

COVE CREEK WATERSHED MANAGEMENT PLAN

BROAD RIVER WATERSHED

HYDROLOGIC UNITS

03050105040040

03050105040050

03050105040060

MCDOWELL AND RUTHERFORD COUNTIES

NORTH CAROLINA



Ecosystem Enhancement Program
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**COVE CREEK WATERSHED MANAGEMENT PLAN
EXECUTIVE SUMMARY
NC Ecosystem Enhancement Program**

This *Watershed Management Plan* for the Cove Creek watershed is the product of a fast-track study conducted for the Ecosystem Enhancement Program (EEP) of the North Carolina Department of Environment and Natural Resources (**Figure 1**). This local watershed plan was developed to identify restoration projects with willing landowners to fulfill wetland and cool-coldwater stream compensatory mitigation needs in the Broad River Basin and to improve ecological function on a sub-watershed level.

This fast-track approach to local watershed planning employed limited methods of watershed assessment focused on ecological functions of the watershed. The phases of the planning process included characterizing the watershed, identifying types and locations of degraded ecological function, and identifying specific projects to address functional degradation. Stakeholder input was limited to sharing local contact information and reviewing potential project maps with local resource professionals.

The study area watershed was divided into 32 subwatersheds. The subwatersheds are relatively similar in landscape, land use, and degree of function. The landscape is characterized by forested ridges separated by narrow to medium-width valley floodplains with small farms dominating the floodplains. Although primarily rural in nature, some residential developments are being built on the forested upper slopes as retirees and vacationers begin to look beyond the Lake Lure area for property.

The Graphic Information System (GIS) analysis revealed no significant water quality issues; however, based on the field evaluation some stressors were noted. The primary stressors observed included stream entrenchment of the mainstem of Cove Creek, inadequate forested buffers, sedimentation, stream bank erosion, livestock access, and possible nutrient enrichment. While many of the small streams flowing into Cove Creek appear to be in relatively good condition, Cove Creek itself is characterized by narrow buffers, mass wasting of banks, and incision. One of the greater threats to water quality is the potential for increased residential development with subsequent increases in stormwater, nutrients, and sediments.

Although extensive stakeholder contact was not within the scope of this watershed study, conversations with local landowners and officials, as well as drive-by observations revealed that extensive middle and upper slope development is underway or in the planning stages. This future development is the greatest threat to the functional health of this watershed.

The GIS analysis was also used to identify potential stream and wetland restoration project sites. Following the GIS screening, attempts were made to contact landowners to obtain access to the identified stream reach. Of the 36 sites identified in the GIS screening, 21 were ruled out based on observation or because they did not meet the drainage area size criteria of a maximum of ten square miles. The remaining 14 potential projects are presented in a Project Atlas as a separate submittal to this *Watershed Management Plan*.

Table of Contents

1.0 INTRODUCTION	1
1.1 Project Study Area.....	1
1.2 Watershed Management Goals.....	3
2.0 WATERSHED CHARACTERIZATION	4
2.1 Sub-watershed Functional Assessment Summary	4
2.2 GIS Screening for Field Assessment Sites	5
2.3 Field Assessment of Sites	6
2.4 Summary of Issues in the Cove Creek Watershed	9
3.0 STRESSORS AND MANAGEMENT STRATEGIES.....	10
3.1 Stream Channel Entrenchment	10
3.2 Inadequate Forested Buffer	11
3.3 Sedimentation	12
3.4 Streambank Erosion.....	14
3.5 Livestock Access	15
3.6 Nutrient Enrichment	16
3.7 Future Stressors – Residential Development and Stormwater	17
3.8 Management Practices Summary	19
4.0 RESTORATION PROJECTS	21
4.1 Project Types	21
4.2 Potential Projects	23
4.3 Project Implementation	23
4.4 Timing of Implementation.....	25
5.0 MONITORING AND EVALUATION NEEDS	26
6.0 REFERENCES	28

Tables

Table 2. Indicators of Function and Project Potential.....	5
Table 3. Estimated Potential Sediment Export Rates for Various Land Uses.....	12
Table 4. Management Practices and Their Appropriate Settings and Targets.....	20
Table 5. Potential Projects from GIS Screening.....	22
Table 6. Potential Projects after Field Surveys.....	23
Table 7. Maintenance Requirements.....	27

Figures

Figure 1. Vicinity Map.....	2
Figure 2. Subwatershed Function	7
Figure 3. Potential Projects.....	8

Exhibits

Exhibit 1. Field Cleared up to Stream Bank.	11
Exhibit 2. Livestock Access to Stream and Buffers Absent.	15

Appendices

Appendix A	Watershed Functions
Appendix B	Sub Watershed Functional Assessment (Technical Memo 1)
Appendix C	GIS Screening for Field Assessment Sites (Technical Memo 2)
Appendix D	Field Assessment of Sites (Technical Memo 3)
Appendix E	Management Practices
Appendix F	Technical and Funding Resources

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1.0 INTRODUCTION

This *Watershed Management Plan* for the Cove Creek watershed is the product of a fast-track study conducted for the Ecosystem Enhancement Program (EEP) of the North Carolina Department of Environment and Natural Resources (**Figure 1**). **This local watershed plan was developed to identify restoration projects with willing landowners to fulfill wetland and cool-coldwater stream compensatory mitigation needs in the upper portion of the Broad River Basin and to improve ecological function on a sub-watershed level.** The compensatory mitigation needs are based on the estimated impacts resulting from implementation of the NCDOT Transportation Improvement Plan. At the time this project was scoped, projected needs were for cool and coldwater stream mitigation.

Although stakeholder involvement was limited to key local resource professionals, this plan may serve stakeholders as a framework for linking EEP restoration projects with other watershed improvement projects initiated at the local level. Information is included on types of projects needed, potential collaborators, funding sources, and technical assistance sources.

This fast-track approach to local watershed planning employed limited methods of watershed assessment focused on ecological functions of the watershed. The phases of the planning process included characterizing the watershed, identifying types and locations of degraded ecological function, and identifying specific projects to address functional degradation. Watershed characterization and project identification activities are documented in three preliminary Technical Memos (discussed in sections 1.2-1.4), which provided the framework for development of this *Watershed Management Plan*.

At the request of EEP, staff also performed landowner contact and site evaluation for the most viable stream restoration projects. This work was conducted concurrently with the watershed planning tasks described in this document.

