Little Contentnea Creek
Riparian Buffer Restoration – Phase 3
Greene County, North Carolina

MITIGATION PLAN

December, 2005

Ecosystem Enhancement PROGRAM

GES
Greene Environmental Services, LLC
90 Ham Produce Road
Snow Hill, NC 28580
EEP contract 005020

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1.0 Introduction

In 2002, the Division of Water Quality's, Ecosystem Enhancement Program (EEP) (formerly the Wetland Restoration Program) collaborated with private environmental firms to restore riparian buffers, streams, and wetlands within the Neuse River drainage basin in an effort to reduce non-point source pollution in its riparian and estuarine systems, particularly nitrate and phosphate. EEP awarded Greene Environmental Services, LLC (GES) of Snow Hill, North Carolina a contract to restore 37.1 acres of riparian buffer along 5,800 feet of an unnamed perennial first order tributary to Contentnea Creek on the Moye Farm in southeastern Greene County (Moye Farm/Contentnea Creek Riparian Buffer Restoration – Phase 1) (Figure 1).

Approximately 17,000 bare root, hardwood tree saplings (18 species) were planted during spring 2003. Weeds were controlled throughout the 2003 growing season using chemical and manual methods. Monitoring along permanent transects during December 2003 indicated an overall density of 792 live saplings per acre (GES, 2003). The 2004 sampling indicated 763 stems per acre. EEP staff toured the site on 18 March 2004 to evaluate the project's status and determined that restoration goals were met or exceeded.

On 31 December 2003, the North Carolina Division of Purchase and Services (PS) issued a Request for Proposals (RFP) on behalf of the EEP to provide Riparian Buffer Mitigation in the Neuse River Basin (RFP16-D4009). Up to 150 Buffer Mitigation Units (BMUs) were requested in four Cataloging Units (CUs). Fifty BMUs were requested in the Contentnea Creek Basin (CU 03020203).

Pursuant to the RFP, projects in Hydrologic Units (HUs) within these four CUs identified as Targeted Local Watersheds (TLWs) in EEP's *Neuse River Basin Watershed Restoration Plan* were given priority during proposal evaluation. TLWs demonstrate the need and opportunity for water and riparian resource restoration, enhancement, and preservation. EEP's selection criteria include water quality problems, cumulative wetland and stream impacts, resource values, watershed approach, partnership opportunities, land cover, and local resource professional comments and recommendations (WRP, 2002).

EEP identified ten TLWs in the Contentnea Creek Basin. In July 2004 GES was awarded a contract for riparian buffer restoration in one of them (HU 03020203070050) and in an adjacent HU (03020203050040), also in Cataloging Unit 03020203 (Phase 2) (Figure 1).

The Phase 2 project has restored 50 acres of riparian buffer along 14,312 feet of stream (20.87 acres are along 5,825 feet of stream that is contiguous with and upstream of the Phase 1 project, and 29.21 acres are along 8,487 feet of Little Contentnea Creek and its unnamed tributary). The Little Contentnea portion of the project lies on the C.L. Stokes farm in USGS Hydrologic Unit 03020203070050, an EEP Targeted Local Watershed (TLW) and EPA 303d listed stream reach. The restoration areas are in USGS Cataloging Unit 03020203, are geographically contiguous, receive nutrient inputs from the same local turkey and on-site hog operations, and are part of neighboring farming operations. Vegetation monitoring during the fall of 2004 indicated a stem density of 474 woody stems per acre.

On 21 October 2004 EEP and PS published another full delivery RFP (16-D05020) for 50 BMUs in the Contentnea Creek Basin (CU 03020203). On 17 February 2005 GES submitted a proposal for 54.16 BMUs. The proposal was accepted by EEP on 27 June 2005. The project, Little Contentnea Creek Riparian Buffer Restoration Phase 3, was planted in late January and early February 2005 and has restored 54.16 acres of riparian buffer along approximately 18,000 feet of Little Contentnea Creek and its unnamed tributaries in EEP TLW 03020203070050. Pursuant to the RFP, all project acreage qualifies as "restoration" because tree density is below the 100 stems per acre threshold in all tracts.

A conservation easement on the property was transferred to EEP on 28 October 2005. It protects the land from development and other specified uses in perpetuity. GES will monitor the restoration area and perform necessary maintenance (including remedial planting, where warranted) for five years to ensure project success. When monitoring has indicated planted stem density of greater than 320 stems per acre after five years, the state of North Carolina will assume maintenance and management responsibilities, in accordance with the terms of the easement.

The Phase 3 project's primary goal is to improve water quality in the Little Contentnea Creek watershed by reducing agricultural nutrient inputs into this system. Establishing, maintaining, and protecting the buffer will enhance microbial denitrification in shallow surface water and ground water that is currently entering local streams, sequester nutrients (chiefly nitrogen and phosphorous) in woody biomass as the buffer matures, and trap nutrient laden sediments before they enter local streams.

A number of secondary benefits will be realized as the buffer matures. As leaf litter and other organic material in the upper soil profile increases, flood attenuation and storage will become important values. A growing canopy that shades the stream will decrease water temperature and algal blooms, which will increase dissolved oxygen levels. As stream banks stabilize and water quality improves, native terrestrial and aquatic organisms will colonize the restoration area and increase local species richness.

