PINE LOG CREEK WATERSHED MANAGEMENT PLAN

A local stakeholder approved plan that outlines the framework for improving water quality in Pine Log Creek and its tributaries

Limestone Valley RC & D Council

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Acknowledgements

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1 Contents

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Executive Summary

The Pine Log Creek Watershed (HU 0315010206), a tributary to Salacoa Creek is located in the Coosa River Basin. It originates near Beasley Gap in the relatively high elevations of Cherokee and Bartow Counties and flows generally northwest through Gordon County. Although part of the Salacoa Creek watershed, Pine Log Creek is listed as an individual 10-digit Hydrologic Cataloguing Unit. The Pine Log Creek HUC consists of six subwatersheds— Spring Creek (12.43 sq mi), Jacks Creek (17.19 sq mi), Ballard/Cedar Creek (30.32 sq mi), Little Pine Log Creek (28.61 sq mi), Calico Valley – Pine Log Creek (13.75 sq mi), and Sugar Hill/Pine Log Creek (24.57 sq mi).

In the Pine Log Creek watershed, a total of five segments are assessed by GAEPD. Of these, two segments were found to be “Supporting” and three are “Not Supporting”. These impairments are the result of excessive fecal coliform bacteria counts and / or heavy sedimentation, as indicated by poor biotic survey results. In order to address these impairments, Total Maximum Daily Load (TMDL) Evaluations were written in 2003 and 2009. A TMDL Implementation Plan was also written in 2006 to evaluate and track water quality protection and restoration. Despite these efforts, little progress has been made over the years to ameliorate the water quality issues in the Pine Log Creek Watershed. This watershed-based plan addresses sediment and pathogen loading in the watershed.

Efforts were made to compile previous monitoring data for the watershed as well as determine current watershed conditions and provide stakeholders with current water quality data and assist with the development of this plan. This monitoring focused on collection of fecal coliform, phosphorous, ortho-phosphate, nitrogen, and total suspended solids (TSS) data. Fecal coliform counts were determined to represent amounts of fecal contamination upstream of each site. TSS was used to represent potential erosion issues upstream of each site. In recent years, reducing NPS nutrient pollution has become a topic of interest in the Coosa Basin, including research into a potential nutrient trading program. To provide baseline data for any future efforts, Nitrogen and Phosphorous were monitored at all sites. Samples were taken from eight sample sites within the watershed (Figure 10). Attempts were made to include samples from both wet and dry season to better capture influences of landscape on NPS.

Monitoring data collected for the development of this plan indicate that fecal coliform appears chronically elevated above background conditions at all sites in the watershed, suggesting widespread sources of fecal coliform. Nutrient data indicate excess nutrient loading that consistently approaches or exceeds concentrations that have been shown to result in response thresholds for benthic algae and invertebrates and result in ecological impairment and elevated enough to create eutrophic conditions.

Agricultural

Agricultural lands were identified for targeting load reductions. Best Management Practices, through cost-shares with landowners, are a likely means by which these agricultural reductions can be realized. The agricultural practices implemented will vary according to the interests of the producers, but will likely include heavy use area protection, streambank stabilization, stream access control for cattle coupled with alternative watering systems, stream buffer enhancement, nutrient management planning, and green infrastructure installation. Natural Resource Conservation Service programs will be a key contributor to the success of the agricultural load reduction component of this plan.

Residential

Residential lands could also be targeted to reduce the contributions of fecal coliform bacteria. Addressing septic system issues and failures have been shown to have positive effects on reducing fecal Coliform bacteria loads in proximal waterbodies. Inclusion of cost-share for septic system repairs, prioritizing systems in proximity to streams and wet weather conveyances, will build further momentum. For this program component, it is anticipated that North Georgia Health District and local county health departments will play a key role. Additional "on-the-ground" conservation could likely be achieved through the implementation of green infrastructure and streambank stabilization in urban areas. Depending on location, these practices may be implemented in collaboration with Calhoun Utilities, county municipalities, or other willing partners in the watershed.

Outreach

In addition to actual “on-the-ground” projects, this document outlines the importance of outreach activities. Volunteers were identified by the stakeholder group as having the potential to contribute toward the reduction of pollutant loads through educating the community about watersheds and the importance of water quality, as well as soil and water conservation. The success of outreach and education efforts will be maximized through effective partnerships with several groups. This Watershed Management Plan recommends that these educational and "on-the-ground” management measures be implemented collectively across several funding opportunities. Re-evaluation of the watershed conditions, through monitoring, was noted as an important aspect that could be supported through an outreach effort or funding request.

Urban

The limited urban landscape inside the watershed made nonpoint considerations for urban run off a lessor assumed factor in the planning process. Nonetheless urban runoff is one potential factor in the health of Pine Log Creek, particularly as more dense urban cores—such as Calhoun—develop and expand over time. Green infrastructure as a means to address runoff resulting from impervious surfaces should be considered in any funding requests associated with Pine Log Creek.

Priority Areas

Extensive use of Geographic Information Systems (GIS) allowed planners to perform Watershed-Scale Modeling in order to identify key priority areas with the highest conservation and restoration values. A partnership with the University of Tennessee’s Interdisciplinary Geospatial Technology Lab produced a Landscape Conservation Suitability analysis as well as a Watershed Priority Index (WMPI), as developed by The Nature Conservancy and other various organizations. Products of these models can be used to focus implementation efforts for the greatest value in pollution reduction. Furthermore, conservation happens at the local level. To facilitate this, each parcel in the Pine Log Watershed was then scored based on inputs from the models. With this data implementation can be directed at projects that have the highest conservation value per implementation dollar.

Assessment protocols and funding

Funding for Implementing this WMP will be made available through NRCS NWQI program funds to address agricultural BMPs. Additional funding should be applied for through available grant opportunities and leveraged community support. A Multiyear budget has been included in this plan based on anticipated funding through both NWQI and potential applications through Georgia EPD 319(h) funds. Assessments made of the Pine Log watershed are included throughout this document and are varied in form. Assessments followed generally accepted methodologies and included IBI, visual surveys, GIS analysis, conservation and restoration modeling, as well as community inputs assessing the social needs and conditions of the watershed.

The proposed implementation schedule includes all 319, NWQI or other funding-based grant activities including water quality monitoring, education and outreach activities, and conservation activities (e.g., agricultural Best Management Practices, septic system repairs, streambank stabilization, etc.). Each of these activities were assumed to continue through each grant implementation period. The stakeholders recommended four consecutive grant implementation periods to be pursued, with the belief that it may allow for significant improvements within the watershed. After this period of time, it is expected that some impaired stream reaches will have been de-listed, and others will at least be improved and approaching compliance with state criteria.

1 Plan Preparation and Implementation

Pine Log Creek Watershed (HU 0315010206) has a total of five reaches that are assessed by the Georgia Environmental Protection Division for meeting state water quality standards. A total of three of these reaches are designated as "Not Supporting" their respective designated uses. These segments are listed due to elevated fecal coliform levels as well as impaired biota, typically a result of excess sedimentation. To address these impairments, Total Maximum Daily Load (TMDL) Evaluations were written in 2003 and 2009. A TMDL Implementation Plan was also written in 2006 to evaluate and track water quality protection and restoration. Despite these efforts, little progress has been made over the years to improve the water quality of the Pine Log and greater Salacoa Creek watersheds. The purpose of this Watershed Management Plan (WMP) is to propose a preferred set of Best Management Practices (BMPs) to implement to restore Pine Log. Creek and timeline on which to implement them. The document is not regulatory in nature, but the preparation process educates stakeholders about the issues and provide suggestions for improvement. It also develops momentum within the community which can then contribute to the restoration effort. The ultimate goals of the planning and restoration process are for impaired segments to be (and remain) delisted and for the integrity of other segments to be maintained. The broader goal is to provide information for stakeholders and landowners in the watershed concerning watershed issues and restoration practices to help them manage the landscape to minimize water and soil resource concerns.

Limestone Valley Resource Conservation and Development Council (RC&D) has developed this plan as part of a National Water Quality Initiative (NWQI) grant to develop new as well as update and improve former Water Quality Management Plans in order to jumpstart restoration activities in the watershed.

The EPA has recommended nine key elements for watershed management plans to help ensure that stakeholder involvement and approval lead to an explicit prescription to eventually meet watershed restoration objectives.

Specifically, the nine key elements are as follows:

1. An identification of the sources or groups of similar sources contributing to nonpoint source (NPS) pollution to be controlled to implement load allocations or achieve water quality standards.
2. An estimate of the load reductions needed to de-list impaired stream segments;
3. A description of the NPS management measures that will need to be implemented to achieve the load reductions established in the TMDL or to achieve water quality standards;
4. An estimate of the sources of funding needed, and/or authorities that will be relied upon, to implement the plan;
5. An information/education component that will be used to enhance public understanding of and participation in implementing the plan;
6. A schedule for implementing the management measures that is reasonably expeditious;
7. A description of interim, measurable milestones (e.g., amount of load reductions, improvement in biological or habitat parameters) for determining whether management measures or other control actions are being implemented;
8. A set of criteria that can be used to determine whether substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether the plan needs to be revised; and;

9. A monitoring component to evaluate the effectiveness of the implementation efforts, measured against the criteria established under item (8) above.

The nine elements provide a better framework for planning successful long-term watershed improvement plans. Utilizing the strategies within them increases the probability of successful implementation of restoration efforts.

Limestone Valley Resource Conservation and Development Council (RC&D) opted to develop a more extensive WMP that focuses more effort on specific watershed details, as well as a more comprehensive Geographic Information Systems (GIS) analysis that investigates several factors that exert an influence on NPS pollution loads. More focus on these details should lead to a more specific WMP that is founded on a greater understanding of the local physical and social environment. Compiling more extensive data should help us better determine priorities in the watershed for targeting Best Management Practice (BMP) installations, allow for better long-term land use and riparian comparisons, and assist in the development of more discreet objectives and milestones. The process used to construct this document was complex and utilized extensive research on the watershed, including water quality monitoring and GIS analysis. Data regarding water quality, fish and macroinvertebrate assemblages, geology, soils, and land use were considered when conducting research on the watershed. The GIS component focused on analyzing riparian buffers, land use percentages, and housing densities. GIS and water quality monitoring were also tools to identify broad areas of likely NPS pollution sources and priority areas for installation of BMPs.

The development of the plan also relied upon the participation of a stakeholder group (Table 1.), which consisted of members from local, state, and Federal government agencies, nonprofit groups, and the private sector. They are a group of volunteers that work in the watershed, have an understanding of the community as well as the landscape, and work to utilize their expertise to reach out to local communities and develop long-term partnerships. Their efforts will help ensure the long-term NPS pollution reduction strategies will be implemented successfully. Three public meetings conducted in 2020 and 2021 were held with the stakeholder group to engage the public in the process of drafting this management plan. Stakeholder members were invited to take part in the process based on professional interests, activity in the watershed and familiarity with previous stakeholder efforts. Local governments were also made aware of the stakeholder process and given the opportunity to participate in the stakeholder group. All members were informed of what was expected of them throughout the stakeholder process, and those that wished to contribute more were allowed and encouraged to do so. A few stakeholders were consulted more regularly due to their expertise and willingness to provide additional support. It is also anticipated that some stakeholders may contribute significantly in the restoration process. Meetings focused on gathering input about potential problems and solutions, developing priorities, evaluating what BMPs might be met with the best public reception, and obtaining insight on the document. Finally, approval was sought for the Watershed Management Plan document to serve as the plan on which restoration and implementation efforts will follow.

Table 1 . Stakeholder Committee

Name	Position	Main Affiliation
Sheri Teems	District Conservationist	NRCS
Stuart Proctor	NRCS Grassland Specialist	NRCS
Richard Osborne	County Planning- Zoning	Bartow County
Missy Phillips	Assistant Sustainability Coordinator	Bartow County
Kyle Ellis	Water & Wastewater Director	Calhoun Utilities
Jim Ledbetter	County Executive	Gordon County
Katie Owens	Field Director	The Nature Conservancy
Jesse Demonbreun-Chapman	Executive Director and River Keeper	Coosa River Basin Initiative
Greg Bowman	Gordon County Agent	UGA Extension
Martha Zapata	Biologist	US Fish and Wildlife
Ani Escobar	Coosa Aquatic Biologist	GA DNR WRD

2 Pine Log Creek Watershed Description

2.1 Location and Subwatersheds

Pine Log Creek (HU 0315010206) is located within the Coosa River Basin. It is a tributary of Salacoa Creek, which flows into the Coosawatee northeast of Calhoun, Georgia. Shortly thereafter it forms the Oostanuala River after it's confluence with the Conasauga River. Ultimately, the Coosa River forms the Alabama River, at the confluence with the Tallapoosa River, and drains into the Gulf of Mexico via the Mobile River.

Pine Log Creek originates near Beasley Gap in the relatively high elevations of Cherokee and Bartow Counties. The mainstem flows generally northwest towards the confluence with Salacoa Creek. Although part of the Salacoa Creek watershed, Pine Log Creek is listed as an individual 10-digit Hydrologic Cataloguing Unit (HUC). The Pine Log Creek HUC consists of six subwatersheds— Spring Creek (12.43 sq mi), Jacks Creek (17.19 sq mi), Ballard/Cedar Creek (30.32 sq mi), Little Pine Log Creek (28.61 sq mi), Calico Valley – Pine Log Creek (13.75 sq mi), and Sugar Hill/Pine Log Creek (24.57 sq mi).

Figure 1. Overview of the Pine Log Creek Watershed and Vicinity.

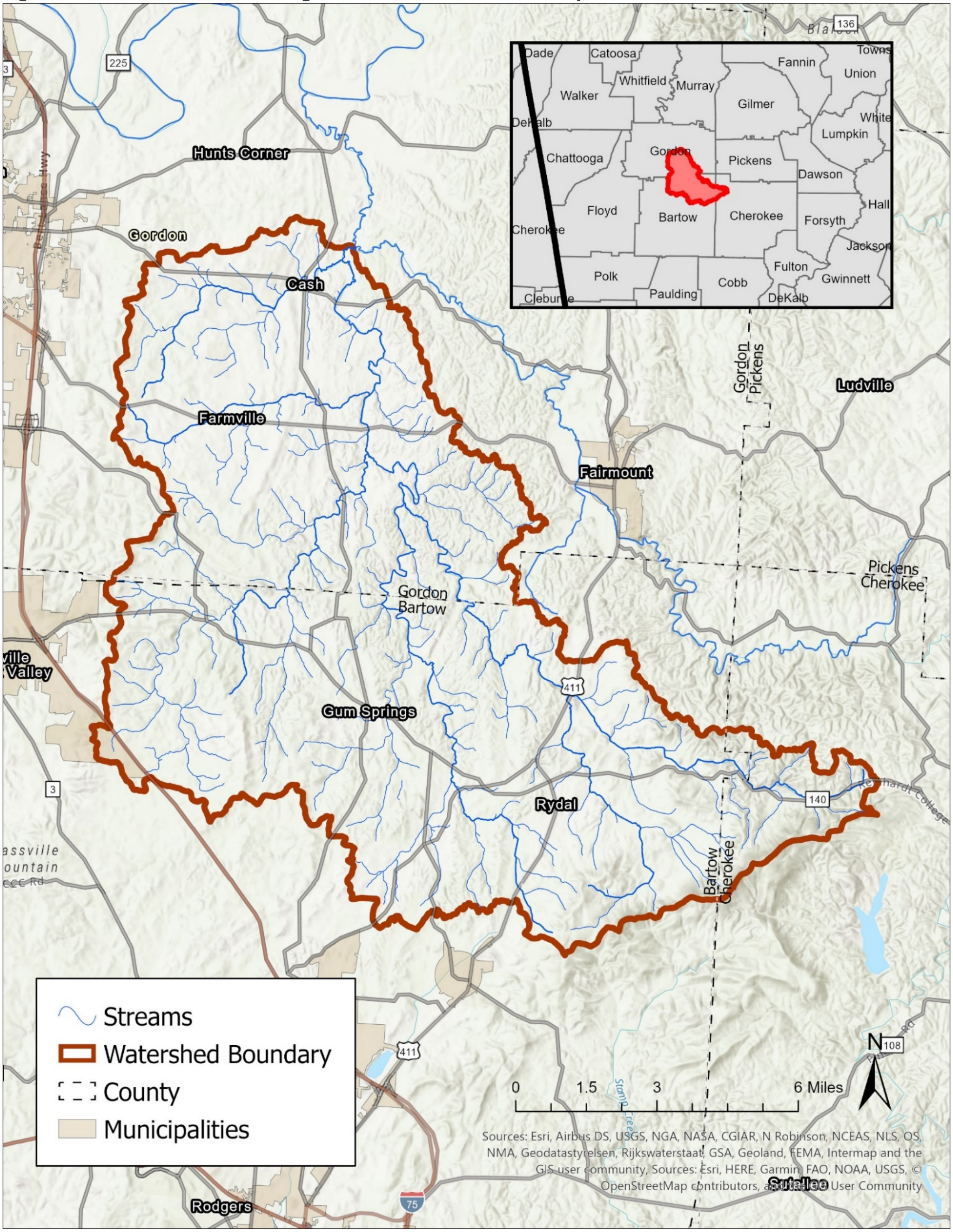
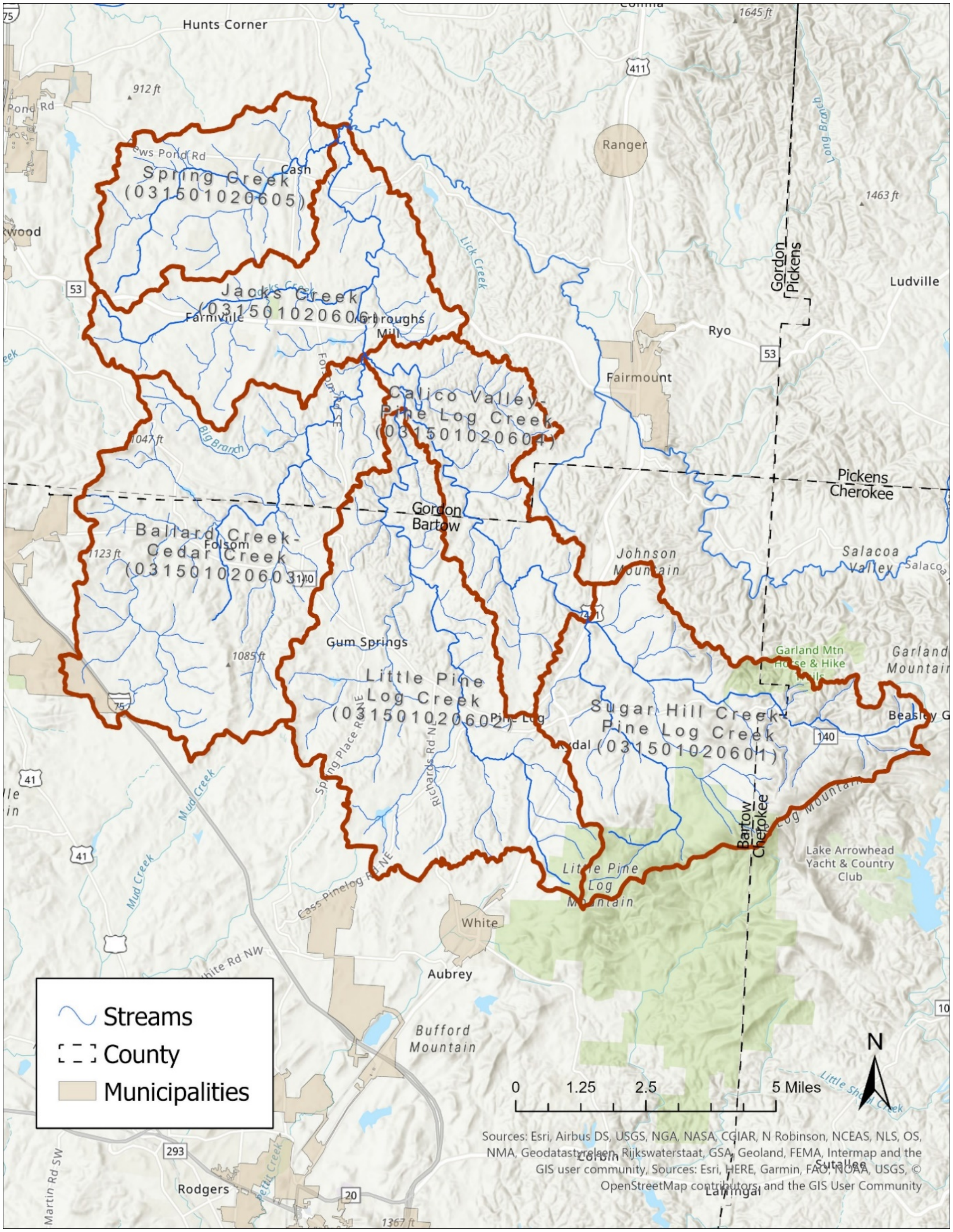


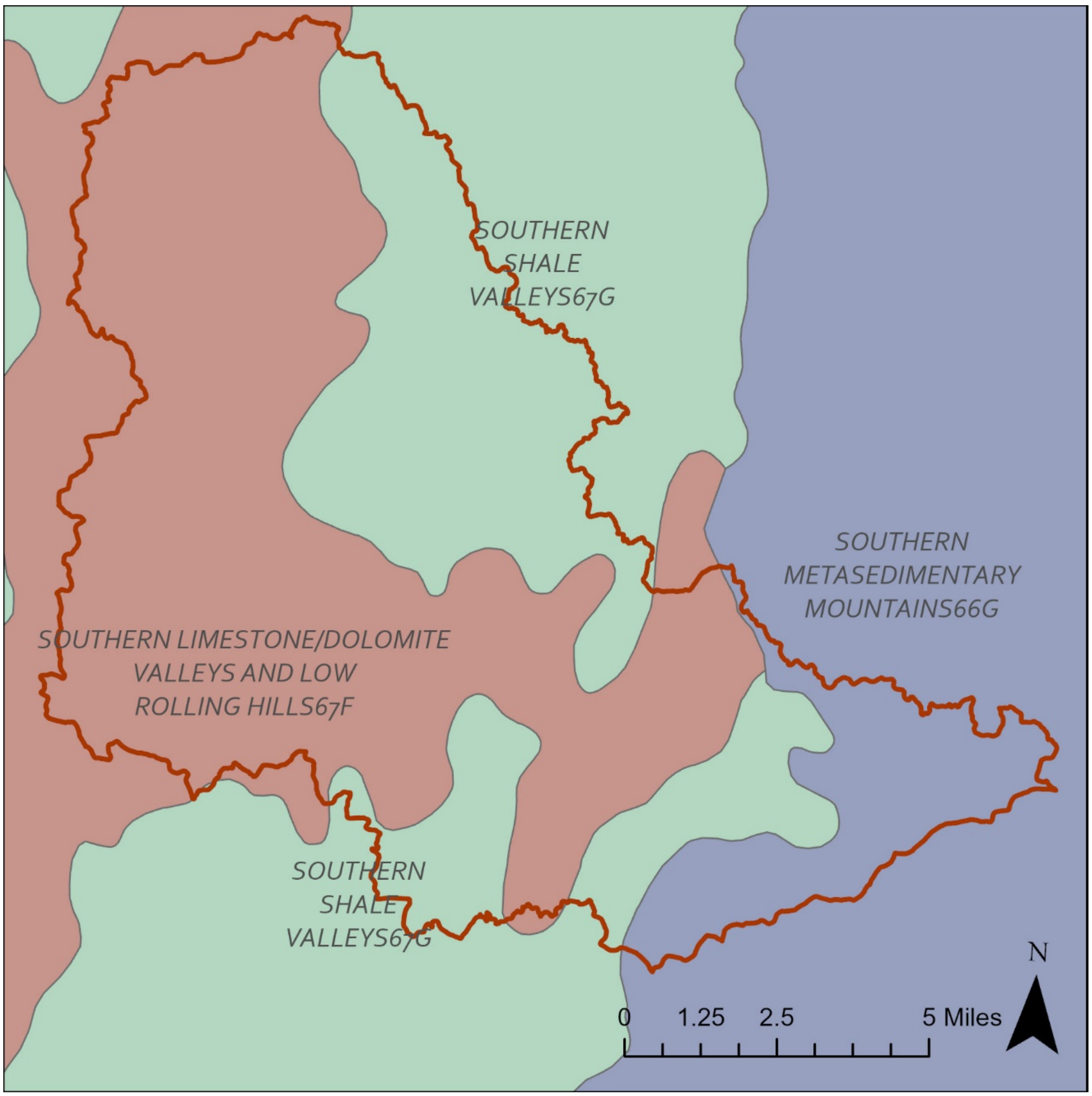
Figure 2. Pine Log Creek Subwatersheds (HUC 12)



2.2 Ecoregion and Physiographic Description

The physiographic type of this area is defined as the Ridge and Valley region in Georgia (Figure 3). For the Ridge and Valley, the ecoregions are a mixture of Southern Limestone/Dolomite Valleys and Southern Shale Valleys. In these regions, the ridges are typically composed of chert and capped sandstone, while the valleys are usually limestone or shale. The thicker, more fertile soils typically form in the valleys from erosion of soil from higher elevations and the weathering of parent rocks. The weathering of sandstone and chert on ridges help form the acidic soils which maintain the forested areas of this region.

Figure 3. Ecoregions of the Pine Log Creek Watershed and Vicinity



2.3 Local Climate

The climate of Calhoun, Georgia, the nearest climate data location for the Pine Log Creek Watershed, is influenced by its latitude and its proximity to the foothills of the Appalachian Mountains. Prolonged periods of extremely hot or extremely cold weather rarely occur. Summers are characterized by moderately warm days and mild nights. Daytime temperatures typically reach 90°F on only one-half of the days during the June, July and August period. Winters may be relatively cold, but periods of cold are normally short in duration and are quickly followed by comparatively mild temperatures. Periods of cold with temperatures below 15°F can be expected each winter, but periods near zero are uncommon. The average yearly rainfall is 53.54 inches with snowfall averaging 1.4 inches. The region averages 99 days of precipitation per year with 210 days classified as sunny. The average July high is 90 degrees (F), and the average January low is 29 degrees (F).

Climate and water data is collected nationally by the United States Geological Service (USGS) utilizing a stream gage system. Unfortunately, there is no USGS stream gage located within the Pine Log Creek Watershed for data collection. Although not located within the watershed, there is a USGS Stream Gage #02383500 on the Coosawattee River near Pine Chapel, Georgia, located six miles from the western border, which will be utilized as a data collection point to represent the local precipitation and hydrological characteristics.

Figure 4. Climate Data for the Calhoun, Georgia

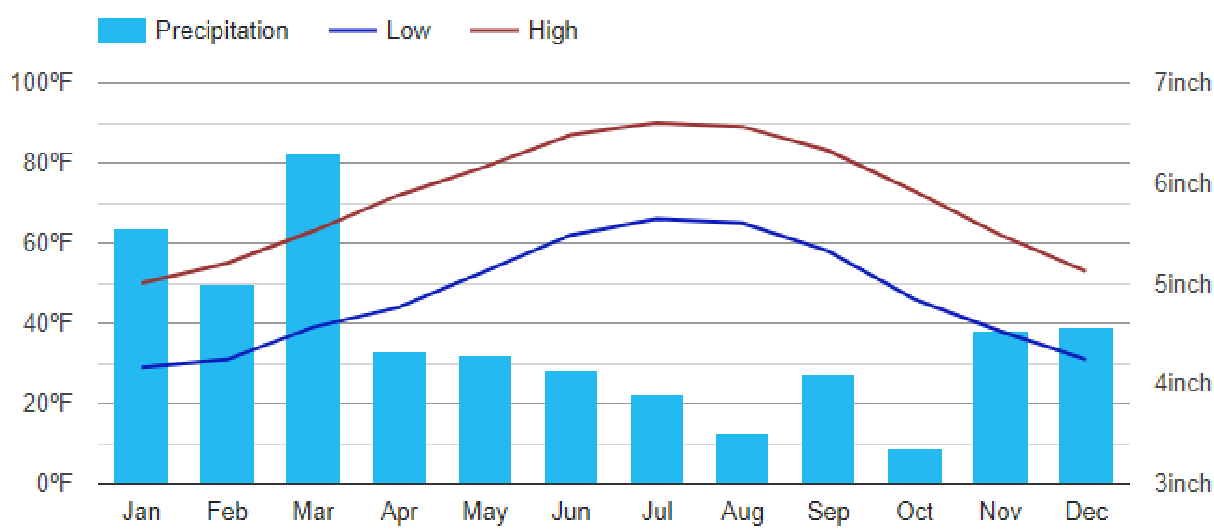
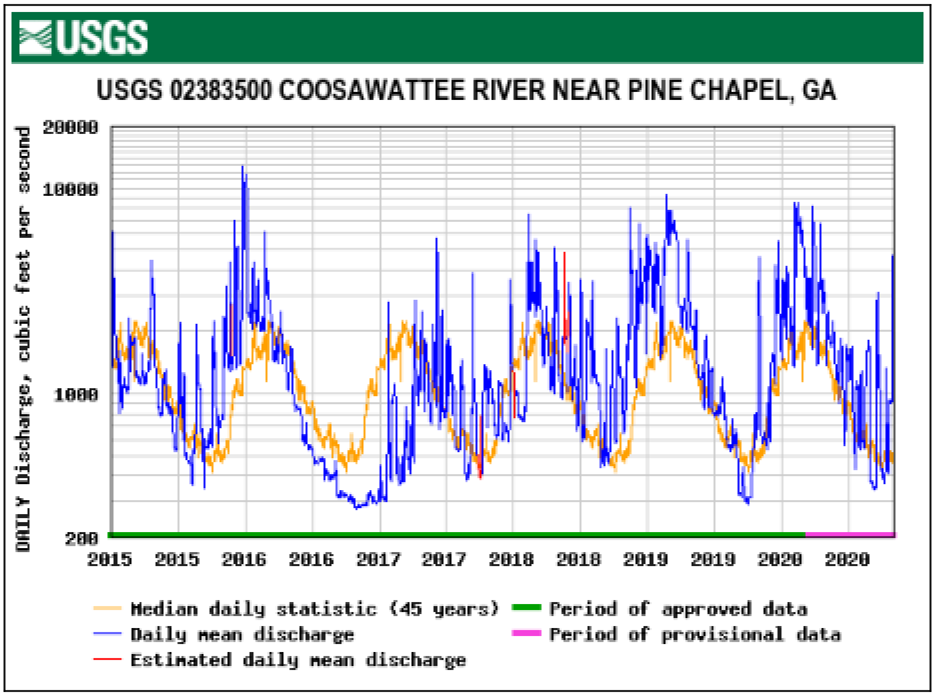


Figure 5. Discharge and Median Daily Statistics for the USGS Gauging Station on the Coosawattee River near Ellijay, GA.



2.4 Important Flora and Fauna

2.4.1 Natural Communities

The geology of the Ridge and Valley region plays a key role in defining the subtypes of Natural Communities. Natural Communities in the Ridge and Valley are often vertically organized because of the variation in geology when moving from ridges down to the valley floor (Edwards et al 2013). Dry communities dominate the ridgetops while mesic and rich communities will be distributed along the midslope, depending on the moisture regime. More diverse communities are often associated with limestone and dolomite in the valley regions. In the valley, Natural Communities can range from diverse mesic forests, where thick loamy soils are able to form, to barren or glade communities where easily erodible limestone gives way to thin soils and exposed, calcareous substrates (Edwards et al. 2013).

Edwards et al (2013) divides Natural Communities in the Ridge and Valley into 3 types—Upland Forests, Rock Outcrops/Prairies/Barrens, and Wetlands. Upland Forests are divided into 5 subtypes—Mesic Forests, Dry Calcareous Forests, Acidic Oak-Pine-Hickory Forests, Pine-Oak Woodlands, and Montane Longleaf Woodlands and Forests. Rock Outcrops/Prairies/ Barrens are divided into 5 subtypes—Coosa Prairies, Cedar Glades, Acidic Glades/Barrens, Calcareous Cliffs, and Acidic Cliffs and Rock Outcrops. Wetlands consist of 5 subtypes—Flatwoods, Calcareous Seepage Fens, Acidic Seepage Wetlands, Sagponds/Sinkholes, and Floodplains and Riparian Zones.

2.4.2 Wildlife and Habitat

The topography of the Pine Log Creek Watershed provides an excellent habitat for a wide variety of species. The mountainous area in the southeastern area of the watershed is home to a substantial population of white-tailed deer (Odocoileus virginianus) and wild turkey (Meleagris gallopavo). Extensive well-watered woodlands and excellent cover provide the perfect habitat for these two species. The floodplain region of the watershed is home to a wide variety of wildlife which include mourning dove (Zenaida macroura), barn swallow (Hirundo rustica), gray squirrel (Sciurus carolinensis), Eastern cottontail (Sylvilagus floridanus), and various species of duck (Anatidae family). Due to the many lakes and ponds in the floodplain, an ever-increasing population of Canadian geese (Anatidae family) can be found. With the extensive network of streams in the watershed, American Beaver (Castor canadensis) and Northern river otter (Lontra canadensis), kingfisher, red winged blackbird, and various species of heron (Ardeidae family) can often be found.

The 2015 Georgia State Wildlife Action Plan (SWAP; GADNR 2015) identifies a number of high priority habitats and watersheds within the Ridge and Valley Ecoregion. The Pine Log Creek Watershed was not identified as a High-Priority Watershed. However, the Salacoa Creek Watershed, which Pine Log Creek is a tributary, is listed as a High Priority Watershed due to the recent occurrence of an ESA-listed aquatic species. Additionally, the Coosawattee River, which Salacoa Creek is a tributary, is listed as number 10 of the top 10 globally significant watersheds within the Georgia Ridge and Valley Ecoregion.

2.4.3 Fisheries

The Pine Log Creek watershed hosts a diverse assemblage of both game and non-game species. Typical fish assemblages include a variety of sunfish, bass, minnow, darter, sucker, and catfish species. A complete species list of fish collected during sampling for this WMP can be found in Appendix C. Typical fish encountered during sampling included bluegill, green sunfish, Coosa bass, spotted bass, northern hogsucker, river chub, and several darter species.

The Georgia Department of Natural Resources (GADNR) have designated Pine Log Creek and its tributaries upstream of Highway 53 as Secondary Trout Streams. GADNR defines a secondary trout stream as one that has no evidence of natural trout reproduction but is capable of sustaining trout year-round. This designation comes with some special criteria limiting the elevation of temperatures to 2 degrees Fahrenheit, limiting construction of impoundments without approval by GAEPD, as well as 50-foot buffers around without a stream buffer variance from GAEPD. Although this designation indicates that According to the GADNR 2020 stocking schedule the mainstem of Pine Log Creek is stocked twice a year – March and May, however it does not indicate the location of stocking.

2.4.4 Listed and Sensitive Species:

According to the Georgia Biodiversity Portal, hosted by the GADNR Wildlife Resources Division, several aquatic animal species tracked by the GADNR are found in the Pine Log Creek Watershed and may be influenced by changes within the watershed. For purposes of this plan, listed species within the Salacoa Creek watershed, of which Pine Log Creek is a tributary, has been included as well. A complete list of aquatic species tracked by GADNR and located in the Pine Log Creek and Salacoa Creek watersheds are listed in Table 2. Three species known from the watershed have federal or state protections: lined chub (*Hybopsis lineapunctata*), Southern clubshell (*Pleurobema decisum)*, and Trispot darter (*Etheostoma trisella)*.

The Southern Clubshell was historicaly found throughout much of the Upper Coosa River Basin in Georgia, however, in the last 20 years this species has only been detected in the Conasauga River and Salacoa Creek watersheds. The Southern Clubshell typically occupies large streams and rivers with moderate flow with sand and gravel substrates. The major threat to these organisms is excessive sedimentation due to inadequate buffer zones, development, and eroding agricultural lands. Where present, excessive sediment covers suitable habitat and can potentially suffocate mussels (Southern Clubshell, Georgia Biodiversity Portal, accessed April 2021).

The trispot darter is currently listed as Threatened by the USFWS. Trispot darters are found in shallow main channel habitats of larger streams and in smaller tributary streams. The primary threat to the Trispot Darter is habitat loss and degradation. This species is endemic to the Coosa River system in Alabama, Georgia, and Tennessee. The USFWS listed the trispot darter due to a number of threats: Reduced Connectivity limiting or preventing fish movement, storm flow changes in intensity and base flow, Channel Modification, Urbanization, Loss of plants along river/ stream margins and stream banks (these darters require shallow vegetated habitat to spawn) which also increases stream temperature and turbidity, and a general increase in sedimentation (https://ecos.fws.gov/ecp/species/8219).

The lined chub is endemic to the Coosa and Tallapossa river systems, with many of the records occurring within the Ridge and Valley region. It is typically found over sandy substrates in pools of small and medium sized streams and along the shoreline in rivers with moderate currents. The lined chub is listed as "Rare" in Georgia but has no federal protection. It's broad range, but isolated populations, makes it susceptible to potential threats. Threats to this species include urbanization, impoundments, and failure to use appropriate Agricultural BMPs.