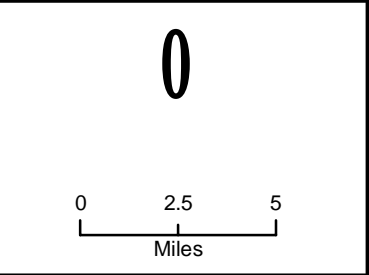
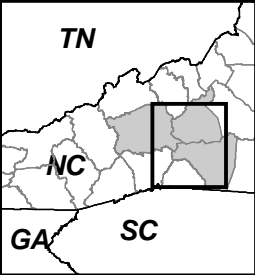
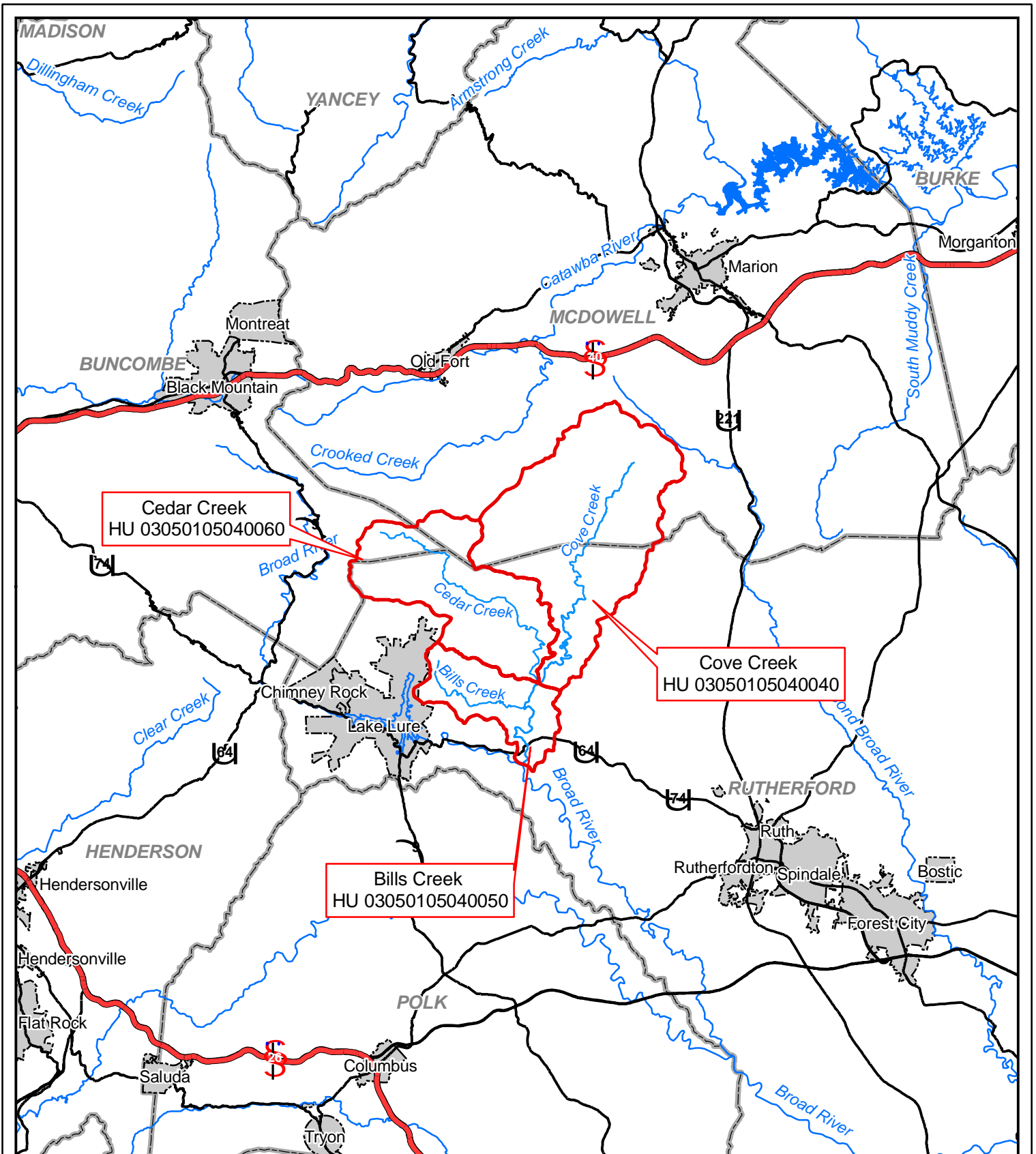
Due to the fast-track nature of the planning effort, stakeholder involvement was limited. Staff met with Natural Resource Conservation Service and Soil and Water Conservation District representatives of McDowell and Rutherford Counties in order to gather information on local issues as well as landowners and to review potential project maps.

1.1 Project Study Area

The 80.4 square mile study area is located within the Broad River Basin of North Carolina. The Cove Creek watershed includes the following 14-digit Hydrologic Units (HUs), shown on **Figure 1**:

- Upper Cove Creek (03050105040040), 42.7 square miles
- Cedar Creek (03050105040060), 25.8 square miles
- Bills Creek (03050105040050), 11.9 square miles

The HUs are located in eastern Buncombe, northwestern Rutherford, and southern McDowell counties in the Blue Ridge physiographic province. The landscape is characterized by forested



**FIGURE 1
VICINITY MAP**

Cove Creek
Local Watershed Plan
Bills Creek, Cedar Creek and Cove Creek
McDowell, Buncombe and Rutherford Counties
North Carolina

ridges separated by narrow to medium-width valley floodplains with small farms in the floodplains. Although primarily rural in nature, some residential developments are being built on the forested upper slopes as retirees and vacationers begin to look beyond the Lake Lure area for property.

The nearest towns are Marion to the north and Lake Lure to the southwest. Both towns are outside the watershed boundaries except for a very small portion of the Lake Lure municipal jurisdiction. Small, unincorporated communities within the study area include Sugar Hill, Whitehouse, and Bills Creek.

1.2 Watershed Management Goals

Simply stated, the goals of this *Watershed Management Plan* are **to identify ways to improve watershed functions and protect against future degradation and loss of watershed functions**. Based on the findings of the preliminary studies, management strategies were developed for dealing with the sources of functional degradation of most concern in the watershed. In accordance with guidance provided by the Watershed Needs Assessment Team (NCDENR *et al.*, 2003), the *Watershed Management Plan* is directed toward restoring and maintaining three main watershed functions:

- **Water quality** - the ability of the water to support aquatic life and other designated uses, such as drinking water or recreation.
- **Stable hydrology** - the occurrence, distribution, and movement of water in a way that supports other watershed functions.
- **Habitat** - the physical, chemical, and biological characteristics necessary for an organism's viability.

More detailed descriptions of these watershed functions are summarized in Table A-1 included in **Appendix A**.

Functional degradation occurs through a chain of events initiated by some change in land or stream corridor use (*e.g.*, conversion from forest to agriculture) or through some specific human activity (*e.g.*, direct wastewater discharge to a stream). Resulting changes in hydraulics, morphology, or other factors precipitate changes in functions, such as the maintenance of habitat diversity, maintenance of sediment regime, and water storage. These functional degradations may result in numerous direct and indirect effects, including changes in stream morphology that perpetuate erosion and down-cutting of the stream, changes in fish populations, and even lowering the water table. In short, watershed processes are highly interrelated and effects can reach far beyond the initial stressor in both space and time.

The purpose of a watershed management plan, therefore, is to recommend specific management actions that achieve a balance in these interrelationships, thereby protecting, maintaining, or restoring key watershed functions. There are eight commonly employed strategies for protection and maintenance of watershed function. The first four strategies listed below are strategies that fall under the purview of local, state, or federal agencies.

- Riparian buffer protection
- Erosion and sediment control practices
- Stormwater management
- Regulation of non-stormwater discharges

The remaining four strategies are more suited to local initiatives, either private or governmental.

- Land use planning
- Land conservation
- Better site design and low-impact development practices
- Watershed stewardship programs

Restoration of watershed function may be accomplished through restoration of wetlands, riparian buffer restoration, and stream restoration using bioengineering and natural channel design techniques. Projects involving these activities may be eligible for funding by the EEP and other state and federal agencies. Specific potential watershed restoration projects are summarized in Section 4.0 of this document and detailed descriptions are provided in the accompanying document, the Project Atlas.

2.0 WATERSHED CHARACTERIZATION

The following section provides a description of the three steps involved in evaluating the watershed followed by a description of the watershed.

2.1 Sub-watershed Functional Assessment Summary

Technical Memo No. 1 (**Appendix B**) was a limited compilation of existing published data in Geographic Information Systems (GIS) and other databases regarding land use, water quality, ecosystem functions, current management measures, and existing restoration and protection needs. The current conditions and functional status of the watersheds were evaluated and possible sources of functional degradation were explored. The watershed evaluation included visual observation of the watershed and analysis of existing data. Subwatersheds were identified and classified for potential future field studies and monitoring. Due to the fast-track nature of the project, extensive field studies were not included in this phase of the watershed evaluation.