2.0 Summary

2.1 Project Description

The Phase 3 project has restored 54.16 acres of riparian buffer along approximately 18,000 feet of Little Contentnea Creek and its unnamed first order tributaries (Figure 1). The entire project lies on property owned by Little Creek Farms, Inc. in USGS Hydrologic Unit 03020203070050, an EEP Targeted Local Watershed and EPA 303d listed stream reach (Figure 2). The entire project is in USGS Cataloging Unit 03020203, is geographically contiguous, receives nutrient inputs from the same on-site hog operations, and is part of two adjacent farming operations (Red Hill Farm and Sandy Ridge Farm).

2.2 Methods

2.2.1 Site preparation

Prior to planting, abandoned farm equipment, debris, and undesirable vegetation was removed from the Phase 3 buffer areas. Remaining woody debris that would have interfered with planting and maintenance was pushed into windrows adjacent to planting areas.

Nearly all stream banks in the Phase 3 buffer restoration areas are incised less than three feet and have 3:1 slopes. Most are shallower. Tract H contains some reaches with steeper slopes and more incised channels. Woody vegetation along most of Tract H's banks was regularly cleared prior to restoration. Once this maintenance was stopped, in October 2004, the woody vegetation (mostly black willow (*Salix nigra*) and sweet gum (*Liquidambar styraciflua*)) re-sprouted and is quite dense in many areas. It was determined that removal of this vegetation and mechanical grading of banks along these reaches would have a net adverse water quality impact. Wax myrtle (*Myrica cerifera*) from 12-inch container stock and black willow stakes were planted at the top and on the sides of stream banks in the erosion-prone reaches without existing dense woody vegetation. The stakes are approximately one half inch in diameter and were harvested from local trees and trimmed to two foot lengths. Silt fencing and straw bales were anchored in these areas to reduce sediment input into the stream.

Where appropriate, undesirable vegetation that would compete with species targeted for restoration was manually removed using chainsaws, brush axes and machetes. Undesirable vegetation included non-native woody species (e.g. Chinese privet (*Ligustrum sinense*)); native and introduced grasses with aggressive, rhizomatous and stoloniferous habits (e.g. cane (*Arundinaria gigantea*) and Bermuda grass (*Cynodon dactylon*)); and native vines (*Smilax* spp.). Native hardwood saplings were avoided. Compacted soils were disked or ripped prior to planting.

2.2.2 Implementation

Approximately 25,500 bare root hardwood saplings of 10 species and 2,500 bald cypress saplings were planted in the Phase 3 restoration area during February 2005 (Table 1). Winstead's Reforestation (Nashville, North Carolina) was contracted to plant the saplings in irregular rows following surface contours and channel alignment during February 2005. Between and within rows, saplings were planted approximately nine feet apart. Density was approximately 520 saplings per acre after planting. This planting density was selected to allow up to 40 percent mortality while meeting the 320 stem per acre targeted density. In addition to the bare root saplings, black willow stakes were planted at the top and on the sides of stream banks in erosion-prone reaches.

Most of the tree species planted are suitable for the range of soil moisture conditions found at the site, but some species (e.g. green ash and bald cypress) are best suited for the more hydric soils nearest the stream and in other low-lying areas. Other species (e.g. red oak and longleaf pine) should be more successful on the more well-drained soils. Two planting zones were developed based on site-specific hydrologic conditions. The hydric zone includes the areas closest to streams with saturated and low chroma soils at or near the surface. The mesic zone includes areas of drier and higher chroma soils that are farther from stream banks (Figure 3). Most of the tree species planted are suitable for the range of soil moisture conditions found at the site and were therefore planted in both zones. Generally, the hydric zone extends outward 20-50 feet from the stream bank and is planted with species tolerant of poorly drained soils. The hydric zone was

significantly expanded where soil moisture warranted (Figure 3). Similarly, where a drier soil moisture regime prevailed, species suitable for more well drained conditions were planted in the mesic zone, which extended to the interior buffer boundary in some areas (e.g. Tract A).

Applying glyphosate herbicide with a concentration of 0.25% was used in spring and early summer to control competing grasses and herbaceous vegetation. The herbicide was applied to actively growing plant tissue in May through July, as deemed necessary. Backpack sprayers were used to apply herbicide concentrating in a 3-foot radius around and in between saplings. Existing native vegetation that is stabilizing the stream bank was avoided. Removal of undesirable woody vegetation was followed by application of glyphosate herbicide to stumps and actively growing tissue. Naturally colonizing tree species, especially sweetgum and loblolly pine, will be removed if they appear to be out-competing planted seedlings. Native species that are allowed to persist will be noted in stem density measurements and separate calculations for total density and planted density will be provided.

Robert J. Goldstein and Associates, Inc. (Raleigh, North Carolina) is the project's technical consultant. RJG&A was responsible for technical design, planning, and construction oversight. Greene Environmental Services performed all construction and maintenance and managed all real estate transactions and negotiations.