Of note, the Coosawattee subbasin, of which Pine Log is a tributary, hosts a diverse assemblage of sensitive aquatic species. This includes a total of six fish and mussel species with federal protection. Although these species have not been recorded in the Pine Log watershed, activities and conditions within the watershed ultimately affect the species in the Coosawattee and greater Coosa Basin.

Table 2. Aquatic Species tracked by the Georgia Biodiversity Portal (GADNR 2020) in the Pine Log and Salacoa Creek watersheds.

Common Name	Scientific Name	State Protection	State Rank	Federal Protection	Watershed
Alabama Rainbow	*Villosa nebulosa*	-	S2	-	Pine Log
Coosa Creekshell	*Villosa umbrans*	-	S2	-	Pine Log
Coosa Fiveridge	*Amblema elliottii*	-	S2	-	Salacoa
Etowah Heelsplitter	*Lasmigona etowaensis*	-	S3	-	Pine Log
Lined Chub	*Hybopsis lineapunctata*	Rare	S2	-	Pine Log
Mountain Shiner	*Lythrurus lirus*	-	S3	-	Pine Log
Ridged Mapleleaf	*Quadrula rumphiana*	-	S3	-	Salacoa
Southern Clubshell	*Pleurobema decisum*	Endangered	S1	Endangered	Salacoa
Trispot Darter	*Etheostoma trisella*	Endangered	S1	Threatened	Salacoa

2.5 Anthropogenic Features

2.5.1 Political Boundaries and Transportation Corridors

The Pine Log Creek watershed lies within three counties, originating in the high elevations of Cherokee and Bartow counties, and transitioning to the broader wide valleys and steep ridges of Bartow and Gordon County. Strikingly few municipalities are located within the watershed. Only the southeastern tip of Adairsville is located in the watershed. However, several municipalities are located near the boundary of the watershed, including Calhoun to the northwest, Fairmount to the east, White to the south, and Cartersville to the south. Although legal boundaries of these municipalities do not intersect the watershed, development from these areas affect the development and growth patterns in the Pine Log Watershed.

Most major roads in the watershed run in the east-west direction. State Route 140 runs east from Adairsville in Bartow County through Rydal in the Pine Log watershed and then on toward Waleska in Cherokee County. To the North, State Route 53 runs east from Calhoun in Gordon County through Sonoraville and intersects Highway 411 running North at the city of Fairmount also in Gordon County. Much of the development in the watershed is located along the highway 411 and highway 53 corridors with the highway 140 corridor being dominated by agriculture within the watershed.

2.5.2 Community Water Supply

Calhoun Utilities supplies most of the water for residents in the area, which can be drawn from multiple sources within the Calhoun Utility infrastructure including intakes from wells, Springs, and the Coosawatee River. People in some areas in the watershed rely on wells as a water source, which are used for both domestic and livestock purposes. Livestock water sources also include streams and ponds. The Spring Creek sub watershed (031501020705) is designated a source water protection watershed by the Natural Resource Conservation Service, USDA. This Sub watershed holds this designation based on its priority as a drinking water source.

2.5.3 Land Use and Development

The 81,113-acre watershed lies within the northwest Georgia region. According to the 2016 National Land Cover Dataset (Dewitz 2019) land cover within the watershed predominantly consists of forest and agricultural land cover types (Figure 6). Forests dominate the landscape with a combined 53% of land cover. As shown in Figure 7, forests tend to dominate the higher elevation ridges and headwaters of the watershed. The secondary land cover type within the watershed consists of agricultural with a combined total of 28%, of which 27% consists of Hay/Pasture. The remaining land cover types consist of Developed – Open Space and Low Intensity—as well as Scrub/Shrub, Herbaceous, and Open Water. Agricultural landcover dominates the valley and lower elevations (Figure 6)

Table 3. Land use within the Pine Log Creek Watershed- NLCD 2016

Land Cover Type (NLCD 2016)	Area (Acres)	% of Watershed**
Open Water	297	0%
Developed, Open Space	4,850	6%
Developed, Low Intensity	1,284	2%
Developed, Medium Intensity	267	0%
Developed, High Intensity	93	0%
Barren Land	33	0%
Deciduous Forest	20,658	25%
Evergreen Forest	13,769	17%
Mixed Forest	8,457	10%
Shrub/Scrub	3,953	5%
Herbaceous	4,566	6%
Hay/Pasture	22,209	27%
Cultivated Crops	456	1%
Woody Wetlands	142	0%
Emergent Herbaceous Wetlands	79	0%
	81,113	100%

Table 4. Land Use by Subwatershed in the Pine Log Creek Watershed- NLCD 2016.

Code	Category	Ballard Creek-Cedar Creek (031501020603)	Calico Valley-Pine Log Creek (031501020604)	Jacks Creek (031501020606)
11	Open Water	1%	1%	1%
21	Developed, Open Space	7%	4%	11%
22	Developed, Low Intensity	9%	4%	13%
23	Developed, Medium Intensity	2%	1%	4%
24	Developed, High Intensity	0%	0%	1%
31	Barren Land	0%	0%	0%
41	Deciduous Forest	16%	16%	13%
42	Evergreen Forest	16%	17%	14%
43	Mixed Forest	29%	37%	25%
52	Shrub/Scrub	5%	8%	3%
71	Herbaceous	5%	7%	5%
81	Hay/Pasture	8%	6%	9%
82	Cultivated Crops	0%	0%	0%
90	Woody Wetlands	1%	0%	0%
95	Emergent Herbaceous Wetlands	0%	0%	1%
		100%	100%	100%

Table 4 cont'd. . Land Use by Subwatershed in the Pine Log Creek Watershed- NLCD 2016

Code	Category	Little Pine Log Creek (031501020602)	Spring Creek (031501020605)	Sugar Hill Creek-Pine Log Creek (031501020601)
11	Open Water	1%	1%	0%
21	Developed, Open Space	7%	13%	6%
22	Developed, Low Intensity	7%	18%	6%
23	Developed, Medium Intensity	1%	3%	1%
24	Developed, High Intensity	0%	0%	0%
31	Barren Land	0%	0%	0%
41	Deciduous Forest	15%	14%	18%
42	Evergreen Forest	18%	9%	18%
43	Mixed Forest	33%	19%	34%
52	Shrub/Scrub	5%	4%	5%
71	Herbaceous	4%	4%	5%
81	Hay/Pasture	7%	12%	7%
82	Cultivated Crops	0%	0%	0%
90	Woody Wetlands	0%	1%	1%
95	Emergent Herbaceous Wetlands	0%	1%	0%
		100%	100%	100%

Figure 6. Land Cover (NLCD 2016) within the Pine Log Creek Watershed

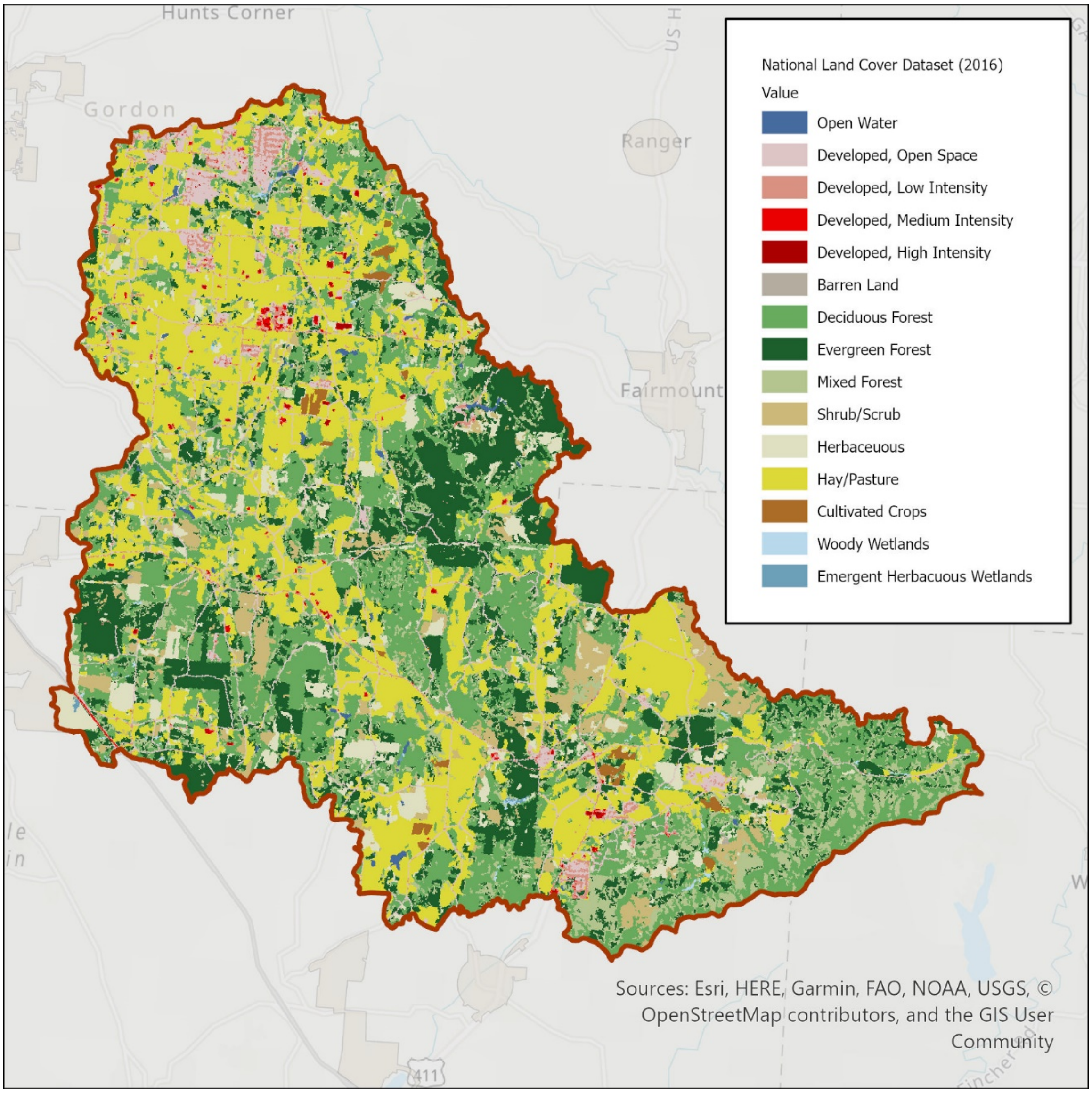
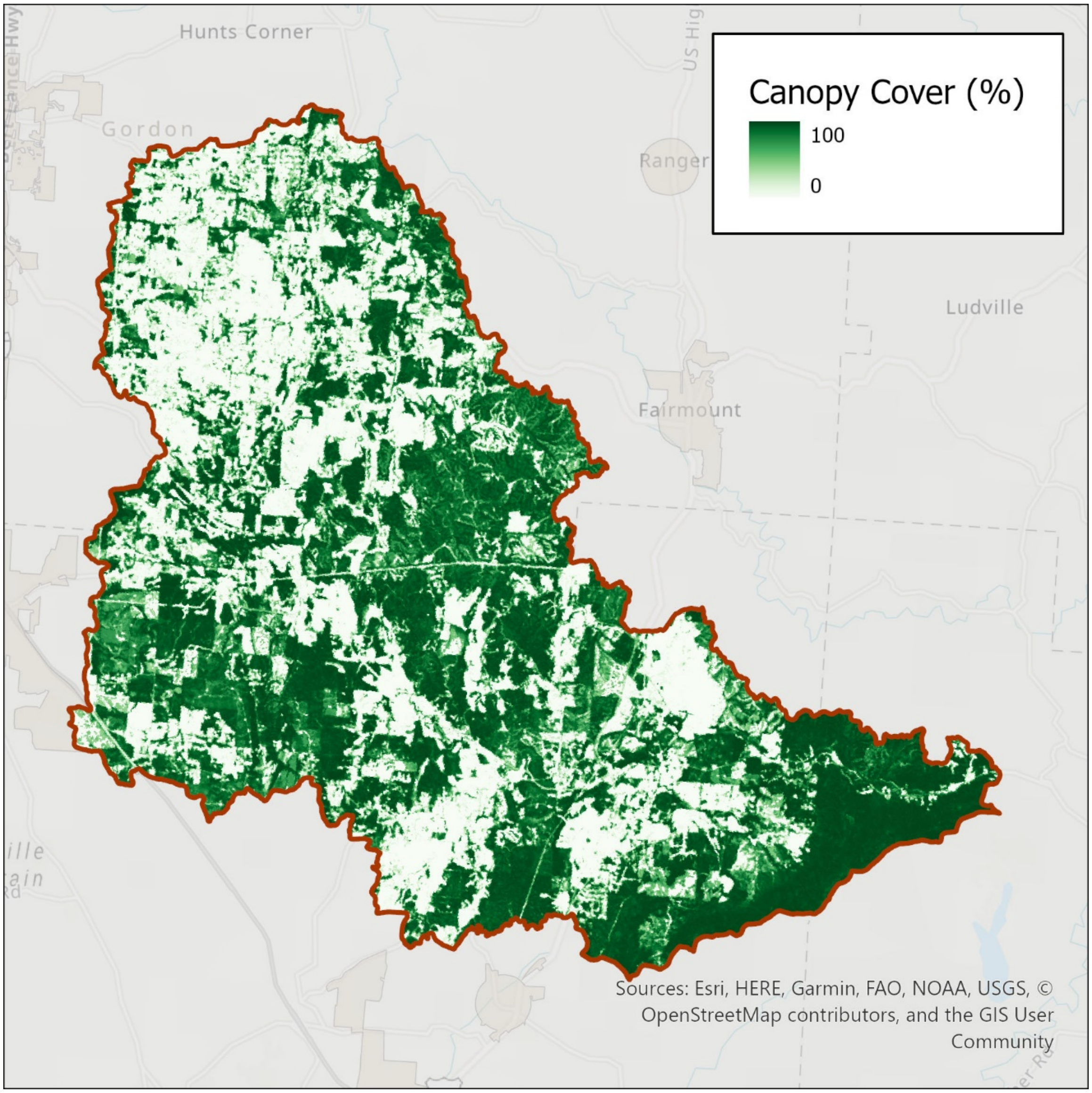


Figure 7. Tree Canopy (NLCD 2016) in the Pine Log Creek Watershed

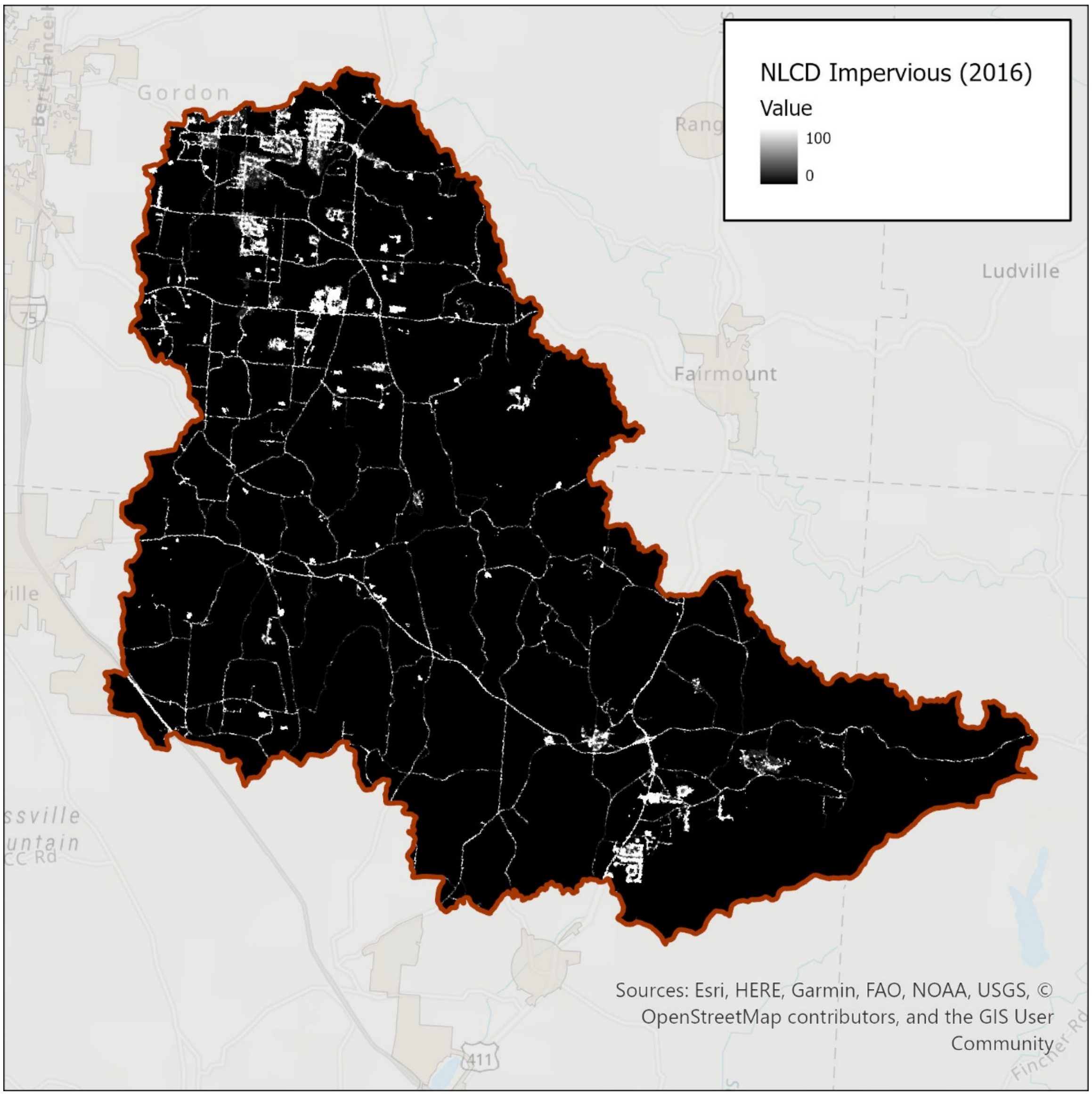


Although no incorporated municipalities lie within the watershed boundary, development from surrounding municipalities inevitably affect growth patterns within the watershed. Much of the development within the watershed is concentrated along the outskirts of municipalities such as Adairsville, Calhoun, White, and Fairmount. Additionally, development tends to concentrate along the State highway 53 and State highway 373 corridors between Calhoun and Fairmount, and Hwy 411 corridor between the towns of White and Fairmount.

A majority of the developed area classifies as "Developed- Open Space" and "Developed- Low Intensity", although a small percentage (<1%) classifies as "Developed- Medium Intensity" (Table 3). Development classification is heavily dependent on the amount of Impervious surface, defined as a surface that is water resistant or impedes the movement of water into the ground. Open Space Development consists of a mixture of constructed structures, but mostly vegetation in the form of lawns. These typically consist of large single-family lots, parks, golf courses, etc. Low Intensity development typically consists single-family housing units. Medium intensity development also typically consists of single-family housing units but with higher impervious surface coverage. Figure 8 depicts impervious surfaces in the Pine Log Watershed, confirming the pattern of development described above.

Describing these development areas in terms of watershed boundaries, the majority of the developed sites are located in the Jacks Creek (031501020606) and Spring Creek Watersheds (031501020705). Spring Creek being predominantly residential development and Jacks Creek consisting of residential, municipal (school), light industrial or retail. The development along highway 411 in the Southern portion of the watershed is mostly residential with some light industry. This straddles the Little Pine Log Creek watershed (031501020602) and Sugar Hill Creek watershed (031501020601) near the unincorporated area of Rydal.

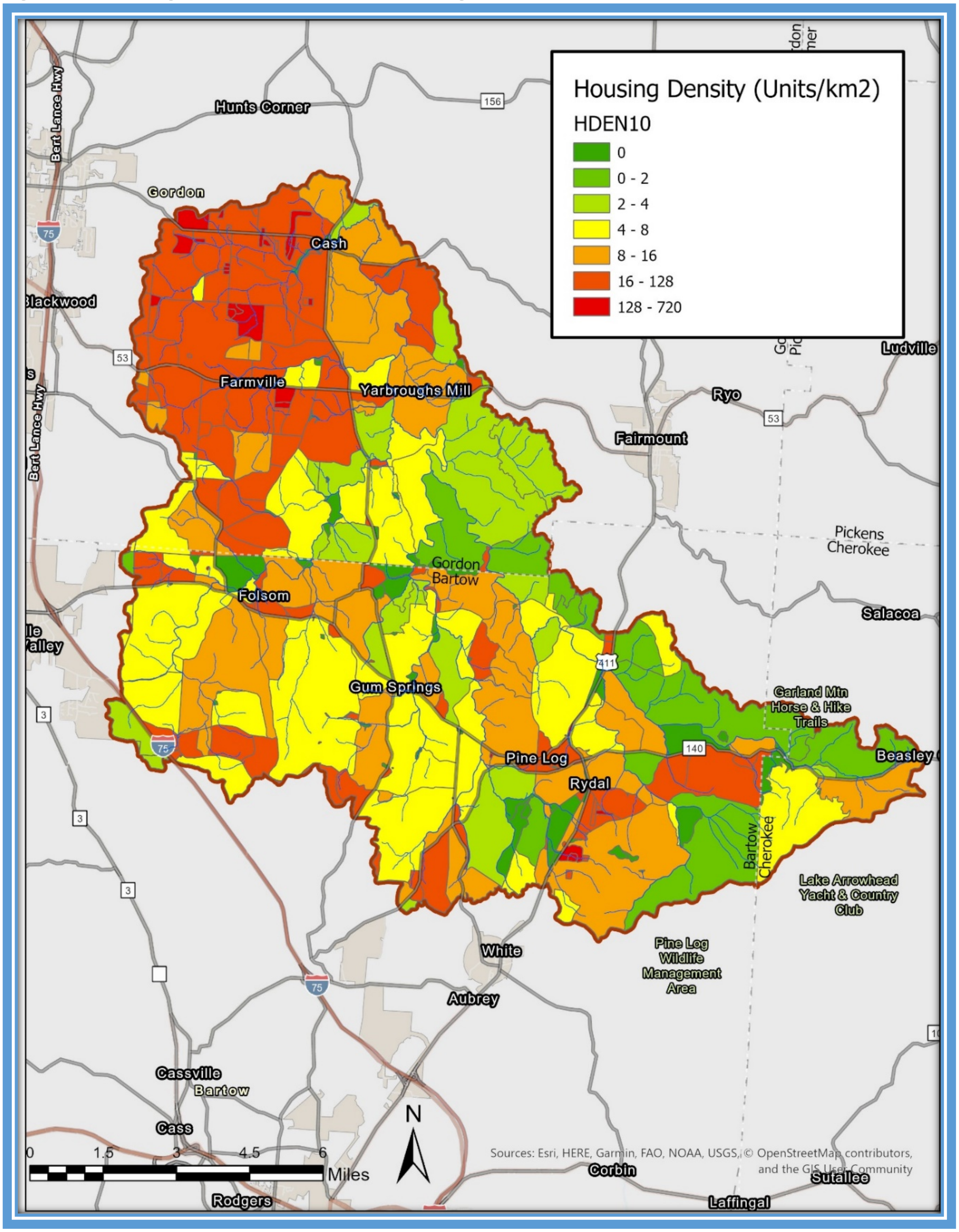
Figure 8. Impervious Surfaces within the Pine Log Creek Watershed (NLCD 2016)



An examination of 2010 Census data can be helpful in visualizing housing densities at the Census Block level (Figure 9). Housing densities within the watershed range from 0-720 Houses per Square Kilometer. Development, as indicated by Housing Density, is again concentrated along the northwest boundary of the watershed, near Calhoun, as well as along the Hwy 411 corridor and the community of Rydal.

Housing densities and development can be an important indicator of location and density of On-Site Disposal Systems, a potentially important contributor to Fecal Coliform impairments.

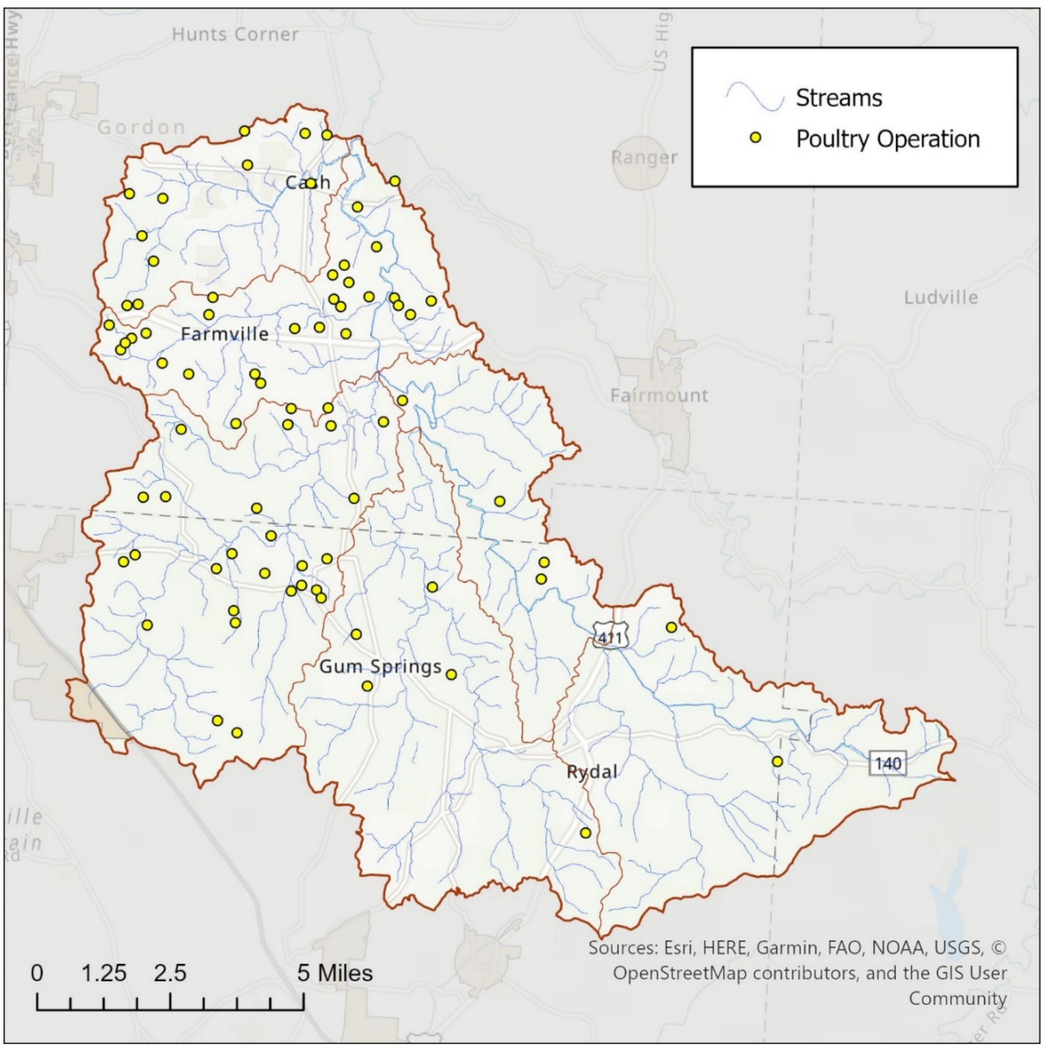
Figure 9. Housing Densities within the Pine Log Creek Watershed



An additional consideration in both the consideration of impervious surface as well as fecal Coliform vectors is the density of Confined Animal Operations such as Poultry houses. Poultry House agricultural productions by nature generate a large volume of manure that is a valuable source of agricultural amendment and nutrient but may also pose a threat to water quality if not properly managed. These manures are used in pasture and field operations to improve fertility and maximize production. Best management practices for the application of these manures will be addressed later in this document. Poultry house operations require large barns that contribute to impervious surfaces. While poultry houses are considered an agricultural operation and are agricultural, they function in a runoff scenario as a developed impervious surface. Given the rural setting of these barns, while large, adequate space is most often available to address best management practices for addressing impervious surface run off from their roofs.

Poultry houses are spread throughout the Pine Log watershed with the greatest concentrations along, first, highway 53 in the Jacks Creek watershed and secondly along highway 140 in the Ballard Creek Watershed. Additional poultry operations are sparsely mixed across the other watersheds with the Spring Creek watershed being the third most densely populated with Poultry houses.

Figure 10. Poultry operations located within the Pine Log Creek Watershed



2.5.4 Active Groups within the Watershed

Federal entities relevant to the WMP development process and/or conservation efforts in the area include the EPA, the Farm Services Agency (FSA), the Natural Resource Conservation Service (NRCS), United States Fish and Wildlife Service (USFWS), United States Fish and Wildlife Service (USFWS), and the United States Forest Service (USFS). State entities relevant to the conservation efforts in the area include the Northwest Georgia Regional Commission., Georgia Department of Natural Resources (DNR), Georgia Department of Public Health, the Georgia Environmental Protection Division (EPD), the Georgia Soil and Water Conservation Commission (GSWCC), Coosa River Soil and Water Conservation District, Limestone Valley Soil and Water Conservation District, and the UGA Agricultural Extension Service. On the local level, active groups include Calhoun Utilities, the Gordon County Board of Commissioners, Limestone Valley RC&D Council, Rolling Hills RC&D Council, Keep Bartow Beautiful, The Nature Conservancy, and Coosa River Basin Initiative as well as many Scout groups and other youth groups. Groups involved in outreach programs, water quality education and monitoring or who will play a significant role in the implementation of this Watershed Management Plan will be discussed further within this document.

3 Watershed Conditions

3.1 Georgia Water Quality Criteria

Georgia's water quality standards are made up of two different groups of criteria. The general criteria apply to all waters, and certain specific criteria exist for each of six designated uses.

The general criteria are more qualitative in nature, and include:

- Waters shall be free of materials, oils, and scum associated with municipal or domestic sewage, industrial waste or any other waste which will settle to form sludge deposits, produce turbidity, color, or odor, or that may otherwise interfere with legitimate water uses.
- Waters shall be free from toxic, corrosive, acidic, and caustic substances in amounts which are harmful to humans, animals, or aquatic life.

The six designated uses in Georgia, which can vary in strictness of standards, are:

- Drinking Water Supply
- Fishing
- Wild River
- Recreation
- Coastal Fishing
- Scenic River

The waters of Pine Log Creek are designated for Fishing. The numeric criteria associated with this designated use are found below. The water quality parameters associated with the numeric criteria are important for several reasons including minimization of human health risk and protection of aquatic fauna. When streams fail to meet water quality criteria for a given designated use, they are listed as impaired on the Georgia Integrated 303(d)/305(b) List.

Table 5. Water Quality Criteria for Fishable Waters

Fecal Coliform Bacteria	Dissolved Oxygen	pH	Temperature
May – Oct < 200 colonies/100 ml as geometric mean*. **Less than 400 as instantaneous max**	< 5 mg/l daily average Not < 4 mg/l at all times	Between 6.0 and 8.5	< 90° F
Nov – April < 1000 colonies/100 ml as geometric mean; < 4,000 as instantaneous max	-	-	-

* The geometric mean of at least 3 samples collected from a site within a 30-day period.

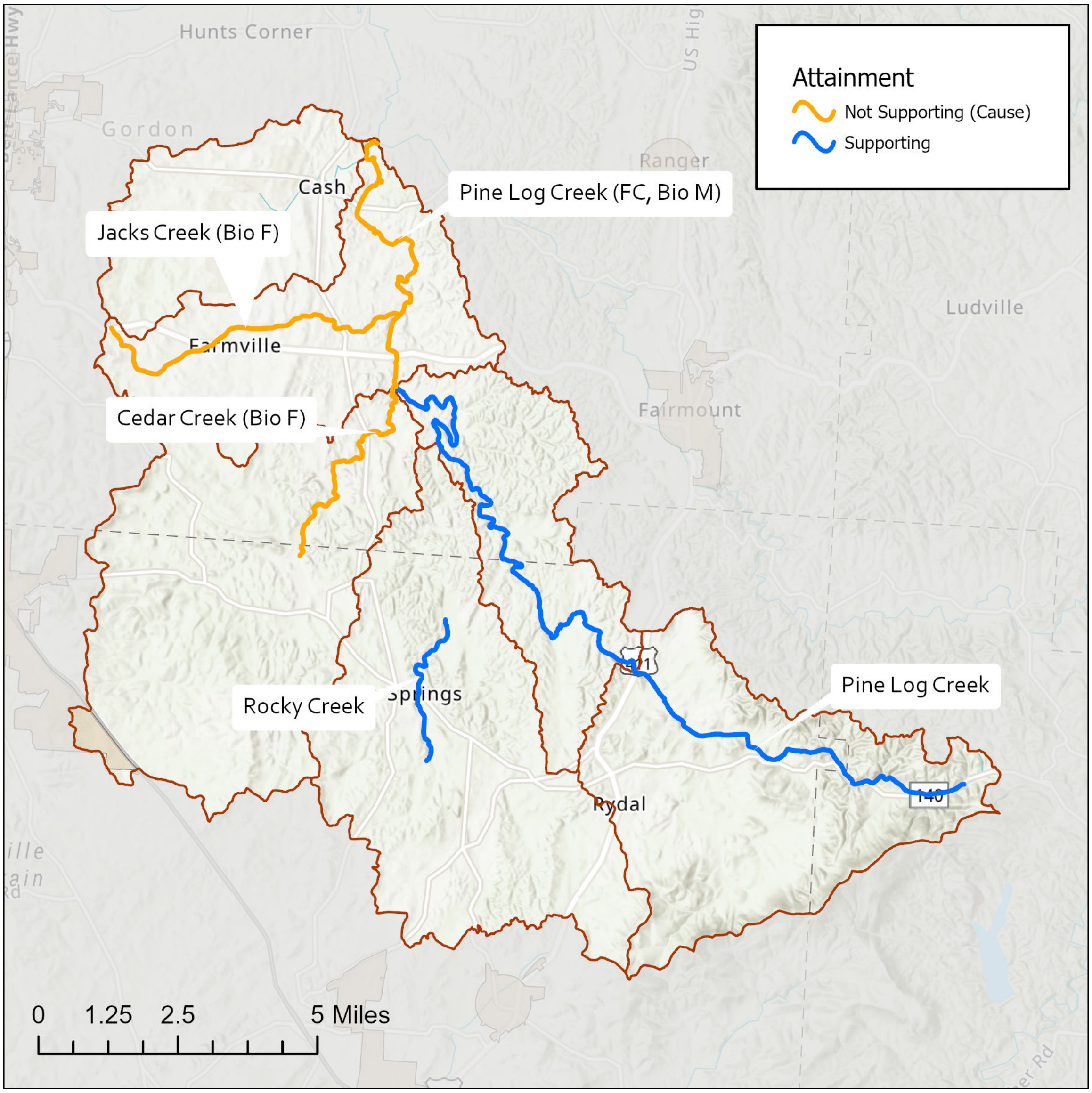
3.2 303d/305b Streams

In the Pine Log Creek watershed, a total of five segments are assessed by GAEPD. Of these, two segments were found to be "Supporting" and three are "Not Supporting". These impairments are the result of excessive fecal coliform bacteria counts and / or heavy sedimentation, as indicated by poor biotic survey results. In order to address these impairments, Total Maximum Daily Load (TMDL) Evaluations were written in 2003 and 2009. A TMDL Implementation Plan was also written in 2006 to evaluate and track water quality protection and restoration. Despite these efforts, little progress has been made over the years to ameliorate the water quality issues in the Pine Log Creek Watershed. This watershed-based plan addresses sediment and pathogen loading in the watershed.

Table 6. Supporting and Not Supporting Stream Segments within the Pine Log Creek Planning Area

Waterbody (Assessed Length)	Location	County	Attainment	Impairment
Pine Log Creek (6 miles)	Cedar Creek to Salacoa Creek	Gordon	Not Supporting	Fecal Coliform, Biota (fish)
Pine Log Creek (19 miles)	Headwaters near Hwy 140 to Cedar Creek	Cherokee, Bartow	Supporting	
Cedar Creek (5 miles)	Ballard Creek to Pine Log Creek	Bartow, Gordon	Not Supporting	Biota (fish)
Jacks Creek (6 miles)	Headwaters to Pine Log Creek	Gordon	Not Supporting	Biota (fish)
Rocky Creek (3 miles)	Pine Log Tributary #21 Dam to Little Pine Log Creek	Bartow	Supporting	

Figure 11. Supporting and Not-Supporting Segments within the Pine Log Creek Watershed



3.2.1 Impacted Biota Impairments

Within the Pine Log Creek Watershed, two segments are designated as impaired due to negatively impacted biota (fish). Cedar Creek is designated as impaired for Fish Biota from the Ballard Creek to its confluence with Pine Log Creek mainstem. Additionally, the entire length of Jacks Creek—from the headwaters to its confluence with Pine Log creek—is Not Supporting due to impacted biota (fish). A stream is considered impaired for impacted biota when sampling of fish or macroinvertebrates reveals negatively impacted assemblages as indicated by poor or very poor Index of Biotic Integrity (IBI) or modified Index of Well Being (IWB) scores. In general, low biotic integrity is caused by a lack of quality fish habitat that results from stream sedimentation. According to Georgia EPD, it is generally assumed that if the sediment loads are reduced to and maintained at acceptable levels, the streams will repair themselves over time. Other parameters (e.g., heavy metals, high temperatures, low dissolved oxygen levels) can adversely affect the aquatic communities, but the TMDL for these stream segments identified the probable impairing pollutant as sediment. Although there are qualitative descriptions in Georgia's water quality criteria that address restrictions on turbidity (a measurement of water clarity that can be used to indicate suspended sediment in the water column), there is no numeric criterion to identify discrete thresholds beyond which violations can be determined for sediment loading. Instead, indices of biotic integrity are used to represent stream health or various levels of degradation.