Three main watershed functions -- Hydrology, Water Quality, and Habitat were addressed. Indicators (**Table 2**) were developed for each of the functions and given a value for each subwatershed; each indicator was then considered for use in a ranking protocol for subwatershed function. Four indicators were used to rank subwatershed function—impervious surface, riparian buffer protection, cleared land, and road crossings.

Table 2. Indicators of Function and Project Potential

Indicators	Hydrology	Water Quality	Habitat
Impervious surface	x	x	
Perennial stream mileage*	x		x
Riparian buffer protection		x	x
Cleared land (all non-forest land uses)	x	x	x
Hydric soils	x		
Slope*	x	x	
Significant Natural Heritage Areas			x
Natural Heritage Program elements			x
Road crossings		x	
Number of dams on streams	x		
Areas with low intensity development		x	

* Indicator of project potential

The study area watersheds were divided into 32 subwatersheds (**Figure 2**). Overall, the GIS analysis revealed a study area that is still in relatively good condition, as expected in such a rural area. The majority of cleared land is in row crops and pasture, and only 5 of 32 sub-watersheds have a cleared area greater than 12%. All but six sub-watersheds have 50-foot forested buffers on greater than 55% of the total stream length. The presence in the study area of a large number of Significant Natural Heritage Areas indicates that terrestrial habitat diversity is high. No serious water quality issues were discernible by the GIS analysis.

The windshield survey verified that conditions in the study area were consistent with that revealed by the GIS analysis. However, the windshield survey did reveal the presence of cattle in many of the streams, which is an important factor in determining potential projects. Presence of livestock and fencing was not discernible from aerial photography.

The original intention was to use this assessment and ranking to focus further screening efforts. However, the functional degradation issues were so moderate that screening for potential project sites was conducted on all 32 subwatersheds to ensure the identification of sufficient projects. The following section summarizes the next level of screening conducted.

2.2 GIS Screening for Field Assessment Sites

Technical Memo No. 2 (**Appendix C**) details the GIS procedures used to identify project sites for field assessment following the sub-watershed functional assessment. Conventional GIS methods were used to locate potential stream and wetland restoration areas. The screening processes used two separate sets of criteria, as outlined below:

Stream Restoration Site Criteria

- Stream classified as perennial or intermittent

- Inadequate buffer protection (less than 30 feet forested width on one or both banks)
- 2,000 feet minimum length
- Valley slope 4% or less
- Sinuosity (stream length to valley length ratio) 1.2 or less
- Drainage area 10 square miles or less
- Five or fewer landowners

Wetland Restoration Site Criteria

- Non-forested land use
- Soil map unit classified as Hydric A or B
- Area of hydric soil 3-4 acres or greater
- Three or fewer landowners

Thirty-six potential stream project sites were identified, which included a total of 129,355 linear feet of stream with inadequate buffer protection. These projects were associated with 230 parcels owned by 194 different landowners, equating to approximately three landowners per 2,000 feet of stream. One potential wetland project site was identified, with a total of 3 acres of potential wetland. See Tables 2 and 3 in Technical Memo No. 2 for descriptions of identified sites and **Figure 3** for the locations of the projects.

2.3 Field Assessment of Sites

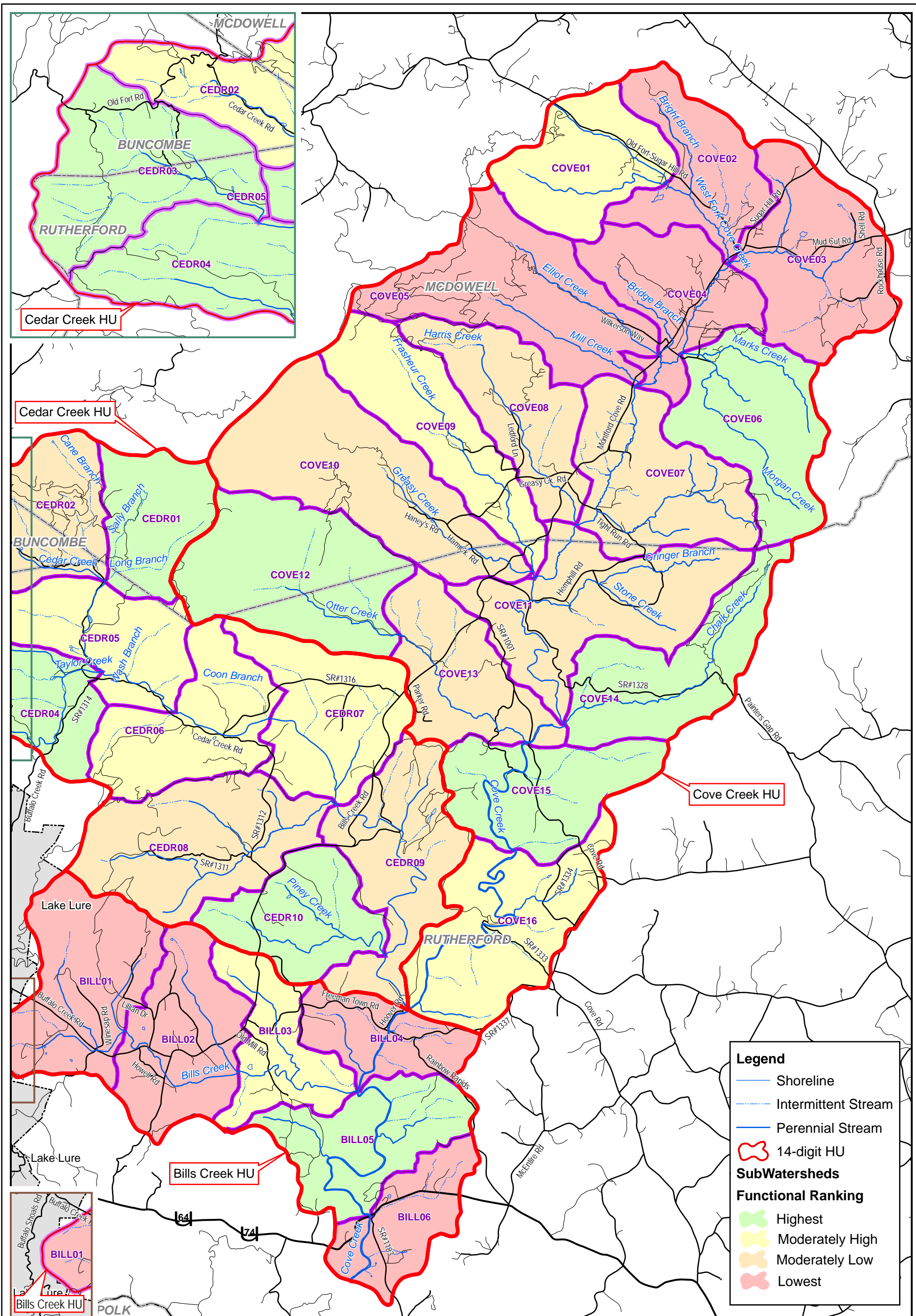
Following the identification of potential sites through the GIS screening, field visits were made to the sites. The purpose of the field assessment was to further assess watershed functional status by making observations of in-stream and landscape conditions (sediment, cattle impacts) not detectable through GIS, and to make an initial determination of mitigation project potential. Technical Memo No. 3 (**Appendix D**) details the methods and findings of the field assessments.

Of the thirty-six sites identified, data were collected at 27 points representing 13 projects sites. Earth Tech was unable to obtain access to all identified sites, and some sites were ruled out as potential projects on the basis of roadside observations.

The field work and functional analysis confirmed that many of the smaller streams in the watershed are relatively stable and overall functional degradation is not severe. It was also confirmed, however, that cattle impacts, inadequate buffers, and sedimentation are concerns in many locations in the watershed. In addition, incision was found to be prevalent.

