# SHEPHERDS TREE MITIGATION PLAN
# IREDELL COUNTY, NORTH CAROLINA

## STATE PROJECT NO. 6.769001T
## TIP NO R-2239

## NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

**June 4, 2001**

## SHEPHERDS TREE MITIGATION PLAN

### TABLE OF CONTENTS

## LIST OF TABLES AND FIGURES

# EXECUTIVE SUMMARY

KCI Associates of North Carolina, under contract to the North Carolina Department of Transportation (NCDOT), has prepared this mitigation plan for restoration, creation and preservation of the Shepherds Tree site wetlands and restoration of site streams to satisfy permit requirements associated with NCDOT roadway projects in the Yadkin River Basin. The site, occupying approximately 160 acres, is located between Triplett Road (SR 2362) and Knox Farm Road (SR 2363) in Iredell County adjacent to Third Creek, southeast of Statesville.

Intense agricultural activity and improvement projects by the Civilian Conservation Corps in the early 1900's resulted in the re-alignment, ditching and berming of Third Creek, as well as the clearing, draining and ditching of adjacent floodplain wetlands and streams. The resulting landscape was essentially depleted of all functions and values of the riparian wetland communities that previously existed on the site.

Due to the absence of records describing the specific communities on the site prior to disturbance, and the fact that very little remnant vegetation or undisturbed reference areas exist, an extrapolation of ecosystem processes and fluvial principals was employed to develop the strategy for restoration of the site. It has therefore been assumed, based on watershed and landscape position, that this site was historically occupied by bottomland hardwood, swamp hardwood and piedmont/mountain levee alluvial forest community types. The communities were interconnected via a series of perennial and intermittent streams which provided a variety of habitat and water quality benefits. The intent of the Shepherds Tree Mitigation Project is to reestablish an integrated wetland-stream complex that will replace ecosystem processes and structures (functions and values) lost as a result of human induced disturbances in the Yadkin River Basin. Such resulting impacts include: a loss of water quality, fragmentation of wildlife habitat and travel corridors, reduced local flood attenuation capacities, and a decrease in regional biodiversity. The restoration strategy is therefore geared strongly towards replacing functions and values that have been lost in the Yadkin watershed.

This project involves stream, wetland and riparian restoration components. These objectives will be achieved through the alteration of the existing site features including: digging breaches in the berm along Third Creek to promote increased flooding, relocation and restoration of the existing ditched stream channel to develop more natural drainage patterns, removal of lateral drains to reduce offsite drainage, site grading to create wetlands and restore streams and re-vegetation of the site with plant species characteristic of the target communities.

The stream restoration will include channel planform, cross section, and profile reconstruction. The stream restoration methodology for this project includes fluvial geomorphologic principles (Rosgen) and innovative bioengineering technology for creating stable channel geometry, planform and bank protection. The intention is to restore the network of streams and channels that likely traversed the site. Anticipated restored functions include improved water quality, habitat, and flood attenuation of the system, complementing the natural community types proposed.

# 1.0 BACKGROUND

The following section describes background information of the site, including existing plant community types, hydrology, and soil conditions. Information was derived from aerial photographs, landowner interviews, vegetation, and soil morphological features.

## 1.1 Site Description

The Shepherds Tree mitigation site is located between Triplett Road (SR 2362) and Knox Farm Road (SR 2363) adjacent to Third Creek in Iredell County, southeast of Statesville, and occupies approximately 160 acres (Figures 1 & 2). At its most downstream point, the site drains a watershed of 49,420 acres and is located on the 2, 10 and 100 year floodplains of Third Creek. Third Creek is a Class C waterway in the Yadkin River watershed.

The position of the Shepherds Tree site in the watershed is characteristic of Piedmont/Mountain Bottomland forests and associated communities. The site is currently under agricultural use and has been substantially altered from its original community makeup in support of this activity. Current land cover includes forest, agricultural fields and scrub-shrub wetlands.

The hydrology of the subject site has been altered. A network of drainage ditches directs water from the lower agricultural fields and several small tributaries flowing from the adjacent uplands into Third Creek. Third Creek has also been straightened, channelized, and bermed to maximize acreage for agriculture, reducing water quality and wildlife benefits for the watershed.

