrence Frequency						
	Annual	**2-yr**	**5-yr**	**10-yr**	**25-yr**	**50-yr**	**100-yr**
Haith Branch	87	116	165	207	268	318	369
Bacoate Branch	145	159	186*	209*	243*	270*	297*
Town Branch	1604	2385	2775	2783*	2850*	2913*	3052*
Total	1836	2660	3126*	3199*	3361*	3501*	3718*

* Peak discharge limited by stormwater system capacity.

Groundwater Assessment

As part of this project's water quality assessment, Headwater Environmental, Inc. provided an evaluation of environmentally impacted sites listed in a publicly available database provided by the North Carolina Department of Environmental Quality (DEQ). The DEQ Division of Waste Management (DWM) maintains an online Site Locator Tool to provide public access to currently available environmental information for sites that the DWM manages, permits, and inventories. Headwater used the Site Locator Tool to review sites within the watershed. NC DEQ-Division of Water Resources (DWR) also provided additional surface water assessment data and information on surface water public complaints, primarily associated with Town Branch, via an internal data repository. Based on Headwater's experience evaluating impacted sites, sites were screened with focus on the likelihood that a site would be impacted with hazardous chemicals or petroleum products. Available environmental reports for those sites were then reviewed to determine if groundwater or surface water contamination had been identified on the property or if impacted soil or sediment, that might migrate from the property to stormwater infrastructure or surface water bodies, was present. A summary of impacted media was included within the report (Headwater Environmental, Inc., 11 November 2019) included in this report's Appendix-Water Quality. Information from the following state or federal programs and incident databases were reviewed during preparation of this assessment:

- Hazardous Waste Sites
- Brownfields Program Sites
- Federal Remediation Branch
- Inactive Hazardous Sites
- Dry-Cleaning Solvent Cleanup Act (DSCA) Sites
- Underground Storage Tank (UST) Incidents
- Aboveground Storage Tank (AST) Incidents
- DWR Incident Reports and Public Complaints

Approximately 160 sites are listed in the DWM Site Locator Tool within the CAW. Those sites were reviewed and prioritized based on the presence of documented contaminated media, in particular impacted groundwater. The locations of the most significant sites are shown on Figure 19. Available groundwater contours and contaminant isoconcentration plumes are shown on the figure where data are available.

Based on a review of environmentally impacted sites and associated reports which include the results of soil, groundwater, surface water, and sediment sampling, the following constituents of primary concern (COPCs) were identified:

- Chlorinated solvents, in particular PCE and related daughter products: PCE is one of the most common chlorinated solvents and is a chemical commonly used in the dry-cleaning industry. It is also used as a chemical intermediate, and for various degreasing applications. PCE is associated with multiple health effects. Groundwater impacted by PCE often results in a laterally extensive groundwater plume and therefore is more likely to reach and impact surface water when groundwater is discharging to a surface water body.
- Petroleum constituents: Petroleum constituents include many compounds differentiated by their relative carbon fractions. Petroleum generally contains benzene, toluene, ethyl benzene and xylene, (often referred to as BTEX compounds). These compounds are generally more toxic than other petroleum constituents.
- PAHs: PAHs are a class of chemicals that occur naturally in many substances, including coal and petroleum products. They are also produced as incomplete combustions products when various substances are burned, particularly when coal, oil, or gas are burned. PAHs are persistent organic pollutants. Generally, PAHs have lower solubility in water so are more commonly associated with soil or sediment contamination

Health information for these compounds is available on the United States Environmental Protection Agency (USEPA) Integrated Risk Information System (IRIS) website (https://www.epa.gov/iris) .

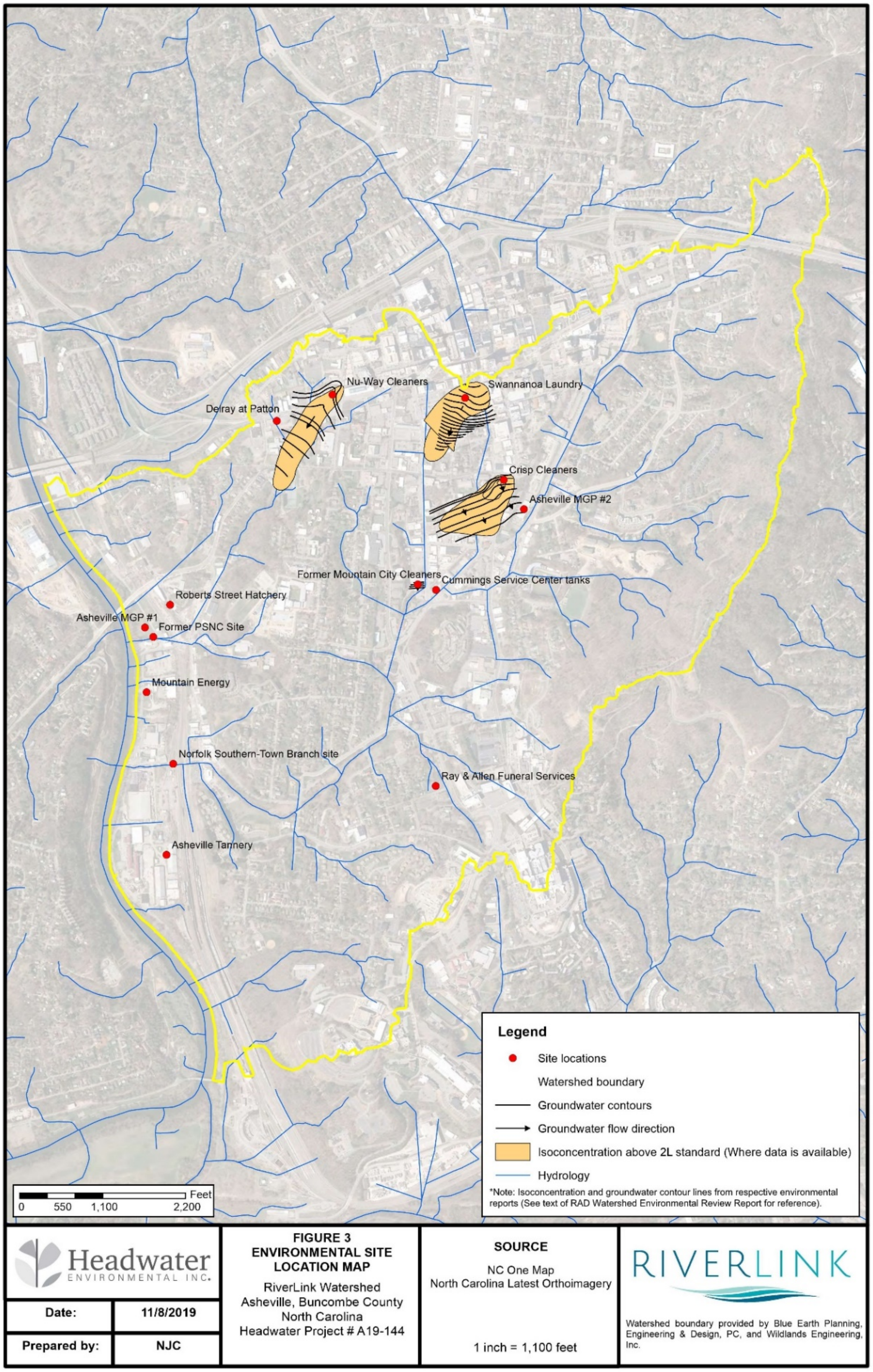


Figure 19 Significant soil and groundwater contamination sites in the CAW.

Surface Water Assessment

This report section summarizes the current physical conditions of the three main CAW streams and presents information about some of the watershed characteristics that are impacting the channel conditions and aquatic habitat.

Description of Haith Branch

Haith Branch originates below Haith Drive where seepage expression was present during October fieldwork, and the field crew estimated this to be an intermittent or perennial boundary. No intermittent or perennial stream features were observed to be piped into the tributary. Except at this origin, where the slope exceeds 10% for first couple hundred feet, the remainder of the stream was measured using GIS contour data to have an approximate slope of 4%, consistent down to the railroad yard. The stream is in a narrow valley.

This catchment drains the area around several A-B Tech buildings, parking lots (including the new parking deck) and access roads as well as parking lots to the north, some of which feed through an existing dry pond stormwater control measure (SCM). A notable observation is that stormwater on Oakland Ave appears to be piped out of this catchment and down Hibernia Street to the Town Branch subwatershed.

There are several empty lots fronting on Haith Drive, and one or more are being built on presently. In addition, there is a large internal lot (3.3 acres) with narrow frontage on Oakland Avenue. Two branches of the tributary converge on this lot. The area has knotweed infestations. Two old culvert crossings were identified along lot lines and the historic use of the area may be of research interest. There was minor head-cutting identified on the right-hand branch, and below their confluence and the boundary of the large internal lot, a series of knick points occurs on A-B Tech property with the channel becoming incised downstream of these. Knick points currently have wood or root material arresting the advancing headcut, but long-term there is a risk of the headcuts continuing to cut upstream inducing erosion and stream instability.

In some locations, sedimentation from upstream or adjacent erosion is severe and cause the channel to lose its form and flow subsurface. There are several minor erosion issues that coincide with MSDBC infrastructure. There are intermittent areas of bank erosion that should be evaluated as a potential stream enhancement effort, along with other opportunities to permanently arrest headcuts and/or raise the channel with priority 1 stream restoration, benefiting stream function and reducing negative impacts of channel instability.

A major sediment source enters the creek left from a severely headcut and eroding ephemeral drainage originating on campus (see Figure 20 and Figure 21). During this project, that area was surveyed by A-B Tech students & staff – their data were used to develop a conceptual remedial plan and will be used for design of a recommended CAWRP implementation project based on Regenerative Stormwater Conveyance (RSC) techniques.

Figure 20 Severely eroded ephemeral channel downstream from A-B Tech stormwater outfall.

Figure 21 Perched stormwater outlet and 13 feet deep plunge pool below A-B Tech campus

Overall, the primary issues in the reach are erosion and some invasive species threats. Due to the overall environmental and ecosystem quality of this area and the potential for the reach to sustain high ecological function, projects serving this tributary were assigned high priority. The area is a bit of an environmental "gem" in the midst of a highly developed urban area. It presents an opportunity to restore and preserve a functioning forest ecosystem, an outdoor education laboratory, and recreational open space. There is a need to act in a timely manner prior to further impacts from buildout of currently undeveloped lots if the full watershed restoration potential is to be fully realized.

Description of Bacoate Branch, Unnamed (Owens Bell) Tributary and Unnamed (Asheville Middle School) Tributary

The Bacoate Branch and Unnamed (Owens Bell) Tributary subwatersheds catch runoff from a range of ultra-urban to dense residential landscapes. The mainstem of Bacoate Branch is heavily wooded within its primary open channel reach. Its upstream catchment is heavily urbanized and piped. There is an additional catchment that contributes to the mainstem of Bacoate Branch below its primary open channel reach. The Bacoate subwatershed and the various catchments feeding open channel reaches of the stream are described below.

Bacoate Branch

Bacoate Branch originates below Hilliard Ave where several stormwater conveyance pipes emerge at the base of a large fill slope immediately to the west of the Aston Park tennis courts. At this location, flow and channel indicators suggest that perennial exists. Bacoate drains approximately 60 acres at this location, approximately 70% of which is impervious. The stream was measured using GIS contour data to have an approximate slope of 7%. Bacoate Branch is in a confined valley and has cut down to bedrock along much of this primary open channel reach. After approximately 900 feet, the branch enters a pipe and is conveyed subsurface for 1600-

1700 feet down to Riverside Drive, dropping 30-40' over that length, where it reemerges and flows in a second open channel reach which is routed under the 8 River Arts Place building and then approximately 350 feet to the French Broad River.

The branch drains heavily urbanized areas in the western portion of Asheville's downtown receiving runoff from the Grove Arcade west and Haywood Street south. The primary contributions to flow and water quality are building rooftops, parking lots and roads. Recommended restoration work in the subwatershed should include redevelopment or rehabilitation of aging parking lots which are prevalent. The goals of that rehabilitation should be to help control the peak discharges entering the stream and provide water quality treatment before the runoff enters the stream.

Bacoate Branch has a bedrock channel bottom along the primary open channel reach, with intermittent areas of bank erosion, particularly in the downstream half of this reach where the stream is pushed against the valley wall. A new sewer main runs parallel and within the stream corridor in this entire reach – the line was installed around 2015. Near the Aston Park tennis courts, there is a severely eroding gully that contributes sediment to the branch (Figure 22). The wooded area consists of mature forested uplands, particularly on the left floodplain terrace, but along the right floodplain and terrace a combination of urban infill development and sewer corridor establishment and maintenance have resulted in tree removal and invasive species infestations.

Figure 22 Eroding gully carries sediment and trash to Bacoate Branch

A proposed greenway corridor parallels Bacoate Branch from Aston Park down to Clingman Avenue Extension. The corridor has potential future connectors that would tie-in along the Unnamed (Asheville Middle School) Tributary described below. The proposed greenway has a stormwater control measure proposed near the top of the daylit reach and proposes a parking lot with other potential stormwater treatment opportunities adjacent to Aston Park. Future connectors (e.g. to AMS or the YWCA) could include efforts to enhance the AMS Tributary.

Overall, the primary observed issues in the reach are erosion and some invasive species threats. Both commercial and residential growth are occurring in this area and are projected to continue.

If the CAWRP restoration potential is to be fully realized, then timely action is required and the future development in the watershed must adopt more than the current minimally required stormwater control measures.

Unnamed (AMS) Tributary

A smaller drainage within this subwatershed joins Bacoate Branch within the piped system near Haywood Road and Clingman Avenue Extension. It drains the northern portion of the AMS area, as well as the YWCA, beginning as an open channel and perennial stream in the wooded area below Charles Street. It flows approximately 500 feet above ground before going below a building and entering a piped system.

The Unnamed AMS Tributary drains several parking lots and streets upstream of its open channel reach, as well as residential areas along Charles and Alline Streets. Where the tributary daylights, there is a severe slope failure along the left valley wall. That slope failure is contributing a significant sediment load to the stream. Historic down-cutting has resulted in the streambed cutting down to bedrock throughout the lower portion of the reach. As a result, below bedrock knick points, there is bank erosion in areas where the stream has high incised banks, although streamside vegetation has slowed the rate of erosion. This intermittent widening is likely to continue until a new stream equilibrium is established throughout the reach. About halfway down the reach, the stream has a sanitary sewer crossing which serves as a knick point for the stream, this is an undesirable situation for both stream and sewer stability. The sewer infrastructure in this area is older than along the mainstem of Bacoate Branch.

As with other reaches in this subwatershed, the primary observed issues in the reach are erosion and some invasive species threats.

Unnamed (Owens Bell) Tributary

Another small drainage within this subwatershed is an unnamed tributary that flows through Owens Bell (pocket) Park. The area through the Park, and another segment from Rector Place to Clingman Place, are the daylit portions of this tributary which is subsequently piped from Owens Bell Lane to the French Broad River. Visual assessment indicates that the stream is ephemeral above Hilliard Avenue.

This tributary drains the western portion of Hilliard Avenue as well as a portion of West Haywood Street and Jefferson Drive including part or all of the Duke Power substations presently under construction at the intersection of Patton and Clingman Avenues. Below these commercial and industrial areas is a residential area with a mix of dense single and multi-family structures.

The Owens Bell Park is a previous stream restoration project site implemented by NC State University in January 2006. The project stabilized streambanks and planted riparian trees and shrubs and has been successful in reestablishing a canopy and stream shading and achieving relative stability of streambanks. Invasive species management has proven to be an on-going challenge on the site. There are streambank stability issues upstream in the Rector Street to Clingman Place reach where overland flow and instream flow along with utility obstructions are contributing factors to localized erosion.

Several potential stormwater control measures (SCMs) have been identified along road right-of-ways and on private property that would be beneficial to channel stability and provide water quality treatment opportunities. Notably, based on GIS parcel analysis, Hilliard Avenue has a wide right-of-way and efforts to enhance the urban forest and implement proposed stormwater storage and treatment opportunities are important enhancement opportunities. In addition, the catchment lends itself to implementation of disconnected impervious surface (DIS) projects to reduce runoff from roofs, driveways, and other impervious areas.

Description of Town Branch

Town Branch, which receives contributing drainage from several piped systems draining the central and east portions of downtown including the south slope, as well as Beaucatcher Mountain contributions which follow Charlotte Street, is first daylit just west of the intersection of Coxe Avenue and Short Coxe/Southside Avenues. It reenters a pipe less than 300 feet downstream and reemerges below Phifer Street and McDowell Avenue. adjacent to the Keystone Laboratories. It flows for approximately a mile to reach the French Broad River, largely as open channel but through multiple culverts or bridges as it nears the river and crosses under Depot Street and the railroad. Along the way, it receives a significant drainage area contribution from an Unnamed Tributary which parallels the eastern portion of Livingston Street. The two drainages have been divided for the discussion below. In addition, headwater tributaries from Beaucatcher Mountain – the only other significant open channel reaches in the watershed - have also been divided for the purposes of discussion.