Based upon observations, another potential water quality issue in this study area might be pesticide and nutrient runoff from nursery operations and golf courses. However, this is not verifiable without biological and water quality sampling.

While many of the smaller streams are in relatively good condition, the mainstem of Cove Creek is deeply incised, and contains areas of mass wasting and bank erosion that contributes sediment to the stream system, degrading water quality. However, few good projects are available along the mainstem of Cove Creek because of the high number of landowners per reach, restrictions on



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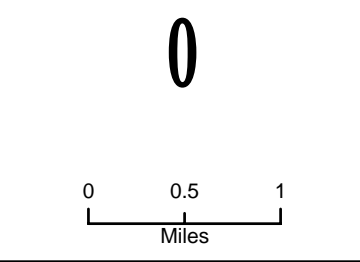
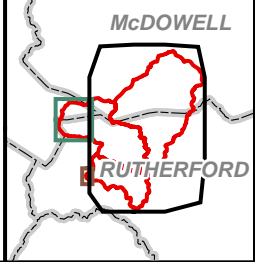
- Shoreline
- Intermittent Stream
- Perennial Stream
- 14-digit HU

SubWatersheds

Functional Ranking

- Highest
- Moderately High
- Moderately Low
- Lowest

FIGURE 2
SUBWATERSHED FUNCTION
 Cove Creek
 Local Watershed Plan
 Bills Creek, Cedar Creek and Cove Creek
 McDowell, Buncombe and Rutherford Counties
 North Carolina



restoration activities due to the size of the watershed, and the presence of roads and homes. The results of the field work are summarized in Table 2 of Technical Memo No. 3.

2.4 Summary of Issues in the Cove Creek Watershed

The GIS analysis revealed no significant water quality issues; however, some stressors were noted during the field evaluation. The primary stressors observed included stream entrenchment of the mainstem of Cove Creek, narrow forested buffers, sedimentation, streambank erosion, livestock activities, and nutrient inputs. While many of the small streams flowing into Cove Creek appear to be in relatively good condition, Cove Creek itself is characterized by narrow buffers, mass wasting of banks, and incision.

Most of the entrenchment observed during this study likely occurred around 100 years ago in response to accelerated timber harvesting on surrounding slopes when mechanized logging methods and rail transport became available. The flood of 1916 had significant effects as well, especially on channel locations. A lesser degree of entrenchment has probably occurred gradually since then in response to increased impervious surfaces in the form of new buildings and paved roads. Stream channelization may also have caused channel entrenchment. Landowners also reported bank erosion following recent hurricanes, mostly resulting from debris jams.

At the time the field work was conducted, the land cover had not changed significantly from what is visible on current aerial photography. Some new development is occurring on the upper slopes but parcel boundaries are not current enough to quantify the area. Of greater significance are reports of future developments. The large Hickorynut Mountain tract (> 6000 acres) on the western watershed boundary changed hands in 2006, but reports have differed on how or if it will be developed. Inexpensive land prices, favorable county tax laws and zoning ordinances, and limited land use planning may fuel development. This will have significant immediate as well as long-term impacts on water quality, habitat, stream morphology, and hydrology.

At this time, there is still a significant amount of high quality terrestrial habitat in the study area on the middle to upper slopes. The greatest loss of terrestrial habitat occurred long ago when the stream bottoms were converted from forest to farmland. Very few small pockets of wetland habitat were observed, probably because of the high degree of stream incision.

In summary, the greatest threat to this watershed is future development. The current stressors and related areas of functional degradations are as follows:

- Stream entrenchment
 - Reduction of flood storage capacity
 - Increased bank erosion leading to increased sedimentation and loss of aquatic habitat
 - Loss of riparian buffers and associated thermal regulation as the banks erode
 - Loss of adjacent wetlands due to lowering of the watertable
- Inadequate forested buffer
 - Loss of thermal regulation

- Habitat fragmentation and loss of diversity in both plant and animal communities
- Changes to vertebrate and invertebrate aquatic communities
- Increased nutrient and sediment inputs
- Reduced moderation of groundwater discharge to stream
- Sedimentation
 - Loss of aquatic habitat and associated fisheries
 - Reduction in water quality due to pollutants attached to sediment particles
- Streambank erosion
 - Loss of aquatic habitat
 - Reduced diversity of aquatic wildlife
 - Loss of riparian buffers and reduced thermal regulation
 - Increased nutrient and sediment inputs
- Livestock access
 - Decreased thermal regulation due to loss of buffers
 - Reduced water quality due to fecal contamination
 - Disturbances to aquatic habitat and communities
- Possible nutrient enrichment
 - Impacts to aquatic communities

Additional details regarding the stressors in the watershed are presented in Section 3.0.

3.0 STRESSORS AND MANAGEMENT STRATEGIES

Section 2 provided information on the function and stressors of the Cove Creek watershed. The following section provides a discussion of the major stressors found in the watershed, sources of the stressors, and the specific management strategies or practices that can be used to address the stressors. Additional details on each management practice can be found in **Appendix E**.

3.1 Stream Channel Entrenchment

The main channel of Cove Creek, as well as some of the larger tributaries, is entrenched. As previously discussed, this entrenchment most likely occurred around 100 years ago in response to accelerated timber harvesting on surrounding slopes as well as a large flood event in 1916. Entrenchment may also occur due to an increase in impervious surface or from channelization. Entrenched streams lead to a variety of functional degradation issues including:

- Loss of floodplain storage as the stream can no longer access the floodplain
- Increased bank erosion which leads to increased sedimentation and loss of aquatic habitat
- Loss of riparian buffers and associated thermal regulation as the banks erode
- Loss of adjacent wetlands due to lowering of the watertable

The primary management strategies to address stream channel entrenchment are:

- Stream restoration
- Stream enhancement

Stabilizing the channel and banks will also reduce sediment input into the stream and use of rock and log structures will help stabilize the channel and create riffles and pools, improving aquatic habitat and fisheries.

3.2 Inadequate Forested Buffer

Agricultural and cleared lands account for 4,189 acres or 8% of the land area in the 32 subwatersheds. Based on field observations, the main forms of agriculture are cattle, corn and nursery stock. Other cultivation land uses, such as gardens and silvicultural operations, are present to a lesser extent. When fields are cleared all the way to the stream banks (**Exhibit 1**), the very narrow or complete absence of wooded buffers contributes to the following areas of functional degradation:

- Habitat fragmentation and loss of diversity in both plant and animal communities
- Loss of thermal regulation and increases in water temperature
- Changes to vertebrate and invertebrate aquatic communities
- Increased nutrients and sediment from adjacent land
- Reduced moderation of groundwater discharge to stream

Exhibit 1. Field Cleared up to Stream Bank.



A variety of management strategies are available to restore or preserve riparian buffers. These include:

- Stream restoration
- Riparian restoration
- Wetland restoration in an adjacent floodplain
- Use of conservation easements to preserve existing buffers
- Livestock exclusion
- Forestry streamside management zones

3.3 Sedimentation

Sediment loads to streams occurs from a variety of sources. These include bank erosion and mass wasting of stream banks, runoff from urban and residential development, agricultural fields, livestock operations, and forestry (**Table 3**). It is often difficult to determine the source, and often more than one factor is contributing to the sediment observed in a stream.

Field observations recorded only moderate sedimentation at the sites evaluated. It should be noted that most evaluation sites were on smaller tributaries flowing into Cove Creek. Observations from road crossings of Cove Creek indicate that bank erosion and in-stream sediment may be more of a problem within the mainstem than the tributaries. Long-time residents report a decrease in trout populations that they attribute to pools filling in with sediment. Others report careless logging and development operations in the area in which roads are poorly maintained and little attention is given to maintenance of erosion control structures.

Table 3. Estimated Potential Sediment Export Rates for Various Land Uses.