## 1.2 Watershed Characteristics

The site is situated in the 030706 sub-basin of the Yadkin River watershed, located in the Piedmont physiographic region of North Carolina and drains approximately 49,420 acres (20,000 hectares) (Figure 3). The watershed is predominantly rural with significant drainage originating from agricultural land. The topographic relief of the watershed is approximately 484 feet (147 meters) ranging from 1200 feet (366 meters) above mean sea level (MSL) in the northwestern portion to 716 feet (218 meters) above MSL in the southeast portion of the watershed. Watershed land use is dominated by agriculture, with limited residential, commercial/industrial, and forested areas.

The study area is found within the USGS Hydrologic Unit 03040102 and DEM sub-basin 030706. According to the Division of Environmental Management, the water quality rating for this section of Third Creek is Class C. Class C waters have a "best usage" explanation for which the waters must be protected. Class C waters must be protected for aquatic life propagation and survival, fishing, wildlife, secondary recreation, and agriculture.[1] The subject site is part of an approximately 20,000 hectare (49,420 acre) watershed.

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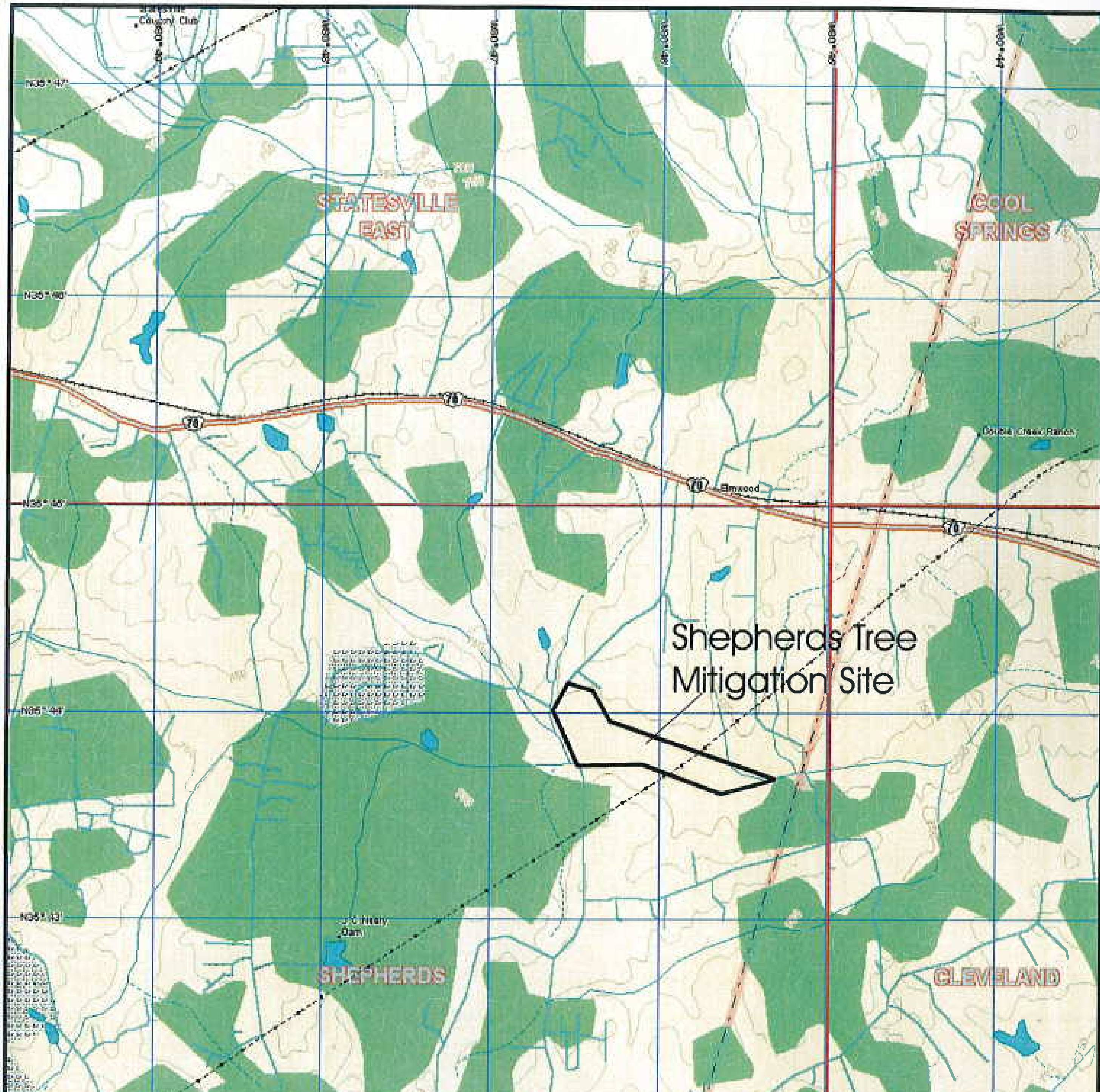
[1] Classification and Water Quality Standards Assigned to the Waters of the Neuse River Basin, Division of Environmental Management, Raleigh, NC, 1992.




