Middle Fork – South Fork of the New River Watershed Plan

Watauga County, North Carolina

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Partners

New River Conservancy

Town of Blowing Rock 1889 North Carolina

Corporate Seal of Watauga County 1849 North Carolina

NC Environmental Quality

New River Basin Coalition

Context

A tributary of the New River, the South Fork New River flows for 89.2 miles through Watauga and Ashe County. Eventually the New River proper begins at the confluence of the North Fork and South Fork in northern Ashe County. The Middle Fork of the South Fork is one of the impaired tributaries within the South Fork Watershed.

The Middle Fork -- South Fork New River flows for over 9 miles, originating east of the Town of Blowing Rock. The first half mile of the Middle Fork flows through wooded and developed land uses. The next half mile flows through a golf course, offering little riparian buffer and several golf course ponds. The river continues through residential Blowing Rock, New River Lake and the New River Lake Community. The river then follows highway 321 through Blowing Rock and feeds into Chetola Lake, a lake by the 87 acre Chetola Resort. From this point, the river continues north towards Boone, North Carolina, converging with the East Fork to form the South Fork of the New River.

A 4.5-mile reach of the Middle Fork, between its origin and 1.2 miles below Chetola Lake, is listed as impaired by the North Carolina Department of Environmental Quality Division of Water Resources (NCDEQ-DWR) (Figure 1). The impaired title is given to waters that are too polluted or degraded to meet water quality standards outlined in Section 303(d) of the Clean Water Act. After a body of water is deemed impaired, the water is prioritized and managed in order for the stream to meet water quality standards. The impaired reach of the Middle Fork begins at the stream's headwaters within the Town of Blowing Rock's Extra Territorial Jurisdiction. The impaired reach passes through several ponds on the Blowing Rock Country Club golf course approximately 0.5 miles downstream of the beginning of the impairment. The impaired reach continues through downtown Blowing Rock along US Highway 321 to Chetola Resort and Chetola Lake, and terminates at the junction of the Middle Fork with Sumpter Cabin Creek near the intersection of US-321 and Edmisten Road.

The Middle Fork's impairment is the result of benthic surveys conducted by DWR. Surveys determined that the stream's benthic community is not adequately supported. The Middle Fork's impairment is influenced by the presence of biological pollutants and ambient chemicals. The impaired reach of the Middle Fork runs through several land use areas associated with particular pollutants. Specifically, the amount of impervious surface, such as pavement, increases rainwater runoff during storms. Rainwater runoff can carry excess nutrients (such as nitrogen and phosphorous), animal waste, sediment, pesticides, metals, and petroleum. Similarly, increased development along a stream can cause streambank erosion. A lack of planted buffers along the banks of the Middle Fork have allowed for considerable erosion to occur, shedding sediment into the river. High sediment loads due to stormwater runoff and erosion negatively impact fish communities and is a possible explanation for this particular impairment. The type, source, and best management practices of these pollutants will be outlined in this plan.

Purpose

New River Conservancy, a non-profit organization, has a mission to protect the waters, woodlands, and wildlife of the New River Watershed. With the support and aid of its partners, the development of a watershed rehabilitation plan works toward achieving this mission. The purpose of this plan is to provide a plan for removing the Middle Fork from the impaired waters list. After identifying sources of pollution and degradation, the plan will provide a vision for the Middle Fork. That vision will address how the creek can ecologically, functionally, and economically improve the New River watershed and Watauga County.

Watershed Characteristics

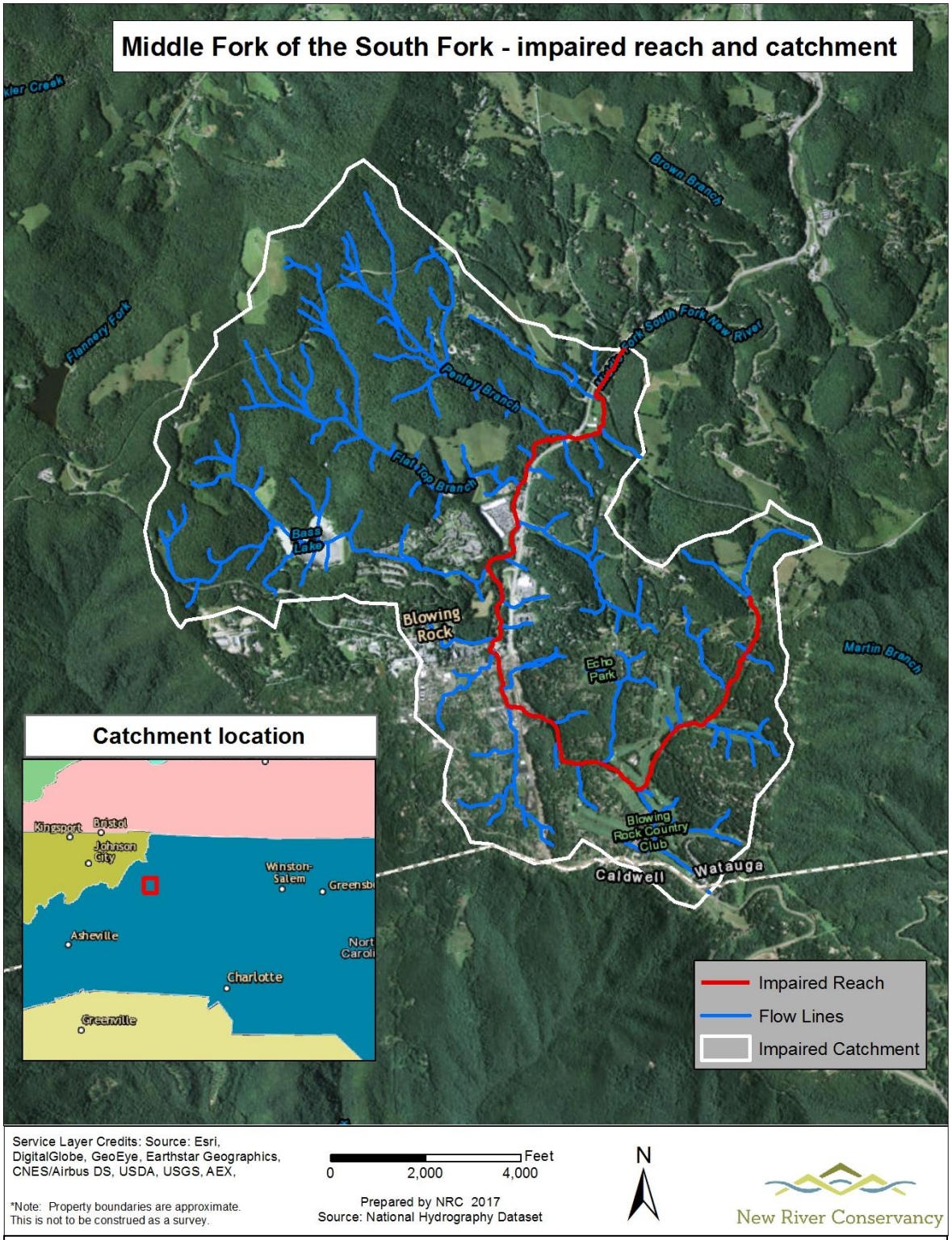

Figure 1: Flow lines within the catchment of the impaired reach of the Middle Fork

Land use and land cover

The Headwaters South Fork Watershed (HUC 050500010201) covers over 22,000 acres consisting of mixed land covers. Of the Headwaters South Fork Watershed, the catchment contributing to the impaired reach of the Middle Fork has an area of 2,584 acres. Forest cover comprises 52.99% of this catchment's total area. Developed land cover is primarily open space and low intensity development, for which impervious surfaces account for <20% and between 20 and 49% of total cover, respectively. (Table 1; Figure 2). The development in and around Blowing Rock is primarily comprised of residential and retail units, parks, and a golf course.

