Stekoa Creek Watershed Management Plan

Confluence of Stekoa Creek and the National Wild & Scenic Chattooga River

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Purpose

The purpose of the Stekoa Creek Watershed Management Plan is to provide a context and a road map for how the watershed could be managed to restore and protect its water quality. This plan will provide an analysis of the sources of the Stekoa Creek watershed's water quality problems, their relative contributions, and then identify management, educational and financing programs, along with stakeholder resources, that would be committed to remediate these problems.

In general, the purpose of watershed planning and implementation is to engage local governments, institutions and decision-makers in the restoration and protection of watersheds through the following series of steps:

- ➢ Characterize existing conditions
- ➢ Identify and prioritize problems
- ➢ Define management objectives
- ➢ Develop protection or restoration measures
- ➢ Implement and adapt selected actions

The Stekoa Creek Watershed Management Plan is intended to help ensure that:

- ✓ Limited resources are directed to priority actions that will address significant water pollution sources
- ✓ The pace of restoration can be accelerated
- ✓ Information is provided to leverage related resources
- ✓ Feedback mechanisms are established to allow adjustments

The Stekoa Watershed Management Plan (Stekoa WMP or WMP) project follows the U. S. Environmental Protection Agency's (EPA) steps for developing a *Nine Element Watershed Management Plan*. In addition, the corrective actions proposed herein will carry out portions of the pertinent Total Maximum Daily Load Implementation Plans (TMDLIP) for Stekoa Creek and its impaired tributaries as specified by the Georgia Department of Natural Resources, Environmental Protection Division (GADNR and/or GAEPD).

Goals to Attain

The goal of the Stekoa WMP is to facilitate the timely implementation of management strategies and corrective and protective actions to improve water quality in the Stekoa Creek watershed. Measures will be spelled out to eliminate pollution sources that have contributed to the impairment of Stekoa Creek and four of its tributaries due to excessive levels of fecal coliform and sediment (sediment impairment is also referenced as "macroinvertebrate biota" impairment). The focus will be on restoring these streams to "supporting" their designated use of fishing on the *State of Georgia's 305(b)/303(d) List of Waters*.

Stekoa Creek has a long and well documented history as a public health hazard to the Rabun County community, and for polluting the National Wild & Scenic Chattooga River.

It is important to note that consequential influences to achieving the goals and objectives of this WMP are:

- ✧ State and local stormwater management codes
- ✧ Sewer and water regulations
- ✧ Local enforcement of erosion, sedimentation and flood plain protection laws
- ✧ Local comprehensive land use plans
- ✧ Intergovernmental cooperation

To move from existing conditions in the Stekoa Creek watershed to include watershed-based perspectives and protection and restoration of impaired waters will require a significant shift in local codes, policies and enforcement, and considerable resources. Thus, the Stekoa WMP recognizes the success of its implementation will also depend on additional actions and alternatives that are complimentary to this WMP, or that are updates to this WMP, which may be dependent on political will and the availability of more resources.

Water Quality Standards A *Total Maximum Daily Load* (TMDL) calculates the maximum amount of a pollutant allowed to enter a water body, so that the water body will meet and continue to meet water quality standards for the particular pollutant and the water body's designated uses.

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The TMDL allocates maximum allowable pollutant loads to point sources and nonpoint sources, which include both anthropogenic and natural pollutant sources. The TMDL includes three components, as follows:
TMDL = LA + WLA + MOS, where:

LA = Load Allocation for nonpoint sources
WLA = Waste Load Allocation for point sources
MOS = Margin of Safety
(Source: www.epa.gov/owow/tmdl)

- The Georgia State Water Quality Standards for *fecal coliform* are:

  May-October (summer): a minimum of 4 water samples collected within a 30-day period resulting in a geometric mean of ≤ 200 colony forming units (cfu) per 100 mL.

  November-April (winter): a minimum of 4 water samples collected within a 30-day period resulting in a geometric mean of ≤ 1,000 cfu per 100 mL.

- The Georgia State Water Quality Standards for *biota* (macroinvertebrates) due to sediment are:

  GAEPD has established narrative criteria for sediment that applies to all waters of the State of Georgia. The purpose of the narrative standard is to prevent objectionable conditions that interfere with legitimate water uses, as stated in Georgia Regulation 391-3-6-.03(5)(c), to wit: All waters shall be free from material related to municipal, industrial or other discharges which produce turbidity, color, odor or other objectionable conditions which interfere with legitimate water uses (GAEPD, 2004).

Scope

Geographic Range Stekoa Creek is located at the headwaters of the Savannah River Basin and originates in northeast Georgia at an elevation of approximately 2,165 feet, near the Eastern Continental Divide in Mountain City. Flowing south from Mountain City, Stekoa Creek enters Clayton, GA, and then runs through Rabun County and the Chattahoochee National Forest before emptying into the National Wild & Scenic Chattooga River. The Stekoa Creek watershed is a sub-basin within the greater Chattooga River Watershed, and is 26,058 acres in size. The Stekoa Creek watershed is 84% private land, which is located primarily in the upper portion of the watershed, and 16% public land, that is found primarily in the lower reach of the watershed, and includes portions of the Chattahoochee National Forest. The hydrologic unit code (HUC) for the Stekoa Creek watershed is 0306010206.

The Stekoa Creek watershed includes the reaches of these primary tributaries: Scott Creek, Saddle Gap Branch, Chechero Creek, She/Pool Creek (Pool Creek is a small tributary to She Creek) and Cutting Bone Creek. With the exception of only Cutting Bone Creek, these tributaries are also listed by the GAEPD and the EPA as impaired waters.

Stekoa Creek has a long and well-documented history of polluting the National Wild & Scenic Chattooga River. Correspondence between the U. S. Forest Service, interest groups and the GAEPD about this issue dates back to at least the late 1970s and early 1980s.

Temporal Range Stekoa Creek has a long and well-documented history of polluting the National Wild & Scenic Chattooga River. Correspondence between the U. S. Forest Service (USFS), interest groups and the GAEPD about this issue dates back to at least the late 1970s and early 1980s. Assessing and discussing the Stekoa Creek watershed's problems over the past 40+ years has prompted the formation of many stakeholder groups, and multiple initiatives intended to make progress in improving Stekoa Creek's water quality. Thus, the Stekoa Watershed Management Plan builds on these prior initiatives, which include:

✧ ***1993-1994 The Stekoa Creek Water Quality Committee*** involved representatives from the Chattooga River outfitting and guiding industry, USFS, GA DNR and interested citizens. *Focus*: Members of the group completed water sampling to raise awareness and to try to initiate progress on cleaning up Stekoa Creek, due to its negative impacts on the Chattooga River. A record of water sampling results was produced, and an agricultural best management practices (BMP) project on Saddle Gap Branch (impaired tributary of Stekoa Creek) was completed.

✧ ***1993-1995 The USFS's "Chattooga River Ecosystem Management Demonstration Project"*** involved researchers from the USFS, Clemson University, and graduate students from several academic institutions. *Focus*: This project encompassed the entire Chattooga River watershed. Portions of several studies addressed

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Stekoa Creek, such as a macroinvertebrate survey, and particularly a study of erosion and sedimentation sources impacting the Chattooga River, which identified Stekoa Creek—out of all the streams in the entire Chattooga watershed—as by far the most problematic source of erosion and sedimentation into the river.

✧ ***2000-2002 Stekoa Creek Total Maximum Daily Load Implementation Plan*** (TMDLIP) GA EPD issued the first Stekoa Creek TMDLIP as a platform for evaluating and tracking water quality protection and restoration. *Focus*: The plan addressed characteristics of the watershed and sources of pollution, and also involved stakeholders and education/outreach activities. The TMDLIP described regulatory and voluntary practices and control actions (known as best management practices) to reduce pollutants; measurable milestone schedules to show development of the BMPs; and, a monitoring plan to determine BMP effectiveness.

✧ ***2004-2006 Stekoa Creek Greenway Association*** involved the Clayton Women's Club, local landowners and the Chattooga Conservancy. *Focus*: Work to establish a greenway along Stekoa Creek and Scott Creek (impaired tributary to Stekoa), to raise awareness about improving water quality.

✧ ***2007 Stekoa Creek Tier 2 TMDLIP*** *Focus*: Under the guidance of the GA EPD, Stekoa Creek's original TMDLIP was updated, with the same objectives and by employing the same methodology as the first TMDLIP.

✧ ***2007-2008 Stekoa Creek Watershed Group***, which included GADNR/EPD, EPA, Federal Emergency Management Agency (FEMA), Chattooga Conservancy, Trout Unlimited and local government officials. *Focus*: The group convened to discuss floodplain filling activities and pollution sources in Stekoa Creek.

✧ ***2008-2009 Southeastern Regional Water Quality Assistance Network*** (SERWQAN) and ***Stekoa Creek Watershed Task Force*** project, which involved EPA, GAEPD, Environmental Finance Center, Georgia Mountains Regional Commission, Southeast Watershed Forum, Chattooga Conservancy, Trout Unlimited and local government officials and stakeholders. *Focus*: The SERWQAN stakeholders group met several times to establish a consensus about the priority issues involved with Stekoa Creek's persistent status as an impaired waterway. These meetings were followed by the formation of multiple task force groups charged with strategic planning and developing and implementing action plans to improve water quality in the Stekoa Creek watershed. On behalf of the City of Clayton, the "Fix Sewage System" task force released a request for proposals soliciting bids from civil engineering companies to research and produce a prioritized list of sewage collection system repairs.

✧ ***2010-2014 Clayton-Rabun County Watershed Project*** was a 319(h) grant awarded to The City of Clayton, which was managed by the Chattooga Conservancy. *Focus*: The project's work plan was designed to address the Stekoa Creek watershed's impairments, in alignment with the revised TMDLIP. On-the-ground actions included septic system repairs; a riparian area and stream bank restoration project; construction of a urban filtration basin to treat storm water discharge from State Highway 441; an agricultural best management practices (AG BMP) project; and, public education and outreach.

This sign warns of a public health hazard from a sewage spill in Clayton.

Altogether, past stakeholder initiatives show consistent agreement on a set of goals and objectives that, if pursued and implemented, would attain a desired future condition of reducing the sediment and fecal coliform pollution loads in the Stekoa Creek watershed. As acknowledged by the Stekoa Watershed Management Plan's watershed advisory committee, this project confirms the historical consensus on priority issues and shall build upon past efforts.

The Stekoa WMP considers a timetable of 1 to 2 years as the first phase in implementing its objectives; 3 to 5 years as the second phase; and, in excess of 5 years for subsequent implementation phases of the WMP. Due to the relatively long history of impairment in Stekoa Creek, it is expected that in excess of 10 years will be necessary to reach the goals described in this WMP.

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Sewage from a sewer line leak flowing towards Shadyside Street in Clayton.

Issues of Concern & Characterization of the Issues' Impacts

♦ **National Wild & Scenic Chattooga River** Stekoa Creek is a major tributary to the federally protected National Wild & Scenic Chattooga River, and is widely acknowledged as the greatest threat to the river's water quality. May 10th, 2014, marked the 40th anniversary of the Chattooga River's status as the crown jewel of the National Wild and Scenic Rivers system in the Southeast, yet for at least as many years the lower section of the Chattooga has suffered under the ill effects of fecal coliform and sediment pollution from Stekoa Creek. In fact, back when the Chattooga River was protected under the Wild & Scenic Rivers Act, the section below the Stekoa/Chattooga confluence was only included under the provision that the City of Clayton and the State of Georgia would work to improve Stekoa Creek's water quality.

♦ **Public Health** Stekoa Creek flows through downtown Clayton and then runs through moderately populated portions of Rabun County, where the possibility of direct contact with the stream presents a public health hazard. In addition, the USFS issues "special use permits" for commercial outfitting and guiding businesses on the Chattooga River. The severity of Stekoa Creek's fecal coliform contamination problem is not obvious to the casual user or visitor to the Chattooga. However, the concentrations of fecal coliform from Stekoa Creek, even though diluted by the river, periodically far exceed the water quality standards that have been set for swimming and associated water contact sports. (Source: Hansen et al, USFS, 1995.) Commercial rafting below the Stekoa Creek / Chattooga River confluence carries the potential risk of exposing thousands of rafters annually to direct contact with the bacterium and viral pathogens contained in Stekoa Creek's polluted water.

♦ **Inflow and Infiltration** The Clayton Wastewater Treatment Plant (WWTP) has a well-documented history of non-compliance with its National Pollutant Discharge Elimination System (NPDES) permit. Non-compliance occurs mainly during heavy rain events. Stormwater inflow and infiltration (I & I) into the City of Clayton's aging sewage collection infrastructure oftentimes compromises or overwhelms the WWTP's ability to fully treat raw sewage before it is released back into Stekoa Creek, which is the WWTP's receiving stream. Stormwater I & I also periodically causes combined sewer overflows in the sewage collection system.

♦ **Agriculture** Predominant agricultural practices in the Stekoa Creek watershed allow livestock free access to streams, and generally do not employ riparian buffer strips and additional BMPs for pastures, field crops, waste management, etc. This creates ongoing, chronic sources of fecal coliform, erosion and sedimentation.

♦ **Roads** The Stekoa Creek watershed contains approximately 176 miles of roadway. The Stekoa Creek watershed has—by far—the most miles of roadway of all

Stormwater infiltration has caused numerous sewage spills into Scott Creek, a tributary to Stekoa Creek.

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All past stakeholder meetings about Stekoa Creek have cited concerns about inadequate enforcement of erosion and sedimentation laws.

the sub-watersheds in the Chattooga River watershed. For example, the Warwoman Creek watershed has the second highest cumulative mileage of roadways at 78.7 miles. (Source: Van Lear, et. al., Clemson University, 1995.) Impervious surfaces such as State Highway 441, State Highway 76, and the "Covered Bridge" shopping center parking lot (in Clayton, GA), as well as routine county gravel road maintenance regimes that direct stormwater discharge directly into Stekoa Creek and its tributaries, contribute large volumes of stormwater pollution as well as ongoing erosion and sedimentation during rain events.

♦ **Erosion and Sedimentation Laws** Without exception, all past stakeholder initiatives about Stekoa Creek's poor water quality have cited concerns about inadequate enforcement of erosion and sedimentation laws. Field surveys during the preparation of this WMP revealed that enforcement of erosion and sedimentation laws remains an active concern.

♦ **Trout Waters** Stekoa Creek and its tributaries are classified as trout waters by the GADNR. However, the severity of impairment in Stekoa Creek makes the stream completely dependent on the GADNR's stocking program to maintain its trout populations. The agency stocks Stekoa Creek 1x monthly from April through July, installing 200-300 fish per stocking event.

♦ **Issue Fatigue** Numerous stakeholder initiatives over the past 25 years targeting Stekoa Creek's persistent pollution problems have addressed such prominent issues as flood plain management; fecal coliform pollution; financing sewer system repairs; stormwater management; and, enforcement of erosion and sedimentation laws. Yet these efforts have yielded inadequate measureable progress on Stekoa's water quality issues. Thus, palpable issue fatigue combined with the status quo of entrenched land management practices and acceptance of Stekoa Creek as persistently polluted presents challenges to implementing some facets of the Stekoa WMP.

♦ **Intergovernmental Conflict** Historically, and in spite of the "issue fatigue" cited above, the public has rallied in support of cleaner water in the Stekoa Creek watershed. Yet ongoing conflicts and political divisions between the City of Clayton and Rabun County over issues of consolidation, ownership and service areas for sewer and water infrastructure present challenges to intergovernmental unity of purpose when it comes to prioritizing and squarely addressing measures for cleaning up Stekoa Creek in a timely manner.

Planning Approach

Developing the Stekoa WMP involved using relatively simple conceptual models as suggested by the EPA's *Handbook for Developing Watershed Plans to Restore and Protect Our Waters*. The conceptual models for the Stekoa WMP employed flow chart-based processes to define the water quality impairment, and then link the impairment with its environmental stressors and impacts, and the source(s) of the impairment. Utilizing a conceptual model is an accepted practice for identifying the relationships between: a) impairments of fecal coliform and sediment; b) sources of these water quality impairments; and, c) their impacts in the Stekoa Creek watershed.

The methodology for composing the Stekoa WMP followed the EPA's *Nine Elements of Watershed Planning* model, which is based on the nine elements presented in the Clean Water Act's section 319 guidelines. **Following these guidelines, the Stekoa WMP's priorities are to:**

✓ *Provide an analysis of the sources of the watershed's water quality problems*

✓ *Estimate the relative contributions from these sources and load reductions expected from applying appropriate best management practices (BMPs)*

✓ *Identify management, educational and financing measures to remediate these problems along with critical target areas for implementation*

✓ *Establish interim milestones to gauge progress on implementing BMPs*

✓ *Set up criteria to evaluate BMP effectiveness; how well WMP recommendations have addressed water quality issues; and, the need for future updates and revisions.*

1. Stream Selection

The U.S. Environmental Protection Agency and the Georgia Department of Natural Resources, Environmental Protection Division, have classified Stekoa Creek and four of its major tributaries as impaired under Section 303(d) of the Federal Clean Water Act for not meeting their designated use of fishing, due to excessive sediment and fecal coliform levels (See p. 9, Figure 2). Stekoa Creek has the dubious honor of being the very first stream in Georgia to receive a TMDLIP after U. S. District Court Judge Marvin Shoob's landmark ruling in 2000, which ordered the State of Georgia to establish maximum pollutant loads for waterways in the Savannah and Ogeechee River basins (See Figure 1, below; Stekoa Creek watershed, in the context of Rabun County and the State of Georgia).

Total Maximum Daily Load Implementation Plans (TMDLIP) for sediment and fecal coliform for the main stem of Stekoa Creek were completed in 2002, aimed at restoring Stekoa Creek to its designated use as a primary trout stream. Stekoa Creek's TMDLIPs were subsequently revisited and Tier 2 TMDLIPs were released in September 2007.

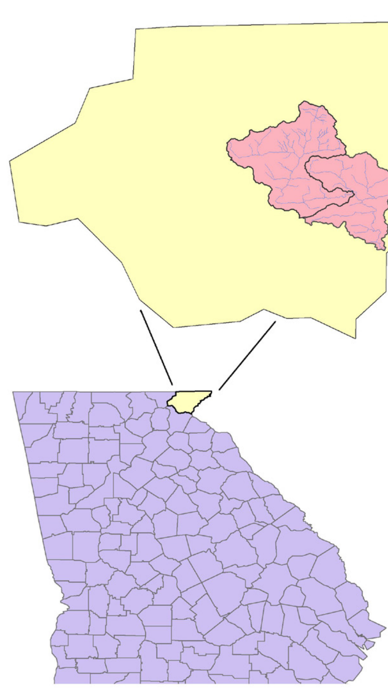
The impaired tributaries to Stekoa Creek, namely Scott Creek, Saddle Gap Branch, She/Pool Creek and Chechero Creek, also have Tier 2 TMDLIPs developed in 2002, for degradation of macroinvertebrate biota due to excessive sediment loadings.

In addition, Scott Creek, Saddle Gap Branch, She/Pool Creek and Chechero Creek are impaired from excessive levels of fecal coliform. However, Scott Creek, Saddle Gap Branch and Chechero Creek do not have TMDLIPs; these streams only have fecal coliform TMDL "implementation strategies" that are represented by water quality restoration "recommendations" in the EPA's 2006 fecal coliform TMDL for Scott Creek, Saddle Gap Branch and Chechero Creek. In other words, no Tier 2 TMDLIPs have been written for these three impaired streams.

Concerning She/Pool Creek, the GAEPD prepared a revised TMDLIP in 2007 for partially supporting streams due to fecal coliform bacteria in the Savannah and Ogeechee River Basins, and this TMDLIP addresses She/Pool Creek.

The City of Clayton, in partnership with the Chattooga Conservancy, recently completed a 319(h) project (August 2014) to begin addressing the Stekoa Creek watershed's impairments in alignment with the management measures outlined in the revised TMDLIPs. These efforts highlighted the need to develop a *Watershed Management Plan* for the Stekoa Creek watershed that addressed the EPA's "Nine Elements of Watershed Planning." Consequently, this watershed managememt plan would have the Stekoa watershed more competitively qualified for additional 319(h) grants, as well as other federal and state funding opportunities, which will be instrumental for implementing the management measures recommended in the plan.

Figure 1: Stekoa Creek Watershed
Rabun County / State of Georgia



Stream Selection

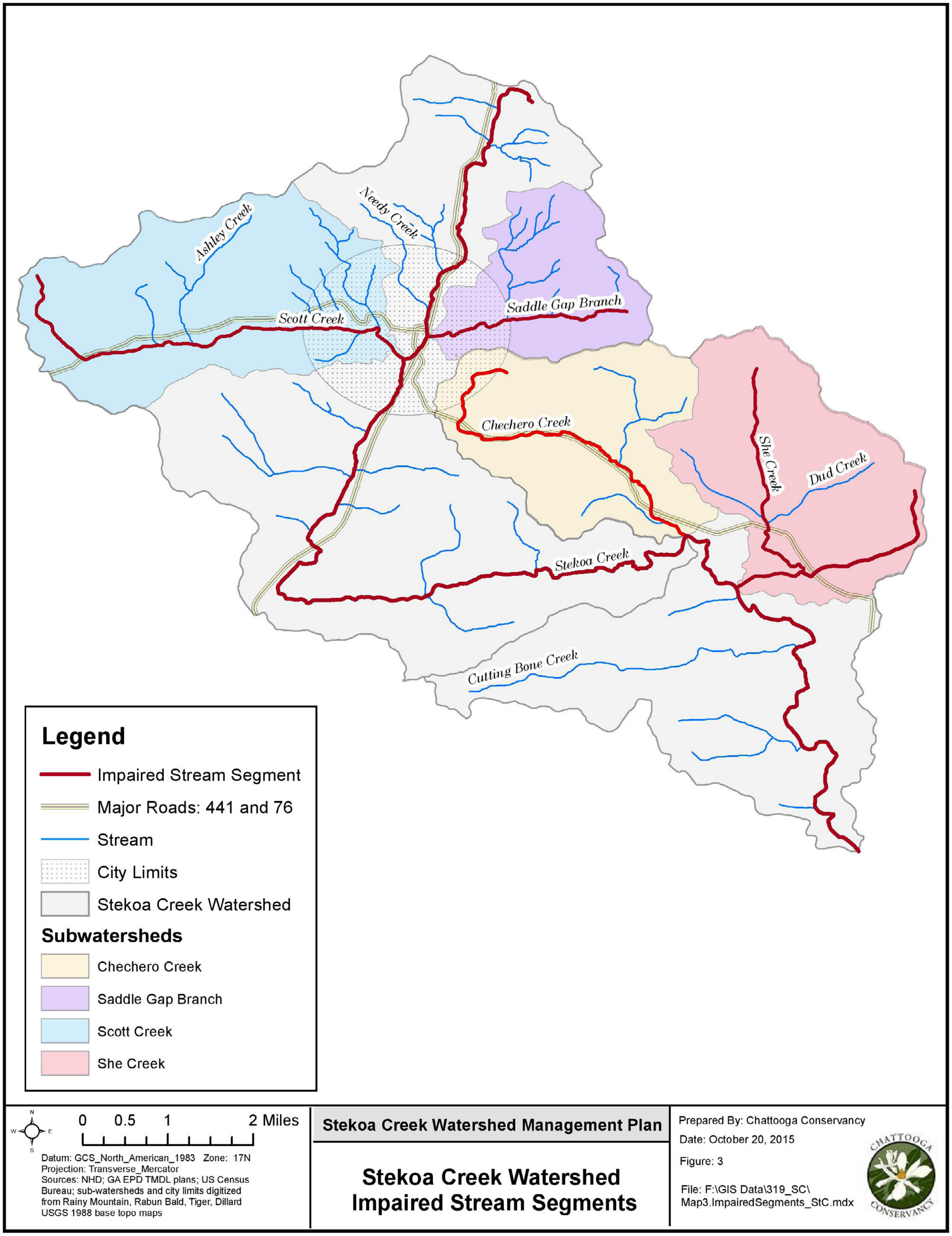


Figure 2: Stekoa Creek Watershed, Impaired Stream Segments

2. Formation of Watershed Advisory Committee

To assist in planning, developing and implementing the Stekoa WMP, a watershed advisory committee (WAC) was assembled. Members were selected from the following categories:

- Local government representatives: public works; water and wastewater departments; marshals; sewer and water authority
- Regional governmental representatives: health department; resource conservation and development council; regional commission
- State and federal representatives: GA Forestry Commission; US EPA; Natural Resource Conservation Service (NRCS); U. S. Forest Service
- Citizens' groups
- Environmental groups

WAC members were invited from the following specific entities:

- City of Clayton, Marshall
- City of Clayton, Public Works Director
- City of Clayton, Superintendent of Water Treatment
- Rabun County Sewer & Water Authority
- City of Clayton, GIS Analyst
- Chattahoochee-Oconee National Forest, Forest Fisheries Biologist
- Georgia Department of Natural Resources, Senior Fisheries Biologist
- Chestatee-Chattahoochee Resource Conservation & Development Council, Executive Director
- North GA Technical College & Soque River Watershed Partnership, Watershed Coordinator
- Rabun County Health Department; Environmental Health
- Rabun County Marshal, Planning & Zoning
- Natural Resources Conservation Service, District Conservationist
- Environmental Finance Center, Senior Project Director
- University of Georgia, Agricultural Extension Agent
- Georgia Conservancy
- Trout Unlimited, Rabun County Chapter
- Wildwater LTD., Vice-president/CEO
- Georgia Forestry Commission
- Georgia Mountains Regional Commission, Planning Director
- U. S. Forest Service, Chattooga River Ranger District

⇨ **See Appendix1 – List of WAC**

3. Source Assessment

The Stekoa Creek watershed source assessment started with a process called "characterizing the watershed." This involved reviewing the watershed's history, problems and pollutant sources, to provide the basis for developing effective management strategies specific to the goal of improving water quality in Stekoa Creek and its impaired tributaries. While providing historical information and current baseline data for the purposes of this watershed management plan, the characterization and analysis process also helped prioritize the most critical needs, issues of concern and the types of goals to strive to attain.