Shepherds Tree Mitigation Plan

Figure 1. Vicinity Map

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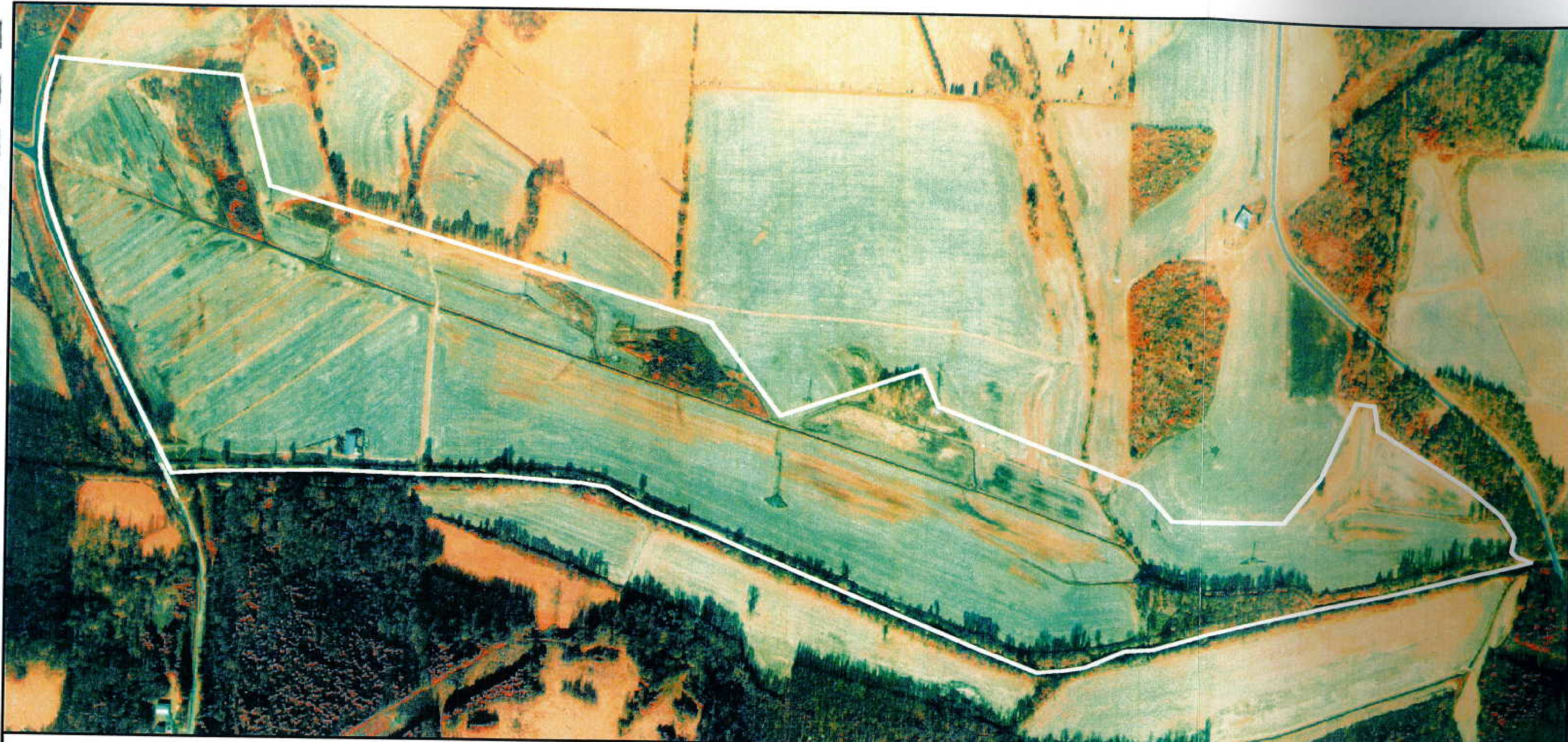