Land Use	Export (ton/acre-year)	Source
Forest		
Mature, undisturbed	0.1-0.4	Hill (1991)
Clear cut harvesting	2-32	SCS (1977)
Select harvesting	0.01-0.02	USEPA (1993)
Forest roads	6.8-33.7	USEPA (1993)
Pasture		
Light to moderate grazing	0.1-0.7	Line <i>et al.</i> (2002)
Heavy grazing	1.3-17	Line <i>et al.</i> (2000)
Cropland		
High residue	3-5	Mud Creek WRC (2003)
Low residue	5-20	Mud Creek WRC (2003)
Residential		
Construction	25	Line <i>et al.</i> (2002)
Completed	1-6	Line <i>et al.</i> (2002)
Highways		
Construction	2-21	Line, unpublished
Completed	0.1-1.0	Wu <i>et al.</i> (2002)
Unimproved roads/driveways	35	SCS (1977)
Streambank Erosion		
Slight	50	SCS (1977)
Moderate	150	SCS (1977)

Types of functional degradation resulting from increased sedimentation include:

- Degraded in-stream habitat, as excessive amounts of sediment impact riffles, fill pools, cover woody debris, and fill void spaces in coarse channel substrate

- Reduction in aquatic wildlife due to direct impacts to aquatic species such as mussels and fish
- Reduction in water quality as phosphorus, metals, pesticides and other pollutants readily attach to sediment particles and thus are transported and stored with the sediment.

A variety of management practices are available to reduce sediment loads. In-stream sources of sediment from bank erosion can be addressed through:

- Stream restoration
- Stream enhancement
- Establishment of riparian buffers

Practices that reduce overland flow of stormwater and maximize soil stability that would be appropriate in agricultural areas include:

- Grassed waterways
- Conservation tillage
- Terracing
- Establishment of field borders
- Stream crossing stabilization

The development of forest and agricultural land into residential, industrial, and commercial areas can create potential sediment sources during construction and increase runoff volumes and rates that can destabilize streams and cause long-term channel erosion. Enforcement of sediment and erosion control laws and developing land in a way that minimizes stormwater runoff are needed to minimize sedimentation in the basin. The next wave of land clearing and development will be taking place on the middle to upper slopes of the watershed with great potential for erosion and sediment export to streams.

For residential developments appropriate management practices include:

- Wet retention and detention ponds
- Constructed wetlands
- Rain gardens
- Rain barrels
- Grassed swales
- Preservation of riparian buffers
- Diligent maintenance of grass or other vegetative cover on newly developed areas
- Zoning ordinances

Forested land accounts for approximately 92% of the land area of the 32 subwatersheds. In forested areas, due to the amount of logging that may occur, land use and land management practices must focus on harvesting operations, which pose their own set of erosion and sedimentation problems when compared with agriculture. The relative infrequency of harvesting operations (15 or 30 year rotations for pine pulpwood or saw timber, 60- to 80-year rotations for

hardwood sawtimber) makes sediment export from this activity less of an immediate concern in terms of overall functional degradation factors, but when harvesting does occur it can be a significant source of sediment. The often large extent of the area affected can require an extensive network of roads and skid trails, which are the most significant source of sediment from clearing operations. There is the potential for large amounts of sediment from these sites to enter streams, especially when the Forest Practices Guidelines, as promulgated in 15A NCAC II.0100-.0209, are not followed.

Forestry practices have evolved over the past decades to incorporate better erosion control and management. In light of research elucidating the water quality impacts of traditional practices such as clear-cutting and road construction, numerous agencies, regulatory authorities and industry groups have developed and attempted to disseminate information regarding forestry best management practices. Such practices, while still evolving, apply basic hydrological concepts to reduce stormwater runoff, erosion, and soil loss associated with forestry. Specifically, forestry BMPs focus on reducing the impact of forestry equipment on exposed soils, as well as stabilizing soils that are susceptible to erosion after cutting. Some of these BMPs include:

- Streamside management zones
- Water bars and turnouts
- Skid trail rotation
- Stream crossing stabilization

3.4 Streambank Erosion

Streambank erosion was observed throughout the watershed although it is of primary concern along the mainstem of Cove Creek. Much of this erosion is due to the entrenchment of the stream which does not allow for flooding and creates stress on the banks during periods of high flow. The entrenchment combined with insufficient riparian buffer in some locations is a particularly damaging combination.

Excessive streambank erosion leads to increased sediments and loss of riparian buffers leading to the following areas of functional degradation:

- Degraded in-stream aquatic habitat
- Reduced diversity of aquatic wildlife/organisms
- Reduced thermal regulation due to loss of riparian buffers
- Increased input of nutrients

Additional areas of functional degradation are discussed in Sections 3.3 and 3.2.

The primary management practices used to address stream bank erosion include:

- Stream restoration
- Stream enhancement
- Establishment of riparian buffers
- Livestock exclusion

- Stream crossing stabilization

3.5 Livestock Access

Numerous cattle operations and horse pastures were observed in the 32 subwatersheds. The majority of these operations are located in the Cove Creek Subwatersheds COVE03, COVE08, COVE09 and COVE11. All of these sites possess pastures with stream buffers that are very narrow or completely absent. Those that have fencing adjacent to streams often have cattle crossings through the streams (**Exhibit 2**). The trampling of the banks by cattle causes instability and erosion, which leads to excess sediment inputs. If pastures are not well-managed and are overgrazed, upland erosion can also add to sediment inputs. Excess nutrient inputs result from fecal contamination rather than fertilizer.

Exhibit 2. Livestock Access to Stream and Buffers Absent.



Areas of functional degradation include:

- Decreased thermal regulation due to loss of buffers
- Reduced water quality due to fecal contamination
- Disturbances to aquatic habitat and aquatic communities

Management practices associated with controlling livestock access are relatively straightforward. These include:

- Cattle exclusion using fencing
- Establishing stable crossings
- Providing alternative watering sources
- Developing and maintaining riparian buffers

3.6 Nutrient Enrichment

In the Cove Creek watershed, agricultural operations account for less than 8% of the total land area. Most cattle operations and row crop areas that were observed were small in size, and therefore probably do not contribute to nutrient input into surface waters to the extent that a large agricultural operation would. No DWQ monitoring stations are located in the watershed, thus no data indicating possible nutrient enrichment were available. However, there is likely some input of nutrients due to livestock operations.

Livestock operations contribute to excess nitrogen and phosphorus in surface waters primarily from the runoff of cow manure during rainfall events or deposition in water from aerial emissions. A major environmental concern with manure is the volatilization of nitrogen into ammonia, which returns to the ground via rainfall or absorption. Manure is often applied to crops as fertilizer, but if applied at very high rates, nitrogen can leach into groundwater and phosphorus can build up in the soils, with both eventually reaching surface waters.

Other sources of nutrients include residential development and golf courses. The Cove Creek watershed occurs in a rapidly developing resort area at the base of the Blue Ridge Mountains in the Broad River basin. This watershed is located east of the resort villages of Lake Lure and Chimney Rock, which have been vacation destinations since the early 1900s. Retirement homes, vacation resorts, and golf courses continue to be built, now mostly on the middle to upper slopes, as the lower slopes and valleys are already developed. As the number of golf courses continues to grow, so does the need for environmental management. Golf courses are often constructed in close proximity to lakes and streams for aesthetic reasons and to meet irrigation needs. The construction of courses in close proximity to sensitive environmental areas, such as streams and ponds, can dramatically impact wildlife and aquatic resources. Residential areas that are built in conjunction with the golf courses are also sources of nutrients.

During the site visits conducted for this report, Earth Tech personnel observed the presence of floating algae in one stream located adjacent to a golf course, UT to Bills Creek. Upon further investigation, it was found that the golf course includes at least one pond that drains into the tributary where the algae were found. Large algal blooms like the one observed can indicate the presence of nutrients in surface waters.