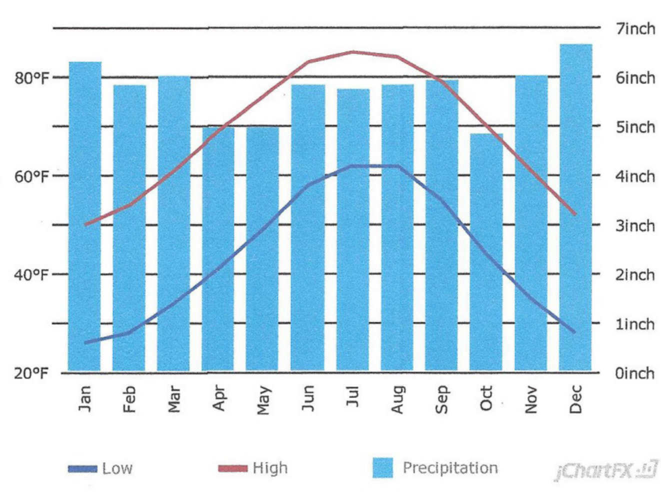
Characterize the Stekoa Creek Watershed

Population Rabun County, Georgia, was established on December 21, 1819, by the Georgia Legislature, and was comprised of land formerly occupied by the Cherokee Indians. The county was named for William Rabun, Governor of Georgia at that time. Since then, Rabun County's population has grown steadily, with two instances of a negative population growth during the early 1900's, and a small decline in 1950. According to the 2010 U.S. Census, the population of Rabun County is 16,276 and its population ranks 102nd out of Georgia's 159 counties. Since 1980, there has been a 55.5% increase in the total population of Rabun County, with the most significant period of growth rate being 29.2% between 1990 and 2000, yielding a net increase of 3,402 residents. As of the 2010 census, more than 70% of the county's total population lived in unincorporated areas, which has been true since the 1980's. The county seat of Clayton has fluctuated between population growth and decline over the past 30 years. Clayton experienced a negative population growth of -12.2% between 1980 and 1990. Since then, Clayton has had periods of rapid growth, 25.2% between 1990 and 2000, and slower growth, just 1.4% between 2000 and 2010 (Source: Rabun Co. Comprehensive Plan, 2013 draft).

Physiography Rabun County is located in two primary physiographic districts: the Blue Ridge Mountains District and the Gainesville Ridges District. The Blue Ridge Mountains District is part of the Blue Ridge physiographic province, which is part of the larger Appalachian Mountain range. The Blue Ridge Mountains District occupies almost the entire county, with the exception of a small portion along the Chattooga River. Rugged mountains and ridges ranging in elevation from 3,500 to 4,700 feet characterize the district, with both narrow and wide stream valleys, many of which lay 1,500 to 2,000 feet below adjacent mountaintops. The southeastern edge of the county has a small strip of the Gainesville Ridges District, which is part of the Piedmont Province. The Gainesville Ridges District is characterized by northeast trending, low parallel ridges dissected by narrow stream valleys, and range from 1,500 to 1,600 feet in elevation. (Source: Rabun Co. Comprehensive Plan, 2013 Draft).

Climate Historically, Rabun County touts the area as a place "Where Spring Spends the Summer." During the winter, valleys are very cool with freezing temperatures and also occasional warming trends; upper slopes and mountain tops are generally quite cold. Precipitation in the winter is usually in the form of rain with some instances of snow, freezing rain and ice storms. Storms with frozen precipitation may be heavy; however, ice and snow cover generally does not persist. During the summer, valleys are very warm and frequently hot, and mountains that are hot during the day usually become pleasantly cool at night. Precipitation is heavy and usually distributed throughout the year, with an annual average rainfall of over 70 inches; in fact, the greater Chattooga River watershed receives the largest quantity of annual precipitation of any area east of the Mississippi. Summer precipitation falls chiefly during thunderstorms, and heavy rain events are common.

Table 1: Precipitation & Temperature Clayton, Georgia 1981-2010



Source: usclimatedata.com, 1981-2010 annual weather patterns

Groundwater Recharge Areas Recharge is the process by which precipitation infiltrates soil and rock to add to the volume of water stored in pores and other openings. Aquifers are soils or rocks that will yield water to wells, and major ground water resources may develop where permeable aquifers underlie or are connected to extensive areas for recharge. Most of northeast Georgia is underlain by crystalline rocks with complex geologic character and with little or no porosity

Source Assessment

Table 2: Hydrology - Wetlands & Impoundments in the Stekoa Creek Watershed

Watershed	wetland forested, shrub	wetland emergent	wetland farmed, other	wetland riverine	impoundments
Stekoa Creek; upper	25.9 ac	1.4 ac	.79 ac	-	31 ac
Stekoa Creek; lower	18.9 ac	2.2 ac	3.2 ac	1.4 ac	12.4 ac
Scott Creek	-	-	-	-	5 ac
Saddle Gap Branch	1.5 ac	-	-	-	4.2 ac
Chechero Creek	3.4 ac	-	-	-	7.5 ac
She Creek & Pool Creek	7.9 ac	1.5	3.4 ac		3.6 ac
Cutting Bone Creek	3.4 ac	.67 ac	-	-	.14

Source: U. S. Fish & Wildlife Service, National Wetlands Inventory, 2015

within the rocks. While the overall porosity tends to be low, the rocks do contain joints and fractures along which groundwater can move. The crystalline rocks are overlain by a weathered zone called saprolite, which is relatively porous. Precipitation infiltrates downward into the soil and saprolite, and fills fractures and joints in the rock where they occur. Wells can obtain water either from the saprolite or from the fractures in the rock; however, the most reliable sources of groundwater are from zones where the bedrock has been intensely fractured.

The most significant recharge areas in the Blue Ridge District are areas of thick soils/saprolite characterized by low slope, and since the Blue Ridge District contains higher elevations and steep slopes, significant groundwater recharge areas are not common. Only two small groundwater recharge areas are documented in Rabun County: one area is located close to the northern border of the Stekoa Creek watershed, and one area is just to the west of the Stekoa watershed. (Source: GA DNR Hydrologic Atlas 18, 1989).

Hydrology - Wetlands & Impoundments The presence of wetlands and freshwater impoundments in the Stekoa Creek watershed was assessed using the U. S. Fish & Wildlife Service's National Wetlands Inventory. This inventory is shown above. (see Table 2, above)

land Use & Habitat Due to the mountainous topography, both agricultural and urban/residential intensive land uses are concentrated along the streams in Rabun County, which include the impaired waterways of Stekoa, Scott, Chechero and She/ Pool Creeks, and Saddle Gap Branch. Stekoa Creek, in particular, bears the brunt of the negative impacts from its proximity to the State Highway 441 corridor, which is an impervious surface with major stormwater management deficiencies that continue to exacerbate water quality problems in the stream. A report sponsored by the Forest Service in 1995 concluded that open graveled and unsurfaced roads, and unfenced pastures in riparian areas, were also major sediment sources (Source: Van Lear et. al., Clemson University). This report further stated that of all the sub-basins in the entire Chattooga River watershed, the Stekoa Creek watershed had by far the most miles of roads, at 173 miles. (See p. 13, table 3, land use, & p. 14, Fig. 3, land Cover map.)

Soils Most of the soils in the Stekoa watershed have a mica content just below the level to be classified as micaceous, and are considered very erosive. (Source: Hansen, USFS 1998). The entire Chattooga River watershed is located within the Blue Ridge Belt, and is a combination of sedimentary and metamorphic rock. The Chattooga watershed is underlain by crystalline bedrock composed primarily of gneisses, mica-schists, quartzes and granites. Loamy, erodible mountain soils have formed from these parent materials in a cool climate characterized by abundant rainfall. At higher elevations, the narrow ridges and steep slopes typically produce shallow sandy loam soils. Middle slopes and broader ridges have deeper, well-drained soils of a fine sandy clay loam texture. Toe slopes and coves have the deepest soils, developed from colluvial material. Soils are readily erodible once the vegetative cover and forest floor have been removed. Many soils and the underlying saprolite (weathered parent material) are heavy in micaceous schist, a material that erodes easily. (Source: Van Lear et. al., Clemson University, 1995.) (See p. 15, figure 4, soils map & key to soils map.)

Flood Plain Management – History Much of Stekoa Creek's flood plain along the State Highway 441 corridor has been filled, resulting in expansive, impervious surfaces directly abutting streambanks; concrete embankments in certain places; mounds of fill dirt and rocks next to the creek; and, massive piles of packed dirt upon which sit developments. These filling activities have caused very large quantities of sediment to be deposited into the main stem of Stekoa Creek, as follows.

Source Assessment

Land Use in the Stekoa Creek Watershed				
Table 3	*Urban low intensity*	*Urban high intensity*	*Clearcut / sparse*	*Deciduous forest*
	13.5%	*1.4%*	*.51%*	*65.25%*
Evergreen forest	*Mixed forest*	*Row crop & pasture*	*Wetland forested*	*Open water*
12.78%	*1.5%*	*4.4%*	*.135%*	*.08%*

Source: Natural Resources Spatial Analysis Lab (NARSAL), Land Use Trends 2008

The Georgia Department of Transportation's (GA DOT) archived map collection shows that as early as 1952, State Highway 441 ran roughly parallel to Stekoa Creek, from the creek's headwaters in Mountain City to just south of Clayton's city limits. Then in 1965, GA DOT re-routed the roadbed south of Clayton by constructing a new section of highway that also was in close proximity to Stekoa Creek. Thus, Highway 441 is positioned next to Stekoa Creek from the stream's origins in Mountain City, all the way to Tiger, GA, near the southern border of the Stekoa watershed. Establishing a level surface for State Highway 441 required filling much of Stekoa Creek's floodplain, that caused erosion and sedimentation deposits into the creek, and created many active vectors of chronic stormwater pollution runoff into the stream.

In the early 1980s, the City of Clayton withdrew from the National Flood Plain Insurance Program (NFIP). However, without flood plain insurance the city was unable to get grants and loans, so by early 1989, Clayton had complied with the minimum requirements to be reinstated in the NFIP. (At this time FEMA commented: "However, in light of the city's past performance in the program and the highly detrimental flood plain development which occurred during the period of the city's withdrawal from the NFIP, we will continue to monitor Clayton's flood plain management program closely to assure its continued compliance.") Yet, the City of Clayton neglected to enforce its flood plain protection ordinance as required by FEMA.

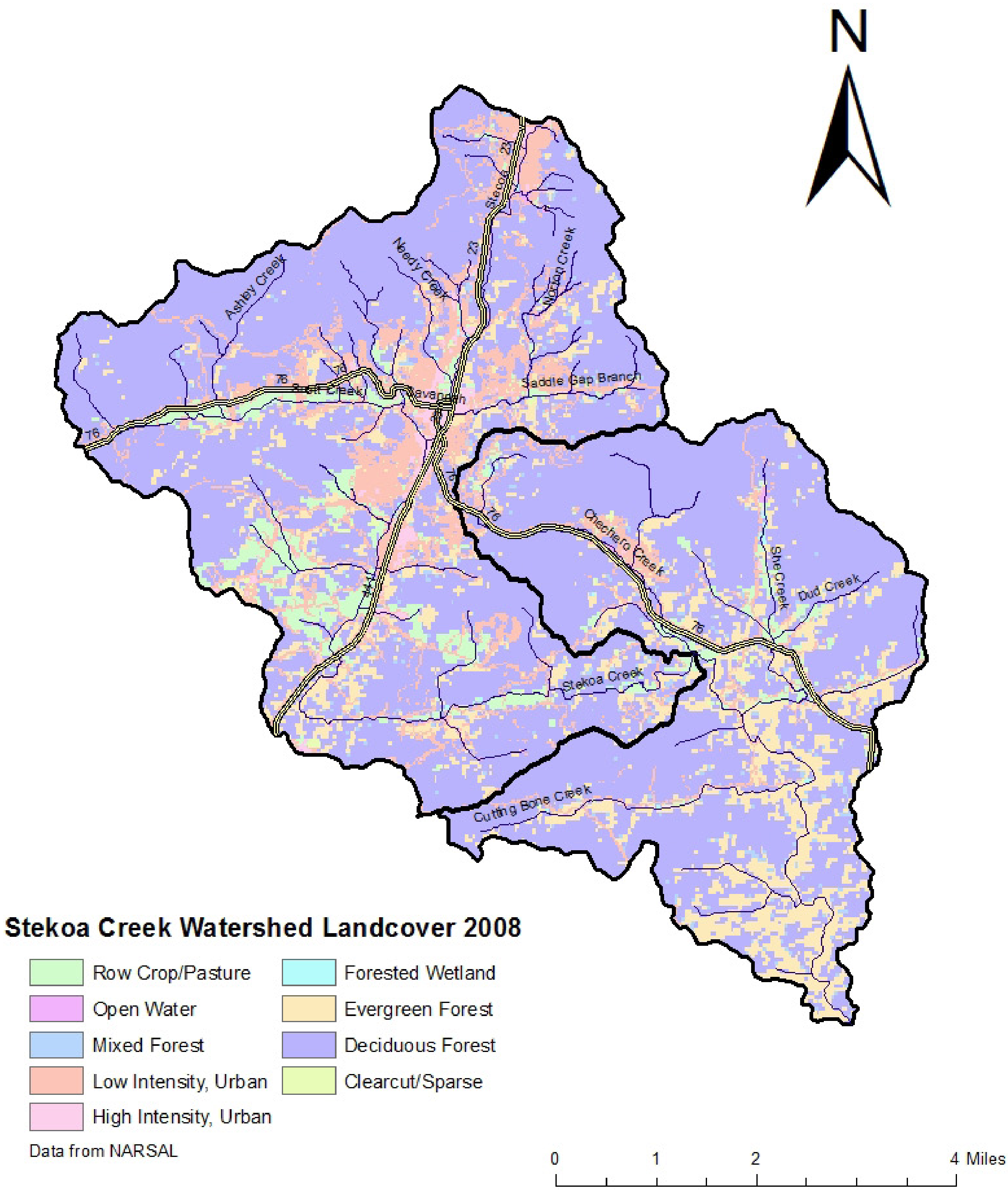
In 2004, the steep topography on the east side of Highway 441 near the Clayton WWTP was leveled to make a flat spot for installing Wal-Mart and Home Depot buildings. Massive amounts of dirt were trucked across Hwy. 441 to fill Stekoa Creek's floodplain, while also re-routing and channelizing the creek for a linear distance of approximately ½ mile. The floodplain filling project was ongoing during a series of major storm events, and the lack of erosion and sedimentation BMPs resulted in enormous quantities of dirt being deposited into Stekoa Creek. Curiously, this project was authorized by the NRCS and was therefore exempt from the GAEPD's erosion and sedimentation regulatory laws, and subsequent enforcement actions. This event remains infamous in the history of land-disturbing and flood plain-filling activities along Stekoa Creek (See p. 16, photo).

In January 2008, Ramey Enterprises (Ramey Enterprises' principal was Tom Ramey Sr., Clayton's mayor at the time) began filling in the Stekoa Creek flood plain within the "floodway" area as defined by FEMA, at the confluence of Stekoa Creek and Needy Creek. Ramey Enterprises was not in compliance with the city's flood plain protection ordinance, and the city marshal issued a stop-work order. Shortly afterwards (at the request of the Chattooga Conservancy) the city imposed a moratorium on all filling in the Stekoa Creek flood plain, and the measure passed Clayton City Council by a unanimous vote. The city marshal also attended a training course on flood plain management, sponsored by the State of Georgia. Here, state trainers recommended changing Clayton's flood plain ordinance that had just prohibited all

A large parking lot built in the flood plain next to Stekoa Creek covers the stream's 50-foot buffer zone, and discharges all of its stormwater runoff directly into the creek.

Source Assessment

Figure 3: Land Cover in the Stekoa Creek Watershed



Source Assessment

Table 4 Key to Soil Types

⇨ *This key contains the soil type and its brief description, and the corresponding acreage of the soil type in the Stekoa Creek watershed*

ACE Ashe-Porters association, moderately steep; *88.4 acres*

ADG Ashe association, stony, very steep; *215.4 acres*

BrC Bradson fine sandy loam, 2 to 10% slopes; *579.4 acres*

BrE Bradson fine sandy loam, 10 to 25% slopes; *4,788.9 acres*

Ch Chatuge loam; *354.7 acres*

DhC Dillard sandy loam, 2 to 6% slopes; *246.2 acres*

DyE Dyke loam, 10 to 25% slopes; *26.3 acres*

EdE Edneyville sandy loam, 10 to 25% slopes; *35.7 acres*

EPF Edneyville-Ashe association, stony, steep; *1,640.8 acres*

EVF Evard association, steep; *1,319.2 acres*

HaC Hayesville fine sandy loam, 2 to 10% slopes; *87.3 acres*

HaE Hayesville fine sandy loam, 10 to 25% slopes; *5,529.2 acres*

PCF Porters association, stony, steep; *75.7 acres*

PCG Porters association, stony, very steep; *88.9 acres*

RLF Ramsey-Lily association, stony, steep; *19.9 acres*

Rx Rock outcrop; *37.4 acres*

SAE Saluda association, moderately steep; *433.5 acres*

SBG Saluda and Ashe stony soils, very steep; *300.2 acres*

To Toccoa fine sandy loam; *303.1 acres*

Tr Transylvania-Toxaway complex *853.1 acres*

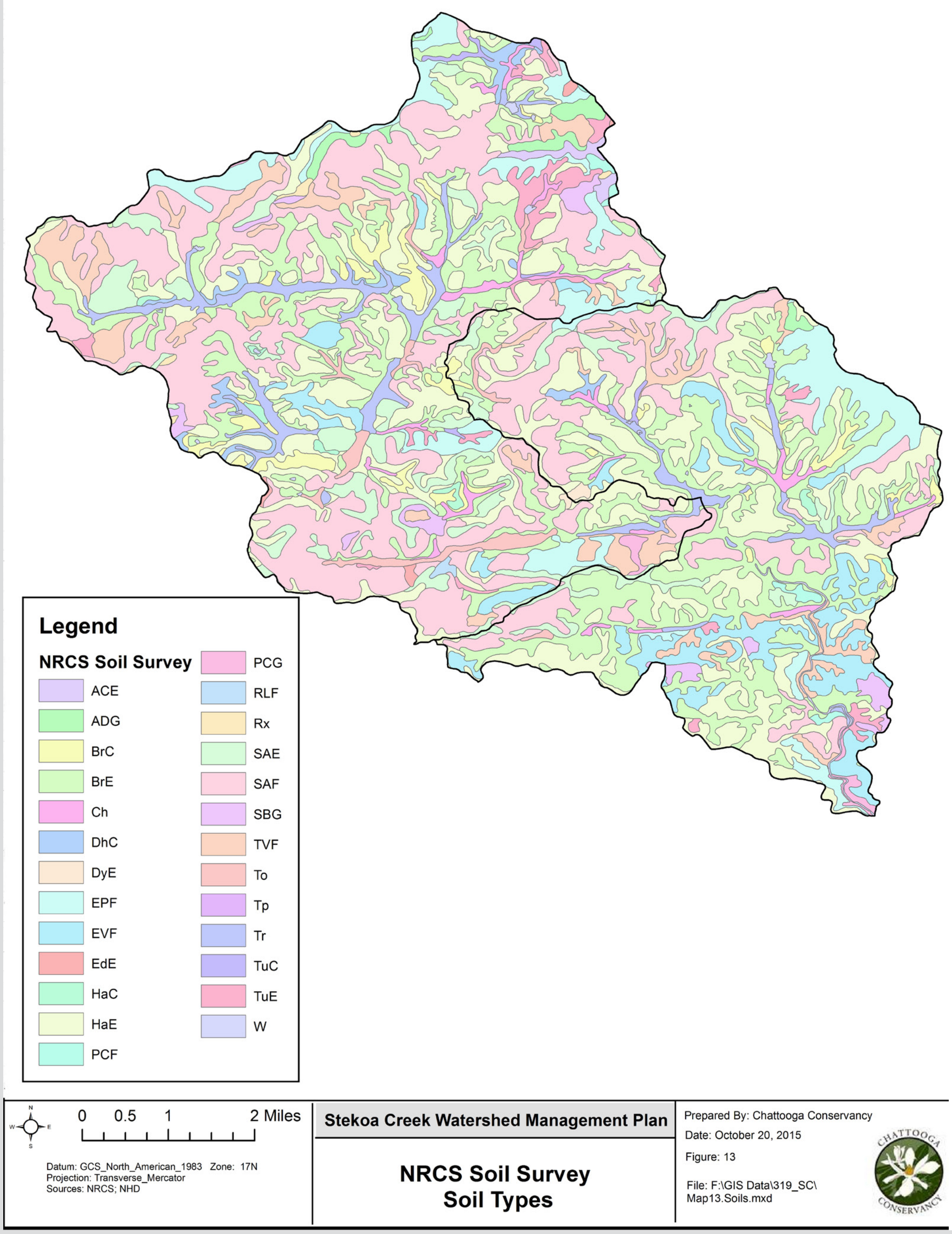
TuC Tusquitee loam, 4 to 10 percent slopes; *63.3 acres*

TuE Tusquitee loam, 10 to 25% slopes; *416.1 acres*

TVF Tusquitee-Haywood association, steep; *1,275 acres*

W Water; *76.5 acres*

Figure 4: Soil Types in the Stekoa Creek Watershed



Source Assessment

filling in the floodway, putting forth the justification that such a prohibition would invite a "takings" lawsuit based on the argument that private property development rights were being taken away by this restriction. The city council abided, and essentially created an opportunity for more floodway filling if the project's engineering studies could claim "no rise," i.e., no increase in water levels during base flood events.

Sewage Collection System and Wastewater Treatment - History The City of Clayton's sewage collection system has persistently contributed to chronic water quality problems related to bacterial pollution. Failing septic systems were also suspected to be causing elevated fecal coliform counts. In addition, the Forest Service concluded that there were a number of problems other than just the sewage treatment infrastructure in Clayton, such as livestock that were allowed to free range into riparian areas and streams.

In 1974, the Chattooga River was included in the National Wild & Scenic Rivers System; however, the section of the Chattooga below Stekoa Creek was so polluted that it was almost excluded from national wild and scenic designation. The *Wild and Scenic Study Report* (USDA Forest Service, 5/1970) for the Chattooga River concluded that Stekoa Creek was the only polluted tributary to the Chattooga, and that fecal coliform counts below the Stekoa/Chattooga confluence were 20 times higher than that suitable for "wild" river classification. Of note was the report's finding that the City of Clayton was dumping "partially treated to raw sewage into the creek." However, the report determined that the section of river polluted by Stekoa Creek should be included in the wild and scenic rivers system, based on the City of Clayton's plans to construct a sewage treatment plant. Clayton completed construction of their sewage treatment facility in 1975.

Water quality problems persisted and on February 3, 1982, the *Clayton Tribune* reported that the Mayor of Clayton admitted that the plant had "never actually met state permit requirements." Subsequent investigations revealed that flow through the sewage treatment plant was often in excess of 5 times of what the plant was designed to handle. The problem stemmed from leaky sewage collection infrastructure compounded by heavy annual rainfall, which periodically caused the holding ponds at the

In 2004, the steep topography on the east side of Highway 441 was leveled to make a flat spot for development, and the earth was used for filling a portion of Stekoa Creek's floodplain, putting a massive amount of dirt into the creek.

Source Assessment

sewage treatment plant to overflow and dump raw sewage into Stekoa Creek.

In March of 1993, GADNR again conducted investigations of continued violations of Clayton's sewage treatment plant, which showed violations of permit limitations. Meanwhile, other problematic issues were beginning to surface. A report by the Environmental Quality Institute issued in December 1993 entitled *A Preliminary Assessment of Pollutant Sources in the Stekoa Creek Watershed* revealed problem sites that included 2 major earth-moving projects on Highway 441 next to Stekoa Creek to create level building sites, as well as a failing GA DOT road-cut on Highway 76 between Clayton and the Chattooga River, and a malfunctioning wastewater treatment plant on the Kingwood County Club property that was degrading Chechero Creek (impaired tributary to Stekoa).