Shepherds Tree Mitigation Plan | Site Boundary | FIGURE 2

Site Boundary

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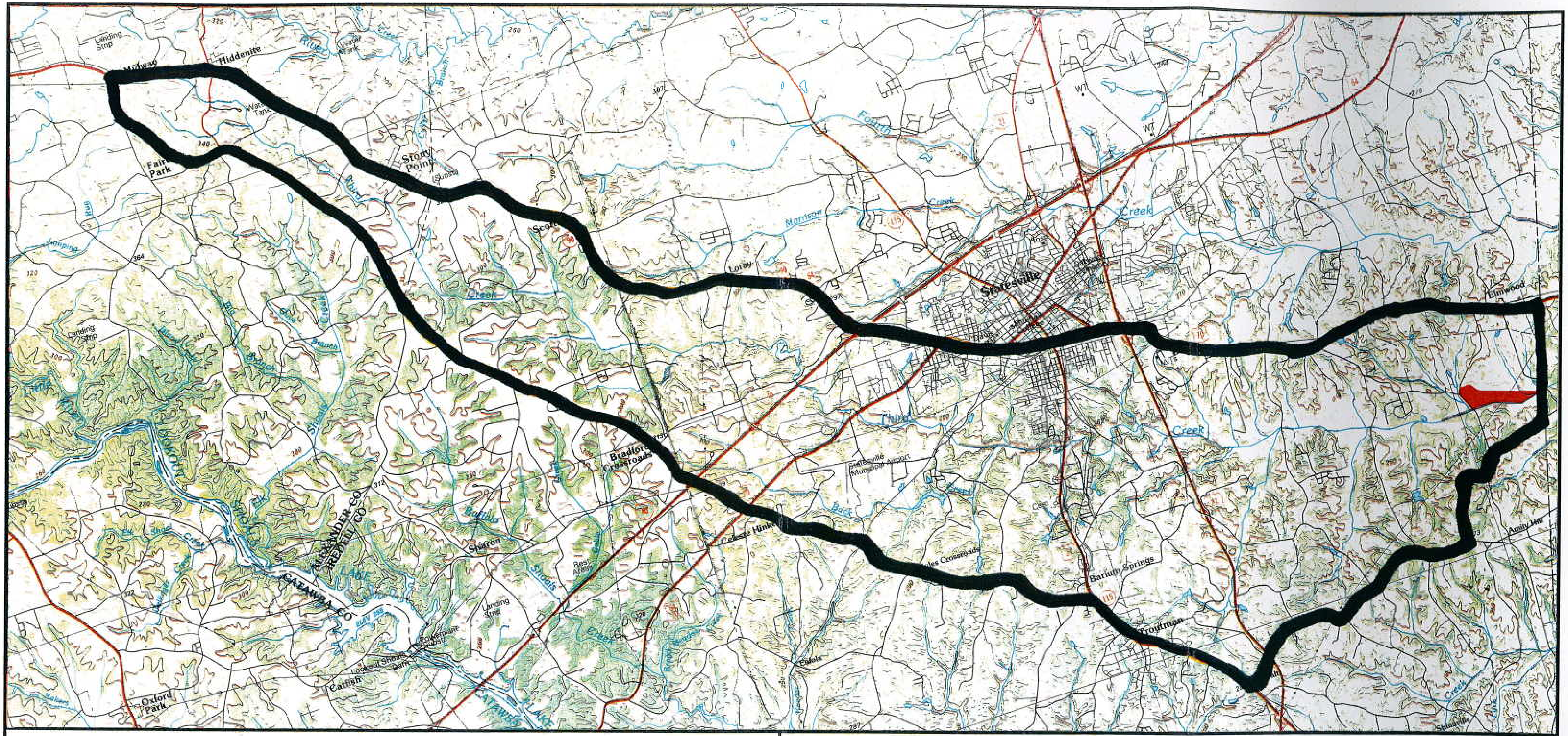