Sediment pollution can originate from many sources including, but not limited to eroding streambanks, construction sites, concentrated agricultural use areas, and cropland. In urban areas, the prevalence of impervious surfaces can lead to increased stormwater runoff, which often results in increased erosion of streambanks, channel incision (downcutting), and eventually habitat homogeneity. Negative implications for aquatic fauna that often result from these types of erosion can include the deposition of fine sediment, which contributes to a loss of habitat diversity, even eliminating certain habitat types, as well as other issues. The deposition of fine sediment on the stream-bottom can result in a change in interstitial spaces (areas between substrate particles), which can have a negative effect on aquatic insect communities and the fish species which feed upon them. Fine sediments also tend to reduce habitat complexity and cover up gravels which are critical areas for fish to spawn. Altogether, significant increases in sediment loads adversely impact the biotic community. (Castro and Reckendorf, 1995).

GAEPD developed a TMDL in 2009 addressing 49 stream segments in the Coosa River Basin, including Jacks Creek and Cedar Creek. This TMDL outlined a need for a 14% reduction in sediment load for Jacks Creek and 0% reduction for Cedar Creek. However, the 2006 TMDL for Pine Log Creek identifies an 88% reduction needed for the listed segment of Cedar Creek. Sediment loading in the Pine Log Creek watershed is attributable to many factors but often related to changes in land use, insufficient buffers around streams, and land disturbance activities.

Table 7. Total Allowable Sediment Loads and the Required Sediment Load Reductions per 2009 TMDL for 49 Segments in the Coosa River Basin

Waterbody	Current Load (tons/yr)	Wasteload Allocation (tons/yr)	Load Allocation (tons/yr)	Total Allowable Load (tons/yr)	Maximum Allowable Daily Load (tons/day)	% Reduction
Cedar Creek	3,508.80		3508.8	3508.80	259.70	0.00
Jacks Creek	1,320.70		1,136.80	1,136.80	84.1	13.93%

Average annual watershed loading rates represent the long-term processes of accumulation of sediments in stream habitat. According to the 2006 TMDL, visual field surveys indicated that habitat was still a concern. Flooding of agricultural fields and insufficient quality or presence of stream buffers could lead to increased sedimentation. Silvicultural practices, land disturbing activities, and unpaved roads were also identified by the TMDL as potential sources for sedimentation. Likewise, visual surveys of impaired reaches and the greater watershed performed for the development of this WMP indicate that these potential sources of sedimentation persist throughout the watershed.

3.2.2 Fecal Coliform Impairments

Pine Log Creek from Cedar Creek to its confluence with Salacoa Creek, is listed as impaired due to Fecal Coliform. Of note, Salacoa Creek downstream of its confluence with Pine Log Creek to the confluence with the Coosawattee is listed as impaired for Fecal Coliform as well. Although generally present in the environment at low levels, high fecal coliform bacteria (and Escherichia coli) concentrations in streams are used as an indicator for significant fecal contamination and more importantly the human health risks and pathogens that often coincide with fecal contamination. For this reason, impairments are often described as pathogen impairments even though they result from high fecal coliform bacteria counts. Although high fecal coliform bacteria concentrations can indicate a human health hazard, they are unlikely to exert negative effects on aquatic species. However, the nutrient enrichment that coincides with fecal contamination may result in indirect effects leading toward eutrophication of water bodies. Nutrient enrichment can result in heavy algal growth that can alter aquatic habitats and cause harmful dissolved oxygen fluctuations. Sources of fecal coliform bacteria in streams include fecal contamination from humans, pets, livestock, and wildlife. More specifically, common causes of elevated fecal coliform counts in impaired rural watersheds include failing septic systems, livestock with direct stream access, applied manure, and natural areas with abundant wildlife.

The 2006 TMDL for Pine Log Creek indicated the need for an 81% reduction in Fecal Coliform. Sources of impairment listed for Fecal Coliform included wildlife, agriculture/livestock, and urban development. Although not within the planning area for this WMP, the segment of Salacoa Creek listed for fecal coliform begins at the confluence with Pine Log Creek and continues to be impaired downstream to its confluence with the Coosawattee River. Pine Log Creek is likely a significant contributor to this Salacoa Creek impairment. The 2009 TMDL Evaluation for 29 Stream Segments in the Coosa River Basin for Fecal Coliform did not include Pine Log Creek, however, included the listed section of Salacoa Creek segment downstream. The 2009 TMDL for pathogens for Salacoa Creek require a 62% load reduction to achieve water quality standards in fecal coliforms and was determined using the 2009 303d load duration curves for designated drainage areas.

3.3 Previous Monitoring/Resource Data Collected in Watershed

During the formation of this WMP, a significant effort was undertaken to acquire any recent data collected in the watershed. In the past, Georgia EPD and Georgia DNR Wildlife Resources Division (WRD) have conducted relevant monitoring within the Pine Log Creek Watershed. A portion of monitoring data from these groups was made available for the purposes of this document, and a relevant subset is presented with in this section.

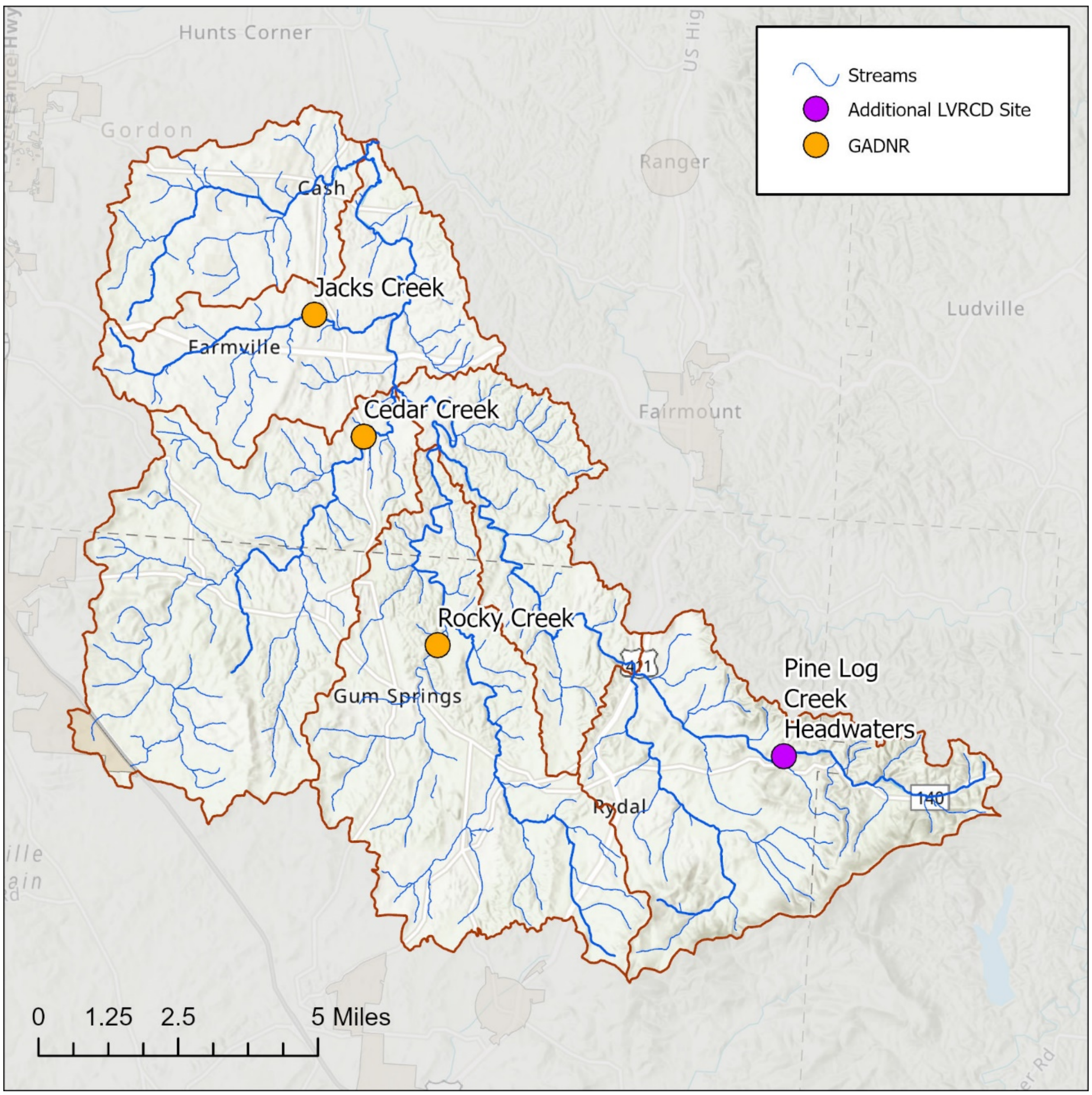
3.3.1 Georgia Wildlife Resources Monitoring Efforts

In addition to Georgia EPD's water quality monitoring efforts, Georgia WRD periodically monitors fish populations and lotic habitats to determine whether statewide criteria are being met. Fish sampling indices and habitat scores from sampling efforts in the Pine Log Creek watershed between 2001-2005 are presented in Table 8.

Table 8. IBI and IWB scores from GADNR in the Pine Log Creek Watershed

Collection	Stream Name	County	Year	IBI Score	IBI Category	IWB Score	IWB Category	Habitat Score
432	Rocky Creek	Bartow	2001	44	Good	8	Fair	117
432	Rocky Creek	Bartow	2002	50	Good	10	Good	99
432	Rocky Creek	Bartow	2007	42	Fair	9	Good	81
506	Cedar Creek	Gordon	2001	28	Poor	8	Fair	89
507	Jacks Creek	Gordon	2001	16	Very Poor	6	Fair	94

Figure 12. GAWRD IBI, IWB, and Habitat assessment sites located in the Pine Log Creek Watershed



IBIs, according to Georgia EPD, assess the biotic integrity of aquatic communities based on the functional and compositional attributes of fish communities. They consist of twelve metrics, which assess species richness and composition, trophic composition and dynamics, and fish abundance and condition. Each metric is scored by comparing its value to that particular scoring criterion of the regional reference site. Collectively, the metric scores are combined to reach an IBI score that can be classified as Excellent, Good, Fair, Poor, or Very Poor.

Comparatively, the modified IWB measures the health of the aquatic community based on the abundance and diversity of the fish community. The IWB is calculated based on the relative density of fish, the relative biomass of fish, the Shannon-Wiener Index of Diversity based on number, and the Shannon-Wiener Index of Diversity based on biomass. Similar to the IBI, these collective scores allow for a classification of Excellent, Good, Fair, Poor, or Very Poor. As of April 2013, the IWB is no longer a part of the Georgia DNR Biomonitoring Program.

Habitat assessments are also a part of the biomonitoring process conducted by WRD and help clarify the results of the biotic indices. The habitat assessment utilized by WRD is broken into three levels that describe: in-stream characteristics, channel morphology, and the riparian zone surrounding the stream. The total habitat scores indicate optimal conditions from 166 to 200, suboptimal conditions from 113 to 153, marginal conditions from 60 to 100, and poor conditions from 0 to 44.

3.4 Monitoring/Resource Data Collected for the Development of the WMP

3.4.1 Water Quality

Efforts were made to determine current watershed conditions and provide stakeholders with current water quality data and assist with the development of this plan. This monitoring focused on collection of fecal coliform, phosphorous, ortho-phosphate, nitrogen, and total suspended solids (TSS) data. Fecal coliform counts were determined to represent amounts of fecal contamination upstream of each site. TSS was used to represent potential erosion issues upstream of each site. In recent years, reducing NPS nutrient pollution has become a topic of interest in the Coosa Basin, including research into a potential nutrient trading program. To provide baseline data for any future efforts, Nitrogen and Phosphorous were monitored at all sites.

Samples were taken from eight sample sites within the watershed (Figure 13). Attempts were made to include samples from both wet and dry season to better capture influences of landscape on NPS. However, complications arising from COVID-19 resulted in a data gap between February and April 2020. Due to the short duration of our study, geometric means were not calculated, but the data gives an indication of the variation within the watershed. No USGS gauging station is located in the Pine Log or Salacoa Creek Watershed. However, a station is located approximately 4.25 airmiles north/northwest of the Pine Log Creek Watershed. 48 hour and 14-day precipitation total as well as discharge were included to characterize general weather conditions during sampling.

Figure 13. Water Quality Sampling Sites located within the Pine Log Creek Watershed

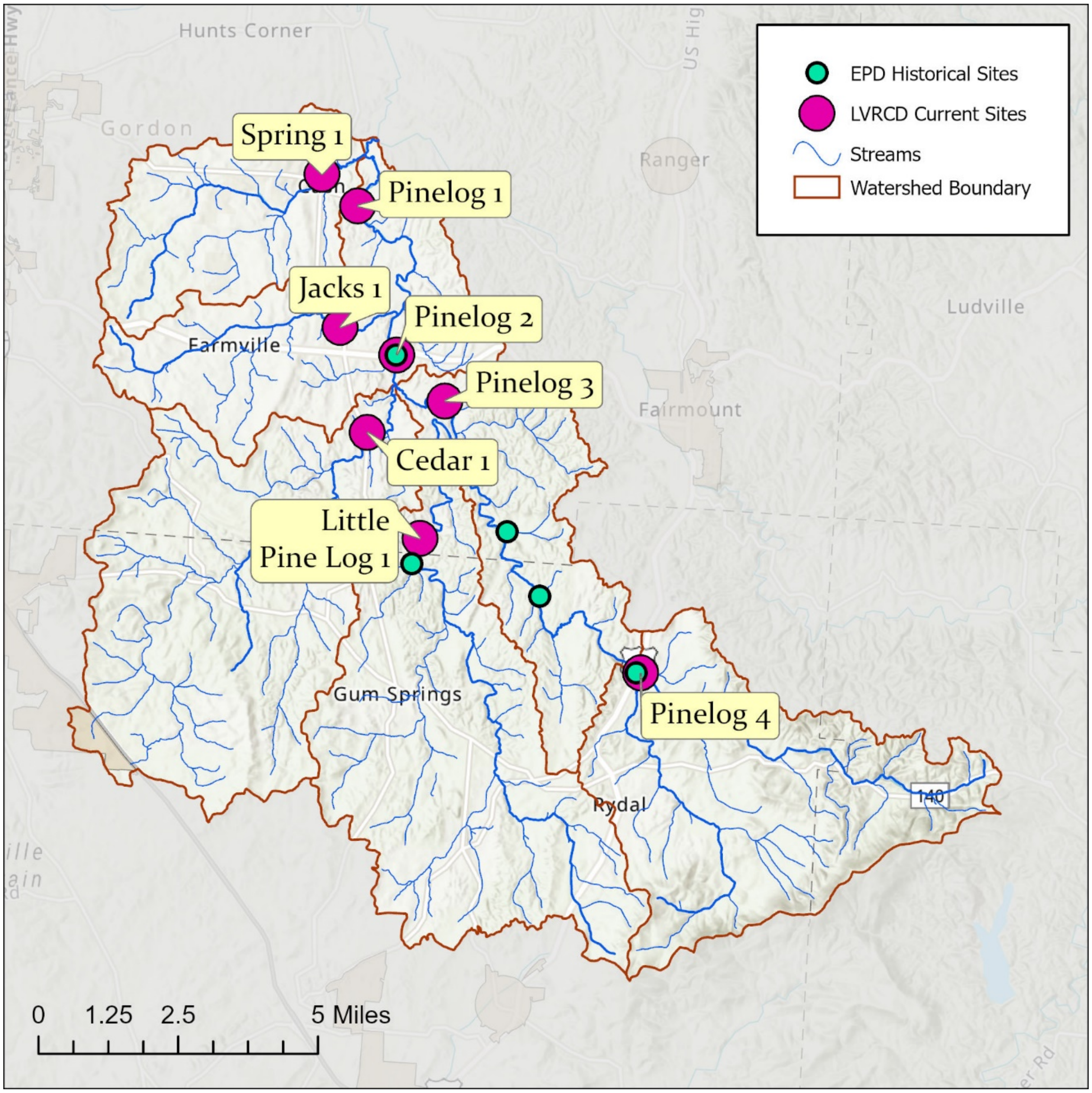


Table 9. USGS Precipitation and Discharge Data for the Gauging Station on the Coosawattee River near Pine Chapel, Georgia (USGS02383500)

Coosawattee River near Pine Chapel GA	1/30/20	2/27/20	5/14/20	6/15/20	7/29/20	8/27/20	9/28/20	11/5/20	12/16/20	1/30/20
48 Hour Rain Total (inch)	0	0	0	0	0	0	0.08	3.8	0	0.1
14 Day Rain Total (inch)	2.3	3.6	0.83	1.98	0.8	3.8	3.7	4.3	4.3	3.2
Discharge (cfs)	1500	5600	2850	1600	555	1705	445	4000	2850	2500

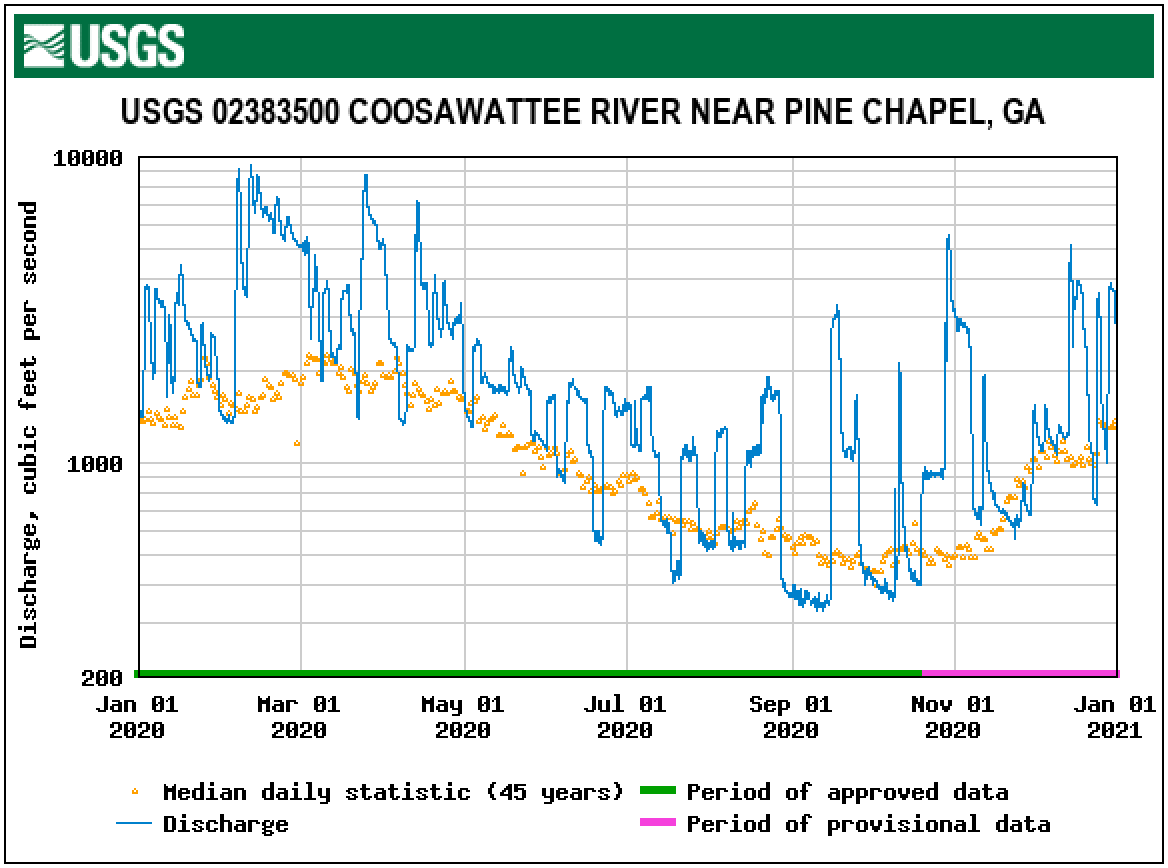


Table 10. Fecal Coliform Data Collected in the Pine Log Creek Watershed During Planning Period

Site	Site Code	Fecal Coliform (CFU/100ml)								
		1/30/20	2/27/20	5/14/20	6/15/20	7/29/20	8/27/20	9/28/20	11/5/20	12/16/20
Spring Creek 1	SC	15	35	240	23	164	82	55	72	3800
Pine Log Creek 1	PLL	60	200	154	500	718	673	800	350	2500
Jacks Creek 1	JC	60	90		338	600	1700	220	182	1800
Pine Log Creek 2	PL53	70	140	208	200	500	20000	1510	510	2500
Cedar Creek 1	CC	85	70	320	1200	882	20000	2000	370	1100
Pine Log Creek 3	PLM	50	75	28	319	250	3200	2000	320	2700
Pine Log Creek 4	PLH	45	110	218	1400	2500	4800	5000	691	1400
Little Pine Log	LPL	120	620	146		955	736	5100	1180	5200

Figure 14. Fecal Coliform Data (CFU/100ml) Collected During the Planning Period

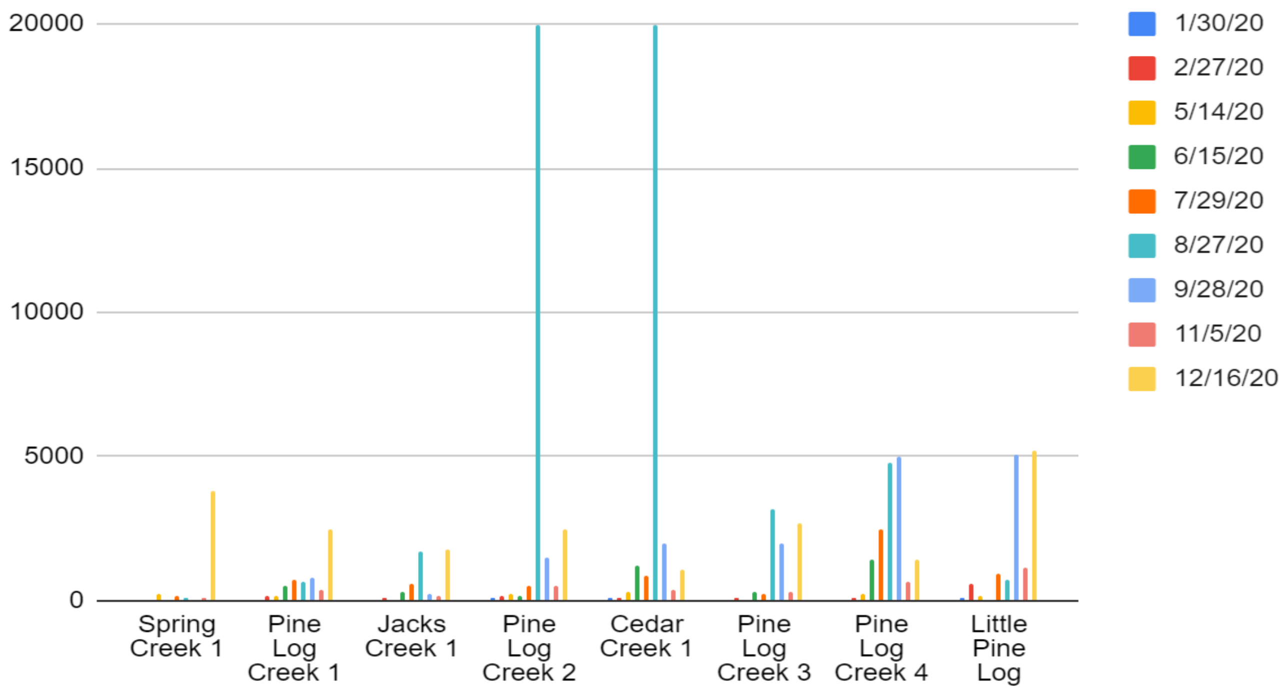


Table 11. Total Suspended Solids Data Collected in the Pine Log Creek Watershed During the Planning Period

Site	Site Code	Total Suspended Solids (mg/L)							
		5/14/20	6/15/20	7/29/20	8/27/20	9/28/20	10/29/20	11/5/20	12/16/20
Spring Creek 1	SC	ND	5.5	9.5	6.5	11.5	27	7.5	10.5
Pine Log Creek 1	PLL	12	16	26.5	5	23	192	7	15
Jacks Creek 1	JC		ND	5	9.5	ND	186	ND	ND
Pine Log Creek 2	PL53	5	8	15.5	37	22	365	ND	13.5
Cedar Creek 1	CC	ND	8	19	22	11.5	421	ND	10.5
Pine Log Creek 3	PLM	7.5	5	13	24.5	9	394	ND	10
Pine Log Headwaters 4	PLH	ND	ND	13.5	23	13	677	ND	7
Little Pine Log	LPL	ND		ND	ND	ND	137	ND	ND

Figure 15. Total Suspended Solids (mg/L) Data Collected in the Pine Log Creek Watershed During the Planning Period

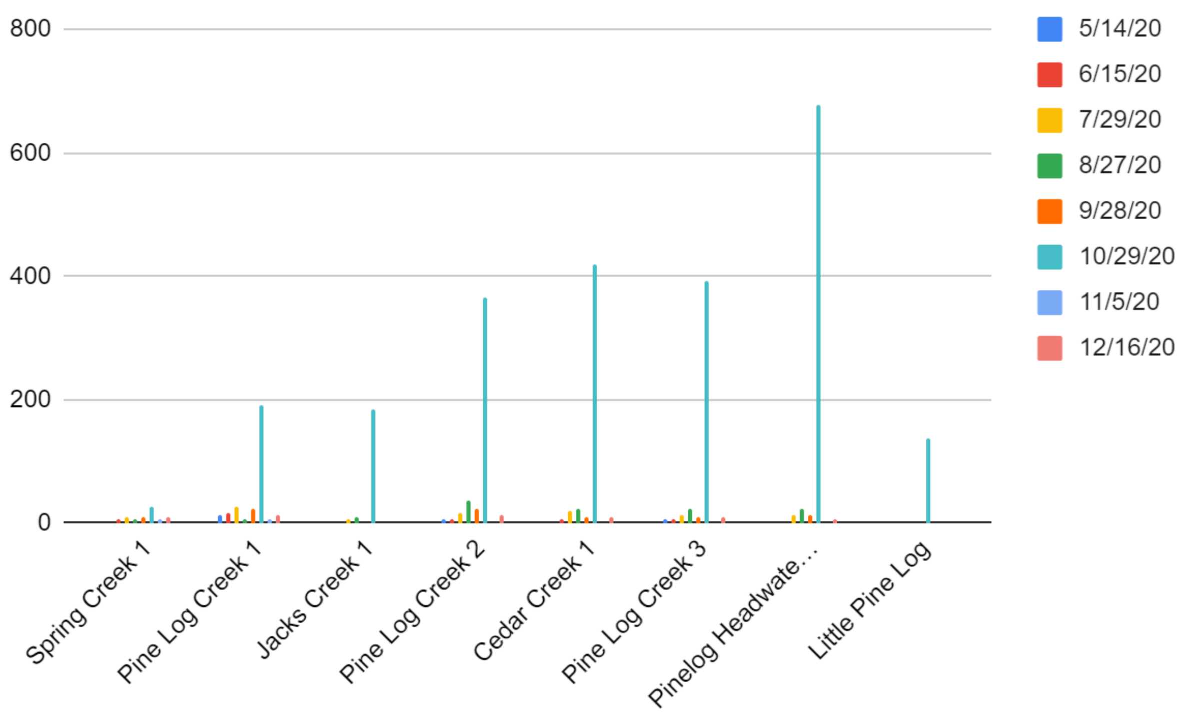


Table 12. Total Nitrogen Data Collected in the Pine Log Creek Watershed During the Planning Period

Site	Site Code	Total Nitrogen (mg/L)								
		1/30/20	5/14/20	6/15/20	7/29/20	8/27/20	9/28/20	10/29/20	11/5/20	12/16/20
Spring Creek 1	**SC**	-	1.8	1.4	1	0.81	ND	1.2	1.3	2.3
Pine Log Creek 1	PLL	-	1.3	1.6	0.8	0.74	0.66	2	1.1	1.6
Jacks Creek 1	JC	2.8	-	1.3	0.86	1.8	1.2	2.6	1.7	2.5
Pine Log Creek 2	PL53	1.5	1.3	0.97	0.9	1.3	0.76	3	1.1	1.5
Cedar Creek 1	CC	1.7	1.8	1.5	1.5	1.2	1.3	3.3	1.6	2.1
Pine Log Creek 3	PLM	1.4	1.1	0.82	0.7	0.53	0.66	2	0.96	0.66
Pine Log Creek 4	PLH	0.4	0.72	ND	ND	ND	ND	2.6	ND	ND
Little Pine Log	LPL	2.1	1.6	-	0.98	0.73	1.1	2.7	1.8	2

Figure 16. Total Nitrogen (mg/L) Data Collected in the Pine Log Creek Watershed During the Planning Period

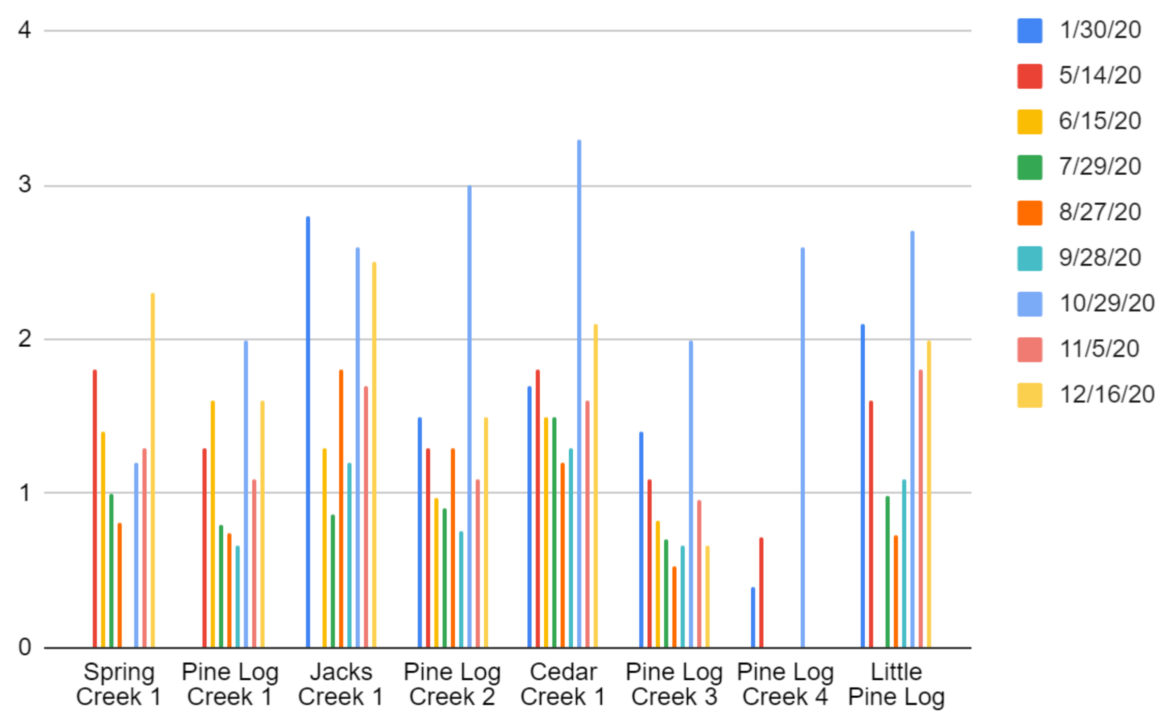


Table 13. Total Phosphorous Data Collected in the Pine Log Creek Watershed During the Planning Period

Site	Site Code	Total Phosphorous (mg/L)								
		1/30/20	5/14/20	6/15/20	7/29/20	8/27/20	9/28/20	10/29/20	11/5/20	12/16/20
Spring Creek 1	**SC**	-	ND	ND	0.1	ND	ND	0.11	ND	0.16
Pine Log Creek 1	PLL	-	ND	ND	0.073	0.06	0.083	0.46	ND	0.067
Jacks Creek 1	JC	-	-	ND	0.095	0.16	0.069	0.87	ND	0.07
Pine Log Creek 2	PL53	0.05	ND	ND	0.065	0.12	0.072	0.88	ND	0.055
Cedar Creek 1	CC	0.05	ND	ND	0.081	0.077	0.064	0.96	ND	0.051
Pine Log Creek 3	PLM	0.05	ND	ND	ND	0.078	0.068	0.41	ND	ND
Pine Log Creek 4	PLH	0.04	ND	ND	ND	0.051	0.05	0.87	ND	ND
Little Pine Log	LPL	0.05	ND	-	0.073	0.06	0.064	0.99	ND	0.052

Figure 17. Total Phosphorous (mg/L) Data Collected in the Pine Log Creek Watershed During the Planning Period

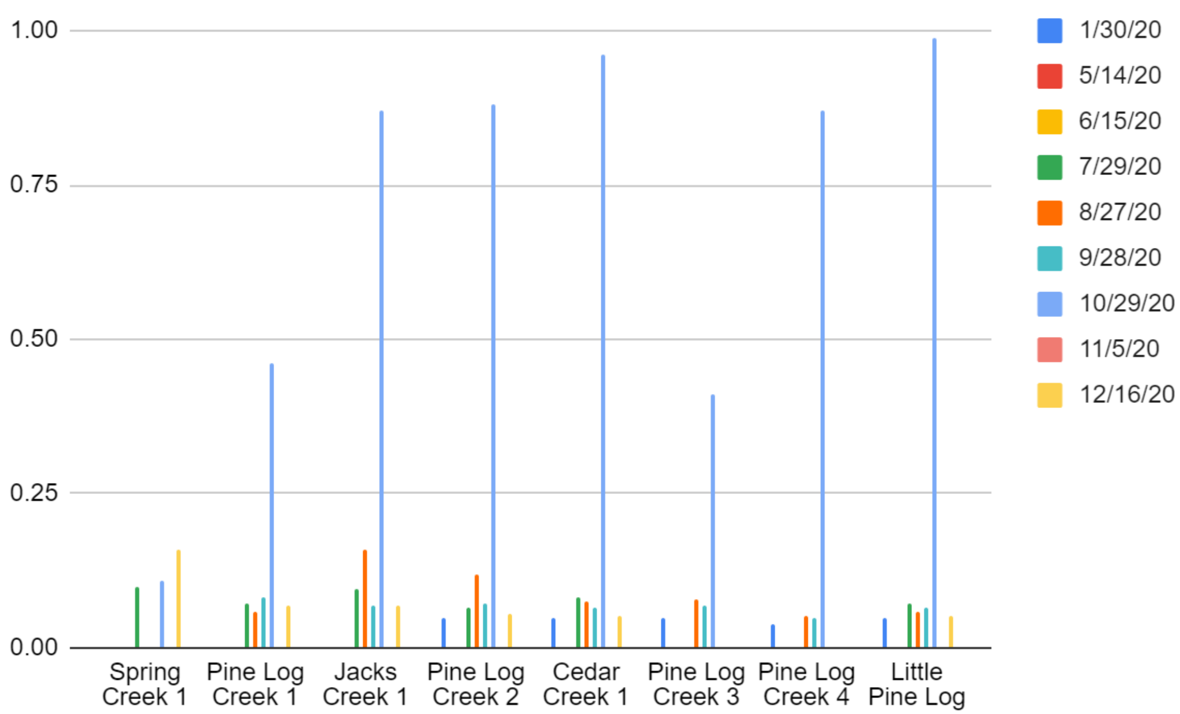
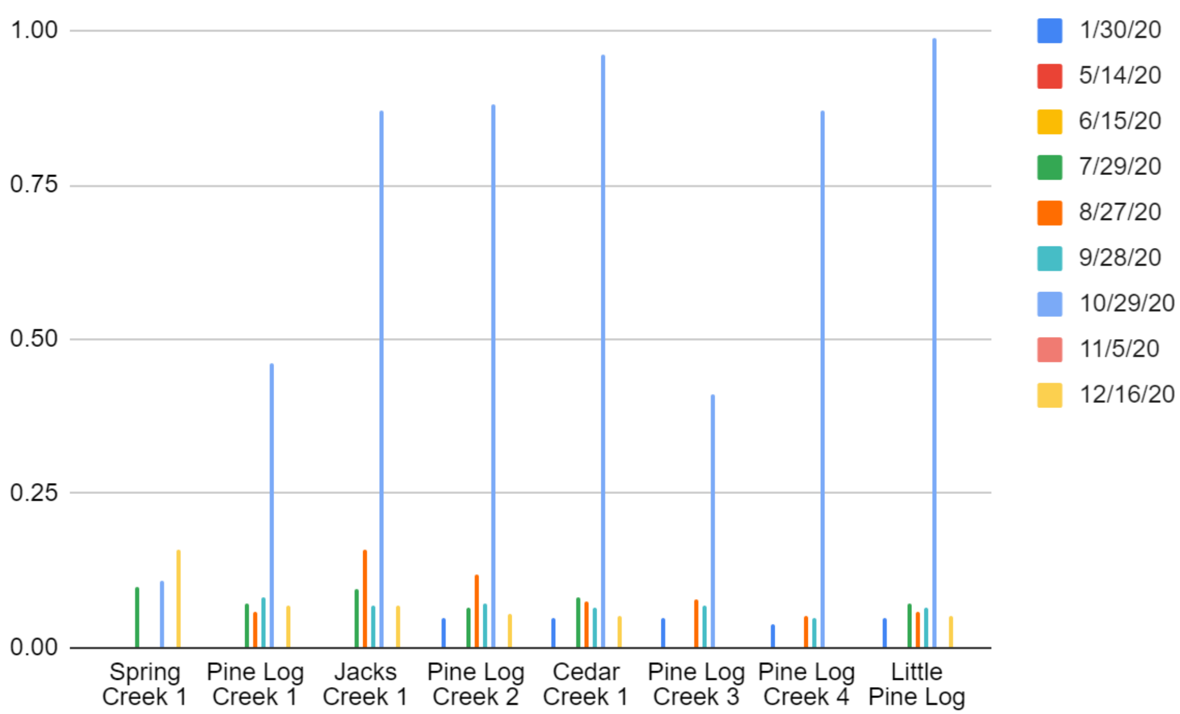


Table 14. Ortho-Phosphate Data Collected in the Pine Log Creek Watershed During the Planning Period

Site	Site Code	Orthophosphate (mg/L)								
		1/30/20	5/14/20	6/15/20	7/29/20	8/27/20	9/28/20	10/29/20	11/5/20	12/16/20
Spring Creek 1	**SC**	-	ND	ND	0.1	ND	ND	0.11	ND	0.16
Pine Log Creek 1	PLL	-	ND	ND	0.073	0.06	0.083	0.46	ND	0.067
Jacks Creek 1	JC	-	-	ND	0.095	0.16	0.069	0.87	ND	0.07
Pine Log Creek 2	PL53	0.05	ND	ND	0.065	0.12	0.072	0.88	ND	0.055
Cedar Creek 1	CC	0.05	ND	ND	0.081	0.077	0.064	0.96	ND	0.051
Pine Log Creek 3	PLM	0.05	ND	ND	ND	0.078	0.068	0.41	ND	ND
Pine Log Creek 4	PLH	0.04	ND	ND	ND	0.051	0.05	0.87	ND	ND
Little Pine Log	LPL	0.05	ND	-	0.073	0.06	0.064	0.99	ND	0.052

Figure 18. Orthophosphate (mg/L) Data Collected in the Pine Log Creek Watershed During the Planning Period



Median Total Nitrogen (TN) and Total Phosphorous (TP) concentrations for each sample site ranged from 0.71-1.75 mg/L and 0.51-0.11 mg/L, respectively. All site-level median TN concentrations exceeded EPA 25th percentile reference criteria of 0.214 mg/L for the Ridge and Valley ecoregion; 100% of samples that were reported as above the detection limit also exceed this criteria (one site is located near the transition between Blue Ridge and Ridge and Valley but still exceeded both criteria; (EPA 2000; Evans-White and others 2013)). Site-level medians exceeded the highest-reported (most conservative) TN threshold concentration (1.169 mg/L) for benthic algae at 6 of 8 sites (Evans-White and others 2013). Pine Log Creek 3 and Pine Log Creek 4 are the only sites that do not exceed the benthic algae threshold of 1.169 mg/L TN (Evans-White and others 2013). Median TP concentrations far exceeded EPA 25th percentile reference condition concentrations (0.01 mg/L). Median TP concentrations reported above the detection limit also approached thresholds for benthic algae (0.074 mg/L) and exceeded this threshold at 2 sites.