The Wild and Scenic Study Report for the Chattooga River concluded that Stekoa Creek was the only polluted tributary to the Chattooga, and that fecal coliform counts below the Stekoa/Chattooga confluence were 20 times higher than that suitable for "wild" river classification.

The Georgia Center for Law in the Public Interest examined the Clayton sewage treatment plant's NPDES monitoring reports for 1994-95, which revealed "serious noncompliance with a number of requirements, including those pertaining to total suspended solids, biochemical oxygen demand and pH," and concluded that there were hundreds of NPDES permit violations over the past few years. The center's report also found that Clayton had upgraded their sewage treatment facility in October 1994, which resulted in some improvement. In June 1995, the city entered into a consent agreement with the GAEPD to install further upgrades to the sewage treatment facility, and during 1996-97, the City of Clayton implemented the additional upgrades.

SEWAGE COLLECTION SYSTEM AND WASTEWATER TREATMENT - CURRENT STATUS The City of Clayton provides wastewater treatment for the towns of Clayton, Mountain City and Tiger. The WWTP is located next to State Highway 441 and Stekoa Creek in Clayton. It is inconclusive whether or not the wastewater treatment plant lies partially within Stekoa Creek's flood plain.
The WWTP has a permit to discharge up to .5 million gallons per day (MGD) of treated sewage effluent into Stekoa Creek. The system serves approximately 1,450 residential and commercial customers.
The WWTP's sewage collection infrastructure is prone to inflow, infiltration and leakage problems, and has been identified as a significant contributor to the degradation of Scott Creek (impaired tributary to Stekoa) and Stekoa Creek. (SOURCE: STEKOA CREEK TIER 2 TMDLIP 9/14/07.) The City of Clayton has continued work to make additional improvements in the WWTP as well as to the sewage collection infrastructure; for example, the city commissioned studies of the collection system, and applied for state and federal grants to replace components of the system. Of note is a recent study dated August 2015 by McKim & Creed, which estimates that $2.5 million is needed to repair and rehabilitate the sewage collection infrastructure.

Sewer limitations and service problems have contributed to political disagreements between the City of Clayton and Rabun County, and have resulted in lawsuits over water/sewer access and fees. (Source: Rabun Co. Comprehensive Plan, 2013 Draft). This has hindered intergovernmental coordination, and presents ongoing challenges for repair and rehabilitation of the sewage collection system and by consequence, improving water quality in Stekoa Creek.

ONSITE SEWAGE DISPOSAL SYSTEMS The majority of unincorporated Rabun County is served by septic systems. Septic systems may be appropriate for many areas; however, variables such as soil type, soil depth, slope angle and general maintenance of the system affect the absorption and filtration capability of septic tanks and drain fields. There is not an ordinance in Rabun County requiring septic systems to be pumped out on a regular basis, which is critical for the system's long-term viability to effectively treat sewage on site. Failing septic systems in the Stekoa Creek watershed have been identified as a significant contributor to degradation of water quality. (SOURCE: STEKOA CREEK TIER 2 TMDLIP 9/14/07.)

SOURCE LOADS AND LOAD REDUCTIONS NEEDED
◈ *For summary of source loads and reductions needed, see p. 20, Table 5.*

◈ Stekoa Creek

The Tier 2 TMDL Implementation Plan (revision 2) dated 9/14/07 states that 14 miles of Stekoa Creek, from the City of Clayton to the Chattooga River, do not meet water

Source Assessment

quality standards due to excessive levels of fecal coliform. The primary sources of fecal coliform pollution in Stekoa Creek have been identified as originating from the City of Clayton's leaking sewage collection infrastructure; failing septic systems in close proximity to Stekoa Creek and/or its tributaries and floodplain; and, agricultural livestock with access to the stream and/or with pens that drain directly into the creek. The TMDL Plan calls for a 76% reduction of the existing fecal coliform waste load for Stekoa Creek to meet its designated water quality standards for fishing, and as a primary trout stream.

Stekoa Creek also has a Tier 2 TMDL Implementation Plan (rev. 2) dated 9/14/07, which states that 14 miles (*incorrect mileage; see note below*) of Stekoa Creek, from upstream of the City of Clayton to the Chattooga River, do not meet water quality standards for the "ability to maintain the biological integrity of the waters of the state" due to excessive levels of sediment. The primary sources of sediment pollution have been identified as originating from urban and residential impervious surfaces and land disturbing activities; agricultural soil exposure; and, land disturbance associated with forestry activities. The TMDL Plan calls for a 75% reduction of the existing sediment load for Stekoa Creek to meet water quality standards.

A massive amount of dirt was deposited in Chechero Creek during the reconstruction of the Kingwood Country Club golf course in 1999.

**Note:*
Contemporary GIS used for this WMP computed the following stream mileages for Stekoa Creek:

- Mountain City (source) to Clayton city limits / northern boundary: 2.9 miles
- Mountain City (source) to Clayton city limits / southern boundary: 5.08 miles
- Clayton city limits / southern boundary, to Chattooga River 12.9 miles

- **Stekoa Creek, total length: 17.98 miles**

◈ Chechero Creek

The Tier 2 TMDL Implementation Plan (revision 2) dated 9/14/07 states that 1.5 miles of Chechero Creek do not meet water quality standards for "ability to maintain the biological integrity of the waters of the state," due to excessive levels of sediment. The primary sources of sediment pollution have been identified as originating from urban and residential impervious surfaces and land disturbing activities; agricultural soil exposure; and, land disturbance associated with forestry activities. The TMDL Plan calls for a 50% reduction of the existing sediment load for Chechero Creek to meet water quality standards.

The US EPA also added Chechero Creek to the State of Georgia's 303(d) list for fecal coliform impairment in 2006 (SOURCES: *APPENDIX B, WATER QUALITY IN GEORGIA 2004-2005*, ALSO REFERENCED AS *GEORGIA'S 2006 305(B) REPORT & FINAL TMDL FOR FECAL COLIFORM IN SCOTT CREEK*, *CHECHERO CREEK & SADDLE GAP BRANCH CREEK*, USEPA, OCTOBER 2006). The probable sources of fecal coliform pollution have been determined to be originating from the City of Clayton's leaking sewage collection infrastructure; failing septic systems in close proximity to Stekoa Creek and/or its tributaries and floodplain; and, agricultural livestock with access to the stream and/or with pens that drain directly into the creek. The EPA's 2006 fecal coliform TMDL for Chechero Creek calls for seasonal reductions in bacteria loadings of 97% during the summer and 7% during the winter.

◈ Scott Creek

The Tier 2 TMDL Implementation Plan (revision 2) dated 9/14/07 states that 3.5 miles of Scott Creek do not meet water quality standards for "ability to maintain the biological integrity of the waters of the State," due to excessive levels of sediment. The primary sources

Source Assessment

of sediment pollution have been identified as originating from urban and residential impervious surfaces and land disturbing activities; agricultural soil exposure; and, land disturbance associated with forestry activities. The TMDL Plan calls for a 50% reduction of the existing sediment load for Scott Creek to meet water quality standards for fishing and as a primary trout stream.

The US EPA also added Scott Creek to the State of Georgia's 303(d) list for fecal coliform impairment in 2006 (Source: *Appendix B, Water Quality in Georgia 2004-2005*, also referenced as *Georgia's 2006 305(b) Report)*. The probable sources of fecal coliform pollution have been determined as originating from the City of Clayton's leaking sewage collection infrastructure; failing septic systems in close proximity to Scott Creek and/or its tributaries and floodplain; and, agricultural livestock with access to the stream and/or with pens that drain directly into the creek. The EPA's 2006 fecal coliform TMDL on Scott Creek calls for seasonal reductions in bacteria loadings of 97% during the summer and 0% in the winter.

◈ Saddle Gap Branch

The Tier 2 TMDL Implementation Plan (rev. 2), dated 9/14/07 states that 3.5 miles of Saddle Gap Branch do not meet water quality standards for "ability to maintain the biological integrity of the waters of the State," due to excessive levels of sediment. The primary sources of sediment pollution have been identified as originating from urban and residential impervious surfaces and land disturbing activities; agricultural soil exposure; and, land disturbance associated with forestry activities. The TMDL Plan calls for a 77% reduction of the existing sediment load for Saddle Gap Branch to meet water quality standards.

The US EPA also added Saddle Gap Branch to the State of Georgia's 303(d) list for fecal coliform impairment in 2006 (Source: *Appendix B, Water Quality in Georgia 2004-2005,* also referenced as *Georgia's 2006 305(b) Report*). The probable sources of fecal coliform pollution have been determined as originating from the City of Clayton's leaking sewage collection infrastructure; failing septic systems in close proximity to Saddle Gap Branch and/or its floodplain; and, agricultural livestock with access to the stream and/or with pens that drain directly into the creek. The EPA's 2006 fecal coliform TMDL on Scott Creek calls for seasonal reductions in bacteria loadings of 93% during the summer and 0% during the winter.

◈ She/Pool Creek

Note: She Creek and Pool Creek are coupled in this WMP because Pool Creek is a small tributary to She Creek.

The Tier 2 TMDL Implementation Plan (revision 2), dated 9/14/07 states that 3 miles of She Creek and 2 miles of Pool Creek do not meet water quality standards for "ability to maintain the biological integrity of the waters of the State," due to excessive levels of sediment. The primary sources of sediment pollution have been identified as originating from urban and residential impervious surfaces and land disturbing activities; and, land disturbance associated with forestry activities. The TMDL Plan calls for a 70% reduction of the existing sediment load for She/Pool Creek to meet water quality standards.

The US EPA also added She Creek to the State of Georgia's 303(d) list for fecal coliform impairment in 2006 (Source: *Appendix B, Water Quality in Georgia 2004-2005,* also referenced as *Georgia's 2006 305(b) Report*). The probable sources of fecal coliform pollution have been determined as originating from failing septic systems in close proximity to She Creek and/or its floodplain; and, agricultural livestock with access to the stream and/or with pens that drain directly into the creek. The GAEPD 2007 *Revised TMDLIP for Partially Supporting Streams due to Fecal Coliform Bacteria in the Savannah and Ogeechee River Basins* calls for no reduction needed in bacteria loadings to She Creek.

Pool Creek is a small tributary to She Creek and is approximately 1.6 miles in length. The US EPA developed a sediment TMDL for She/Pool Creek in 2005 and added the two segments to the State of Georgia's 303(d) list in 2006 as being impaired due to sediment (Source: *Appendix B, Water Quality in Georgia 2004-2005*, also referenced as *Georgia's 2006 305(b) Report*). The 2007 sediment TMDLIP for She/Pool Creek calls for a 70% reduction to meet water quality standards.

Environmental Indicators of Water Pollution

The environmental indicators for measuring levels of water pollution in this WMP will focus on fecal coliform and *E. coli* as the primary indicators of bacteria, and turbidity as the primary indicator of sediment loads. These indicators were chosen based on current TMDLIPs for the subject waterways as well as the historical record of quantitative data that has been assembled for evaluating water quality in Stekoa Creek, which will allow for a consistent quantitative measurement of progress towards improving water quality in the watershed. To help measure progress in improving water quality, this WMP will also consider the water quality performance indicators of stream temperature, the presence or absence of optical brighteners, and the quality of riparian and in-stream habitat.

Table 5

Stream Segments Not Supporting / Partially Supporting Designated Uses in the Stekoa Creek Watershed				
Waterbody • ***Designated Use*** • ***Status***	• ***Reach*** • ***Extent***	• ***Criterion Violated*** • ***Percent Reduction Needed from TMDL***	***Potential Causes***	***Date Listed***
Stekoa Creek • Fishing • Impaired: fecal coliform	• Clayton to Chattooga River • 14 miles	• Fecal coliform 76% reduction	*Urban*: leaking sewer systems *Residential*: leaking septic systems *Agricultural*: livestock	TMDLIP 2002 Revision 9/2007
Stekoa Creek • Fishing • Impaired: sediment	• Upstream of Clayton to Chattooga River • 18 miles	• Bio (sediment) 75% reduction	*Urban/residential*: impervious surfaces and land disturbance. *Forestry*: land disturbance. *Agricultural*: soil exposure	TMDLIP 2002 Revision 9/2007
Scott Creek • Fishing • Impaired: sediment, fecal coliform.	• Rabun County • 3.5 miles	• Bio (sediment) 50% reduction • Fecal coliform 97% reduction - summer 0% reduction – winter	*Urban/residential*: Impervious surfaces and land disturbance. *Forestry*: land disturbance. *Agricultural*: soil exposure	TMDLIP sediment, 9/2007 EPA listed for fecal coliform; EPA fecal coliform TMDL, 2006
Chechero Creek • Fishing • Impaired: sediment, fecal coliform.	• Rabun County • 1.5 miles	• Bio (sediment) 50% reduction • Fecal coliform 97% reduction – summer 7% reduction - winter	*Urban/residential*: Impervious surfaces & land disturbance. *Forestry*: land disturbance. *Agricultural*: soil exposure	TMDLIP sediment 9/2007 EPA listed for fecal coliform in 2006; EPA fecal coliform TMDL, 2006
Saddle Gap Branch • Fishing • Impaired: sediment, fecal coliform	• Rabun County • 3.5 miles	• Bio (sediment) 77% reduction • Fecal coliform 93% reduction – summer 0% reduction - winter	*Urban/residential*: impervious surfaces & land disturbance. *Forestry*: land disturbance. *Agricultural*: soil exposure	TMDLIP sediment 9/2007 EPA listed for fecal coliform in 2006; EPA fecal coliform TMDL, 2006
She/Pool Creek • Fishing • Impaired: sediment • EPA listed for fecal coliform.	Rabun County 3 miles/She 1.6 miles/Pool	• Bio (sediment) 70% reduction • Fecal coliform She Creek only - No reduction needed.	*Urban/residential*: impervious surfaces & land disturbance. *Forestry*: land disturbance.	TMDLIP sediment 9/2007 EPA listed for fecal coliform in 2005, She Creek only; GAEPD fecal coliform TMDLIP, 2007

4. Assessment and Characterization of Current Conditions

▶ Visual Stream Survey

The visual stream surveys of the Stekoa Creek watershed occurred from July 2013 to December 2014. These surveys covered Stekoa Creek, Chechero Creek, Scott Creek, Saddle Gap Creek, She/Pool Creek and Cutting Bone Creek. (Note: Cutting Bone Creek is not 303(d)/305(b) listed; however, the EPA recommended that Cutting Bone Creek be put on a "watch list" for sediment impairment. [Source: *Assessment of Water Quality Conditions, Chattooga River Watershed*, USEPA, 5/1999].

♦ Stekoa Creek

Stekoa Creek Watershed - Overview

The Stekoa Creek watershed is approximately 45 square miles encompassing 26,058 acres, and includes about 66.5 miles of streams before reaching the Chattooga River. The entire watershed consists of 84% private land and 16% national forest land, with approximately 173 miles of roadway. (Source: Van Lear et. al., Clemson University, 1995.) Stekoa Creek contributes 60% of the total suspended solid load in the Chattooga River, yet its land base is only 12% of the Chattooga River watershed area (Source: Hansen, USFS, 11/1998).

⦿ ***Land cover in the Stekoa Creek watershed*** *is summarized in* ***Table 6***. (Source: NARSAL, 2008)

Table 6	*Urban, low intensity*	*Urban, high intensity*	*Clearcut sparse*	*Deciduous forest*
	13.5%	*1.4%*	*.51%*	*65.3%*
Evergreen forest	*Mixed forest*	*Row crop & pasture*	*Wetland forested*	*Open water*
12.8%	*1.5%*	*4.4%*	*.14%*	*.08%*

Visual Stream Survey - Overview

➢ Stekoa Creek is a third order tributary to the National Wild & Scenic Chattooga River, and originates close to the Eastern Continental Divide at 2,240 feet above sea level near Cox Lake in Mountain City, GA. Stekoa Creek flows primarily south and then east over the course of approximately 18 miles, from the headwaters down to its confluence with the Chattooga, which is about halfway down the river's renowned Section IV.

➢ The stream's gradient is somewhat steep in the first 4 miles, mostly moderate in the middle 8 miles and very steep in the last 6 miles, with an average gradient of about 71 feet per mile. (Source: Hopey, UNC Asheville, 1995).

➢ Annual precipitation in the watershed is from around 70 inches in the north to over 45 inches near the tributary's mouth at the Chattooga River, and is characterized by heavy storm events.

Stekoa Creek contributes 60% of the total suspended solid load in the Chattooga River, yet its land base is only 12% of the Chattooga River watershed area.

➢ From Mountain City, Stekoa Creek runs parallel to State Highway 441 for about 6 miles, through a landscape that generally appears as small town / urban, with established stretches of sprawl, roadside residential areas, pockets of agricultural activities, and visible elements of expanding development. The natural hydrology of Stekoa Creek's upper reach has been vastly altered by the presence of the State Highway 441, which was completely routed onto a parallel course with Stekoa Creek as of 1965. This section of the Highway 441 corridor is a busy south-north route that stretches all the way from south Georgia to Atlanta, and from there through NE Georgia to Cherokee, NC, and then beyond to the Great Smoky Mountains National Park. While paralleling Highway 441, Stekoa Creek flows south to bisect Clayton, GA, after which the stream flows through more urban landscape and then serves as the receiving waters for the city's sewage treatment plant.

➢ The Clayton WWTP and its sewage collection system is located entirely within the Stekoa Creek watershed, and is a gravity-fed system with sewage collection lines paralleling and/or crossing the creek and its tributaries at many locations.

➢ After leaving the southern border of Clayton's city limits, the next 6 miles of Stekoa Creek is characterized by farms, pasture lands, residences and unpaved county roads.

➢ Stekoa Creek's final 6 miles are almost exclusively contained within the Chattooga River Ranger District of the Chattahoochee National Forest, where the stream is bordered by relatively undisturbed, mesic mixed oak and pine forests.

Current Conditions

Physical surveys of Stekoa Creek show a wide variety

Assessment and Characterization of Current Conditions

of character, ranging from a channelized and polluted urban creek entrapped in concrete and rap-rap ditches, to a steep mountain stream dropping over waterfalls and coursing through undisturbed native habitat deep in national forest lands.

The headwaters of Stekoa Creek are located in Mountain City, in the vicinity of the Eastern Continental Divide. The headwaters are composed of one unnamed branch originating on the east side of Highway 441, and another unnamed branch originating on the west side of Highway 441. The east branch flows into an impoundment of approximately 20 acres named Cox Lake (at Camp Blue Ridge, a summer camp of about 250 acres), and the west branch flows under Highway 441, and then into a ditch that runs through a trailer park.

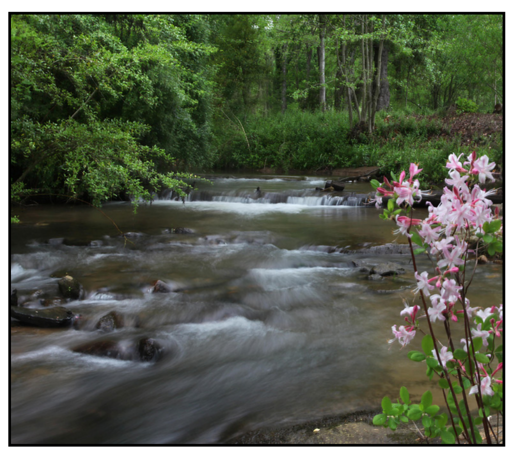
An unnamed headwaters branch of Stekoa Creek in Mountain City flows through a ditch in a trailer park.

These two unnamed branches merge near the north end of File Street, which is a short paved road on the east side of Highway 441, that has both a north and south entry into the highway. After the branches join, Stekoa Creek flows adjacent to the west shoulder of File Street, bordering intermittent sheds and animal pens, where the stormwater runoff from these establishments drains directly into the stream. The creek drops significantly in this short stretch, and cascades over several waterfalls. Near the southern end of File Street, Stekoa Creek borders several trailers and small junk car/misc. storage lots that are perched on the creek's streambank.

At the intersection of File Street and Highway 441, Stekoa Creek flows through a large culvert under File Street, after which the creek's streambanks are armored with rocks and rip-rap for a short distance. The creek continues south and parallels the east side of Highway 441, moving away from the highway to run directly behind road-side trailers and commercial buildings. Then the creek enters undeveloped, forested private land and descends steeply through several waterfalls (Source: Hopey, UNC Asheville, 1995), after which the stream continues through a zone of shrubby growth and woodlots. At this point, near the intersection of Old Highway 441/South Main Street, a large land-disturbing activity is evident on the west side of Highway 441, where a new hospital complex is under construction. (This project was fined in 8/2016 for several erosion and sedimentation violations that caused tons of sediment to be deposited into Coffee Branch, just upstream of its confluence with Stekoa Creek.)

State Highway 441, throughout its placement in close proximity to Stekoa Creek, is a chronic source of stormwater pollution into the stream. The creek substrate along this reach of the stream is primarily sand and silt that is part of a moving load of sediment introduced during the construction of Highway 441, as well as subsequent floodplain filling along the highway.

Nearing Clayton, Stekoa Creek's gradient decreases and the stream continues to exhibit a heavy sediment load from road construction and other land disturbing actions. Then at around mile 3, Stekoa Creek turns slightly to the west and flows through a culvert under Highway 441, and emerges near the parking lot of an expansive, single-story building currently housing the Georgia Mountain Market. The City of Clayton's sewage collection infrastructure begins to parallel and/or cross the creek from this point forward (until reaching the WWTP, further downstream). The creek turns south again, and flows for about ¼ mile through a 3-acre tract known as the Stekoa Creek Park. The tract was recently restored, from a trash dump that was over grown with non-native invasive species into native habitat and green space, as part of 319(h) grant project. The vegetation of native trees, shrubs and wildflowers offers the stream a brief sanctuary of green space and an intact riparian buffer zone. Shortly after entering this tract, a small tributary named Coffee Branch flows from the northwest and joins Stekoa, after which the



A 1/4 mile stretch of Stekoa Creek's riparian zone was restored in 2014 during the development of Stekoa Creek Park.

Assessment and Characterization of Current Conditions

Undersized culverts in Stekoa Creek, installed by way of an agricultural exemption, have created eroding stream banks.

creek passes through the remnants of an old grist mill and drops down an attractive, lively rapid.

After the Stekoa Creek Park tract, the creek flows through a plot of agricultural land containing horses and llamas that have direct access to the creek. This landowner installed a couple undersized culverts in Stekoa Creek using an agricultural exemption (see picuture above). During storm events, the creek has flowed around the undersized culverts to create an ongoing source of erosion and sedimentation into the stream.

Then Needy Creek, flowing from the northeast, joins Stekoa Creek just before Stekoa passes under Ramey Boulevard, after which the creek runs directly behind a strip of commercial buildings including Chick-fil-A, Huddle House and a liquor store. After passing this strip, Stekoa flows through a culvert under Old Livery Street, and behind a car-wash and Dairy Queen. Miscellaneous bits of urban garbage that includes trash from the parking areas of these establishments can readily be seen on Stekoa's stream banks.

Just past the Dairy Queen, at the intersection of East Savannah Street/Hwy. 76 and Highway 441, the creek enters a large culvert and flows under East Savannah Street. Stekoa Creek continues south, moving closer to Highway 441 and passing in front of Regions Bank and the Covered Bridge Shopping Center's expansive parking lot, which covers the 50-foot buffer zone and abuts the stream banks. At the north end of the Covered Bridge Shopping Center complex, Saddle Gap Branch flows from the east and through a box culvert under Highway 441 to join Stekoa Creek. At this point Stekoa Creek is sandwiched in between Highway 441 to the east, and the shopping center's impervious parking lot to the west, both of which channel large volumes of polluted stormwater directly into the stream. Stekoa Creek's streambanks exhibit severe erosion damage from the impact of the relentless stormwater runoff.

At the southern end of the shopping center parking lot at the intersection of Highway 441, Highway 76 and Chechero Street, a McDonald's franchise sits on the west bank of Stekoa Creek. The combined stormwater runoff from the McDonald's parking lot and the surrounding impervious surfaces is extreme, such that the ongoing build-up of erosion and sedimentation has blocked a section of the box culvert that channels Stekoa Creek under this intersection. After Stekoa flows through this box culvert, the stream passes in front of a CVS building and turns briefly to the west where Scott Creek, flowing from the west, joins Stekoa Creek. Both the Scott Creek and Saddle Gap Branch tributaries carry a visibly heavy load of sediment, and both are 305(b)/303(d) listed for sediment and bacteria.

After the Scott Creek confluence, Stekoa turns south again and runs behind the Duvall car dealership. The dealership recently resurfaced their large gravel parking lot, and paved it right up to the edge of the creek's embankments. Here, Stekoa Creek is confined in a deep ditch and its streambanks are armored with rip-rap boulders. About 50 yards downstream of the Stekoa/Scott Creek confluence, a small, unnamed tributary joins Stekoa Creek from the east; this branch originates up on Duggan Hill and flows under Highway 76 East, then flows in a ditch behind the Duckett Apartments complex (public housing project) and through a culvert under Highway 441.