| Shepherds Tree Mitigation Plan | Watershed Boundary | FIGURE 3 |
|---|---|---|

Watershed boundary

Mitigation area

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## 2.0 EXISTING CONDITIONS

### 2.1 Vegetative Communities

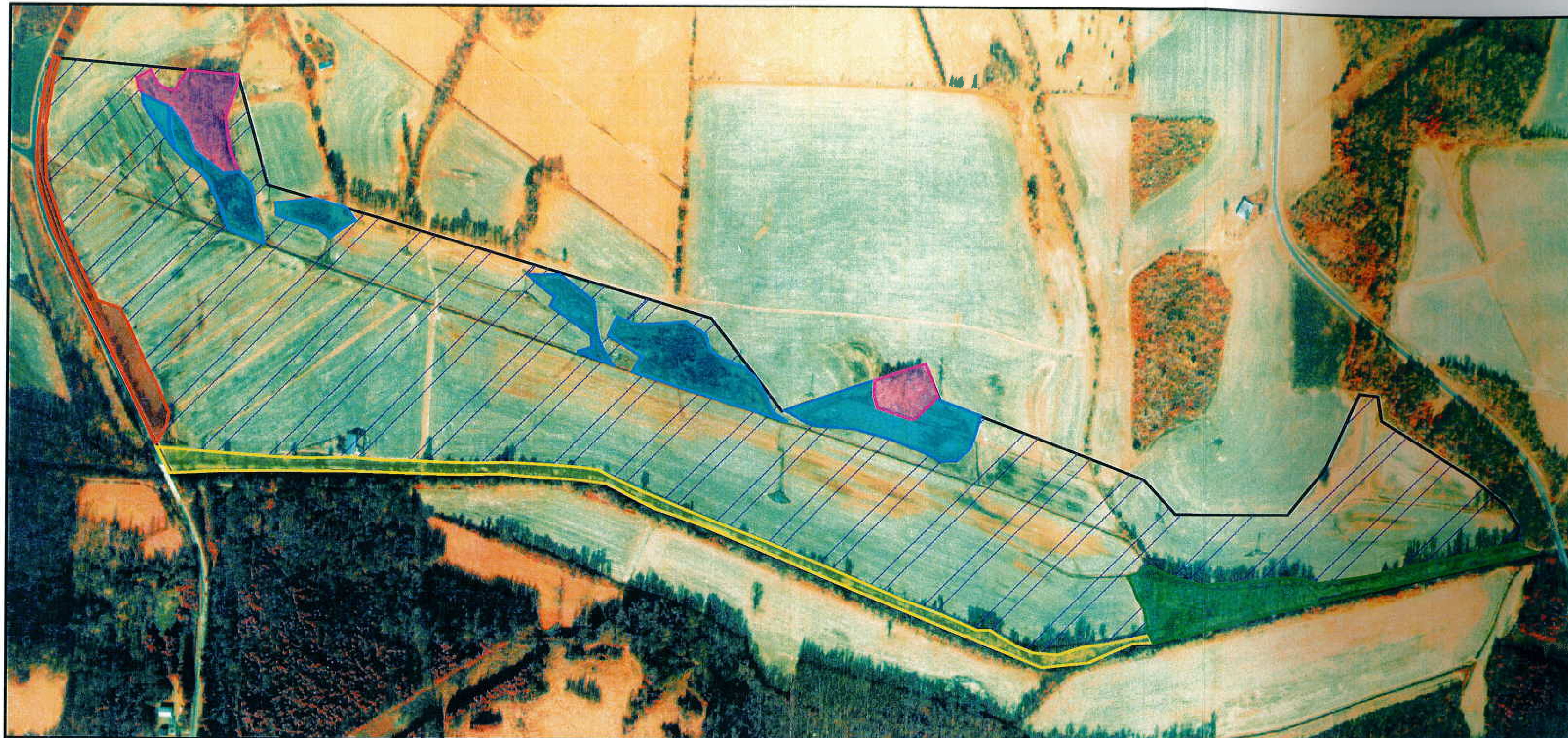
An evaluation of the community types present on site was conducted on December 17 and 18, 1998. The site was surveyed for community composition and species lists for each recognized community were created. Several distinct community mosaics were recognized and more complete species lists with dominance were compiled. These lists were utilized to best fit the communities described here to a designation in the Classification of the Natural Communities of North Carolina (Schafale & Weakley 1990).

A field survey was conducted to identify the dominant plant communities on the subject site (Figure 4). Dominant communities on the subject site include Piedmont/Mountain Levee Forest, Low Elevation Seep, Emergent wetland, Scrub-Shrub wetland, and agricultural fields. A spoil pile (berm) and an upland side-slope (roadside shoulder) were also mapped on-site; however, both are considered minor components of the plant community.

Piedmont/Mountain Levee Forests are prevalent on the floodplain of Third Creek and its tributaries. Woody species of the canopy include *Fraxinus pennsylvania* (green ash), *Platanus occidentalis* (sycamore), *Betula nigra* (river birch), *Liquidambar styraciflua* (sweet gum), *Acer rubrum* (red maple), and *Quercus michauxii* (swamp chestnut oak). The midstory includes *Acer negundo* (boxelder) and *Acer rubrum* (red maple). The understory includes vines and herbs such as *Arundinaria gigantea* (giant cane), *Pueraria lobata* (kudzu), and *Toxicodendron radicans* (poison ivy).