While the majority of the watershed is covered by mixed forest, development is concentrated along the river in the Town of Blowing Rock, as indicated by greater presence of developed land cover within 300 ft of the impaired reach (Table 1). Developed land classes make up 75.43% of the buffer, while forested cover contributes 20.88%. Additionally, the majority of the densest development is located within the 300 ft buffer; medium/high intensity development account for 25.89% of the buffer area as compared to 9.11% of the entire catchment.

Table 1: Land cover classes in the impaired catchment and within a 300 ft buffer of the impaired reach

Land Cover Class	Watershed	Buffer
Open Water	0.97%	1.13%
Developed, Open Space	29.93%	48.82%
Developed, Low Intensity	5.50%	14.12%
Developed, Medium Intensity	3.61%	11.77%
Developed, High Intensity	0.55%	0.72%
Other	1.33%	1.54%
Forested	52.99%	20.88%
Open Pasture/Hay	5.11%	1.02%

Twenty-six miles of tributaries flow into the Middle Fork. A number of tributaries flow through the development surrounding the town of Blowing Rock and have channelized reaches lacking riparian vegetation.

Watershed Significance

The Middle Fork has considerable economic and recreational benefits for Watauga County, the Town of Blowing Rock, and the New River Watershed. Parks and residential areas along the stream provide aesthetic value and water for recreation, agriculture, and industry. Streams in the New River Watershed support populations of trout and are a popular destination for anglers. Similarly, the river is a major recreational hub for tourists, who generated an economic impact roughly $216.72 million in tourism revenue in Watauga County during 2013 (NC Department of Commerce, 2013). Multiple Natural Heritage sites are present within the Middle Fork watershed (Figure 3). The Blue Ridge Parkway is the largest natural heritage area in the watershed, and crosses the Middle Fork in Southern Watauga County. Watauga County Parks account for other protected areas in the watershed.

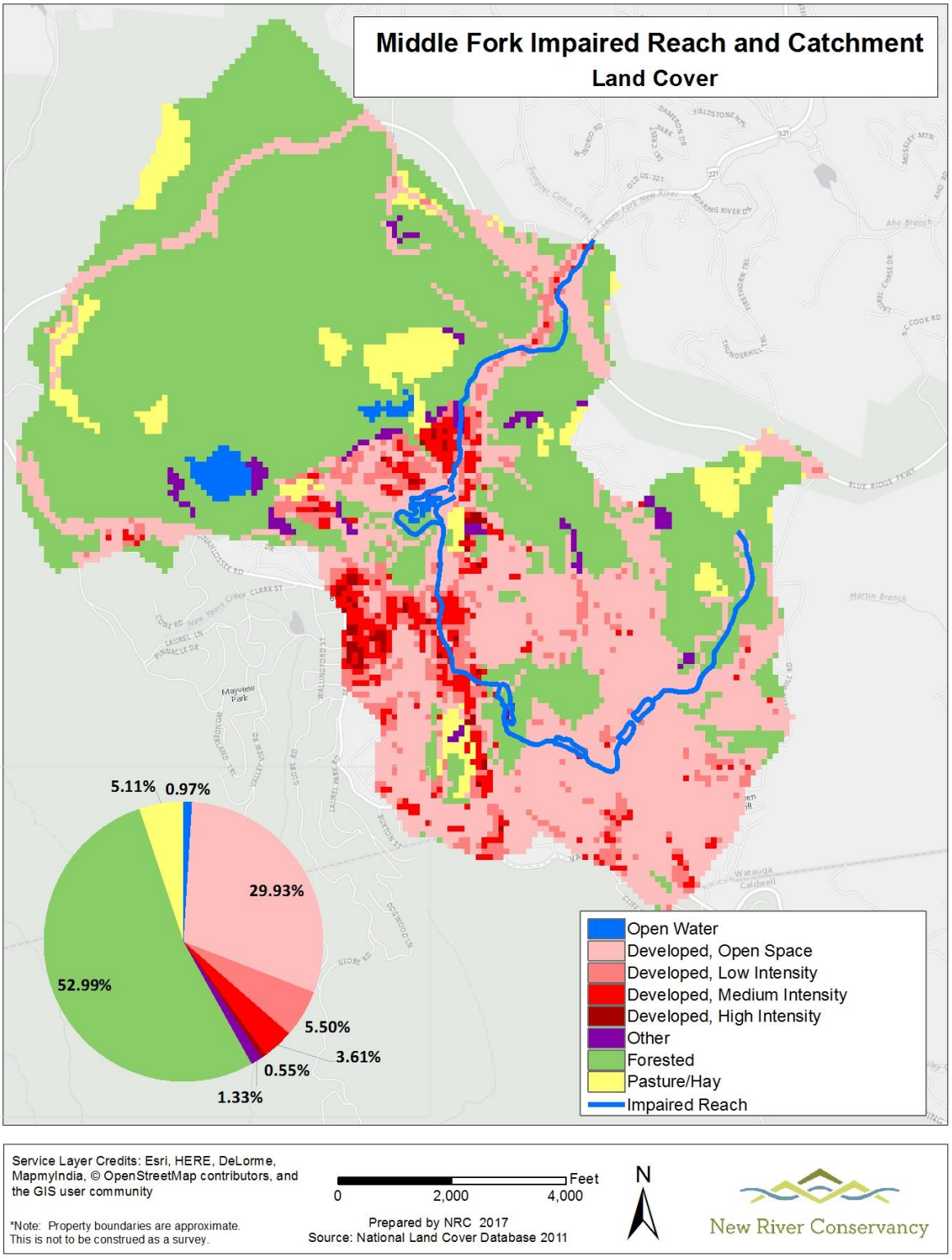

Figure 2: Land Cover in the Middle Fork Watershed (Homer et al., 2015).