Functional degradation resulting from excessive nutrients include:

- Algal blooms and reduced dissolved oxygen, resulting in impacts to aquatic wildlife

Controlling the phosphorus and nitrogen produced by livestock operations often revolves around managing the diet of the animals. Excess nitrogen in the form of protein and amino acid supplements is often added to livestock feed, particularly with dairy cattle. Because of uncertainty about the exact nitrogen and phosphorus requirements of cattle, farmers will often over-supplement. Recent research, however, has developed specific calculations for the exact amounts of nitrogen and phosphorus required by cattle and other livestock, creating a practice of managing these nutrients through what it called precision feeding. According to some studies, precision feeding can decrease nitrogen runoff from cattle operations by nearly 34%, and

phosphorus runoff by nearly 50% (Sudduth *et. al*, 2004). Moreover, injecting manure directly into soil, rather than applying on the ground, reduces the amount of nitrogen and phosphorus that is caught in runoff during rain events. Other management practices that can be used include:

- Livestock exclusion
- Riparian buffers

Management practices for residential areas include:

- Bioretention areas
- Constructed wetlands
- Wetland restoration
- Stormwater retention/detention basins
- Homeowner education

Best Management Practices for golf courses focus on nutrient and pesticide management, water conservation, conservation of native habitat, and stormwater management. These include:

- Turf clipping management
- Vegetative buffer strips/zones
- Fertilizer application rates
- Drainage pattern modifications
- Irrigation management
- Use of native plants

3.7 Future Stressors – Residential Development and Stormwater

Residential areas in the watershed consist largely of scattered houses on several to many acres of land, with a few mobile home parks in various portions of the watershed. The residents that were called and visited are a mixture of those who have lived in the area for their entire lives or the majority of their lives, and newcomers who have built permanent residences or summer vacation homes in the area. Potential water quality problems associated with residential areas in rural watersheds such as Cove Creek typically include nutrient input into streams and the presence of fecal coliform bacteria from leaking septic tanks and from septic fields. Moreover, residential areas can cause increased stormwater runoff and pollutant input into streams from impervious surfaces such as driveways and rooftops. If residences are located adjacent to streams, riparian buffers are often lacking as residents plant small gardens, or mow up to the stream banks for aesthetic purposes.

Although residential areas are relatively sparse throughout the watershed, anecdotal evidence from residents indicates that several large tracts of land, most located on ridgetops and mountainsides, are slated for development as multi-lot residential areas. Construction of residential areas, particularly on hillsides, could potentially be a large source of sediment in the near future. Because of this, land use plans and ordinances must focus on requiring BMPs for

any residential development within the watershed to prevent sedimentation and stormwater runoff from becoming a major problem.

Stormwater from residential areas can be a significant source of pollutants, especially from developments of the size being planned for the future in this area. Developing forests and farms into higher density residential land use creates areas of impervious surfaces that prevent precipitation from soaking into the ground. Consequently, this increases the amount of precipitation that runs over the land surface and becomes stormwater runoff. To convey the increased runoff quickly and safely to streams, stormwater systems with pipes, ditches, and channels are built. The combination of the increased volumes and rapid conveyance of stormwater creates short-term bursts of water to streams, which often results in erosion of the channel bed and banks. The short duration bursts of stormwater also cause stress on aquatic insects and fish by washing rocks, submerged logs, and other structures downstream and burying habitat under fine sediments. In addition to its physical effects, stormwater can also carry nitrogen, phosphorus, metals, sediment, and toxic organic pollutants washed from developed areas such as parking lots, industrial plants, roads, and residential subdivisions.

There are both federal and state programs, administered by the NC Division of Water Quality, that determine when stormwater controls are required by law (NCDENR, 2006b). There are currently no industrial or commercial operations in the study area requiring state or federal stormwater permits (personal communication, Ronald Harmon, Rutherford County Planning Administrator, Dec. 13, 2006). However, this may change as the watershed becomes more developed. The federal rules primarily apply to large industrial facilities and to municipalities of at least 50,000 people (40 CFR 122.32). The state rules focus on new development and construction activities in sensitive watersheds. Lake Lure, the only municipality that is partially in the Cove Creek watershed, does not currently fall under the Phase II stormwater rules, although the rules are expected to be modified to eventually include smaller municipalities (NCDENR, 2006b).

In subwatersheds where stormwater discharges may become a concern, a review of NPDES permits, local ordinances, and inspection schedules would be the first course of action. If a pollution source is identified and regulatory action is not sufficient to promote compliance, a targeted program of education and incentives may be useful. Owners of facilities similar to the facilities of the offending discharger (*e.g.*, all gas station owners) could be identified through trade associations or other means and provided with information regarding the impacts of non-compliance, *e.g.*, fish kills, endangerment of human health, increased costs for additional inspections, or aesthetic concerns. Incentives may be offered such as certification and recognition programs or on-site technical assistance.

Stormwater management BMPs are installed in urban and residential areas to control peak and cumulative runoff rates as well as sediment, nitrogen, phosphorus, metals, and other pollutants. There is a wide range of stormwater BMPs and each must be designed to the specific site conditions for maximum effectiveness.

3.8 Management Practices Summary

A wide variety of management practices are available to address the stressors identified in the Cove Creek watersheds. More detailed descriptions of these management practices can be found in **Appendix E**. These strategies include:

- Stormwater BMPs
 - Level spreaders
 - Wet retention/detention ponds
 - Bioretention areas
 - Stormwater or constructed wetlands
- Agricultural BMPs
 - Terracing
 - Conservation tillage
 - Strip cropping
 - Grassed waterways
 - Livestock exclusion
- Forestry BMPs
 - Streamside management zones
 - Water bars on access roads
- Stream restoration techniques
- Buffer restoration and preservation
- Golf course turf management practices
- Land use planning and regulations
- Education

Although these practices are best suited for one setting or another, there is some overlap in the techniques used. **Table 4** below lists the various practices selected for use in the Cove Creek watershed and shows the typical setting or land use type (management setting) for which they are used. The table also shows the target, or measurable element, that the various practices are designed to manage.

Table 4. Management Practices and Their Appropriate Settings and Targets

Management Practice	Management Setting					Stressor					
	Cropland	Forestry	Livestock	Residential	Golf Course	Stream Channel Entrenchment	Inadequate Forest Buffer	Sedimentation	Streambank Erosion	Livestock Access	Nutrients
Stream Restoration	X		X	X	X	X	X	X	X		
Wetland Restoration		X	X								X
Conservation Tillage	X							X			X
Terracing	X							X			X
Grassed Waterways	X	X						X			X
Field Borders	X							X			X
Livestock Exclusion			X				X		X	X	
Fertilizer Management	X			X	X						X
Riparian Buffers	X	X	X	X	X		X	X	X		X
Water Bars & Diversions		X									
Stream Crossing Stabilization		X	X						X	X	
Reseed Cut/Fill Areas		X									
Bioretention				X	X						X
Wet Retention & Detention				X	X			X			X
Level Spreaders	X			X							X
Constructed Wetlands			X	X	X			X			X
Rainwater Collection				X	X						X
Forestry Streamside Management Zones		X				X	X	X	X		
Golf Course Management Practices					X		X				X
Zoning Ordinances				X				X			X
Low Impact Development				X				X			X
Education	X	X	X	X	X		X	X	X	X	X

4.0 RESTORATION PROJECTS

A key component of this management plan was the identification of potential stream and wetland restoration projects. A Project Atlas has been developed and submitted to EEP as a separate document. The Atlas contains landowner and parcel information as well as other detailed information. The following section summarizes the results of the restoration project search, but specific project types and locations are not discussed.