Stekoa Creek's streambanks exhibit severe erosion damage from the impact of relentless stormwater runoff from Hwy. 441 and parking lots that cover the creek's 50-foot buffer zone.

Assessment and Characterization of Current Conditions

A large swath of impervious surfaces in the vicinity of and including the Duvall car dealership surround Stekoa Creek.

Downstream of the car dealership complex, Stekoa Creek continues to flow due south and is bordered by another small shopping complex and more impervious parking areas on both sides of the creek. At one point, the creek's embankments consist of poured concrete, to facilitate the drainage of stormwater runoff from the parking areas directly into the stream.

After flowing behind a Checkers franchise, Stekoa Creek moves closer to Highway 441 and runs in front of Quality Inn, Med-Link Rabun and the Beck Funeral Home. Then Stekoa passes under a bridge on Radio Lane and runs by the Clayton WWTP, which operates under a NPDES permit to discharge .5 million gallons per day of treated effluent into Stekoa Creek.

Just downstream of the WWTP is a section of Stekoa Creek measuring approximately ½ mile in length that was channelized during a major land disturbing event, where tons of dirt were excavated from the east side of Highway 441 and then dumped on the west side of Highway 441 to fill Stekoa Creek's floodplain (SEE PAGES 13 & 16), to create a flat area for constructing a Home Deport and Wal-Mart.

After passing the Wal-Mart and Home Depot complex, which is located on the opposite side of Highway 441 than the creek, an unnamed stream enters Stekoa from the town of Tiger to the west. Before it joins Stekoa, the Tiger tributary is impacted by livestock, where cattle have direct access to the water at the spot where Ice Plant Road crosses the unnamed stream. Then another unnamed tributary enters Stekoa from the east, at the intersection of Highway 441 and Stekoa Falls Road. The tributary flows from the Stekoa Falls Road neighborhood and passes through residential areas with no BMPs, after which the stream flows right next to Stekoa Falls Road, where urban trash deposits and vectors of stormwater runoff enter the branch.

Beyond the confluence of the unnamed tributary from Stekoa Falls Road, Stekoa Creek flows through pastures containing cattle with direct access to Stekoa Creek. Then Stekoa passes beneath a bridge on Bethel Church Road near its intersection with Highway 441, and afterwards follows a private road called Shirley Road. Here, the creek flows through a tract of private land under agricultural management for livestock, swine and row crops. This farm is visible from Highway 441, and it sits on sloped land that is absent of agricultural BMPs, where animal manure, abattoir waste, erosion and sedimentation are channeled directly into an unnamed tributary to Stekoa, as well as into Stekoa Creek proper. AG BMPs are needed here to stem the chronic flow of bacteria and sediment into Stekoa Creek.

After passing through the Shirley Road tract, Stekoa Creek bends to the east around mile 12 and crosses under Highway 441, at the highway's intersection with Rickman Airfield Road. Stekoa Creek turns to the south again to follow Rickman Airfield Road, and is now briefly

Concrete embankments channel stormwater discharge into Stekoa Creek at a parking lot site in Clayton.

Assessment and Characterization of Current Conditions

characterized by a steep gradient, swift runs over bedrock substrate and several waterfalls, with the largest waterfall located about ¼ mile downstream of the Highway 441 crossing. After this steep descent on the west side of the paved section of Rickman Airfield Road, Stekoa Creek bends to the east and runs under a concrete bridge, after which Rickman Airfield Road is surfaced with gravel. At this point, about 1/3 mile of the road's gravel section is located right next to Stekoa Creek. This is a county road that requires frequent grading and re-graveling to maintain its surface. The maintenance regime includes several culverts and turn-outs that channel stormwater runoff from the road directly into the creek. BMPs for gravel road and stormwater management would be well placed here.

Stormwater discharge from Rickman Airfield Road is directed into Stekoa Creek through ditches and culverts.

Stekoa continues east along Rickman Airfield Road, first passing a wedding venue called Chota, and then running through a long flood plain stretch of intensively used agricultural lands, which include row crops and populations of fowl, swine, canines, horses and cattle. Flowing from south to north, numerous perennial streams drop from the steep hillsides and enter Stekoa Creek in this stretch; these streams are universally trenched as drainage ditches cutting through the agricultural pastures and fields. One AG BMP project (319 grant-funded) was implemented in this area in 7/2014, and involved installing cattle exclusion fencing along approximately 1 linear mile of Stekoa, as well as hardened stream crossings and several heavy use areas. Ample opportunities are present for implementing more AG BMP projects along this stretch of Stekoa Creek.

Stekoa Creek's gradient is relatively low throughout this section, and the stream exhibits a sand and silt substrate, with deeper pools on the meandering corners of the waterway. Stekoa passes under another concrete bridge near the end of Rickman Airfield Road, and the creek continues eastward and enters a forested landscape of multiple tracts of private land. The stream exits this forest and borders an agricultural field before crossing Claude Smith Road, and then turns north to parallel this road for about ¼ mile before bending to the east again and winding through several more agricultural tracts.

Nearing East Wolf Creek Road, Stekoa Creek turns south and again passes through agricultural lands before making a quick bend to the east to flow under a bridge at E. Wolf Creek Road. This bridge has an old staff gauge at its base, and is an historical water sampling site that has been used for Forest Service studies of Stekoa Creek's water quality. She Creek joins Stekoa Creek not far downstream of the E. Wolf Creek Road bridge, after which Stekoa turns south again to parallel the E. Wolf Creek Road for about ¼ mile, then moving away from the road by bending to the east once again. The roads and agricultural areas cited above would all be appropriate for implementing site-specific BMPs.

After leaving its parallel course with E. Wolf Creek Road, Stekoa Creek flows east and then south, through two tracts of private land that border the Chattahoochee National Forest. In the neighborhood of Carl Taylor Field Road (a dead-end road off of E. Wolf Creek Road), Cutting Bone Creek flows into Stekoa Creek from the west. Cutting Bone Creek parallels the E. Wolf Creek Road before joining Stekoa, bringing much sediment into the stream.

Below the Cutting Bone confluence, Stekoa leaves the private land and enters a 14,700-acre tract of national forest land for about ¼ mile, and then runs through an isolated and undeveloped tract of private land. Exiting the private land, Stekoa Creek flows back into the national forest. With a few twists and turns, Stekoa Creek runs a generally southern course through a mixed mysophytic forest and flows over numerous steep drops, all the way to its confluence with the Chattooga River.

During very dry conditions, the mouth of Stekoa Creek at the Chattooga River exhibits a subtle yet distinct milky hue as compared to the waters of the Chattooga. After a rain event, Stekoa is densely muddy, with an earthy and oftentimes unpleasant smell.

Assessment and Characterization of Current Conditions

♦ Chechero Creek

Chechero Creek Watershed - Overview

Chechero Creek is an impaired tributary to Stekoa Creek. The headwaters of Chechero Creek originate on Screamer Mountain, near a high point of the circuitous Polly Gap Road in Clayton, GA. The Chechero Creek drainage includes the south side of Screamer Mountain, the northeast side of Stroud Mountain, the southwest edge of the City of Clayton, and 1.9 miles of State Highway 76 East. The Chechero Creek watershed has an area of 2,761 acres, with a variety of soil types consisting of the Bradson-Hayesville-Dyke, Taxaway-Transylvania-Chatuge, Evard-Saluda-Tusquitee and Hayesville-Brason-Fannin series. The majority of the watershed is privately owned, with a few small tracts owned by the U. S. Forest Service. Chechero Creek flows for approximately 4 miles and then empties into Stekoa Creek.

The absence or improper design of BMPs during reconstruction of the Kingwood golf course caused a massive amount of dirt to wash into Chechero Creek, evidence of which remains today.

⦿ ***Land cover in the Chechero Creek watershed*** *is summarized in* ***Table 7***. *(Source: NARSAL, 2008)*

Table 7	*Urban, low intensity*	*Urban, high intensity*	*Clearcut sparse*	*Deciduous forest*
	14.9%	*.27%*	*.26%*	*72.7%*
Evergreen forest	*Mixed forest*	*Row crop & pasture*	*Wetland forested*	*Open water*
7.8%	*1.1%*	*2.7%*	*.16%*	*.07%*

Visual Stream Survey - Current Conditions

Chechero Creek forms at approximately 2,220 feet in elevation, originating on the west face of Screamer Mountain near its summit. From there, the stream turns and flows downstream in a southerly direction through privately owned land consisting primarily of residences and small condo/apartment complexes. No BMPs or inadequate BMPs are employed to maintain a riparian buffer zone next to Chechero Creek. Several county roads are located in this portion of the Chechero watershed, including Old Buncombe Road and Old Chechero Road, which are unpaved and thus require periodic grading and graveling, resulting in subsequent erosion and sedimentation that washes into drainage ditches during rain events, and from there into Chechero Creek. Of note is Old Buncombe Road, which fords Chechero Creek causing an ongoing and chronic source of sedimentation and erosion.

Near the intersection of Old Chechero Road and Highway 76 East, Chechero Creek crosses under Highway 76 East and then drops as an attractive waterfall right next to the Chechero trash and recycling station, afterwards flowing to the east behind the station. Opposite the Chechero recycling station, the GA DOT constructed a large, terraced road-cut to install a passing lane on Highway 76 during the 1980's. The road-cut is about ¼ mile long and is on a steep hillside, where ephemeral springs in the midst of the road-cut terraces have caused several chronic failing areas. Periodically, and usually resulting from a heavy rain event, chunks of soil and rock slide down the road-cut and fall to the shoulder of Highway 76 East, where stormwater runoff washes the dirt down the shoulder of the highway for a short distance and then into Chechero Creek. The GA DOT should take action to install permanent BMPs on the road-cut to address this sediment source.

After flowing by the recycling station, Chechero Creek continues east behind a few residences located on lots facing Highway 76 and then crosses under the highway again not far from the Chechero recycling station, near the intersection of Coffee Road and Highway 76. Then the creek runs directly below a pasture containing a variety of farm animals including horses, goats and mules; the pasture slopes downhill such that erosion, sedimentation and stormwater runoff drain into the creek. At the bottom of the pasture the farm animals have direct access to Chechero Creek for drinking water, which brings the accompanying negative impacts of erosion, sedimentation and bacterial pollution at that spot.

Next, Chechero Creek enters the Kingwood Country Club grounds where it begins to flow to the southeast, and the creek enters a shallow, sediment-filled impoundment. After dropping through the pond's stand pipe, Chechero Creek undergoes major alteration by way of streambank

Assessment and Characterization of Current Conditions

Chechero Creek is channelized and stripped of native vegetation as it flows through the Kingwood golf course.

armoring and channelization, to flow through the golf course's fairways and around some putting greens. The armored streambanks through the country club exhibit some scouring, which contributes to the massive deposit of sediment into the creek that occurred when the golf course was reconstructed and restored n 1999. During that time, the improper design and/or absence of BMPs and subsequent lack of erosion and sedimentation enforcement actions caused a huge amount of dirt to wash into Chechero Creek, and evidence of this huge input of sediment into the stream remains today. Of note is that the water sampling program for this WMP did not test for fertilizers and pesticides commonly associated with golf course maintenance. Due to the proximity of Chechero Creek and the golf course, it is expected that nutrient and chemicals from the golf course are carried into the creek during rain events.

After leaving the Kingwood County Club complex, Chechero Creek enters a wooded area before intersecting with Levee Road at the site of the New Hope Baptist Church. Levee Road fords Chechero Creek, causing a chronic source of sedimentation and erosion into the creek. Chechero Creek crosses under Highway 76 East again and enters a hayfield pasture, where the shallow streambanks are armored with rip-rap and devoid of any canopy cover. Chechero Creek winds in an easterly direction through several more tracts under agricultural management that includes cattle and row crops absent BMPs. Then Chechero Creek turns to the southeast to join Stekoa Creek in the pastures located behind the new Chechero Fire Station on Highway 76 East.

♦ ***<u>Scott Creek</u>***

Scott Creek Watershed - Overview

Scott Creek is an impaired tributary to Stekoa Creek. Scott Creek is Stekoa Creek's biggest tributary as well as its largest sub-watershed at 4,002 acres. The headwaters of Scott Creek originate at about 2,500 feet, west of Steele Knob, in the taller mountains that lie north of Dan Crane Road on Highway 76 West. The creek flows south from the mountains and down through a patch of national forest land, then crosses under Highway 76 West near Dan Crane Road before turning east, and running from west to east along the south side of Hwy. 76 West in a roughly parallel course to the highway. Scott Creek is 4.7 miles long, and joins Stekoa Creek in downtown Clayton, in the midst of a large swath of impervious surfaces.

- ***Land cover in the Scott Creek watershed*** *is summarized in* ***Table 8.*** *(Source: NARSAL, 2008)*

Table 8	*Urban, low intensity*	*Urban, high intensity*	*Clearcut sparse*	*Deciduous forest*
	14.5%	*.4%*	*.27%*	*74%*
Evergreen forest	*Mixed forest*	*Row crop & pasture*	*Wetland forested*	*Open water*
5.5%	*.66%*	*4.9%*	*n/a*	*.005%*

Visual Stream Survey - Current Conditions

From its origin near Steele Knob, Scott Creek flows south through the Chattahoochee National Forest and then crosses under Highway 76 West near Dan Crane Road before turning to the east and running along the south side of Hwy. 76 West. Starting in the vicinity of Dan Crane Road and continuing along the Hwy. 76 West corridor to the Clayton Municipal Complex, the Scott Creek flood plain is under mostly agricultural management, and the stream carries a visible and heavy sediment load.

After crossing Highway 76, Scott Ceek flows through pastures managed for row crops as well as farm animals including cattle, horses and poultry. Fencing of livestock from the creek is scant, and the same can be said for the presence of riparian buffer strips. Ample opportunities for implementing BMPs are evident. On the north side of Highway 76, a couple of poultry barns sit in the more hilly terrain that slopes down towards the highway. One small tributary named Ashley Creek as well as several unnamed perennial streams enter Scott Creek from the north, after passing under Highway 76.

In addition to agricultural management, the Scott Creek flood plain is also populated with houses, trailers, occasional country stores and one church, which are all serviced by on-site septic systems. Multiple county roads branch off from Highway 76 and lead south, crossing

Assessment and Characterization of Current Conditions

over Scott Creek to access residences and agricultural operations on the south side of the creek. Old Mill Lane and Kastner Lane exemplify this mix of residential and agricultural land uses, and BMPs in the riparian zone are largely absent

Nearing Clayton, the Mountain Lakes Hospital complex is positioned in the Scott Creek watershed, on the

Scott Creek's pollution sources include sites where livestock have access to the creek and storrmwater from pastures flows into the stream.

north side of Hwy. 76. The reach of Clayton's sewage collection system also becomes evident as manholes and sewage lines are visible, paralleling and crossing the stream. Once in Clayton, Scott Creek flows behind the Clayton Municipal Complex, and is bordered by a field that is designated as a greenway zone and disc golf area. The Clayton Municipal Complex sits in the Scott Creek floodplain. Just past the complex, a small channelized tributary named Ginger Creek flows under Hwy. 76 and into Scott Creek from the north. Along its course, note that Ginger Creek is very impacted by development and the absence of BMPs in its buffer zone. Local E& S law enforcement was questioned during this WMP source assessment in June 2015, because trees were removed from Ginger Creek's embankments and mechanized clearing of its riparian zone occurred with no variance approval by the GA EPD.

After passing the Ginger Creek tributary, Scott Creek flows behind the Rabun County Civic Center and a community garden area. Next to the community garden and flowing from the north, an unnamed perennial stream borders the garden's southeast side before joining Scott Creek; this unnamed stream consistently registered spikes in *E.coli* counts (as per the water sampling tests associated with this WMP) after rain events, possibly due to runoff from the garden. A piped discharge of water from an unknown origin enters this unnamed stream about midway through its run by the community garden.

Just downstream of the community garden site, another small tributary known locally as Cool Springs enters Scott Creek from the south. Scott Creek then flows behind a commercial shop where it's evident that debris and paving materials have been systematically dumped over the stream's left embankment for a number of years. Here, and just before Scott Creek flows under the high bridge on Marsengill Street, a junction of sewer lines is visible; one comes from the direction of Cool Springs and the other from Scott Creek. This zone has

Ginger Creek, tributary to Scott Creek, exhibits a lack of BMPs in its stream buffer zone as illustrated by this recent (5/2015) clearing operation.

Behind the Rabun County Civic Center, Scott Creek has been a dump for paving waste; this area also has a history of combined sewer overflows.

Assessment and Characterization of Current Conditions

a history of combined sewer overflows (CSO), where the manhole is positioned adjacent to the creek (see p. 6, CSO on Scott Creek).

After crossing under Marsengill Street, Scott Creek flows under a bridge on Shadyside Drive and behind the Clayton Housing Authority's public housing project. A sewage collection line crosses the creek just below the public housing project, that is chronically stressed by flotsom from the stream. Then the creek runs behind a commercial garden business, and joins Stekoa Creek just upstream of the Duvall car dealership site. There is a documented history of sewage overflows, leaks and high *E. coli* levels in the Scott Creek reach of Clayton's sewage collection infrastructure, particularly from the Marsengill Street area to the creek's junction with Stekoa Creek. In addition to the creek's sediment load, water sampling data show an excessive levels of *E. coli* bacteria in Scott Creek, which should be addressed by a TMDLIP.

Sewage lines cross Scott Creek, which often leads to flotsam and debris jams on the infrasturcture.

SADDLE GAP BRANCH

SADDLE GAP BRANCH WATERSHED - OVERVIEW

Saddle Gap Branch is about 2.1 miles long, and is an impaired tributary to Stekoa Creek. Saddle Gap Branch begins at Saddle Gap, which is a topographic feature located just west of the headwaters of the Warwoman Creek sub-watershed, and the point where the Bartram Trail crosses Warwoman Road near Becky Branch. The Saddle Gap Branch watershed is 1,781 acres, and is located entirely on private land. Saddle Gap Branch flows from the east to the west towards the City of Clayton, where is empies into Stekoa Creek just downstream of the Hwy. 441 / East Savannah Street intersection.

⦿ ***Land cover in the Saddle Gap watershed** is summarized in **Table 9**. (Source: NARSAL, 2008)*

Table 9	*Urban, low intensity*	*Urban, high intensity*	*Clearcut sparse*	*Deciduous forest*
	18.2%	*1.38%*	*.47%*	*64.8%*
Evergreen forest	*Mixed forest*	*Row crop & pasture*	*Wetland forested*	*Open water*
11.1%	*2.1%*	*1.9%*	*n/a*	*.12%*

VISUAL STREAM SURVEY - CURRENT CONDITIONS

Saddle Gap Branch runs downstream roughly parallel to Warwoman Road, often within close proximity to the road and a variety of rural houses, home offices and relatively small commercial businesses that appear to employ a minimum of BMPs. At the boundary of Clayton city limits, Norton Creek flows into Saddle Gap from the north, from Hogback Mountain and Courthouse Gap. Just before Norton Creek joins Saddle Gap, an agricultural BMP project was implemented on a tract that installed a hardened stream crossing on Norton Creek as well as livestock exclusion fencing on a stretch of Saddle Gap.

After the Norton Creek confluence and crossing into city limits, Saddle Gap Branch flows under Laurel Heights Road and then under Polly Gap Road. Just uphill from the Polly Gap junction is the former site of the AID Corporation, which has is registered as a toxic waste dump area with the GA EPD, and that has monitoring wells tracking the spread of a plume of poisoned groundwater in the area. Saddle Gap Branch then runs through a pasture populated by a modest quantity of livestock, and parallels Rickman Road (Warwoman Road branches off). Here, Saddle Gap Branch borders a graded and largely unvegetated tract that is managed as a wood lot and landscaping business. Then the branch continues directly behind a small strip mall containing a laundry mat and several other businesses, and flows under Highway 441 to join Stekoa Creek at the northern area of the Covered Bridge Shopping Center on Highway 441.

SHE / POOL CREEK

POOL CREEK WATERSHED - OVERVIEW & VISUAL STREAM SURVEY - CURRENT CONDITIONS

Pool Creek is 1.8 miles long and is a small tributary to She Creek, which is an impaired tributary to Stekoa Creek. The headwaters of Pool Creek originate on the Chattahoochee National Forest, on the southeast shoulder of Rainy Mountain at approximately 1,880 feet above sea

Assessment and Characterization of Current Conditions

level. The creek descends about 160 feet in elevation on national forest land before entering private land near the terminus of the Pool Creek Road. Here, Pool Creek flows into two small impoundments, one on either side of Pool Creek Road, which the creek crosses. Pool Creek then parallels the Pool Creek Road, flowing under a few driveways and through a relatively rural neighborhood with widely spaced residences and fields under active agricultural management, with no BMPs. At the intersection of Pool Creek Road and Highway 76 East, the creek flows under the highway and joins She Creek.

She Creek Watershed - Overview

She Creek originates on private land at the Rainy Mountain Boy Scout Camp tract, which is located at the end of Rainy Mountain Road off of Highway 76 East. She Creek is located entirely on private land and is 3.5 miles long; the watershed is 3,362 acres in size.

⦿ ***Land cover in the She Creek watershed*** *is summarized in* ***Table 10****. (Source: NARSAL, 2008)*

Table 10	*Urban, low intensity*	*Urban, high intensity*	*Clearcut sparse*	*Deciduous forest*
	5.9%	*.18%*	*.42%*	*73.2%*
Evergreen forest	*Mixed forest*	*Row crop & pasture*	*Wetland forested*	*Open water*
13.4%	*1.2%*	*5.4%*	*.3%*	*.19%.*

Visual Stream Survey - Current Conditions

She Creek starts on the northwestern flank of Rainy Ridge at approximately 1,680 feet above sea level, just south of Green Gap on the Bartram Trail. Not far from its source, She Creek flows downstream to enter an impoundment called Lake Toccoa, that is used as an amenity of the Rainy Mountain Boy Scout Camp for swimming and other recreational purposes. Exiting Lake Toccoa, She Creek flows south and parallels Rainy Mountain Road, and then bends away from the road to enter land used for agricultural purposes. Here, the creek flows on the far side of a pasture and then runs in close proximity to 4 chicken houses. She Creek flows through several more fields and pastures before running through a culvert under Jeff Ramey Lane, after which the creek enters another set of fields and pastures that lack any riparian area canopy or buffer strip. Before crossing under Highway 76 East, She Creek runs on the edge of agricultural land that is plowed up to the edge of the stream, creating a chronic input of sediment into the creek.

She Creek borders the edge of a field that is plowed up to the edge of the stream, which creates a chronic input of sediment into the creek.

Just after flowing under the highway, She Creek enters an agricultural tract that contains a small, overgrown tree nursery, where the creek was re-routed during the early spring of 2014 to eliminate a severely eroding ox-bow bend in the stream. The project involved digging a new streambed, lining the streambanks with large, stacked rip-rap and rock chunks, and then blocking the ox-bow so that She Creek was re-routed into the newly armored ditch. As evident to passersby, the project did not employ silt fences, mulch or other BMPs during construction, resulting in erosion and sedimentation into She Creek.

After leaving the She Creek re-route site, the creek flows through a forested tract and then passes under Woods Road, where the stream enters more agricultural lands exhibiting scant BMPs. The stream course then makes a sweeping arc to the east, back towards Hwy. 76 East, and bends again 180 degrees around to the west, flowing along the edge of a pasture with cattle free-ranging into the stream. After leaving this pasture, She Creek runs through a small tract of forested land and joins Stekoa just downstream of the East Wolf Creek Road Bridge.

♦ *Cutting Bone Creek*

Cutting Bone Creek Watershed - Overview

Cutting Cone Creek is the only un-impaired, significant tributary to Stekoa Creek. However, note that over 15 years ago the EPA stated that due to increasing sediment deposits, Cutting Bone Creek should be placed on a "watch list" to provide heightened attention to controlling sources of sediment inflow to the stream. (Source: *Assessment of Water Quality Conditions, Chattooga River Watershed*, USEPA, May 1999.) This

Assessment and Characterization of Current Conditions

recommendation should be advanced because the Stekoa Creek WMP's visual stream survey observed that Cutting Bone Creek now carries a heavy sediment load due to its proximity to a section of the East Wolf Creek Road. This is a county gravel road maintained with regular turnouts that channel stormwater runoff directly into the creek. Cutting Bone Creek is 3.6 miles long, and its watershed encompasses 1,717 acres.