Town Branch

Town Branch emerges from a large concrete stormwater tunnel just north of Coxe Avenue, flows through a short open channel reach and then enters a corrugated metal culvert above McDowell Avenue. Within a few hundred feet, Town Brach reemerges below Phifer and McDowell. For the next approximately 5000 feet it is primarily open channel, though it passes through large culvers under four streets upstream of the railroad yard, and then culverts under the railroad yard, Old Lyman and Lyman Streets before discharging to the French Broad river. It drops approximately 40’ in 4000 feet down to Depot Street.

Town Branch is deeply incised, its thalweg sitting 15 to 20 feet lower than the adjacent streets and open areas. It has frequent bedrock control within the streambed, establishing the stream gradient. In many areas, the stream has a narrow bankfull bench typical of steeper stream channels and the bench and slopes are wooded up to the top of terrace. Most of the stream corridor runs through City-owned land which is planned to largely be maintained as open space. The proposed alignment of the Nasty Branch Greenway (scheduled for construction in 2021) will run along the terrace. Sanitary sewers run along the corridor with crossings in multiple locations. The stream buffer is generally a narrow wooded area, extending only to the top of terrace;

beyond this, invasive species are present where the corridor is not maintained in grass. Invasive species exist within the buffer to varying degrees. On the terrace, infestations are particularly bad between Congress Street and South French Broad Ave, with kudzu being the most egregious and porcelain berry also prominent. There are intermittent areas of bank erosion along the corridor, often the result of pipe outlets or crossings, or sometimes the result of long-term adjustments resulting from channelization and hardening such as placed stone and rubble and retaining walls.

Overall, the primary issues in the reach are localized erosion and buffer integrity. The corridor presents good opportunities to implement various types of streambank enhancement and buffer restoration, as well as stormwater management. Education and public engagement are related opportunities due to the future prominence of this corridor as a paved greenway. There are several stormwater management components proposed as part of the future greenway plans, including a large, terraced bioretention area that will capture and treat runoff from Pine Grove Ave and Congress Street. There is a great opportunity to complete other watershed management efforts complimentary to the greenway implementation either during or following implementation. There is an existing wetland on the left terrace near the bend in Gaston Street that needs better vegetative management and that may be suitable as a retrofit opportunity to enhance stormwater treatment. A proposed restoration project is to use this area, from Choctaw to below Livingston Street Park, as a pilot area for development of a Riparian Area Management Plan that, eventually, could be extended City-wide.

Unnamed (Livingston Street) Tributary

Draining medical facilities and parts of the A-B Tech campus at the top of its catchment, and Livingston Heights and adjacent residential areas in the Erskine-Walton neighborhood, the Unnamed (Livingston Street) Tributary is mostly piped. There is potential for daylighting several reaches as well as for several stormwater control measures within its watershed. It enters Town Branch just below South French Broad Avenue via a pipe located on the left bank.

The UT is contained in a concrete channel and has daylit portions within the Livingston Heights apartment complex. This complex has a high density of on-street parking that was observed to be a contributor of vehicle fluids into stormwater runoff. Restoration of the concrete channel to a more natural condition and rehabilitation of a constructed wetland, are potential restoration projects along this tributary. Disconnecting impervious surfaces within the apartment complex and the adjacent neighborhood could be effective in reducing stormwater runoff and improving water quality. Potential retrofit activities in the headwaters of the tributary have potential to provide improved volume and water quality treatment of highly impervious headwater catchment areas.

Unnamed (Beaucatcher Mountain) Tributaries

Several first and second order headwater streams originate on the slopes of Beaucatcher Mountain east of downtown and drain toward South Charlotte Street. All these tributaries enter pipe systems above Charlotte Street and join with Town Branch near Coxe and Southside Avenues. The headwaters of Beaucatcher Mountain are largely intact forests. On the south end of Beaucatcher Mountain, the land is owned by the City and part of Mountainside Park above Asheville Memorial Stadium and McCormick Field. Heading north, headwater streams traverse recently developed parcels and are under future risk of development.

Macroinvertebrates

There is relatively little quantitative data regarding the water quality in the CAW streams. Most of the watershed drains into Town Branch (aka Nasty Branch). The volunteer-based Stream Monitoring Information Exchange (SMIE)[2] performs macroinvertebrate sampling and analysis for sites across the western North Carolina mountains and foothills. Evidenced by its SMIE Biotic Index score, Town Branch is one of the most biologically impaired streams in Buncombe County. The figure below compares SMIE's sampling sites on Town Branch, Smith Mill Creek at Louisiana Avenue, and Bent Creek at the NC Arboretum. Smith Mill Creek is recognized as an impaired water on the State's 303-d list. Bent Creek is recognized at a relatively pristine creek in an urban/suburban setting.

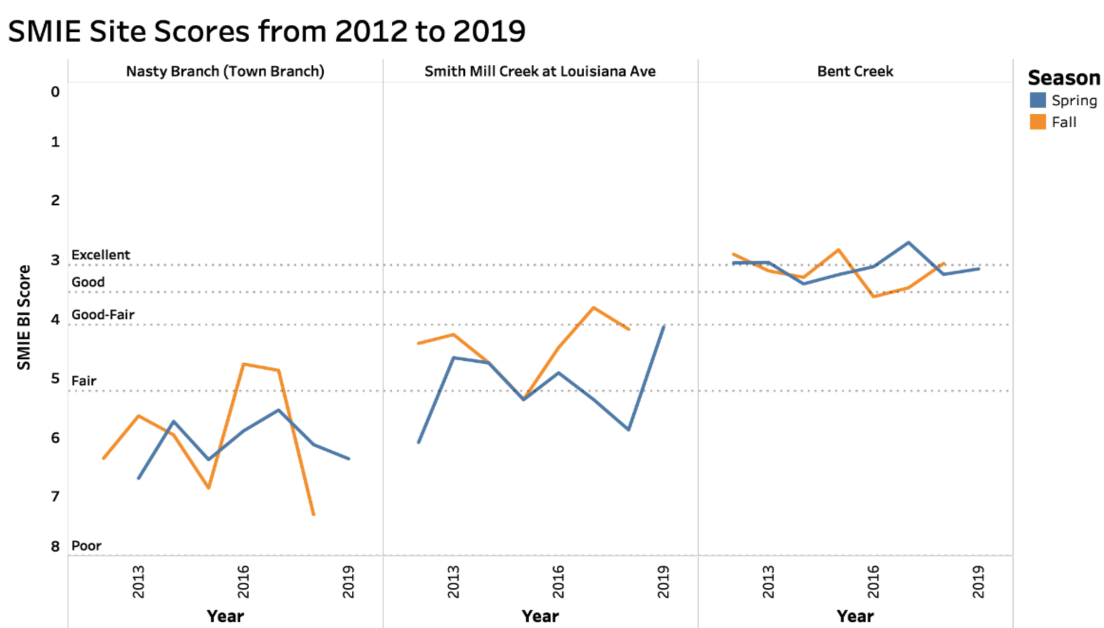


Figure 23 Macroinvertebrate Biotic Index Scores for Town Branch

In September 2019, Penrose Environmental performed macroinvertebrate sampling and analysis at five locations in the watershed in order to help with the baseline evaluation of biological conditions of stream channels (Penrose Environmental , September 2019). A copy of the

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[2] http://www.environmentalqualityinstitute.org/smie-stream-monitoring-information-exchange.php

Penrose report is in Appendix-Water Quality. Benthic invertebrates, or aquatic insects, comprise an assemblage of taxa that inhabit the sediment or live on or in other bottom substrates in the aquatic environment. They vary in size from forms small and difficult to see without magnification to other individuals large enough to see without difficulty. Benthic invertebrates are large enough to be seen without magnification and live at least part of their life cycles within or on the substrate. This community of aquatic organisms is found in all aquatic habitats including very small perennial stream systems (1st and 2nd order), which normally support a very limited fish fauna. These communities integrate the effects of short-term environmental perturbations. Sensitive species respond quickly to stress, while community shifts are generally more long-term. In addition, benthic macroinvertebrate communities respond to the various types of water pollution in predictable fashions.

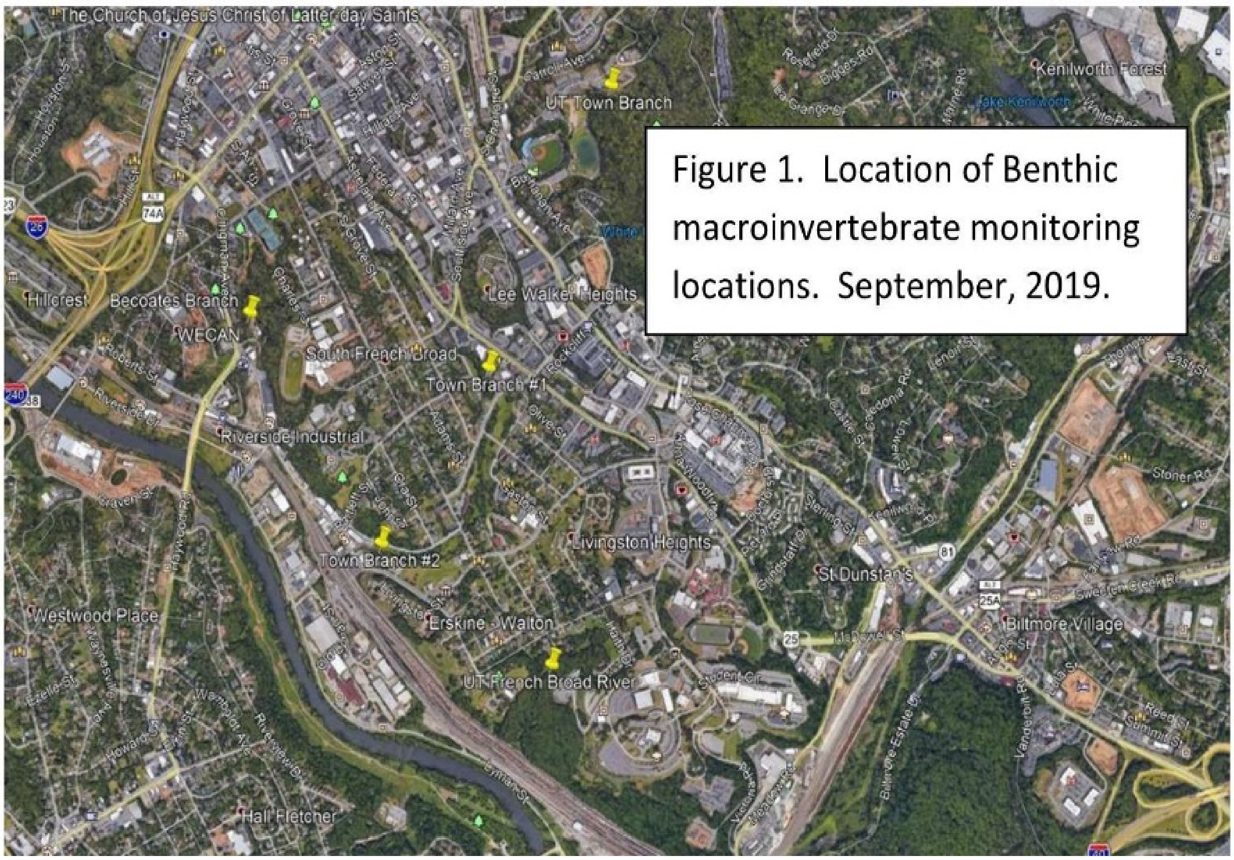

Figure 24 Locations of macroinvertebrate sampling stations

The simplest method of macroinvertebrate data analysis is the tabulation of species richness (number of species). Species richness is the most direct measure of biological diversity. The association of good water quality with high species (or taxa) richness has been thoroughly documented. Increasing levels of pollution gradually eliminate the more sensitive species, leading to lower and lower species richness. Bioclassifications were assigned to the collection sites in Town and Bacoate Branch using DWR classification criteria (the number of EPT taxa). However, the DWR recommends that bioclassifications are not given to very small streams and the use of the biotic index exclusively from these features may be misleading. Taxa richness and the presence of intolerant taxa will be used to compare between site differences during this survey. Biotic index values are included in the summary at the small sites only as a relative comparison between collection locations.

When interpreting the table below, sites with both higher total taxa richness and higher numbers of intolerant taxa have relatively better water quality, as reflected by their Biotic Index values (a lower index value represents higher quality) These results suggest that UT Town Br and Haith Branch (a.k.a. UT FBR) have better water quality than the lower reaches of Town Branch (Town Br. #1 and Town Br. #2), and Bacoate Branch.

Table 1. Benthic Macroinvertebrate Summary. River Arts District. September, 2019					
Monitoring station	UT Town Br	Town Br. #1	Town Br. #2	Becoates Br	UT FBR
Monitoring Location	McCormick	McDowell	Ralph St.	Grey Eagle	AB Tech
Ephemeroptera	3	1	3	1	2
Plecoptera	4	0	0	0	1
Trichoptera	4	5	3	3	4
Diptera; Misc	2	2	3	1	4
Diptera; Chironomidae	1	6	10	4	4
Coleoptera	2	0	0	0	3
Odonata	1	0	1	0	2
Oligochaeta	0	2	1	1	0
Crustacea	1	1	1	1	0
Mollusca	1	1	1	0	0
Other Taxa	0	0	1	0	0
Total Taxa Richness	19	18	24	11	20
EPT Taxa Richness	11	6	6	4	7
EPT Abundance	44	8	35	26	20
# Taxa ≤ 2.5 (intolerant taxa)	10	1	1	2	9
Biotic Index	3.30	5.90	6.57	3.50	2.91
Bioclassification	Not rated	Fair	Poor	Not rated	Not rated

Figure 25 Reproduction of metric table from Penrose Environmental Report

On 12 May 2020, Reece Environmental Consulting performed a macroinvertebrate sampling and analysis on Haith Branch downstream of the macroinvertebrate sampling site used by Penrose Environmental. The new site was selected because it is downstream of the confluence with a highly eroded gully that contributes a heavy sediment load to Haith Branch (See report by Reece Environmental in the Appendix-Water Quality). Compared with the upstream site, there is a great variance in the taxa richness. Overall taxa richness declined by 8 compared to the sampling site above the source of discharge. EPT taxa richness declined by 2, and there were 3 fewer intolerant taxons compared to the initial assessment. These results can be summarized as a roughly 30% decrease in EPT and intolerant species diversity, and a roughly 40% decrease in total species diversity compared to the sample site above the stormwater input. The biotic index score is less favorable at 3.25 compared to 2.91; however, it needs to be noted that due to the small watershed and stream size this number can be misleading. This sampling site, now labelled HB-1, is recommended to be used in the CAWRP long-term monitoring plan.

A NCDEQ stream assessment team performed macroinvertebrate sampling at multiple locations along Town Branch in June 2020. Analysis of their findings is pending.

Bacteria

Since January 2019, the French Broad RiverKeeper has been collecting and analyzing water samples at five sites along Town Branch. One of the constituents analyzed has been e. coli. The table below notes the locations of samples collected, the number of samples analyzed, and the average number of e. coli colonies observed. Across all samples, e. coli concentrations varied between 50 and nearly 65,000.

Sample site along Town Branch	Number of Samples	Average number of e. coli (colonies per 100ml)
Old Lyman Bridge	8	1530
Depot St	17	910
S. French Broad	17	2134
Choctaw	17	3691
Coxe Avenue @ Southside	8	6599

On 29 October 2019, water quality samples were collected at six sites in the watershed. The samples were taken during a sustained dry period during which there had been no significant rainfall for at least 72 hours. The samples were analyzed by an NC DEQ laboratory and laboratory findings for bacterial indicators are presented below. The surface water standard for total coliform bacteria is 200 colony forming units per 100 ml (CFU/100 ml) based on a geometric mean over multiple samples. The e.Coli is reported in most probable number (MPN), which historically has been used as roughly equivalent to CFU. The State does not have an e.Coli surface water standard but USEPA does provide a recreational use guidance with recommendations for e.Coli below a geometric mean of 126 CFU/100 ml and a statically threshold value of 410 cfu/100 ml). The highlighted cells in the table denote values that exceed USEPA recreational use guidance.