Table 1. Trees Planted in the Phase 3 Riparian Buffer Restoration

Species	Common Name	Number Planted	(Percent of Total)	Soil Drainage Suitability
Fraxinus americana	white ash	4,200	15	mesic
Fraxinus pennsylvanica	Green ash	9,000	32	hydric
Liriodendron tulipifera	yellow poplar	300	1	mesic, hydric
Pinus palustrus		1,000	4	
Platanus occidentalis	coastal sycamore	5,000	18	mesic
Quercus nigra	water oak	2,000	7	mesic
Quercus pagoda	cherrybark oak	500	2	mesic
Quercus phellos	Willow oak	2,000	7	mesic, hydric
Quercus virginiana	live oak	1,000	4	mesic
Quercus rubra	Northern red oak	500	2	mesic
Taxodium distichum	Bald cypress	2,500	9	hydric
	TOTAL	28,000	100	

3.0 Success Criteria

The project will demonstrate successful buffer restoration by establishing no fewer than 320 live trees per acre of at least three species in the project area after five consecutive years of

monitoring. The average number of trees per acre will be calculated using monitoring data for the entire project. This shall be the sole criterion used to evaluate the project's success. After five years' monitoring, and meeting this targeted density, the project will be deemed successful and complete.

While total density is the only criterion that will be used to evaluate ultimate project success from a contractual perspective, other parameters will be considered during the monitoring period to gauge interim progress and identify management needs. In addition to total density, cross-sectional area and height measurements will be recorded during monitoring. These data will allow relative average values for these parameters to be calculated for each species. Average and relative values can be calculated for the entire project and individual 1,000 foot reaches.

4.0 Monitoring

Robert J. Goldstein and Associates, Inc. ((RJGA) (Raleigh, North Carolina)) will conduct monitoring at the end of the growing season for five consecutive years, starting in 2005. Their report will be submitted to EEP on or before 31 December of each year during the project's five year monitoring period (2005 through and including 2009).

The project's monitoring program follows the guidelines presented in EEP's Exhibits 3 and 4, which were referenced in the Request for Proposals (EEP, 2004). The project was divided into 17 sampling units, each occupies approximately 1,000 linear feet of stream reach. A minimum of three sample quadrats was randomly located in each monitoring unit using a custom GIS program (ArcView script) that allowed minimum distances to be input (20 meters between samples to avoid overlap and two meters from the easement perimeter to reduce edge effects). The species area curve method described in Exhibits 3 and 4 were used to determine adequate sample number. Based on this method a total of 60 permanent sampling quadrats were established in the 17 units. nine units required four samples. Sample adequacy was met in the remaining units with three samples (Figure 4).

All sample quadrats measure 100 square meters and are either ten-meter by ten-meter or five meter by 20 meter. Quadrat dimension and orientation were determined subjectively at each randomly located point based on species composition, diversity, range of hydroperiod and other locally important factors (e.g., presence of erosion control devices or disturbance) (Figure 3).

In each of the 100 square meter quadrat each tree's diameter at breast height (135 centimeters) and total height was recorded. Species that naturally colonized plots (i.e. not planted) were noted (e.g., *Pinus tadea*, *Liquidambar styraciflua*, and *Acer rubra*) and will be identified in the monitoring reports and total stem density will be calculated with and without these species.

Annual monitoring reports will present average and relative density, height, and cross-sectional area by species for the entire project area. Summary data for each sampling unit will also be presented.

5.0 Mitigation

The project's Request for Proposals defines areas eligible for riparian buffer restoration as those containing less than 100 trees greater than five inches diameter at breast height (135 centimeters) per acre. Tree density for each tract was calculated on a per acre basis pursuant to the RFP's Buffer Restoration definition. Using this definition, tree density for all tracts combined measured 31.68 trees per acre. This calculation assumes a 50 foot wide buffer per side, which produces a total project area of 31.68 acres. Much wider buffers were appropriate for restoration in many tracts, based on soils and hydrology. If density calculations were based on the actual restoration area (54.16 acres), total density for the entire project would be 22.16 trees per acre. Densities presented below follow the RFP definition.

Vegetation within the Phase 2 project site has been modified by farming and drainage for decades. Remnant tree stands with individuals at least five inches in diameter at breast height exist along narrow strips immediately adjacent to the stream channels in portions of Tracts B, C, D, E-1, E-2, and F. Portions of Tract A also have woody vegetation, but all stems measured less than five inches dbh. All trees at least five inches dbh were counted in the Phase 3 project area and total 977. The highest tree density (number of trees ≥ five inches dbh/(50 x per side of stream buffered x linear feet of stream reach/43560)= number of trees per acre) measured was 87.59 trees per acre in Tract B. Tree density in all tracts was less than the allowable limit of 100 trees per acre. All tracts are therefore considered restoration and none was presented to EEP as enhancement or preservation.

6.0 Maintenance and Contingency Plans

Glyphosate herbicide with a concentration of 0.25% will be used to control competing grasses and herbaceous vegetation. The herbicide was applied to actively growing plant tissue from May through July, and as necessary. Backpack sprayers were used to apply herbicide concentrating in a 3-foot radius around and in between saplings. Existing native vegetation that is stabilizing the stream bank will be avoided. Where competing weed species threaten plantings past mid-summer, when herbicide application becomes less successful, weeds will be controlled using manual and mechanical methods (machetes, small mowers and string trimmers). Naturally colonizing tree species (e.g., *Pinus tadea*, *Liquidambar styraciflua*, and *Acer rubra*) will be removed if they appear to be out-competing planted species. Native species that are allowed to persist will be noted as such during stem density measurements and in monitoring reports.