⦿ ***Land cover in the Cutting Bone Creek watershed*** *is summarized in* ***Table 11****. (Source: NARSAL, 2008)*

Table 11	*Urban, low intensity*	*Urban, high intensity*	*Clearcut sparse*	*Deciduous forest*
	5.3%	*-*	*.1%*	*79.6%*
Evergreen forest	*Mixed forest*	*Row crop & pasture*	*Wetland forested*	*Open water*
13.1%	*1.4%*	*.43%*	*.17%*	*-*

Visual Stream Survey - Current Conditions

Cutting Bone Creek originates on national forest land at 1,840 feet on the western, descending flank of Eastman Mountain. The creek flows downstream through a forested environment until it crosses under the E. Wolf Creek Road, after which the creek parallels this road while running east through agricultural lands lacking BMPs. The East Wolf Creek Road is a long county road that cuts from Highway 76 East over to Highway 441; the section of road next to Cutting Bone Creek is located in or near the creek's flood plain and has regular turnouts channeling stormwater runoff directly into the creek. Near the intersection of E. Wolf Creek Road and Carl Taylor Field Lane, Cutting Bone continues east to parallel Carl Taylor Field Road and flows through the agricultural lands along this road. Near the end of Carl Taylor Field Road and the stream's entrée back into national forest land, Cutting Bone Creek flows into Stekoa Creek, which then turns south towards the Chattooga River.

▶ Review of Existing Data

A significant record of data exists documenting water quality in the Stekoa Creek watershed. This data record includes numerous years of targeted water sampling results as well as studies of sediment sources, fish surveys, insect surveys and macroinvertebrate surveys. The data has been assembled by a wide variety of individuals and organizations including the GA DNR, U.S. Forest Service, EPA, academic institutions, students, community groups and non-governmental organizations. This data record exists due to the 40+ years of negative impacts that Stekoa Creek's water quality has inflicted on the National Wild & Scenic Chattooga River. To reference this information, please see:

⇨ **Appendix 2 – Bibliography and Literature Review**

⇨ **Appendix 3 – List of Historical Data**

▶ Monitoring

Historical water quality data was helpful in identifying consistent hot spots of fecal coliform and sediment pollution in the Stekoa Creek watershed. Review of existing data showed the need to update water quality information, and to establish some new sampling sites to hone in on suspected sources of pollution. It was determined that a targeted water quality monitoring plan would be implemented to produce a contemporary record of data, and a characterization of the causes and sources of bacteria and sediment pollution in the Stekoa Creek watershed.

▶ Water Quality Monitoring Plan

The *Stekoa Creek Watershed Targeted Water Quality Monitoring Plan* was approved by the GA EPD prior to conducting any water sampling and analysis. Water quality samples and in-stream measurements were collected from September 2013 through September 2014 at targeted locations using Georgia Adopt-A-Stream and other GA EPD approved techniques.

The purpose of the *Stekoa Creek Watershed Targeted Water Quality Monitoring Plan* was to provide a contemporary picture of water quality conditions within the watershed by: a) identifying pollution hotspots of sediment and *E. coli* bacteria; b) recording indications of malfunctioning septic systems; c) establishing pre-Best Management Practice baseline data; and, d) verifying stream segments in need of corrective action as well as protection. The data collected is not to be used for water quality listing purposes by the GA EPD.

Note: The *Stekoa Creek Watershed Targeted Water Quality Monitoring Plan* elected to use *E. coli* as the indicator for the quantifiable measurement of the presence of bacterial pathogens in surface waters. *E. coli* is a subgroup of fecal coliform bacteria. The EPA recommends *E. coli* as an indicator for assessing potential health risks in recreational waters because *E. coli* are more closely related with swimming-related gastrointestinal illnesses than other fecal coliform bacteria. Like other fecal coliform bacteria, *E. coli* indicates the potential presence of disease-causing pathogens, and *E. coli* can directly harm humans who come into contact with it during recreational activities such as fishing, swimming or boating, where

Assessment and Characterization of Current Conditions

there is opportunity for ingestion of contaminated water.

⇨ See **Appendix 4: *Targeted Water Quality Monitoring Plan for the Stekoa Creek Watershed in Rabun County, Georgia.***

Implementing the *Targeted Water Quality Monitoring Plan for the Stekoa Creek Watershed* accomplished the following metrics:

- Water quality data was collected at 42 sites in the Stekoa Creek watershed. (Note that a few sites were dropped after sampling showed that water quality was consistently within acceptable standards.)
- Twenty-two water sampling events were completed over the course of one year (9/17/13 - 9/30/14).
- The measurements collected were: water and air temperature; *E. coli* bacteria levels (CFUs/100ml); turbidity (NTU); and, the relative presence/absence of optical brighteners, as measured by a fluorometer.
- Geographical Information Systems (GIS) maps were produced to depict the results of the data collected by the *Stekoa Creek Watershed Targeted Water Quality Monitoring Plan*.
- The complete data record of water sampling results for *E. coli* is included in this report as Appendix 5. In addition, Appendix 6 contains the comprehensive data record of water sampling results for *E. coli*, tubidity, optical brighteners and stream/air temperature.

The source assessment for the Stekoa WMP focused on *E. coli*, turbidity and optical brightener monitoring, and the apparent causes — i.e., probable bacteria and sediment pollution sources, based on observed land use practices and activities, as well as proximity to sewage collection infrastructure — of the stream's failure to meet water quality standards.

⇨ *See* **Figure 5: Map of Stekoa Creek Watershed Bacterial Sampling Locations** (See p. 33)

⇨ *See* **Figure 6: Map of Stekoa Creek Watershed, Bacterial Sampling Locations_ Level of Impairment** (See p. 34)

⇨ *See* **Appendix 5: Stekoa Creek Watershed E. Coli Bacteria Sampling Data 9-13_9-14 Final**

⇨ *See* **Appendix 6: Stekoa Creek Watershed WQM Data Table_comprehensive**

⇨ *See* **Appendix 7: Map of Stekoa Creek Watershed Water Sampling Sites_Rank**

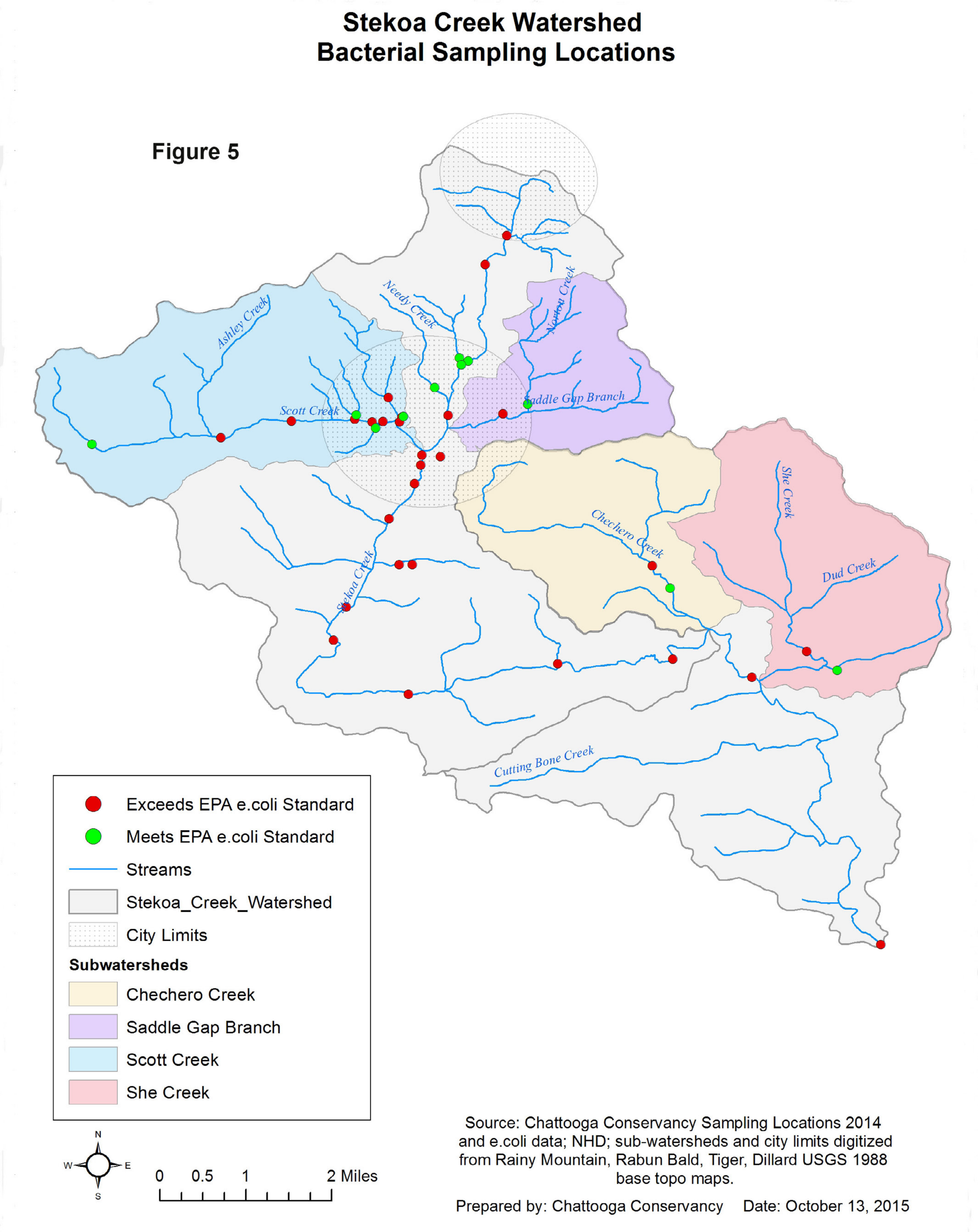
Filling at this site next to Coffee Branch, a tributary to Stekoa Creek, lacks BMPs for stopping erosion into the stream.

The source assessment's results indicated that the primary sources of E. coli bacteria and sediment loadings in the Stekoa Creek watershed can be attributed to:

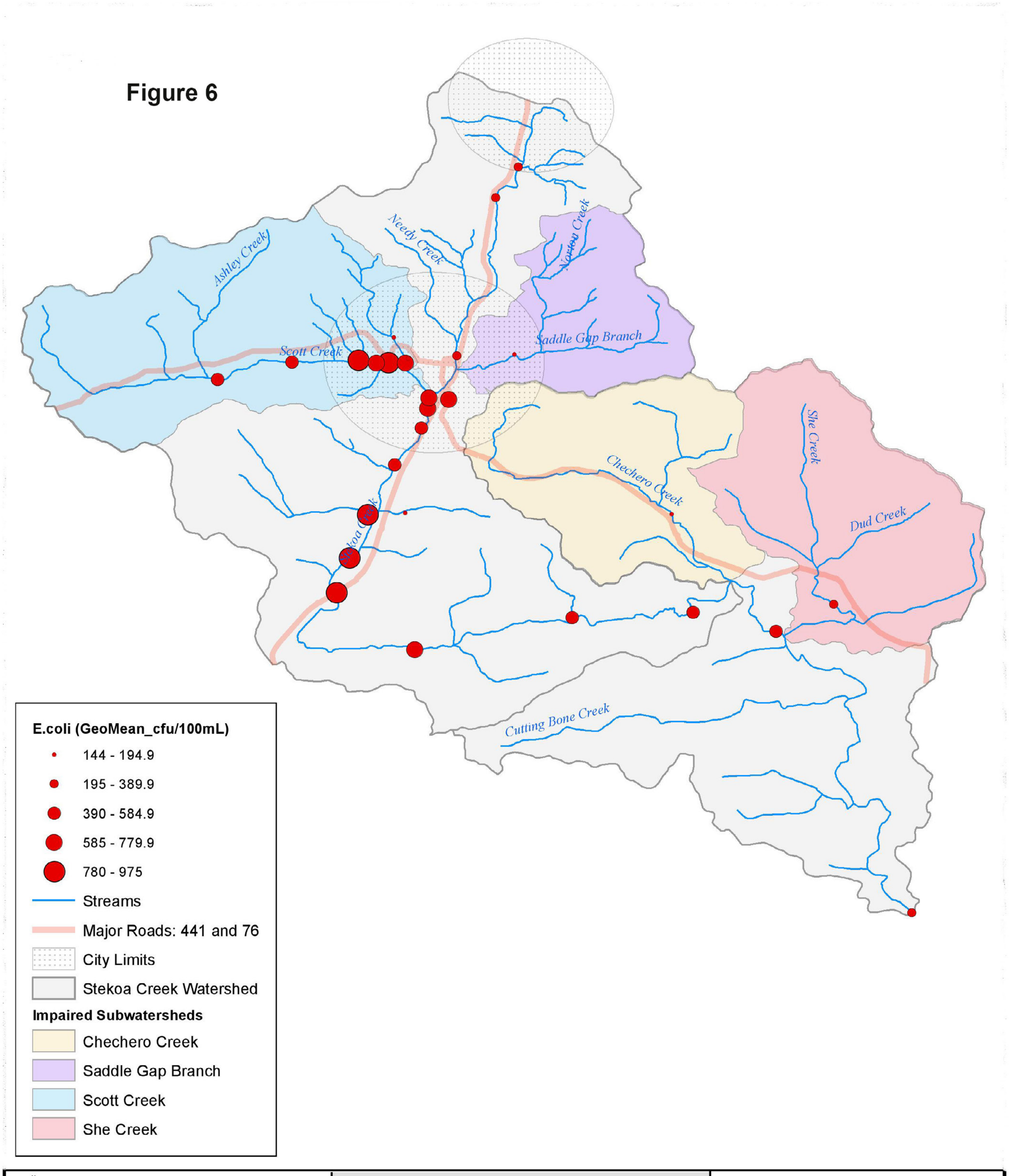
- ***Livestock and agricultural practices, absent BMPs***
- ***Sewage collection system leaks***
- ***Septic system failures***
- ***Land disturbing activities, absent BMPs***
- ***Gravel/dirt roads***
- ***Stormwater discharge***
- ***Urban runoff (humans and animals)***
- ***Stream bank erosion***
- ***Hydromodification***

Consistent with the TMDL implementation plans for the subject streams in the Stekoa Creek watershed, recommended management measures will be targeted towards reducing pollution inputs from agricultural, forestry, and urban/residential sources (urban/residential pollution inputs include stormwater; septic systems; sewage collection systems; highways and bridges; gravel and dirt roads; and, hydromodification).

Assessment and Characterization of Current Conditions



Assessment and Characterization of Current Conditions



Datum: GCS_North_American_1983 Zone: 17N
Projection: Transverse_Mercator
Sources: Chattooga Conservancy Sampling Locations 2014 and e.coli data; NHD; sub-watersheds and city limits digitized from Rainy Mountain, Rabun Bald, Tiger, Dillard USGS 1988 base topo maps

Stekoa Creek Watershed Management Plan

Bacterial Impairment Severity

Prepared By: Chattooga Conservancy
Date: October 20, 2015
Figure: 6
File: F:\GIS Data\319_SC Map6.BacterialImpairmentSeverity _102115.mxd

CHATTOOGA CONSERVANCY

5. Recommended Management Measures

Overview

The results from visual stream surveys, targeted water sampling, inquiry and analysis indicate that water quality could be greatly improved through the application of site specific best management practices (BMPs) and targeted management measures. In the following pages, the Stekoa Creek Watershed Management Plan cites BMPs, and actions that implement these BMPs, where polluted runoff from the source has been identified as a concern. In general, the best management practices are to be implemented immediately adjacent to a waterbody, or upland to address the targeted pollutant sources.

It is important to identify exactly which management practices can be implemented in the critical areas identified. Potential practices should be screened vis-à-vis a variety of factors to narrow down the options to those that are the most promising and acceptable, considering such factors as pollutant reduction efficiencies, legal requirements, cost and physical constraints. Also of critical importance is the fact that many of the management practices are voluntary. Once the management practices are identified and screened, the final practices selected should be prioritized as the most effective in achieving the load reductions needed to improve water quality, or meet the standards for bacteria and sediment, or the acceptable ratings for macroinvertebrate biota.

Recently installed cattle exclusion fencing along a section of Stekoa Creek will help prevent futher erosion of this streambank.

⇨ See **page 36, Figure 7: Upper Stekoa Creek Watershed, Priority Sites for Corrective Action**

⇨ See **page 37, Figure 8: Lower Stekoa Creek Watershed, Priority Sites for Corrective Action**

Method

The management practices may include structural controls, nonstructural controls, or a mix of both. Structural controls are built facilities that typically capture runoff, treat it through chemical, physical or biological means, and discharge the treated effluent to receiving waters, groundwater, or conveyance systems. Nonstructural practices usually involve changes in activities or behavior, and focus on controlling pollutants at their source. It should be noted that it is much more effective from both a cost perspective as well as for reducing pollutant loads to prevent or control pollution at its source, rather than to implement structural controls and/or to retrofit areas with structural controls.

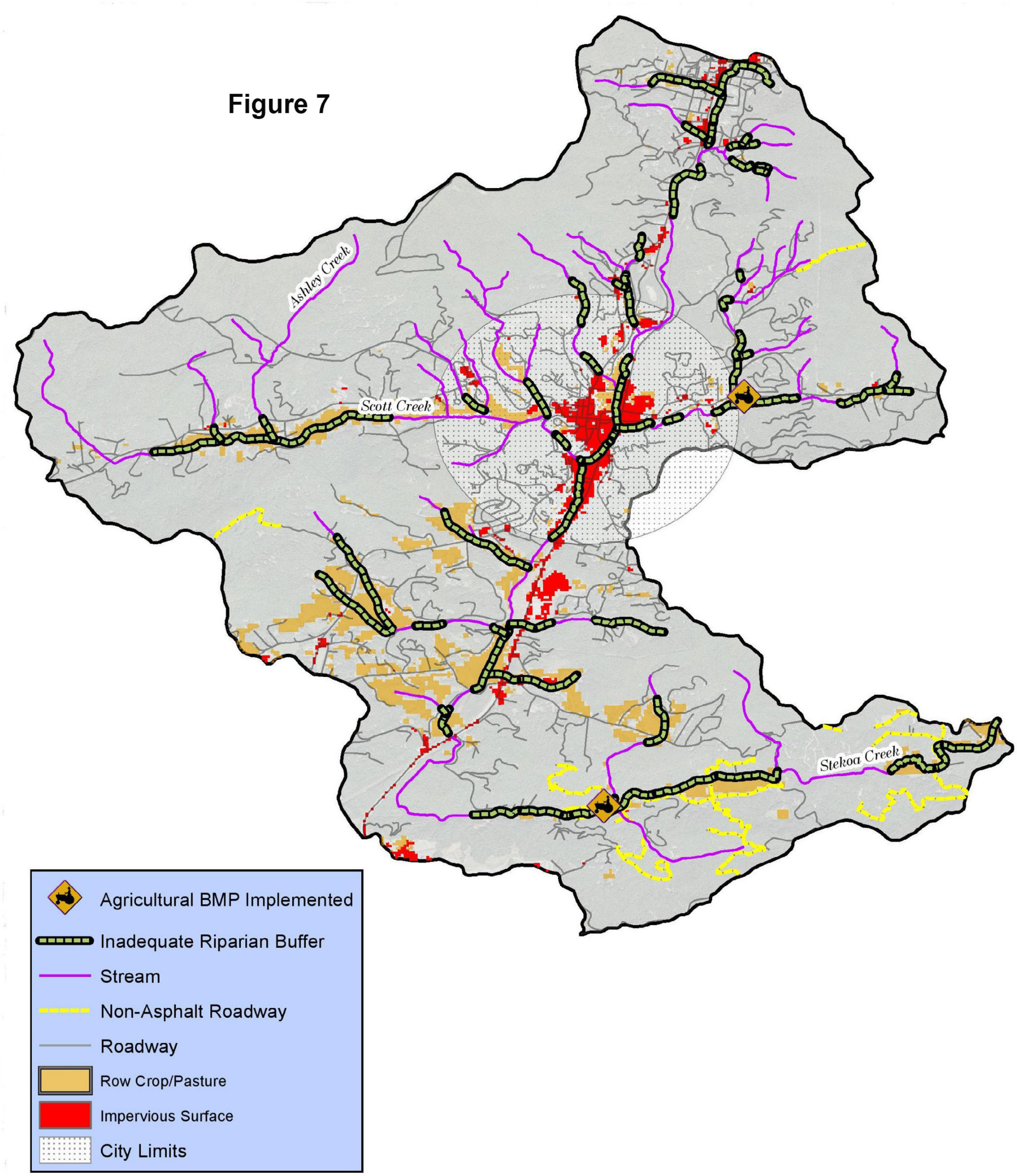
Goals

Achievement of the estimated fecal coliform/*E. coli* and sediment load reductions needed to attain water quality standards will require numerous concurrent management and resource protection strategies. The management measures included in this WMP describe many BMPs that would result in effective load reductions for fecal coliform/*E. coli* and sediment. However, it should be noted that a number of management practices could result in reducing both. These BMPs are proposed to address the Stekoa Creek watershed's hot spots of pollution as identified during the watershed assessment. In addition to the targeted pollutants of fecal coliform/*E. coli* and sediment, BMPs for urban/residential areas to control and mitigate stormwater runoff are also included. Decreasing the volume of stormwater runoff from urban/residential areas is expected to reduce the concentration of fecal coliform/*E. coli,* sediment and other pollutants delivered to streams, as well as lessen the excessive erosion and sedimentation that comes with periodic high flows associated with impervious surface areas. The goal is to implement measures to significantly reduce or eliminate fecal coliform/*E. coli* and sediment pollutant sources in the Stekoa Creek watershed, resulting in progress towards or the attainment of desired water quality standards.

Initial Steps to Prioritize BMPs in Critical Loading Areas

The first step in prioritizing management measures for reducing or eliminating fecal coliform/*E. coli* and sediment loading was to define a set of available watershed improvement tools based on current technology and accepted watershed management practices.

Recommended Management Measures



0 0.375 0.75 1.5 Miles

Datum: GCS_North_American_1983 Zone: 17N
Projection: Transverse_Mercator
Sources: NHD; U.S. Census Bureau; NAIP; Chattooga Conservancy 2015 BMP Implementation Sites, Road Sedimentation sites and inadequate riparian buffer sites; and city limits digitized from Rainy Mountain, Rabun Bald, Tiger, Dillard USGS 1988 base topo maps

Stekoa Creek Watershed Management Plan

Upper Stekoa Creek Watershed Priority Sites for Corrective Action

Prepared By: Chattooga Conservancy
Date: October 26, 2015
Figure: 10a
File: F:/GIS Data/319_SC/Map10a.CorrectiveSites_UpperStC.mxd

Recommended Management Measures

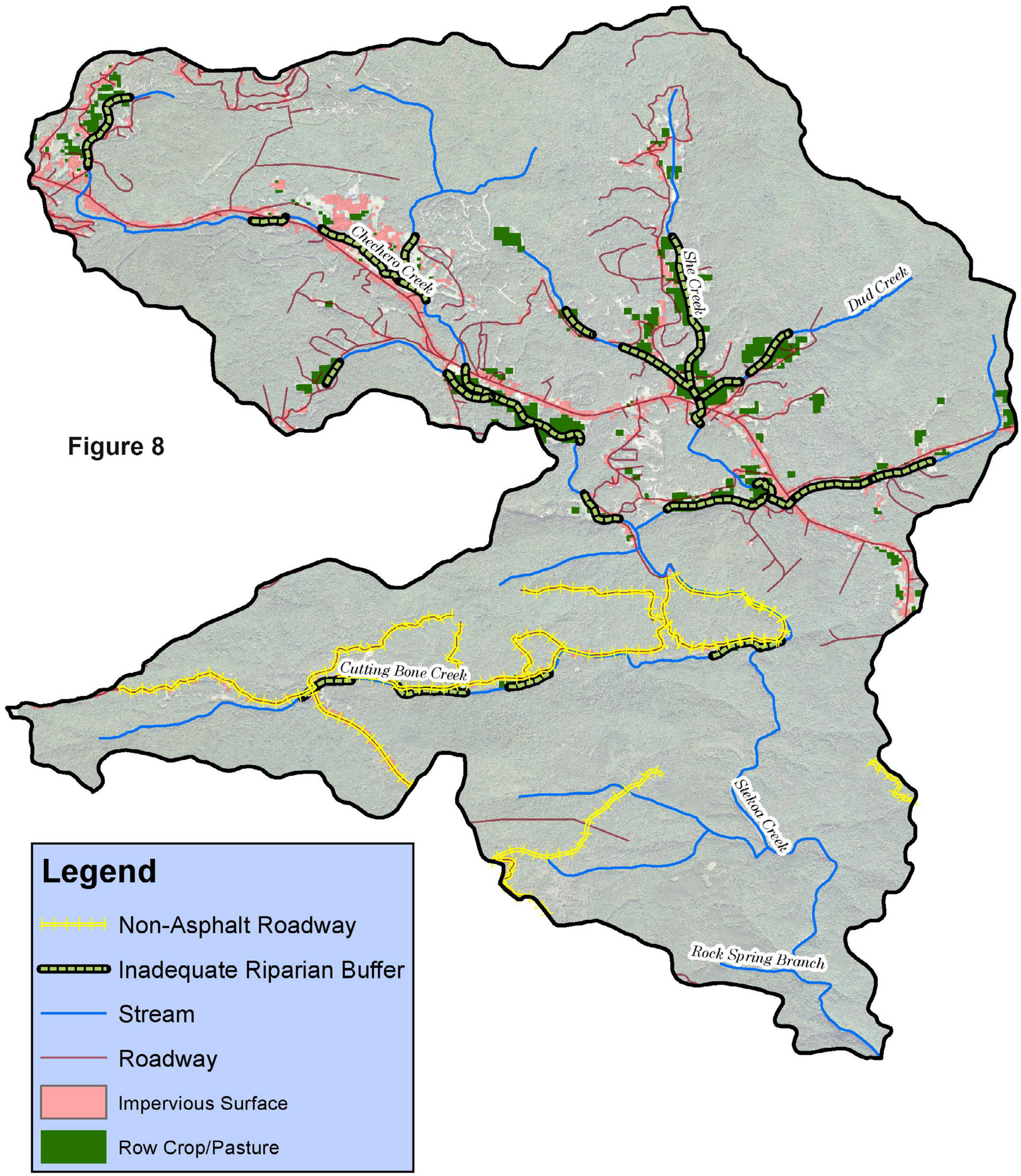


Figure 8

Datum: GCS_North_American_1983 Zone: 17N
Projection: Transverse_Mercator
Sources: NHD; NAIP; NARSAL; US Census Bureau; Chattooga Conservancy inadequate riparian buffers sub-watershed digitized from Rainy Mountain, Rabun Bald, Tiger, Dillard USGS 1988 base topo maps

Stekoa Creek Watershed Management Plan

Lower Stekoa Creek Watershed Corrective Action Priority Sites

Prepared By: Chattooga Conservancy
Date: October 20, 2015
Figure: 10b
File: F:\GIS Data\319_SC\Map10b.CorrectiveSites_LowerStC.