Fecal coliform appears chronically elevated above background conditions at all sites in the watershed. All sites approached or exceeded the non-human criteria for streams and rivers of 500 CFU/100 ml. This suggests widespread sources of fecal coliform in the watershed.

Collectively, data suggests that the Pine Log Creek watershed suffers from excess nutrient loading that consistently approaches or exceeds concentrations that have been shown to result in response thresholds for benthic algae and invertebrates and result in ecological impairment (Evans-White and others 2013). Further, nutrient concentrations are elevated enough to create eutrophic conditions (Dodds and Cole 2007). While both N and P concentrations appear elevated, TP concentrations are particularly elevated. TP concentrations as low as 0.030 mg/L can result in impaired ecosystems state (Evans-White and others 2013; Taylor and others 2014; Rosemond and others 2015). Even in small, shaded, streams where benthic algae is primarily light-limited, excess nutrients can accelerate the decomposition of dead leaves and wood that provide the energy base for aquatic organisms (Ferreira and others 2015; Rosemond and others 2015) as well as alter macroinvertebrate communities (Evans-White and others 2009; Davis and others 2010; Cook and others 2017). Further, elevated nutrient concentrations are associated with reduced biodiversity of macroinvertebrates and fish-typically driven by increased dominance of a few taxa (Wang and others 2007; Evans-White and others 2009; Taylor and others 2014). Pine Log Creek may have an impaired ecological state due to elevated nutrient concentrations throughout the watershed.

3.4.2 Biotic Monitoring

To assess fish populations within the watershed three previously sampled sites (GAEPD, Table 15.), as well as one additional site in the Headwaters, were assessed to provide fish Index of Biotic Integrity (IBI) scores. The function and role of IBI scores in assessing watershed health are explained in Section 3.3.2. Scores ranged from 16 (Very Poor) to 46 (Good). Because the sampling site in this study was at the border of the two physiographies/ecoregions, a second fish IBI score using criteria for the Coosa River drainage in the Blue Ridge Ecoregion is included below.

Cedar Creek - One historical fish IBI score is available for Cedar Creek in Gordon County. On 21 Aug 2001 the IBI score was 28, which ranks this fish community as Poor. One explanation for this discrepancy is that our study used five backpack shockers to sample fishes. If fish sampling in 2001 used fewer backpack shockers, this may have not captured the true makeup of the fish community. A second explanation could involve a real improvement in water quality.

Rocky Creek (Little Pine Log Subwatershed) - Three historical fish IBI scores are available for Rock Creek in Bartow County. The two earlier IBI scores (2 May 2001: IBI = 44; 6 August 2002: IBI = 50) were slightly higher or lower scores relative to the current study and also ranked Good. The latest fish IBI score (10

Oct 2007: IBI = 42) was lower and ranked at the upper end of Fair. The historical and current fish IBI scores show that the fish community composition in Rock Creek has fluctuated slightly over two decades but has remained relatively constant.

Jacks Creek - One historical fish IBI score is available for Jacks Creek in Gordon County. On 21 Aug 2001 the IBI score was the same as in this study, 16, which ranks this fish community as Very Poor. This consistently low score over two decades indicates that the lower water table (compared to the other creeks sampled in this study), perched culvert acting as an upstream migration barrier, and over 75% of the of the land use in the watershed upstream of our sampling site is agriculture and development all consistently contribute to Very Poor condition of the fish community at this site.

Pine Log Creek Headwaters - The IBI score for Pine Log Creek Headwaters was 34, which ranks this fish community as Fair. Because the sampling site in this study was at the border of the two physiographies/ecoregions, a second fish IBI scoring using criteria for the Coosa River drainage in the Blue Ridge Ecoregion was calculated. This fish IBI score was slightly higher, 38, but still ranks this fish community as Fair. Attributes for this ranking are species richness declines as some expected species are absent; few, if any, intolerant or headwater intolerant species present; trophic structure skewed toward generalist, herbivorous, and sunfish species as the abundance of insectivorous cyprinid and benthic fluvial specialist species decreases. Given that 93 % of the drainage basin area upstream of the sampling site was forested, and fish IBI scores were determined using criteria for two different physiographies/ecoregions, the ranking of Fair seems unusually low, given the watershed conditions upstream.

Table 15. Fish Index of Biotic Integrity Ratings in the Pine Log Creek Watershed.

Site	Cedar Creek	Pine Log (Ridge & Valley Calculation)	Pine Log (Blue Ridge Calculation)	Rocky Creek	Jacks Creek
Fish IBI scores	42	34	38	46	16
Fish IBI rank	Fair	Fair	Fair	Good	Very Poor

3.5 Watershed-Scale Analysis

Analyzing spatial patterns and processes of land use at the watershed scale can assist planners in identifying critical areas for protection and restoration. To further understand these patterns in the context of the Pine Log Watershed, LVRCD partnered with the University of Tennessee (Chattanooga) Interdisciplinary Geospatial Technology (IGT) Lab to develop watershed-scale models. Their work is presented below in the following sections. These models will help identify key priority areas and parcels to target implementation for NPS reduction.

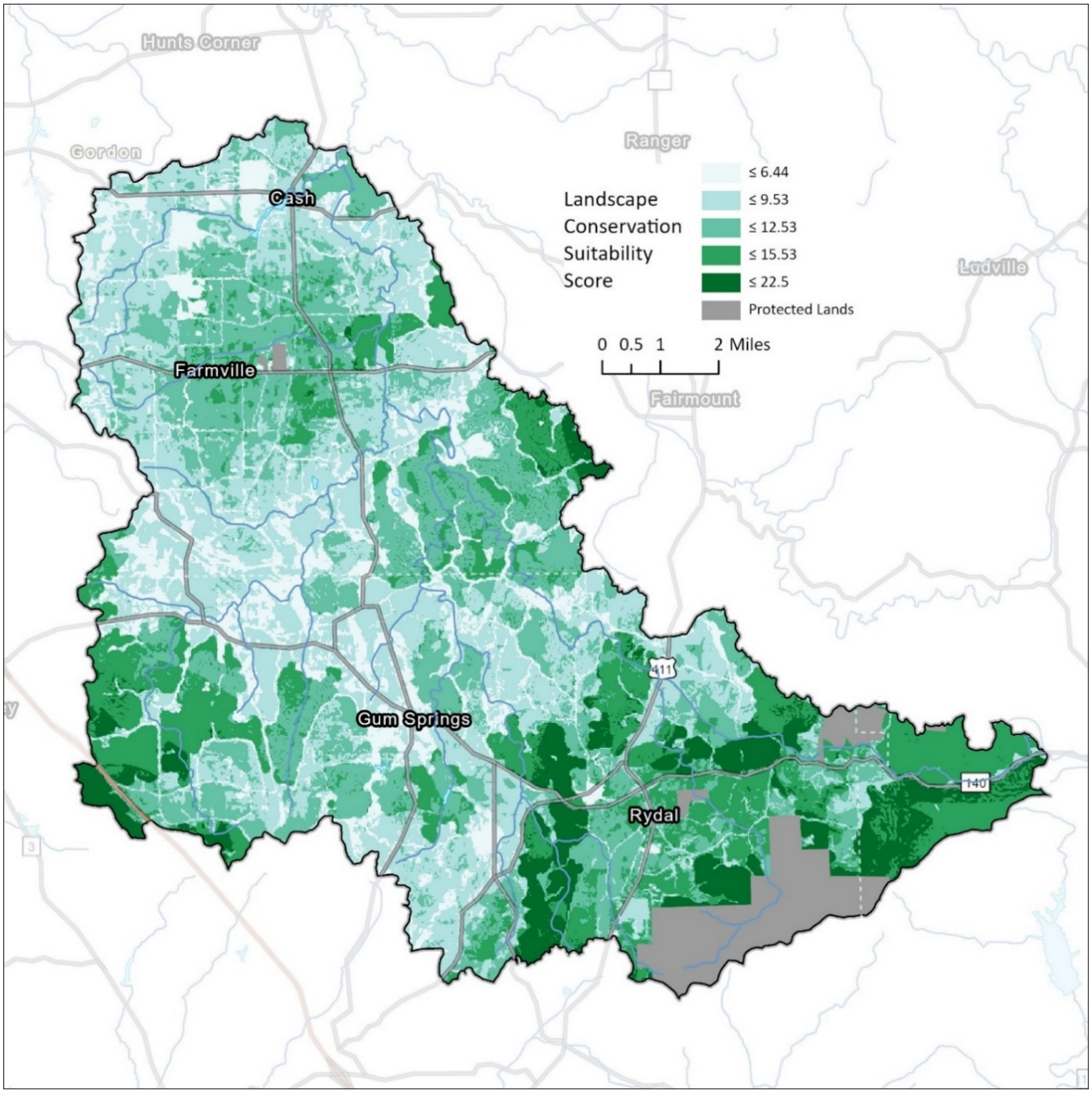
3.5.1 Landscape Conservation Suitability Analysis

The landscape conservation suitability model for Pine Log was originally developed for the Thrive Regional Partnership Natural Treasures Alliance by UTC's IGT Lab, with input from representatives of the Open Space Institute, The Nature Conservancy, and the Tennessee River Gorge Trust. This model prioritizes intact habitat cores, intact cores by connectedness, wildlife corridors, above average climate resilient lands, and areas near protected lands to identify the highest priority areas for habitat protection. Table 16 outlines a complete list of input data, attributes, and weighting that went into the final suitability analysis. These data were mapped and overlayed in GIS using a weighted overlay approach to produce the final suitability model for Pine Log with potential scores ranging from 1-24, with higher scores being more ideal for conservation of wildlife habitat (Figure 19).

Table 16. Input Data and Weights for the Landscape Suitability Model

Dataset	*Key Attribute (reclassified to 1-5 scale)*	*Weighted Overlay Value*	*Data Source*
Esri Green Infrastructure Intact Habitat Cores	core score	1	https://www.arcgis.com/home/item.html?id=0d2f35395c3c43ecb7685df9be63dd84
Intact Habitat Cores by Connectivity Importance	pixel value based on between centrality	0.5	https://nation.maps.arcgis.com/home/item.html?id=fe42b11c901d4dbab8833c2415ed21b7
Habitat Fragments	present/absent	0.5	https://nation.maps.arcgis.com/home/item.html?id=c27ff9b9a80b44dcb94ac7ad084a1eca
Habitat Cost Surface (wildlife corridors)	value of cost service, lower value, higher priority for conservation	1	https://nation.maps.arcgis.com/home/item.html?id=98882d18558a4659962d2b39a49ae7ed
Climate Resilience	above average resilience scores	1	https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/terrestrial/resilience/Pages/default.aspx
Proximity to Protected Lands	distance (meters)	1	https://www.usgs.gov/core-science-systems/science-analytics-and-synthesis/gap/science/protected-areas

Figure 19. **Map of Landscape Conservation Suitability. Areas of high value (dark green) indicate lands with intact habitat, high resilience, and connectivity. These are areas that can sustain and protect ecosystems, species richness, viewsheds.**



3.5.2 Watershed Management Priority Index

The Watershed Management Priority Index (WMPI) is a GIS model that allows stakeholders to analyze and overlay landscape attributes that affect water quality. The methodology used to create the WMPI for Pine Log has been implemented previously by the US Forest Service in their "Forest to Faucet" program, The Nature Conservancy, and other various conservation organizations. The WMPI contains two sub-models: A Restoration Priority Index (RPI; Figure 20) and a Conservation Priority Index (CPI; Figure 21). The general idea of these is to prioritize areas for conservation or restoration that can protect or enhance stream health. The main drivers of these models are land cover classes, soils types, and slopes. If an area with a high CPI value is converted from forest to impervious surface, it has potential to degrade water quality. Whereas if an area with a high RPI value is converted from agricultural landcover to natural landcover, it has the potential to improve water quality (i.e., stabilizing streams with riparian vegetation). Together, the CPI and RPI models can be used to analyze parcels for protection and enhancement of stream quality.

To create the WMPI for the Pine Log watershed, UTC's IGT Lab collected readily available data for the region. Each of the 7 layers in the following chart (Table 17) were extracted and ranked on a scale of 1-3, with 3 being the most desirable. After processing and analysis, all 7 layers were then compiled in a weighted overlay to create the final index with scores ranging from 1-21, with higher scores being more suitable for conservation and restoration.

The WMPI methodology was adapted from The Nature Conservancy in analyzing the lower Savanah River, outlined in the report titled "Preserving Water Quality in the Savannah River" (Krueger & Jordan).

Table 17. Watershed Priority Index input data and weights.

Dataset	RPI Attributes (reclassified to 1-3 scale)	CPI Attributes (reclassified to 1-3 scale)	Weights	Source
Landcover Class	barren land, pasture/hay, cultivated crops = 3 shrub/scrub, grassland/herbaceous = 2	All Forest Types = 3	1	https://www.usgs.gov/centers/eros/science/national-land-cover-database?qt-science_center_objects=0#qt-science_center_objects
Streams Proximity	0-30m = 3 30-60m = 2 60-90m = 1	0-30m = 3 30-60m = 2 60-90m = 1	1	https://www.usgs.gov/centers/eros/science/national-land-cover-database?qt-science_center_objects=0#qt-science_center_objects
Wetlands Proximity	0-30m = 3 30-60m = 2 60-90m = 1	0-30m = 3 30-60m = 2 60-90m = 1	1	https://www.fws.gov/wetlands/
Soil Hydrologic Group	Group A = 1 Group B, C = 2 Group D, A/D = 3	Group A = 1 Group B, C = 2 Group D, A/D = 3	1	https://www.arcgis.com/home/item.html?id=cdc49bd63ea54dd2977f3f2853e07fff
Soil Erodibility-Kfactor	low = 1 moderate = 2 high = 3	low = 1 moderate = 2 high = 3	1	https://www.arcgis.com/home/item.html?id=cdc49bd63ea54dd2977f3f2853e07fff
Slope	high = 3 medium = 2 low = 1	high = 3 medium = 2 low = 1	1	https://www.usgs.gov/core-science-systems/national-geospatial-program/national-map
Active River Areas	material collection zones and FEMA 100-year flood zones = 3	material collection zones and FEMA 100-year flood zones = 3	1	https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/reportsdata/freshwater/floodplains/Pages/default.aspx

Figure 20. Map of WMPI Restoration Priority Index. Higher values indicate lands suitable for restoration or better land management practices to enhance/protect stream quality.

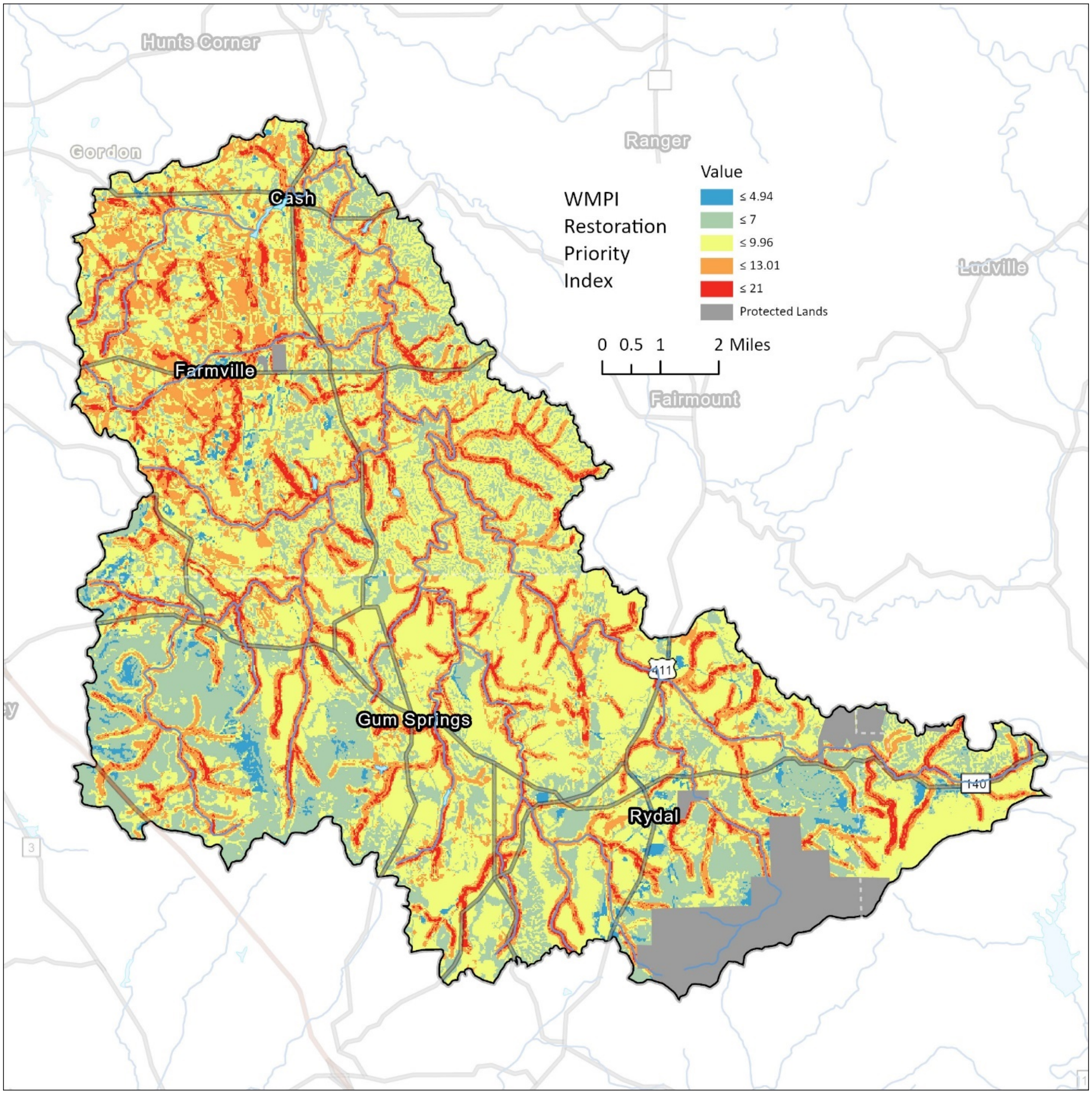
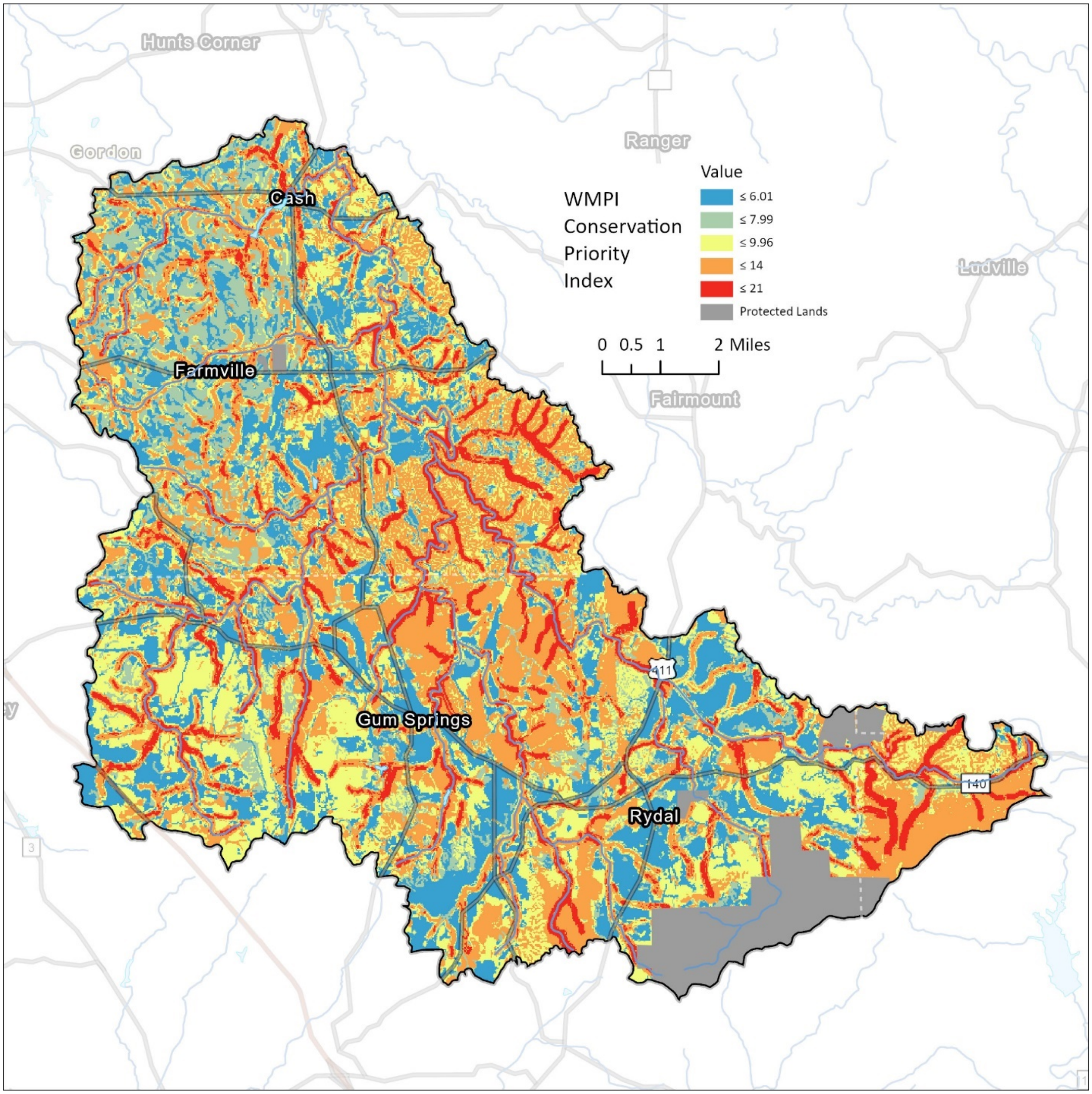


Figure 21. Map of WMPI Conservation Priority Index. Higher values indicate lands that if protected, can protect stream quality.



3.5.3 Parcel Ranking

Conservation happens at the parcel level. For this reason, every parcel in the Pine Log watershed was scored using the models described above with the geoprocessing tool *zonal statistics*. Zonal statistics summarizes the numerical raster cell values of all the cells found in a bounding geography - in this case, parcels and returns user defined statistics. For the analysis, we used the mean and a standard deviation value to rank parcels. With these two values, conservation planners can compare parcels to one another, based on overall landscape conservation suitability values and WMPI RPI & CPI scores (Figure 22, Figure 23 respectively).

Additionally, using the 2016 NLCD, the land cover composition of each parcel was also calculated and displayed as a percentage.

Figure 22. Map of WMPI Restoration Priority Index by parcels normalized for parcel comparison.

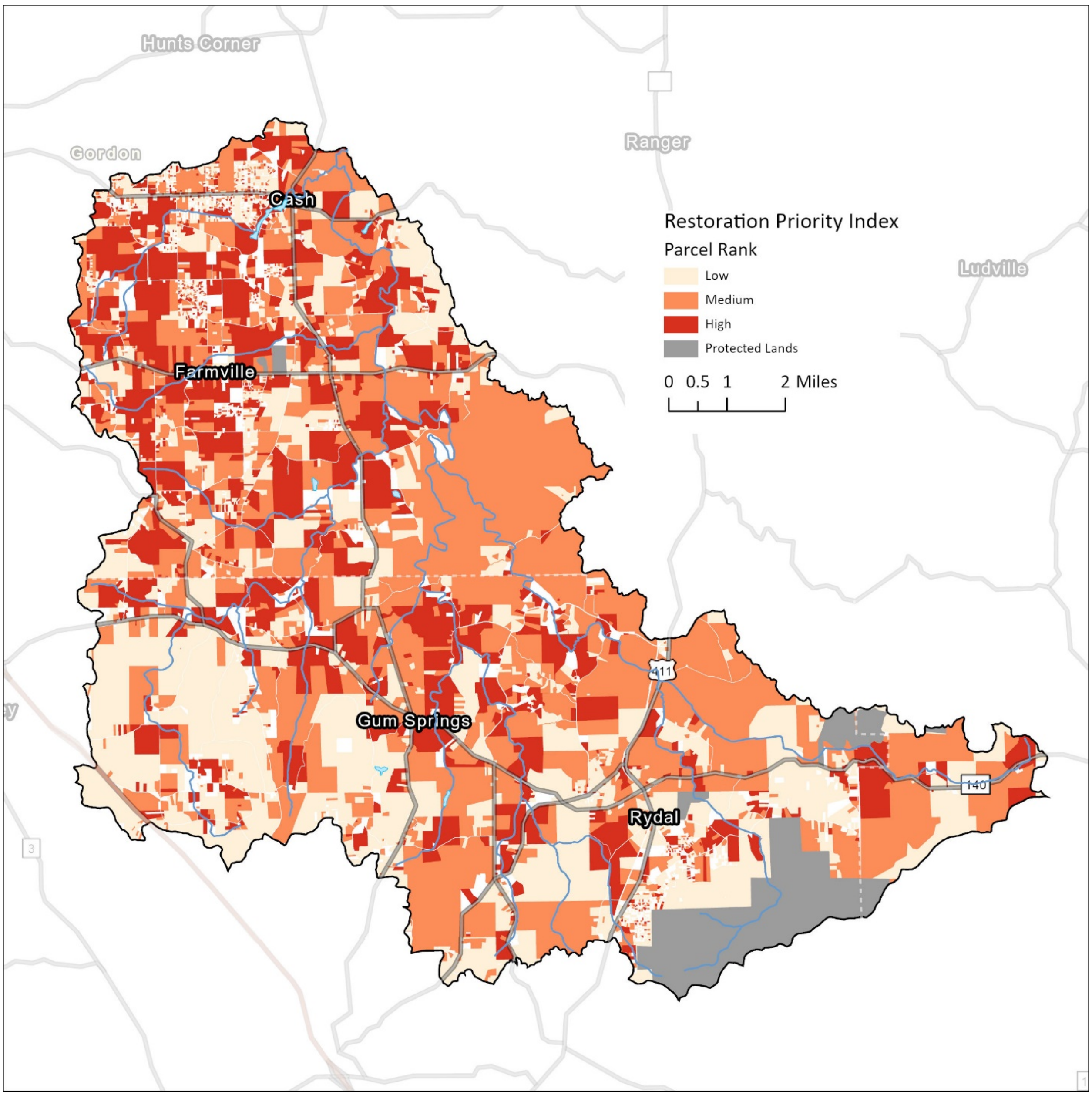
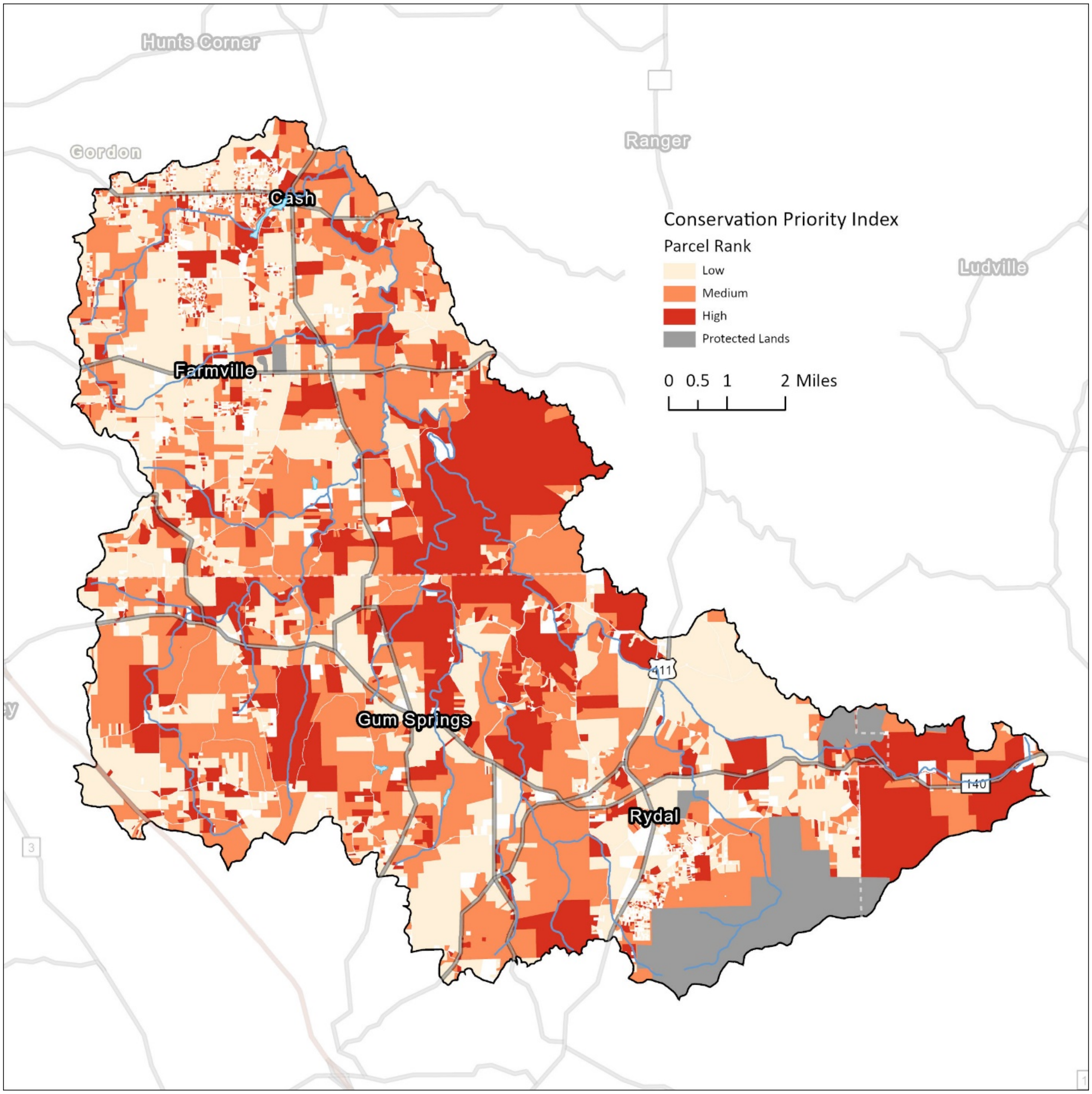


Figure 23. Map of WMPI Conservation Priority Index by parcels normalized for parcel comparison.



3.5.4 Riparian Buffer Analysis

The riparian area serves as a buffer between activities that occur on the landscape and the water in the stream by physically catching pollutants (e.g., sediment, nutrients, bacteria) from runoff during rain events. They are critical to the health of waterways. In healthy stream systems, extensive root systems stabilize the soils close to streams and, most importantly, the stream banks. Without these root systems, erosion is more prevalent, and the banks often erode and collapse leading to sedimentation issues. The vegetation also provides shade for the stream, which aids in keeping the temperatures low (and dissolved oxygen high). Dense vegetation in the riparian zone also contributes falling dead and dying vegetation into the stream channel, providing diverse habitat for aquatic life. Conducting an analysis of buffers within an impaired watershed has become an acceptable way to assess areas in need of restoration. Insufficient riparian buffers often indicate sources of NPS pollution. These areas could simply be a place where pollutants enter the stream through runoff, or even a place where livestock enters the stream (heavy use inhibits vegetative growth) thereby allowing direct introduction of NPS pollutants.

For the development of the Pine Log Creek WMP, an analysis of the watershed Study Area was performed to assess the general condition of the riparian corridor regarding woody vegetation. This stream buffer analysis was completed due to the importance of vegetative buffer zones (i.e., riparian zones) for stream and water quality conditions. This analysis focused on defining the degree to which stream segments had sufficient canopy cover as determined by the National Land Cover Database (NLCD) Tree Canopy Cover Product (Homer 2015). The NLCD provides data on land cover and land cover change at a 30-meter resolution. Also, due to the relatively low-resolution of the data – 30 meters – this assessment is intended as a high-level metric to help identify watersheds within the study area that may require more analysis to identify potential stressors. The areas having insufficient riparian zones are depicted in red.