In areas with significant mortality, as evidenced by monitoring data or qualitative observation, remedial planting will be done. Planting density will be determined on a case-by-case basis, depending on local conditions and needs. Silt fences and other erosion control measures will be inspected at least twice per year and replaced or maintained as needed.

7.0 References

Green Environmental Services, LLC. 2003. First Annual Monitoring Report – 2003 Growing Season. Moye Farm Riparian Buffer Restoration Project – Phase 1.

Green Environmental Services, LLC. 2004. Second Annual Monitoring Report – 2004 Growing Season. Moye Farm Riparian Buffer Restoration Project – Phase 1.

Green Environmental Services, LLC. 2004. First Annual Monitoring Report – 2004 Growing Season. Moye Farm Riparian Buffer Restoration Project – Phase 2.

North Carolina Ecosystem Enhancement Program. 2004. Request for Proposal, Full Delivery Project to Provide Riparian Buffer Mitigation in the Neuse River Basin. RFP 16-D05020.

Figure 1.

General Location - Little Contentnea Creek Riparian Buffer Restoration - Phase 3 - Greene County, NC

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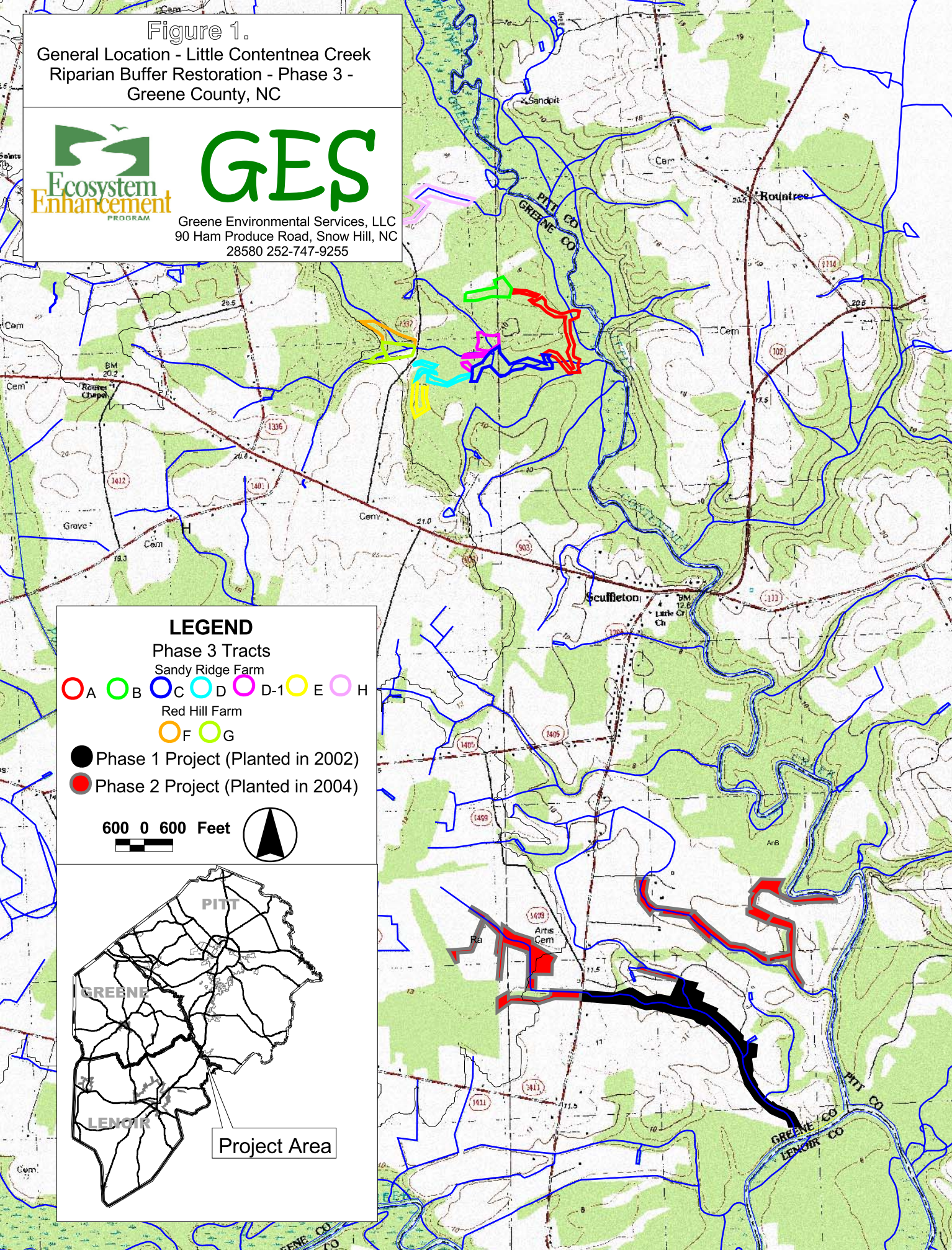

Figure 2.