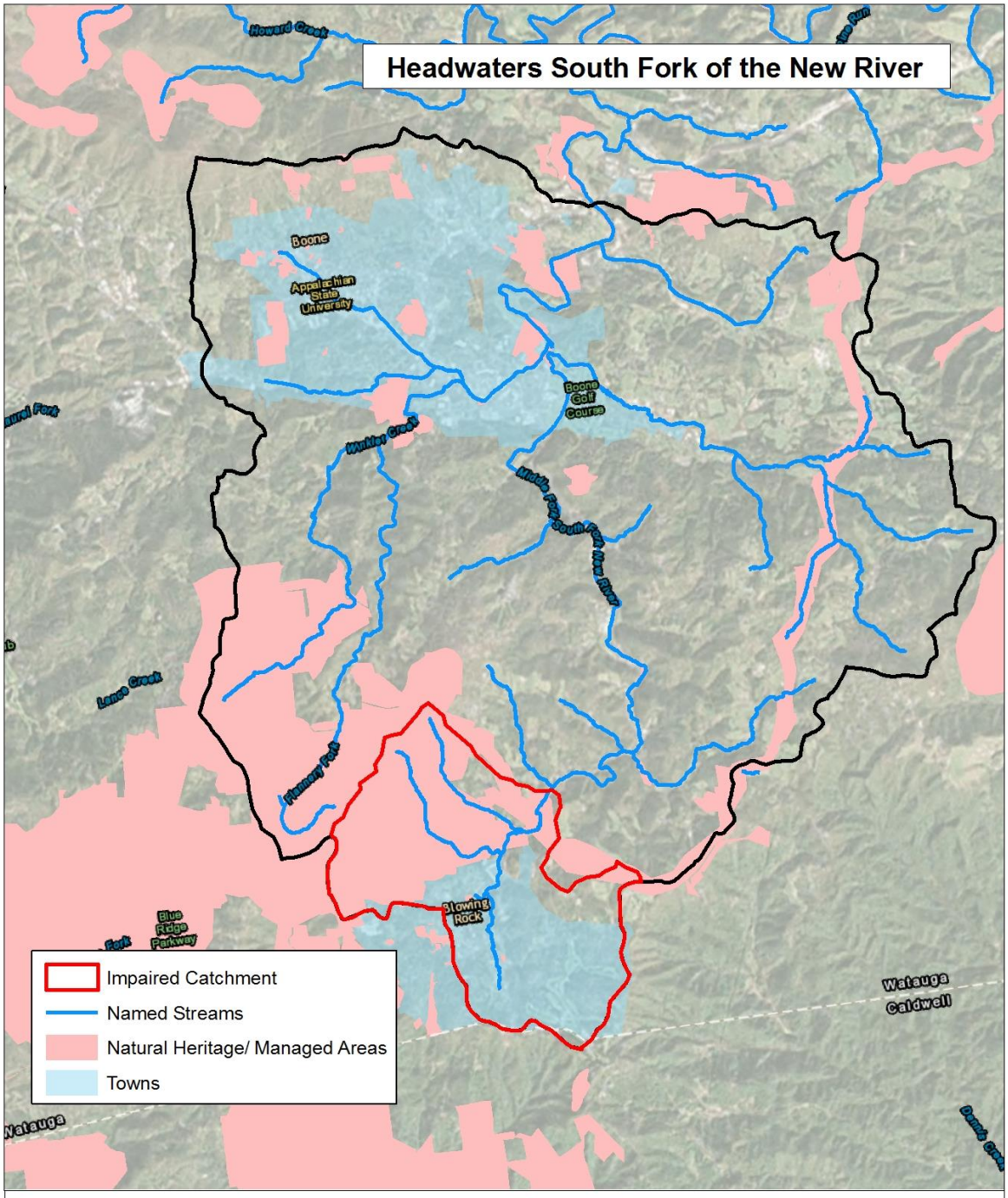

Figure 3: Natural Heritage Areas in the Headwaters South Fork Watershed

Element Occurrences

The Natural Heritage program collects information on occurrences of rare plants, animals, natural communities, and animal assemblages and records this data as Element Occurrences (NC Department of Environmental Quality, 2013)(Table 1; Table 2). Element Occurrences (EOs), are defined as an area of land where a species is, or was, present. EOs are typically created for native species that are at risk or imperiled.

Five EO species are present within the impaired Middle Fork watershed. The entire Headwaters South Fork watershed includes 19 EO species, eight of which are considered critically impaired. The abundance of Element Occurrences in the watershed highlight the potential of the stream as a biodiversity hotspot.

Table 1: Element Occurrences in the Middle Fork Watershed

Scientific Name	Common Name	NC Status	State Rank	Type	Taxonomic Group
Polygonia progne	Gray Comma	SR	S1	Terrestrial	Butterfly
Myotis leibii	Eastern Small-footed Myotis	SC	S2	Terrestrial	Mammal
Neotoma magister	Appalachian Woodrat	SC	S2S3	Terrestrial	Mammal
Filipendula rubra	Queen-of-the-prairie	E	S1	Wetland	Vascular Plant
Tortula papillosa	Papillose Tortula	SR-P	S1	Terrestrial	Moss

Table 2: Key to Element Occurrence species rank

Conservation Status Ranks	
Status	Definition
S1	Critcally Impaired
S2	Imperiled
S3	Vulnerable
SX	Presumed Extirpated
*S#S#	Indicates a numeric range rank

Town of Blowing Rock

As the Middle Fork enters downtown Blowing Rock, it flows nearby stormwater infrastructure and concentrated impervious surfaces, and experiences associated nonpoint source pollution. Additionally, sewer lines are run along the Middle Fork (Figure 4) and could be at risk of damage as bank erosion continues to occur. Additionally, the close proximity of sewer lines to the stream pose a hazard in infiltration and inflow (INI) into sewer lines causes a sewer line backup. Some stormwater BMP's are already in place within the Town of Blowing Rock. A pair of retention ponds placed along US-321 capture stormwater runoff from the highway as well as the Middle Fork, reducing downstream peak flows, which decreases flooding risks and bank erosion. Additionally, retention ponds allow sediment suspended in turbid stormwater to settle, decreasing sediment loading downstream.