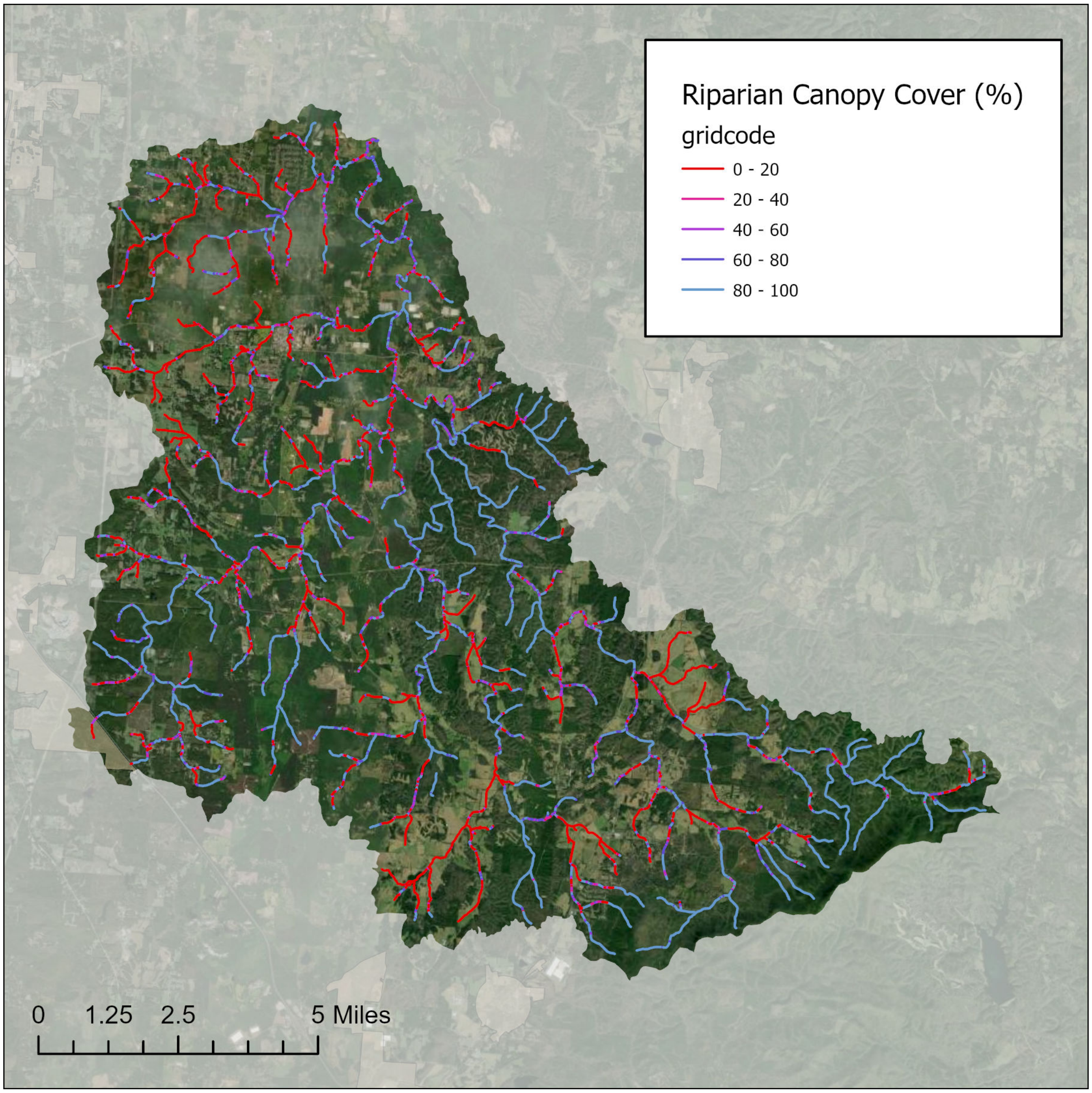
Table 18. Miles of Stream within the Pine Log Creek Planning Area and its Associated Canopy Cover (%)

Subwatershed	Miles of Stream by Percent Canopy Cover					
	0 - 20	21 - 40	41 - 60	61 - 80	81 - 100	Total
Ballard Creek-Cedar Creek (031501020603)	19.4	3.0	6.2	8.4	26.4	63.5
Calico Valley-Pine Log Creek (031501020604)	4.5	1.0	2.8	4.2	18.2	30.7
Jacks Creek (031501020606)	14.5	2.0	4.6	6.1	8.7	35.7
Little Pine Log Creek (031501020602)	20.2	2.7	3.9	5.8	24.3	56.9
Spring Creek (031501020605)	13.0	1.8	2.9	3.7	5.7	27.1
Sugar Hill Creek-Pine Log Creek (031501020601)	11.2	2.1	3.2	5.7	26.5	48.7
Total	82.8	12.6	23.6	33.9	109.8	262.7

Table 19. Percent of Total Stream Length by Percent Canopy Cover within the Pine Log Creek Planning Area

Subwatershed	Percent of Total Stream Length by Percent Canopy Cover					
	0 - 20	21 - 40	41 - 60	61 - 80	81 - 100	Total
Ballard Creek-Cedar Creek (031501020603)	31%	5%	10%	13%	42%	100%
Calico Valley-Pine Log Creek (031501020604)	15%	3%	9%	14%	59%	100%
Jacks Creek (031501020606)	40%	6%	13%	17%	24%	100%
Little Pine Log Creek (031501020602)	35%	5%	7%	10%	43%	100%
Spring Creek (031501020605)	48%	7%	11%	14%	21%	100%
Sugar Hill Creek-Pine Log Creek (031501020601)	23%	4%	6%	12%	55%	100%
Total	32%	5%	9%	13%	42%	100%

Figure 24. A map depicting riparian buffer condition within the Pine Log Creek Watershed. Streams depicted in red represent areas within the riparian buffer that have less than 20% canopy coverage.



4 Pollutant Source Assessment

4.1 Nonpoint Sources

Nonpoint source pollution (NPS) comes from many diffuse sources, as opposed to point source pollution which originates from a single source. NPS encompasses a wide range of pollutants distributed across the landscape and washed into streams during rain events. These pollutant sources are difficult to trace and regulate since they are typically ubiquitous and originate from numerous land parcels with various owners. NPS pollution can also be quite variable over time due to variable land uses, management practices, grazing rotations, runoff events, seasonal shifts and other factors. Since there are few potential or permitted point sources identified in this watershed, most of the pollutants are assumed to originate from NPS. Although the management of particular parcels will not be discussed within this plan, it is apparent that the most prevalent nonpoint source pollution issues in the watershed relate to insufficient riparian buffers along streams, livestock access to streams, the application of poultry manure, failing septic systems, streambank erosion, stormwater runoff, undersized culverts, drainage ditches and tile drains from agricultural fields, unpaved roads and potentially others sources such as impervious surfaces and runoff related to development to name a few.

4.1.1 Agriculture

Land uses within the Pine Log Creek Watershed representing, pasture and hay make up 22,209 acres or approximately 27% of the land in the watershed. Cultivated crops make up 456 acres or <1% of the watershed area. When excluding forestlands which traditionally contribute low levels of inputs NPS, overall farming lands (~28%) are the dominant land use in the watershed likely contributing significant nonpoint source pollution loads. Land in farms can be subdivided into use categories of cattle, horse, and chicken operations with each subgroup potentially contributing significantly to nonpoint source pollution loading.

A large percentage of agricultural land use consisting of hay and pasture lead to a likelihood that livestock are a contributor to fecal coliform levels in the watershed. While some farms fence their cows from accessing the creek, most do not. Cattle were regularly seen standing in streams during sampling and visual surveying. In addition, rain events wash pathogens from the adjacent fields and high use areas directly into the creek, particularly where there is no buffer zone to provide filtration.

Due to the significant volume of dry chicken manure spread on pasture and hay land in both Gordon and Bartow Counties, it is likely to be a prime contributor to the fecal coliform loading of the watershed. General NPDES land application system (LAS) permits are not required by the state for Animal Feeding Operations (AFO), such as poultry farms, that apply dry litter, at the time of this writing. The number of poultry farms has dramatically increased over the past several years to the point that Gordon County placed a moratorium on construction of AFOs, in 2018, while regulatory guidelines could be developed. The addition of Poultry litter to fields as an amendment through a LAS poses inherent risks beyond the transport of fecal coliform vectors. The application of Manure is most commonly planned based on Nitrogen need of the pasture, crop or hay field. Poultry litter contains approximately a 3 to 1 ratio of Phosphorus to Nitrogen, and this leads to Phosphorus loading of spoils in areas where litter is annually applied. Phosphorus is a major contributor to eutrophication in waterbodies when particles bonded to the nutrient are transported to surface waters.

Additional input of pathogens and nutrients can also be due to proximity of chicken houses, and their waste storage areas, to the creek and its tributaries. Furthermore, the practice of injecting waste into the soils as a soil amendment is increasing in the watershed and may be contributing to nutrient and fecal loading.

Beef cattle are the dominant pastured livestock in the watershed. Generally, beef cattle are maintained in pastures except for winter feeding. Winter Feeding often occurs in a “sacrifice” paddock to reduce traffic on wet dormant grasses and allow for ease of hay or grain feeding. All classes of pastured livestock could contribute to raised levels of fecal coliform if feces left in pastures eventually washes into the streams during runoff events or fields become inundated in floodplains. When cattle, have continuous access to streams, they can directly deposit waste into streams. In addition, the access leads to trampling of riparian vegetation, loss of bank stability, and often the eventual collapse of stream banks. Bank instability issues often lead to continuous significant sediment loading into streams. In addition, the sediment itself is also a potential dwelling/ source/ load for pathogens. Since pathogens adhere to sediment particles and can survive longer while in sediment, the actual abundance of coliforms may be higher and more persistent than measured. (Burton, et al., 1987) Nutrients also adhere to sediment and enrich the water column leading to algal blooms and potentially toxic water conditions for humans, pests, and wildlife. These algal blooms are intensified by warming waters that are created when stream buffers no longer provide shade, compounding the issue rooted in livestock access to creeks.

4.1.2 Wildlife

Depending on the animals present within the watershed, wildlife contributions of fecal coliform and sediment to streams vary considerably. Based on the TMDL written for this section of Georgia and information provided by the Wildlife Resources Division of Georgia DNR, the animals that spend most of their time in and around aquatic habitats are the most important wildlife sources of fecal coliform bacteria. Wildlife on the valley floor, in particular geese and ducks, are present in significant numbers and may have a pronounced impact on water quality. The valley provides a natural flyway for both geese and ducks during migrations and reduced buffers make streams accessible. In addition, there are numerous farm ponds and lakes pocketing the watershed providing excellent habitat for waterfowl. Waterfowl are considered significant contributors since they spend a large portion of their time on surface waters and deposit feces directly into the host water body. The Canada Geese not only populate the lakes during migrations, but also spend increasing amounts of time on the lakes throughout the year. The lakes, due to shallow depth and a muddy bottom, are potentially an incubator for feces left by the waterfowl. Other potential contributors include aquatic mammals such as beaver, muskrat, and river otters. Feral pig populations (*Sus scrofa*) may also contribute small amounts to the load, but local hunters have been removing them and the Coosa River Soil and Water conservation District has an active trap rental program for feral pig population reduction.

The large proportion of forested lands in this upper portion of the watershed suggests that wildlife may be contributing to the fecal coliform load in those areas and downstream, however our data from the forested lands indicate minimal impacts. Reduction of fecal coliform contributions from wildlife will not be a major focus of the plan. The plan will, instead, emphasize the reduction of anthropogenic induced sources of fecal coliform bacteria.

4.1.3 Urban/Suburban Runoff

Development pressures on natural water channels often result in changes to the stream structure and health and ultimately impact the community. Sediment pollution is one major contributor to stream morphology that is often associated with development. Storm water discharges and increased velocity of water inputs into streams often result in damage to vegetation, man-made structures downstream, stream banks, and generally have a negative effect. Sediment either generated through these increase flows or carried across impervious surfaces into water bodies often transport nutrients and pathogens that contribute to degraded water quality. Impervious surfaces in the Spring creek residential dominated area and the development corridor along highway 53 in Jacks creek watershed could be major contributors to sediment loading. Threat of additional development as Calhoun continues to grow will only further the impacts of development from activities such as land clearing, impervious surface construction and other development related impacts. Land-disturbing activities are a consistent contributor of sediment to streams nationwide. These activities include clearing, grading, excavating, or filling of land. Disturbance of land typically removes the vegetation, which exposes the surface sediment to rain events resulting in erosion and sediment delivery into streams. For example, conversion of forests to developed land (clearing) is often associated with water quality degradation. In more developed areas, stormwater runoff can also contribute to erosion issues in streams. This type of runoff originates from developed land that contains higher proportions of impervious surface cover (rooftops, parking lots, roads, etc.). These surfaces concentrate large quantities of water into the stream quickly, resulting in stream bank erosion and incision. Eventually, as banks collapse, streams tend to widen and collect additional sediment, which can lead to losses in habitat variation. Assisting communities on the outskirts of Calhoun with the installation of various, additional stormwater practices and other green infrastructure may be able to reduce these issues in the Pine Log Creek Watershed.

Low population density in the bulk of the watershed would suggest that agricultural or wildlife contributors are the dominant fecal coliform influence, however areas of Bartow and Gordon County have been identified by Public health officials as chronically failing septic zones. These identified zones coincide with elevated fecal levels observed during watershed sampling efforts conducted throughout 2020. These failing septic systems contribute to the fecal Coliform detected in watershed sampling. Old septic systems and addition of new systems with increased development create an added risk of continued septic system induced fecal coliform pollution. Repair and maintenance of septic systems should be encouraged through programs and outreach in order to reduce continued failures and impacts. Households should be encouraged or incentivized to connect to County sewer when and where it is available.

4.2 Point Sources

Point sources of pollution are those which are delivered to a waterbody via “discrete conveyances”. These sources are regulated through the NPDES permitting system. Point sources typically include industrial sites, municipal separate storm sewer systems, and confined animal feeding operations (CAFOs). A query of the EPA PCS-ICIS database indicates there are no major permitted point sources in the watershed. Many poultry farms operate dry manure management systems. Under current state rules dry manure operators are not required to permit their operations. Though permits are not required for dry poultry litter operations, nutrient management plans are considered best management practice and help to address nutrient application 4 R’s (Right rate, Right time, Right source, Right place). The majority of this litter is managed with land application to fields, this process takes a nutrient point source and diffuses the nutrients to a non-point potential contributor. Operators managing egg washing poultry farms, liquid swine or other liquid manure management would be required to receive NPDES permitting. Industry is often a contributor to point source pollution and the watershed has very little industry.

5 Watershed Improvement Goals

5.1 Overall Objectives

5.1.1 Restoration

The primary objective of this WMP is to outline a framework that will lead to the restoration of the Pine Log Creek Watershed to achieve and maintain compliance with state standards. Three segments have been placed on Georgia's 303 (d)/305 (b) list, totaling over seventeen miles of impairments. A major component of restoration efforts will include implementing cost share programs that incentivize landowners to address pollution sources on their privately-owned lands. Reductions in relevant pollutants will be tracked through water quality monitoring and potentially by sampling fish or macroinvertebrate assemblages. State-designated water quality collection and analysis protocols will be followed during periodic sampling events in an effort to de-list stream segments impaired for high fecal coliform bacteria counts. In addition, sampling rotations by monitoring groups (from Georgia EPD) should help indicate improvements in biotic integrity as they occur within the streams of the watershed. Should these groups not revisit these streams, a local effort may be made to sample them again to see if biotic assemblages have improved.

5.1.2 Anti-degradation

Through water quality sampling data obtained during the formation of this WMP, it was recognized that the entire watershed contained sources of fecal coliform and sediment, and that in addition to the current impairments, other stream segments had at least some potential to be listed at some point as well. Due to this recognition, anti-degradation efforts were emphasized as a primary objective of restoration efforts. For this reason, any cost-share program should be implemented on a watershed-wide basis. In addition, outreach efforts will be focused on the whole watershed to raise awareness of existing programs that make best management practices more affordable to private landowners and prevent further degradation of stream segments within the watershed.

5.1.3 Education

Educating local citizens on the uniqueness of their watershed, the NPS threats present in the area, and what can be done to address these issues is key to successfully implementing BMPs and watershed restoration. Education and outreach efforts are paramount if watershed goals and objectives are to be reached. Involving local communities in the watershed improvement process is important to success and providing an opportunity for local stakeholders to gain an understanding of their watershed. Restoration education needs to be a priority program component to supplement BMP installation efforts. Presentations at local events should be used as a means to reach a broad audience in the community. An Active 4-H program in Gordon County is an excellent opportunity to engage in Adopt-a-stream programing and serve as an interface between education, agriculture, and the community. Other specific educational examples include demonstrating green infrastructure, engaging in stream cleanups, rain barrel workshops, native tree planting and canoe cleanup floats down local waterways.

6 Pollution Reduction

6.1 Load Reductions

As defined by the EPA, a Total Maximum Daily Load is the calculation of the amount of a pollutant allowed to enter a waterbody so that it will meet water quality standards for a particular pollutant. The calculation is made up of Waste Load Allocation (WLA), Load Allocations (LA), and a Margin of Safety (MOS). WLAs represent point sources including NPDES discharges such as wastewater treatment facilities, CAFOs, and stormwater discharges. LAs represent nonpoint sources of pollution, which are considered all sources that are not NPDES discharges as well as background sources. The MOS accounts for all uncertainty including seasonal variations, etc. After calculating the TMDL for a certain pollutant for a segment of stream, the current pollutant load for the stream can be calculated through water quality sampling. These two calculations can then be used to calculate the load reduction needed to meet water quality standards.

Although the state of Georgia has not adopted Water Quality Standards associated with nutrients and there are no current TMDLs for nutrients in Georgia, Lake Weiss, located just across the state line in Alabama, does have an EPA-approved TMDL for nutrient impairment. The Coosa River, of which the Pine Log Creek watershed is ultimately a tributary, drains to Lake Weiss. The TMDL calls for a 30% reduction in total phosphorus loads measured in the Coosa River at the state line. According to the TMDL, approximately 70% of TP is associated with nonpoint runoff.

In 2009 two separate TMDL evaluations—sediment and fecal— were completed for multiple stream segments in the Coosa River Basin. Since Pine Log Creek was not listed for fecal until after the fecal evaluation was completed, it is not specifically listed. However, Salacoa Creek—which Pine Log Creek drains to—does have a TMDL and associated load reduction calculated. Those data can be found in Table 20. Fecal TMDL Calculation and Load Reduction for Salacoa Creek The TMDL calls for a 62% reduction in fecal loads in order to meet the TMDL. Because no WLAs are identified in the TMDL, it can be assumed that a majority of the load comes from nonpoint sources.

Table 20. Fecal TMDL Calculation and Load Reduction for Salacoa Creek

Stream Segment	Current Load (counts/ 30 days)	WLA (counts/ 30 days)[1]	WLAsw (counts/ 30 days	LA (counts/ 30 days)	MOS (counts/30 days	TMDL (counts/ 30 days)	% Reduction
Salacoa Creek	8.04E+13			2.77E+13	3.08E+12	3.08E+13	62%

In the TMDL evaluation for sediment, Cedar Creek and Jacks Creek were identified and TMDLs calculated for these segments. These calculations and associated load reductions are identified in Table 21. The TMDL identified a 13.93% reduction in Jacks Creek and a 0% reduction in Cedar Creek. Because no load is associated with WLAs (point sources), it can be assumed that a majority of the sediment is a result of nonpoint sources. The TMDL evaluation noted that over recent history there has been a significant reduction in farmland under cultivation in the past century and, as a result, a reduction in erosion from those land uses. This would suggest that much of the current sediment loading in these systems may be a result of legacy sediments and, given enough time, streams will repair themselves and further reduce sediment loading.

Table 21. Sediment TMDL Calculations and Load Reductions for Stream Segments within the Pine Log Creek Watershed.

Stream Segment	Current Load (tons/yr)	WLA (tons/yr)	WLAsw (tons/yr)	LA (tons/yr)	Total Allowable Load (tons/yr)	Maximum Allowable Daily Load (tons/day)	% Reduction
Cedar Creek	3508.8			3,508.8	3,508.8	259.7	0%
Jacks Creek	1,320.7			1,136.8	1,136.8	84.1	13.93%

To analyze the potential load reductions that could be achieved through watershed restoration, a STEPL model—designed by the EPA—was built for Cedar Creek. The STEPL model (Spreadsheet Tool for Estimating Pollutant Load) is a spreadsheet tool that uses algorithms to calculate nutrient and sediment loads from different land uses and the load reductions that could occur from the implementation of BMPs. Although the STEPL model is capable of modeling nutrients as well, for purposes of this plan we used the model to analyze the potential sediment load reductions that might be achieved during implementation of this watershed management plan. Future versions of this model will include Fecal Coliform loading but is not yet available.

The model requires land use and precipitation data to calculate outputs. The model calculates annual sediment load by using the Universal Soil Loss Equation (USLE) and sediment delivery ratio. Potential sediment loads for the HUC-12 watersheds within our planning area are presented in Table 22.

The STEPL model calculates potential load reductions through use of BMPs in multiple ways. When dealing with specific project-level BMPs, such as streambank stabilization at a particular site, STEPL allows the user to calculate a refined load reduction based on the length and height of the bank, soil type, as well as the severity of erosion. However, since outreach to specific individuals and projects was not an objective of this plan, this type of approach would not be suitable. Alternatively, STEPL can calculate potential load reductions by identifying a particular BMP—Stream bank stabilization, filter strips, etc—and applying that to a proportion of specific land-uses within each subwatershed.

For this exercise, we assumed a Livestock Exclusion BMP would be applied to 40% of the pastureland area within each subwatershed. We also assumed a grass filter/buffer strip BMP could be applied to 40% of the cropland within the Jacks and Cedar Creek subwatersheds. Estimated loads and load reductions based on these assumptions are presented in Table 22. Based on this approach, initial rounds of implementation could potentially reduce loads by 577 tons/year. The addition of green infrastructure and Urban BMPs—not included in this model, but a significant factor contributing to non-point source sediment—could also significantly affect load reductions.

Table 22. Estimated Loads and Potential Load Reductions Calculated Using the STEPL Model

Watershed	Sediment Load (no BMP)	Sediment Load (with BMP)	BMP Application Rate on Crop/Pasture	Percent Reduction
	tons/year	tons/year	%	%
Cedar Creek	1833.7	1486.2	40/40	19
Jacks Creek	1612.6	1289.9	40/40	20
Total	3446.3	2776.1	-	-

It should be noted that the total estimated sediment load calculated for Cedar Creek with STEPL is significantly lower than the load calculated by the 2009 TMDL and is confounding. Future work in this area should reconcile differences in the model. However, this approach still provides a high-level estimate of load reductions that can be achieved through implementation. It can also be used during implementation as a planning tool to maximize the efficacy of implementation funds. Likewise, it can be used as a tool to track load reductions as more specific project-level BMPs are implemented.

6.2 Existing Conservation Programs

Currently, a number of conservation programs exist in the Pine Log Creek Watershed to assist landowners and managers in protecting natural resources and conserving water as well as soil. Program partners range from nonprofit organizations to federal and state programs. Many of these conservation programs are utilized throughout the United States to conserve and protect natural resources. The WMP conservation program list will focus on those conservation efforts specifically addressing fecal coliform and/or sedimentation reduction in this section.

6.2.1 Current Structural Programs and Practices

A table of conservation programs and associated managing entities is included below. This list may not be exhaustive, though these are the known, successful, conservation opportunities. The programs range from forestry to agriculture and also present options for addressing stormwater infiltration measures and septic system rehabilitation. These management measures which assist in controlling pollutant loads resulting in decreased levels of fecal coliform and/or sedimentation. Listed programs allow for development and implementation of voluntary conservation management plans.

Table 23. Existing Structural Conservation Programs

Structural Measure	Responsibility	Description	Impairment Source Addressed
Clean Water Act Section 319 Nonpoint Source Grants	US EPA, GA EPD	Makes Federal funding available for impaired watersheds to address nonpoint source pollution concerns and ultimately seek to move toward de-listing impairments.	Agriculture/ Residential/ Urban
Healthy Watershed Initiative	US EPA	Makes federal funding available to identify and protect healthy watersheds	Agriculture/ Residential/ Urban
Conservation Reserve Program	FSA, NRCS	Addresses problem areas on farmland through conversion of sensitive acreage to vegetative cover such as establishing vegetative buffers along waterways. Conversion costs are shared with FSA, and the landowner receives an annual payment for maintaining the conversion.	Agriculture

Conservation Tillage Program	Limestone Valley RC&D, Limestone Valley SWCD (Gordon & Cherokee) as well as Rolling Hills RC&D (Bartow)	Makes conservation tillage equipment available for rent within the watershed, helping producers plant their crops with minimal disturbance to the soil. This reduces erosion from cropland and increases water retention and nutrients.	Agriculture
Environmental Quality Incentives Program (EQIP)	NRCS	Works to address resource concerns on agricultural lands. EQIP is a cost-share program (75% typically but 90% for water quality priority practices) for landowners seeking to implement BMPs on their property.	Agriculture
Conservation Stewardship Program (CSP)	NRCS	A program that incentives conservation management practices with annual payments for completed conservation.	Agriculture
National Fish Passage Program	USFWS, National Fish Passage Program, SARP	Works to address barriers to the movements of aquatic organisms as well as improve aquatic habitats.	Biotic Communities
Septic System Permitting and Inspection Program	North Georgia Health District/ County Health Departments	Septic system repairs and installations are permitted and inspected by North Georgia Health District Staff. This not only ensures that systems are functioning, but also that they are installed by a licensed individual according to state regulations	Urban/Residential
Stream, Riparian Buffer, and Streambank Improvement Efforts	USFWS, Partners for Fish and Wildlife Program (implemented with local sponsoring partners)	Works to address stream habitat, riparian buffer, and streambank issues on private lands through a cost-share program aimed at areas key to fish and wildlife habitat improvement.	Agriculture/ Biotic Communities/ Residential
National Water Quality Incentive Program	NRCS –NWQI	Promote the conservation of agricultural lands for the improvement of water quality	Agriculture

Many programs also provide non-structural practices in the Pine Log Creek Watershed and most are not unique to the area (Table 24). These practices, although not physically reducing pollution, can arguably improve water quality as much or more than structural practices themselves. Changing behaviors and/or attitudes and, making a real difference in both the cultural and natural landscape over time.

Table 24. Existing Non-Structural Conservation Programs

Non-Structural Measure	Responsibility	Description	Impairment Source Addressed
Army Corps of Engineers	USACE	Conducts permitting for Section 404 of the Clean Water Act, which regulates the	All inclusive

Regulatory Program		discharge of dredged or fill materials into US waters of the US, including wetlands.	
Conservation Technical Assistance Program	NRCS	Assists landowners with creating management plans for their lands, including but not limited to Farm and Forest Conservation Plans and Comprehensive Nutrient Management Plans (CNMPs).	Agriculture
Endangered Species Act	USFWS	Among other things, this act ensures projects with a Federal nexus avoid deleterious impacts on listed aquatic organisms and their habitat.	Impacted Biota/ Sedimentation
Georgia Erosion and Sedimentation Act	Georgia EPD	Among other things, it prevents buffers on state waters from being mechanically altered without a permit.	All inclusive
Georgia Water Quality Control Act (OCGA 12-5-20)	Georgia EPD	Makes it unlawful to discharge excessive pollutants into waters of the state in amounts harmful to public health, safety, or welfare, or to animals, birds, aquatic life, or the physical destruction of stream habitats.	All inclusive
Land Conservation and Preservation	US Forest Service, TNC	Conservation and preservation of lands for appropriate management measures addressing water quality, aquatic organisms, and habitat.	All inclusive
UGA Cooperative Extension Program	Gordon Co./ Cherokee co./ Bartow Co. Extension Office	Assists with general agricultural assistance, which includes providing suggestions for soil and water conservation.	Agriculture
Keep Bartow Beautiful	Keep America Beautiful affiliate	Education and restoration projects focused on stormwater, litter prevention, and general environmental protection.	All Inclusive
Coosa River Basin Initiative	CRBI	Educate and advocate for the improvement of water quality both in the community and through legislative action.	All Inclusive
Soil and Water conservation Commission	GSWCC	A state of Georgia entity that promotes conservation through review of sediment and erosion control plans, promotion of conservation and support of local districts	Urban/Residential/ Agricultural
Soil and Water Conservation Districts	Coosa River S&W District, Limestone Valley S&W District	Promote Conservation, oversight of projects, management of flood control structures represent local counties as a state district.	All Inclusive

6.3 Proposed Conservation Program for the Pine Log Creek Watershed

A comprehensive approach is recommended to ensure progress is achieved toward meeting the watershed goals. It should be noted that small and focused effort are an option in addressing specific areas of the watershed, but a comprehensive approach will have the greatest impact and benefit. The following proposed program, the Pine Log Creek Watershed Restoration Program (PCWRP), would be an endeavor partially funded by Clean Water Act (§319), NWQI and other grants (and assisted by in-kind donations of stakeholders, agencies, and non-governmental organizations). These funding sources would provide cost-sharing for practices that have been identified as a means to addressing water quality issues. This PCWRP would attempt to raise awareness of the water related issues in the area. It would also work to educate citizens about potential watershed solutions.

6.3.1 Proposed Structural Practices of the Pine Log Creek Watershed Restoration Program

Water quality analyses and stakeholder surveys indicate, certain segments are more heavily impacted than others in the watershed. The listed segments, for fecal coliform and impacted biota, both are concentrated in the lower watershed. The entire watershed impacts the lower watershed; therefore, BMP installations need to be implemented throughout the watershed in order to have the greatest effect. The highest priority restoration areas are identified in the modeling and depicted in the map previously shown in Section 3.5.2 (Figure 20).These priority areas should be targeted for structural improvements but not limit the scope of the improvement area. Emphasis should be placed on each of the major sources of pollutants which include agriculture, failing septic systems, forestry and stormwater runoff.

Agricultural activity encompasses a large proportion of land use within the watershed, based on this, the PCWRP could include a cost-share program that will help local farmers implement conservation practices. Agricultural conservation practices should focus on reduction in fecal coliform and/or sediment contributions to receiving waters. Grazing operations are a dominant agricultural use in the watershed, as such conservation practices focused on this land use should be prioritized for best results in water quality. Practices related to grazing include fencing, heavy use pads, alternative watering sources, forage enhancements and others as indicated by a positive score in the Conservation Physical Effects Scoring Sheet located in Appendix B. Practices with a positive score, identified in this NRCS developed matrix would reduce water quality impacts in the watershed. Projects that address erosion issues may include vegetative practices or structural improvements. Examples of vegetative improvements would be critical area planting, forested buffer, conservation cover, grassed waterways and others listed on the NRCS priority matrix. Erosion related examples of structural practices would be stream bank stabilizations, fencing, lines waterways and outlets to name a few. One practice of particular note would be riparian plantings either through Forest buffer planting (NRCS code 391) or riparian hedgerow planting (NRCS Code 422). These two practices help to establish shade and filtration that are both needed for stream health and water quality. Buffer condition being one major deficiency identified in both GIS analysis and visual surveys, buffer improvements have been identified as an area for potential high impact improvements. Ultimately, many types of agricultural BMPs will be installed as a part of the PCWRP. Any positively scoring practices identified in the Conservation Practice Physical Effects should be considered.

Failing septic systems were identified by the stakeholder group to be a potential contributor to the fecal coliform bacteria load in the watershed. The PCWRP could include a cost-share program to address this issue. High failure rates are said to occur for several reasons, including poorly percolating soils and outdated system. A cost-share program in the area would incentivize system repairs. Cost-share rates could vary according to the proximity of the failure to surface waters, socioeconomic factors, nature of the cost share program or other factors. Higher rates will generally be offered on projects that more significantly reduce pollutant loads.

Portions of the watershed were identified by stakeholders to have impacts from development. These areas are prime locations for the use of storm water management BMPs. Stormwater BMPs such as rain gardens, infiltration basins, bioswales, and other green infrastructure help to reduce the impacts of pulses of stormwater, created by impervious surfaces in developed areas. Offering green infrastructure and stormwater BMP cost-share opportunities to local groups, municipalities, businesses and homeowners would greatly increase the adoption of these practices and could reduce impacts created by development areas. Demonstration of green infrastructure installations would also assist with community adoption through education while reduce the stormwater impacts at the demonstration site.

The Lake Weiss TMDL for nutrient impairment calls for a 30% reduction in total phosphorus loads in the Coosa River at the Georgia-Alabama state line. Though segments of Pine Log creek are not specifically listed for nutrients, due to the lack of water quality standards for nutrients in Georgia, but it should be noted that these segments are within the Upper Coosa drainage. Nutrients and BMPs for addressing nutrients, including Comprehensive Nutrient Management Plans, should be considered within the Pine Log watershed based on the Upper Coosa TMDL. Specific BMPs for addressing Nutrients transported to surface waters can be found in the *Conservation Physical Effects Index* document located in appendix by referencing the Section, “field sediment, nutrient, and pathogen loss”. Nutrient trading is being studied in the Coosa Basin and may be a viable option for addressing nutrient loading on saturated fields in a nutrient trading program. A 2013 feasibility study of Nutrient trading viability in the Coosa basin is listed in the literature cited section and may serve as a resource in better understanding what a Nutrient trading program in the Coosa drainage may look like. This program is not yet operating but may become an option and should be considered in the future.

6.3.2 Proposed Non-Structural Practices of the Pine Log Creek Watershed Restoration Program

Education and outreach should be a key part of promoting cost-share program benefits and engaging the public. Demonstrating Conservation BMPs accomplishes both the conservation outcomes as well as local education. Adoption of BMPs often starts with firsthand knowledge of the practices, process, and effects. A few examples of successful outreach are local newspaper articles derived from the press releases, creek days, and public workshops are all acceptable ways to spotlight the benefits of agricultural BMPs. Other efforts will offer educational opportunities during volunteer workdays (riparian plantings, stream cleanups, etc.).

An outreach plan should be developed for every grant related to improving the watershed. These outreach plans should identify annual or semi-annual events that will be held that encourage public participation in the watershed improvement process. Events could include online presentations and feedback groups, canoe floats, stream cleanups, training or classes, and the establishment of viable Adopt-A-Stream groups. Although many of the streams within this watershed may be too small for floats or too remote for effective cleanups, other opportunities to connect community to creeks are possible. As a part of an outreach plan, press releases should be periodically issued to local newspapers or on community social media pages to highlight watershed opportunities as well as watershed issues and solutions. Promotions should also include local presentations to stakeholder groups in order to spawn interest in the restoration efforts by reminding local groups of the benefits the implementation effort is seeking to provide (e.g., reduced human health risk and water treatment costs and increased financial assistance within the community). An outreach plan should always include promotion of significant progress made in the watershed toward water quality goals.

7 Implementation Program Design

7.1 Management Strategies

Both structural and non-structural controls are the recommended strategic approach for implementing this WMP and managing a program within the watershed to address the fecal coliform and sediment issues. It is the intent of the proposed restoration program (PCWRP) to de-list segments within the watershed through restoration efforts. This should be accomplished by increasing the available agricultural BMP cost-share opportunities, creating a septic system repair cost-share program, assisting in the stabilization of problematic streambanks, improving local stormwater management, making available educational opportunities to encourage public participation in the watershed improvement process, and monitoring water quality to track improvements and potentially de-list impaired segments. Septic system failures will be identified and addressed with the technical assistance provided by the local county health departments, particularly the Gordon and Bartow County Health Departments. The NRCS can assist with technical assistance with respect to agricultural projects. Calhoun Utilities and other stakeholders could assist with streambank projects, green infrastructure installations and water quality sample analysis. Other agencies and non-governmental organizations will make key contributions to outreach efforts, as well as other facets of the program. All participation in grant programs will be voluntary in nature, and great care should be taken to respect private property rights. In order to de-list several stream segments through implementation of a number of small projects, it is likely a long-term investment of time and significant funding will be necessary. Assuming the behaviors and land management practices improve over time, the benefits of clean water can last generations. It has been estimated that approximately 40% of the critical areas within the watershed can be treated with BMP installations to reduce NPS pollution through the implementation Clean Water Act §319 grants meshed with NWQI grants and other funding. The stakeholder recommended program, as outlined here, would cumulatively fund approximately $1,300,000 worth of projects, excluding landowner contributions, and be implemented over the course of Ten years (including grant proposal submission periods). NQWI funding could be a significant portion of this funding total as the program addresses agricultural BMPs within priority watersheds, of which Pine Log is one. This proposed allocation of funds is similar to other restoration efforts that have been funded in the state yet is to be focused on a smaller geographic scale, which should lead to more pronounced improvements. It is believed that multiple stream segments could be de-listed as a result of this effort, although there is a possibility that more funding could be necessary to accomplish that goal.

7.2 Management Priorities Project Fund Allocation

Cost-share programs are to be developed for agricultural BMP installations (including cattle access control, streambank stabilization, riparian enhancement, etc.), septic repairs and pumpouts, and stormwater improvement projects. Due to the dominance of forests and agriculture in this watershed, allocation of potential funds should favor Agricultural BMP's followed by septic system repairs and pumpouts, and stormwater projects, and education and outreach. Adjustments can be made when necessary to capitalize on successful efforts and ensure we learn from less desirable outcomes.