Watersheds - Little Contentnea Creek
Riparian Buffer Restoration - Phase 3 -
Greene County, NC

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Phase 3 Tracts

Sandy Ridge Farm

A B C D D-1 E H

Red Hill Farm

F G

Phase 1 Project (Planted in 2002)

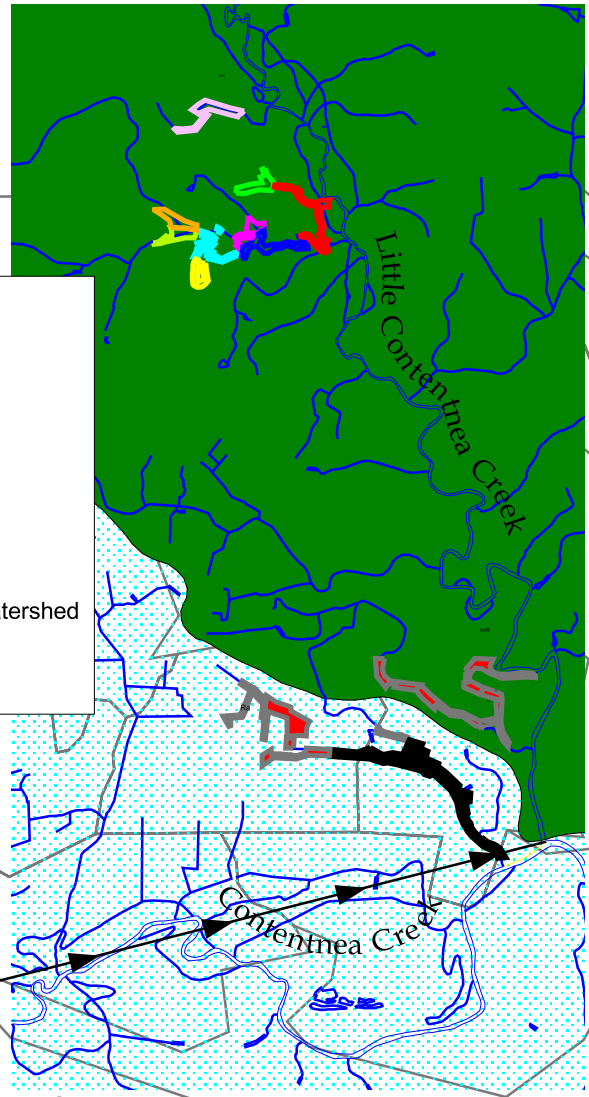
Phase 2 Project (Planted in 2004)

Targeted Local Watersheds

- HU 03020203020030
- HU 03020203020040
- HU 03020203040020
- HU 03020203060010
- HU 03020203060020
- HU 03020203060040
- HU 03020203070010
- HU 03020203070030
- HU 03020203070040
- HU 03020203070050

Contentnea Creek Watershed (CU 03020203)

Neuse River Basin



Orange
Durham
Franklin
Nash
Edgecombe
Wake
Wilson
Pitt
Johnston
Greene
Wayne
Lenoir
Craven
Beaufort
Pamlico
Duplin
Jones