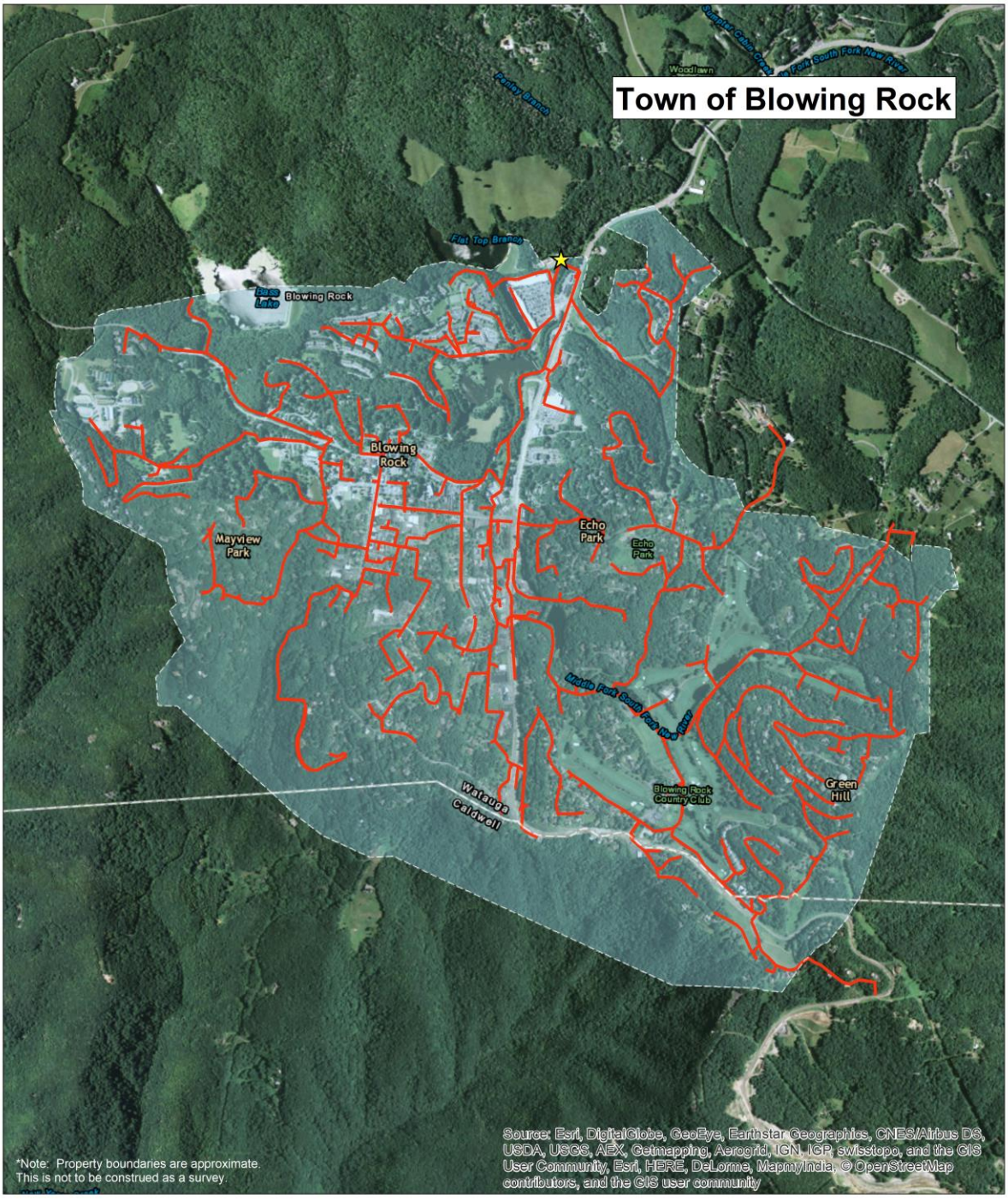

Figure 4: Sewer lines within Blowing Rock

Type of Pollutants

Pollution sources are divided into nonpoint source pollutants and point source pollutants. Nonpoint source pollutants derived from diffuse sources are usually conveyed by stormwater from farms, parking lots, rooftops, and roads, which contain pollutants that wash into the stream during rain events.

Nonpoint source pollutants in the Middle Fork Watershed include:

- Sedimentation: Loose soil from bank erosion
- Bacteria: Potentially pathogenic microbes typically from agricultural waste and stormwater runoff
- Nutrients: Elevated levels of nitrogen and phosphorus from agricultural runoff
- Thermal pollution: increases in water temperature introduced by runoff from warm surfaces and increased exposure of the stream surface to solar radiation.

Sedimentation

Elevated sediment loads pose several problems for aquatic ecosystems. High concentrations of suspended sediment in the water column reduce the amount of light available for photosynthesis to aquatic vegetation, and settling material can reduce the availability of trout spawning beds. Solar radiation absorbed by suspended sediment also serves as a mechanism to increase water temperature. Development in the Middle Fork Watershed has contributed to increased sediment loads in the stream. Impervious surfaces in close proximity to the stream increase the magnitude of peak flows during storms, which increase bank erosion. Furthermore, removal of riparian vegetation reduces soil cohesion in streambanks, increasing their vulnerability to erosion during high flows. Concentrated sediment releases can also occur as a product of construction activities within the watershed. Channelization and culverting are also present in the impaired reach. Both practices increase flow velocities and disturb the stream channel's morphology and aquatic habitat.

Bacteria

Agricultural drainage and stormwater runoff is responsible for high levels of bacteria levels in many rivers and creeks. 'Indicator' bacteria levels, typically fecal coliforms and E. coli, are used to determine the concentration of bacteria in streams and lakes. These bacteria are not typically harmful to human health, but their presence indicates can be used to determine if harder-to-detect strains of bacteria are presence in a body of water. Harmful bacteria that have a range of effects on aquatic ecosystems and human health are more likely to be present in streams with high concentrations of E. coli and fecal coliforms.

Nutrients

Nutrient pollution, typically an excess of nitrogen and phosphorous, represents another widespread environmental problem. In a river, nitrogen and phosphorous support the growth of algae and aquatic plants. Both nutrients are necessary for any aquatic ecosystem, but can have negative effects on aquatic ecosystems at high concentrations. Large spikes of nutrients resulting from stormwater runoff harm water quality, food resources, and habitat. Algae growth resulting

from high concentrations of excess nutrients depletes the water column of dissolved oxygen, which in turn influences the availability of suitable habitat. In severe cases, hypoxic conditions can trigger fishkills.

Thermal Pollution

In addition to bank stabilization, riparian buffers provide shade, reducing water temperature, especially during the summer. Water temperature is a critical component of water quality, especially for thermally sensitive trout populations. For example, water temperature influences fish mortality, distribution, growth and developmental rates, reproductive fitness, pollutant, uptake, and competitive interactions. Additionally, dissolved oxygen solubility decreases at higher water temperatures, and is a major determinant of habitat availability during the summer. Furthermore, reaches of stream lacking a riparian buffer in close proximity to impervious surfaces are likely to exhibit spikes in temperature during summer storms. Rainwater falling on warm asphalt and concrete during such events is high in temperature and has the ability to run off quickly into streams.

Baseline Watershed Information and Monitoring Needs

Benthic macroinvertebrate surveys have been emphasized by DWR in determining water quality. These surveys, conducted by water quality professionals, survey aquatic insects that live in streams. Some of these insects are indicators of water quality. During these surveys, taxa richness, biotic indices, and abundances are calculated. Each of these values are important in determining water quality and are defined as by the state below.

- *Taxa Richness*: The number of different species represented
- *Biotic Indices*: 1 to 10 scale indicating quality of an aquatic environment based on types of organisms found
- *EPT Abundance*: The number of Mayflies, Stoneflies, and Caddisflies found

The stream's benthic community was determined to be in 'fair' condition following benthic surveys conducted in September 2009 by NCDEQ-DWR. The designation resulted in the stream's placement on NC's 303(d) impaired waterbodies list in 2012. A benthic impairment designates water that is degraded and will not support an adequate benthic community. Results of the 2009 benthic surveys in the Middle Fork catchment are presented in Appendix 1. Additional benthic and fish survey data is available from the EPA's Storage and Retrieval (STORET) and Water Quality Exchange (WQX).

Chemical data has not been collected in the watershed since the 1970s. As such, water quality monitoring should be performed prior to the implementation of BMPs to establish a baseline of currently water quality conditions. Monitoring should also continue following the implementation of BMPs. Establishing baseline information is critical to the watershed planning process, as it allows the project team to evaluate the impact of BMPs and make further recommendations. Monitoring needs will be addressed by members of New River Conservancy's New River Water Watchers (NRWW) and New River Basin Coalition (NRBC) programs.

NRBC is a voluntary ambient monitoring program that is a component of the NCDEQ Monitoring Coalition Program. Coalition members are typically National Pollutant Discharge Elimination System (NPDES) permit holders. NRBC members collect ambient data quarterly. Funding is being sought to add a NRBC member in Blowing Rock to monitor conditions in the Middle Fork.

NRWW is a citizen science-based water quality monitoring program that covers the New River Watershed. Members monitor basic water quality parameters monthly, including water temperature, pH, dissolved oxygen, water clarity, E. coli, and fecal coliforms. NRWW will monitor points at strategic locations in the impaired catchment in order to determine source areas of pollution and BMP effectiveness.