Sample Site – 29 October 2019 Dry-weather Sampling	e.Coli (mpn/100ml)	Fecal (cfu/100ml)
BB-1 – Bacoate Branch at 8 River Arts Place	228	130
BB-2 – Bacoate Branch above Grey Eagle	816	230
TB-1 – Town Branch upstream of Depot Street	687	220
TB-2 – Town Branch downstream of South French Broad St.	579	230
TB-3 – Tributary to Town Branch upstream of McCormick Field	131	110
UT-1 – Haith Branch (previously Unnamed Tributary)	728	220

On 24 January 2020, water quality samples were collected at six sites in the watershed. The samples were taken during a wet period with active overland runoff occurring. The samples were analyzed by an NC DEQ laboratory and laboratory findings for bacterial indicators are presented below.

Sample Site – 24 January 2020 Wet-weather Sampling	e.Coli (mpn/100ml)	Fecal (cfu/100ml)
BB-2 – Bacoate Branch above Grey Eagle	739	550
BB-1 – Bacoate Branch at 8 River Arts Place	179	96
TB-1 – Town Branch upstream of Depot Street	2420	650
TB-2 – Town Branch downstream of South French Broad St.	>2420	780

The consistently high concentrations of these indicator bacteria are evidence that anything more than brief, incidental human contact is not advised for the three streams monitored during this project. The CAWRP includes projects and policy recommendations that can help address that impairment and the recommended long-term monitoring plan calls for continuing bacterial monitoring, a bacteria source tracking study, and tracking of bacteria through the CAWRP implementation period.

Water and Sediment Sampling – Chemical Analysis

The Environmental Quality Institute's (EQI) 2016 report on water quality trends[3] in Buncombe County, based on data collected by the Volunteer Watershed Information Network (VWIN), rated Town Branch as "Poor," assigning it a score among the five lowest in the County.   This report on chemical sampling results of waters across western NC, scores sites on a scale of 0 to 100. Comparing the biotic indices of Town Branch and Smith Mill Creek, Smith Mill Creek scored 67 while Town Branch scored 58. Taking a larger regional look, Town Branch was ranked 109 out of 146 VWIN assessment sites evaluated across western NC. Due to a lack of funding, the Town Branch VWIN program was suspended in 2016 and restarted in 2020 with funding secured for three years.

The following table, from the 2016 EQI report, shows the VWIN scores and composite rating for Asheville's urban streams. Note that analysis of the available data found no statistically significant trend (improvement or degradation) in water quality for Town Branch.

site #	site name	sediment	nutrients	overall	rating	trend
	VWIN - WNC Regional Average	**62**	**82**	**72**		
	Urban Watersheds of Asheville					
52	Buttermilk Creek	58	75	67	**Below Average**	
34	Lower Hominy Creek at SR 191	50	83	67	**Below Average**	
53	Moore Branch	50	67	58	**Poor**	
54	Nasty (Town) Branch	50	67	58	**Poor**	
35	Smith Mill Creek at Louisiana Blvd.	58	75	67	**Below Average**	↗
47	Glenn Creek at entrance to UNCA	75	67	71	**Average**	↗
7A	Glenn Creek at UNC-A Botanical Gardens	75	67	71	**Average**	↗
7B	Reed Creek at Reed Creek Confluence	75	67	71	**Average**	↗
55	Lower Reed Creek	50	67	58	**Poor**	
39	South Creek at Beaver Lake	67	75	71	**Average**	↗
8	Beaverdam Creek at Beaver Lake	75	83	79	**Average**	
	Average for this grouping	**62**	**72**	**67**		
	percent sites below regional average	**54%**	**82%**	**91%**		

Figure 26 VWIN Scores of Buncombe County Streams (1996)

During this project, sampling was conducted during dry and wet periods in Town Branch, Bacoate Branch and Haith Branch (a.k.a. Unnamed Tributary). The locations of the sampling sites are shown in the figure below. A summary spreadsheet of the water quality data collected during this project may be reviewed here:
(https://drive.google.com/file/d/1yyjjUzsn5q4XzefiulgyK5VO1ClDCIgX/view)

[3] Environmental Quality Institute, Water Quality Trends in Buncombe County Streams from 1990 to 2016: The Volunteer Water Information Network, Technical Report No. 17-3, Published July 2017.

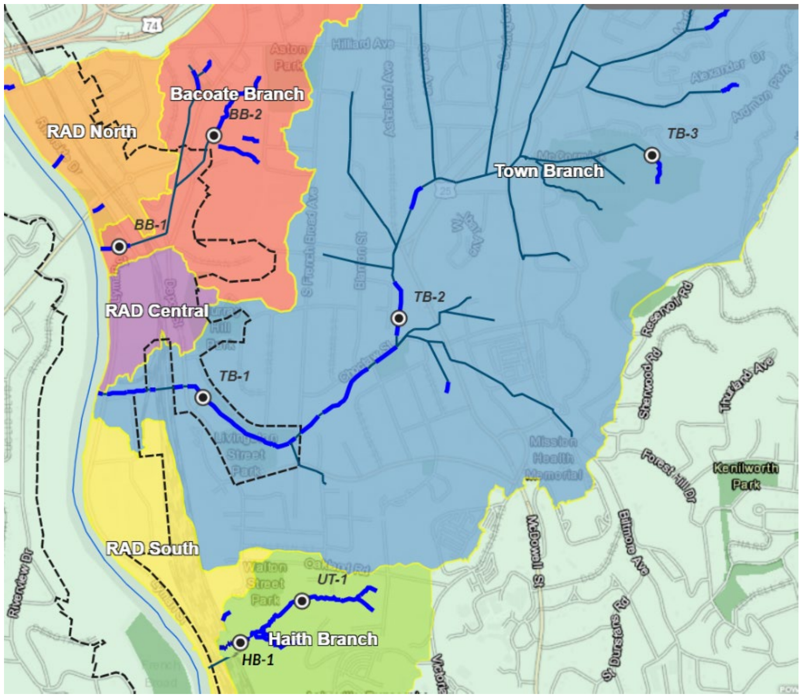

Figure 27 CAW Monitoring Sites

That testing tended to confirm the 2016 EQI conclusions and extended the water quality concerns to Bacoate Branch. In addition, the tests indicated concern for metals contamination in all three streams. Additional testing is required to confirm these findings. In the following tables constituents that are above a "level of concern" that warrants additional monitoring are highlighted with a tan background.

Site: TB-1: Nutrient Concentration (mg/l)								
Sampling Date	NH3 as N	NO2+NO3 as N	TP as P	TKN as N	K	Mg	Na	Ca
29-Oct-19		2.6	0.04		4.9	12.0	25.0	28
24-Jan-20	0.16	0.54	0.10	0.85	2.2	2.5	16.0	7.1

Site TB-1: Metals Concentration (ug/l)									
Sampling Date	Al	Ba	Cr	Cu	Fe	Mn	Ni	Pb	Sr	Zn
29-Oct-19		110			270	34			150	21
24-Jan-20	770	41		5.1	1600	61		2.5	41	31

Site TB-1: Additional Measures				
	Turbidity	COD	TDS	TSS
Sampling Date	NTU	mg/L	mg/L	mg/L
29-Oct-19	1.4		207	
24-Jan-20	22	22	82	26

Site: TB -2 Nutrient Concentration (mg/l)								
Sampling Date	NH3 as N	NO2+NO3 as N	P	TKN as N	K	Mg	Na	Ca
29-Oct-19		3.1	0.03		4.7	12.0	26.0	27
24-Jan-20	0.13	0.36	0.15	0.64	2.4	2.3	9.9	5.8

Site TB-2: Metals Concentration (ug/l)										
Sampling Date	Al	Ba	Cr	Cu	Fe	Mn	Ni	Pb	Sr	Zn
29-Oct-19		120			190	39			190	40
24-Jan-20	2100	58	5	12	3300	83	3.1	5.7	30	84

Site TB-2: Additional Measures				
Sampling Date	Turbidity	COD	TDS	TSS
	NTU	mg/L	mg/L	mg/L
29-Oct-19			196	
24-Jan-20	55	39	51	67

Sampling Site: TB-3 Nutrient Concentration (mg/l)								
Sampling Date	NH3 as N	NO2+NO3 as N	P	TKN as N	K	Mg	Na	Ca
29-Oct-19			0.03	0.22	3.5	5.8	11.0	8

TB-3 Metals Concentration (ug/l)										
Sampling Date	Al	Ba	Cr	Cu	Fe	Mn	Ni	Pb	Sr	Zn
29-Oct-19	960	85			1300	29			80	10

TB-3 Additional Measures			
	Turbidity	COD	TDS
Sampling Date	NTU	mg/L	mg/L
29-Oct-19	15		101

Site: BB-1: Nutrient Concentration (mg/l)								
Sampling Date	NH3 as N	NO2+NO3 as N	TP as P	TKN as N	K	Mg	Na	Ca
29-Oct-19	0.06	2.7			5.1	9.7	15.0	25
24-Jan-20	0.12	0.56	0.09	0.55	2.5	2.4	4.0	6.6

Site BB-1: Metals Concentration (ug/l)										
Sampling Date	Al	Ba	Cr	Cu	Fe	Mn	Ni	Pb	Sr	Zn
29-Oct-19	57	120			370	130	3.8		160	23
24-Jan-20	1500	56		25	2800	95	12	5.4	36	70

Site BB-1: Additional Measures				
	Turbidity	COD	TDS	TSS
Sampling Date	NTU	mg/L	mg/L	mg/L
29-Oct-19	2.6		152	
24-Jan-20	38	22	18	50

Site: BB-2: Nutrient Concentration (mg/l)								
Sampling Date	NH3 as N	NO2+NO3 as N	TP as P	TKN as N	K	Mg	Na	Ca
29-Oct-19		3.7			4.7	11.0	13.0	27
24-Jan-20	0.10	0.10	0.32	1.00	4.3	3.9	1.3	4.7

Site BB-2: Metals Concentration (ug/l)										
Sampling Date	Al	Ba	Cr	Cu	Fe	Mn	Ni	Pb	Sr	Zn
29-Oct-19		150			54	10			140	16
24-Jan-20	7600	150	12	42	12000	360	9.4	21	17	170

Site BB-2: Additional Measures				
	Turbidity	COD	TDS	TSS
Sampling Date	NTU	mg/L	mg/L	mg/L
29-Oct-19	1.7		150	
24-Jan-20	170	63	26	291

Site: UT-1: Nutrient Concentration (mg/l)								
Sampling Date	NH3 as N	NO2+NO3 as N	TP as P	TKN as N	K	Mg	Na	Ca
29-Oct-19		2.8			3.2	5.2	5.1	12

Site UT-1: Metals Concentration (ug/l)										
Sampling Date	Al	Ba	Cr	Cu	Fe	Mn	Ni	Pb	Sr	Zn
29-Oct-19	120	120			220	21			61	

Site UT-1: Additional Measures				
	Turbidity	COD	TDS	TSS
Sampling Date	NTU	mg/L	mg/L	mg/L
29-Oct-19	2.5		57	

Contaminants in a stream's bed can impact aquatic organisms and may be introduced into the water column by scour, changes in the water’s acidity and other means. On 5 November 2019 sediment samples were collected from one site on each of the three major tributaries and analyzed for a wide range of potential contaminants. All the sediment samples were collected from a submerged area between 1 and 5 inches below the top of the creek bed. The table below presents the levels of contaminants detected at above the DEQ laboratories’ minimum reporting levels.

CAW Sediment Sampling Laboratory Results 5 November 2019					
Constituent	**Symbol**	**units**	**TB-1**	**BB-1**	**UT-1**
Silver	Ag	mg/Kg		0.25	
Aluminum	Al	mg/Kg	10000	11000	6200
Arsenic	As	mg/Kg	0.78	1.5	0.85
Barium	Ba	mg/Kg	120	130	37
Cadmium	Cd	mg/Kg		0.25	
Calcium	Ca	mg/Kg	1500	1300	190
Cobalt	Co	mg/Kg	11	15	
Chromium	Cr	mg/Kg	35	37	22
Copper	Cu	mg/Kg	35	29	5.3
Iron	Fe	mg/Kg	29000	30000	8700
Lead	Pb	mg/Kg	16	25	7
Mercury	Hg	mg/Kg	0.02	0.02	0.06
Magnesium	Mg	mg/Kg	4200	410	1000
Manganese	Mn	mg/Kg	370		110
Molybdenum	Mo	mg/Kg		0.43	
Nickel	Ni	mg/Kg	11	21	2.9
Potassium	K	mg/Kg	4300	3500	780
Selenium	Se	mg/Kg		0.23	
Sodium	Na	mg/Kg	100	94	31
Strontium	Sr	mg/Kg	6.4	10	1.6
Zinc	Zn	mg/Kg	110	140	52
Aroclor1260		ug/Kg		98.6	
alkanes		ug/Kg		210	
Chrysene		ug/Kg		680	
Fluoranthene		ug/Kg		1400	
perylene		ug/Kg		470	
Phenanthrene		ug/Kg		880	
Pyrene		ug/Kg		1400	
TPH		mg/Kg	47		17

The contamination in these streams are typical of urban streams across North Carolina. The water quality data assembled for, and collected during, this project indicates that both Bacoate Branch and Town Branch are not safe for prolonged human contact, their aquatic ecosystems are impaired, and they are delivering high concentrations of pollutants to the French Broad River.   Those streams are impaired. While Haith Branch may not rise to the level of being called impaired, it is certainly stressed by stormwater runoff from the A-B Tech campus and by the lack of appropriate stormwater control measures.

While there may not be enough data that meets the necessary NCDEQ standards for data collection and analysis for NCDEQ to take the regulatory step of designating the waters as impaired, that should not preclude taking restoration action. As further data is collected, the formal declaration of these streams as impaired waters may assist in obtaining funding to address the sources of contamination and to provide appropriate treatment and remediation.

Illicit Discharges into Town Branch

Figure 28 Black water from unknown source in Town Branch.

Figure 29 Black water in Town Branch near the French Broad.

There have been several reports of illicit discharges of both black and white materials into Town Branch over the years, the latest reports occurring during this study. The North Carolina Division of Water Resources (NC-DWR) has investigated those reports, making observations, and collecting water samples to determine the nature of the illicit materials and determine the sources. Unfortunately, the investigations have not always reached conclusions on either the nature of the materials or their source.

Several illicit discharges were observed during this study, including:

- Washing of commercial vehicles immediately above a stormwater inlet without the use of inlet protection or other best management procedures.
- Inadequate erosion and sediment control measures at a construction site.
- Improperly stored material at a metal fabricating facility that let to a white water discharge to Bacoate Branch.

Figure 30 White water discharge into Town Branch.

In addition to presenting potential health and safety concerns for anyone in or near the receiving water, illicit discharges can have severe and long-lasting impacts on the aquatic ecosystem.

Successful restoration of the watershed will require improved detection and source identification of illicit discharges. Improving the use of best management practices and enforcement of stormwater pollution prevention plans at facilities and construction sites across the watershed will be required.

Estimated Pollutant Exports

Numerous studies in North Carolina and across the nation have provided estimates of the amount of pollutants exported (contained in runoff) from various land uses. Those estimates were examined and adjusted for local conditions (water quality sampling and laboratory analyses) during the development of a watershed master plan for Asheville's Ross Creek watershed (Brown and Caldwell, August 2007). The pollutant export coefficients adopted for that plan are shown in the following table (labeled: Table 5-15. Pollutant Export Coefficients) from the Ross Creek Master Plan. Documentation of the research supporting the adopted values is contained in the Ross Creek Master Plan.

Table 5-15. Pollutant Export Coefficients

Land Use Type	Total Nitrogen (lbs/ac/yr)	Total Phosphorus (lbs/ac/yr)	TSS (lbs/ac/yr)	Fecal (cu*10^9/ac/yr)
Residential <10 Acres	10.9	1.0	450	9.04
Residential >10 Acres	1.6	0.2	160	6.85
Agricultural	6.2	0.9	1800	10.41
Apartment Complex	12.3	1.5	450	9.04
Commercial	13.6	2.0	300	2.74
Institutional: Religious	13.6	2.0	300	2.74
Public Service	22.6	2.6	300	2.74
Road and ROW	22.6	2.6	300	9.04
Residential >10 Acres: Vacant	1.6	0.2	90	0.68
Residential <10 Acres: Vacant	1.6	0.2	90	0.68
Commercial: Vacant	1.6	0.2	200	1.37

For estimating the export of pollutants from the CAW under current (2019) conditions, each of the land use categories was assigned a water quality code (see following table).

WQ Code	Area (Acres)	Area (%)	Land Use Category
1	33.95	2.6%	Unknown
2	58.27	4.5%	HD Residential
3	225.67	17.4%	Mixed & MD Residential
4	69.91	5.4%	LD Residential
5	247.59	19.1%	Services - Food,Medical,Auto
6	417.70	32.2%	Commercial & Services - Financial, etc.
7	3.83	0.3%	Roads and Pavement
8	70.58	5.4%	Vacant - Natural Area
9	122.69	9.5%	Vacant
10	46.04	3.6%	Manufacturing/Storage

The pollutant export coefficients assigned to each land use category are shown below.