Low Elevation Seeps are found in two areas along the toe of the slopes where the upland and floodplain meet. The canopy includes *Fraxinus pennsylvania* (green ash), *Acer rubrum* (red maple), and *Acer negundo* (boxelder). The understory includes *Lindera benzoin* (spicebush), *Acer rubrum* (red maple), and *Acer negundo* (boxelder). The herb layer is limited to sporadic occurrences of *Carex* sp.

The Scrub-Shrub vegetative communities are dominated by *Salix nigra* (black willow), *Cornus amomum* (silky dogwood), *Rosa multiflora* (multiflora rose), *Rubus allegheniensis* (blackberry), *Sambucus canadensis* (American elderberry), and *Acer negundo* (boxelder).



| Shepherds Tree Mitigation Plan | Existing Plant Communities | FIGURE 4 |
|---|---|---|

- Agricultural field
- Piedmont/Mountain Levee Forest
- Spoil pile
- Scrub-Shrub Wetland
- land Sideslope
- w Elevation Seep

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## 2.2 Soils

Soils were evaluated to determine their type, distribution and extent based on field profile descriptions and the Iredell County Soil Survey (Figure 5). The distribution of soil types on the site was reasonably consistent with the soil survey. Soils in the study area include Congaree, Chewacla, Wehadkee, Worsham, Altavista, Wilkes, Lloyd, and Colfax series, as well as Udorthents. The Congaree, Chewacla, and Wehadkee series are soils found on the floodplain and are formed by deposition of recent alluvium. Under natural conditions, flooding is frequent.

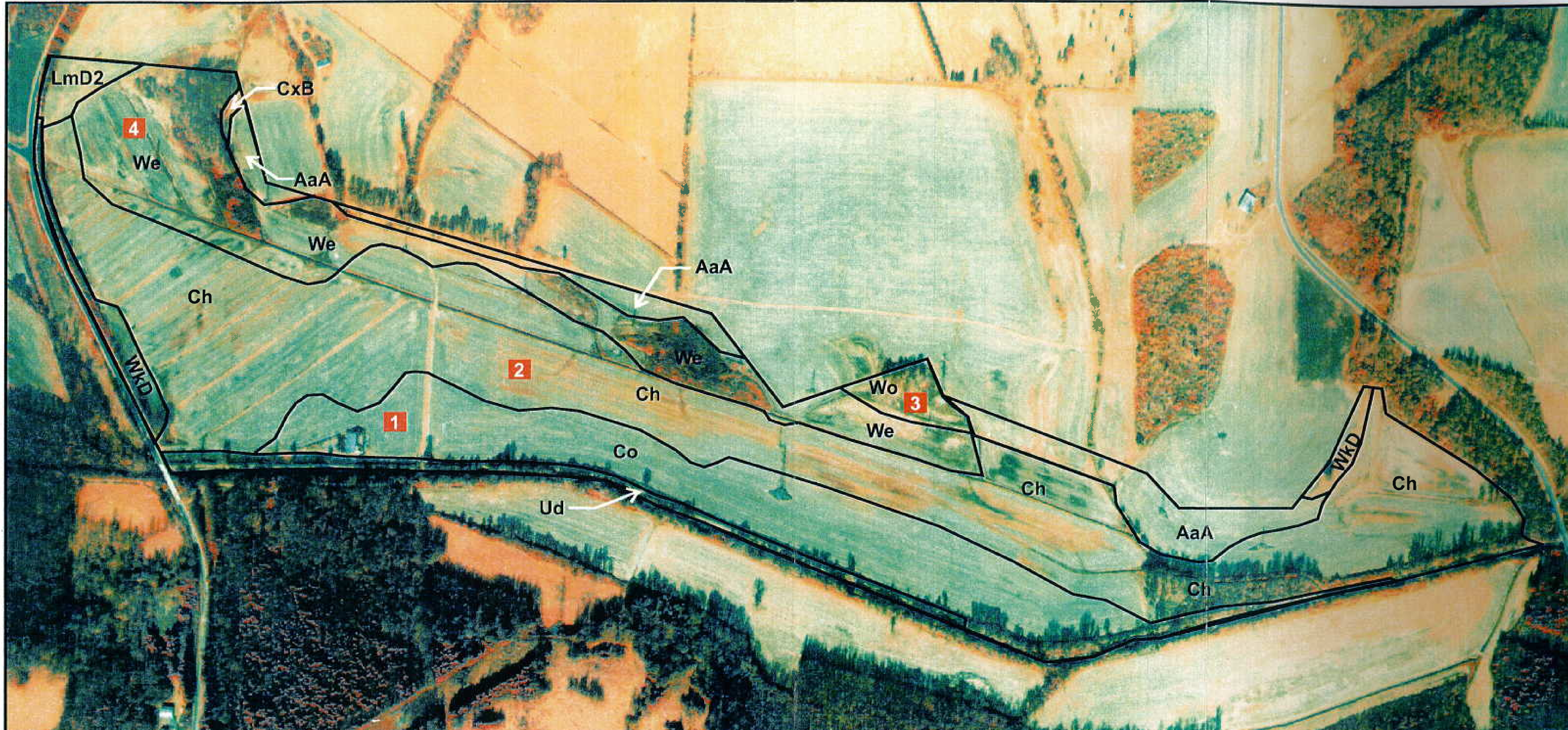
Congaree soil is found closest to the river channel and contains coarse material due to the rapid settling out of sands during flood events. Due to the soil texture, elevation, and proximity to the Third Creek, water drains quickly from the profile, hence the water table is found well below the surface (> 5 feet).