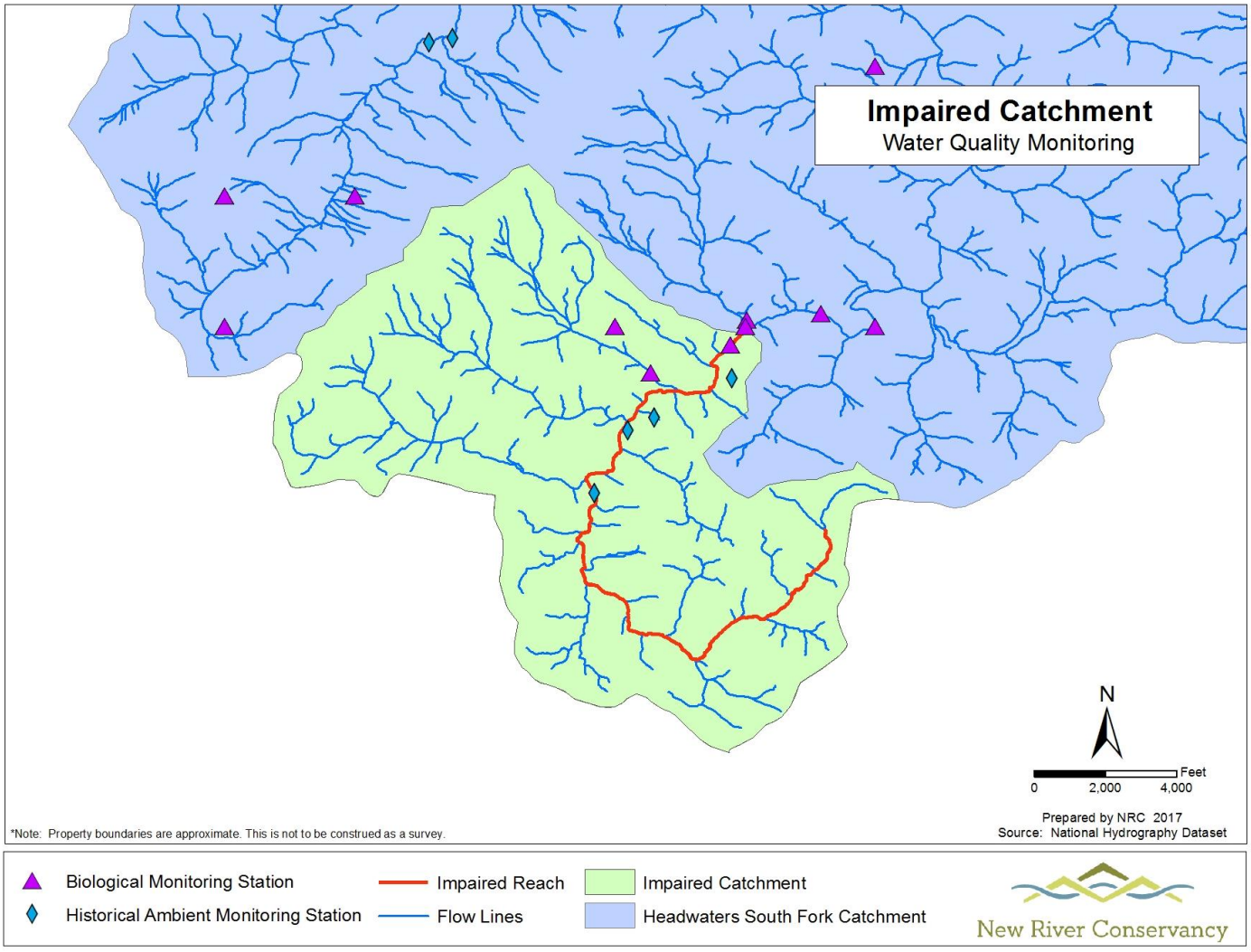

Figure 5: NCDEQ-DWR water quality monitoring sites

Field Assessments

General field assessments accompanied biological and physical data in order to better understand the practices contributing to the Middle Fork's impairment. Numerous common practices present along the Middle Fork are detrimental to the health of the river and its ability to serve as an ecosystem. Field assessments were performed to identify sources of pollution and potential restoration sites (Figure 6). Best management Practices recommended for each site are listed in the Recommended BMPs section. The following were considered widespread:

- Mowing to edge of the bank and removing native trees and shrubs, a common practice for much of the stream and its tributaries that contributes to bank destabilization.

- Channel straightening, resulting in increases in flow velocity, and potentially increasing bank erosion. Similarly, fast flow in channelized reaches eventually reaches choke points, increasing the likelihood of flooding and bank erosion at high flows. Furthermore, channelization can be detrimental to fish populations that depend on pools as habitat.

- Stormwater runoff, which can be better managed to control flooding, erosion, and the release of pollutants. Poorly installed culverts are contributing to bank erosion. Additionally, impassable culverts reduce river connectivity and habitat.

Field assessments were supplemented by modeling with the Universal Soil Loss Equation (USLE. An empirical model originally used to calculate agricultural soil loss rates, USLE has also been widely used for conservation purposes. With USLE, soil loss rates are calculated as the product of rainfall, runoff, soil erodibility, slope length/slope steepness, and landcover factors (Hickey, 2000). In the Middle Fork Watershed, average annual tons of soil loss per 30 m grid cell were calculated in order to identify sites vulnerable to bank erosion (Figure 7). Sites with high soil loss potential along streams and not under forest cover were visited and assessed.