4.1 Project Types

For the purposes of this watershed management plan, potential projects identified by the GIS search were broken down into five categories:

1. **Visited - Potential project for EEP** - this category refers to potential project sites that were visited and at which data were collected. Based on visual observation and data analysis, these sites have been deemed suitable for restoration projects conducted by the EEP, either as Restoration, Enhancement Level I, Enhancement Level II, or Preservation projects, or a combination thereof.
2. **Visited - Potential project for the Natural Resource Conservation Service (NRCS), NC Wildlife Resource Commission (WRC), or other** - this category refers to potential project sites that were visited and at which data were collected, however based on visual observation and data analysis the streams did not appear to require the level of restoration that is typically suitable for an EEP project. Streams in this category might require livestock exclusion fencing, riparian zone management, or some other form of conservation practice which can be provided through programs conducted by the NRCS, WRC, or other agency.
3. **Visited - No project** - this category refers to potential project sites that were visited and at which data were collected, however, based on visual observation and data analysis, these sites did not exhibit a need for restoration, or they possessed physical constraints which would make any restoration or conservation practices impractical.
4. **Not Visited - Refused entry or contact attempts failed** - this category refers to potential project sites that were not visited because the landowners either refused entry for data collection or never responded to mail solicitations or phone calls.
5. **Not Visited - Ruled out by mapping or drive-by** - this category refers to potential project sites that were not visited due to their being ruled out either by drive-by observation of the watershed or evaluation of topographic maps.

In total, 36 potential projects were identified by the GIS screening (see *Technical Memo No. 2*). Earth Tech attempted to visit all sites not otherwise ruled out. Data were collected from 27 points representing 13 project sites. Data collection methods and results are described in **Appendix D**, *Technical Memo No. 3*.

*Cove Creek
Watershed Management Plan*

Table 5. Potential Projects from GIS Screening

Group	Project ID	Sub-watershed ID	Stream Name	Number of Owners	Number of Parcels	Length of Stream (feet)
1	11	COVE06	Cove Creek	5	5	3661
1	18	COVE09	Frasheur Creek	19	23	11217
1	20	COVE11	Greasy Creek	17	18	12430
1	28	COVE03	Morgan Creek & UT	7	9	4444
1	29	COVE07	UT Cove*	4	4	2119
1	33	BILL01	UT Bills	6	7	3312
1	34	COVE03	UT Morgan	3	3	2399
1	53	COVE08	Harris Creek	2	1	4837
2	15	COVE07	Cove Creek	4	6	2152
2	16	COVE11	Cove Creek	3	8	2411
2	21	COVE08	Harris Creek	11	10	3613
2	25	COVE07	Old Boney Creek	4	5	5378
2	38	COVE07	Cove Creek	9	9	3169
2	54	COVE01	Wood Branch	1	1	3955
3	9	CEDR05	Cedar Creek	4	7	1329
3	26	COVE12	Otter Creek	10	13	2685
4	4	BILL03	UT Bills	2	2	2081
4	5	BILL03	Bills Creek	2	3	3484
4	10	CEDR07	Cedar Creek	6	6	3018
4	27	COVE11	Stone Creek	8	11	3688
4	50	CEDR07	UT Cedar	2	4	2262
4	52	CEDR08	Youngs Creek & UT	2	3	2438
5	1	COVE02	UT West Fork Cove	2	2	1822
5	2	CEDR03	Taylor Creek	4	4	2193
5	3	COVE13	Otter Creek	5	5	2080
5	6	COVE02	Bright Branch	3	4	2491
5	8	CEDR05	Cedar Creek	3	4	2596
5	22	COVE03	Morgan Creek	10	11	3849
5	24	COVE06	Morgan Creek*	2	2	2567
5	30	COVE07	UT Old Boney	1	2	3220
5	31	COVE13	UT Otter	6	6	2407
5	32	COVE13	UT Otter	8	10	3447
5	35	BILL01	UT Bills	8	9	4983
5	37	COVE03	West Fork Cove Creek	3	3	5279
5	41	COVE14	Chalk Creek & UT	4	4	2604
5	45	BILL01	Bills Creek	5	6	3790

1 - Visited - Potential Project for EEP

2 - Visited - Potential Project for NRCS, WRC or other

3 - Visited - No project

4 - Not Visited - Refused entry or contact attempts failed

5 - Not Visited - Ruled out by mapping or drive-by

* Viewed from road, appears to be good project but no landowner response

4.2 Potential Projects

Following the GIS screening attempts were made to contact landowners to obtain access to the stream reach. Of the 36 sites identified in the GIS screening, 22 were ruled out based on observation or because they did not meet the drainage area size criteria of a maximum of 10 square miles. The remaining 14 potential projects are summarized in **Table 6** and are presented in the Project Atlas. **Table 6** provides information on the grouping of each project, as well as the potential type of restoration and BMPs that could be conducted at each site.

Table 6. Potential Projects after Field Surveys

Group	Project ID	Sub-watershed ID	Stream Name	Number of Owners	Number of Parcels	Length of Stream (feet)	Stream Status*	Stream Restoration	Stream Enhancement	Buffer Restoration	Buffer Enhancement	Agricultural BMPs	Livestock BMPs	Wetland Restoration
1	11	COVE06	Cove Creek	5	5	3661	P	X			X			
1	18	COVE09	Frasheur Creek	19	23	11217	P	X	X		X	X	X	X
1	20	COVE11	Greasy Creek	17	18	12430	I & P	X	X		X		X	X
1	28	COVE03	Morgan Creek & UT	7	9	4444	I		X	X	X		X	
1	29	COVE07	UT Cove*	4	4	2119	I	X			X	X		
1	33	BILL01	UT Bills	6	7	3312	P		X	X		X		
1	34	COVE03	UT Morgan	3	3	2399	P	X		X			X	
1	53	COVE08	Harris Creek	2	1	4837	P		X	X			X	
2	15	COVE07	Cove Creek	4	6	2152	P		X	X	X	X		
2	16	COVE11	Cove Creek	3	8	2411	P		X	X	X		X	
2	21	COVE08	Harris Creek	11	10	3613	P		X	X	X	X	X	
2	25	COVE07	Old Boney Creek	4	5	5378	P		X	X		X	X	
2	38	COVE07	Cove Creek	9	9	3169	P		X		X	X		
2	54	COVE01	Wood Branch	1	1	3955	P		X				X	

1 Visited - Potential Project for EEP

2 Visited - Potential Project for NRCS, WRC or other

*Viewed from road, appears to be good project but no landowner response

The 3 acres of wetland restoration in BILL06 identified by GIS in Technical Memo No. 2 was ruled out based on drive-by observations. About 0.6 acres of potential wetland restoration was identified during field work on Sites 18 and 20. **Figure 3** in Section 2 maps the locations of the different project types.

4.3 Project Implementation

The technical assistance needed to implement the recommended functional improvement practices is readily available. The local Soil and Water Conservation District and local USDA NRCS offices are well-positioned to design and install livestock exclusion fencing and associated alternate watering systems. The NC Agricultural Cost Share and Environmental

Quality Improvement Program (EQIP) cost share rates for BMPs are designed to cover 50-75% of the total cost of the practice. Conservation District or NRCS personnel can also oversee stream restoration projects on smaller streams. Full-scale restoration and stabilization of larger streams can be contracted to consulting firms specializing in this practice. The cost of stream restoration varies considerably based on site conditions, but has generally ranged from \$70 to as much as \$200 per foot. Funding for stream and wetland restoration, including fencing and watering systems, is available through EEP.

Standard stormwater BMP design and installation is typically handled by consulting engineers or municipal engineering departments. Funding to offset the cost of these BMPs is available through state 319 grants, Clean Water Management Trust Fund (CWMTF) grants, or stormwater utility fees if such a program is initiated by local municipalities. Grant-funded demonstration projects conducted by universities are also a possibility.