	Estimated Annual Export Rate			
WQ Code	TN	TP	TSS	Fecal
	lbs/ac-yr	lbs/ac-yr	lbs/ac-yr	cu*10^9/ac-yr
1	11.2	1.4	275	5.21
2	12.3	1.5	450	9.04
3	10.9	1	450	9.04
4	1.6	0.2	160	6.85
5	16.6	2.2	300	2.74
6	13.6	2	300	2.74
7	22.6	2.6	300	9.04
8	1.6	0.2	90	0.68
9	1.6	0.2	125	0.91
10	19.6	2.4	300	5.89

The current estimated average annual exports of nutrients, sediment, and bacteria (fecal coliform) from the three primary tributaries that drain through the River Arts District follows:

	Total by Watershed Annual Export (units/yr)			
Watershed	TN (#)	TP (#)	TSS (#)	Fecal (cfu*10^9)
Town Branch	11661	1478	334279	5337
Bacoate Branch	2313	305	54857	770
Haith Branch	1119	159	27364	329

The average annual export per acre in each subwatershed follows:

	Average by Watershed Annual Export (units/acre-yr)			
Watershed	**TN (#)**	**TP (#)**	**TSS (#)**	**Fecal (cfu*10^9)**
Town Branch	11.16	1.41	319.82	5.11
Bacoate Branch	14.39	1.90	341.40	4.79
Haith Branch	12.28	1.75	300.37	3.61

The next four figures illustrate the spatial distribution of estimated average annual pollutant exports by catchment.

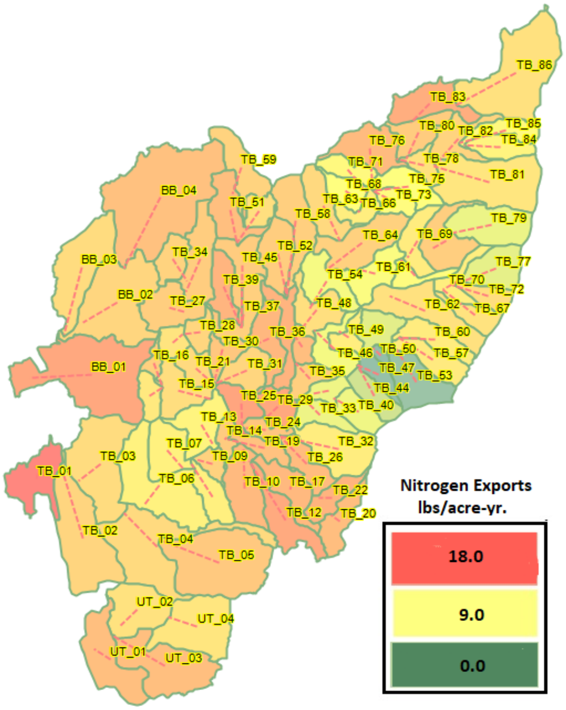

Figure 31 Estimated Total Nitrogen Exports

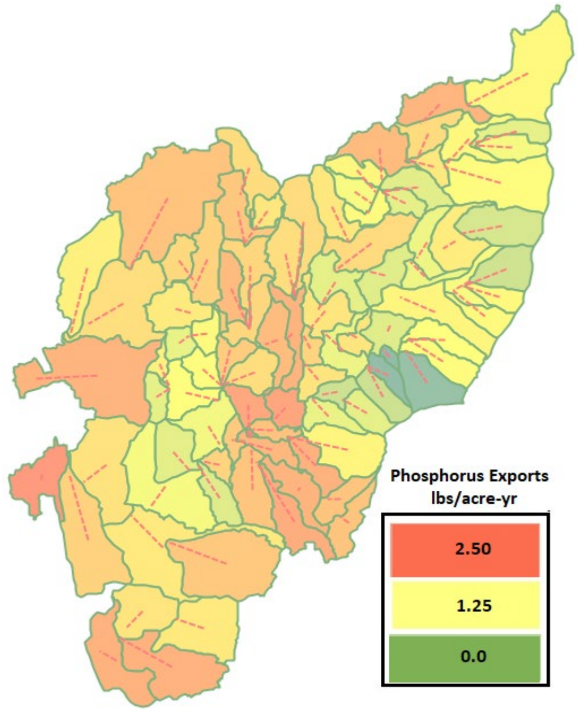

Figure 32 Estimated Total Phosphorus Exports

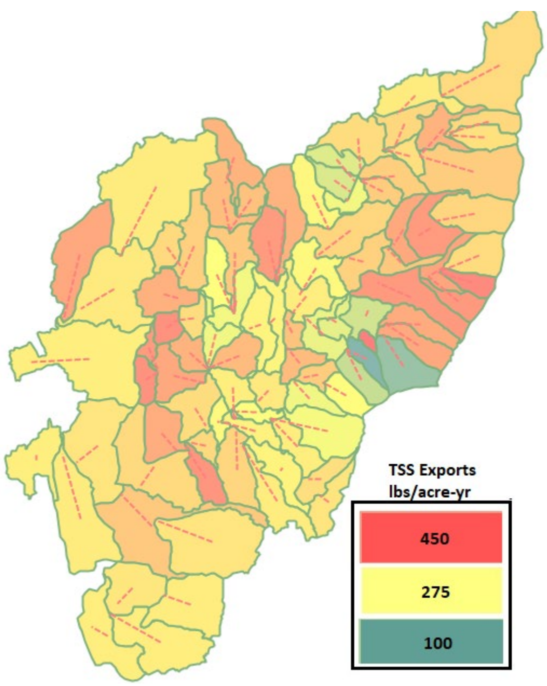

Figure 33 Estimated TSS Exports

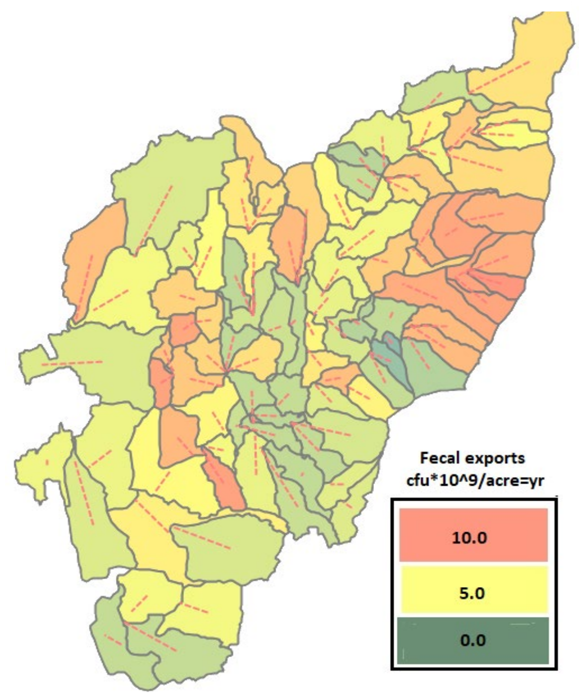

Figure 34 Estimated Fecal Coliform Exports

Field Assessment Observations

During this project, the project team recorded remote and field observations and notes at over 400 locations around the watershed (see table below). The observations are categorized by:

- Macroinvertebrates and Water/Sediment Quality Sampling – In-stream observations that result in quantified assessments of water quality conditions (see Water Quality tab).
- Watershed Hot Spots – Observations of notable conditions. These may report locations that needed further investigations during the field assessments.
- Utility Conditions – Observations of sewer and stormwater infrastructure
- Existing and Potential SCMs – Existing SCMs were examined for function and retrofit opportunities. Additional observations were made where new SCMs may be needed.
- Stream Reach Assessments & Linear Features – The reach assessments included notes of the degree of incision of the streams, bank conditions, riparian area conditions, in-stream habitat and other characteristics. Other linear features included in this category include features such as swales, gullies, ditches and longitudinal seeps.
- Neighborhoods and Other Areas – Observations of stormwater conditions within a localized area.
- Misc. Notable Points – Includes observations of trash, poorly managed dumpsters, locations of invasive species and other environmental conditions.

Observation Type	Number of Observations
Macroinvertebrates and Water/Sediment Quality Sampling	19
Watershed Hot Spots	83
Utility Conditions	42
Existing and Potential SCMs	89
Stream Reach Assessments & Linear Features	58
Neighborhoods and Other Areas	16
Misc. Notable Points	134
Total	**441**

Note that many of the observations relate to the same, or related, physical features but were made independently by different staff, often with a different focus on the problem or opportunity.

Following the field assessments, senior project staff reviewed the data and assigned a priority value of 0, 1 or 2 to each significant observation that was specifically related to a watershed problem or restoration opportunity. While all the observations are relevant to assessing water quality, higher priorities were assigned to those needing further investigation or that represent potential water quality improvement measures.

Figure 35 presents the observations that were assigned priority equal to or greater than zero. These observations received further evaluation and, in many cases, presented areas that were targeted for water quality improvement measures and/or specific projects in the watershed restoration plan.

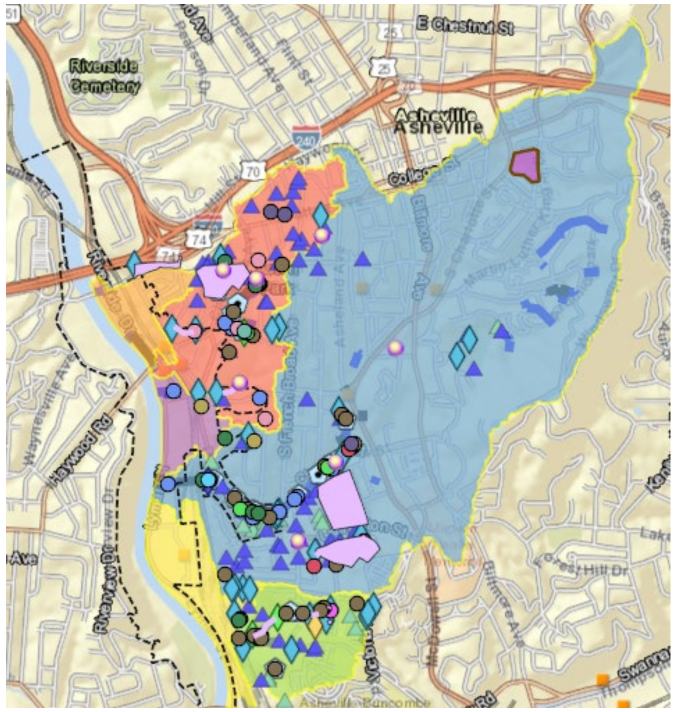

Figure 35 Field Assessment Observations assigned a Priority

Examples of the points and areas assigned priority 2 include:

- Areas of severe erosion identified in the Bacoate Branch and Haith Branch subwatersheds. Many of these areas may be addressed by Regenerative Stormwater Conveyance (RSC) measures.
- Opportunities to achieve stream bank and riparian area improvement and conveyance improvements at several reaches along Bacoate and Town Branches.

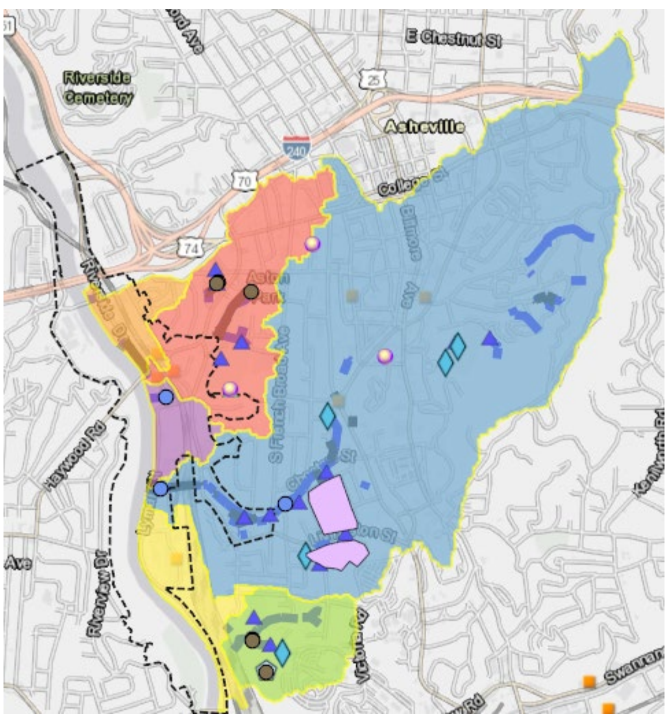

Figure 36 Field Assessment Observations with priority > 1

- An opportunity to expand a planned stormwater capital improvement project to provide increased street flooding mitigation and water quality treatment.
- Neighborhoods and community centers where there are good opportunities to disconnect impervious areas from the stormwater system, implement rainwater harvesting, and use harvested rainwater to support community gardens and landscape irrigation.
- Locations of sanitary sewer repairs and improved maintenance.
- Opportunities to retrofit existing SCMs for improved water quantity and quality and to construct new SCMs.

Explore the field observations in the interactive StoryMap (https://bit.ly/3ib96X7)

Future Watershed Conditions

The purpose of this watershed assessment is to support the development and implementation of the watershed restoration plan. Objectives of the plan include improving water quality and the stream and riparian ecosystems. In that objective is the desire to increase the safety of human contact with the watershed's streams and the reconnection of the community with those streams. Progress on accomplishing those goals will require years of consistent effort. The CAWRP recommends the initiation of projects over a seven-year period. Project completion and obtaining results will take longer. Thus, in addition to the snapshot of the current watershed conditions, it is necessary to look at the likely changes in the watershed over the coming decade.

To develop a view of the likely change of the CAW over the next ten years, City and other planning reports were reviewed, with attention paid to:

- Current zoning within the City,
- Living Asheville: A Comprehensive Plan for Our Future adopted by the City Council in June 2018,
- GroWNC Regional Plan prepared by the Land of Sky Regional Council of Governments, and
- Asheville's East of the Riverway project and its reports on Alternatives to Gentrification and Equitable Development.

LIVING ASHEVILLE
A COMPREHENSIVE PLAN FOR OUR FUTURE
Adopted June 2018

In developing estimates of the impact of growth and development on the CAW, the City's Preferred Growth Scenario and the Land of Sky Preferred Growth Scenario for the region were adopted. It was further assumed that measures to control gentrification and provide for equitable development identified in the City's reports would impact future development.

Asheville's current population exceeds 92,000 people with an expected increase of over 10,000 during by 2030. Total economic development will likely keep pace with, or exceed, the residential development in the City and in the CAW. Many people who work and recreate in Asheville live outside the City. Currently nearly 76% of Asheville's workforce live outside the City limits. While that percentage is likely to hold, increases in population and residential density within the CAW and the City's expected growth area are expected to exceed the City average in the coming decade. The following table presents an overview of the expected changes in population and housing density in Asheville, along with a look at how that growth will likely cluster into identified Growth Areas.

Three Generations of Future Growth

	2018	2023	2028
City of Asheville Population	91,000	96,000	101,000
City of Asheville Population Density	3.2 pers/acre	3.3 pers/acre	3.5 pers/acre
Percent of the City Living Within 1/4-mile Growth Area	20%	24%	28%
Population Density of the 1/4-mile Growth Area	3.3 pers/acre	4.2 pers/acre	5.1 pers/acre
Percent of the City Living Within 1/2-mile Growth Area	60%	63%	64%
Population Density of the 1/2-mile Growth Area	3.4 pers/acre	3.7 pers/acre	4 pers/acre

Figure 37 Asheville's Projected Growth 2018-2028

Innovation Districts are important components of Asheville's growth plans. There are three innovation districts contained, at least in part, in the CAW:

- Asheville's Downtown has been identified as an Innovation District and a Growth Area due to its significance as an economic center for the entire region.
- South Slope is just south of the Downtown area and is currently a robust mix of uses including residences, entertainment, service and industrial businesses, breweries, art establishments, and medical services. The area is transforming with industrial properties being redeveloped into urban residential and service business uses. Public infrastructure investments and zoning are being used as means of guiding the development toward the City's preferred growth scenario and meeting the goals of equitable development.
- River Arts District was designated to support redevelopment and growth in the Swannanoa and French Broad River corridors. The RAD is a designated business corridor of artist studios, river outfitters, retail, bars and restaurants and other service businesses. Major public investment in the district include the RAD Transportation Improvement Plan (RADTIP). Continued redevelopment in the RAD will likely significantly transform this area over the coming decade, impacting not only the designated innovation district but the neighborhoods that adjoin it and lie along the primary transportation routes linking the RAD to the downtown area, the Mission Hospital area, and elsewhere.

The mechanics of developing a quantitative scenario of 2030 watershed conditions involved using GIS and the City's parcel data to review each of the catchments defined for the watershed model and the selection of parcels that have a likelihood of development or redevelopment over the next decade. Factors considered included: current land use and assessed value, proximity to transportation corridors and bus routes, the parcel's location in an innovation or preferred growth area, and maintenance of the current character of neighborhoods. While the reassignment of land use to any parcel may be incorrect, in aggregate the 2030 scenario developed for the future watershed model is consistent with the City's Preferred Growth Scenario.