Chewacla soil is found further away from the stream channel, in a slightly lower landscape position. The texture tends to be finer as the silts and some clay settles out during flooding. The seasonal high water table tends to occur within 1.5 feet of the surface. This is considered a secondary hydric soil, *i.e.* hydric inclusions may be found within the map unit.

At the toe of the slope and at the furthest point from the stream channel, the Wehadkee series is found. This is a poorly drained soil found on the lowest floodplain position that has high silt and clay content compared to the other floodplain soils. Surface and groundwater inputs of water from the surrounding uplands, as well as flood events, create conditions where soil saturation is frequent. This hydric soil has a dark colored surface horizon and a medium to high organic matter content. A large inclusion of the Worsham soil was found within the Wehadkee map unit. This soil has a dark (10YR 4/2) surface horizon, underlain by a darker horizon (3/N black), depicting alluvial and colluvial deposition, and saturated conditions (see Appendix 2). Both the surface horizon and subsurface horizons are high in sand content. Presently, overbank flooding is infrequent on this property. With the construction of the 8–12 foot high berms from dredging activities, where the Udorthents (altered soil) are present, overbank flow is highly restricted. Consequences of this activity include the reduction in soil moisture and the loss of sediment deposition onto the floodplain soils.

Hydric soils occupy approximately 70 acres, 4.5 acres of which are currently classified jurisdictional wetlands. None of the agricultural areas hold Prior Converted wetland status, according to the NRCS office in Iredell County (Figure 6). Secondary hydric soils occupy approximately 60 acres, and alluvial soils occupy approximately 30 acres of the site. Surrounding the floodplain, several upland soils are found within the mitigation area including the Altavista, Wilkes, Lloyd, and Colfax series. These are generally found slightly above floodplains, at the base of slopes or around the head of seeps. Further attributes of these soils are listed in Table 1[2] and Appendix 2.

[2] Soil Survey of Iredell County, North Carolina 1960. USDA - NRCS.




| Shepherds Tree Mitigation Plan | Soils | FIGURE 5 |
|---|---|---|

*Soil Series:*

Ch - Chewacla loam
Co - Congaree
We - Wehadkee silt loam
AaA - Altavista
WkD - Wilkes loam
Wo - Worsham loam
CxB - Colfax sandy loam
Ud - Udorthents
LmD2 - Lloyd loam
Soil Pit Locations