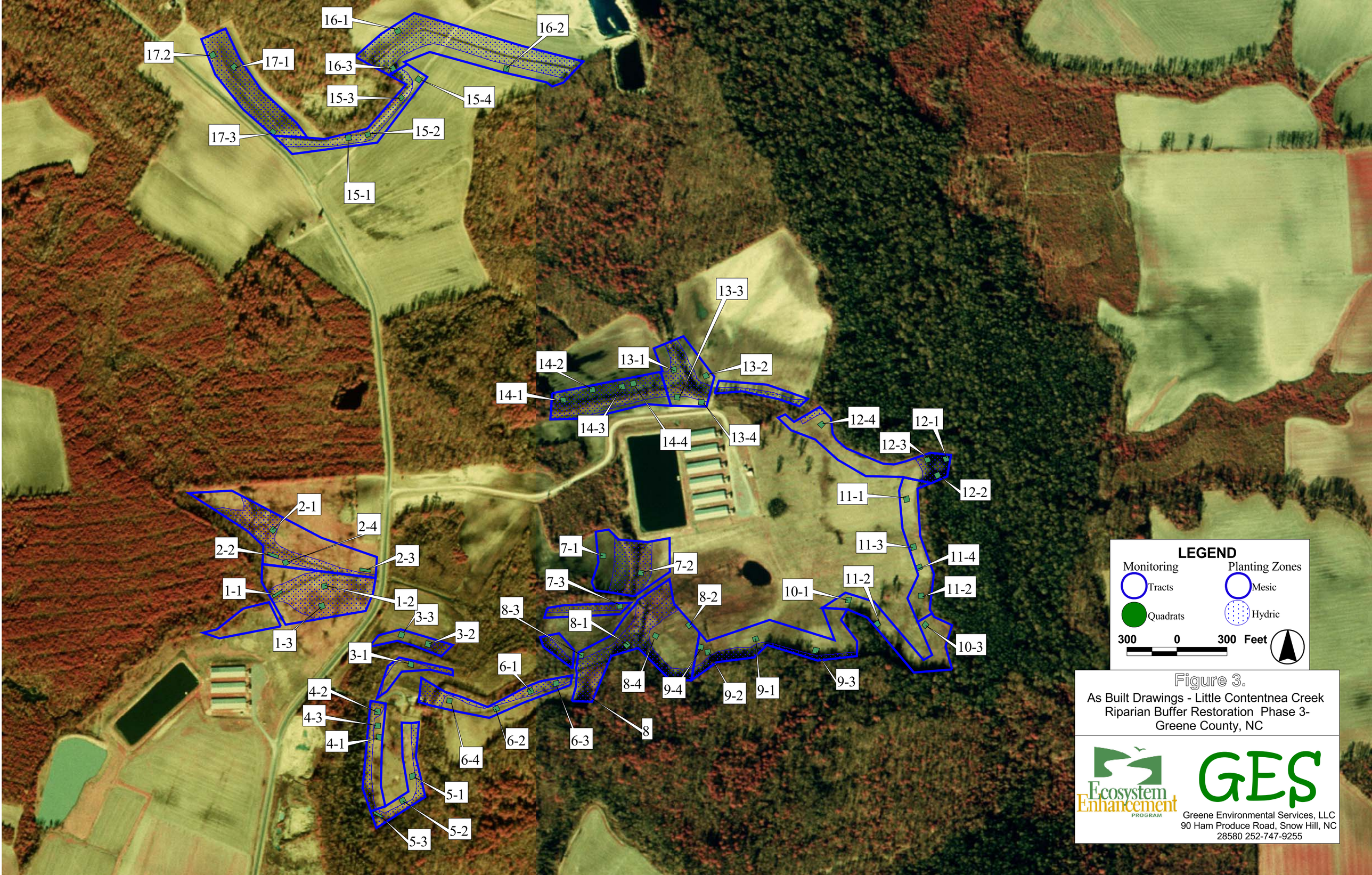


Figure 3.

As Built Drawings - Little Contentnea Creek Riparian Buffer Restoration Phase 3- Greene County, NC

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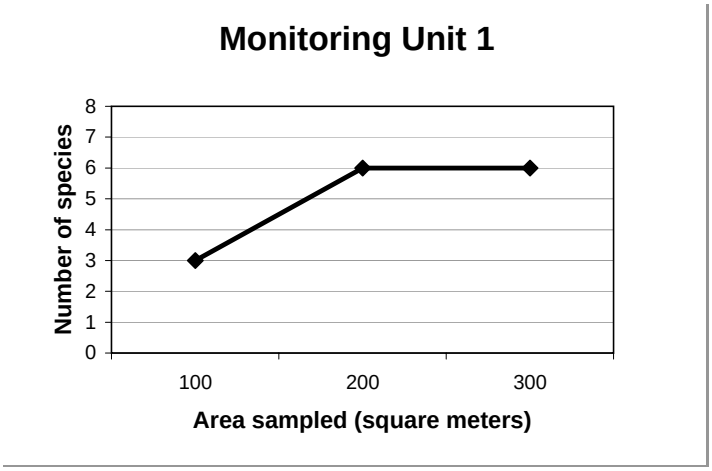
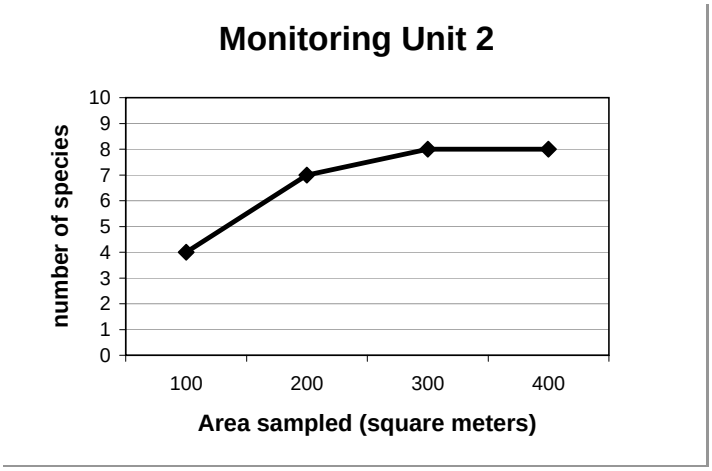
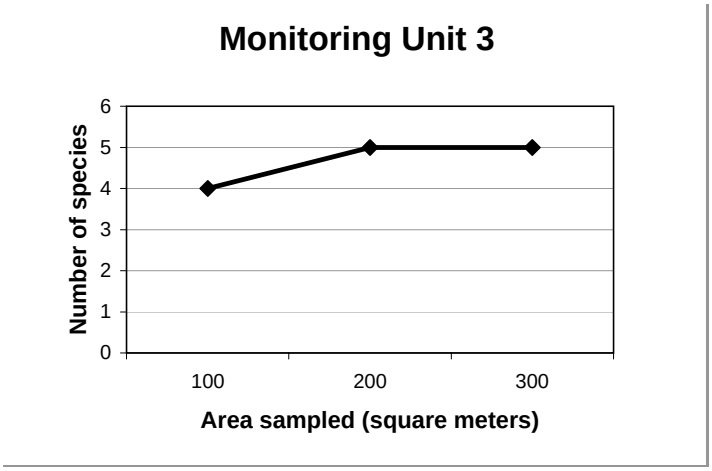
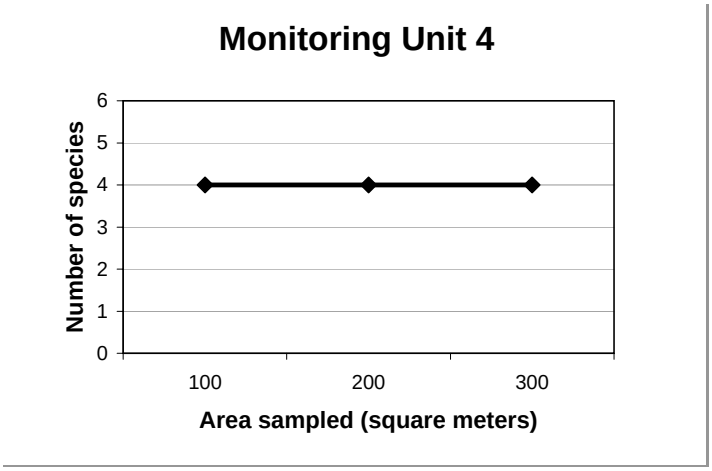
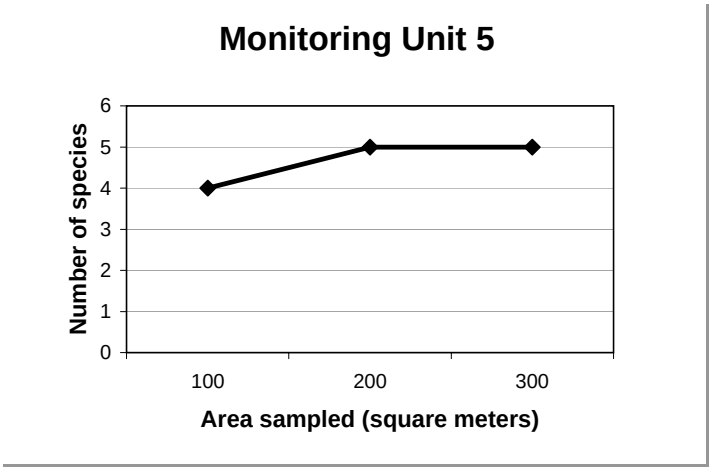
Figure 4. Species/Area Curve - Contentnea Creek/Little Contentnea Creek Riparian Buffer Restoration - Phase 3