Estimated Impacts on the Watershed

The in-fill development, changes in impervious area and changes in parcel use in coming years will have an impact on the hydrology and the water quality of stormwater runoff. This section examines the expected changes in impervious area between 2019 and 2030 and estimates the increases in stormwater runoff and stormwater collection and conveyance system flooding that will result. Following that analysis, the changes in the export of pollutants were estimated using the same procedures and land use-based export coefficients applied previously in this report.

Changes in Impervious Area and Stormwater Runoff

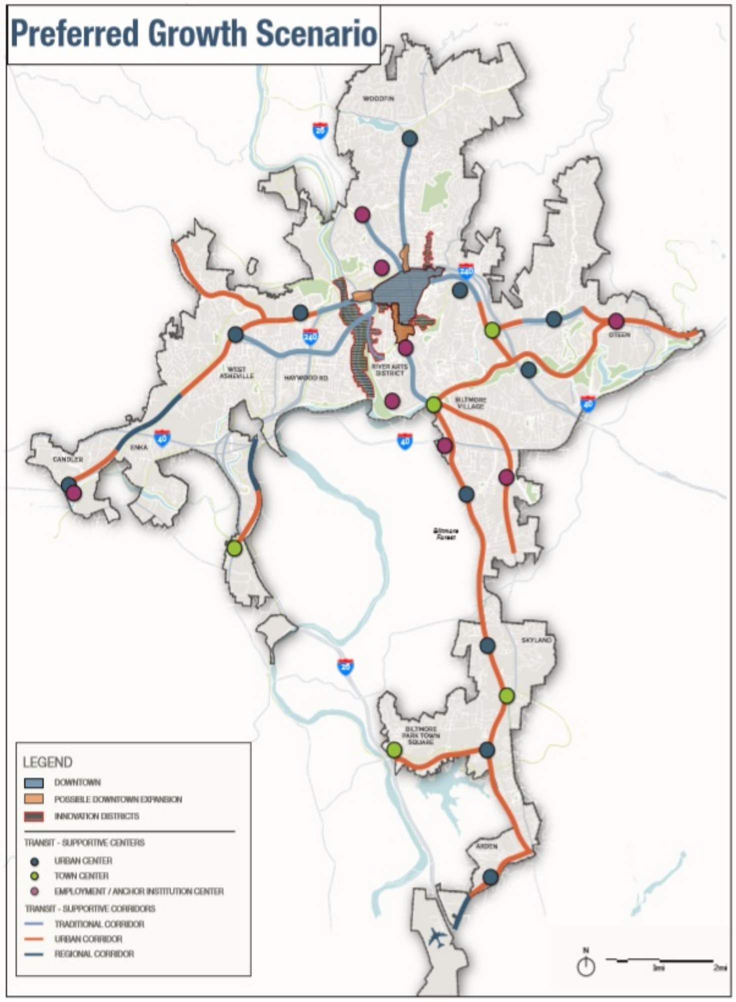

Figure 38 Asheville's Preferred Growth Scenario.
[Living Asheville: A Comprehensive Plan for Our Future]

To estimate the change in impervious area in each catchment, the current parcel land use data was compared with the City's Preferred Growth Plan. Among the most significant observations were the expectation that the City's "downtown" area is likely to extend westward and downslope in the Bacoate Branch subwatershed and that the Biltmore Avenue and McDowell Street corridors will continue trends toward higher density and commercial use. Throughout most of the watershed it was assumed that over one-half of the privately-owned, vacant parcels would be developed in ways consistent with the City's Preferred Growth Plan. In the catchments intersecting the growth corridors that was interpreted as development of parcels into commercial and high-density residential units. In other area in-fill development was generally assigned to either medium of high-density residential with some commercial development depending upon the current characteristics of the neighborhood and proximity to major transportation corridors and existing commercial land use. Note that the increase in impervious percentage noted below should be interpreted as increase in "effective" impervious area. That is, the table assumes that future development will, on average, meet higher development standards than past development in terms of controlling impervious area created and in the implementation of stormwater control measures (SCMs).

	Impervious %		Difference
Watershed	**2019**	**2030**	**11 Years**
Town Branch	43.6%	45.9%	2.2%
Bacoate Branch	50.6%	52.9%	2.2%
Haith Branch	31.0%	32.6%	1.7%

Increases in the effective impervious area leads to increased stormwater runoff and to higher peak discharge rates. The SWMM model used to examine 2019 flooding in the watershed was adjusted to represent the expected 2030 conditions and the runoff and flooding recomputed. The following table presents the additional number of stormwater system locations where flooding is expected to occur due to the increase in impervious area between 2019 and 2030. The right-most two columns show the volumetric increase in total watershed runoff and in the stormwater system flooding. Note that the expected flooding is based on the current (2019) infrastructure.

Event	Bacoate Branch		Town Branch		Entire Modeled Watershed	
	# of Nodes Flooding	# Nodes Flooding more than 10,000 $feet^3$	# of Nodes Flooding	# Nodes Flooding more than 10,000 $feet^3$	Increase in total runoff volume (million gallons and percentage)	Increase in total flood volume (million gallons and percentage)
Annual	0	1	0	0	1.32 (3.0%)	0.114 (17.3%)
2-Year	1	1	0	0	1.48 (2.7%)	0.193 (16.0%)
5-Year	2	1	1	0	2.71 (3.7%)	0.232 (9.9%)
10-Year	0	0	1	0	1.02 (1.1%)	0.274 (7.6%)
25-Year	0	0	1	1	1.89 (1.8%)	0.448 (7.4%)
50-Year	0	0	1	1	1.95 (1.6%)	0.434 (5.0%)
100-Year	0	0	4	3	2.10 (1.5%)	0.557 (4.7%)

Increased Pollutant Exports

The method used to estimate pollutant exports from the watershed is based on parcel use, only indirectly accounting for impervious area. The following tables present the estimated pollutant exports for 2030, represent the 2019 exports, and tabulate the expected increases in total units and percentage. No adjustments have been made to account for the potential for improved land use practices and maintenance. Thus, we hope, the tabulated increases represent a “worst case” analysis given the City’s development plan. The means by which the expected increases may be avoided, and future water quality improved over current conditions, will be addressed later in this report.

2030	Total by Watershed Annual Export (units/yr)				Average by Watershed Annual Export (units/acre-yr)			
Watershed	TN (#)	TP (#)	TSS (#)	Fecal (cfu*10^9)	TN (#)	TP (#)	TSS (#)	Fecal (cfu*10^9)
Town Branch	12356	1573	348879	5572	11.82	1.50	333.79	5.33
Bacoate Branch	2486	327	58803	820	15.47	2.04	365.95	5.10
Haith Branch	1161	163	28616	339	12.74	1.79	314.11	3.72

2019	Total by Watershed Annual Export (units/yr)				Average by Watershed Annual Export (units/acre-yr)			
Watershed	TN (#)	TP (#)	TSS (#)	Fecal (cfu*10^9)	TN (#)	TP (#)	TSS (#)	Fecal (cfu*10^9)
Town Branch	11661	1478	334279	5337	11.16	1.41	319.82	5.11
Bacoate Branch	2313	305	54857	770	14.39	1.90	341.40	4.79
Haith Branch	1119	159	27364	329	12.28	1.75	300.37	3.61

Difference	Total by Watershed Annual Export (units/yr)				Average by Watershed Annual Export (units/acre-yr)			
Watershed	TN (#)	TP (#)	TSS (#)	Fecal (cfu*10^9)	TN (#)	TP (#)	TSS (#)	Fecal (cfu*10^9)
Town Branch	695	95	14600	236	0.67	0.09	13.97	0.23
Bacoate Branch	173	23	3945	50	1.08	0.14	24.55	0.31
Haith Branch	42	4	1252	10	0.46	0.04	13.74	0.11

Difference (%)	Total by Watershed Annual Export (units/yr)			
Watershed	TN	TP	TSS	Fecal
Town Branch	6.0%	6.5%	4.4%	4.4%
Bacoate Branch	7.5%	7.4%	7.2%	6.5%
Haith Branch	3.7%	2.4%	4.6%	2.9%

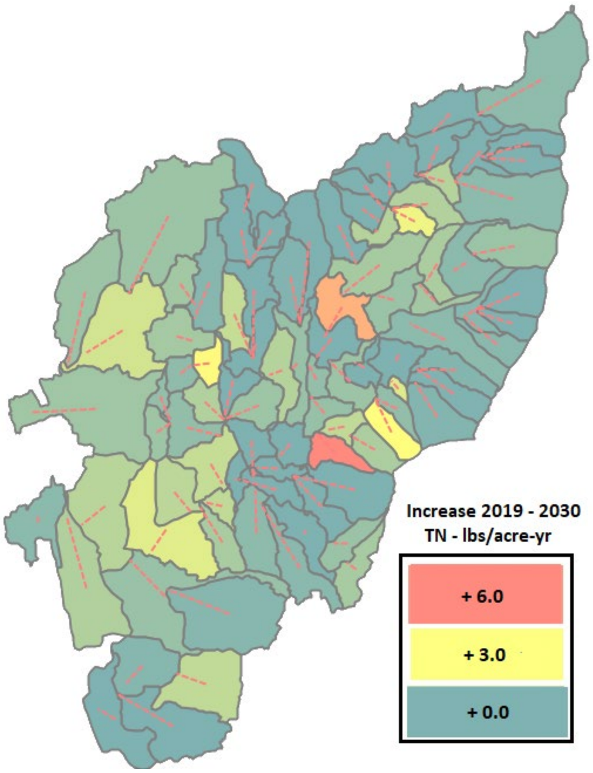

Figure 39 Expected increase in annual Nitrogen exports by 2030.

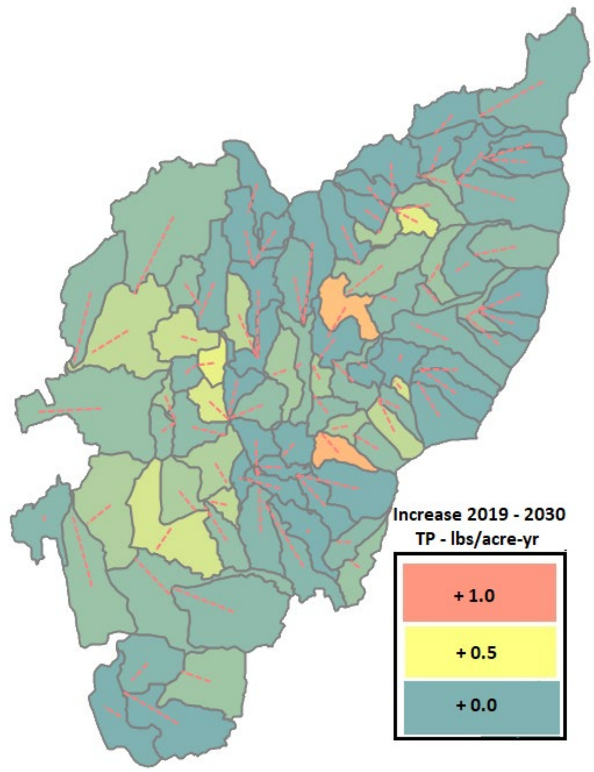

Figure 40 Expected increase in annual Phosphorus exports by 2030.

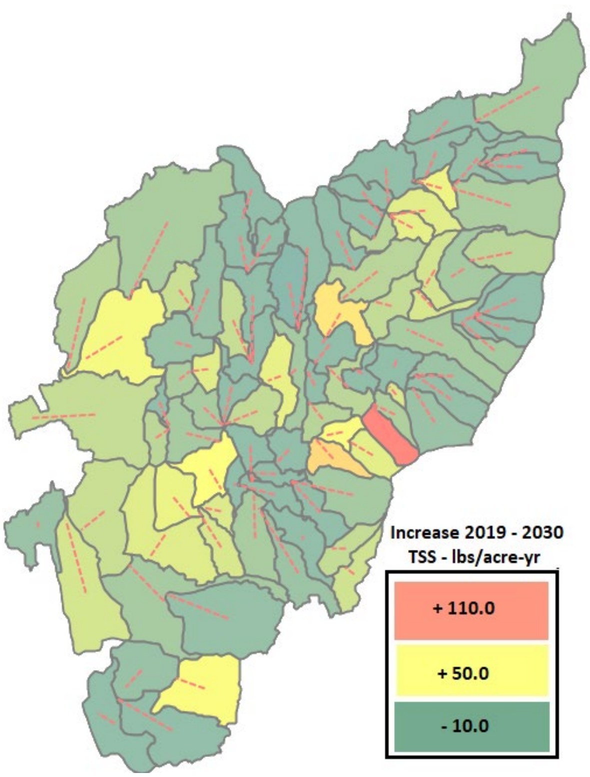

Figure 41 Expected increase in annual Total Suspended Solids exports by 2030.

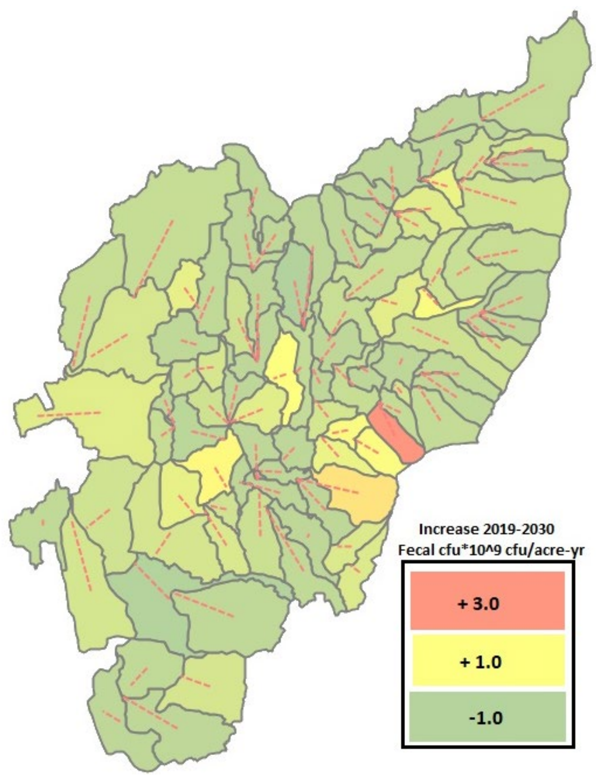

Figure 42 Expected increase in annual Fecal Coliform exports by 2030.

Sources of Impairment

The NC Department of Environmental Quality has the responsible to determine the State's waters to be classified as "impaired" by failure to meet standards and to support their designated uses. In this report, impairment is used only in the sense that the condition is likely significant and adverse to human and aquatic life, without determining whether the stream should be listed as "impaired."

There are many potential sources of water quality and aquatic habitat impairment in urban watersheds. Conditions that could led to water quality impairment are certainly prevalent in the CAW. The following briefly describes some of the common sources of impairment in urban streams and notes the evidence available regarding that source in the CAW.

Impervious Area - Generally, studies have found that statistically significant water quality impairment occurs when the percentage of impervious area in a watershed rises above 10 percent. As previously reported, the CAW has an impervious percentage above 40 percent. There are a number of factors that cause highly impervious watersheds to have biological impairments, including:

- Highly impervious watersheds have "flashy" hydrology. Because rainwater cannot collect on, and soak into, the ground, the discharge in streams rises quickly during a rainfall event and falls quickly following rainfall. This creates a less stable aquatic environment, less sustaining of aquatic life and habitat.
- The elevated discharges and associated high stream velocities that result from highly impervious areas can cause excessive erosion. The CAW's streams are deeply incised from years of erosive flows. In many reaches the streams are eroded to bedrock and become wide enough to accommodate elevated discharges, limiting erosion. Bedrock streams often exhibit a lack of diversity of aquatic habitat, impairing their biological functions. Also, repeated incidence of sediment accumulation during low-flows, followed by extensive bed material scouring during high-flows destroys stream habitat. Finally, small tributaries to the main streams have had their gradients increased and many are having extensive "headcutting" upstream of their confluence with the larger stream, destroying the tributary habitat and delivering heavy sediment loads to the larger stream. These impacts have been observed throughout the CAW.
- Large areas of roadway and parking lot pavement get extremely hot during sunny, summer days. When rainfall occurs on those areas and quickly runs off, the watersheds stream temperatures rise rapidly, harming aquatic life.
- Roadways and parking lots are often "sealed" with coal tab-based sealants or other materials high in Polycyclic Aromatic Hydrocarbons (PAHs). PAHs are known to be carcinogenic and harmful to aquatic life. While there is no direct data on the use of high-PAH concentrate sealants in Asheville, other NC cities have documented their extensive

use. Several NC cities have banned, or regulated, the use of high-PAH sealants and others have pending regulations. Asheville does not restrict the use of high-PAH sealants.