Recommended Management Measures

The second step was to match the most appropriate, likely-to-succeed solutions to the dominant land uses in the Stekoa watershed, i.e., the watershed's agricultural, urban/residential, and forested landscapes. The third step was to identify critical sites in the watershed where these practices could possibly be applied. This process involved the use of GIS and field reconnaissance. Potential sites were identified based on several observable site characteristics including size, location, land use and physical constraints. The process specifically looked for ways to achieve project goals and objectives through a variety of improvement sites, and was conservative in terms of omitting or failing to identify potential sites. This strategy was used to ensure that as many opportunities as possible were included that might provide potential benefits to water quality in the Stekoa Creek watershed. (See pp. 36 & 37, Maps of Priority Sites for Corrective Action.)

The management measures and BMPs presented in the following tables have been identified as potential candidates for mitigating erosion, sedimentation, stormwater and bacterial pollution sources. The implementation of management measures and BMPs would involve technical experts from the NRCS, EPA and others to design each site-specific installation to be the most effective and sustainable for each particular situation. Specific projects should be considered on a case-by-case basis among Stekoa Creek and its sub-watersheds, to address the "hot spots" identified during the watershed assessment.

The 2012 Census of Agriculture developed by the USDA reported the area used as farmland in Rabun County to be 8,064 acres, or 3% of the county's land area. Although this is a relatively small percentage of the total land use, these agricultural operations arguably have a disproportionate effect on water quality because they can be found in the floodplain, riparian and lowland areas along Stekoa Creek and all of its major tributaries.

Expected Load Reductions From Implementing BMPs in Critical Loading Areas

Expected load reductions for each BMP activity are a function of the specific size, extent, soil texture and other variables at the site. The EPA has developed two spreadsheet models for calculating expected load reductions for specific BMP activities, which are available online at: http://it.tetratech-ffx.com/steplweb/. BMPs manuals produced by the Natural Resource Conservation Service and the American Society of Civil Engineers can also be used to reference more general load reduction information for certain BMPs. In addition, Table 12 (see p. 39) includes expected load reductions for certain BMPs.

Management Measures for Agricultural Sources

The 2012 Census of Agriculture developed by the USDA reported the area used as farmland in Rabun County to be 8,064 acres, or 3% of the county's land area (Source: *Rabun County Profile, 2012 USDA Census of Agriculture*). Although a relatively small percentage of the total land use, these agricultural operations arguably have a disproportionate effect on water quality because they can be found in the floodplain, riparian and lowland areas along Stekoa Creek and all of its major tributaries. The primary agricultural nonpoint source pollutants are nutrients (particularly nitrogen and phosphorus), erosion and sediment, animal wastes, pesticides and salts.

Agricultural nonpoint sources enter surface water through direct surface runoff, or through seepage to groundwater that in turn recharges a surface water outlet. Various farming activities result in soil erosion. Sediment produced by erosion can damage fish habitat and wetlands, and in addition, often transports excess agricultural chemicals resulting in contaminated runoff. This runoff in turn affects changes to aquatic habitat such as increased temperature and decreased oxygen. The most common sources of excess nutrients in surface water from agricultural nonpoint sources are chemical fertilizers and manure from animal facilities, which cause eutrophication in surface water. Pesticides used for pest control in agricultural operations can also contaminate surface as well as groundwater resources. Runoff and leachate from irrigated lands may transport sediment, nutrients, salts, and other materials. Lastly, certain grazing practices in riparian and upland areas can deplete grass or herbaceous cover from pastures, and cause sediment and animal waste to enter surface waters, thus degrading water quality.

⦿ **Table 12** presents a prioritized summary of management measures to reduce sources of fecal coliform and sediment from agricultural sources. Note that in many instances, management and protection strategies can address both bacteria and sediment.

Recommended Management Measures

Table 12 - *Management Measures for Agriculture*

Source: Best Management Practices for Georgia Agriculture, Georgia Soil & Water Conservation Commission, 9/2013.

FECAL COLIFORM BMPs

Alternative Water Sources – includes using troughs and tanks to provide livestock with watering sources away from streams to reduce direct fecal coliform contribution and associated erosion. This measure is often used in conjunction with exclusion fencing.

Exclusion Fencing – provides barriers to prohibit livestock from freely entering streams. Allows for periodic “turning out” of animals to graze in the vegetated buffer for short periods of time, thus controlling areas where fecal loadings are present. This practice can reduce fecal coliform loads in streams by 50-99%.

Critical Area Planting – establishes permanent vegetation (preferably native plant material) in highly erodible areas to reduce sediment and filter bacteria. Critical area plantings may reduce fecal coliform and sediment runoff by as much as 75%.

Riparian Herbaceous Cover – uses grasses, forbs, and trees directly on stream banks to protect wildlife habitat, provide wildlife habitat, and to stabilize stream banks and channels. This practice can reduce fecal coliform and sediment loads by 50-75%.

Riparian Forest Buffers – uses trees, shrubs, and grasses to filter surface runoff prior to entering streams. This practice can reduce fecal coliform and sediment loads in surface runoff by 50-75%.

Filter Strips – are vegetated areas between cropland, grazing land, or disturbed areas and surface waters to protect water quality. Filter strips may remove as much as 50-80% of nutrients and sediment from surface runoff.

Stream Crossings – provide a stable stream bed and reduce erosion where livestock must cross streams, which can significantly reduce both fecal coliform and sediment loads.

Nutrient Management – assists growers and producers in improving farm management and litter or manure application strategies. Nutrient management can reduce phosphorus loads by 35% and nitrogen loads by 15%.

Animal Waste Storage – includes composters and stack houses for manure and litter storage. Proper composting reduces viable bacteria and nutrient concentrations, reducing fecal coliform loads by 70-80%.

SEDIMENT BMPs

Heavy Use Area Protection – reduces sediment and bacterial runoff up to 80% by protecting areas with heavy livestock traffic such as troughs and feeding areas.

Pasture and Forage Planting – prevents soil erosion by establishing native vegetation (preferable) or introduced forages in fields or pastures.

Grassed Waterways – are natural channels to slow the flow of water, remove excessive sediment and nutrients, and prevent gully erosion. Grasses waterways can reduce sediment loads by 60-80%.

Field Borders – are permanently vegetated buffers around pastures to reduce soil erosion, that can reduce sediment loads by 50-80%.

Conservation Cover – is the establishment of permanent vegetative cover to prevent erosion and protect water quality on retired agricultural land, which can reduce sediment loads by 90%.

Prescribed Grazing – manages grazing animals for long term benefits; promotes vegetative quality and quantity and reduces erosion, reducing sediment loads by 75%.

Streambank and Shoreline Protection – stabilizes and protects streambanks to significantly reduce erosion and prevent water quality degradation.

Stream Channel Stabilization – strengthens or stabilizes the bed or bottom of the channel in very specific instances when normal protection and riparian buffers are inadequate to protect water quality.

Tree/Shrub Establishment – slows runoff and allows for increased infiltration of runoff, thus reducing pollutant concentrations by up to 50%.

Recommended Management Measures

Management Measures for Forestry

Rabun County contains an abundance of prime forest land, most of which is managed by the United States Forest Service and contained within the boundaries of the Chattooga River Ranger District of the Chattahoochee National Forest. The 1998 USDA *Forest Statistics for North Georgia* identified 207,300 acres of total forestland in Rabun County, or 87% of the total area in the county.

Table 13 - *Management Measures for Forestry*

Source: Georgia's Best Management Practices for Forestry Manual Georgia Forestry Commission, May 2009.

SEDIMENT BMPs

Pre-harvest Planning — designed to ensure that silvicultural activities, including timber harvesting, site preparation, and associated road construction, are conducted in a way that takes into account potential nonpoint source pollutant delivery to surface waters.

Streamside Management Zones (SMZ) — establishes areas along surface waters that are managed to protect the water quality of the adjacent waterbody. SMZs protect against soil disturbance and reduce the delivery of sediment and nutrients from upslope activities to waterbodies.

Road Construction/Reconstruction and Management — should reduce generation and delivery of sediment from road construction or reconstruction, and prevent sedimentation and pollution from runoff-transported materials on existing roads.

Timber Harvesting Prescriptions — intended to reduce NPS pollution resulting from timber harvesting operations, including the location of roads, skid trails and log landings, the operation of ground-skidding and cable yarding equipment, and the prevention of pollution from petroleum products.

Site Preparation and Forest Regeneration — components of this measure address keeping slash materials out of drainages, operating machinery on the contour, and protecting the ground cover in ephemeral drainages and SMAs.

Fire Management — intended to reduce the potential nonpoint source pollution and erosion resulting from prescribed fire for site preparation and from methods for suppression of wildfire.

Privately owned forest land in Rabun County accounts for 57,900 acres or 24% of the total area in the county (Source: 1998 USDA *Forest Statistics for North Georgia* and *Rabun Co. Comprehensive Plan*, 2013 draft).

Sediment, nutrients, pesticides and temperature are the pollutants commonly associated with forestry activities. Sediment concentrations can increase because of the accelerated erosion during timber harvesting activities; water temperatures can increase through removal of riparian area shade; slash and other organic debris can accumulate in water bodies, depleting dissolved oxygen; and, organic and inorganic chemical concentrations can increase as a result of harvesting and applications of fertilizers and pesticides. These potential increases in water quality contaminants are usually proportional to the severity of site disturbance, and the impacts of silvicultural nonpoint source pollution depend on site characteristics, climatic conditions and the forestry practices employed.

⦿ **Table 13** presents a prioritized summary of management measures to address sources of sediment from forest harvesting activities.

Management Measures for Urban / Residential Areas

During urbanization, pervious surfaces such as vegetated and forested lands are converted to uses that typically involve increased areas of impervious surfaces such as roads, sidewalks, parking lots and roofs. In response to site clearing, grading and the addition of impervious surfaces and maintained landscapes, hydrologic and hydraulic changes occur. Most problematic are the greatly increased stormwater runoff volumes, and the ensuing pollutant loadings to surface waters that accompany these changes to the landscape. The pollutants contained in stormwater runoff could include oil, grease and toxic chemicals from motor vehicles; pesticides and nutrients from lawns and gardens; road salts; heavy metals from roof shingles, motor vehicles and other sources; thermal pollution from dark impervious surfaces such as streets and rooftops; and, viruses, bacteria and nutrients from pet waste, failing septic systems and leaking sewage collection infrastructure. As population density increases with urbanization, there is a corresponding increase in pollutant loadings.

▶ There are six major categories of urban/residential nonpoint pollution sources that affect surface waters: 1) runoff from developing areas; 2) runoff from construction sites; 3) runoff from existing development; 4) on-site sewage disposal systems; 5) general sources

Recommended Management Measures

(households, commercial, and landscaping); and, 6) roads, highways, and bridges. (Source: *National Management Measures to Control Nonpoint Source Pollution from Urban Areas* EPA-841-B-05-004 November 2005).

Urbanization in the Stekoa Creek watershed has included flood plain filling; installing bridges over Stekoa Creek and channeling the waterway into multiple culverts beneath access roads and the highway; construction of large areas of impervious surfaces next to Stekoa Creek; and, building residential areas and retail stores with associated septic systems and sewage collection infrastructure, all of which are located within or immediately next to Stekoa Creek's riparian buffer zone.

Most problematic are the greatly increased stormwater runoff volumes, and the ensuing pollutant loadings to surface waters that accompany these changes to the landscape. The pollutants contained in stormwater runoff could include oil, grease and toxic chemicals from motor vehicles; pesticides and nutrients from lawns and gardens; road salts; heavy metals from roof shingles, motor vehicles and other sources; thermal pollution from dark impervious surfaces such as streets and rooftops; and, viruses, bacteria and nutrients from pet waste, failing septic systems and leaking sewage collection infrastructure.

▶ The management practices to address the categories of urban/residential nonpoint source pollution can be grouped into two basic categories: *non-structural practices* and *structural practices*.

Non-Structural Practices prevent or reduce urban runoff problems in receiving waters by reducing potential pollutants or managing runoff at the source, and take the form of regulatory controls such as codes, ordinances, regulations, standards and rules, or the establishment of voluntary, community-wide pollution prevention programs. Non-structural controls can be further subdivided into land use practices and source control practices. Land use practices are aimed at reducing impacts on receiving waters by minimizing, controlling or preventing development in sensitive areas of the watershed, and/or by including green space, greenways, parks, rain gardens and other green infrastructure in local development standards while also accommodating growth. Source control practices are aimed at preventing or reducing potential pollutants at their source before they come into contact with runoff or aquifers. Some source controls are associated with new development, and others are implemented after development occurs and include pollution prevention activities that attempt to modify aspects of human behavior, such as educating citizens about the proper disposal of used motor oil and pet waste, and the application/disposal of lawn fertilizers and pesticides.

Studies demonstrate that the range of non-structural practices known as "pollution prevention" dramatically and cost-effectively reduce the frequency and concentration of pollutants winding up in stormwater. Management, planning, development design, or material substitution or reduction that incorporates stormwater pollution prevention before an activity takes place, are almost always the most effective as well as cost-effective means to reducing stormwater pollution. In already urbanized zones of the upper Stekoa Creek watershed, some pollution prevention measures may have limited opportunities for application; however, where new development is imminent such measures are certainly needed and appropriate.

Structural Practices

To reduce stormwater runoff problems in established developments, treatment with structural measures can be an effective alternative. Structural practices are engineered to manage or alter the flow, velocity, duration, and other characteristics of stormwater runoff by physical means. In doing so, they can control stormwater volume and peak discharge rates, and in some cases, improve water quality. Structural practices can also have ancillary benefits such as reducing downstream erosion, providing flood control and promoting ground water recharge.

There is a large and comprehensive library of educational publications and resources available on stormwater BMP selection, installation and maintenance, and the specific management measures that could minimize and treat stormwater runoff. Many of these practices are broadly known as green infrastructure, which at the local scale includes an approach to managing stormwater by infiltrating it into the ground during rainfall using vegetation or porous surfaces, or by capturing the stormwater for later re-use. Elevated stormwater flows also necessitate the construction of runoff conveyances,

Recommended Management Measures

A parking lot bioswale can control and naturally filter parking lot stormwater runoff.

or the modification and retrofitting of existing drainage systems with green infrastructure to avoid or mitigate erosion of streambanks and steep slopes. Retrofitting such practices in the upper Stekoa watershed has broad opportunities and much fertile ground for their application, as follows.

Green infrastructure is an approach to water management that protects the natural drainage patterns while restoring the hydrologic cycle. By improving stormwater management and flood mitigation, it has shown to be effective in enhancing community safety and quality of life. Utilizing both natural and engineered systems, a comprehensive green infrastructure program can cleanse stormwater, conserve ecosystem functions, and provide a wide array of benefits to people and wildlife. Green infrastructure solutions can be implemented on differing scales ranging from site-level installations to broader, watershed-level efforts. On the local scale, green infrastructure practices include rain gardens, permeable pavements, green roofs, infiltration planters, trees and tree boxes, and rainwater harvesting systems. At the largest scale, the preservation and restoration of natural landscapes (such as forests, floodplains, and wetlands) provide additional benefits to the larger green infrastructure program. To date, investments in green infrastructure have been driven by a variety of motivations. Communities may invest in green infrastructure to limit the cost of managing peak stormwater flows and/or combined sewer overflow control. Private property owners may choose to invest in green infrastructure to limit their stormwater discharge fees and/or limit the cost of water for irrigation. Foundations and/or non-governmental organizations (NGOs) may invest in green infrastructure for the above-named reasons, which ultimately improve the quality of life in an area.

The measures discussed in *National Management Measures to Control Nonpoint Source Pollution from Urban Areas* (EPA-841-B-05-004, 11/2005) are exhaustive, and are hereby incorporated by reference into this watershed management plan as potentially appropriate for application in the Stekoa Creek watershed.

⦿ A prioritized selection of management measures for urban stormwater pollution sources is presented in **Table 14** (See p. 43).

Hydromodification The EPA defines hydromodification as the alteration of the natural hydrologic characteristics of coastal and non-coastal waters, which in turn could cause degradation of water resources. Examples include filling in wetlands, and for streams include dredging, straightening, channelization, stream relocation, construction along streams, construction and operation of dams and impoundments, land reclamation activities, and streambank erosion. Channelization and channel modification can disturb stream equilibrium; disrupt riffle and pool habitats; create changes in stream velocities; eliminate the function of floods to control channel-forming properties; alter the base level of a stream; and, increase erosion and sediment loads. Many of these impacts are related; for

A rain garden constructed at Stekoa Creek Park in 2014 prevents polluted stormwater from Highway 441 from flowing into Stekoa Creek.

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Table 14 - *Management Measures for Urban Stormwater Runoff*

Source: National Management Measures to Control Nonpoint Source Pollution from Urban Areas EPA-841-B-05-004 November 2005.

STORMWATER RUNOFF PREVENTION BMPs

Impervious Surface Reductions – through street and parking lot design and the use of technologies such as permeable pavement and green roofs.

Construction Practices – to ensure that grading and clearing are done appropriately and that a system of BMPs is considered prior to development. This includes measures for mass grading, sequencing development, and maintaining the proper site-specific BMPs.

Soil Erosion Control on Exposed Soils – using mulches, blankets and mats, vegetative measures, structural methods, inlet protection, silt fences, check dams and temporary sedimentation basins or traps.

STORMWATER TREATMENT BMPs

Infiltration Basins - are impoundments in which incoming urban runoff is temporarily stored until it gradually infiltrates into the soil surrounding the basin.

Infiltration Trenches - are shallow excavated ditches that have been backfilled with stone to form an underground reservoir. Urban runoff diverted into the trench gradually infiltrates from the bottom of the trench into the subsoil and eventually into the ground water.

Vegetated Filter Strips - are areas of land with vegetative cover that are designed to accept runoff as overland sheet flow from development.

Grassed Swales - are an infiltration/filtration method that is usually used to provide pretreatment before runoff is discharged to treatment systems, and are typically shallow, vegetated ditches designed so that the bottom elevation is above the water table to allow runoff to infiltrate into ground water.

Porous Pavement and Permeable Surfaces - reduces much of the need for urban runoff drainage conveyance and treatment off-site. Instead, runoff is diverted through a porous asphalt layer into an underground stone reservoir.

Concrete Grid Pavement - consists of concrete blocks with regularly dispersed void areas that are filled with pervious materials, such as gravel, sand or grass, allowing infiltration of surface water into the underlying soil.

Water Quality Inlets - are underground retention systems designed to remove settle-able solids.

Extended Detention Ponds - temporarily detain a portion of urban runoff for up to 24 hours after a storm, using a fixed orifice to regulate outflow at a specified rate, allowing solids and associated pollutants the required time to settle out.

Wet Ponds - are basins designed to maintain a permanent pool of water and temporarily store urban runoff until it is released at a controlled rate.

Constructed Wetlands - are engineered systems designed to simulate the water quality improvement functions of natural wetlands to treat and contain surface water runoff pollutants and decrease loadings to surface waters.

Filtration Basins - are impoundments lined with filter media, such as sand or gravel. Urban runoff drains through the filter media and perforated pipes into the subsoil.

Sand Filters - are a self-contained bed of sand to which the first flush of runoff water is diverted. The runoff percolates through the sand, where colloidal and particulate materials are strained out by the surface of the filter media.

Retention and Detention Systems – including bioretention cells and rain gardens, which detain pollutants and detain storm water for release more slowly, over time. These measures can help reduce storm water volume and pollutant concentration, and help prevent harmful effects of storm water on aquatic life.

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Sections of Stekoa Creek in Clayton have undergone hydromodification that includes channelizing and confining the stream within rip-rap embankments.

example, straightening a stream can increase stream velocities and destroy downstream pool and riffle habitats, as well as lead to more frequent and severe erosion. Hydromodification is one of the leading sources of impairment in our nation's waters, and is well-represented in the Stekoa Creek watershed.

In the upper portion of the watershed, hydromodification practices have facilitated the urban and residential development that occupies the riparian buffer zone along the main stem of Stekoa Creek within the highway corridor. In the City of Clayton, long sections of the creek have been subjected to major hydromodification projects such as confining the stream within rip-rap embankments and concrete walls, as well as straightening and channelization of the waterway. Here, Stekoa Creek is a poster child of a waterway where its natural ecological integrity has been seriously damaged by hydromodification practices, resulting in severe stream bank erosion from stormwater runoff.

The management measures in Table 15 (a prioritized selection of management measures) have been selected to restore streams altered by hydromodification in the Stekoa watershed and include vegetative practices, structural practices, and integrated designs. Vegetative practices can be defined as the use of live and dead plant materials in combination with natural and synthetic support materials for slope stabilization, erosion reduction and vegetation establishment. Structural practices are engineered to manage or alter the flow, velocity, duration, and other characteristics of runoff by physical means. Integrated designs employ a combination of vegetative practices and structural practices. The management practices described in the preceding Tables 14 (urban stormwater runoff) and 12 (agriculture) are also applicable to remediate hydromodification of streams in the Stekoa Creek watershed.

When considering the comprehensive management measures presented in the preceding tables, of note is that many of the operation and maintenance solutions for channelization are also practices that can be used for stream bank stabilization. For example, a stream channel that has been hardened with concrete walls will benefit from opportunities to replace the concrete walls with appropriate vegetative or combined vegetative and non-vegetative structures along the stream bank when possible. These same practices may be applicable to stabilize downstream banks that are eroding and creating a nonpoint source pollution problem because of upstream development, hardened stream banks and other factors. Also noteworthy is that a growing body of research indicates that management techniques that emulate nature and work with natural stream processes are more successful as well as more economical, and that integrated designs employing a combination of traditional structural methods and soil bioengineering techniques have proven to be more cost effective than either method applied independently.

⦿ **Table 15** (SEE P. 45) presents a prioritized selection of management measures to restore streams altered by hydromodification in the Stekoa watershed, and includes vegetative practices, structural practices and integrated designs.

Sewage Collection Infrastructure & Septic Systems Because bacterial pollutant loads in the Stekoa Creek watershed are directly linked to the City of Clayton's

A sewer manhole overflow into Coffee Branch, a tributary to Stekoa Creek, contributes to the bacteria load in Stekoa Creek.

TABLE 15 - *Management Measures To Address Hydromodification of Streams*

Source: National Management Measures to Control Nonpoint Source Pollution From Hydromodification EPA 841-B-07-002, 7/2007.

Correct/Prevent Detrimental Changes to Instream & Riparian Habitat from the Impacts of Existing Channelization - Identify/implement projects to improve physical/chemical characteristics of surface water in channels.

Bank Shaping & Planting - Re-shaping a streambank to establish a stable slope angle, placing topsoil and other material needed for plant growth on the streambank, selecting/installing appropriate plant species on the streambank.

Branch Packing - Alternating live branch cuttings and compacted backfill to repair small slumps and holes in slopes.

Brush Layering - Placing live branch cuttings interspersed between layers of soil on cut slopes or fill slopes.

Brush Mattressing - Digging a slight depression on the bank and creating a mat or mattress from woven wire or single strands of wire and live, freshly cut branches from sprouting trees or shrubs.

Check Dams - Small dams constructed across a drain way to reduce channel erosion by restricting flow velocity.

Coconut Fiber Roll Technique - Cylindrical or block structures composed of coconut husk fibers held together with twine, to protect slopes from erosion, trap sediment and encourage plant growth within the fiber roll.

Runoff Intercepts - Terraces, berms & ditches that break up a slope through areas of low slope in the reverse direction.