Bioretention areas, level spreaders, rainwater harvesting, and, to a lesser extent, constructed stormwater wetlands are not as common as some traditional stormwater BMPs such as detention ponds, and therefore design and installation guidelines are not as well developed. In particular, design guidelines for the bioretention and level spreader BMPs are still being developed by researchers; hence, not only should the practices be designed by a knowledgeable practicing engineer, but they should also be reviewed by researcher(s) familiar with the practices. Financial assistance could be provided from the 319 program, the CWMTF, or other sources.

Like technical assistance, much of the informational and educational support for collaborative watershed management can be conducted by personnel of the Conservation District, NRCS, and the NC Cooperative Extension Service or through a watershed group or coordinator. Providing information to personnel in these agencies would be the best way of disseminating it to rural landowners. The NC Division of Land Resources, in addition to administering and enforcing the State Sediment and Erosion Control regulations, sponsors periodic seminars or training programs to those involved in land clearing activities on proper techniques and practices for minimizing sediment pollution. These seminars are typically taught by The University of North Carolina Water Resources Research Institute (WRRRI).

Extensive use of rain barrels and other residential stormwater management practices would require a relatively intensive educational program. One-page flyers in utility bills, public service announcements on radio, and newspaper articles have been shown to be successful means of disseminating information on a widespread basis. Local conservation organizations, master gardeners, and municipal employees may also develop workshops and demonstration projects for neighborhoods and business associations. Several successful models for these types of programs exist across the state. The Town of Cary, for example, has arranged for a volume discount from a rain barrel manufacturer and makes them available to residents at periodic truckload sales. This award-winning program provides information and educational opportunities on water quality, water supply, and water conservation topics through monthly utility bill inserts, regular workshops, and a neighborhood block leader program.

The US Environmental Protection Agency Clean Water Act Section 319(h) funds are administered by NC Division of Water Quality (DWQ). These funds are available for non-point

source pollution management, including stormwater control. Types of projects funded include demonstration of innovative BMPs, water quality monitoring and modeling, environmental education and technology transfer, and restoration of waters impaired due to non-point source pollution. Grant applications are received once a year, usually around the end of May.

Other potential grantors, such as private foundations, may be considered as well. Funding cycles vary, and would have to be investigated on an individual basis.

A compilation of technical resources and potential funding sources available to assist with the design and funding of the various projects in this *Watershed Management Plan* can be found in **Appendix F**.

4.4 Timing of Implementation

Implementation of the *Watershed Management Plan* is dependent on a number of factors such as the availability of local leaders and resource agency personnel to further customize the plan and set schedules and milestones according to local priorities. Other factors include grant funding cycles, state and local budget priorities, and complexity of design and construction of the various practices. Even after the implementation of the plan, the quality of water resources often takes several years to improve significantly as the various projects stabilize.

The Clean Water Management Trust Fund is a major grantor to municipalities and conservation organizations seeking to restore and protect surface water quality. Grant applications are accepted for projects such as improvements to wastewater treatment and collection systems; stormwater management; repair of septic tanks and removal of straightpipes; wetlands, riparian buffer and stream restoration; acquisition of buffers, floodplains, wetlands, and greenways; and agricultural best management practices. Applications are received once a year, on March 1.

Once projects are defined and funding is obtained, designers and contractors can provide timeline estimates for individual projects. For a typical stream or wetland restoration project funded through EEP, the design and permitting process usually takes about one year. Construction may take from 2-6 months depending on the size of the project, and planting of the project would be restricted to the winter dormant season. Typically stormwater BMPs do not require permits. Design may take 2-4 weeks, and construction may take 1-2 months. The contact persons for EEP projects in the Cove Creek watershed include:

Ecosystem Enhancement Program
2090 US Highway 70
Swannanoa, NC 28788

Western Project Manager
Deborah Daniel
Deborah.A.Daniel@ncmail.net
Phone: 828-337-4528

Western Watershed Planner
Andrea Leslie

Andrea.Leslie@ncmail.net

Phone: 828-337-3455

5.0 MONITORING AND EVALUATION NEEDS

Water quality monitoring can be performed at a variety of levels to evaluate whether implementation of the watershed management plan is having qualitative effect on the streams within the watershed. The type and intensity of monitoring conducted on the watershed improvement projects recommended in this plan depends on which entity implements the project, as well as on budget constraints. Various types of monitoring include:

- Biological monitoring performed by DWQ Environmental Sciences Section for their Basinwide Assessment Reports
- Annual monitoring of stream restoration projects by EEP
- Performance measurements of BMPs that are implemented throughout the watershed
- Volunteer monitoring programs such as those developed through the local Cooperative Extension Service or with the state's Stream Watch program
(http://www.ncwater.org/Education_and_Technical_Assistance/Stream_Watch/)

If the purpose of the monitoring is to evaluate the effectiveness of management measures, many factors must be considered in developing a monitoring plan. Components of a monitoring plan should include:

- Site configuration (upstream-downstream, paired watershed, or single downstream station)
- Duration
- Discharge monitoring methods
- Sample analysis parameters
- Frequency and number of monitoring events
- Covariates such as rainfall, construction stage, impervious surface, or other parameters that are important to interpreting the monitoring results.
- Data/statistical analysis
- Quality assurance plan

Costs of monitoring should be considered a part of the cost of implementing any project. The desired level of intensity should be determined in the planning and design stage. Appropriate personnel should be identified to conduct the monitoring according to the requirements of the entity implementing the project.

Monitoring also must include an evaluation of the structural and functional integrity of the BMP over time. **Table 7** lists the types and frequencies of maintenance required on the various BMPs and restoration types. Refer to **Appendix F** for cost data from published research for some of the BMPs. Generally, the only costs involved are labor and materials, as needed.

Table 7. Maintenance Requirements.

Practice	Maintenance Requirements	Frequency of Maintenance***
Stream restoration*	None if properly built	
Wetland restoration*	Sediment removal, cleaning of outlet structure, vegetation upkeep	As needed, inspection at least 2x per year
Conservation tillage	None	NA
Grassed waterways	Mowing or reseeding, sediment removal	As needed
Field borders	Mowing or reseeding, sediment removal	As needed
Nutrient management	None	NA
Wooded and grassed buffers	Vegetation maintenance	NA
Water control structures	Clean outlet structure, replace boards**	As needed, inspection at least 2x per year
Livestock exclusion fencing	Fence maintenance	As needed, inspection at least 2x per year
Wet retention/detention ponds	Sediment removal, cleaning of outlet structure, vegetation upkeep	As needed, inspection at least 2x per year
Bioretention areas	Replacement of soil material if clogged, possible flushing of drain pipes, clean high flow outlet structure, landscape vegetation maintenance	As needed, inspection at least 2x per year
Level spreaders	Occasion sediment removal, repair of the level lip, removal of woody vegetation	As needed, inspection at least 2x per year
Stormwater wetlands	Sediment removal, cleaning of outlet structure, vegetation upkeep	As needed, inspection at least 2x per year
Rainwater collection systems	Maintain pipes and fittings	As needed, inspection at least 2x per year

*Maintenance not required beyond 5-year monitoring period. Voluntary maintenance could include invasive species management, replacement of vegetation, erosion control or repair in case of stream structure failure.

** For maximum water quality effectiveness the water table height (*i.e.*, height of the boards) should be managed as described in Evans *et al.*, (1991).

***Frequency of Maintenance is from Line, 2005

In addition to the technical monitoring, a system of regular progress reporting to local stakeholders should be developed. Newsletters, newspaper articles, and/or radio or television stories should keep the stakeholders informed of both short-term accomplishments and long-term goals.

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