Dense urban infrastructure, transportation, stormwater and sanitary is associated with water quality impairment. Some of the mechanisms include:

- The use of salt and other de-icing materials on roadways, parking lots and sidewalks can have harmful impacts upon aquatic life. Asheville's winter climate, steep slopes and highly impervious areas make this a likely suspect for water quality impairment.
- Bridges and culverts for urban streets often concentrate flows, increase stream velocities and disconnect natural channels, adversely impacting stream habitat.
- In urban areas the stormwater sewer system is designed to provide positive drainage to roadways and properties and to quickly collect and convey stormwater from an area. The City of Asheville designs it stormwater collection system to avoid significant roadway flooding for all storms up to the 25-year (4% chance of occurrence in any given year) storm event. Most of the mileage of the historical stream beds of Bacoate and Town branches and their tributaries are now enclosed in stormwater pipes and tunnels. The natural, biological functions of streams do not operate in a closed, piped environment. Any substantial reach of piping that separates open channel reaches of a stream impedes the movement of aquatic life in the stream. This condition is prevalent in the CAW.
- Urban land uses, particularly medium and high-density residential areas and other special uses (e.g. dog parks, ponds that host geese) often have high bacterial counts in their runoff. Stormwater systems that quickly collect runoff and move it underground, limits the exposure of bacteria to oxygen and sunlight that deactivate pathogens.
- As previously noted, there are many miles of sanitary sewers and related infrastructure in the CAW. All such systems have a certain amount of leakage and spillage. The fecal and e-coli water quality collected in the CAW, particularly the low-flow water quality samples taken during this study, are an indication of sanitary sewer leakage.

Contaminated groundwater is a concern in the CAW, particularly during low-flow periods. As noted earlier in this report, the following constituents of primary concern (COPCs) were identified:

- Chlorinated solvents, in particular PCE and related daughter products: PCE is one of the most common chlorinated solvents and is a chemical commonly used in the dry-cleaning industry. It is also used as a chemical intermediate, and for various degreasing applications. PCE is associated with multiple health effects. Groundwater impacted by PCE often results in a laterally extensive groundwater plume and therefore is more likely to reach and impact surface water when groundwater is discharging to a surface water body.
- Petroleum constituents: Petroleum constituents include many compounds differentiated by their relative carbon fractions. Petroleum generally contains benzene, toluene, ethyl

benzene and xylene, (often referred to as BTEX compounds). These compounds are generally more toxic than other petroleum constituents.

Trash in streams not only reduce the aesthetic value of streams but present a physical hazard to human and animal use of the stream. A large amount of trash was observed throughout the Bacoate and Town Branch subwatersheds and in certain reaches of Haith Branch.

Invasive aquatic and terrestrial plants can impact the water quality and the use of streams. There are significant portions of the open channel reaches of the CAW streams that have extensive stands of invasive plants.

Community Outreach and Education

A successful watershed restoration effort requires building collaboration across a broad range of stakeholders. The following is a list of stakeholders who participated and supported this project.

- A-B Technical Community College faculty and staff
- A-B Tech Sustainability Committee
- Asheville Greenworks
- Bountiful Cities
- City of Asheville Housing Authority
- City of Asheville Parks & Recreation
- City of Asheville Stormwater
- Environmental Quality Institute
- French Broad River Academy
- French Broad River Partnership
- Land of Sky Regional Council
- Mountain True
- Metropolitan Sewerage District of Buncombe Co.
- NC Department of Environmental Quality
- NC Department of Transportation
- River Arts District Business Assoc.
- River Arts District Artists Assoc.
- Southside Rising
- South French Broad Neighborhood Assoc.
- West-Asheville Clingman Neighborhood Assoc.

Those organizations provided representatives at stakeholder meetings, supplied data from their organizations, reviewed selected findings from the field assessments, discussed the desirability and feasibility of proposed watershed restoration projects and assisted in other ways. The NC Department of Environmental Quality – Division of Water Resources (NCDWR) assisted in the collection of water quality samples and provided sampling supplies and laboratory services. NCDWR also provided a stream assessment team that performed macroinvertebrate sampling and stream assessment along Town Branch during June 2020.

Among the stakeholder outreach events and meetings conducted during the project were:

- Key Stakeholder Kick-off Meeting (14 Aug 2019)
- Haith Branch Reconnaissance with A-B Tech Faculty and Staff (17 Sep 2019)
- Meeting with City of Asheville Neighborhood Services (19 Sep 2019)
- Meeting with A-B Tech Sustainability Committee (11 Oct 2019)
- Presentation booth at the Grant Center Fall Festival (2 Nov 2019)
- Information booth at the French Broad River Partnership Annual Meeting (6 Nov 2019)
- Water and Art - Project Open House (15 Nov 2019)
- Presentation at the Collider -Asheville's Climate Center (11 Dec 2019)
- Meeting with City of Asheville Capital Projects Staff (7 Feb 2020)
- Ecologist Reconnaissance of Haith Branch Watershed (14 Feb 2020)
- Meeting with City of Asheville Housing Authority Staff (20 Feb 2020)

Additional outreach and education efforts included an on-line community survey (Survey: https://docs.google.com/forms/d/1RxPmMQVyqZrt37vuY1swPcWp0gijGP2VyErpcd_V5GA/viewform?edit_requested=true). Early results on the community responses can be reviewed at: https://drive.google.com/file/d/1zbu5ulEVHNv6F8TDXNpO8vt8wbVSn3uk/view?usp=sharing.

In addition, RiverLink ran a successful Name that Creek Campaign that resulted in the Unnamed Tributary to the French Broad River below the A-B Tech campus being named Haith Branch. This name has been endorsed by Asheville City Council and will be submitted to the US Geological Survey naming committee.

The outreach and education efforts were important to the project in many ways. First, stakeholders brought a wide range of watershed and community issues to the attention of the project team and informed the team about past and current efforts to address those issues. Similarly, stakeholders brought knowledge of the locations, character and constraints on potential projects that could be included in the watershed plan. Just as important, the stakeholders provided additional outreach to additional organizations and to community members whose support and collaboration will be necessary to complete the CAWRP.

Figure 43 CAWRP information booth at the Grant Center Fall Festival

Targeted Areas and Opportunities

The field assessment, stakeholder discussions and subsequent analysis resulted in 49 specific physical projects being developed for the CAWRP, along with recommendations for 12 policy initiatives and volunteer-based programs. Further information on each of those recommendations are available in the Appendix – Prioritized Projects and on the interactive StoryMap.

There are five areas in the CAW that have been targeted for concentrated restoration actions:

- Haith Branch Subwatershed
- Area above McCormick Field
- The Livingston Heights, Congress and Pine Grove Neighborhoods
- The Nasty Branch Greenway Corridor
- Upper Bacoate Branch Subwatershed

These areas were chosen because they presented several priority watershed and stormwater management problems that need addressing and because the restoration team was able to identify potential sites and projects that would address the needs. Many, but not all, of the recommended projects lie within these targeted areas. The following provides brief descriptions of each of the targeted areas.

Targeted Area – Haith Branch Subwatershed

This targeted area is the entire Haith Branch subwatershed that lies between the AB-Tech campus and Walton Street Park. It is comprised of project analysis units UT-01, UT-02, UT-03 and UT-04[4], containing a total of 91.1 acres with an average slope of 16.7 percent and aggregate impervious ratio of 30.6 percent. The watershed is comprised of residential properties and Walton Street Park in the north, residential and commercial properties in the east, and the AB-Tech campus to the south. The western portion of the watershed is comprised of woods and the railroad yard. Haith Branch runs from Haith Drive, through a

Figure 44 Haith Branch Subwatershed

[4] Haith Branch was previously known as Unnamed Tributary to the French Broad River. The analysis units and their labels were determined prior to the stream being named.

wooded area between Walton Street Park and the A-B Tech campus.

In the context of the overall CAW, the wooded sections of this area have ecologic features that make it a remnant “gem,” unrivaled by any other areas in the CAW except for the upland slopes off the west side of Beaucatcher Mountain. A significant part of the area has mature forest and relatively intact riparian environments that support a variety of wildlife and native plant species. The major impacts to the area come from: the large percentage of impervious surface in its upland areas and inadequate stormwater management, the MSD sewer corridor, invasive species, and human activity along trails that produce trash and erosion. The A-B Tech community uses the area for recreational and academic purposes. A trail system has been developed in the area and classes in environmental science, surveying and other academic programs use the area as an outdoor, hands-on learning facility. There are some A-B Tech students who use a trail through the area that connects the Walton Street Park to the AB Trek trailhead. Wildlife, including deer, bear, turkey, raccoon, and others are seen along the tributary and upland wooded areas.

Nine of the recommended projects, and several of the policy initiates, address this targeted area.

Observations

During this project, several field teams made observations of the watershed, water quality samples were obtained and analyzed, and problems identified.

Figure 45 An initial tour of the watershed with A-B Tech staff.

In September 2019, Penrose Environmental performed macroinvertebrate sampling to help with the baseline evaluation of biological conditions of the stream channel. The results of macroinvertebrate analysis showed a taxa richness of 20 (second highest of the five sample sites in the CAW) and a Biotic Index of 2.91 (the best score of the five sites). Those results provide a preliminary indication of a healthy aquatic environment.

On October 5, 2019 sediment samples were collected and sent for laboratory analysis. The most notable result being a report of Diesel Range Organic compounds of 17 mg/Kg.

Figure 46 Haith Branch

Field observations made starting in September 2019 have identified several problem areas to address. The most significant physical problem is a large erosion plunge pool and gully that has formed below a 36-inch diameter stormwater outfall that drains parking lots and buildings on the A-B Tech campus. The gully begins in a 13 feet deep plunge pool and continues through a deeply eroded, channel. At the end of the eroded channel, flow spreads out into an area of deposition and debris through which a set of braided channels have formed. This area represents a safety hazard and contributes to water quality and aquatic habitat degradation due to the sediment load that it delivers to Haith Branch.

As a contribution to this project, with the expectation that it will assist in the design of some regenerative stormwater conveyance measures to be installed, an A-B Tech surveying class provided a physical survey of the outfall and area (including trees that could be impacted by construction) and of a portion of the A-B Tech campus that drains to the outfall.

A second eroding channel was identified in the southwestern portion of the watershed. This one, relatively minor, caused by runoff from another A-B Tech parking lot.

The Municipal Sewer District has a sewer line that runs through the watershed parallel and in close proximity to Haith Branch. There are several locations along the stream where bank erosion will have to be addressed in order to avoid that erosion damaging the sewer line. It is desirable to address the eroding banks using principles of natural design and avoiding the use of large equipment and bank "hardening" measures.

Figure 47 Erosion plunge pool at stormwater outfall.

There are many areas impacted by invasive species within the watershed. An invasive plant management program would serve to improve the ecological health and wildlife habitat.

Although needing attention, as previously stated this watershed is a functional, relatively healthy ecosystem. The mature forest, existing riparian and upland environments make this an area worth restoring, celebrating, and protecting.

Figure 48 Deeply incised gully below plunge pool.

Figure 49 A stand of suspected Hill Cane in the watershed. Hill cane (Arundinaria appalachiana). It grows along areas that have upland slopes, bluffs and oak and hickory forests.

In February 2020, Kevin Caldwell from Mountain-to-Sea Ecological, joined members of the project team for a reconnaissance of this targeted area. He noted opportunities for restoration of “seeps” which are state-listed rare "small patch" habitats in the area, the richness of both the riparian and upland areas, exceptional forest age, maturity, and large diameter trees, suitable habitat for several rare species, neotropical songbird habitat, and the opportunity for invasive plant management. As the team engineers discussed approaches to the large erosion gully, Kevin noted: “I can easily visualize a huge “restored seep” here using a combination of hard and organic materials. You could easily disperse water over and through this zone while retaining high amounts of water in the space for slow release that would rehydrate the swampy cove below it, and provide a more natural and consistent flow to the stream below.”

Lower reaches of the watershed contain stands of River cane (Arundinaria gigantea), also known as canebreak bamboo. This species grows in low wooded areas, swamps, and riverbanks. It once widely ranged from Florida, to Ohio and Maryland, but presently farm and developed lands have taken over their growing grounds. River cane has been known to grow as tall as 30 feet.

Erosion gully

The highest priority for restoration and improvements in this area is the erosion gully. The project team has discussed several options for the work with an emphasis on using natural design techniques and avoiding the disturbance that would be caused by accessing the site with large equipment and performing extensive grading. There is a clear opportunity to address the on-going erosion, mitigate an existing safety hazard, and accomplish additional restoration objectives. Success of this effort may require either complimentary flow attenuation upstream of the stormwater outfall or a “bypass” channel to stably accommodate large flows (or both).

Figure 50 The watershed contains several "seeps" such as this one. The restoration and management of these areas would provide important native plant, amphibian, and other wildlife benefits.

Rehab/Retrofit of existing SCM(s)

There is a stormwater control measure (SCM) on the A-B Tech campus above Haith Drive that consists of a grassed swale and a dry stormwater detention basin. That SCM was evaluated for retrofit potential to improve its function. The analysis indicated that there is little potential for improved function by retrofitting. However, there are repairs needed on the banks of the detention basin and perhaps opportunities to improve infiltration along the grassed swale.

Riparian Area Management Plan and Invasive Plant Management

One of the recommendations of the CAWRP is the initiation of an interagency group that will develop a City-wide Riparian Area Management Plan (RAMP). The group would examine the policies and maintenance procedures on public lands and easements that impact water quality and habitat. This targeted area is proposed as a pilot project for the development of the RAMP.

Vegetation management within the watershed could significantly improve the wildlife habitat and the value of the area for recreational and educational use. Recommendations at this time include conducting an invasive plant inventory and mapping and an initial effort to manage invasive plants within a riparian zone closest to Haith Branch and in an area immediately downstream of the large erosional gully.

Trash clean-up

There is a large amount of trash and debris that has accumulated in the wooded areas of the watershed, particularly downstream of the erosional gully, along Haith Branch and in the vicinity of the path linking Walton Street Park to the A-B Tech campus. A volunteer-based cleanup of the area is recommended, followed by the development of a waste management plan. The plan should include consideration of trash collection and management at Walton Street Park and on the A-B Tech campus near the A-B Trek trailhead and signage within the watershed.

Bank stabilization and stream restoration

Due to the high percentage of impervious area in the upper reaches of the watershed and the stormwater collection system, Haith Branch is subjected to “flashy,” high-velocity flow. As previously noted, the stream is incised and has moderate levels of bank erosion at numerous locations. Some of the bank erosion locations will present a problem to MSD in the near future. There are numerous locations where stream restoration and bank stabilization could be accomplished at relatively low costs. Those improvements would include recollecting the stream with a high-flow or “floodplain” bench.

Water quality improvements at Walton Street Park

There are several opportunities to improve stormwater management at Walton Street Park, improving water quality and reducing adverse impacts on the community immediately downstream of the park. The opportunities include diverting the culvert outlet at the northern end of the parking lot into a constructed series of rain gardens, constructed pocket wetlands, and grass swales, improving drainage from the areas with the existing tennis courts and pool, and improving drainage and reducing slope erosion downstream of the baseball field.

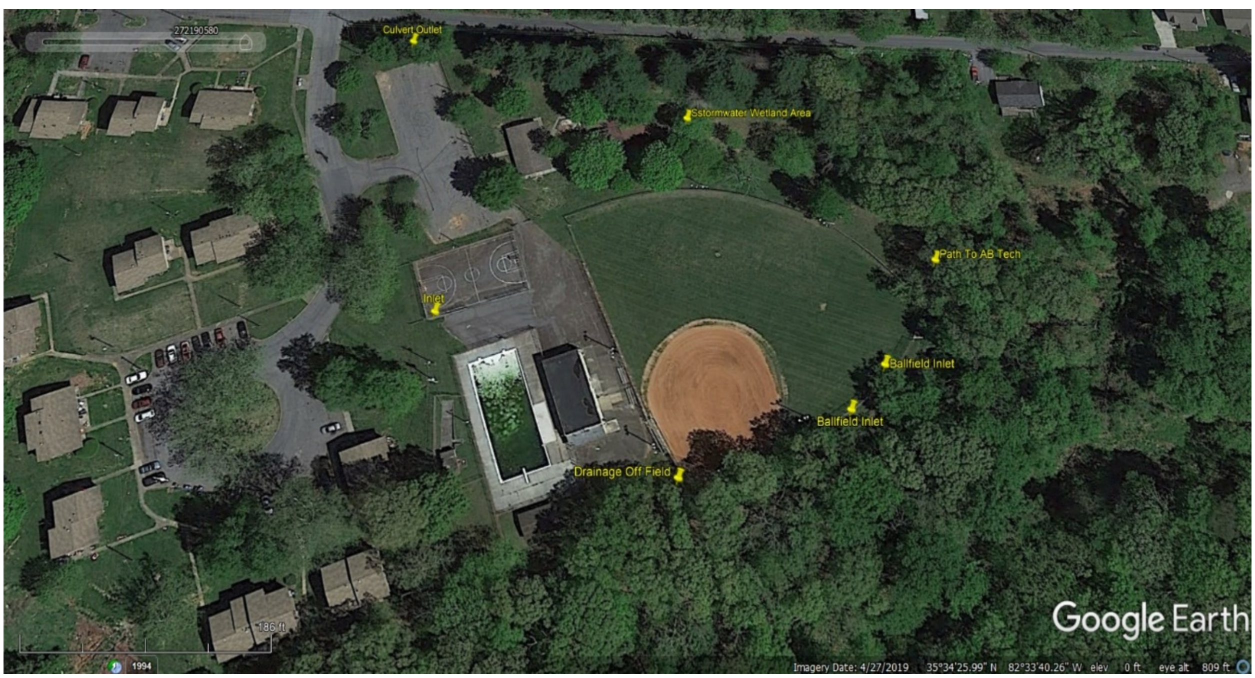

Figure 51 Aerial View of Walton Street Park

Targeted Area – Area above McCormick Field

The area above McCormick Field is targeted for stormwater control measures that would assist the City in controlling street flooding along the Town Branch stormwater system and provide water quality and aquatic ecosystem improvements.