Dormant Post Plantings - Sprouting species embedded into streambanks to reduce flow velocities and trap sediment.

Erosion Control Blankets - Combine vegetative growth and synthetic materials for a high-strength mat that helps prevent soil erosion.

Establish & Protect Stream Buffers - To help stabilize the stream and prevent streambank erosion.

Identify & Preserve Critical Areas - Through conservation easements, leases, deed restirctions, covenants and transfer of development rights.

Joint Planting - Tamping live cuttings of rootable plant material into soil between the joints or open spaces in rocks.

Live Cribwalls - To rebuild a streambank in a nearly vertical setting, live cribwalls consist of a hollow, box-like structure of untreated timbers filled with backfill material and layers of live branch cuttings that root inside the crib and extend into the slope.

Live Facines - Long bundles of branch cuttings bound together in a cylindrical structure and placed in shallow contoured trenches to reduce erosion.

Live Staking - The insertion and tamping of live, rootable vegetative cuttings into the ground.

Mulches & Mulch Mats - Can be applied to disturbed soil to protect the area while vegetation becomes established.

Non-Eroding Roadways – Are tailored to the topography, soils and overall drainage pattern to prevent road-related water quality problems.

Sediment Basins/Traps – Engineered impoundment structures that allow sediment to settle out of stormwater runoff.

Sediment Fences – Filter sediment out of runoff as the runoff flows through the fabric of the fence.

Seeding – Establishes a vegetative cover on disturbed areas to control soil erosion.

Sodding – Provides immediate stabilization by covering disturbed areas with pieces of turf.

Tree Revetments – A row of interconnected trees anchored to the toe or upper streambank to reduce stream flow velocities, trap sediment and provide a substrate for plant establishment and erosion control.

Vegetated Buffers – Naturally occurring filter systems that remove nutrients and other pollutants from runoff, trap sediments and shade the water body.

Vegetated Gabions – Wire-mesh rectangular baskets filled with rock and soil, and laced together to form a structural toe or sidewall. Live branches are then placed on each consecutive layer between the rock-filled baskets to take root and join together the structure and bind it to the slope.

Vegetated Geogrids – Consist of layers of live branch cuttings and compacted soil with natural or synthetic geotextile materials wrapped around each layer, to rebuild and vegetate eroded streambanks.

Vegetated Reinforced Soil Slope – Is an earthern structure constructed from rootable, live plant material along with rocks, geosynthetics, geogrids and/or geocomposites.

Wildflower Covers – Are hardy, drought-resistant and very effective for erosoin control and contaminant absorbtion.

Wing Deflectors – Are structures that protrude from either streambank and designed to deflect flows away from the streambank, create scour pools and enhance stream diversity.

Recommended Management Measures

leaking sewage collection infrastructure as well as to failing septic systems (SOURCE: STEKOA CREEK TMDLIP 9/2007), point and non-point source pollution from these sources is also considered in this WMP.

⦿ **Table 16** (BELOW) presents a prioritized list of management measures for sewage collection and septic systems to remediate point and non-point sources of fecal coliform.

ROADS (PAVED) & BRIDGES The upper reach of Stekoa Creek is greatly impacted by State Hwy. 441 and a multitude of access roads and bridges. Implementing management measures and runoff controls for highways and bridges is of high priority in this watershed management plan. Also, in the near future, the Georgia Department of Transportation (GA DOT) will be engaged in widening Hwy. 441, from the northern boundary of Clayton's city limits to the North Carolina state line, which includes the headwaters portion of Stekoa Creek.

⦿ In consideration of the GA DOT's plans to widen Highway 441 and other forthcoming road construction projects, **Table 17** (SEE P. 47) presents basic management guidelines for during and after road construction projects.

In addition, a specific management practice strategy for bridges involves the use of "scupper drains," which can be implemented to mitigate the bridges' sources of stormwater pollution as follows: The most prevalent mitigation practice to direct the drainage from the bridge to an on-shore treatment system is via a scupper drain system. A scupper drain is an opening in the floor of a bridge that provides a means for rain or other water accumulated on the roadway surface to drain into the space beneath the structure. In this instance, rather than draining directly to the water below, the runoff can be conveyed from scupper drains through a pipe to adjacent land, where it could be sent to a retention pond or other runoff treatment practice. (SOURCE: *EPA NATIONAL MANAGEMENT MEASURES TO CONTROL NONPOINT SOURCE POLLUTION FROM URBAN AREAS, NOV. 2005, EPA-841-B-05-004.)*

> ***The report <u>Sedimentation in the Chattooga River Watershed</u> concluded that "unpaved multipurpose roads were the biggest sedimentation problem in the watershed," and that the "frequency of sediment sources associated with roads was highest in Georgia."***

DIRT & GRAVEL ROADS In 1995, Dr. David Van Lear, Professor of Forestry at Clemson University, conducted extensive field research as a component of the U. S. Forest Service's "Chattooga River Ecosystem Management Demonstration Project," and published a report entitled *Sedimentation in the Chattooga River Watershed.* The report concluded that "unpaved multipurpose roads were the biggest sedimentation problem in the watershed," and that the "frequency of sediment sources associated with roads was highest in Georgia." The report further disclosed that of all the sub-basins in the Chattooga River watershed, the Stekoa Creek watershed had by far the most miles of roads, at 173 miles (SOURCE: *SEDIMENTATION IN THE CHATTOOGA RIVER WATERSHED*). Although the Van Lear report is over 20 years old, surveys performed as a component of the preceding source

TABLE 16 - *Management Measures for Septic & Sewage Collection Systems*

Source: National Management Measures to Control Nonpoint Source Pollution from UrbanAreas EPA-841-B-05-004 November 2005

Development of Septic System Inventories and Assessment of Maintenance Needs - Including system location, type, age, design capacity, maintenance schedule, and potentially affected water resources.

Septic System Repair & Maintenance – To include pumping septic tanks at least once every 5 years, and inspections to determine where on-site sewage disposal systems are not properly designed, installed, or maintained.

Constructed Wetlands - Have traditionally been used for polishing effluent that has already had some degree of treatment. Vegetated submerged beds, also known as submerged constructed wetlands, subsurface flow constructed wetlands, or plant rock filters are designed primarily to reduce concentrations of biochemical oxygen demand and suspended solids in wastewater effluent from the septic tank.

Sewer Collection System Repair & Inspections – Can prevent and detect bacterial loading from broken pipes or overflowing manholes. To address fecal coliform contamination from the sewage collection system, continued repair, rehabilitation and replacement of an aging system is needed.

Storm Water Drain Repair & Inspections - Includes the removal of storm drains that are hooked to sanitary sewers, which may overwhelm the capacity of the sewage collection system during heavy rain events resulting in sewage overflows into state waters.

Recommended Management Measures

assessment confirm that dirt and gravel roads in the Stekoa Creek watershed persist as a major source of erosion and sedimentation in the watershed, and that corrective maintenence measures should be considered and implemented.

⦿ **Table 18** (SEE P. 48, TOP) summarizes environmentally sensitive maintenance and mitigation practices for protecting and restoring water quality from the impacts of unpaved roads located in close proximity to streams.

GOLF COURSES There is one golf course development in the Stekoa Creek watershed, at the Kingwood Country Club on Highway 76 East, which is located in the Chechero Creek sub-watershed. Chechero Creek flows through the center of the Kingwood Country Club golf course. The land use associated with the Kingwood golf course, this has the potential to be a significant source of polluted runoff due to the land area involved, quantity of chemicals used for turf management, and the position of Chechero Creek in the middle of the golf course.

⦿ **Table 19** (SEE P. 48, BOTTOM) presents a prioritized list of measures for remediating polluted stormwater runoff from a golf course.

TABLE 17 - *Management Measures for Paved Roads*

Source: EPA National Management Measures to Control Nonpoint Source Pollution from Urban Areas, November 2005, EPA-841-B-05-004, Ch. 7.

New Road Surfaces - disconnect and infiltrate stormwater runoff using structural runoff controls to mitigate impacts of roads and provide a significant degree of water quality protection. Protect wetlands and streams by minimizing road-and bridge-related impacts and water crossings, and by establishing setbacks during construction. Reduce the generation of pollutants from maintenance operations by minimizing the use of pesticides, herbicides, fertilizers, and deicing salts and chemicals; and, reduce the generation and runoff of pollutants during highway and bridge repair operations by decreasing the use of hazardous materials and incorporating practices to prevent spillage into sensitive areas.

Live Stakes - involve inserting and tamping live, root-able vegetative cuttings into the ground to create a living root mat that stabilizes the soil by reinforcing and binding soil particles together and extracting excess soil moisture.

Fascines - are long bundles of branch cuttings bound together into sausage-like structures, and installed in contoured trenches to reduce surface erosion and rilling.

Brush Layers – are branches placed perpendicular to the slope contour to break up the slope length and prevent surface erosion.

Branch-Packing - involves reinforcing a slope with alternating layers of live branch cuttings and compacted backfill to repair small, localized slumps and holes in earthen embankments.

Live Gully Repair - is similar to branch-packing and is used to repair rills and gullies.

Live Crib Walls - are hollow, boxlike structures of interlocking untreated timber members installed with backfill material and layers of live branch cuttings, and are appropriate for stabilizing the toe of a slope and reducing its steepness.

Vegetated Rock Walls - consist of a combination of rocks and live branch cuttings used to stabilize the toe of steep slopes.

Joint Planting - stabilizes slope faces by planting live cuttings in spaces between stones or riprap.

Chemicals from the Kingwood golf course have the potential to contribute a significant amount of polluted runoff into Chechero Creek.

Table 18 - *Management Measures for Erosion, Sedimentation & Stormwater Runoff from Gravel/Dirt Roads*

Sources: Georgia Better Back Roads Field Manual, Georgia Resource Conservation & Development Council, May 2009; Environmentally Sensitive Maintenance for Dirt & Gravel Roads, Report Number USEPA-PA-2005, Feb. 2005

In-sloping - is applied to a road constructed along a steep bank, with a steep uphill bank on one side and a steep downhill bank on the other side, ending at the edge of a stream. In-sloping means the entire surface of the road slopes toward the uphill embankment side to eliminate drainage over the downhill embankment, into the stream.

Out-sloping - is applied when the road crosses a gentle sloping terrain, and means the entire surface of the road slopes toward the downhill side allowing the natural sheet flow conditions to prevail.

Ditch Turnouts & Vegetative Filter Strips - should automatically go together. The ditch turnout carries the flow from the ditch, away from the road and into a vegetative filter strip, which filters out the sediment-laden ditch water, increases water infiltration into the ground and permits only clean runoff into a nearby stream.

Broad Based Dips - are shallow gradual dips across the road in the direction of water flow, directing water to an outlet or turnout to a vegetative filter strip.

Grade Breaks - are long gradual breaks in the longitudinal grade of a road on a downhill slope, breaking the road into shorter lengths for more efficient drainage.

Culvert End Structures - are built at either the entrance or outlet end of a culvert opening, to reduce erosion.

Aprons - installed at culvert outlets to spread the water flow and dissipate the erosive energy.

Through-Drains - are cross culverts that are placed to handle natural springs or spring seeps flowing perpendicular to the road, and carry them under the road to the other side to continue in the original channel.

Stream-Saver Systems - raise the road profile over the low-point stream crossing, and the road surface remains level for an extended area away from the stream on both sides, and use broad-based dips and turnouts to vegetative filter strips for road and ditch flows on each approach.

Raising Entrenched Roads - involves major filling of the road cross-section between high banks, bringing the road surface back up to the original road surface elevation. When the road is immediately next to a stream, the road is raised up-slope away from the stream, allowing for sheet flow across a vegetated filter strip.

Slope Geometry, Benching, & Diversion Swales - are all related to bank stability. Diversion swales divert upslope surface water before it washes over the top of the road bank and into the road's drainage ditch. Benching is commonly used on long, steep slopes, with the benefits of holding soil, water, seed and mulch for enhanced vegetation growth.

Roadside Trees - provide shade, control dust and invasive species, and offer the benefit of being beautiful.

Road Separation Fabrics - geosynthetic fabrics that separate subsoil from the road aggregate, providing improved road stability, reinforcement, drainage, prevention of subgrade pumping of fines, and thereby dust reduction.

Table 19 - *Management Measures for Erosion, Sedimentation & Stormwater Runoff from Golf Courses*

Source: BMPs for the Enhancement of Environmental Quality on Florida Golf Courses, FL Dept. of Env. Protection, Jan. 2007

Protect the Natural Integrity of Waterbodies – by establishing streamside buffers.

Prevent Erosion and Retain Sediment -- install a combination of management and physical practices to settle solids and associated pollutants in runoff from heavy rains and/or from wind.

Protect Environmentally Sensitive Ecosystems - avoid construction in areas susceptible to erosion and sedimentation.

Follow the Amended U.S. Golfing Association Guidelines - for maintenance of greens.

Develop & Implement Nutrient Management Plans - so that nutrients are applied without causing leaching into ground and surface waters.

Develop & Implement an Integrated Pest Management Plan -- by following EPA guidelines for the proper application, storage and disposal of pesticides.

Develop & Implement Irrigation Management Practices - to conserve water while matching needs of the turf.

Develop & Implement a Surface Water Quality Monitoring Plan – using sampling parameters based on specific water quality issues of concern as per the TMDLIP of the stream.

Develop/Implement a Lake Management Plan – designed to restore/protect water quality re: dissolved oxygen, sedimentation, native plant populations and riparian buffer zones.

6. Working with the Public

The Stekoa Creek Watershed Management Plan's educational component has identified a number of proposed outreach efforts, including activities at schools, homeowner seminars, watershed festivals, public service announcements, and electronic and print media. The goals of these outreach activities are to provide the general public and community officials with information on:

- Nonpoint source pollution
- Local watersheds
- Water quality problems
- Solutions to water quality problems
- Biological, physical, and chemical water quality information for the watershed
- Watershed Management Plan implementation, revisions & updates

Public Education Resources Prior to implementing a targeted education and outreach program, the specific audience will be identified and analyzed. Based on the characteristics of each audience, a specific communication medium will be chosen and the message will be crafted and packaged for optimum effect. An excellent resource for creating awareness, educating specific audiences, and motivating positive behavior change to improve water quality is *Getting In Step - A Guide for Conducting Watershed Outreach Campaigns* (3rd edition, November 2010 EPA 841-B-10-002 https://cfpub.epa.gov/npstbx/files/getnstepguide.pdf). This publication is exhaustive, and can be used in alliance with other resources to guide outreach efforts, such as guidance from the National Environmental Services Center (http://www.nesc.wvu.edu/) and the EPA's "Adopt Your Watershed" program (http://water.epa.gov/action/adopt/index.cfm) .

Education and outreach can include sampling streams for macroinvertebrates and learning why they are important indicators of water quality.

Public Education Options & Activities Standard examples of public education strategies include: a school program, that could involve educating students pre-K through high school about water quality issues and getting them involved in bacteriological, biological and chemical monitoring of surface waters near their school districts. Classroom and outdoor sessions with younger students could feature hands-on lessons in macroinvertebrate sampling, including equipment demonstration, examination of preserved or live macroinvertebrate samples, and the installation of in-stream leaf packs (http://stroudcenter.org/education/index.shtm) for future macroinvertebrate sampling. Young children love seeing and touching bugs, and could receive an explanation as to why they are important to water quality. Sessions with older students could include both in-class and field activities, with the class lessons covering such topics as water quality, nonpoint source and point source pollution, and the impacts of everyday activities on water quality including priority topics such as erosion, stormwater discharge, and hydromodification. The field exercises could involve students in visual assessments of streams and macroinvertebrate sampling. Teachers could organize a watershed festival event highlighting the natural resources housed in their local watershed, threats to water quality, and solutions to the water quality issues.

Adult community outreach efforts could include evening seminars, stream clean-ups, and instructions on how to install a rain garden. For example, the local health department could sponsor an evening seminar describing septic system maintenance, followed by the distribution of an informational packet that explains the symptoms and effects of failing septic systems. The local agricultural extension outreach agent could develop presentations and informational packets that describe the benefits of implementing agricultural best management practices, and funding opportunities for installing agricultural BMPs. The local marshal could present information about the benefits of installing stormwater management practices, and their benefits to water quality and the community.

Working with the Public

Educational outreach materials for the general public would be designed to emphasize practices that individuals or neighborhoods could implement to assist their communities in preventing pollution and water quality impairments caused by everyday activities, such as the proper disposal of household chemicals and pet waste. In addition, a comprehensive public information and education program could explain the basis, purpose, and details of installing green infrastructure, stormwater management facilities and agricultural BMPs, and the vital role this could play in improving water resources and the quality of life in their communities. This information can be presented through flyers, brochures, public service announcements, social media outlets, posters, and other educational aids.

Training programs and educational materials for public officials, public employees, contractors, and the general public are crucial to implementing effective stormwater management programs.

Presentations by green infrastructure and storm water management experts to planning boards, municipal councils and committees can also be of great assistance. The presentations could be augmented by developing training, educational programs and materials for public officials, contractors, and others involved with the design, funding, installation, operation, inspection and maintenance of stormwater remediation structures. Training programs and educational materials for public officials, public employees, contractors, and the general public are crucial to implementing effective stormwater management programs. Contractor certification, inspector training, and competent design review staff are also important for program implementation and continuing effectiveness of stormwater remediation strategies.

Pollution Prevention Activities That Result in Behavioral Changes These management measures have been included in the Stekoa WMP to ensure that the community is abreast of pollution prevention activities that could result in behavioral changes to reduce nonpoint source pollutant loading. Some of the major pollution sources addressed by these management measures include: storage, use and disposal of household hazardous chemicals, including automobile fluids, pesticides, paints, solvents, etc.; lawn and garden activities, including the application and disposal of lawn and garden care products, leaves and yard trimmings; turf management on golf courses, parks, and recreational areas; operation and maintenance of onsite disposal systems (septic systems); discharge of pollutants into storm drains, including floatables, waste oil and litter; commercial activities including management of parking lots, gas stations and other entities not under NPDES purview; and, disposal of pet / domestic animal excrement.

⦿ **Table 20** presents a prioritized list of management measures for pollution prevention. Flexibility is the key in the specific activities for this management measure, to align with local needs and priorities, community acceptance, and the availability of funding. In addition, flexibility is necessary to determine acceptance of administrative mechanisms that could be practical or effective solutions.

Table 20 - *Management Measures for Pollution Prevention*

Source: EPA, National Management Measures to Control Nonpoint Source Pollution from Urban Areas, November 2005, EPA-841-B-05-004, Ch.9

Public Education – outreach activities utilizing resources such as *Getting In Step - A Guide for Conducting Watershed Outreach Campaigns* (see also additional resources on pp. 49-50, Section 6, Working With the Public).

Conservation Easements and Greenways – to control or prevent land use in sensitive areas of the watershed, and/or minimize the total land used for development while also accommodating growth.

Trash Control – including periodic stream clean-ups, and for roadside and parking lot trash.

Septic System Inspection and Maintenance – see Table 16 (p. 46).

Pollution Prevention, Training and Urban Runoff Control Plans - for local governments and/or commercial establishments, which could include measures such as ordinances, certification and training requirements.

Proper Management of Maintained Landscapes – including lawns, parks and golf courses, to eliminate sources of stormwater runoff, nutrient, bacterial and/or chemical pollution from entering streams.

Promotion of Alternative and Public Transportation – including bicycle and walking trails, as well as carpools and public transportation options.

Promotion and Installation of Green Infrastructure – see pp. 42-43 and Table 14 (p. 43).

7. Implementing Recommended Best Management Practices

The goals of the Stekoa Creek Watershed Management Plan's Implementation Schedule are to:

- Promote the application of agricultural, forestry and urban/residential best management practices to improve water quality by systematically reducing sources of fecal coliform and sedimentation pollution in the Stekoa Creek watershed, so that Stekoa Creek, Saddle Gap Branch, Scott Creek, Chechero Creek and She Creek can attain water quality standards for their designated use of fishing.

- Attain measureable improvements in Stekoa Creek's water quality by the application of agricultural, forestry and urban/residential best management practices, so that the stream will cease to be a public health hazard and polluted tributary to the National Wild & Scenic Chattooga River.

⊙ **Table 21** (See pp. 52-55) presents the **Stekoa Creek Watershed Management Plan BMP Implementation Schedule.**

The BMPs entered in Table 21 were selected based on the following criteria: most effective for critical areas; most feasible given existing community support and potential funding sources; and, most likely to reduce/control pollutant loadings.

Implementation of this plan will begin when funding is secured for any of the management measures described in the preceding pages. In lieu of designated and secured funding, the milestone timetable in the chart below is depicted with a generalized timeline of short, mid and long term implementation. The success of implementing the Stekoa WMP will depend on the leadership of a project manager, which could be established within the city or county government and/or with a local non-profit by securing the commitment and funding to create this position. Success, of course, is also dependent on the support of the City of Clayton and Rabun County to cooperatively pursue and apply the management measures named in this watershed management plan.

Criteria To Measure Success Quantitative measurements of the various watershed management plan implementation projects delineated in the preceding implementation schedule will be of the most importance in gauging how these actions have contributed to accomplishing the goal of attaining state water quality standards for impaired streams in the Stekoa Creek watershed. Tracking water quality improvements through a Targeted Water Quality Monitoring Plan and other environmental indicators will measure progress toward reducing levels of fecal coliform and sediment. Tracking programmatic and social indicators will show that the implementation program is gaining momentum and accomplishing goals. For example, participation rates of students and community members in education and outreach opportunities, and of agricultural producers, private property owners, local governments and local/state agencies can help measure progress and determine the successes of WMP implementation.

Success, of course, is also dependent on the support of the City of Clayton and Rabun County to cooperatively pursue and apply the management measures named in this watershed management plan.

⊙ **Table 22** (See p. 56) presents a number of **environmental, programmatic and social indicators useful in measuring success**.

Financial and Technical Resources The Stekoa Creek WMP will require significant financial and technical resources for its implementation. Of note is that the City of Clayton recently received an estimate from the engineering firm McKim & Creed, who projected the expense of $2.5 million to repair/rehabilitate the city's sewage collection infrastructure, a persistent source of fecal coliform pollution in the Stekoa Creek watershed. Clayton has secured a substantial loan from the Georgia Environmental Finance Authority to repair the high priority sites in the sewage collection infrastructure.

Concerning the various implementation projects recommended in the preceding pages of the watershed management plan, the total dollar amount needed for executing these projects to the extent necessary to meet water quality goals is considerable, and unknown at this time. However, Table 23 presents known expenses as well as the anticipated cost of implementing a variety of management measures named in this WMP, incorporating some financial information gained from a recently executed 319(h) project called the Clayton-Rabun County Watershed Project (EPD grant # 751-100052) and GA NRCS Practice Payment figures. Please note that this list is not exhaustive; the initial years of implementing the Stekoa Creek WMP will provide valuable insight as to the total amount of money that will be necessary to meet water quality standards. (*Financial and Technical Resources continues on p. 56.*)

⊙ **Table 23** (See p. 57) presents **cost range examples for selected management measures**.