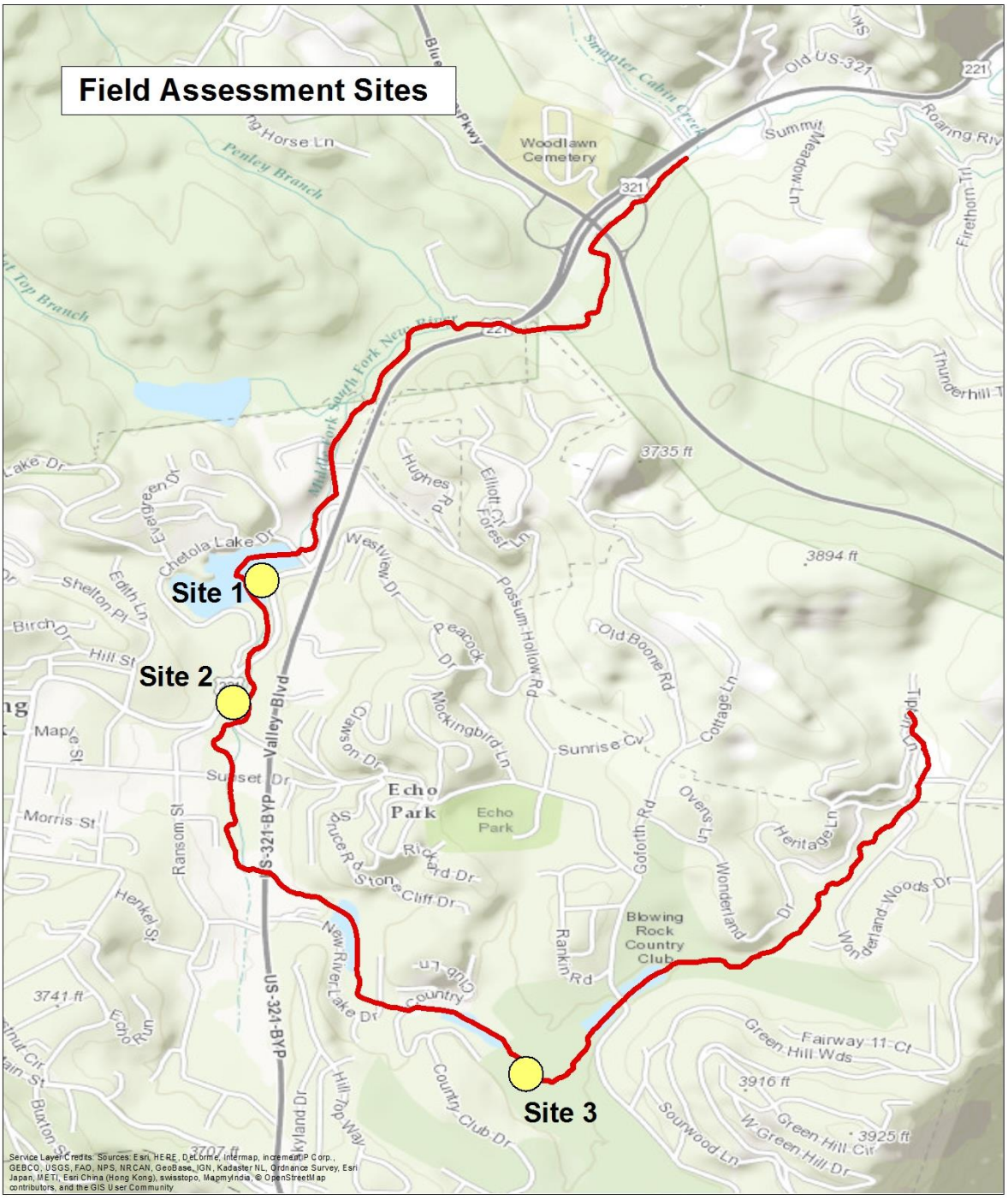

Figure 6: Sites visited during field assessment

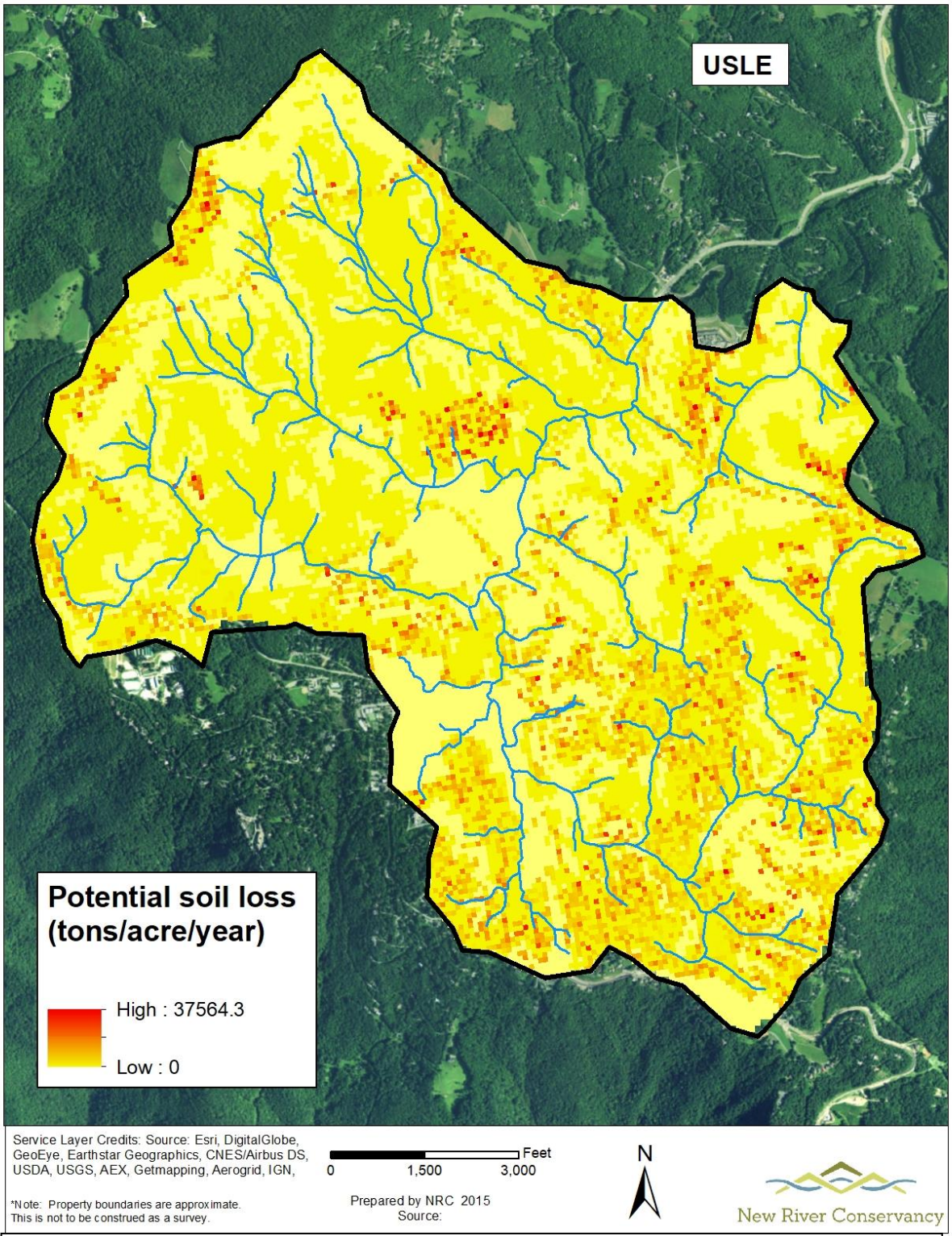

Figure 7: USLE model results for the Middle Fork Watershed

Site 1 – Area surrounding Chetola Lake and Chetola Dam

Priority: Moderate

The impoundment of water by dams affects a number of ecological aspects of the Middle Fork. Several impoundments are likely increasing the water temperature in excess of natural conditions. Elevated temperatures influences aquatic organisms which are adapted to particular ranges of temperature. Changes in water temperature regimes can cause considerable changes to growth and developmental rates, reproductive fitness, pollutant uptake, competitive interactions, and mortality in aquatic ecosystems. As a result, food chains may be compromised. The cascade of factors can result in a substantial loss of biodiversity.

Restoration projects surrounding Chetola Lake are needed to restore ecosystem function. The thermal stress caused by the dam could be repaired by releasing water from the bottom, instead of the top. Combined releases from the top and bottom of dams is considered to be the best practice, since cold bottom-released water is typically lower in temperature during summer, while top released water contains less sediment.

In addition, restoration projects in the area around Chetola Lake could indirectly mitigate impacts caused by the dam. A restored riparian buffer can filter pollutants from surface runoff and cool water by partially shading the water surface. The banks of the unnamed tributary connecting Chetola Lake and Bass Lake are eroding due to the lack of a riparian buffer. Water temperature is likely to be elevated. This creek is one of many in need of restoration in the area.

Dam at the at the inflow of the Middle Fork into Chetola Lake

The Middle Fork at the entrance of Chetola Lake. The stream is vegetated on one side and lacks a riparian vegetation the other, however, the backwater created by the dam minimizes bank erosion

Chetola Lake. The lake is exposed to the sun and has a large surface area, increasing downstream temperature. Most of the land surrounding the lake is not vegetated.