This area was studied as part of the City of Asheville's 10-year Stormwater Capital Improvement Plan and during planning for renovation of Mountainside Memorial Stadium. During both of those studies the construction of a detention stormwater control measure (SCM), stream daylighting, infrastructure repairs and other improvements were recommended in the area above McCormick Field. The detention SCM and other improvements were incorporated into the City's Stormwater CIP but have not been constructed. The CAWRP recommends construction of some of those projects, with modifications. Five of the CAWRP projects are in this targeted area. An additional project, infrastructure improvements near the intersection of Coxe and Southside Avenues, is also included among the CAWRP recommended projects.

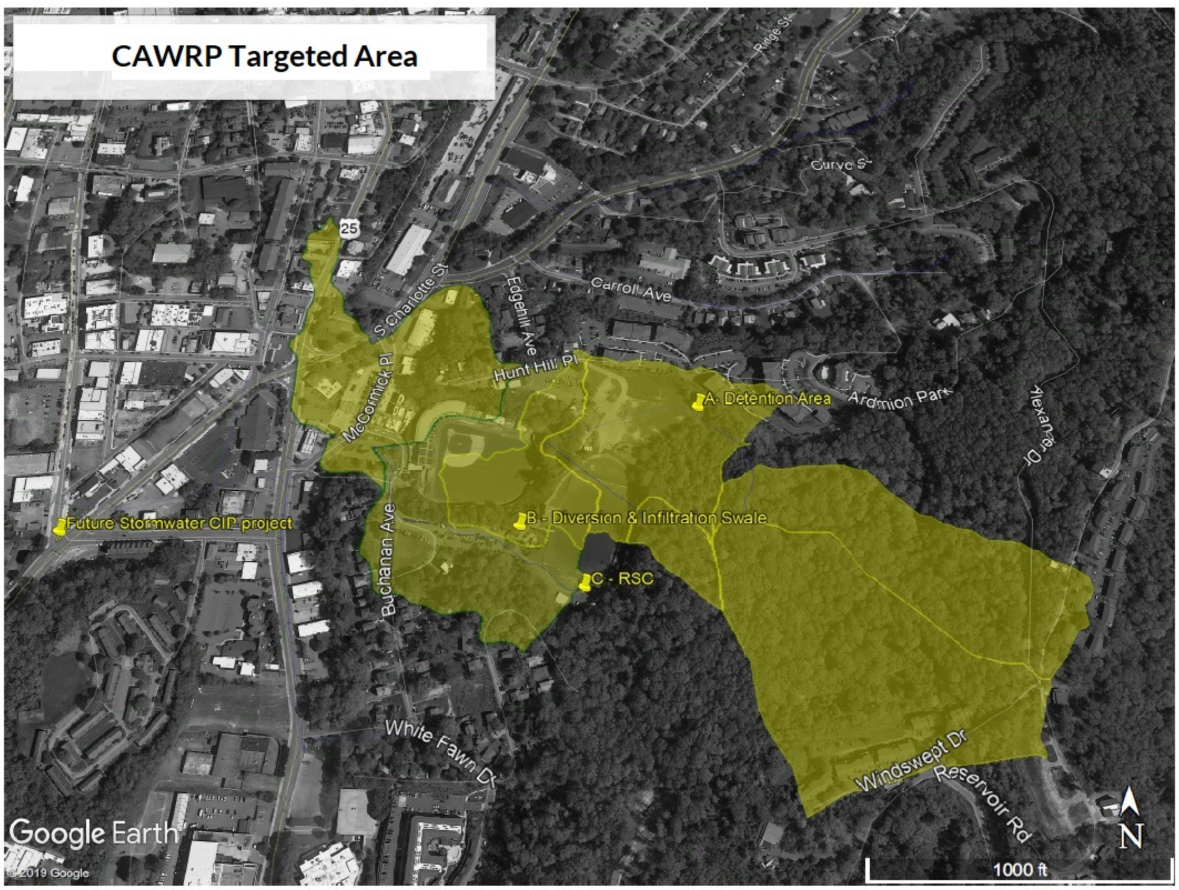

Figure 52 CAWRP Targeted Area above McCormick Field

Targeted Area – Livingston Heights, Congress and Pine Grove Neighborhoods

The area shown in the figure below is targeted to have six watershed restoration projects. Four of the projects are on the City of Asheville Housing Authority parcel, another (a pilot disconnected impervious surfaces (DIS) project) will be on the properties of interested homeowners in the Congress Street to Pine Grove Avenue neighborhood, and another on City-owned property along the planned Nasty Branch greenway.

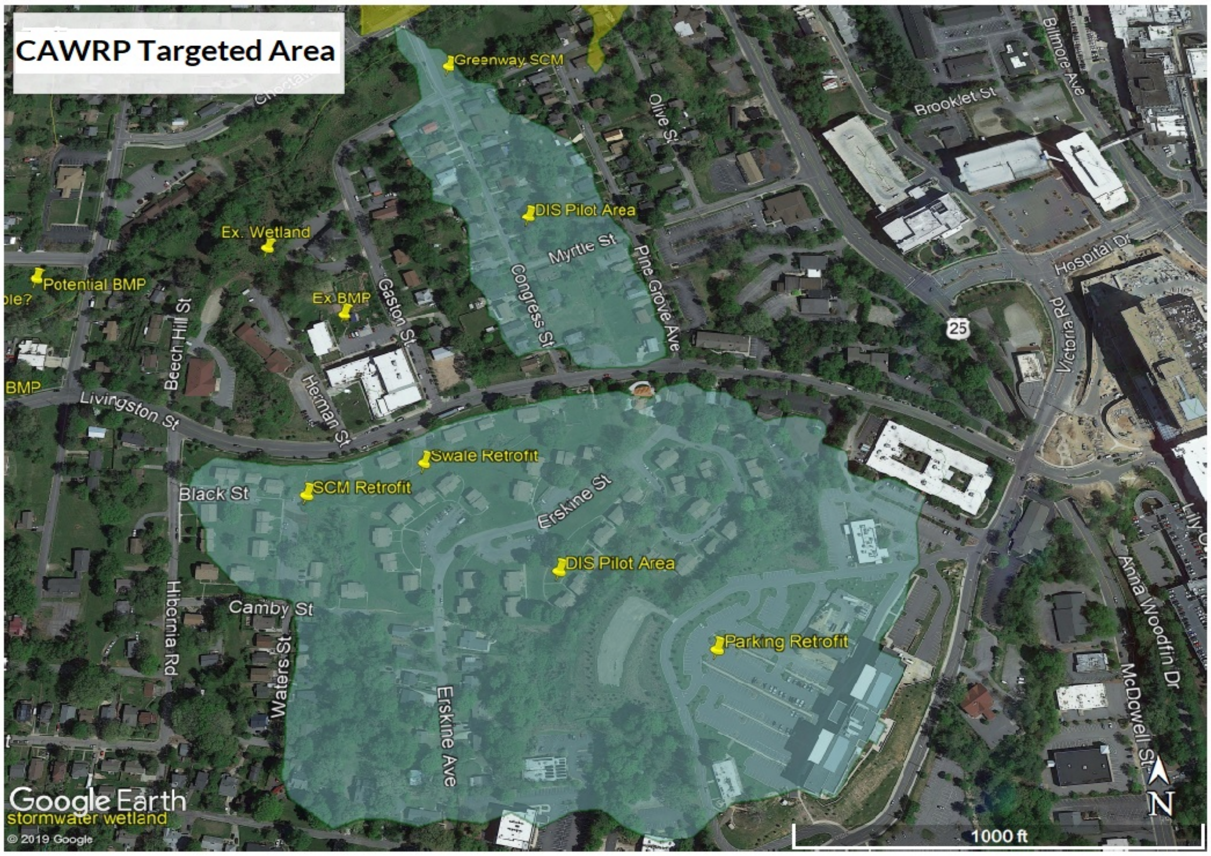

Figure 53 Targeted Area - Livingston Heights, Congress and Pine Grove

In the Livingston Heights neighborhood one of the proposed projects would work with residents and the property owners/managers (Asheville Housing Authority) to design and install green infrastructure projects that harvest roof runoff and direct runoff from other impervious surfaces to rain gardens, pocket wetlands, and other infiltration areas. Rainwater harvesting will provide water supply for community gardens, an existing orchard, and other purposes. The project is scalable depending upon community interests and available funding. The recommended scale is to provide rainwater harvesting on 25,000 square feet of rooftop and connecting another 25,000 square feet of roads and parking lot to pervious infiltration areas.

Another Livingston Heights project is designed to stop flooding that currently occurs frequently across Waters Street and the parking area and yards of the residents in that area. The project will restore and enlarge a previous detention area, turning it into a stormwater wetland. The recommended size of the constructed wetland is approximately 15,000 square feet. It will consist of a mix of pools from 1 to 2 feet depth and shallow areas. An outlet structure will be constructed to control water levels. The outlet will connect to the existing stormwater pipe system. Part of the runoff coming into the wetland will be from a small ephemeral stream that is currently contained in a concrete swale. Restoration of that stream to more natural conditions and establishing a healthy riparian zone beside it will improve water quality as well as the aesthetic and recreational values of the area.

The Congress Street to Pine Grove Avenue area is targeted to have a DIS project. This project will work with three or more homeowners to disconnect downspouts, redirect driveway runoff and address other impervious surfaces. Along with the expected stormwater runoff and water quality improvements, cooperating residents would benefit from construction of rain gardens and other landscaping features designed to demonstrate innovative stormwater practices and enhance the properties.

Targeted Area – Nasty Branch Greenway Corridor

One of the recommended policy initiatives is the development and implementation of a riparian area management plan (RAMP) for the Nasty Branch Greenway Corridor between Choctaw Street and Depot Street. The RAMP developed during this project would serve as a model for practices to be extended throughout the City. In addition to the RAMP, a culvert removal, addressing runoff from the Grant Center, and enhancements to existing and planned stormwater control measures within the corridor are recommended. Beyond the water quality and habitat benefits, this area provides an excellent opportunity to demonstrate good stormwater and land management practices and provide an outdoor recreation and education area for the community.

Figure 54 The Nasty Branch Greenway Corridor

Targeted Area – Upper Bacoate Branch

There are 15 projects recommended in the Bacoate Branch subwatershed with 5 of the high priority projects in the targeted area shown below. The recommended projects include a neighborhood DIS project, restoration of two badly eroded gullies using Regenerative Stormwater Conveyance (RSC) practices, and bioretention areas. There is a future greenway expansion planned to parallel Bacoate Branch and, with that greenway, the opportunity to construct several stormwater control measures and perform both streambank stabilization and stream restoration.

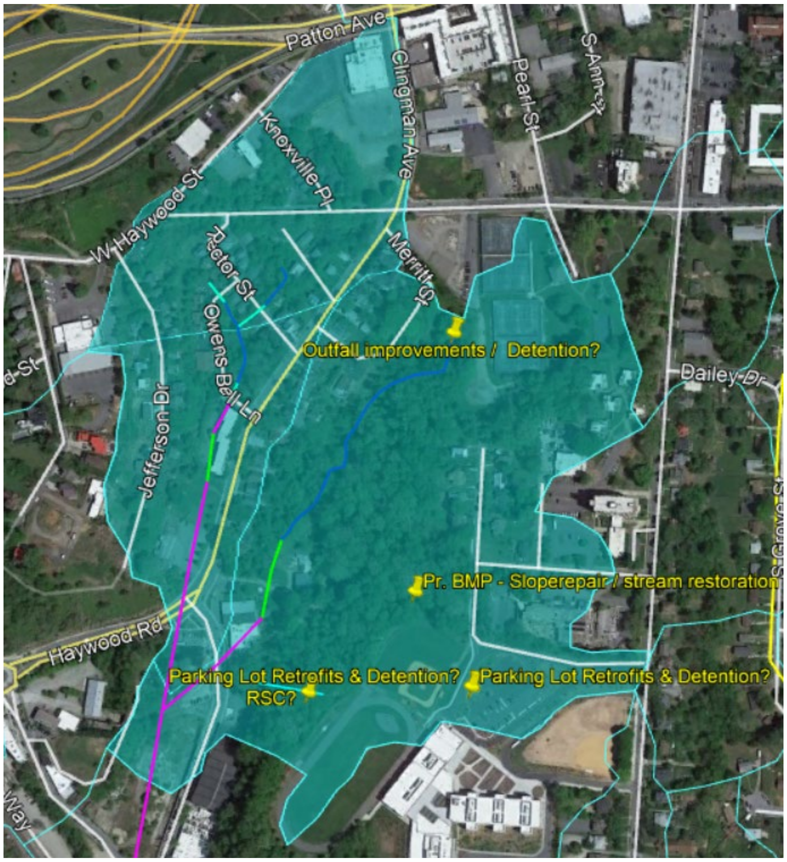

Figure 55 Targeted Area - Upper Bacoate Subwatershed

Project Costs and Proposed Implementation Schedule

There are 62 proposed projects and a monitoring plan that address the CAWRP goals. Information about each of the projects is provided in the Appendix – Prioritized Projects and an on-line summary spreadsheet of the projects may be reviewed here:
https://drive.google.com/file/d/1HBWrubMXdUXfrI6rscpf66YPswYP5Kp1/view

Those projects that have been assigned high priority have an estimated total cost of the next phase of project development (generally moving from conceptional design to a Basis of Design Report (BODR) or Preliminary Design) of $105,000 and will cost approximately $1.5 million to fully implement. Medium priority projects have a next phase cost of $165,000 with a total cost of just over $700,000. Low priority projects have a next phase cost of $29,000 and a total cost just under $1 million. Thus, the estimated capital cost of projects that will both mitigate the impacts of continued growth within the watershed and establish a path towards watershed restoration is about $3.2 million. Note that estimate does not include costs that may be incurred due to recommended policy changes addressing issues such as improved utility maintenance and repair, expanded street sweeping, public investment in cost-sharing for disconnecting impervious areas on private property, improved and enforced stormwater pollution prevention plans, and other initiatives.

Meaningful progress towards watershed restoration will likely cost between $5 million and $10 million dollars, expended over the next decade. While that is a significant investment, the benefits to water quality and the aquatic ecosystem, as well as to human health and safety, will pay the City and its communities rich dividends.

The proposed budget for the start of all the recommended implementation projects (priorities High, Medium and Low) is shown in the following table, distributed over the next seven calendar years. Also shown is the estimated total budget required for each year in order to meet the recommended implementation schedule.

Calendar Year	Recommended Project Initiation Budget	Estimated Total Budget Needed for Implementation
2020	$32,000	$32,000
2021	$216,000	$216,000
2022	$12,000	$954,000
2023	$3,500	$1,433,000
2024	$10,000	$170,000
2025	$4,000	$121,000
2026	$19,000	$96,000
2027	$2,000	$183,000

Initiation of the high priority projects is recommended in the next two years. The schedule of the actual construction of the projects will be determined by the time required to obtain community support, design the project, and obtain the necessary funding. Early implementation of the high priority projects will be important to increase public awareness and educate decisionmakers as to the value and cost-effectiveness of the CAWRP. Also, the early projects focus on demonstrating practices that can be replicated on public and private lands across the watershed. Early support of the CAWRP, and replicating the practices it demonstrates, is essential to obtaining restoration goals within the next decade.