7.2.1 Cost-Share Rates and Priority Areas

Agricultural BMPs addressing water quality should be considered for cost share at a rate relative to the funding available, conservation value, and need. NRCS programs historically have provided conservation cost share between 75% and 90%. NRCS Source Water Protection Priority Watersheds under the 2018 Farm Bill designate specific water quality improvement BMPs to automatically receive 90% cost share. This adjustable rate emphasizes the need and importance of BMPs in improving water quality. EPA funded 319 projects in other watersheds in North Georgia have set agricultural cost share rates at 60% this rate has often incentivized conservation but at a delayed schedule following NRCS program allocations.

Stormwater projects have also been cost-shared upon at a rate of 60% in similar funded watersheds. This rate again allows completed projects to adequately assist in providing matching fund contributions that count toward grant requirements. When the high costs of these practices are prohibitive, a portion of the cost-shares could be offset by donated advisement, planning, and expertise. In addition, the utilization of donated labor to assist with or complete stormwater, streambank biostabilization, and riparian planting projects may contribute to cost-share obligations. On private lands, the cost-shares should incentivize landowners with considerable streambank concerns to act to improve their properties while assistance is available. Additional Funding, while not assisting to reduce the match component, may be available from funders such as the Fish and Wildlife Partners Program. The partners program is applicable when a priority watershed segment could have positive impacts on threatened or endangered species.

For septic system repair projects and pumpouts, cost-share rates should depend on the demand. If demand for repair assistance is high, cost-shares should be set at lower rates in order to accommodate as many projects as possible and achieve the greatest water quality improvement. The most ideal projects for water quality improvement will be those significantly addressing the pollutants in close proximity to streams within or just upstream of impaired reaches. However, inclusion of landowners from the entire Pine Log Creek Watershed to be eligible for program cost-shares on projects that address water quality concerns is necessary to maximize program participation by building important momentum within the local community. In addition, since the problem areas are in the downstream reaches, all areas of the Pine Log Creek Watershed likely contribute to the impaired status of local stream segments, albeit to varying degrees.

Since certain septic system repair projects may address resource concerns more than others, variable cost-share rates should be considered to reflect the anticipated water quality improvement. For example, a septic system within 100 feet of an impaired stream would generally receive a higher cost-share rate than one located much farther away. This method of incentivizing participation will bring about the greatest load reductions while maximizing the overall number of participants. Similarly, impoverished members of the community may be further incentivized with higher cost-share rates in order to ensure they get failing systems repaired.

7.3 Interim Milestones

This section seeks to outline objectives and milestones that could be used by any group (in any combination) seeking funds for restoration efforts in the watershed. This WMP should be implemented for multiple years over several grants, each of which may have its own updated objectives and milestones according to changes in watershed conditions and/or management strategies.

OBJECTIVE #1: Create an agricultural BMP cost-share Prioritization in the watershed.
MILESTONES:

- Hold meetings with the NRCS to review modeling and prioritize appropriate BMPs.
- Advertise the available Programs through local outlets
- Issue success stories

Agricultural BMPs should focus on NRCS designated Source Water Protection Practices (updated yearly, 31 total as of 2021). Success stories may be developed with the public affairs specialists of funding agencies, nonprofits, or by grant sponsors. Installation should be on a strictly voluntary basis, and landowner confidence and satisfaction should be a primary focus. This will allow any program to develop a positive reputation in the area, which is hoped to eventually garner more conservation interest in the watershed.

OBJECTIVE #2: Create a septic system repair and pumpout cost-share program in the watershed.

MILESTONES:

- Identify local certified septic system contractors interested in participating in the program.
- Hold meetings with Public Health representatives to design program.
- Establish initial cost-share criteria based on proximity of system to state waters.
- Maintain the septic repair and pumpout program throughout the implementation process.

The repair process should involve the submission of bids from locally owned businesses with an interest in participating on grant projects. The homeowner should be allowed to choose which bid to accept. The rate of cost-share should be considered when possible, on a sliding scale that will result in offering more assistance to projects that will likely result in the greatest load reductions.

OBJECTIVE #3: Create a Green Infrastructure project cost-share program in the watershed.

MILESTONES:

- Identify potential Green Infrastructure sites with load reduction and outreach as key factors
- Hold meetings with local industries, Utilities, and stormwater experts to consider sites
- Seek to incorporate volunteer or donated labor to cover cost-share contributions for projects.
- Advertise the available opportunities and locations
- Issue press releases for successful stormwater and streambank biostabilization projects.
- Maintain the program throughout the implementation process.

OBJECTIVE #4: Reduce pollution inputs through education and outreach.

MILESTONES:

- Promote activities to the public to learn more about the creek. Such as recreational uses of the creek, hands on educational programs, and citizen science programs.
- Provide volunteer opportunities for the public to assist with stream restoration and cleanup efforts.
- Promote Georgia's Adopt-A-Stream Program through training and resourcing local groups.
- Conduct presentations discussing watershed restoration efforts at local events.
- Publish information to the public about the restoration process and NPS pollution issues and solutions.

Education and outreach should be designed to raise the awareness of citizens in the area through media and "hands-on" events. Programs such as Adopt-a-Stream are an excellent opportunity to promote both the hands-on learning and also encourage ongoing stewardship. Stream cleanups, creek walks/floats, and rain garden and rain barrel workshops should be planned to be offered to interested citizens in the area throughout any implementation effort. This ensures that the general public is provided the opportunity to not only learn about the watershed, but also participate in restoration events. These events should engage the public and ultimately lead to agricultural BMP and streambank stabilization projects, as well as septic system repairs.

OBJECTIVE #5: Implement BMPs to achieve load reductions

MILESTONES:

- Identify farmers willing to cost share on agricultural BMP projects
- Identify homeowners within targeted subwatersheds with failing or without proper septic systems.
- Implement septic repairs and pumpouts in the watershed.
- Implement agricultural BMPs in the watershed.
- Implement stormwater BMPs in the watershed.
- Estimate load reductions from projects when possible.
- Implement outreach and education activities

BMPs that address fecal coliform and sediment should be emphasized on agricultural lands. These include activities that restrict cattle access to the stream while providing alternative water sources, stabilize eroding areas, and enhancement of riparian zones. Failing septic systems and "straight-pipes" should be identified and repaired to reduce the contribution of fecal coliform originating from residential areas. Streambank stabilization projects should be sought on urban sites that experience heavy flows from increased impervious surface cover. Green infrastructure and stormwater projects should be implemented in urban areas or areas with considerable impervious surfaces.

OBJECTIVE #6: Document changes in water quality throughout WMP implementation.

MILESTONES:

- Submit a targeted water quality monitoring plan for each grant received.
- Monitor several sites regularly, including at locations with sampling histories.
- Conduct Pre- and Post-BMP monitoring for large agricultural BMP projects near significant streams when appropriate.
- Sample to potentially de-list streams impaired for fecal coliform.
- Initiate WMP revisions.

Baseline data has been collected throughout this planning process at various locations within the watershed. This would allow for future comparisons when data is gathered to determine if improvements are measurable and if so, their significance. Targeted monitoring (accompanied by a Targeted Water Quality Monitoring Plan) should occur at least once for each grant received. When large agricultural BMP projects are implemented near significant streams, an effort should be made to sample for the pollutants of concern before and after project completion. This may allow inferences to be made about what projects are most beneficial, as well as build local confidence on finding solutions to water quality issues.

A SQAP should be also written for each grant that is received. This will guide efforts to sample fecal coliform according to the procedure necessary to “de-list” stream segments should standards be found to have been met. Biological monitoring will also be conducted as part of regular Georgia DNR/EPD rotations and will provide insight on whether the local biotic integrity in the impaired segments is improving. Additional biotic monitoring (e.g., fish IBIs and IWBs, etc.) could be conducted in conjunction with a university, or other qualified entity, to investigate whether the biotic community has improved in the impacted biota segments should funding be approved.

OBJECTIVE #7: Engage community leaders regarding stream health in the watershed and community impacts.

MILESTONES:

- Establish connections with local community leaders.
- Conduct presentations to community leaders discussing water quality issues and the solutions that BMPs can provide.
- Share water quality data and interpret the results with local community leaders for discussion purposes.

County personnel should be updated regularly through presentations at local meetings to keep up involvement and/or awareness during the implementation process.

7.4 Indicators to Measure Progress

The number of completed projects (e.g., septic system, agricultural, stormwater, streambank stabilization, etc.), as well as outreach event attendance should reveal progress that the implementation program is gaining momentum. Landowner participation rates can be another useful tool in determining the success of program implementation. It is hoped that the rate of participation will increase through subsequent years of watershed restoration due to education and outreach efforts, as well as the gradual acceptance of BMPs within the watershed. Education and outreach participation rates can be analyzed to help measure progress. More import, in the long run, will be to measure how these projects have translated toward the goals of accomplishing the necessary load reductions and eventually de-listing the impaired segments within the watershed. For the stream segments impaired for high fecal coliform bacteria counts, tracking water quality improvements will best indicate progress toward reducing fecal contamination and eventually de-listing streams. Water quality improvements should be revealed using two water quality sampling regimes intermittently throughout the implementation process. Both types of water quality monitoring (targeted sampling and "de-listing" sampling) should be used to measure progress towards delisting of segments impaired for exceeding fecal coliform standards. For stream segments impaired for poor biotic diversity, progress may be more difficult to indicate. IBI sampling may be conducted in order to measure changes in the biotic communities resulting from implementations or other changes in the watershed. Targeted water quality monitoring may potentially reveal changes in TSS (total suspended solids) within the water column over time, but Georgia DNR/EPD or a reliable partner/ contractor, when funds permit, will be relied upon to sample fish and macroinvertebrates.

7.5 Technical Assistance and Roles of Contributing Organizations

Anticipated new or additional contributions to the watershed restoration effort are highlighted in this section. Organizations seeking to implement this WMP should rely on technical expertise from the NRCS with respect to agricultural BMP implementation. The North Georgia Public Health District and local county public health departments should be relied upon with respect to septic system BMPs. The program also relies on in-kind assistance with logistics and education/outreach activities from other groups listed below (Table 25.).

Table 25. Table of Roles and Responsibilities for the Implementation of this Watershed Management Plan

Organization Roles and Responsibilities		
Organization Name	**Organization Type**	**Description of Role in Pine Log Creek WMP Implementation**
Calhoun Utilities	Utility	Provide donated services in order to aid the restoration efforts. Analyze water samples for fecal coliform and TSS concentrations, which will be collected by project partners throughout implementation of this plan.
Gordon County Government	County	Provide local oversight, maps, and assistance
Cherokee County Government	County	Provide local oversight, maps, and assistance.
Bartow County Government	County	Provide local oversight, maps, and assistance.
Environmental Protection Agency	Federal Agency	Provide EPA Clean Water Act Section 319 funds to Georgia EPD to administer through the state 319 grant program.

Georgia Department of Natural Resources	State Agency	Conduct biotic monitoring at sites in the watershed that can reveal improvements or de-list impairments. Advise on aquatic resources.
Georgia Environmental Protection Division	State Agency	Administer Clean Water Act Section 319 Grants to provide funding for this restoration program. Conduct monitoring rotations at sites in the watershed for fecal coliform bacteria that can reveal improvements or aid in de-listing efforts.
Limestone Valley Soil and Water Conservation District	State Agency	Assist with marketing for agricultural BMPs in the watershed. Potentially help identify willing landowners in the watershed that are interested in the program.
Limestone Valley RC&D Council	Non-Profit, Community board directed	Lead implementation efforts including submitting grant applications, serving as grantee fulfilling reporting obligations, marketing program components, spearheading outreach efforts, managing finances, conducting monitoring, and managing projects.
Natural Resources Conservation Service	Federal Agency	Provide technical expertise for agricultural BMPs. This process will include multiple farm visits, the development of a conservation plan for the landowner, project supervision and project inspection. All projects will be installed according to NRCS specifications and standards. NWQI, EQIP and other Farm Bill program implementation.
North Georgia Public Health District	State Agency	Provide technical expertise for septic system repairs. This process will include assessing, planning, permitting, and inspection of installed or repaired septic system components. Help may also be provided through identification of potential septic system repair projects. Assistance may also be provided during workshop preparation if applicable.
Northwest Georgia Regional Commission	State Agency	Provide technical assistance for implementation efforts in the watershed. Serve as a vehicle to promote the Restoration Project and assist in marketing its outreach efforts.
US Fish and Wildlife Service	Federal Agency	Consult on any project that may potentially impact instream aquatic habitat. Provide Partners funding for eligible sections of the watershed. Provide landscape level plan support for revisions and prioritization. Provide training and data sets for aquatic organisms (SARP)
University of Georgia Cooperative Extension	State Agency	Assist in marketing efforts for program components and outreach events.
Coosa River Basin Initiative	Local Non-profit	Serve as a vehicle to promote the Restoration Project and assist in marketing its outreach efforts
Keep Bartow Beautiful	Bartow County Government	Outreach and education partner as well as advisor on Green Infrastructure
The Nature Conservancy	Nonprofit	Assist in marketing efforts for program components and outreach events.

7.6 Getting Started

Efforts to implement this watershed management plan could begin upon the approval and adoption of this plan. A goal of implementing impactful BMPs in 40% of the watershed by 2031 has been set based on prioritization models. Funding opportunities may either slow or expedite this goal with education and outreach being a key component of success in the first three years of implementation. Multiple funding cycles will be needed to fully realize this 2031 goal and ultimately to de-list segments. Efforts to begin working towards the de-listing of impaired stream segments will begin soon after the approval of this plan.

8 Education and Outreach Strategy

Engaged stakeholders and community participation are needed to sustain any gains in water quality. Education and outreach are key elements to achieving the goals of improving the Pine Log Watershed. The objective of the education and outreach strategy is to reach as many residents in the watershed as possible. Outreach should entail programs that provide a sense of shared ownership of the creek and stewardship of the creek resources. Increasing citizen participation in implementation or outreach programs increases the potential success rate of the restoration plan.

The following is a list of sample events that could be held in the watershed. Match for grant s could be generated through these events through calculating volunteer labor, supplies, or other in-kind donations. Flyers places in locally appropriate grocery stores, restaurants, and farm supply stores are a great way to get the word out, social media posts, partner list servs, and local media outlets.

- Creek Days and Fishing Derbies
- Educational activities for farmers and citizens about the need for shading in the riparian zone and volunteer stabilization projects.
- Green Infrastructure is important not only for residents, but business and industry in the watershed. Hold workshops and select potential demonstration sites.
- Stormwater Mitigation Plans for chicken farms, industry, and municipalities
- Adopt a Stream workshops and Rivers Alive Clean ups
- Ecotourism: Creek Snorkeling, Creek Tubing, Birdwatching, Wildflower walks, paddling
- Investigate the potential for a Blue Way Trail on navigable waters
- Agricultural Tourism
- Small Farmer/ New farmer education workshops
- Workshops for DIY stream stabilization, rainwater collection systems, and green infrastructure.
- Litter awareness campaign with Keep Bartow Beautiful.
- Educational activities with scouts, 4H, Church youth groups and at schools.

In addition, volunteers could be recruited for the following activities:

Riparian Tree Plantings

Flyers and press releases would advertise the availability of trees and live stakes to be planted along streams in the Pine Log Creek Watershed. It is anticipated that trees and the tools with which to plant them would be obtained through the use of grant funds or donations from non-federal sources. Outreach through clubs and school groups could offer digital training options for property owners on how to plant riparian areas. Riparian tree planting events with volunteers could also be held on the banks of streams and creeks in the watershed. The primary purpose would be to utilize volunteer labor to plant trees in an effort to increase the riparian buffer within the watershed, but also to increase education concerning the watershed. Community buffer planting events can aid in promoting the overall restoration of the watershed through informational literature and digital media.

Rain barrel and Rain Garden Workshops

Rain barrel workshops and classes offer citizens an opportunity to create their own BMP and learn about their watershed in the process. In the past, these events have generated overwhelming interest from local communities, and have attracted the most enthusiastic volunteers. Furthermore, rain barrels, or other rainwater collection devices, are desired by a diverse array of citizens including both farmers and homeowners, which is the exact demographic that is needed to implement BMPs on residential and agricultural lands. For the purposes of conducting outreach through a 319(h) grant project, this outreach activity would have the primary objective of incentivizing rain barrel construction and installation to reduce NPS pollution but would also serve as the sounding board from which to advertise other available BMP funds. At these events, citizens should receive specific information about cost-share funds for projects that benefit both landowners and our natural resources, information about Pine Log Creek's water quality issues (with watershed map visual aids), and the opportunity to work to construct and take home a free rain barrel for their home or barn. Volunteers from these events should be encouraged to participate further in identifying potential BMP sites and assisting with other outreach events. Follow-up communications should be initiated to keep these interested citizens engaged throughout the implementation process.

Adopt-A-Stream Workshops

Workshops focused on the Adopt-A-Stream curriculum help local citizens, groups and clubs engage in citizen science through an organized program. The data collected can be logged and utilized on the Adopt-A-Stream website for future use and provides the individuals collecting data with a sense of valuable contribution. Workshops can be held along creeks, at parks or anywhere surface water is available for demonstration of techniques. Educational workshops such as Adopt-A-Stream are important to engage interested citizens but also to educate citizens about the health or their watershed. Workshops and educational presentations such as Adopt-A-Stream should be a part of any grant outreach plan.

River's Alive Cleanup

Rivers Alive cleanup events could be established across the Pine Log Watershed and beyond in order to provide outreach activities for volunteers in the local communities. This type of outreach is flexible and can allow for socially distanced contributions to the project as volunteers work within family groups or social pods. Many sites could be set up and volunteers report or log in through digital signup sheets or at selected trash collection drop off sites. Educational materials should be made available at each event or in the digital signup sheet to inform volunteers about the restoration project, any grants currently underway, and ways they can continue to help.

Water Quality Monitoring and Stream Cleanup Canoe Floats

These events should be designed to attract members of the local community to volunteer to clean up our local waterways from a canoe and/or sample water quality during a training session on how to use Adopt A-Stream equipment for water quality sampling. These volunteers could paddle while picking up all accessible trash within the stream and on the banks, and/or sample water quality at several sites, while learning about the importance of varying water quality parameters, agricultural and residential runoff issues and how they pertain to Pine Log Creek. Maps and handouts should be distributed at stops along the way to discuss streambank erosion, pollution sources, BMPs, and steps they can take on their own property to reduce pollution. In addition, local aquatic fauna should be a topic of discussion in order to convey what could be at stake should pollution problems continue. Volunteer labor and donated material values will be recorded and reported as matching funds for any applicable 319 grants.

9 Implementation Plan

Table 26. Implementation Timeline

Timeline: 12 years. 4 phases. First application for funding to be submitted fall of 2021.

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Apply for funding	X			x			x			x		
Agricultural BMP installation		x	x	x	x	x	x	x	x	x	x	x
Stormwater BMP installation			x		x		x	x	x	x	x	x
Septic Tank rehab		x	x	x	x	x	x	x	x	x	x	
Streambank stabilization			x	x	x	x	x	x	x		x	
Nutrient Management plans		x	x	x	x	x	x	x	x	x		
Native species replanting in buffer zones and at park		x	x	x	x	x	x	x	x	x		
AAS training and network		x		x		x		x		x		x
Rivers Alive Cleanup	x	x	x	x	x	x	x	x	x	x	x	x
Education and Outreach activities	x	x	x	x	x	x	x	x	x	x	x	x
Re evaluate plan and update						x					x	

9.1 Estimates of Funding

Agricultural BMP- Name (Code)	Quantity	Cost/Unit*	Total Cost
Fencing (382)	166,541	$1.52	$253,143
Watering Facility (614)	98	$1,475.25	$144,458
Heavy Use Area- Rock on geotextile (561)	146,881	$1.27	$186,539
Livestock Pipeline (516)	48,960	$1.77	$86,660
Riparian Forest Buffer (391)	289	$622.65	$180,105
Riparian Herbaceous cover (390)	145	$552.61	$79,923
Hedgerow Planting- Riparian Scenario (422)	189,000	$1.27	$240,030
Comprehensive Nutrient Management Plans (102)	51	$4,977.80	$253,868
		Subtotal	$1,424,725
		Typical Cost-Share	75%
		Total Agricultural Treatment Cost	$1,068,544
Septic System BMPs	**Quantity**	**Cost/Unit**	**Total Cost**
Conventional System Repair	100.00	$ 3,500.00	$350,000
Experimental System Installation	10	$ 7,000.00	$70,000
		Subtotal	$420,000
		Typical cost-Share	50%
		Total Septic Treatment Cost	$210,000
Green Infrastructure BMPs	**Quantity**	**Cost/Unit**	**Total Cost**
Conventional Stormwater Treatment	3.00	$ 20,000.00	$60,000
Experimental Stormwater Treatment	1	$ 30,000.00	$30,000
		Subtotal	$90,000
		Typical cost-Share	60%
		Total GI Treatment Cost	$54,000
Education and Outreach	**Quantity**	**Cost/Unit**	**Total Cost**
Education and Outreach Programs	4.00	$ 8,000.00	$32,000
		Subtotal	$32,000
		Typical cost-Share	60%
		Total Education & Outreach	$19,200
Total Watershed Treatment Cost Excluding Landowner Contributions (Cost-Share)			**$1,351,744**

*Cost/Unit based on 2021 NRCS Georgia Planning Estimator

Table 27. ***A display of estimated financial requests for each of four multi-year 319 or NWQI grants sought by an organization attempting comprehensive watershed restoration. The proportions are derived by stakeholder recommendations, and the amounts were estimated using local knowledge, EPA statistics, NRCS cost estimates, and GIS analysis.***

	Agricultural BMP and Stream bank	**Septic System Rehab**	**Green Infrastructure and Urban Streambank**	**Outreach and Education**	**TOTAL**
Proposal 1 - 2021	$320,563	$63,000	$16,200	$5,760	$405,523
Proposal 2 - 2024	$320,563	$63,000	$16,200	$5,760	$405,523
Proposal 3- 2027	$213,709	$42,000	$10,800	$3,840	$270,349
Proposal 4- 2030	$213,709	$42,000	$10,800	$3,840	$270,349
Total					**$1,351,744**

10 Summary of Nine Elements

1. An identification of the sources or groups of similar sources contributing to nonpoint source pollution to be controlled to implement load reductions or achieve water quality standards.

The Pine Log Creek Watershed has streams that fail to meet the criteria within the State of Georgia for pathogens and impacted biota, which respectively tend to result from fecal contamination and excessive sediment loads. Load reductions of these pollutants are necessary in three stream segments, so the WMP focuses on fecal coliform bacteria and sediment as the nonpoint source (NPS) pollutants of concern and identifies several consistent sources for these pollutants (discussed in detail in Section 4), each of which relates to land use. This WMP identifies agricultural lands for targeting load reductions of both fecal coliform bacteria and sediment pollution through the installation of Best Management Practices (BMPs; e.g., controlling livestock access to water sources, installing alternative watering sources, protecting heavy use areas, etc.). In addition, residences will be targeted for septic system repairs to reduce the contributions of fecal coliform bacteria from failing septic systems. Streambank stabilization and stormwater projects will be completed on agricultural and/or urban land when feasible. Residential, urban, suburban, and agricultural populations daily contribute to NPS pollution in many cultural ways as well through habits, routines and practices. These non-structural and non-landscape driven NPS contributions are addressed through educational and outreach efforts outlined throughout this plan.

2. An estimate of the load reductions expected for the management measures described under number 3 (below);

The load reductions recommended in Total Maximum Daily Load (TMDL) documents are featured in Section 6.1. Management measures that will be implemented to achieve load reductions include agricultural projects, stormwater and streambank stabilization projects, and septic system repairs. Agricultural BMPs will vary according to the interests of the farmers, and it is difficult to predict the frequency that each practice will be used during implementation, as well as where projects will be located, the current onsite conditions, and the significance of the NPS pollution at each site to be ameliorated. Septic system repairs will also be conducted as part of the WMP implementation process, especially in proximity to blueline streams. However, the type of repairs, the proximity to streams, and the contributions to instream fecal coliform counts may vary for each septic repair project. Complicating matters further, conditions within the watershed will change over time. Due to the complexity involved in predicting the load reductions from the broad management measures provided below, the WMP instead seeks to focus on the completion of multiple projects and intermittently evaluating where the watershed is within the restoration process. Eventually, the management measures implemented should result in restoration to the extent that the necessary load reductions will be met, and the impaired segments will be able to remain delisted.

3. A description of the NPS management measures that will need to be implemented to achieve the load reductions established in the TMDL or to achieve water quality standards.

A number of management measures including both structural and non-structural practices have already accomplished and will continue to accomplish various objectives. These practices are highlighted within Section 6.2 and Section 6.3. WMP implementation will also aim to execute additional structural controls to include some combination of the agricultural practices, streambank stabilization efforts, stormwater infiltration measures and a number of septic system repairs directed toward NPS load reductions (discussed in Chapters 6 and 7). The management measures should be implemented across several grants with each involving monitoring to gain updates on current watershed conditions and completing projects potentially according to changing priorities. In conjunction with these efforts, we recommend implementing non-structural controls geared towards promoting watershed improvements with educational involvement within the watershed.

4. An estimate of the amounts of technical and financial assistance needed, and/or the authorities that will be relied upon to implement the plan;

The groups responsible for each existing and new management measure are described within Section 7 of the WMP. Estimates of funding needs are indicated only for activities conducted exclusively for WMP implementation. The process used to estimate the financial resources utilized is described in greater detailed in Section 7, and was chosen due to the complexities of implementing load reductions "on the ground" through voluntary conservation practices. The anticipated sources of funding to achieve restoration goals are several Natural Resource Conservation Service NWQI grants, Environmental Protection Agency (EPA) Section 319 grants administered by the Georgia Environmental Protection Division (EPD), in conjunction with in-kind services from Gordon County, North Georgia Health District, County Health Departments, landowners, and volunteers from across the region.

5. An informational/educational component that will be used to enhance public understanding of and participation in implementing the plan;

Public education and outreach recommendations are identified in Section 8. The more successful programs should remain standard practices for the duration of the implementation process. The recommended educational programs focus on water quality monitoring, green infrastructure demonstration, septic system maintenance, and stream cleanups, among others. Additional programs should be designed and implemented as necessary.

6. A schedule for implementing the management measures that is reasonably expeditious.

The proposed implementation schedule is found in Section 9 and initially estimates implementation activities to occur through 2030. This includes water quality monitoring and implementation activities (e.g., agricultural BMPs, and septic system repairs), in addition to education and outreach. Each of these activities will continue through each grant implementation period, although priorities may be reevaluated and subsequently altered with each grant period. Currently, we anticipate that four grant implementation periods may allow for the goals of the WMP to be accomplished.

7. A description of interim, measurable milestones (e.g., e.g., amount of load reductions, improvement in biological or habitat parameters) for determining whether management measures or other control actions are being implemented;

A number of goals and objectives are recommended as interim milestones proposed to implement the management measures of this watershed improvement plan. These are included in Section 7.3. The initial goals of the WMP include developing a septic system cost-share program, building momentum toward implementation of agricultural management practices, completing septic, stormwater, streambank stabilization, and agricultural projects that reduce pollutant loads, carrying out educational activities, and monitoring to observe where extra focus is necessary and maintain that load reductions are occurring as a result of implementation. Over the course of implementation, each grant will include interim milestones with more finite objectives for each of the overall goals (i.e., number of agricultural and septic projects, number of newspaper articles, number of Adopt-A-Stream (AAS) programs initiated, multiple years of water quality monitoring data, etc.).

8. A set of criteria that can be used to determine whether substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether the plan needs to be revised; and;

Several sources of the pollutants of concern will be addressed by WMP implementation. Water quality data collection is ongoing to determine priorities and current conditions and will continue intermittently to indicate how projects on the landscape are translating into water quality changes. Yet, it may be a few years before enough projects are completed in each subwatershed to significantly affect water quality. Therefore, throughout the implementation process, project types and locations will be documented to get an idea of the extent of water quality improvements as projects become more prevalent within each subwatershed and the entire Pine Log Creek Watershed. This will allow management measures to be adapted to effectively address concerns that may arise with improvements in the implementation strategy. In the interim, continued monitoring of water quality and determination of the success of completed projects is necessary to determine if revisions are needed. At the least, revisions should be submitted in an addendum to this document in 2025 to evaluate successes and adaptations to the initial management measures recommended in this WMP. Section 7.4 includes how progress will be indicated and considers documenting the details of each project, load reductions per project when applicable, increased public interest, and changes in water quality that indicate progress toward the overall goal of de-listing impaired segments within the watershed. A partnership between EPA and NRCS has established monitoring schedules for NWQI watersheds that will also serve to monitor water quality improvements and better help track progress and inform adjustments that maybe needed, particularly in the agricultural implementation of BMPs.

9. A monitoring component to evaluate the effectiveness of the implementation efforts, measured against the criteria established under item (8).

In Section 7.4, the WMP recommends that two different monitoring protocols continue to be conducted within the watershed as the new management measures (and the ongoing programs discussed in Section 6.2) are implemented. One type of monitoring is identified as “Targeted Monitoring” and involves sampling at specific sites in both wet and dry periods to help establish baseline conditions and monitor for improvements. The second type of monitoring is for “de-listing” purposes and follows a strict procedure (regardless of weather) in an attempt to show that restoration has been achieved.

Glossary of Acronyms

AAS - Adopt-A-Streams

BMP - Best Management Practice

CNMP - Comprehensive Nutrient Management Plan

CRBI- Coosa River Basin Inititive

DNR - Department of Natural Resources

EPA - Environmental Protection Agency

EPD - Environmental Protection Division

GIS - Geographic Information Systems

IBI - Index of Biotic Integrity

NPS - Nonpoint Source

NRCS - Natural Resource Conservation Service

RC&D - Resource Conservation and Development Council

SQAP - Sampling and Quality Assurance Plan

TMDL - Total Maximum Daily Loads

TP- Total Phosphorus

WMP - Watershed Management Plan

NWQI- National Water Quality Incentive

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Appendix A

Conservation Effects Scoring Sheet

Conservation Practice Physical Effects

Legend to practice physical effects quantities found on page 6.

SWAPA+E	CART Category ↓	Resource Concern ↓ / Practice Name →	Access Control	Access Road	Agrichemical Handling Facility	Amendments for Treatment of Agricultural Waste	Animal Mortality Facility	Aqua-culture Ponds	Aquatic Organism Passage	Bedding	Brush Manage-ment	Building Envelope Improve-ment	Channel Bed Stabiliz-ation	Clearing & Snagging	Combustion System Improvement	Composting Facility	Conservation Cover	Conservation Crop Rotation	Constructed Wetland	Contour Buffer Strips	Contour Farming	Contour Orchard and Other Perennial Crops	Controlled Traffic Farming	Cover Crop	Critical Area Planting	Dam
		Practice Code→	472	560	309	591	316	397	396	310	314	672	584	326	372	317	327	328	656	332	330	331	334	340	342	402
Soil	Wind and water erosion	Sheet and rill erosion	3	1	0	0	0	0	0	2	1	0	0	0	0	0	4	4	0	3	2	4	0	4	5	0
		Wind erosion	1	0	0	0	0	0	0	0	1	0	0	0	0	0	4	4	0	0	0	0	0	4	5	0
	Concentrated erosion	Ephemeral gully erosion	4	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	3	5	0
		Classic gully erosion	4	1	0	0	0	0	0	0	1	0	2	0	0	0	1	0	0	0	0	0	0	0	4	2
		Bank erosion from streams, shorelines or water conveyance channels	5	0	0	0	0	0	0	0	0	0	2	2	0	0	1	0	0	0	0	0	0	0	4	1
	Soil quality limitations	Subsidence	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Compaction	4	2	0	0	0	0	0	-1	0	0	0	0	0	0	3	2	0	0	0	0	4	2	2	0
		Organic matter depletion	1	0	0	1	0	0	0	-1	0	0	0	0	0	0	5	4	0	2	1	2	0	2	5	0
		Concentration of salts or other chemicals	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	-1
		Soil organism habitat loss or degradation	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	2	2	1	1
		Aggregate instability	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	1	2	1	2
Water	Weather resilience	Naturally available moisture use	3	0	0	0	0	0	0	-1	2	0	0	0	0	0	0	1	0	0	1	2	1	1	0	0
		Ponding and flooding	1	1	0	0	0	0	0	5	1	0	2	2	0	0	1	1	2	1	1	1	0	2	0	2
		Seasonal high water table	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	-1	-1	-1	0	1	0	-1
		Seeps	1	0	0	0	0	0	0	0	0	0	2	0	0	0	1	1	0	-2	-2	-2	0	1	0	-2
	Source water depletion	Surface water depletion	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	2
		Groundwater depletion	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
		Inefficient irrigation water use	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	0	2
	Field sediment, nutrient and pathogen loss	Nutrients transported to surface water	1	0	0	2	2	-2	0	-2	0	0	0	0	0	2	4	2	4	2	2	2	0	2	2	0
		Nutrients transported to groundwater	1	0	0	2	2	-2	0	1	0	0	0	0	0	2	4	2	1	-1	-1	-1	0	2	2	-1
		Pathogens and chemicals from manure, biosolids or compost applications tranported to surface water	1	0	0	2	2	-2	0	-2	0	0	0	0	0	2	1	1	4	1	1	0	0	1	0	-2
		Pathogens and chemicals from manure, biosolids or compost applications tranported to groundwater	1	0	0	2	2	0	0	1	0	0	0	0	0	2	1	0	3	-1	0	0	0	2	0	0
		Sediment tansported to surface water	3	1	0	0	0	0	0	-1	2	0	1	-2	0	2	4	2	5	2	2	2	0	2	4	2
	Field pesticide loss	Pesticides transported to surface water	1	0	0	0	0	0	0	-2	-1	0	0	0	0	0	2	2	2	2	1	1	0	2	0	0
		Pesticides transported to groundwater	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	1	1	0	-1	-1	0	2	0	0
	Storage and handling of pollutants	Nutrients transported to surface water	1	0	0	2	2	-2	0	-2	0	0	0	0	0	2	4	2	4	2	2	2	0	2	2	0
		Nutrients transported to groundwater	1	0	0	2	2	-2	0	1	0	0	0	0	0	2	4	2	1	-1	-1	-1	0	2	2	-1
		Petroleum, heavy metals and other pollutants transported to surface water	1	0	0	2	0	0	0	-2	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0
		Petroleum, heavy metals and other pollutants transported to groundwater	1	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Air	Air quality emissions	Emissions of airborne reactive nitrogen	1	0	1	4	0	0	0	-1	0	2	0	0	4	1	1	0	0	0	0	0	0	1	0	0
		Emissions of greenhouse gasses - GHGs	1	0	0	1	1	0	0	-1	1	2	0	0	2	1	4	1	1	1	0	1	0	4	1	0
		Emissions of ozone precursors	1	0	1	1	-1	0	0	-1	0	2	0	0	4	1	1	0	0	0	0	0	0	0	0	0
		Emissions of particulate matter (PM) and PM precursors	2	2	1	3	0	0	0	-1	0	2	0	0	4	1	2	1	0	1	0	0	0	3	2	0
		Objectionable odor	0	0	0	4	3	0	0	0	0	0	0	0	0	3	0	0	-1	0	0	0	0	0	0	0
Plant	Pest pressure	Plant pest pressure	5	0	0	0	0	1	0	-1	4	0	4	1	0	1	3	3	-2	3	0	3	0	4	4	0
	Degraded plant condition	Plant productivity and health	3	2	0	1	0	0	0	2	2	0	2	0	0	0	4	3	0	2	1	1	1	3	5	0
		Plant structure and composition	4	0	0	0	0	0	0	0	4	0	4	0	0	0	4	1	4	5	0	0	1	4	4	0
	Fire management	Wildfire hazard from biomass accumulation	3	4	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Animal	Livestock production limitation	Feed and forage balance	3	0	0	0	0	0	0	0	4	0	0	0	0	0	0	2	0	1	0	0	0	2	0	0
		Inadequate livestock shelter	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Inadequate livestock water quantity, quality and distribution	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
	Terrestrial habitat	Terrestrial habitat for wildlife and invertebrates	4	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	1	1	2	1
	Aquatic habitat	Aquatic habitat for fish and other organisms	1	0	0	0	0	1	4	0	0	0	1	0	0	0	1	0	0	1	1	1	0	0	1	2
		Elevated water temperature	3	0	0	0	0	-2	2	0	0	0	1	-1	0	0	1	0	0	0	0	0	0	0	0	0
Energy	Inefficient energy use	Energy efficiency of equipment and facilities	0	0	0	2	0	0	0	0	0	5	0	0	4	0	0	0	0	0	0	0	0	0	0	0
		Energy efficiency of farming/ ranching practices and field operations	0	1	0	1	0	0	0	0	0	0	0	0	1	2	1	1	0	1	1	1	0	1	0	0

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Conservation Practice Physical Effects

Legend to practice physical effects quantities found on page 6.