Outflow from Chetola Dam.

The creek connecting Bass Lake and Chetola Lake lacks a riparian zone immediately above the inflow into the lake. A riparian buffer would decrease water temperature and nutrient/bacteria concentration in the reach.

Site 2: Middle Fork between Church Street and US-221
Priority: High

The reach of the Middle Fork between Church Street and US-221 (following Valley Boulevard), flows in close proximity to a number of parking lots associated with businesses along US-321. This particular stretch of the stream has been poorly managed. Poorly installed culverts have disturbed habitat, particularly by reducing spawning success. Culverts elevated above the stream surface are often impassable for fish, preventing upstream migration and reproduction.

Several reaches have limited riparian vegetation and have experienced erosion and warming within the water column. In particular, a 500 ft reach along US-221 which would benefit from a wider riparian buffer with more native species. A healthy riparian buffer would increase bank stability and protect landowners from continued bank erosion. A buffer would also provide aesthetic value and educational opportunities, especially given the site's central location.

The Middle Fork along US-221 behind Don Caster Outlet. Native woody shrubs would provide shade and bank stability.

Downstream from Sunset Drive. This reach is in need of a riparian buffer.

Several of many poorly installed culverts. The area could be improved by the addition of a rain garden, which would slow stormwater, reduce surface runoff, and filter pollutants as runoff infiltrates.

Potential rain garden site along the Middle Fork at Sunset Drive

Site 3: Blowing Rock Country Club golf course
Priority: Low

The headwaters of the Middle Fork connect several impoundments on the Blowing Rock Country Club golf course. The impoundments and the stream both lack riparian vegetation, resulting in elevated water temperature. Additionally, restoration of the stream through the addition of a vegetated riparian corridor would enhance the aesthetic value of the course as well as improve wildlife habitat.

Multiple water impoundments exist on the golf course. Unshaded ponds elevate water temperature.

Creek on the Blowing Rock Country Club Golf Course. Streambanks are lacking proper riparian zones and are vulnerable to thermal pollution.

Best Management Practices

The following Best Management Practices (BMPs) are recommended for the sites visited during field assessments based on the observations and analysis within the NC Basinwide Water Quality Plan (NC Department of Environmental Quality-Division of Water Resources, 2011).

Streambank stabilization

- Preserve streambank stability by planting riparian vegetation and protecting existing vegetation
- In cases of severe bank erosion, the installation of engineered rock structures may be necessary to redirect flow away from streambanks

Riparian buffer rehabilitation

- Riparian buffers should be widely implemented and existing buffers should be preserved. Vegetation is of crucial importance to the biological, chemical, and physical health of the stream as well as the bank's stability.
- Native riparian vegetation is recommended. Native species are adapted to the local ecology and have deep, fibrous root systems.

Stormwater management

- Install rain gardens, permeable pavement, bioswales, and urban vegetation in order to slow stormwater and filter pollutants from runoff.

Streambank stabilization accomplished with a native riparian buffer.

Innovative Stormwater Management in rural and urban areas. A) rain garden in Fairfax, VA. B) Casey & Casey permeable pavement project in Boone, NC.

Clawson-Burnley Wetland Park in Boone, NC, designed to capture urban stormwater before it reaches the South Fork New River.

BMP implementation costs and estimates of load reduction

Costs associated with restoration projects are listed in Table 3. Implementation costs were estimated from an average of New River Conservancy's previous projects and from stormwater management guidance (University of Maryland Extension, 2016) Pricing for streambank restoration and stormwater projects varies widely based on project scale, materials, and other needs.

Pollutant load reductions were determined using the EPA Region 5 model, a spreadsheet based modeling tool which provides estimates of sediment and nutrient load reductions for both agricultural and urban BMPs based on channel characteristics (Environmental Protection Agency, 2017). Nitrogen, phosphorus, and sediment load reductions associated with riparian buffer planting were calculated assuming that all recommended buffers were implemented.

Table 3: Estimated costs associated with BMP implementation

management measure	cost	unit
Streambank restoration	$150-250	per linear foot
Riparian buffer rehabilitation	$10	per linear foot
Rain garden installation	$5-$25	per square foot
Permeable pavement installation	$0.50-$10	per square foot

Table 4: Potential load reduction associated with riparian buffer planting at project sites.

site number	sediment (ton/yr)	phosphorus (lb/yr)	nitrogen (lb/yr)
1	2.2	2.0	3.9
2	73.4	62.4	124.8
3	14.8	12.6	25.1

Plan Implementation

Implementing the recommendations in this plan is a multistep process. Along with coordination among the project team, the initial priority will be involving community members, landowners, and institutions. The steps envisioned are listed below:

1. NC Department of Environmental Quality approval of plan.

2. Focus on sites to implement BMPs. Establish chemical monitoring stations and begin monitoring water quality.

3. Work with landowners, the Town of Blowing Rock, and community institutions to implement the Best Management Practices outlined above.

4. Continue to monitor biological, physical, and chemical water quality parameters in the Middle Fork and its tributaries to assess the effectiveness of BMP implementation.

5. Apply the recommendations and results of this plan to other impaired waters in the New River Watershed. .

Technical and Financial Assistance

This project is leveraging funds from several institutions. New River Conservancy will work with landowners, contractors, the Town of Blowing Rock, Natural Resources Conservation Service, and the Clean Water Management Trust Fund. Recommended BMPs will be designed and installed by engineering contractors. NRC continues to partner with contractors from Brushy Fork Environmental Consulting, Inc, Foggy Mountain Nursery and Stream Restoration, LLC, and Resource Institute, Inc, to design and install BMPs for restoration projects.

Prioritization

Prioritization will be given to sites based on multiple criteria:

- The extent of erosion and sedimentation
- Public access or high visibility due to educational opportunities
- Land use
- Landowner willingness
- Site's potential to improve water quality
- Site's potential to remove the East Fork from the impaired waterbodies list
- Funding availability for projects at the site

Educational Opportunities

The projects suggested provide excellent educational opportunities for the public. NRC is seeking volunteer water quality monitors to contribute to the NRWW program in the Middle Fork. Volunteers contribute critical water quality data and serve as stewards of their local streams. NRC is also actively seeking student involvement. During past projects, NRC has partnered with high school and university students to perform benthic macroinvertebrate surveys at project sites. The surveys provide the project team with supplemental data and give students hands-on experience. Finally, NRC has offered internships to students to contribute to writing watershed plans and provide assistance in the field. In addition to learning more about water quality, interns are exposed to the nonprofit work environment and gain practical work experience. Interpretive material installed at project sites will demonstrate and display information on pollution and mitigation strategies.

Project Phasing

To implement this project, we propose a 1-2-year timeline for sites deemed high priority. Projects commencing after the initial timeline will be implemented as funding becomes available. Steps for each suggested project are listed in Appendix 2.

Conclusion

The Middle Fork Watershed has the opportunity to be a healthy ecosystem. However, the benthic community data collected by the NCDEQ suggest that the creek is unable to support the aquatic ecosystem as expected. Implementing the Best Management Practices outlined in this plan will improve water quality, provide economic benefits, and enhance ecosystem services. Without the implementation of BMPs, the stream will continue to degrade, consequently increasing future rehabilitation costs.