This document contains the CAWRP recommendations and cost estimates as of the date on its cover, but it will become out of date. One of those tools produced during the project is an interactive StoryMap that can be used to explore the latest CAWRP findings, recommendations, estimated costs, and schedule. See: https://bit.ly/3ib96X7

Monitoring Plan

Part of a Nine-Element Watershed Plan is development of a monitoring program that will last throughout the implementation period and help to establish progress towards the plan's goals and the effectiveness of the measures implemented. The recommended monitoring plan builds upon the water quality monitoring that has been completed prior and during this project. It does so by focusing on the impairments and their likely sources that have been identified and on the adopted restoration goals. There will be limited resources to support water quality monitoring over the 10-year, or longer, CAWRP implementation period. For that reason, the monitoring plan was developed as a prioritized list of recommendations. The Monitoring Plan Technical Memorandum may be reviewed at:
https://drive.google.com/file/d/1veX-fa3XpbDHUL4rOibl7lZc1A96s4d-/view

This project's findings clearly indicate that continued, and expanded, water quality monitoring is warranted. The long-term monitoring plan must be based on that conclusion, on the goals of the watershed restoration project, on the locations and characteristics of the proposed improvements to be implemented in the coming years, and on a reasonable estimate of the financial resources that may be available for monitoring. Figure 56 shows the locations of the sites where monitoring has and/or is recommended to occur.

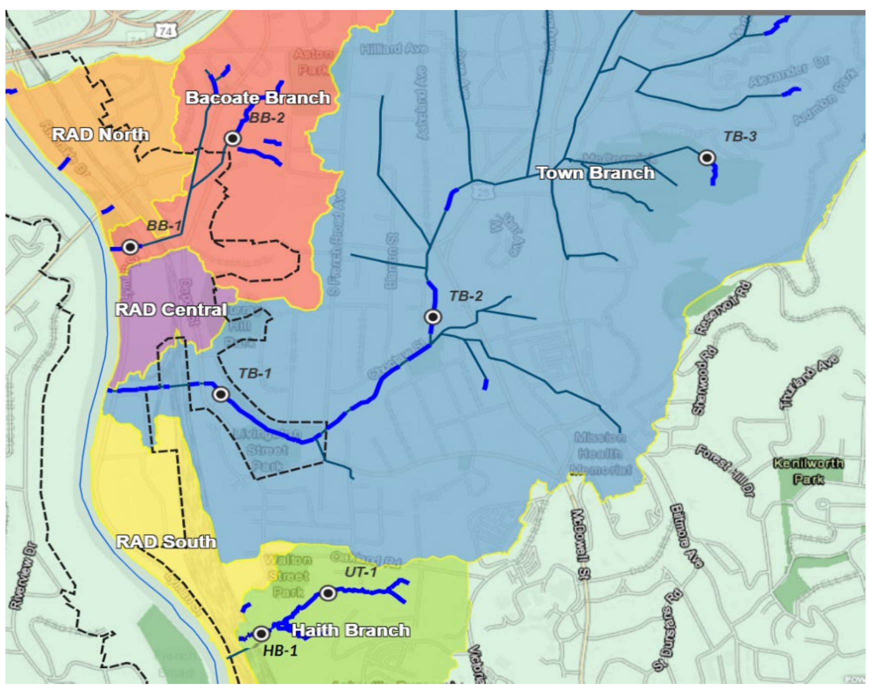

Figure 56 CAW Monitoring Sites

If fully implemented, the recommended monitoring plan would cost, over the 10-year implementation period, just over $300,000. About $29,000 of that amount is budgeted to support current and expanded volunteer-based monitoring. $166,000 is allocated to purchasing of professional services (including field sampling and laboratory services). That cost could be substantially reduced by engaging trained volunteers. Finally, $112,000 is allocated to special studies including bacteria source tracking and reevaluation of watershed pollutant exports in years 2025 and 2030. The following summarizes the components of the monitoring plan. Details and itemization of expected monitoring costs are provided in Appendix-Monitoring Plan.

Priority 1 - Macroinvertebrates

Macroinvertebrate sampling and analysis is recommended to occur twice per year (Spring and Fall) at one station on each of the three streams at sites: TB-1, BB-2 and HB-1. The recommended sites are low in the watershed, receiving drainage from the areas that will be most impacted by the recommended implementation measures. As such, they will help gauge the effectiveness of those measures over an extended period and serve to establish the general trends of ecological health in the three streams.

Priority 2 - Bacterial

As reported in the Water Quality section of this report, the French Broad RiverKeeper has invested in bacterial monitoring of Town Branch during the water recreation season, recognizing Town Branch as a major contributor of bacteria to the very popular reach of the French Broad near Asheville. During this project, that monitoring was supplemented with targeted wet- and dry-period sampling from each of the three streams. The RiverKeeper's program currently samples multiple locations along Town Branch but does not sample either Bacoate Branch or Haith Branch. Sites BB-2 and HB-1 should be included in future bacterial monitoring. If necessary, a reduction in the number of sites along Town Branch sampled in order to sample the other streams is warranted.

During this project there was some evidence that bacterial loading is impacted by leakage in the sanitary sewer system. Unfortunately, only one set of dry- and wet-weather samples, which could help identify those sources, was obtained. During the implementation period, at least one set of targeted dry- and wet-weather bacterial samples should be collected from sites TB-1 and TB-2, annually. In addition, by 2025 and 2030, a bacterial source tracking study (likely using genetic identification techniques) should be conducted along Town Branch to help differentiate the human and non-human bacterial sources and local sources.

Priority 3 - Chemical

The Volunteer Watershed Information Network (VWIN) program provided water sampling and analysis, covering a range of constituents, for Town Branch for several years but suspended the program in 2016 due to a lack of funding. VWIN received funding in 2020 as part of this study to monitor Town Branch, Bacoate Branch and Haith Branch for three years. The monitoring was restarted in March 2020. That monitoring should be continued through the CAWRP's entire implementation period. The current and recommended monitoring sites are BB-2, TB-1 and HB-1. That monitoring will be important to establishing progress on the restoration and preservation of the watershed.

The commercial cost to perform the above recommended monitoring, after the 3-year VWIN monitoring period, would be approximately $7500 annually. Use of volunteers and a non-profit laboratory, such as is provided by the VWIN program, could reduce that cost by 50 percent or more.

The sediment and the dry- and wet-weather sampling and analysis for metals and organic compounds that occurred during this project should be conducted, at minimum, in 2025 and 2030. The recommended sites for this effort at BB-1, HB-1, TB-1 and a new site (TB-0) on Town Branch to be located downstream of the railroad yard.

Priority 4 - Streamwatch

Significant illicit discharges have repeatedly occurred to both Bacoate Branch and Town Branch. Such discharges can have severe and long-lasting impacts upon the streams' aquatic ecosystem as well as impact human health and safety. The significant reduction of illicit discharges is a necessary component of restoring these streams. Establishing and sustaining a volunteer-based StreamWatch program focused on Bacoate Branch and Town Branch will directly support this project's goals of:

- Reducing the delivery of pollutants to the French Broad River.
- Increasing public awareness of illicit discharges resulting in improved detection, investigation, and enforcement of pollution prevention regulations.
- Increasing public awareness and appreciation of the stream reaches within the watershed.

Priority 5 - Pollutant Loading Analysis

During this project, annual pollutant loads from the watershed to the French Broad River were estimated using land use and cover data and data about the impervious percentage of small catchment areas that comprise the watershed. During that analysis, information about the City of Asheville's Preferred Growth Plan was used to estimate future pollutant loads that may occur by 2030. That pollutant loading analysis should be updated in 2025 and 2030, each analysis reflecting then current conditions and including a revised 10-year forecast.

Conclusion

The streams in the area that we call the Central Asheville Watershed have a history that started long before we named them, long before Asheville existed. The recent chapters are a tale of abuse and neglect that have left them impaired and unable to best serve our communities. That trend need not define the future. This watershed restoration plan presents means of halting stream degradation and a path toward restoration. The pen is in our hands. What will we write in the next chapter?

Appendix – Water Quality

This appendix contains the technical reports submitted during this project, including water quality laboratory results, and additional reference material. To support both this report and the CAWRP's interactive StoryMap, the directory of the appendix and the documents are maintained on RiverLink's webserver: CAW Appendix Directory-Water Quality (https://docs.google.com/spreadsheets/d/1xblKGC5RnoltFCX5Y_3W_vz1-FzhcT20/edit?pli=1#gid=1960476367)

Appendix – Prioritized Projects

This appendix contains brief descriptions of the recommended watershed restoration projects along with cost estimates and additional supporting material. To support both this report and the CAWRP's interactive StoryMap (https://bit.ly/3ib96X7), the directory of the appendix and the documents are maintained on RiverLink's webserver. Note that the project descriptions and cost estimates presented in this report agree with the appendix documentation as of the date of this report (August 2020). However, it is RiverLink's intention to update project plans, schedules, and cost estimates as new information becomes available. Thus, over time, it is recommended that the interactive StoryMap be used to obtain the latest information and track the progress of the implementation of the Central Asheville Watershed Restoration Plan.

A current spreadsheet summarizing each of the projects can be downloaded here: https://drive.google.com/file/d/1HBWrubMXdUXfrI6rscpf66YPswYP5Kp1/view The spreadsheet contains details of the recommended projects that may not appear in the interactive StoryMap and project summaries, including:

- Current and next stage of the project
- Recommended or projected start date of the next stage
- Estimated next stage and project completion costs
- Project priority: High, Medium, or Low
- Recommended lead organization
- Potential partners, and
- Funding opportunities.

Just as the City's Preferred Growth Plan was considered in development of a future watershed conditions scenario, the growth, development, and equity goals expressed in the Comprehensive Plan were considered in the conceptualization of the recommended restoration projects. Specifically, fourteen of the City's goals presented in the Comprehensive Plan are addressed by the restoration plan. The following table illustrates the goals supported by each recommended project. As projects are revised through each phase of their development, the alignment with the City's goals may change. The latest available table may be reviewed here: https://drive.google.com/file/d/1zU5i0e57Fa3MeN86Bbo2iGlE7q5XiXqM/view

Central Asheville Watershed Restoration Plan				
Recommended Projects Alignment with City's Comprehensive Planning Goals				
Project Number	**Subwatershed**	**Project Name**	**Priority**	**Supports Asheville's Comprehensive Plan Goals**
1	Town Branch	Mountainside Memorial Park SCM	H	5, 20, 22,23, 25, 28, 39
2	Town Branch	McCormick 1	M	22
3	Town Branch	McCormick 2	M	22
4	Town Branch	McCormick 3	M	22, 25
5	Town Branch	Mountainside Memorial Parking	M	20, 22, 23, 25
6	Town Branch	Coxe & Southside	L	22
7	Town Branch	Tolula Lane	L	22, 25
8	Town Branch	Choctaw near Town Branch Crossing	M	20, 23, 25,31
9	Town Branch	Enhanced SCM along Greenway	M	11, 18, 20, 23, 25, 28, 31, 39
10	Town Branch	Gaston, Congress, Pine Grove Streets	H	1, 18, 20, 22, 23, 25, 28, 33
11	Town Branch	Livingston Heights 1	H	18, 20, 22, 23, 25, 31, 33, 39
12	Town Branch	Livingston Heights 2	H	18, 20, 22, 23, 25, 31, 33, 39
13	Town Branch	Livingston Heights DIS	H	1, 18, 20, 22, 23, 25, 28, 33, 39
14	Town Branch	Hibernia & Black St Stormwater Box	L	22, 23, 31, 33
15	Town Branch	Town Branch Greenway Riparian Area Mgmt	H	1, 5, 11, 18, 20, 22, 23, 25, 31, 32, 39
16	Town Branch	Palmer Steet End SCM	L	20, 22, 23, 25
17	Town Branch	Southern Steet SCM 1	L	20, 22, 23, 25
18	Town Branch	Southern Steet SCM 2	L	20, 22, 23, 25
19	Town Branch	Livingston Street Park 1	M	1, 5, 11, 18, 20, 22, 23, 25, 31, 32, 39
20	Town Branch	Livingston Street Park 2	M	20, 23, 25, 33, 39
21	Town Branch	Lower Town Branch Restoration	M	1, 5, 11, 18, 20, 22, 23, 25, 31, 32, 39
22	Bacoate Branch	WNC Baptist Fellowship	M	1, 18, 20, 22, 23, 25, 28, 33
23	Bacoate Branch	Senior Opportunity Center	L	1, 18, 20, 22, 23, 25, 28, 33
24	Bacoate Branch	Life on Earth	L	1, 18, 20, 22, 23, 25, 28, 33
25	Bacoate Branch	Bacoate Greenway SCM	H	11, 18, 20, 23, 25, 28, 31, 39
26	Bacoate Branch	Jefferson Drive SCM	M	5, 20, 22, 23, 25
27	Bacoate Branch	Hillard & W. Haywood	M	20, 22, 23, 25
28	Bacoate Branch	Northern end of Charles Street	L	20, 22, 23, 25
29	Bacoate Branch	Bacoate Branch DIS Pilot Project	H	1, 18, 20, 22, 23, 25, 28
30	RAD North	Concentrated flow & erosion off I-240	L	5, 20, 22, 25
31	Bacoate Branch	Aston Park SCM	M	1, 20, 22, 23, 25, 39
32	Bacoate Branch	Aston Park RSC	H	1, 20, 22, 23, 25, 39
33	Bacoate Branch	Aston Park & Charles St.	M	1, 20, 22, 23, 25, 39
34	Bacoate Branch	Bacoate Greenway	H	11, 20, 22, 23, 25, 31, 39
35	Bacoate Branch	Aston Park to Lyman St. Ext.	H	20, 22, 23, 25
36	Bacoate Branch	Lyman St. Ext. detention/pocket wetland	M	23, 25
37	Bacoate Branch	8 River Arts Place Community Center	H	1, 20, 25, 32, 39
38	RAD North	Park Avenue end	L	5, 20, 22, 25
39	Haith Branch	Walton Street Park 1	H	1, 5, 18, 20, 22, 23, 25, 32, 33, 39
40	Haith Branch	Walton Street Park 2	M	5, 20, 22, 25
41	Haith Branch	AB Tech Parking 1	M	22, 23
42	Haith Branch	Haith Branch Slope	M	20, 22, 23, 25, 39
43	Haith Branch	AB Tech Parking 2	M	1, 5, 20, 22, 23, 25
44	Haith Branch	Facilities Way Parking Detention	H	1, 5, 20, 22, 23, 25
45	Haith Branch	Facilities Way Scour Hole	M	22, 23,25
46	Haith Branch	Outfall repair & major RSC	H	20, 22, 23, 25, 31, 39
47	Haith Branch	Haith Branch bank stabilization & utility protection	M	22, 23, 25
48	Asheville	Riparian Area Management Plan	H	1, 11, 18, 20, 23, 25, 31, 32, 39
49	Asheville	Stream & Illicit Discharge Watch Program	H	23, 31, 32
50	Asheville	Improved and Enforced Stormwater Pollution Protection	H	1, 20, 23, 31, 32, 33
51	Asheville	Public Education on Sanitary Sewers	M	23, 32
52	Asheville	Street Sweeping Program	M	5, 23, 31
53	Asheville	Polycyclic Aromatic Hydrocarbon Policy	H	23, 31
54	Asheville	Support Urban Reforestation Programs	M	1, 18, 20, 23, 31, 32,33
55	Asheville	Watershed & Stream Cleanup Days	M	23, 31, 32
56	Asheville	Existing SCM Maintenance	H	23, 31, 32
57	Asheville	Initiate Water Quality Assistance Program	M	1, 18, 20, 22, 23, 25, 28, 31, 33
58	Bacoate Branch	Knoxville Place - RSC Conveyance	L	22, 23, 25
59	Haith Branch	RAMP Pilot Area	H	1, 11, 18, 20, 23, 25, 31, 32, 39
60	Town Branch	Culvert Removal	L	22, 23, 25
61	Asheville	Adopt-A-Storm Drain Program	M	5, 22, 23, 31, 32
62	Asheville	Storm Drain Filter Pilot Study	M	5, 20, 22, 23, 25, 32

Goal	**Description**
1	Encourage Responsible Growth
5	Make Streets More Walkable, Comfortable and Connected
11	Build Out the Greenway Network
18	Promote Social Equity and Paths to Upward Economic Mobility
20	Implement Green Infrastructure and Enhance the Urban Tree Canopy
22	Mitigate Flooding and Erosion
23	Protect Land and Water Assets
25	Encourage Naturalized Stormwater Management Techniques
28	Create a Sustainable Path to Balanced Budgets
31	Promote General Health and Wellness
32	Improve Community Involvement in Decision-Making
33	Prioritize Investments Equitably and Fairly Across Neighborhoods
35	Increase Access to Opportunities for All
39	Enhance and Celebrate Asheville's Unique Places and Destinations