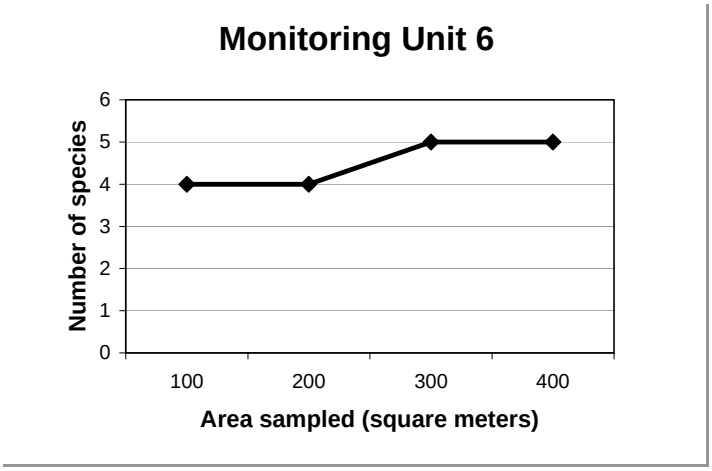
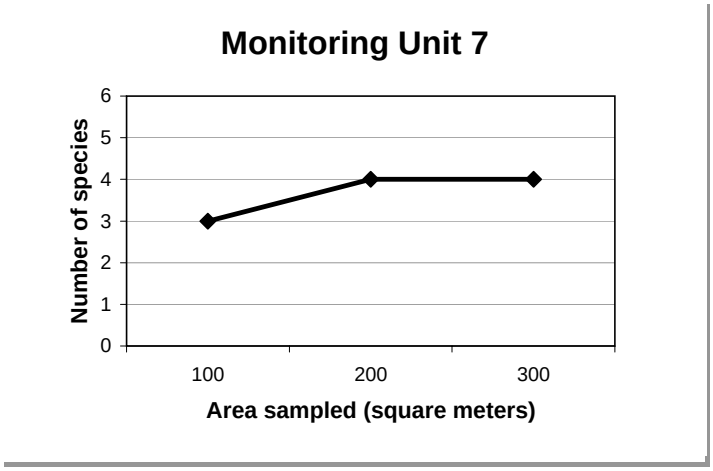
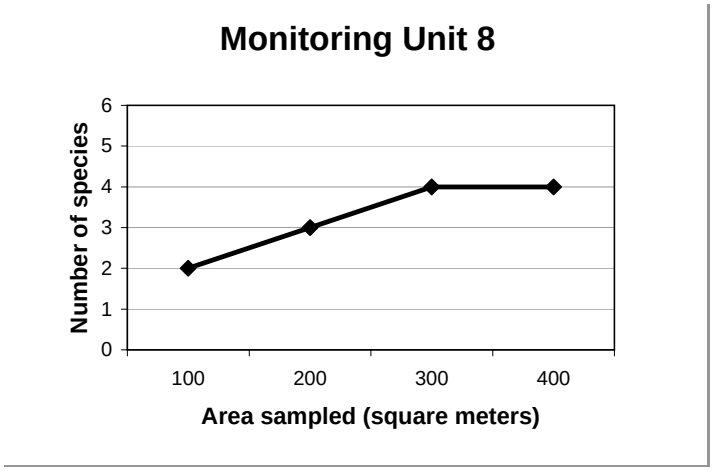
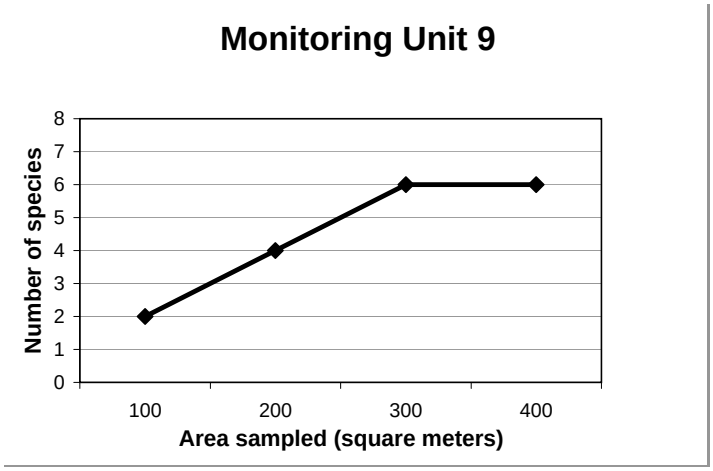
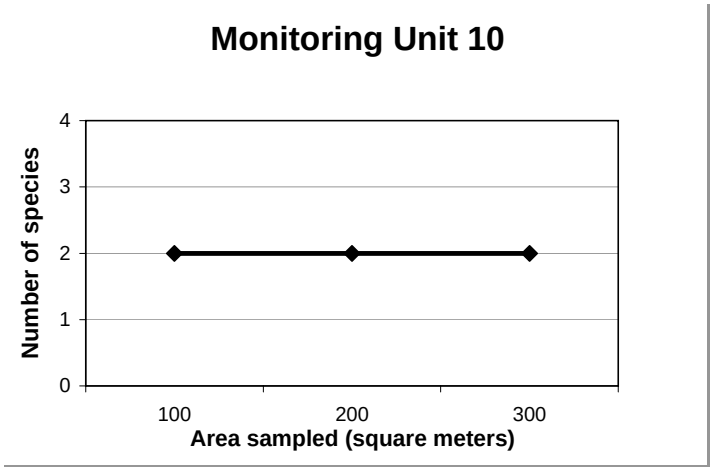