The success of this plan depends on the community's support. Landowners must be willing to implement the practices outlined. The project team has already begun the process of working with landowners and institutions in the watershed. Several projects are in the process of being proposed and funding is being sought. Finally, this project serves as an excellent opportunity for the community to learn about water quality. Having members of the community of Blowing Rock as stewards of their watershed will inspire future generations.

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Appendix 1

2009 DEQ benthic macroinvertebrate survey results

Station	Date	Scientific Name	Result Value
KB150	9/30/2009	Leuctra	Common
KB150	9/30/2009	Ceratopsyche macleodi	Abundant
KB150	9/30/2009	Hydatophylax argus	Common
KB150	9/30/2009	Nyctiophylax	Common
KB150	9/30/2009	Dolophilodes	Abundant
KB150	9/30/2009	Malirekus hastatus	Abundant
KB150	9/30/2009	Sweltsa	Common
KB150	9/30/2009	Phylocentropus	Abundant
KB150	9/30/2009	Palpomyia	Common
KB150	9/30/2009	Diplectrona modesta	Abundant
KB150	9/30/2009	Optioservus ovalis	Abundant
KB150	9/30/2009	Tallaperla	Abundant
KB150	9/30/2009	Cambarus	Rare
KB150	9/30/2009	Lanthus	Common
KB150	9/30/2009	Stylogomphus albistylus	Rare
KB150	9/30/2009	Cordulegaster	Rare
KB150	9/30/2009	Oulimnius latiusculus	Common
KB150	9/30/2009	Dixella	Common
KB150	9/30/2009	Molanna	Rare
KB150	9/30/2009	Dicranota	Rare
KB150	9/30/2009	Tipula	Abundant
KB150	9/30/2009	Hexatoma	Common
KB150	9/30/2009	Rhyacophila acutiloba	Abundant
KB150	9/30/2009	Pycnopsyche	Rare
KB150	9/30/2009	Natarsia	Rare
KB150	9/30/2009	Sericostomatidae	Rare
KB150	9/30/2009	Psilotreta	Rare
KB150	9/30/2009	Litobrancha	Common
KB150	9/30/2009	Elimia	Abundant
KB150	9/30/2009	Glossosoma	Rare
KB150	9/30/2009	Baetis tricaudatus	Common
KB150	9/30/2009	Leucrocuta	Common
KB150	9/30/2009	Epeorus	Rare
KB150	9/30/2009	Stenacron	Common
KB150	9/30/2009	Stenonema meririvulanum	Abundant
KB150	9/30/2009	Stenonema mediopunctatum	Rare
KB150	9/30/2009	Drunella	Rare
KB150	9/30/2009	Eurylophella	Common
KB150	9/30/2009	Paraleptophlebia	Abundant

Station	Date	Scientific Name	Result Value
KB68	9/30/2009	Tallaperla	Rare
KB68	9/30/2009	Baetis intercalaris	Common
KB68	9/30/2009	Paraleptophlebia	Rare
KB68	9/30/2009	Eurylophella	Rare
KB68	9/30/2009	Stenonema modestum	Abundant
KB68	9/30/2009	Stenonema mediopunctatum	Common
KB68	9/30/2009	Cheumatopsyche	Abundant
KB68	9/30/2009	Hydropsyche betteni	Abundant
KB68	9/30/2009	Hydatophylax argus	Common
KB68	9/30/2009	Rhyacophila fuscula	Rare
KB68	9/30/2009	Baetisca	Rare
KB68	9/30/2009	Ceratopsyche sparna	Common
KB68	9/30/2009	Baetis tricaudatus	Common
KB68	9/30/2009	Goera	Rare
KB68	9/30/2009	Stenacron interpunctatum	Rare
KB68	9/30/2009	Baetis pluto	Rare

Station	Date	Scientific Name	Result Value
KB149	9/30/2009	Sericostomatidae	Rare
KB149	9/30/2009	Parametriocnemus	Common
KB149	9/30/2009	Leuctra	Rare
KB149	9/30/2009	Palpomyia	Rare
KB149	9/30/2009	Stenacron interpunctatum	Rare
KB149	9/30/2009	Simulium	Rare
KB149	9/30/2009	Tipula	Abundant
KB149	9/30/2009	Hexatoma	Common
KB149	9/30/2009	Ptilostomis	Rare
KB149	9/30/2009	Ceratopsyche macleodi	Common
KB149	9/30/2009	Nyctiophylax	Common
KB149	9/30/2009	Elimia	Abundant
KB149	9/30/2009	Hyalella	Rare
KB149	9/30/2009	Lanthus	Common

Station	Date	Scientific Name	Result Value
KB148	9/29/2009	Ceratopsyche sparna	Common
KB148	9/29/2009	Baetis pluto	Common
KB148	9/29/2009	Hydropsyche betteni	Common
KB148	9/29/2009	Neureclipsis	Rare
KB148	9/29/2009	Cheumatopsyche	Abundant
KB148	9/29/2009	Ceratopsyche bronta	Common
KB148	9/29/2009	Dolophilodes	Common
KB148	9/29/2009	Rhyacophila fuscula	Rare
KB148	9/29/2009	Stenacron interpunctatum	Common
KB148	9/29/2009	Hydatophylax argus	Rare
KB148	9/29/2009	Acentrella turbida	Common
KB148	9/29/2009	Baetis intercalaris	Common
KB148	9/29/2009	Soyedina	Rare
KB148	9/29/2009	Stenonema modestum	Abundant
KB148	9/29/2009	Stenonema mediopunctatum	Abundant
KB148	9/29/2009	Plauditus	Rare
KB148	9/29/2009	Baetis tricaudatus	Abundant
KB148	9/29/2009	Baetis flavistriga	Abundant
KB148	9/29/2009	Goera	Rare

Appendix 2

Site 1 – Area surrounding Chetola Lake and Chetola Dam

Step	Task
1	Reach out to landowner
2	Set meeting to discuss project and options with landowner and lawn maintenance staff.
3	Finalize which streambanks will be planted and which sites need more extensive restoration
4	Landowner signs 15-year agreement not to disturb project.
5	Plant riparian zones during next immediate planting season (Oct-Mar).
6	Monitor plantings the following spring.
7	Final monitoring during second following spring. Determine if more plants are needed to complete the enhancement of the streambank.

Site 2 – Middle Fork between Church Street and US-221

Step	Task
1	Reach out to landowner(s).
2	Set stakeholder meeting to discuss project and options with landowner(s).
3	Finalize which streambanks will be planted and which sites will need more extensive restoration
4	Landowner signs 15-year agreement not to disturb project.
5	Begin permitting and grant application processes on project sites that will require sloping and rock structures.
6	Plant riparian zones during next immediate planting season (Oct-Mar).
7	Implement all projects that required permits and additional funding.
8	Monitor all projects the following spring.
9	Final monitoring during second following spring. Determine if more plants are needed to complete the enhancement of the streambank.

Site 3 – Blowing Rock Country Club golf course

Step	Task
1	Reach out to landowner.
2	Set meeting to discuss project and options with landowner and golf course maintenance staff.
3	Landowner signs 15-year agreement not to disturb planting project.
4	Plant riparian zones during next immediate planting season (Oct-Mar).
5	Monitor plantings the following spring.
6	Final monitoring during second following spring. Determine if more plants are needed to complete the enhancement of the streambank.