Implementing Recommended Best Management Practices

TABLE 21
Stekoa Creek Watershed Management Plan BMP Implementation Schedule

Management Strategies	*Who Should Be Involved*	Milestone Benchmarks		
		Years 1-2	Years 3-5	Years 5+
Objective: ***Public education and outreach about water quality issues, and the benefits of implementing pollution prevention measures as well as best management practices to reduce fecal coliform and sediment pollution from agricultural, forestry and urban/residential sources.*** *(See Table 20, p. 50, and pp. 49-50, Working With the Public)*				
Task: Create educational media about agricultural, forestry and urban/ residential BMPs	Project manager (lead), & : Rabun County Health Department, NRCS, UGA AG Extension Agent, GA Forestry Commission, Clayton marshal, Rabun County marshal	√	√	
Task: Identify landowners for AG BMP opportunities	Project manager (lead), &: NRCS, UGA AG Extension Agent	√	√	
Task: Identify landowners for forestry BMPs	Project manager (lead), &: GA Forestry Commission	√	√	
Task: Identify landowners for urban/ residential BMPs	Project manager (lead), &: Rabun County Health Department, Clayton marshal, Rabun County marshal	√	√	
Task: Distribute educational media about agricultural, forestry, urban/ residential BMPs to the appropriate demographic group	Project manager (lead), &: Rabun County Health Department, NRCS, UGA AG Extension Agent, GA Forestry Commission, Clayton marshal, Rabun County marshal, *Clayton Tribune*, *Rabun Laurel*, SKY 104, local homeowner's and Lake Burton/Lake Rabun civic associations, cooperating businesses	√	√	
Task: Develop and publish quarterly educational media articles about pollution prevention measures, green infrastructure strategies, and BMPS for agriculture, forestry and urban/ residential areas	Project manager, *Clayton Tribune*, *Rabun Laurel*, SKY 104, local homeowners, Lake Burton and Lake Rabun civic associations, cooperating businesses	√	√	
Task: Assemble and distribute educational resources for students	Project manager, Rabun County schools	√	√	
Task: Host water quality monitoring workshops for student groups	Project manager, GA Adopt-A-Stream, Rabun County schools	√	√	√
Task: Develop, publish and distribute a Stekoa Creek watershed facts and watershed protection measures booklet	Project manager	√	√	
Task: Assemble and distribute specific pollution prevention information and mitigation resources for the community	Project manager, Rabun County Health Department	√	√	√

Implementing Recommended Best Management Practices

TABLE 21
Stekoa Creek Watershed Management Plan BMP Implementation Schedule

Management Strategies	*Who Should Be Involved*	Milestone Benchmarks		
		Years 1-2	Years 3-5	Years 5+
Task: Host one or more annual clean-up of Stekoa Creek and its impaired tributaries	Project manager, City of Clayton, Rabun County, civic organizations	√	√	√
Task: Continue to develop a greenway along Stekoa Creek and Scott Creek	Project manager, City of Clayton, Rabun County, civic organizations	√	√	√
Task: Protect greenway tracts permanently with conservation easement agreements	Project manager, City of Clayton, Rabun County, Chattooga Conservancy	√	√	√
Objective: ***Implement best management practices to reduce fecal coliform and sedimentation pollution from agricultural sources.*** *(See Table 12, p. 39)*				
Task: Contact agricultural landowners about participating in programs	Project manager, NRCS, UGA AG Extension Agent	√	√	
Task: Design and monitor the installation of appropriate AG BMPs	NRCS	√	√	√
Objective: ***Implement best management practices to reduce sedimentation pollution from forestry sources.*** *(See Table 13, p. 40)*				
Task: Contact forest landowners about participating in programs	Project manager, GA Forestry Commission	√		
Task: Design and monitor the installation of appropriate forestry BMPs	GA Forestry Commission	√	√	
Task: Contact the U. S. Forest Service to request remediation of certain system roads and closure of illegal ATV trails in the Stekoa watershed	Project manager	√		
Task: The Chattooga River Ranger District completes remediation of system roads and closures illegal ATV trails	Chattooga River Ranger District, U. S. Forest Service	√	√	√
Objective: ***Implement best management practices to reduce fecal coliform and sedimentation pollution from urban/residential sources.*** *(See Table 14, p. 43; Table 15, p. 45; Table 16, p. 46; Table 17, p. 47; Table 18, p. 48; Table 19, p. 48)*				
Task: Continue planned repairs to the City of Clayton's sewage collection infrastructure	City of Clayton, McKim & Creed, *Sanitary Sewer System Rehabilitation Study 2015*	√	√	√

Implementing Recommended Best Management Practices

TABLE 21
Stekoa Creek Watershed Management Plan BMP Implementation Schedule

Management Strategies	*Who Should Be Involved*	Milestone Benchmarks		
		Years 1-2	Years 3-5	Years 5+
Task: Contact residents and businesses using septic systems to engage them in septic system maintenance, repair and rehabilitation programs	Project manager, Rabun County Health Department	√	√	√
Task: Identify and implement site-specific stormwater management practices and/or retrofits for impervious surfaces to improve water quality	Project manager, engineering consultant, residents and businesses, Clayton marshal, Rabun County marshal	√	√	√
Task: Identify and implement site-specific management practices and/or retrofits for addressing hydromodification to improve water quality	Project manager, engineering consultant, residents and businesses, Clayton marshal, Rabun County marshal	√	√	√
Task: Identify and implement site-specific management measures to mitigate erosion and sedimentation into surface waters from dirt or gravel county roads	Project manager, engineering consultant, Rabun County	√	√	√
Task: Secure a commitment from the GA DOT that planning and implementation of widening Hwy. 441 within the Stekoa watershed will incorporate BMPs and green infrastructure to address hydromodification and impervious surfaces	GA DOT, Clayton marshal, Rabun County marshal	√	√	
Task: Identify opportunities and secure a commitment from GA DOT to exercise mitigation banking to implement stream bank restoration on Stekoa Creek as a component of the Hwy. 441 widening project.	GA DOT, project manager	√		
Task: Identify and implement site-specific management measures to mitigate nonpoint source pollution from golf courses	Project manager, Kingwood Country Club	√	√	

Implementing Recommended Best Management Practices

TABLE 21

Stekoa Creek Watershed Management Plan BMP Implementation Schedule

Management Strategies	*Who Should Be Involved*	Milestone Benchmarks		
		Years 1-2	Years 3-5	Years 5+
Objective*: Maintain and restore stream buffers to the greatest extent possible.* *(Components of this objective are in all of the management measures' tables)*				
Task: To the greatest extent possible, implement proactive measures to restore riparian areas and stream banks within the designated 50-foot buffer zones on Stekoa Creek, Scott Creek, Chechero Creek, She Creek, Cutting Bone Creek and Saddle Gap Branch.	City of Clayton, Rabun County, GA DOT	√	√	√
Task: Restore degraded stream banks and the riparian zone at bridges over Stekoa Creek that provide access to Hwy. 441.	GA DOT, City of Clayton, Rabun County	√	√	√
Objective*: Establish a long term water quality monitoring program to provide contemporary data to support decision-making.* (*See Section 6., Working with the Public, pp. 49-50; Section 8, Developing the Long Term Monitoring Plan, p. 61; and, Section 4, Assessment and Characterization of Current Conditions, Monitoring, p. 31.)*				
Task: Update EPD-approved Targeted Water Quality Monitoring Plan for *E. coli* and sediment to provide for continued and post BMP monitoring.	Project manager	√		
Task: Conduct ongoing short-term monitoring by AAS-qualified personnel under GA EPD-approved Targeted Water Quality Monitoring Plan.	Project manager	√	√	
Task: Conduct long-term water quality monitoring by AAS-qualified personnel under EPD approved Targeted Water Quality Monitoring Plan.	Project manager			√
Objective*: Secure funding to initiate progress on implementing the Stekoa Creek Watershed Management Plan* *(See Financial and Technical Resources, pp. 56-60)*				
Task: Submit a proposed work plan, grant request and associated documents to apply for various funding options.	City of Clayton, Rabun County, Rabun County Health Department, Georgia Mountains Regional Commission, Chattooga Conservancy	√		√

Implementing Recommended Best Management Practices

TABLE 22

Criteria to Measure Success - useful examples

Indicator Type	Indicator Measurement
Environmental	Water quality data for fecal coliform or *E. coli*, and turbidity (sediment) in Stekoa Creek, Scott Creek, Chechero Creek, She Creek, Saddle Gap Branch
Environmental	Water quality data for dissolved oxygen, stream temperature, pH, conductivity
Environmental	Monitoring data for quality of riparian habitat, quality of instream habitat, and benthic macroinvertebrate community structure
Social	Number of participants in education and outreach programs
Social	Number of inquiries and responses to "call to action" media
Programmatic	Number and size (acres, linear feet, etc.) of agricultural, urban/residential and forestry BMPs implemented
Programmatic	Number of education and outreach programs held
Programmatic	Quantity of educational and outreach media presented
Programmatic	Acreage of riparian habitats conserved through conservation easements.
Programmatic	Acreage and linear feet of streamside protection established by greenways
Programmatic	Number of creek clean-ups

Financial and Technical Resources - *continued*

There are a variety of financing mechanisms that can be applied to watershed improvement efforts, and some mechanisms offer planners more reliability and predictability than others. For example, when relying on grant funding, it is difficult to do effective long term planning because grant funding decisions are oftentimes unpredictable. Thus, in addition to grant opportunities, proponents of implementing the Stekoa WMP should also be focused on more sustainable and predictable sources of financing.

⦿ The list below (and continued on p. 58) first presents technical resources, then sources of grant funding, and lastly, suggests some longer-term financing mechanisms to strive towards.

▶ *Technical Resources*

Environmental Finance Center: Works to enhance the ability of governments and other organizations to provide environmental programs and services in fair, effective and financially sustainable ways.

Georgia Adopt-a-Stream: Provides manuals, training, and technical support to increase public awareness of the state's nonpoint source pollution and water quality issues, and encourage community participation in addressing these issues.

Natural Resource Conservation Service: Provides technical expertise and conservation planning for farmers, ranchers and forest landowners wanting to make conservation improvements to their land.

Chestatee-Chattahoochee RC&D: Assists individuals and communities in utilizing and protecting natural resources while improving the economy, environment and quality of life.

UGA Agricultural Extension Service: Provides technical assistance to landowners on agricultural practices, water and soil testing.

Implementing Recommended Best Management Practices

TABLE 23

Cost Range Examples for Selected Management Measures

Note: Agricultural practices may be eligible for a 75% subsidy through the USDA EQIP program

Repair / rehabilitate sewage collection infrastructure, City of Clayton, GA	*$2.5 million*
Stream bank restoration – bioengineered	*$21,000 / 100 feet / severely eroded streambank*
Riparian area restoration, includes removing invasive species and installing native plants	*$20,000 / 1.5 acres / severely impacted site*
Septic system, new – conventional (1)	*$4,000 - $6,000*
Septic system, new – advance treatment system (1)	*$12,000 - $15,000*
Urban filtration basin and stormwater delivery system	*$14,000 - $20,000*
Bio-swales	*$11 per square foot*
Porous concrete	*$2 – $6.50 per square foot*
Interlocking pavers	*$5 - $10 per square foot*
Composting facility (AG)	*$5 - $7 per square foot*
Conservation cover (AG)	*$200 - $500 per acre*
Cover crop (AG)	*$75 - $150 per acre*
Critical area planting (AG)	*$160 - $950 per acre*
Diversion (AG grading and shaping)	*$2.50 per linear foot*
Fence (AG)	*$1.50 - $3 per foot*
Filter strip (AG)	*$250 - $450 per acre*
Heavy use area protection (AG)	*$1.50 - $7 per square foot*
Nutrient management system (AG)	*$2 - $23 per acre*
Riparian forest buffer (AG)	*$260 per acre*
Stream crossing (AG)	*$4 - $7 per square foot*
Stream bank and shore line protection (AG)	*$19 - $160 per linear foot*
Water well	*$4,500 - $7,000*

Implementing Recommended Best Management Practices

Blue Ridge Mountain Soil and Water Conservation District: Provides soil and water conservation advice and technical assistance to landowners.

Northeast Georgia Regional Commission: Offers assistance to local governments for planning, economic development, grant preparation, administration and job training.

Partners for Fish and Wildlife Program: May provide technical and financial assistance to private landowners to restore or improve native habitats for fish and wildlife.

Funding for Green Infrastructure: The EPA offers many resources on their website; for example, the following link discusses market-based approaches to funding green infrastructure: https://wiki.epa.gov/watershed2/index.php/Market-Based_Approaches_to_Green_Infrastructure:_Financing_Distributed_Stormwater_Management

▶ ***Grants / Financial Resources***

319: Under Section 319(h) of the Clean Water Act, the EPA awards a Nonpoint Source Implementation Grant to the GA EPD. GA EPD then disburses these grant funds to projects that support the implementation of the Georgia Nonpoint Source Management Program. This grant program requires a substantial match. Once a watershed management plan has been developed for an area, future rounds of 319 funding may be possible, particularly for implementation of projects identified within the plan.

Aquatic Ecosystem Restoration Projects (Section 206): This program is through the Army Corps of Engineers and involves the design and building of projects to restore aquatic ecosystems for fish and wildlife.

Southeast Aquatic Resources Partnership: Provides funding for aquatic habitat restoration and species conservation.

USDA Environmental Quality Incentives Program: Provides financial and technical assistance to agricultural producers to address natural resource concerns and deliver environmental benefits such as BMPs for improved water and air quality, conserved ground and surface water, reduced soil erosion and sedimentation, and improved or created wildlife habitat.

USDA Conservation Stewardship Plan: Helps agricultural producers maintain and improve their existing conservation systems and adopt additional conservation activities to address priority resources concerns. Participants earn payments for conservation performance—the higher the performance, the higher the payment.

Audubon Cooperative Sanctuary Program for Golf: Is an education and certification program that helps golf courses protect the environment on their property.

EPA Environmental Education Grants Program: Supports environmental education projects that promote environmental awareness and stewardship, and helps provide people with the skills to take responsible actions to protect the environment.

USDA Conservation Reserve Program: Assists agricultural producers to set aside environmentally sensitive land for conservation benefits.

USFWS Five Star Restoration Program: Provides challenge grants for environmental restoration projects involving partnerships to address wetland, riparian, forest and coastal habitat restoration, urban wildlife conservation, stormwater management, education and outreach.

North Georgia Community Foundation/Community Impact Program: Offers grant funding opportunities to 501(c)(3) organizations in north GA counties for projects addressing quality of life issues.

USFWS Partners for Fish and Wildlife Habitat Restoration Program: Provides technical and financial assistance to private landowners to restore or improve native habitats for fish and wildlife, and may be used to restore riparian buffers and degraded wetlands.

River Network Partner Grants: Can be applied for by conservation groups to help build a volunteer base to implement protection and management strategies.

NRCS Watershed Protection and Flood Prevention Program: Offers technical and financial assistance for watershed protection, water supply, water quality, erosion and sediment control, and fish and wildlife habitat enhancement.

Watershed Assistance Grants: Provides small grants to local watershed partnerships for organizational development.

EPA Pollution Prevention Grant Program: Funds grants/cooperative agreements that implement pollution prevention technical assistance services and/or training for businesses and support projects that utilize pollution prevention techniques to reduce and/or eliminate pollution from air, water and/or land.

Implementing Recommended Best Management Practices

USDA National Integrated Water Quality Program: For improving water quality through research, education, and extension activities.

USDA Wetlands Reserve Program: Pays agricultural operators to set aside environmentally sensitive lands from production.

Rabun County Chapter of Trout Unlimited: Provides volunteer labor for stream clean up projects, and helps fund stream habitat and restoration activities through Trout Unlimited's Embrace-A-Stream program.

Audubon/Toyota Together Green Grants: Offers grant funding for community-based projects that conserve or restore habitat and protect species, improve water quality or quantity, and reduce the threat of climate change by reducing energy use and improving efficiency.

USDA Technical Assistance to Develop and Implement Conservation Programs: Assists landowners in planning, designing, implementing, monitoring, and evaluating fish and wildlife habitat development projects in Georgia.

Georgia Wetlands and Stream Trust Fund: Preserves wetlands or streams that need protection.

USDA Wildlife Habitat Incentives Programs: Are voluntary programs for landowners to implement applicable wildlife habitat practices.

NRCS Agricultural Conservation Easement Program: Provides financial and technical assistance to help conserve agricultural lands and wetlands and their related benefits.

Duke Energy Water Resources Fund: To improve water quality mainly in the Carolinas; however, specific parts of Georgia may also be eligible.

National Fish and Wildlife Foundation: Provides funding to projects that sustain, restore and enhance the nation's fish, wildlife, and plants and their habitats. Stekoa Creek's designation as a major tributary to the National Wild & Scenic Chattooga River may help in this instance.

Tull Charitable Foundation: Provides grants for a variety of causes to nonprofit organizations in the State of Georgia.

GA Environmental Finance Authority: The State Revolving Fund provides low-interest financing for publicly-owned water and wastewater projects; the Land Protection Program provides financing for local governments, state agencies and non-government organizations for permanent land conservation projects, including water quality protection for rivers, streams, and lakes.

▶ ***Financial Resources / Working with Local Government Entities***

Rabun County and the City of Clayton, which are irrevocably tied to the Stekoa Creek watershed, have a stake in Stekoa Creek's water quality as a prominent quality of life resource, and as an economic asset or liability. Research shows that in many cases, local governments have provided funds for watershed protection and restoration. Some local financing options include:

General Fund Contributions: A local government may choose to dedicate a portion of its general fund to water quality improvement efforts.

A Portion of Water or Wastewater Fees Revenue: The local water utility may use its discretion to dedicate a portion of its operating budget to water quality protection projects.

Watershed Protection Utility Fee: The local water utility may add a mandatory fee to its water/wastewater bill that is restricted to watershed efforts.

Contributions from Individual Rate Payers: Some utilities have provided their customers the option of paying more than is due on their water bill. The voluntary contribution is dedicated to water quality efforts such as planting additional trees.

Stormwater Utility Revenue: Some local governments have created a separate utility that charges a fee that funds stormwater management in particular. These utilities have a mission that aligns well with watershed improvement efforts and can be a source of funding for partners involved in these types of projects.

Clean Water State Revolving Fund: The federal government provides money to each state for managing a loan program for clean water projects. These loans are relatively low interest ones, and in very specific cases, less than 100% of the loan needs to be repaid. A sister program, the *Drinking Water State Revolving Fund* has also been used for financing projects related to water quality. In the State of Georgia, only local government entities are eligible for these loans. However, a watershed group may partner with the local government to implement the project. Approval for the loan is contingent on a clear and reliable revenue source for repayment.

Implementing Recommended Best Management Practices

▶ ***Financial Resources / Working with Private Entities***

Nationwide, there is considerable attention to the potential role of private entities in financing of water quality projects. Collectively known as public private partnerships (P3s), this concept can take a range of forms:

Public Private Partnerships (P3s): P3s are established to share the risk and reward of constructing and operating facilities (such as green infrastructure projects) for the benefit of the community. Municipalities may be attracted to P3s because they can defer up-front costs. This may be of particular interest to municipalities that are approaching their bonding limit. Conversely, investors are attracted because of the high level of transparency, investment premiums, and secured repayment streams.

Donations From Local Businesses: Donating funds to a cause such as water quality protection can be a boon to a business's image in the community. With proper recognition from the watershed project, such as signs with logos and ribbon cutting events, local businesses may be encouraged to provide financial contributions.

▶ ***Financial Resources / Diversity of Funding & Partners***

The healthiest approach to financing watershed improvements may be a diverse funding base. As planners strive towards more sustainable funding sources, grants will probably continue to play a role in the overall budget. As part of diversifying the sources of funding, watershed improvement efforts should also aim to engage a diverse set of stakeholders and partners. Since watershed lines usually cross political boundaries, there is an opportunity to generate funds from different jurisdictions. For example, a typical watershed may intersect with multiple cities, a county, a soil and water conservation district, water planning region, and a regional commission. All of these partners have a stake in water quality. Another key role that partners can play is providing matching funds in a grant application. Many grant programs have a cost share or match requirement. Funders tend to look favorably on applications where the match comes from partners, demonstrating the support of these partners for the project.

A tool known as the ***Capacity for Watershed Protection Investment Dashboard*** may be used to model the potential financial input of various partners, and can be accessed at http://www.efc.sog.unc.edu/reslib/item/capacity-watershed-protection-investment-dashboard. This *Capacity for Watershed Protection Investment Dashboard* was created for water utility managers and other water resource managers to use in considering options for generating local funds for watershed protection. The tool includes a "slider" that can be manipulated to show how much revenue can be generated by raising water rates. It also includes other options such as creating a "watershed fee" through property tax bills instead of the utility bill. Funds generated by these options can be used as a match for grants that require a cost-share. Alternatively, the funds can be used to amortize a loan, since the tool demonstrates to lenders how the funds will be generated for loan repayment.

> ***A tool known as the Capacity for Watershed Protection Investment Dashboard may be used to model the potential financial input of various partners, and was created for water utility managers and other water resource managers to use in considering options for generating local funds for watershed protection.***

If the watershed projects involve wetland areas, another tool, the ***Financing Wetland and Water Quality Improvements Tool*** http://www.efc.sog.unc.edu/reslib/item/financing-wetland-and-water-quality-improvements-tool is also useful in modeling input from multiple partners. This revenue tool allows one to ten separate governments, non-profits, or other entities looking to partner together on water quality projects to estimate how much money they can raise from various sources. In particular, the tool allows these partners to look at the revenue potential from changes to property taxes, sales taxes, water and wastewater fees, stormwater fees, flood control zone fees, permit fees, grants, and other sources. The tool has options for partners looking to raise a specific level of revenue, or for partners to see how much revenue they could generate by entering multiple scenarios into the tool.

Crowd Source Payments/Donations: There has been increased attention in methods of collecting funds from "crowds" through IT applications for specific initiatives. Crowd source platforms such as *Kickstarter* are becoming more popular to raise funds for specific projects, either as low interest loans or direct contributions.

8. Developing the Long Term Monitoring Plan

Targeted Water Quality Monitoring Plan All future water quality monitoring would be in accordance with an EPD approved *Targeted Water Quality Monitoring Plan* for fecal coliform and/or *E. coli*, and turbidity. The monitoring plan would contain Standard Operating Procedures for field data collection and laboratory analyses to ensure the quality of the data. In addition to data collected during the watershed assessment, it is suggested that macroinvertebrate data be added to the information already available.

Routine monitoring for sediment and bacteria will continue as well as work to refine “hot spot” locations for corrective action. The goal is to ensure that BMPs are implemented in places where they will result in water quality improvements and progress towards attainment of water quality standards and designated uses. In all cases where BMPs are installed or management measures implemented, both pre- and post- activity monitoring would occur upstream and downstream of the subject area. The monitoring will evaluate and assess physical, chemical and biological variables as applicable, to monitor trends in stream habitat, water quality, and the biotic community. Parameters evaluated would include:

- *Turbidity*
- *E. coli bacteria levels*
- *Macroinvertebrate community structure and function*
- *Dissolved oxygen*
- *Stream temperature*
- *pH*
- *Conductivity*

An Adopt-A-Stream class monitors for benthic macroinvertebrates at Stekoa Creek Park.

- *Quality of riparian habitat*
- *Quality of instream habitat*

Additionally, fecal coliform/*E. coli* bacteria analysis by a certified water/wastewater treatment operator such as from the City of Clayton or Rabun County would occur to add to the record of data, with special attention paid to stream segments listed for fecal coliform impairment.

Monitoring can include visual assessments of the quality of riparian area habitat.

9. Watershed Management Plan Implementation, Evaluation & Revision

⦿ **See Table 21, pp. 52-55** for the **Stekoa Creek Watershed Management Plan BMP Implementation Schedule.**

Keys to Success The keys to successful implementation of the Stekoa Creek Watershed Management Plan include:

- ★ *Measurable goals and objectives;*
- ★ *Dedicated staff to carry out administrative duties;*
- ★ *Consistent, long-term funding;*
- ★ *Dedicated individuals who are supported by local government agencies;*
- ★ *Local ownership of the watershed plan;*
- ★ *A method for monitoring and evaluating implementation strategies;*
- ★ *Involvement of stakeholders in planning the next phase of implementing the WMP;*
- ★ *Open communication between organization members; and,*
- ★ *Watershed Management Plan implementation, revisions & updates.*

Careful attention to these key factors should be assured in the next phase of implementing the Stekoa WMP.

The Players To address agricultural, forestry and urban/residential impacts in the Stekoa Creek watershed and future remediation of its negative impacts on water quality, it's important to note that the following entities are positioned to "make or break" the implementation of the proposed management measures:

➔ Within their respective jurisdictions, both the City of Clayton and Rabun County are the Local Issuing Authorities for Land Disturbing Activities under the Georgia Erosion & Sediment Pollution Control Act, and thus have lead responsibilities in the control of erosion and sedimentation during site development, and ensuring that proper site planning and storm water management occurs to protect wetlands, riparian areas and water quality.

➔ The Rabun County Health Department is responsible for designing new septic systems and addressing failing septic systems.

➔ The City of Clayton owns the majority of the sewage collection/distribution system in the Stekoa Creek watershed, and bears the responsibility for maintaining this system as well as addressing its chronic problems of inflow, infiltration and sewage spills, that have a long and well-documented history of polluting Stekoa Creek and several of its tributaries. Here, it's useful to note that during heavy rain events, stormwater from impervious surfaces can enter the sewage collection system through inflow and infiltration as well as by flooding manholes. Under this circumstance, the Clayton Wastewater Treatment Plant's capacity can be overwhelmed, resulting in a combined sewer overflow (CSO) that releases stormwater and partially treated or untreated sewage directly into Stekoa Creek.

➔ The Rabun County Sewer & Water Authority is a new entity whose future intentions and involvement in the Stekoa Creek watershed's sewage collection infrastructure—both existing and new—is still developing.

➔ The Georgia Department of Transportation is positioned to widen Highway 441 from Clayton city limits. Although the agency is under a General Stormwater MS4 Permit which requires the application of best management practices during both pre- and post-construction of state roads, highways, and bridges, this project could have major, negative impacts on Stekoa Creek.

➔ Success is also dependent on the support of the City of Clayton and Rabun County to cooperatively pursue and apply the management measures named in this watershed management plan.

➔ Lastly, the State of Georgia has the overall authority and responsibility to protect the "waters of the State" throughout the project area.

Evaluation Timeline Evaluation of three major components of the Stekoa WMP should occur every five (5) years, and include the following:

◈ *Inputs* — the elements of the process used to implement a program i.e., resources of time and technical expertise, stakeholder participation.

◈ *Outputs* — the tasks conducted and the products developed i.e., implementation activities such as installing management practices.

◈ *Outcomes* — the results or outcomes realized from implementation efforts, i.e., environmental improvements like water quality.

The Watershed Advisory Committee should convene every five years to revise and adjust the Stekoa WMP implementation schedule in a methodical manner, and in accordance with these evaluation components.