SWAPA+E	CART Category	Resource Concern	Deep Tillage	Dike	Diversion	Drainage Water Management	Dry Hydrant	Early Successional Habitat Development/ Mgt.	Emergency Animal Mortality Management	Farmstead Energy Improvement	Fence	Field Border	Filter Strip	Fire-break	Fish Raceway or Tank	Fishpond Management	Forage Harvest Management	Forest Stand Improvement	Forest Trails and Landings	Grade Stabilization Structure	Grassed Waterway	Groundwater Testing	Heavy Use Area Protection	Hedge- row Planting	Herbaceous Weed Treatment	High Tunnel System	Irrigation Pipeline
		Practice Code	324	356	362	554	432	647	368	374	382	386	393	394	398	399	511	666	655	410	412	355	561	422	315	325	430
Soil	Wind and water erosion	Sheet and rill erosion	1	0	1	0	0	0	0	0	1	4	4	-1	0	0	1	1	-1	0	0	0	2	0	4	0	0
Soil	Wind and water erosion	Wind erosion	0	0	0	2	0	0	0	0	0	4	4	-1	0	0	1	0	0	0	0	0	2	1	4	0	0
Soil	Concentrated erosion	Ephemeral gully erosion	0	0	2	0	0	0	0	0	0	1	1	-1	0	0	0	1	-1	0	5	0	2	0	2	-1	0
Soil	Concentrated erosion	Classic gully erosion	0	1	2	0	0	0	0	0	0	0	0	-1	0	0	0	1	-1	2	4	0	2	0	2	0	2
Soil	Concentrated erosion	Bank erosion from streams, shorelines or water conveyance channels	0	-2	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	2	1	0	0	0	4	0	0
Soil	Soil quality limitations	Subsidence	-1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Soil	Soil quality limitations	Compaction	5	0	0	-1	0	0	0	0	1	2	2	-2	0	0	3	-1	1	0	0	0	1	1	0	0	0
Soil	Soil quality limitations	Organic matter depletion	-4	0	0	2	0	0	0	0	0	4	4	-2	0	0	1	1	-1	0	3	0	0	2	0	0	0
Soil	Soil quality limitations	Concentration of salts or other chemicals	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0
Soil	Soil quality limitations	Soil organism habitat loss or degradation	1	0	0	0	0	0	0	0	1	2	1	-2	0	0	1	1	-1	2	2	0	-2	0	1	0	0
Soil	Soil quality limitations	Aggregate instability	1	0	0	0	0	0	0	0	1	1	1	-2	0	0	1	1	-1	2	3	0	1	0	1	0	0
Water	Weather resilience	Naturally available moisture use	2	0	2	0	-1	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	-1	0
Water	Weather resilience	Ponding and flooding	0	2	2	-2	0	0	0	0	0	1	1	0	0	0	0	0	0	0	3	0	-1	0	0	-3	0
Water	Weather resilience	Seasonal high water table	2	-1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1
Water	Weather resilience	Seeps	-2	-1	-1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Water	Source water depletion	Surface water depletion	0	1	-1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	1	0	2	0	0
Water	Source water depletion	Groundwater depletion	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	-1	0	-1	0	1	0	0
Water	Source water depletion	Inefficient irrigation water use	2	0	2	0	-1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	3
Water	Field sediment, nutrient and pathogen loss	Nutrients transported to surface water	1	0	3	1	0	0	2	0	0	2	5	0	-1	0	1	1	1	0	2	0	1	2	0	0	1
Water	Field sediment, nutrient and pathogen loss	Nutrients transported to groundwater	-2	0	1	-1	0	0	2	0	0	1	2	0	-1	-2	0	2	0	0	0	0	0	0	0	0	0
Water	Field sediment, nutrient and pathogen loss	Pathogens and chemicals from manure, biosolids or compost applications tranported to surface water	0	0	1	1	0	0	2	0	2	1	3	0	-1	0	1	1	0	0	1	0	2	0	0	0	1
Water	Field sediment, nutrient and pathogen loss	Pathogens and chemicals from manure, biosolids or compost applications tranported to groundwater	0	0	0	1	0	0	2	0	0	0	1	0	-1	0	0	1	0	0	0	0	0	0	0	0	1
Water	Field sediment, nutrient and pathogen loss	Sediment tansported to surface water	0	0	2	0	0	0	0	0	0	2	5	-1	0	0	0	0	0	2	5	0	2	0	0	-1	1
Water	Field pesticide loss	Pesticides transported to surface water	0	2	1	2	0	0	0	0	0	2	2	0	0	0	2	0	0	0	2	0	0	1	-1	0	0
Water	Field pesticide loss	Pesticides transported to groundwater	0	2	1	2	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water	Storage and handling of pollutants	Nutrients transported to surface water	1	0	3	1	0	0	2	0	0	2	5	0	-1	0	1	1	1	0	2	0	1	2	0	0	1
Water	Storage and handling of pollutants	Nutrients transported to groundwater	-2	0	1	-1	0	0	2	0	0	1	2	0	-1	-2	0	2	0	0	0	0	0	0	0	0	0
Water	Storage and handling of pollutants	Petroleum, heavy metals and other pollutants transported to surface water	0	0	1	2	0	0	0	0	0	0	4	0	0	0	1	1	0	0	1	0	0	0	0	0	0
Water	Storage and handling of pollutants	Petroleum, heavy metals and other pollutants transported to groundwater	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Air	Air quality emissions	Emissions of airborne reactive nitrogen	-1	0	0	0	0	0	-1	2	0	1	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0
Air	Air quality emissions	Emissions of greenhouse gasses - GHGs	-1	0	0	1	0	0	1	2	1	2	1	1	0	0	0	2	0	0	1	0	0	1	1	0	0
Air	Air quality emissions	Emissions of ozone precursors	-1	0	0	0	0	0	-1	2	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0
Air	Air quality emissions	Emissions of particulate matter (PM) and PM precursors	-2	0	0	2	0	0	0	2	0	2	1	1	0	0	0	1	0	0	0	0	2	2	0	0	0
Air	Air quality emissions	Objectionable odor	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Plant	Pest pressure	Plant pest pressure	0	0	0	0	0	4	0	0	0	0	0	-1	0	4	0	3	1	0	4	0	0	4	4	0	0
Plant	Degraded plant condition	Plant productivity and health	2	0	2	2	0	4	0	0	2	5	2	3	0	4	1	5	1	0	5	0	0	2	2	2	2
Plant	Degraded plant condition	Plant structure and composition	0	0	0	0	0	4	0	0	0	5	2	0	0	4	1	5	0	0	4	0	0	5	4	0	0
Plant	Fire management	Wildfire hazard from biomass accumulation	0	0	0	0	2	0	0	0	0	0	0	5	0	0	0	5	3	0	0	0	0	0	1	0	0
Animal	Livestock production limitation	Feed and forage balance	2	0	0	4	0	1	0	0	3	0	0	0	0	0	2	2	1	0	1	0	0	0	4	0	0
Animal	Livestock production limitation	Inadequate livestock shelter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Animal	Livestock production limitation	Inadequate livestock water quantity, quality and distribution	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Animal	Terrestrial habitat	Terrestrial habitat for wildlife and invertebrates	0	0	0	0	0	5	0	0	1	1	1	1	0	0	1	2	0	1	1	0	0	2	1	0	0
Animal	Aquatic habitat	Aquatic habitat for fish and other organisms	0	-1	0	0	0	0	0	0	0	2	4	1	1	4	0	1	1	1	1	0	0	0	0	0	0
Animal	Aquatic habitat	Elevated water temperature	0	0	0	0	0	-2	0	-2	0	0	0	0	-1	0	0	1	0	0	0	0	0	1	0	0	0
Energy	Inefficient energy use	Energy efficiency of equipment and facilities	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Energy	Inefficient energy use	Energy efficiency of farming/ ranching practices and field operations	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	1	1	0	1	0	1	0	0	0	0

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Conservation Practice Physical Effects

Legend to practice physical effects quantities found on page 6.

SWAPA+E	CART Category ↓	Resource Concern ↓ / Practice Name →	Irrigation Reservoir	Irrigation System, Micro-irrigation	Irrigation Water Manage-ment	Karst Sinkhole Treatment	Land Clearing	Land Smoothing	Lighting System Improvement	Lined Waterway or Outlet	Livestock Pipeline	Livestock Shelter Structure	Mulching	Nutrient Management	Obstruc-tion Removal	Open Channel	Pasture and Hay Planting	Pest Management Conservation System	Pond	Pond Sealing or Lining, Compacted Soil Treatment	Pond Sealing or Lining, Flexible Membrane	Prescribed Burning	Prescribed Grazing	Pumping Plant	Recreation Area Improve-ment	Recreation Land Grading and Shaping
		Practice Code→	436	441	449	527	460	466	670	468	516	576	484	590	500	582	512	595	378	520	521A	338	528	533	562	566
Soil	Wind and water erosion	Sheet and rill erosion	0	0	0	0	0	0	0	0	0	0	4	0	0	0	1	2	0	0	0	2	4	0	1	0
		Wind erosion	0	0	2	0	0	0	0	0	0	0	4	0	0	0	1	2	0	0	0	2	4	0	1	0
	Concentrated erosion	Ephemeral gully erosion	0	0	0	4	0	1	0	5	0	0	0	0	0	0	0	2	0	0	0	1	3	0	1	0
		Classic gully erosion	2	0	0	4	0	0	0	2	0	0	0	0	0	0	0	2	2	0	0	1	1	0	1	4
		Bank erosion from streams, shorelines or water conveyance channels	1	0	0	0	0	0	0	0	0	3	0	0	0	2	0	0	1	0	0	1	3	0	1	2
	Soil quality limitations	Subsidence	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	2	0	0
		Compaction	0	0	0	0	-1	-2	0	0	0	0	0	-1	-1	0	2	2	0	0	0	0	2	0	1	0
		Organic matter depletion	0	0	1	0	-3	-2	0	0	0	0	1	2	1	0	1	2	0	0	0	1	4	0	1	1
		Concentration of salts or other chemicals	0	1	2	2	0	-1	0	0	0	0	1	4	0	0	0	0	-1	1	1	-1	2	0	0	0
		Soil organism habitat loss or degradation	0	0	0	0	-3	-3	0	0	0	0	1	0	0	0	3	2	0	0	0	0	2	0	1	-3
		Aggregate instability	0	0	0	0	-4	-4	0	1	0	0	1	0	0	2	3	0	0	0	0	0	2	0	1	-3
Water	Weather resilience	Naturally available moisture use	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0	2	2	2	0	2	2	0	0
		Ponding and flooding	2	2	0	-2	-1	2	0	2	0	0	1	0	0	5	1	0	2	0	0	1	1	2	1	2
		Seasonal high water table	-1	2	1	0	0	2	0	2	0	0	-1	0	0	2	0	0	-1	2	2	0	0	2	0	0
		Seeps	-1	2	0	0	0	2	0	2	0	0	-1	0	0	1	0	0	-2	1	1	0	0	2	0	0
	Source water depletion	Surface water depletion	0	0	0	0	1	0	0	0	0	0	0	0	0	0	3	0	2	0	0	0	1	0	0	0
		Groundwater depletion	0	0	0	0	-2	0	0	-1	0	0	1	0	0	2	3	0	1	0	0	0	1	0	0	0
		Inefficient irrigation water use	2	4	5	0	0	2	0	0	0	0	2	0	0	0	0	0	2	2	2	0	0	2	0	0
	Field sediment, nutrient and pathogen loss	Nutrients transported to surface water	0	2	2	2	-1	1	0	0	0	3	2	5	0	-1	1	0	2	2	2	2	1	0	0	0
		Nutrients transported to groundwater	-1	2	2	2	0	2	0	2	0	0	0	5	0	0	0	0	-1	2	2	1	1	0	0	0
		Pathogens and chemicals from manure, biosolids or compost applications tranported to surface water	0	2	2	2	-1	0	0	0	0	2	0	4	0	0	1	0	-2	0	0	0	1	0	0	0
		Pathogens and chemicals from manure, biosolids or compost applications tranported to groundwater	0	1	2	2	0	0	0	0	0	0	0	4	0	0	0	0	0	2	2	0	1	0	0	0
		Sediment tansported to surface water	2	1	2	2	-1	1	0	5	0	2	2	0	0	0	1	2	2	0	0	1	2	0	1	2
	Field pesticide loss	Pesticides transported to surface water	0	2	2	2	-1	1	0	0	0	0	2	0	0	0	1	5	0	0	0	0	2	0	1	0
		Pesticides transported to groundwater	0	2	2	2	0	1	0	0	0	0	0	0	0	0	0	5	0	0	0	0	1	0	1	0
	Storage and handling of pollutants	Nutrients transported to surface water	0	2	2	2	-1	1	0	0	0	3	2	5	0	-1	1	0	2	2	2	2	1	0	0	0
		Nutrients transported to groundwater	-1	2	2	2	0	2	0	2	0	0	0	5	0	0	0	0	-1	2	2	1	1	0	0	0
		Petroleum, heavy metals and other pollutants transported to surface water	0	1	2	0	-1	0	0	1	0	0	0	2	0	-1	1	0	0	0	0	1	0	0	0	0
		Petroleum, heavy metals and other pollutants transported to groundwater	0	1	2	2	0	0	0	0	0	0	0	2	0	0	0	0	0	1	1	0	0	0	0	0
Air	Air quality emissions	Emissions of airborne reactive nitrogen	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	2	0	0
		Emissions of greenhouse gasses - GHGs	0	1	1	0	-1	-1	0	0	0	0	0	4	0	0	4	0	0	0	0	2	2	2	2	-1
		Emissions of ozone precursors	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	2	0	0
		Emissions of particulate matter (PM) and PM precursors	0	1	2	0	-1	0	0	0	0	0	2	2	0	0	1	2	0	0	0	0	2	2	1	0
		Objectionable odor	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	-1	1	0	0	0
Plant	Pest pressure	Plant pest pressure	0	1	1	0	-2	2	0	0	0	0	2	0	0	0	0	4	0	0	0	4	1	0	3	4
	Degraded plant condition	Plant productivity and health	2	2	2	0	2	2	0	0	2	0	2	4	0	0	1	0	2	1	1	5	5	2	1	3
		Plant structure and composition	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	4	4	0	1	0
	Fire management	Wildfire hazard from biomass accumulation	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	2	0	3	0
Animal	Livestock production limitation	Feed and forage balance	0	4	4	0	0	0	0	0	0	3	0	4	2	0	5	0	0	0	0	5	5	0	0	0
		Inadequate livestock shelter	0	0	0	0	-2	0	0	0	0	5	0	0	-1	0	0	0	0	0	0	-1	2	0	0	0
		Inadequate livestock water quantity, quality and distribution	4	0	0	0	0	0	0	0	5	0	0	0	0	0	0	2	5	4	4	0	0	5	0	0
	Terrestrial habitat	Terrestrial habitat for wildlife and invertebrates	0	0	0	0	-2	0	0	-1	0	0	1	0	0	0	4	2	2	0	0	2	2	0	0	-2
	Aquatic habitat	Aquatic habitat for fish and other organisms	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	2	4	0	0	0	0	0	0	0
		Elevated water temperature	0	0	0	0	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Energy	Inefficient energy use	Energy efficiency of equipment and facilities	2	3	3	0	0	0	5	0	3	0	2	0	0	0	0	0	0	0	0	0	0	4	0	0
		Energy efficiency of farming/ ranching practices and field operations	0	0	0	0	1	0	0	0	2	0	1	0	1	0	0	1	0	0	0	1	1	0	0	0

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Conservation Practice Physical Effects

Legend to practice physical effects quantities found on page 6.

SWAPA+E	CART Category ↓	Resource Concern ↓ / Practice Name →	Residue and Tillage Management, No Till	Residue and Tillage Management, Reduced Till	Restoration and Management of Rare or Declining Habitats	Riparian Forest Buffer	Riparian Herbaceous Cover	Roof Runoff Structure	Roofs and Covers	Sediment Basin	Shallow Water Development and Management	Silvopasture Establish-ment	Spring Develop-ment	Sprinkler System	Storm-water Runoff Control	Streambank and Shoreline Protection	Stream Crossing	Stream Habitat Improvement and Management	Strip-cropping	Structure for Water Control	Structures for Wildlife	Sub-surface Drain	Surface Drainage, Field Ditch	Surface Drainage, Main or Lateral	Terrace	Trails and Walk-ways
		Practice Code→	329	345	643	391	390	558	367	350	646	381	574	442	570	580	578	395	585	587	649	606	607	608	600	575
Soil	Wind and water erosion	Sheet and rill erosion	4	4	2	3	2	1	0	0	0	4	0	0	0	0	0	0	4	0	0	4	1	0	5	1
		Wind erosion	5	4	2	2	2	0	0	0	0	3	0	2	0	0	0	0	4	0	0	-1	-1	-1	1	1
	Concentrated erosion	Ephemeral gully erosion	0	0	2	1	1	3	0	2	0	3	0	0	2	0	0	0	0	0	0	4	2	2	4	1
		Classic gully erosion	0	0	0	3	0	1	0	2	0	2	1	0	0	0	0	0	0	0	0	1	0	0	2	4
		Bank erosion from streams, shorelines or water conveyance channels	0	0	0	4	4	1	0	0	0	2	1	0	3	4	2	5	0	0	0	1	0	0	1	2
	Soil quality limitations	Subsidence	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-2	-1	0	0	0
		Compaction	2	1	0	2	4	0	0	0	0	0	-1	-1	1	0	0	0	0	0	0	2	1	0	-1	2
		Organic matter depletion	2	2	0	4	4	0	0	0	1	3	0	0	0	0	0	0	2	0	0	-2	-2	0	2	0
		Concentration of salts or other chemicals	0	0	-1	1	2	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2	2	0	0	0
		Soil organism habitat loss or degradation	4	3	0	5	0	0	0	0	0	3	0	0	0	0	0	0	1	0	0	0	0	0	-1	0
		Aggregate instability	3	2	0	4	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0	0	1	-1
Water	Weather resilience	Naturally available moisture use	2	2	0	0	0	3	0	0	0	2	2	0	0	0	0	0	1	2	0	1	2	2	3	0
		Ponding and flooding	2	1	0	-1	-3	-1	-1	2	2	2	1	2	4	0	0	0	1	2	0	4	2	2	4	2
		Seasonal high water table	-1	0	0	2	2	1	0	-2	0	1	2	1	-1	0	0	0	0	0	0	4	2	2	-1	0
		Seeps	-1	0	0	1	2	1	0	-2	0	1	2	0	-1	0	0	0	0	0	0	4	0	0	-1	0
	Source water depletion	Surface water depletion	0	0	0	3	0	0	0	0	1	3	0	0	-1	0	0	0	0	5	0	0	0	0	-1	0
		Groundwater depletion	0	0	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0	5	0	0	0	0	2	0
		Inefficient irrigation water use	2	1	0	0	0	0	0	0	0	0	2	5	0	0	0	0	0	2	0	2	2	2	0	0
	Field sediment, nutrient and pathogen loss	Nutrients transported to surface water	2	2	0	5	5	2	0	5	1	3	0	2	2	1	1	0	1	0	0	-2	-2	-2	2	0
		Nutrients transported to groundwater	1	0	0	5	5	2	0	-1	1	2	0	1	0	0	0	0	0	0	0	1	1	1	-2	0
		Pathogens and chemicals from manure, biosolids or compost applications tranported to surface water	1	1	0	3	3	2	0	2	2	1	1	2	0	1	-3	0	1	0	0	0	-2	-2	2	1
		Pathogens and chemicals from manure, biosolids or compost applications tranported to groundwater	0	0	0	1	2	0	1	-1	-1	1	0	1	0	0	2	0	0	0	0	1	1	2	-1	0
		Sediment tansported to surface water	4	3	2	5	4	1	0	4	2	3	1	1	4	2	2	2	2	1	0	2	1	-1	2	2
	Field pesticide loss	Pesticides transported to surface water	4	4	0	3	2	0	0	2	0	2	0	2	0	0	0	0	2	0	0	2	0	0	2	0
		Pesticides transported to groundwater	0	0	0	1	2	0	0	-1	0	1	0	2	0	0	0	0	0	0	0	2	1	0	-2	0
	Storage and handling of pollutants	Nutrients transported to surface water	2	2	0	5	5	2	0	5	1	3	0	2	2	1	1	0	1	0	0	-2	-2	-2	2	0
		Nutrients transported to groundwater	1	0	0	5	5	2	0	-1	1	2	0	1	0	0	0	0	0	0	0	1	1	1	-2	0
		Petroleum, heavy metals and other pollutants transported to surface water	0	0	0	3	2	0	1	2	2	1	2	1	2	0	0	0	0	0	0	0	-2	-2	2	0
		Petroleum, heavy metals and other pollutants transported to groundwater	0	0	0	1	1	0	1	-1	1	1	0	1	0	0	0	0	0	0	0	1	1	2	-1	0
Air	Air quality emissions	Emissions of airborne reactive nitrogen	2	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Emissions of greenhouse gasses - GHGs	4	3	1	3	2	0	4	0	0	2	0	1	0	1	0	1	0	0	0	0	0	0	0	0
		Emissions of ozone precursors	2	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Emissions of particulate matter (PM) and PM precursors	5	4	0	1	1	0	2	0	0	1	0	3	0	0	0	0	2	0	0	0	0	0	0	1
		Objectionable odor	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plant	Pest pressure	Plant pest pressure	0	0	4	3	4	0	0	0	1	0	0	1	0	4	0	4	0	0	0	0	0	0	0	0
	Degraded plant condition	Plant productivity and health	2	2	4	5	5	0	0	0	2	5	2	2	0	4	0	4	2	0	0	2	2	2	2	0
		Plant structure and composition	0	0	4	5	4	0	0	0	4	-1	0	0	0	4	0	4	0	0	0	0	0	0	0	0
	Fire management	Wildfire hazard from biomass accumulation	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Animal	Livestock production limitation	Feed and forage balance	0	0	2	0	4	0	0	0	1	3	2	4	0	1	2	0	1	0	0	4	4	4	0	1
		Inadequate livestock shelter	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Inadequate livestock water quantity, quality and distribution	0	0	0	0	0	2	0	0	0	0	5	0	0	0	2	0	0	1	0	0	0	0	0	1
	Terrestrial habitat	Terrestrial habitat for wildlife and invertebrates	1	0	5	5	2	0	0	-1	5	2	0	0	0	2	0	1	1	0	4	0	0	0	0	0
	Aquatic habitat	Aquatic habitat for fish and other organisms	0	0	5	5	0	0	0	0	0	3	0	0	0	2	1	2	2	4	3	0	0	0	0	4
		Elevated water temperature	0	0	2	5	2	0	0	0	0	1	0	0	0	1	0	2	0	1	0	0	0	0	0	0
Energy	Inefficient energy use	Energy efficiency of equipment and facilities	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
		Energy efficiency of farming/ ranching practices and field operations	4	3	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0

Conservation Practice Physical Effects

Legend to practice physical effects quantities found on page 6.

SWAPA+E	CART Category ↓	Resource Concern ↓ / Practice Name →	Tree/Shrub Establish-ment	Tree/Shrub Site Preparation	Tree/ Shrub Pruning	Under-ground Outlet	Upland Wildlife Habitat Manage-ment	Vegetated Treatment Area	Waste Facility Closure	Waste Recycling	Waste Separ-ation Facility	Waste Storage Facility	Waste Transfer	Waste Treatment Lagoon	Water and Sediment Control Basin	Water Harvesting Catchment	Watering Facility	Water Well	Well Decom-missioning	Wetland Creation	Wetland Enhance-ment	Wetland Restoration	Wetland Wildlife Habitat Management	Wildlife Habitat Planting (ac)	Windbreak/ Shelterbelt Establishment
		Practice Code→	612	490	660	620	645	635	360	633	632	313	634	359	638	636	614	642	351	658	659	657	644	420	380
Soil	Wind and water erosion	Sheet and rill erosion	5	-1	1	0	3	4	0	0	0	0	-1	0	0	0	2	2	0	0	0	0	0	2	1
		Wind erosion	5	-1	0	0	3	4	0	0	0	0	-1	0	0	0	2	2	0	0	0	0	0	0	5
	Concentrated erosion	Ephemeral gully erosion	4	-2	0	5	3	0	0	0	0	0	-1	0	2	0	2	2	0	0	0	0	0	0	2
		Classic gully erosion	2	-1	0	4	2	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0
		Bank erosion from streams, shorelines or water conveyance channels	2	0	0	-1	1	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0
	Soil quality limitations	Subsidence	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Compaction	2	-1	0	0	0	3	0	0	0	1	-1	1	0	0	0	0	0	0	0	0	0	0	2
		Organic matter depletion	4	-2	1	0	0	3	0	1	1	1	0	1	0	0	0	0	0	2	1	1	0	0	4
		Concentration of salts or other chemicals	1	0	0	0	0	-2	2	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1
		Soil organism habitat loss or degradation	5	-1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5
		Aggregate instability	5	-1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4
Water	Weather resilience	Naturally available moisture use	1	2	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3
		Ponding and flooding	0	0	0	4	-3	0	0	0	0	0	0	0	2	0	0	0	0	2	2	2	2	0	0
		Seasonal high water table	2	0	0	0	2	-2	0	0	0	0	0	0	-2	0	0	2	0	-1	0	0	0	0	2
		Seeps	2	0	0	0	0	-1	0	0	0	0	0	0	-2	1	0	0	0	0	0	0	0	0	2
	Source water depletion	Surface water depletion	3	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	0	3
		Groundwater depletion	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	-2	0	0	0	0	0	0	0
		Inefficient irrigation water use	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	2	0	0	0	0	0	0	1
	Field sediment, nutrient and pathogen loss	Nutrients transported to surface water	1	0	1	-1	0	4	0	2	2	4	2	4	0	0	4	0	0	3	3	3	0	1	1
		Nutrients transported to groundwater	1	0	1	0	0	-2	0	2	2	2	2	2	-1	0	0	0	2	1	1	1	0	1	1
		Pathogens and chemicals from manure, biosolids or compost applications tranported to surface water	1	0	0	-1	0	5	0	0	2	2	2	4	0	0	2	-1	0	1	1	1	1	1	0
		Pathogens and chemicals from manure, biosolids or compost applications tranported to groundwater	1	0	0	0	0	0	2	2	2	2	2	2	-1	0	1	0	2	0	0	0	0	0	0
		Sediment tansported to surface water	3	-1	0	0	2	2	0	0	0	0	0	0	4	0	2	0	0	2	2	2	3	1	1
	Field pesticide loss	Pesticides transported to surface water	1	-1	1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	3
		Pesticides transported to groundwater	1	-1	1	0	0	0	0	0	0	0	0	0	-1	0	0	0	2	1	1	1	0	0	0
	Storage and handling of pollutants	Nutrients transported to surface water	1	0	1	-1	0	4	0	2	2	4	2	4	0	0	4	0	0	3	3	3	0	1	1
		Nutrients transported to groundwater	1	0	1	0	0	-2	0	2	2	2	2	2	-1	0	0	0	2	1	1	1	0	1	1
		Petroleum, heavy metals and other pollutants transported to surface water	1	0	0	1	0	0	0	0	2	0	0	0	0	0	1	0	0	2	2	2	0	0	1
		Petroleum, heavy metals and other pollutants transported to groundwater	1	0	0	0	0	0	0	0	2	1	0	1	-1	0	0	0	2	0	0	0	0	0	0
Air	Air quality emissions	Emissions of airborne reactive nitrogen	0	0	0	0	0	0	1	-1	1	-1	-1	-1	0	0	0	0	0	0	0	0	0	0	3
		Emissions of greenhouse gasses - GHGs	4	0	0	0	2	1	1	-1	1	-1	0	-3	0	0	0	0	0	1	1	1	1	0	4
		Emissions of ozone precursors	0	0	0	0	0	0	1	-1	2	-1	-1	1	0	0	0	0	0	0	0	0	0	0	0
		Emissions of particulate matter (PM) and PM precursors	1	0	0	0	2	0	1	-1	1	-1	-1	-1	0	0	0	0	0	0	0	0	0	0	4
		Objectionable odor	2	0	0	0	0	2	1	-1	4	-2	-1	-1	0	0	0	0	0	-1	-1	-1	-1	0	3
Plant	Pest pressure	Plant pest pressure	5	5	0	0	4	4	0	0	0	0	-1	0	0	0	0	0	0	4	4	4	4	0	1
	Degraded plant condition	Plant productivity and health	5	5	5	2	4	2	0	2	0	2	0	2	2	0	2	1	0	4	4	4	4	1	5
		Plant structure and composition	5	5	4	0	4	5	0	2	0	0	0	0	0	0	0	0	0	4	4	4	4	2	1
	Fire management	Wildfire hazard from biomass accumulation	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Animal	Livestock production limitation	Feed and forage balance	0	0	0	0	2	1	0	1	0	0	0	0	0	0	2	2	0	2	2	2	2	0	1
		Inadequate livestock shelter	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
		Inadequate livestock water quantity, quality and distribution	0	0	0	0	0	0	0	0	1	0	0	0	0	5	5	5	0	0	0	0	0	0	0
	Terrestrial habitat	Terrestrial habitat for wildlife and invertebrates	5	0	2	0	5	0	0	0	0	0	0	0	2	0	2	0	0	2	2	2	5	5	3
	Aquatic habitat	Aquatic habitat for fish and other organisms	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4
		Elevated water temperature	1	0	0	0	0	0	0	0	0	0	0	0	-2	0	1	0	0	0	0	0	0	4	0
Energy	Inefficient energy use	Energy efficiency of equipment and facilities	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	3
		Energy efficiency of farming/ ranching practices and field operations	1	0	0	1	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	3

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Conservation Practice Physical Effects

Legend to practice physical effects quantities found on page 6.

SWAPA+E	CART Category ↓	Resource Concern ↓ / Practice Name → / Practice Code →	Windbreak/ Shelterbelt Renovation 650	Woody Residue Treatment 384
Soil	Wind and water erosion	Sheet and rill erosion	1	1
		Wind erosion	5	1
	Concentrated erosion	Ephemeral gully erosion	2	1
		Classic gully erosion	0	1
		Bank erosion from streams, shorelines or water conveyance channels	0	0
	Soil quality limitations	Subsidence	0	0
		Compaction	2	-2
		Organic matter depletion	4	-1
		Concentration of salts or other chemicals	1	0
		Soil organism habitat loss or degradation	5	1
		Aggregate instability	4	1
Water	Weather resilience	Naturally available moisture use	3	1
		Ponding and flooding	0	0
		Seasonal high water table	2	0
		Seeps	2	0
	Source water depletion	Surface water depletion	3	1
		Groundwater depletion	0	0
		Inefficient irrigation water use	1	0
	Field sediment, nutrient and pathogen loss	Nutrients transported to surface water	1	0
		Nutrients transported to groundwater	1	0
		Pathogens and chemicals from manure, biosolids or compost applications tranported to surface water	0	0
		Pathogens and chemicals from manure, biosolids or compost applications tranported to groundwater	0	0
		Sediment tansported to surface water	1	1
	Field pesticide loss	Pesticides transported to surface water	3	0
		Pesticides transported to groundwater	0	0
	Storage and handling of pollutants	Nutrients transported to surface water	1	0
		Nutrients transported to groundwater	1	0
		Petroleum, heavy metals and other pollutants transported to surface water	1	0
		Petroleum, heavy metals and other pollutants transported to groundwater	0	0
Air	Air quality emissions	Emissions of airborne reactive nitrogen	2	1
		Emissions of greenhouse gasses - GHGs	1	2
		Emissions of ozone precursors	0	1
		Emissions of particulate matter (PM) and PM precursors	2	1
		Objectionable odor	2	0
Plant	Pest pressure	Plant pest pressure	1	3
	Degraded plant condition	Plant productivity and health	5	5
		Plant structure and composition	1	1
	Fire management	Wildfire hazard from biomass accumulation	0	3
Animal	Livestock production limitation	Feed and forage balance	1	3
		Inadequate livestock shelter	5	1
		Inadequate livestock water quantity, quality and distribution	0	0
	Terrestrial habitat	Terrestrial habitat for wildlife and invertebrates	3	0
	Aquatic habitat	Aquatic habitat for fish and other organisms	4	0
		Elevated water temperature	0	0
Energy	Inefficient energy use	Energy efficiency of equipment and facilities	3	0
		Energy efficiency of farming/ ranching practices and field operations	3	0

Legend of Effects Quantification	
5	Substantial Improvement
4	Moderate to Substantial Improvement
3	Moderate Improvement
2	Slight to Moderate Improvement
1	Slight Improvement
0	Not Applicable
0	Neutral
-1	Slight Worsening
-2	Slight to Moderate Worsening
-3	Moderate Worsening
-4	Moderate to Substantial Worsening
-5	Substantial Worsening

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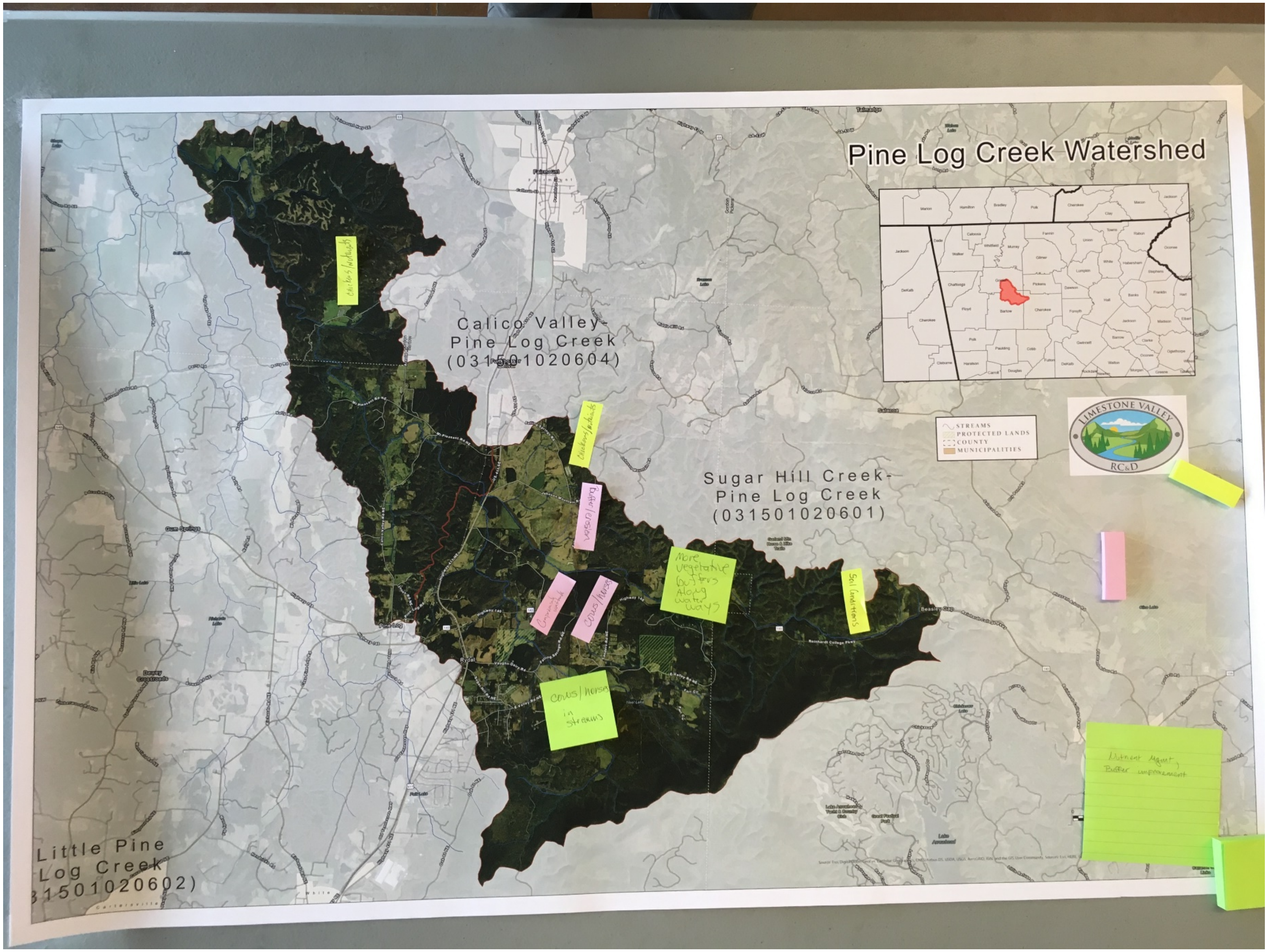
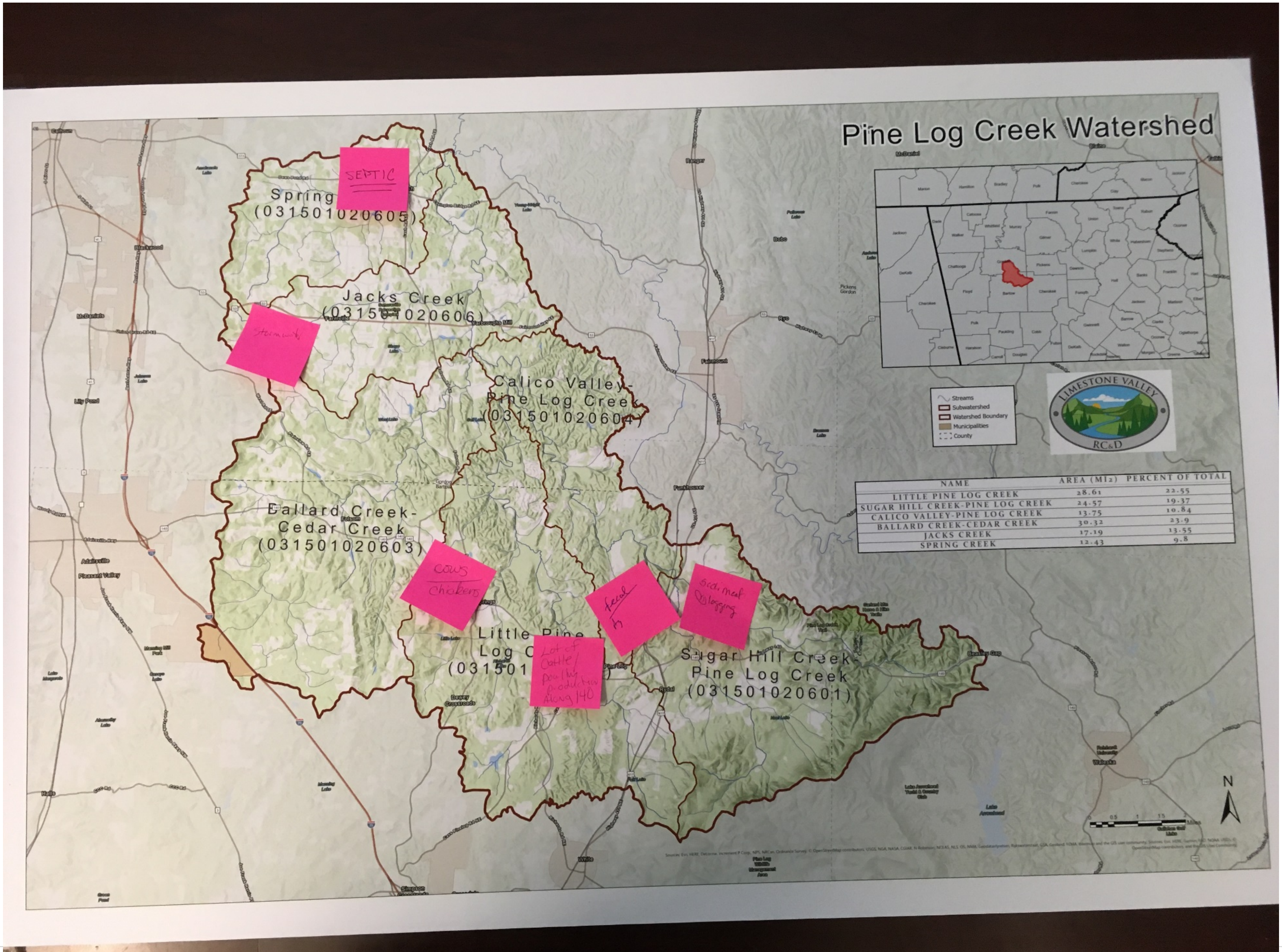
Appendix B