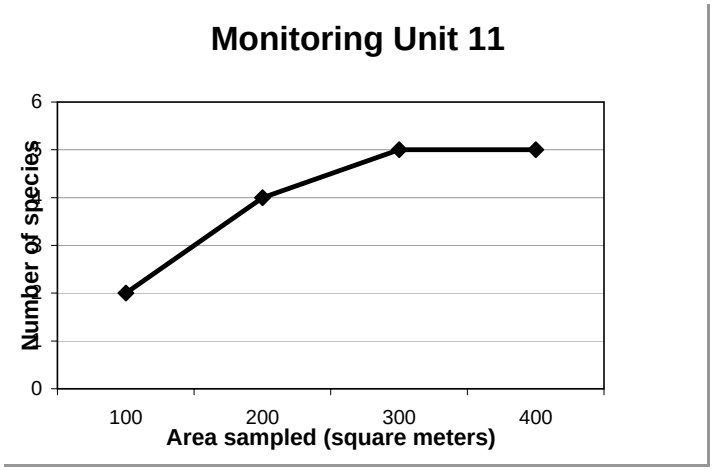
Figure 4. (continued) Species/Area Curve - Contentnea Creek/Little Contentnea Creek Riparian Buffer Restoration - Phase 3











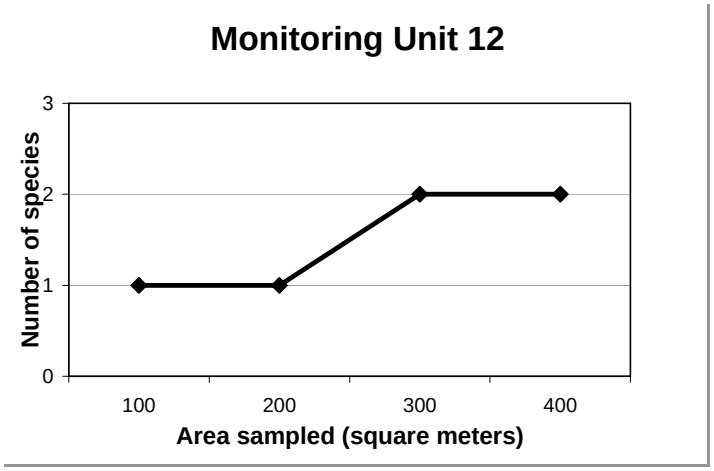


Figure 4. (concluded) Species/Area Curve - Contentnea Creek/Little Contentnea Creek Riparian Buffer Restoration - Phase 3