Stakeholder Meeting Notes


Pine Log Creek Watershed
Calico Valley-
Pine Log Creek
Sugar Hill Creek-
Pine Log Creek
(031501020601)
Little Pine
Log Creek
STREAMS
PROTECTED LANDS
COUNTY
MUNICIPALITIES
LIMESTONE VALLEY
RC&D
Buffer/erosion
cows/horses
More vegetative buffers Along water ways
Soil Conditions
cows/horses in streams
Highway 140
Reinhardt College Pkwy


Pine Log Creek Watershed
Ballard Creek-
Cedar Creek
(031501020603)
Little Pine
Log Creek
(031501020602)
STREAMS
PROTECTED LANDS
SUBWATERSHED
COUNTY
MUNICIPALITIES
LIMESTONE VALLEY
RC&D
Chicken litter
Cows in stream
Stormwater
Sediment
Septic
Old septic systems
Fecal septic


Pine Log Creek Watershed
Spring (031501020605)
Jacks Creek (031501020606)
Calico Valley-Pine Log Creek (031501020604)
Ballard Creek-Cedar Creek (031501020603)
Sugar Hill Creek-Pine Log Creek (031501020601)
SEPTIC
Stormwater
cows chickens
Streams
Subwatershed
Watershed Boundary
Municipalities
County
LIMESTONE VALLEY RC&D
NAME | AREA (MI2) | PERCENT OF TOTAL
LITTLE PINE LOG CREEK | 28.61 | 22.55
SUGAR HILL CREEK-PINE LOG CREEK | 24.57 | 19.37
CALICO VALLEY-PINE LOG CREEK | 13.75 | 10.84
BALLARD CREEK-CEDAR CREEK | 30.32 | 23.9
JACKS CREEK | 17.19 | 13.55
SPRING CREEK | 12.43 | 9.8
N


Spring Creek
(031501020605)
old septic
Septic
Failed septic
cows in stream
chickens/cows
Poultry
LIMESTONE VALLEY RC&D
N

Appendix C

Biotic Monitoring

Pine Log Creek Watershed 2020 IBI report

Prepared by:

Bernie Kuhajda and Shawna Fix
Tennessee Aquarium Conservation Institute

For:

Limestone Valley RC&D

4 December 2020

Introduction
The purpose of this project is to provide current fish IBI scores on four sites in four different streams within the Pine Log Creek watershed in Bartow and Gordon counties, GA (Figure 1). This watershed is approximately 127 sq. miles and the major land use features are forest, agriculture and development (Figure 2). Limestone Valley RC&D's mission is to enhance the communities within their eleven-county area by promoting conservation, water quality improvement, natural resource education and sustainable agriculture. The Tennessee Aquarium Conservation Institute was contracted by Limestone Valley to assist in these IBI surveys and write a report on the findings. Data will be used to inform management decisions within the Pine Log Creek watershed.

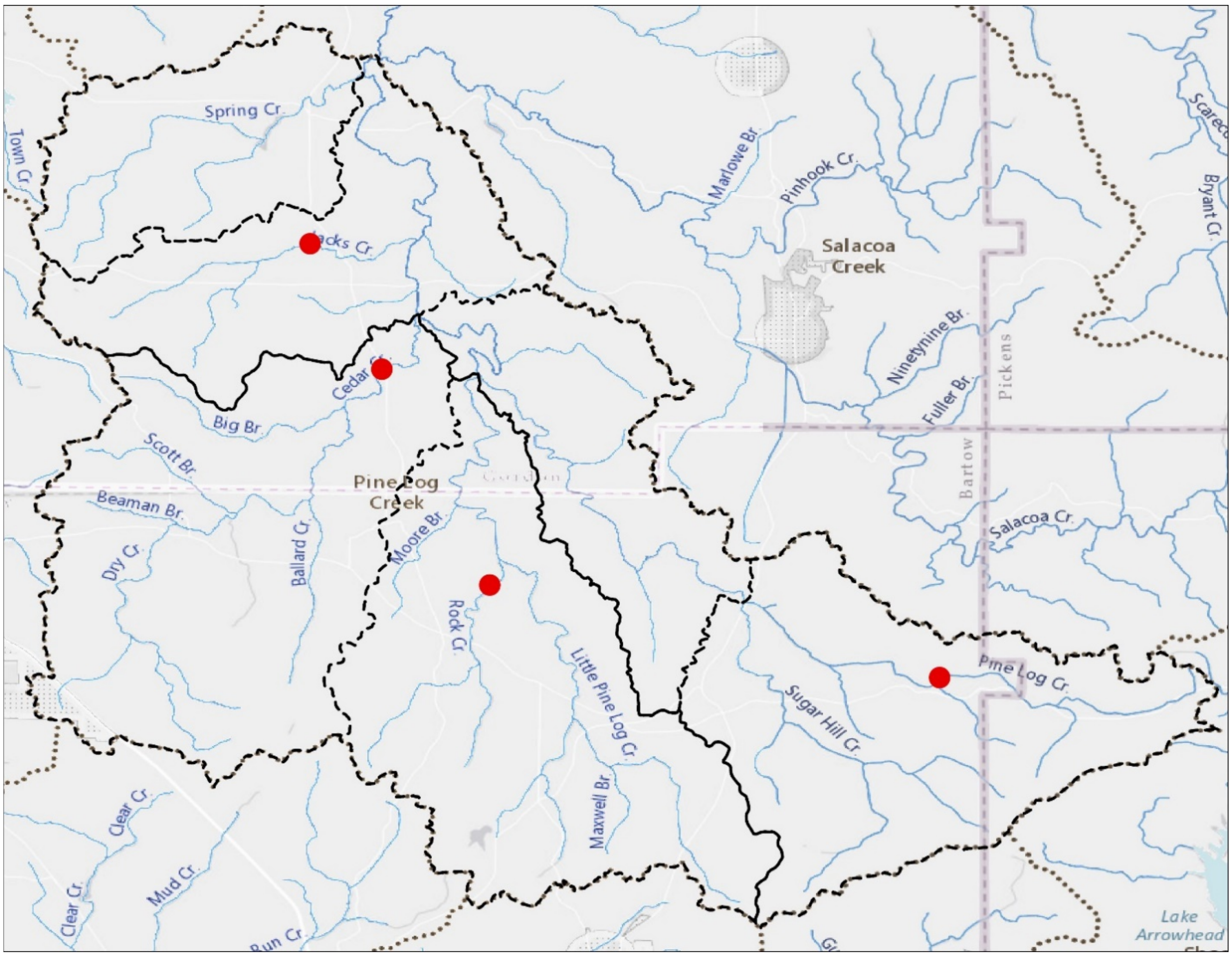


Figure 1. Sites (red dots) on four streams within the Pine Log Creek watershed sampled for this study. Dark dashed lines represent sub-watershed at the HUC 12 level.

Methods
Four streams within the Pine Log Creek watershed (Figure 1) were sampled following Georgia Department of Natural Resources' (GADNR) Standard Operating Procedures for Conducting Biomonitoring on Fish Communities in Wadeable Streams in Georgia (https://georgiawildlife.com/sites/default/files/wrd/pdf/SOP/streamsurvey_Part1.pdf). The Pine Log Creek watershed is within the Coosa River drainage and the vast majority of the watershed is in the Ridge and Valley physiographic province/ecoregion. Therefore fish IBI scoring criteria used in this study followed those specifically tailored for this region of Georgia (Scoring Criteria for the Index of Biotic

Integrity and the Index of Well-Being to Monitor Fish Communities in Wadeable Streams in the Coosa and Tennessee Drainage Basins of the Ridge and Valley Ecoregion of Georgia, https://georgiawildlife.com/sites/default/files/wrd/pdf/SOP/streamsurvey_SOP_Part4_RidgeValley.pdf). The headwaters of Pine Log Creek are in the Blue Ridge physiographic province/ecoregion, and the sampling site on upper Pine Log Creek for this study was at the border of the two physiographies/ecoregions. Therefore fish IBI scoring criteria following those specifically tailored for the Blue Ridge ecoregion of Georgia (Scoring Criteria for the Index of Biotic Integrity and the Index of Well-Being to Monitor Fish Communities in Wadeable Streams in the Coosa and Tennessee Drainage Basins of the Blue Ridge Ecoregion of Georgia, https://georgiawildlife.com/sites/default/files/wrd/pdf/SOP/streamsurvey_SOP_Part5_BlueRidge.pdf) were used in determining an alternative fish IBI score for site on Pine Log Creek in this study.

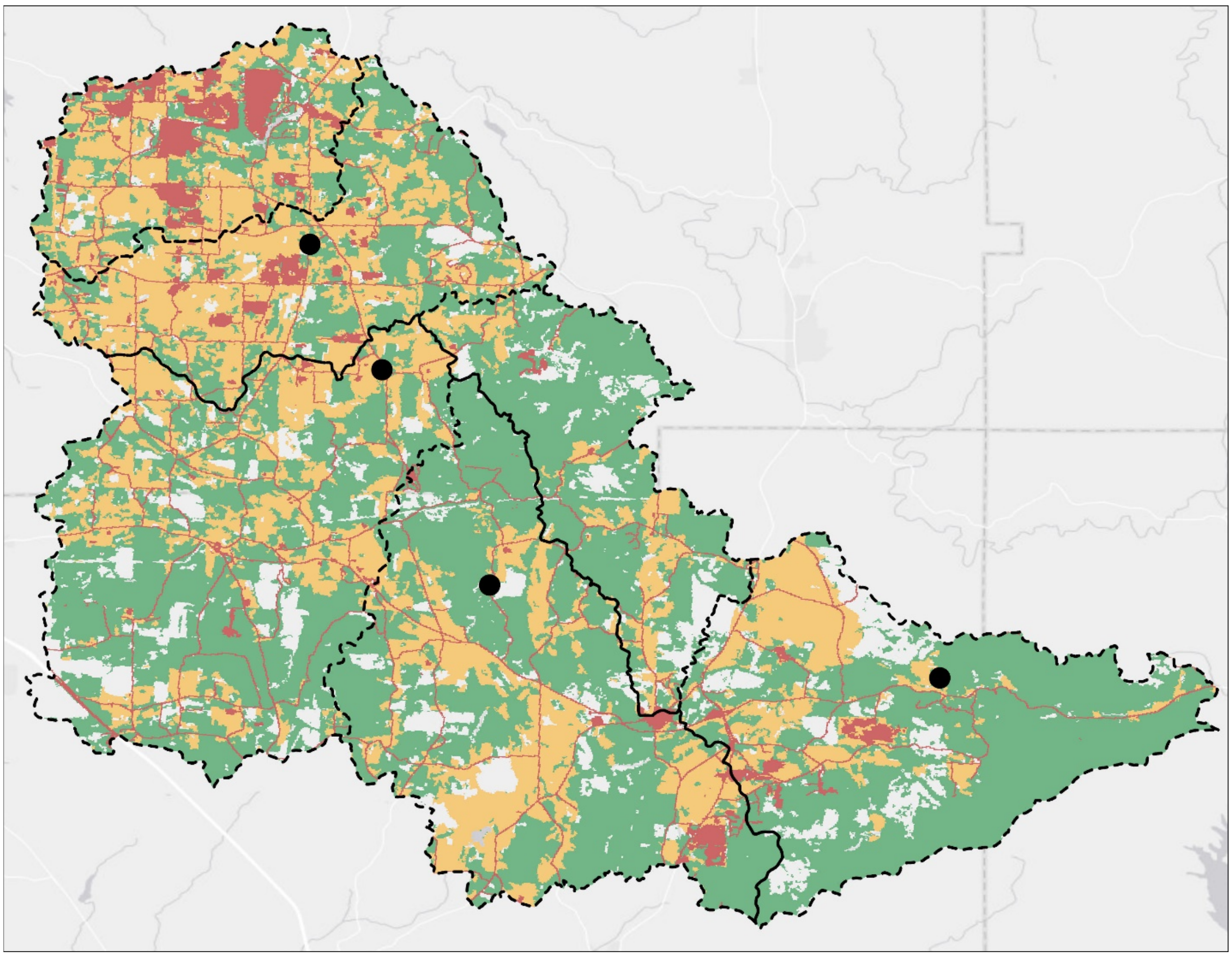


Figure 2. Major land use within the Pine Log Creek watershed. Green = forest, yellow = agriculture, red = development. Sites (black dots) on four streams sampled for this study. Dark dashed lines represent sub-watershed at the HUC 12 level.

Each stream was sampled at a single site. Backpack shockers and dipnets were used for fish sampling. Total seconds shocked from all backpack shockers used at a site were recorded. Fishes were held in containers with fresh creek water and aerators as they were identified to species and counted (Figure 3). Photo vouchers of most fish species were taken (Appendix A). Water quality (temperature (°C) DO (mg/L), conductivity (µS), pH, turbidity (NTU), salinity) was measured using a YSI multiport sonde (electronic probe). Alkalinity (ppm) and total hardness (ppm) were taken at Cedar Creek only with a Hach field spectrometer.

Figure 3. Sorting, identification, and enumeration of fishes during IBI study in Cedar Creek, GA, on 1 October 2020.

Days prior to fish and water quality sampling, five stream transects were established at each site to obtain an average stream width (m). Other measurement taken at these transects included stream depth (m) and silt depth (cm) at 1/4, 1/2, and 3/4 of stream width from a shoreline. Average stream width was needed to determine the length of the stream reach to be sampled for fishes at each site. Within the stream reach, the total number of pools, riffles, and bends, and the deepest pool were recorded. Other habitat assessments (riffle/run and glide/pool habitats) were also scored using GADNR protocols. Major land use (percent forest, agriculture, development) in the drainage basin area above each sampling site was calculated in GIS.

The four streams sampled include:
Cedar Creek upstream of Folsom Road (34.42708, -84.80198), Gordon County, GA, 1 Oct 2020.
Pine Log Creek just north of GA Hwy 140 (34.3513, -84.66492), Bartow County, GA, 8 Oct 2020.
Rock Creek along Nally Road (34.374069, -84.775488), Bartow County, GA, 8 Oct 2020.
Jacks Creek upstream of Wesley Chapel Road SE (34.45791, -84.81964), Gordon County, GA, 8 Oct 2020.

Results and Discussion
Forest, agriculture, and development represented 85-97% of the land use upstream of the four sites sampled within the Pine Log Creek watershed. The percent of each of these major land uses varied greatly between stream systems. The Pine Log Creek (headwaters) watershed was almost completely forested and had little agriculture or development (93, 2.5, and 1.7%), while the opposite was found in

the Jacks Creek watershed (20, 62, and 13%). The Cedar and Rock Creek watershed had just over 50% forest, approximately 25 % agriculture, and the rest development or other land uses (Table 1).

Table 1. Percent major land use in drainage basin area upstream of sites sampled for fish IBI data within the Pine Log Creek watershed.

Site	% Forest	% Agriculture	% Developed	Total
Cedar Creek	53.92	25.06	6.27	85.25
Pine Log Creek	93.20	2.51	1.69	97.40
Rock Creek	55.26	26.07	4.61	85.95
Jacks Creek	20.23	61.99	13.27	95.49

Cedar Creek upstream of Folsom Road (34.42708, -84.80198), Gordon County, GA. 1 Oct 2020
Cedar Creek was the largest site sampled, both in stream width (average 10.7 m) and drainage area above the sample site (28.53 sq. miles). The stream reach sampled for fishes in Cedar Creek was 235 m long, but this reach was based on incorrect preliminary stream width data. This reach should have been 374.5 m based on the correct average stream width at the specific location sampled, but the 235 m reach sampled contained 5 pools, 12 riffles, and 2 bends, which should adequately represent the fish community. Stream width averaged 10.7 m, stream depth 0.55 m, and silt depth 7.4 cm. The majority of the sampled reach flowed through a pasture with grazing cattle. The riparian zone was sparse or missing, bank erosion was evident, and cattle had access to the stream at several locations. A rain event had occurred several days prior to sampling, which contributed to the somewhat higher water levels and turbidity reading. Water quality parameters are given below in Table 2.

Table 2. Water quality parameters for Cedar Creek.

Water Quality Cedar Creek	
Elevation (ft)	687
Water Temp (°C)	14.9
DO (mg/L)	8.09
Conductivity (µS)	297.4
pH	7.5
Turbidity (NTU)	21.4
Total Hardness (ppm)	102.6
Alkalinity (ppm)	175
Salinity	0.14

Fish sampling occurred from 10:45-14:30, which included several stops for fish identification and enumeration. Five backpack shockers were used in fish sampling for a total of 23,902 seconds of shocking at this site. A total of 26 fish species in 8 families were collected, 25 of them native species. Total number of individuals was 617, with one minnow not identifiable to species and not used in IBI analyses (Table 3).

Table 3. Fish species and number of specimens collected in Cedar Creek. Asterisk = non-native species.

Species	**Common Name**	**Specimen count**	**Family**
Ichthyomyzon gagei	Southern Brook Lamprey	5	Petromyzontidae
Dorosoma cepedianum	Gizzard Shad	1	Clupeidae
Campostoma oligolepis	Largescale Stoneroller	28	Cyprinidae
Cyprinella venusta	Blacktail Shiner	6	Cyprinidae
Luxilus chrysocephalus	Striped Shiner	89	Cyprinidae
Luxilus sp.	–	1	Cyprinidae
Notropis chrosomus	Rainbow Shiner	1	Cyprinidae
Notropis stilbius	Silverstripe Shiner	25	Cyprinidae
Semotilus atromaculatus	Creek Chub	23	Cyprinidae
Hypentelium etowanum	Alabama Hog Sucker	39	Catostomidae
Minytrema melanops	Spotted Sucker	1	Catostomidae
Moxostoma duquesnei	Black Redhorse	8	Catostomidae
Moxostoma erythrurum	Golden Redhorse	66	Catostomidae
Gambusia affinis	Western Mosquitofish	9	Poeciliidae
Cottus carolinae	Banded Sculpin	60	Cottidae
**Lepomis auritus*	Redbreast Sunfish	32	Centrarchidae
Lepomis cyanellus	Green Sunfish	31	Centrarchidae
Lepomis macrochirus	Bluegill	93	Centrarchidae
Lepomis megalotis	Longear Sunfish	44	Centrarchidae
Lepomis microlophus	Redear Sunfish	6	Centrarchidae
Lepomis miniatus	Redspotted Sunfish	3	Centrarchidae
Micropterus coosae	Redeye Bass	7	Centrarchidae
Micropterus henshalli	Alabama Bass	7	Centrarchidae
Micropterus salmoides	Largemouth Bass	2	Centrarchidae
Etheostoma coosae	Coosa Darter	11	Percidae
Etheostoma stigmaeum	Speckled Darter	4	Percidae
Percina nigrofasciata	Blackbanded Darter	15	Percidae
	Total	**617**	

Calculated metrics that are used in scoring for fish IBIs are given in Table 10. Based on these metrics and scoring criteria for the Coosa River drainage in the Ridge and Valley Ecoregion, the IBI score for this site was 42, which ranks this fish community as Fair. Attributes for this ranking are species richness declines as some expected species are absent; few, if any, intolerant or headwater intolerant species present; trophic structure skewed toward generalist, herbivorous, and sunfish species as the abundance of insectivorous cyprinid and benthic fluvial specialist species decreases. Almost one-third of the land use in the watershed upstream of our sampling site is agriculture and development, which is the likely cause of this Fair rank.

One historical fish IBI score is available for Cedar Creek in Gordon County. On 21 Aug 2001 the IBI score was 28, which ranks this fish community as Poor. One explanation for this discrepancy is that our study used five backpack shockers to sample fishes. If fish sampling in 2001 used fewer backpack shockers, this may have not captured the true makeup of the fish community. A second explanation could involve a real improvement in water quality as the Clean Water Act of 1972 became implemented in the Cedar Creek watershed by state agencies, and the fish community responded to these improvements.

Pine Log Creek just north of GA Hwy 140 (34.3513, -84.66492), Bartow County, GA, 8 Oct 2020

Pine Log Creek was the smallest site sampled in drainage area above the sample site (6.06 sq. miles) but had the second highest average stream width (5.7 m). The stream reach sampled for fishes in Pine Log Creek was 199.5 m long. This reach contained 3 pools, 6 riffles, and 1 bend. Stream width averaged 5.7 m, stream depth 0.20 m, and silt depth 3.4 cm. The majority of the sampled reach flowed through forest that was part of the Pine Log Creek trail managed by Bartow County, GA. Most of the shoreline had an extensive riparian zone. Bank erosion was evident near the trail crossing (see Figure 4). Water quality parameters are given in Table 4. It is noteworthy that the conductivity of upper Pine Log Creek (79 µS, Table 4) was considerably lower than Cedar, Rock, or Jacks creeks (244.6-297.4 µS, Tables 6, 8), indicative of the low conductivity typically found in Blue Ridge streams.

Figure 4. Pine Log Creek at trail crossing. Photo obtained from trail website at https://www.bartowga.org/departments/pine_log_creek_walking_trail.php

Table 4. Water quality parameters for Pine Log Creek.

Water Quality Pine Log Creek	
Elevation (ft)	899
Water Temp (°C)	16.0
DO (mg/L)	8.96
Conductivity (µS)	79
pH	6
Turbidity (NTU)	3.1
Total Hardness (ppm)	

Alkalinity (ppm)	
Salinity	0.04

Fish sampling occurred from 9:45-11:30, which included several stops for fish identification and enumeration. Two backpack shockers were used in fish sampling for a total of 12,600 seconds of shocking at this site. A total of 12 fish species in 5 families were collected, 11 of them native species. Total number of individuals was 430 (Table 5).

Table 5. Fish species and number of specimens collected in Pine Log Creek. Asterisk = non-native species.

Species	**Common Name**	**Specimen count**	**Family**
Campostoma oligolepis	Largescale Stoneroller	10	Cyprinidae
Luxilus chrysocephalus	Striped Shiner	14	Cyprinidae
Notropis chrosomus	Rainbow Shiner	140	Cyprinidae
Notropis xaenocephalus	Coosa Shiner	88	Cyprinidae
Semotilus atromaculatus	Creek Chub	55	Cyprinidae
Hypentelium etowanum	Alabama Hog Sucker	28	Catostomidae
Cottus carolinae	Banded Sculpin	48	Cottidae
**Lepomis auritus*	Redbreast Sunfish	4	Centrarchidae
Lepomis macrochirus	Bluegill	1	Centrarchidae
Lepomis megalotis	Longear Sunfish	1	Centrarchidae
Micropterus coosae	Redeye Bass	28	Centrarchidae
Etheostoma coosae	Coosa Darter	13	Percidae
	Total	**430**	

Calculated metrics that are used in scoring for fish IBIs are given in Table 10. Based on these metrics and scoring criteria for the Coosa River drainage in the Ridge and Valley Ecoregion, the IBI score for this site was 34, which ranks this fish community as Fair. Because the sampling site in this study was at the border of the two physiographies/ecoregions, we calculated a second fish IBI scoring using criteria for the Coosa River drainage in the Blue Ridge Ecoregion. This fish IBI score was slightly higher, 38, but still ranks this fish community as Fair. Attributes for this ranking are species richness declines as some expected species are absent; few, if any, intolerant or headwater intolerant species present; trophic structure skewed toward generalist, herbivorous, and sunfish species as the abundance of insectivorous cyprinid and benthic fluvial specialist species decreases. Given that 93 % of the drainage basin area upstream of our sampling site was forested, and we determined fish IBI scores using criteria for two different physiographies/ecoregions, the ranking of Fair seems unusual.

<u>Rock Creek along Nally Road (34.374069, -84.775488), Bartow County, GA, 8 Oct 2020</u>
Rock Creek was the largest of the three "small" creeks sampled (Rock, Pine Log, and Jacks) in drainage area above the sample site (7.52 sq. miles) but was intermediate in average stream width (5.3 m). The stream reach sampled for fishes in Rock Creek was 185 m long. This reach contained 4 pools, 3 riffles, and no bends. Stream width averaged 5.3 m, stream depth 0.23 m, and silt depth 2.9 cm. The entire sampled reach flowed along Nally Road, with a narrow riparian zone between the road and the stream. The other side of the stream was forest. Water quality parameters are given in Table 6.

Table 6. Water quality parameters for Rock Creek.

Water Quality Rock Creek	
Elevation (ft)	735
Water Temp (°C)	16.2
DO (mg/L)	8.14
Conductivity (µS)	224.6
pH	6.5
Turbidity (NTU)	2.87
Total Hardness (ppm)	
Alkalinity (ppm)	
Salinity	0.13

Fish sampling occurred from 13:00-15:00, which included several stops for fish identification and enumeration. Two backpack shockers were used in fish sampling for a total of 8,768 seconds of shocking at this site. A total of 23 fish species in 8 families were collected, 22 of them native species. Total number of individuals was 373 (Table 7).

Table 7. Fish species and number of specimens collected in Rock Creek. Asterisk = non-native species.

Species	**Common Name**	**Specimen count**	**Family**
Lampetra aepyptera	Least Brook Lamprey	1	Petromyzontidae
Campostoma oligolepis	Largescale Stoneroller	11	Cyprinidae
Luxilus chrysocephalus	Striped Shiner	98	Cyprinidae
Notropis chrosomus	Rainbow Shiner	23	Cyprinidae
Notropis xaenocephalus	Coosa Shiner	7	Cyprinidae
Semotilus atromaculatus	Creek Chub	7	Cyprinidae
Hypentelium etowanum	Alabama Hog Sucker	20	Catostomidae
Minytrema melanops	Spotted Sucker	1	Catostomidae
Moxostoma duquesnei	Black Redhorse	6	Catostomidae
Moxostoma erythrurum	Golden Redhorse	23	Catostomidae
Ameiurus nebulosus	Brown Bullhead	1	Ictaluridae
Gambusia affinis	Western Mosquitofish	4	Poeciliidae
Cottus carolinae	Banded Sculpin	11	Cottidae
**Lepomis auritus*	Redbreast Sunfish	29	Centrarchidae
Lepomis cyanellus	Green Sunfish	7	Centrarchidae
Lepomis macrochirus	Bluegill	18	Centrarchidae
Lepomis megalotis	Longear Sunfish	82	Centrarchidae
Lepomis miniatus	Redspotted Sunfish	3	Centrarchidae
Micropterus coosae	Redeye Bass	14	Centrarchidae
Etheostoma coosae	Coosa Darter	3	Percidae
Etheostoma stigmaeum	Speckled Darter	1	Percidae
Percina kathae	Mobile Logperch	1	Percidae
Percina nigrofasciata	Blackbanded Darter	2	Percidae
	Total	**373**	

Calculated metrics that are used in scoring for fish IBIs are given in Table 10. Based on these metrics and scoring criteria for the Coosa River drainage in the Ridge and Valley Ecoregion, the IBI score for this site was 46, which ranks this fish community as Good. Attributes for this ranking are species richness somewhat below expectation, especially due to the loss of the most intolerant forms; good number of individuals, with several species of suckers, minnows, and benthic invertivores present; trophic structure shows some signs of stress. Almost one-third of the land use in the watershed upstream of our sampling site is agriculture and development, which is the likely cause of this site being at the middle of IBI score for a Good ranking (44-50 = Good).

Three historical fish IBI scores are available for Rock Creek in Bartow County. The two earlier IBI scores (2 May 2001: IBI = 44; 6 August 2002: IBI = 50) were slightly higher or lower scores relative to the current study and also ranked Good. The latest fish IBI score (10 Oct 2007: IBI = 42) was lower and ranked at the upper end of Fair. The historical and current fish IBI scores show that the fish community composition in Rock Creek has fluctuated slightly over two decades but has remained relatively constant.

Jacks Creek upstream of Wesley Chapel Road SE (34.45791, -84.81964), Gordon County, GA, 8 Oct 2020
Jacks Creek was the smallest site sampled in average stream width (3.9 m) and had the second smallest drainage area above the sample site (7.52 sq. miles). The stream reach sampled for fishes in Jacks Creek was 105 m long. This reach only contained 3 pools, with no riffles or bends. Stream width averaged 3.9 m, stream depth 0.27 m, and silt depth 1.1 cm. The sampled reach flowed adjacent to a mowed landscape with little or a narrow riparian zone. The lower end of the stream reach ran along Wesley Chapel Road SE. The stream was incised with steep banks, little to no flow, and tannin-stained pools. Water quality parameters are given in Table 8.

Table 8. Water quality parameters for Jacks Creek.

Water Quality Jacks Creek	
Elevation (ft)	697
Water Temp (°C)	17.7
DO (mg/L)	9.38
Conductivity (µS)	291.3
pH	6.5
Turbidity (NTU)	221
Total Hardness (ppm)	
Alkalinity (ppm)	
Salinity	0.04

Fish sampling occurred from 15:55-16:50, which included one stop for fish identification and enumeration. Two backpack shockers were used in fish sampling for a total of 8,844 seconds of shocking at this site. A total of 12 fish species in 5 families were collected, 11 of them native species. Total number of individuals was 292 (Table 9).

Table 9. Fish species and number of specimens collected in Jacks Creek. Asterisk = non-native species.

Species	Common Name	Specimen count	Family
Campostoma oligolepis	Largescale Stoneroller	91	Cyprinidae
Luxilus chrysocephalus	Striped Shiner	5	Cyprinidae
Semotilus atromaculatus	Creek Chub	15	Cyprinidae
Hypentelium etowanum	Alabama Hog Sucker	7	Catostomidae
Gambusia affinis	Western Mosquitofish	1	Poeciliidae
**Lepomis auritus*	Redbreast Sunfish	21	Centrarchidae
Lepomis cyanellus	Green Sunfish	64	Centrarchidae
Lepomis macrochirus	Bluegill	80	Centrarchidae
Lepomis megalotis	Longear Sunfish	2	Centrarchidae
Lepomis microlophus	Redear Sunfish	2	Centrarchidae
Micropterus henshalli	Alabama Bass	1	Centrarchidae
Etheostoma coosae	Coosa Darter	3	Percidae
	Total	**292**	

Calculated metrics that are used in scoring for fish IBIs are given in Table 10. Based on these metrics and scoring criteria for the Coosa River drainage in the Ridge and Valley Ecoregion, the IBI score for this site was 16, which ranks this fish community as Very Poor. Attributes for this ranking are fish present are mostly generalist and sunfishes; condition factors of fishes are typically poor and unhealthy; juvenile individuals dominate the sample; fishes with disease, eroded fins, lesions, and tumors common, although we did not note diseased fishes in our sampling in Jacks Creek. Jacks Creek had very little flowing water, with fishes isolated in tannin-stained pools. Just below our sampling reach was a perched box culvert under Wesley Chapel Road SE, which likely limits upstream movement of fishes into our sampled reach. These conditions likely contributed to the Very Poor ranking.

One historical fish IBI score is available for Jacks Creek in Gordon County. On 21 Aug 2001 the IBI score was the same as in this study, 16, which ranks this fish community as Very Poor. This consistently low score over two decades indicates that the lower water table (compared to the other creeks sampled in this study), perched culvert acting as an upstream migration barrier, and over 75% of the of the land use in the watershed upstream of our sampling site is agriculture and development all consistently contribute to Very Poor condition of the fish community at this site.

Table 10. Calculated metrics used with scoring criteria to determine fish IBI scores for Cedar, Pine Log (Ridge & Valley and Blue Ridge Provinces), Rock, and Jacks creek within the Pine Log Creek watershed.

	Cedar	Pine Log	Pine Log	Rock	Jacks
Physiographic province/ecoregion	Ridge & Valley	Ridge & Valley	Blue Ridge	Ridge & Valley	Ridge & Valley
Reach Length	263	199.5	199.5	185	105
Grand_Total_specimens	616	430	430	372	292
DBA (drainage basin area upstream of site)	28.534	6.059	6.059	7.522	7.236
log_10_DBA	1.455	0.782	0.782	0.876	0.859
Number of Individuals	616	430	430	373	292
Number of species	26	12	12	23	12
Total number of native fish species	25	11	11	22	11
Total number of benthic invertivore species	4	2	2	5	1
Total number of native sunfish species (DBA < 15 sq. mi)	–	2	2	4	4
Total number of native centrarchid species (DBA >15 sq. mi)	8	–	–	–	–
Total number of native insectivorous cyprinid species	4	3	3	3	1
Total number of round bodied sucker species	4	1	1	4	1
Total number of sensitive species (DBA < 15 sq. mi)	–	1	1	3	0
Total number of intolerant species (DBA > 15 sq. mi)	1	–	–	–	–
Evenness	83.24	77.24	77.24	76.03	68.65
% individuals as *Lepomis* species	33.9	1.4	1.4	37.3	57.9
% individuals as insectivorous cyprinid species	19.6	56.3	56.3	34.3	1.7
% individuals as generalist feeders/herbivore species (DBA < 15 sq. mi)	–	26.3	26.3	11.3	58.6
% individuals as top carnivore species (DBA > 15 sq. mi)	2.6	–	–	–	–
% individuals as benthic fluvial specialist species	33.1	20.7	20.7	18.3	3.4
Number of individuals collected per 200 meters	468.4	431.1	431.1	403.2	556.2
% individuals with external anomalies	0	0	0	0	0
Fish IBI scores	42	34	38	46	16
Fish IBI rank	Fair	Fair	Fair	Good	Very Poor
	Cedar	Pine Log	Pine Log	Rock	Jacks

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