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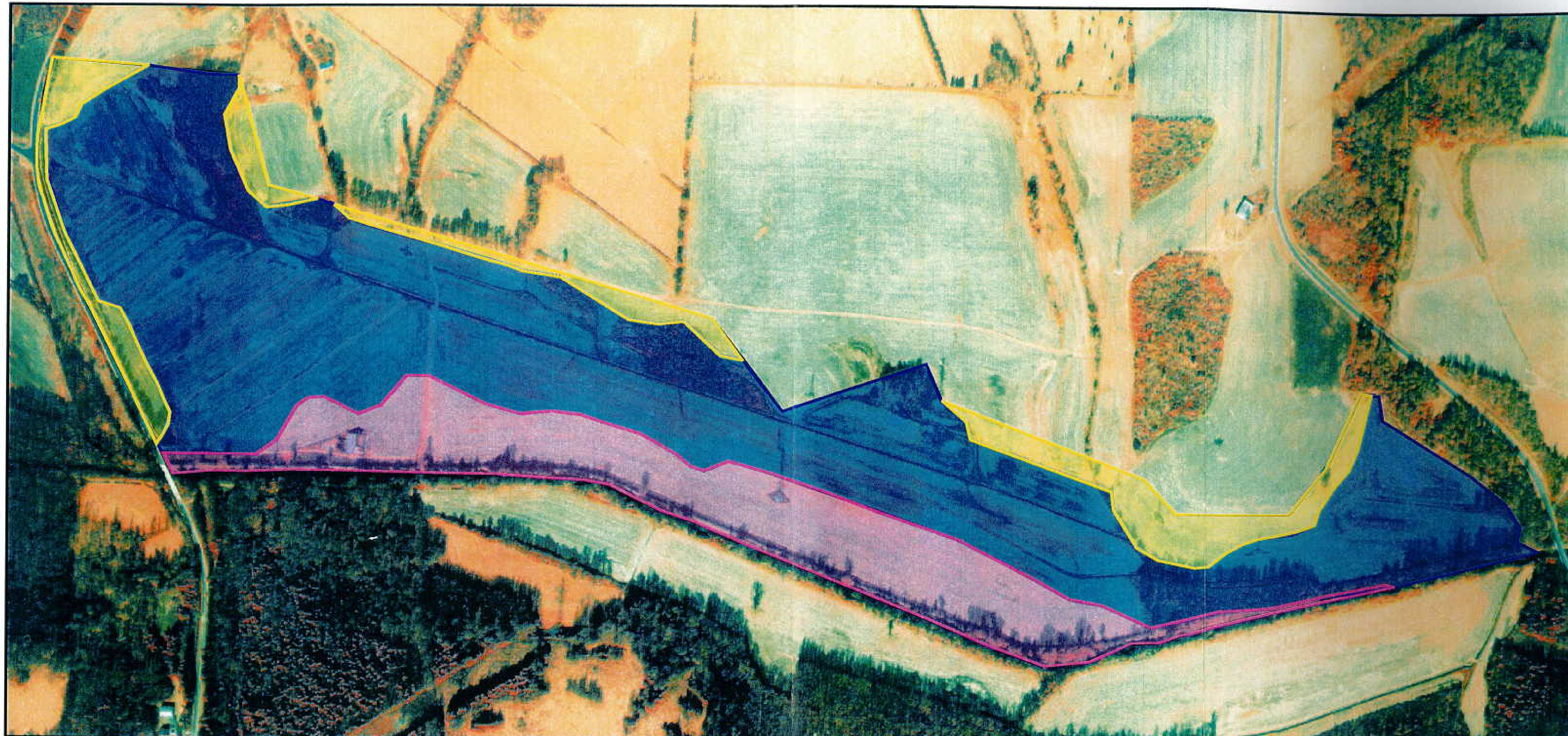

| Shepherds Tree Mitigation Plan | Hydric Soils Distribution | FIGURE 6 |
|---|---|---|

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Hydric and Secondary Hydric Soil

Alluvial Soil

Non-Hydric Soil

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Table 1.
Soil Descriptions from Iredell County Soil Survey

| Soil Series | Taxonomic classification | Landscape position | Seasonal high water table | Drainage class | Hydric | Approximate acreage |
|---|---|---|---|---|---|---|
| Congaree | Typic Udifluvent | Floodplain | >1.8 meters (>6 feet) | Well drained | No | 29.5 |
| Chewacla | Fluvaquentic Dystrudept | Floodplain | Within 0.45 meters (1.5 feet) | Somewhat poorly drained | Secondary | 83* |
| Wehadkee | Fluvaquentic Endoaquept | Floodplain | At or near the surface | Very poorly drained | Yes | 25 |
| Worsham | Typic Ochraquult | Seep | At or near the surface | Poorly drained | Yes | 2 |
| Altavista | Aquic Hapludult | Upland | 0.45 – 1.2 m (1.5- 3 feet) | Somewhat poorly drained | No | 8 |
| Lloyd | Rhodic Kanhapludults | Upland | >3 meters (>10 feet) | Well Drained | No | 1.5 |
| Colfax | Aquic Fragiudult | Upland | 0.45 – 1.2 m (1.5- 3 feet) | Somewhat poorly drained | No | 5 |
| | Udorthent | Berm | | | No | 4 |
| Wilkes | Typic Hapludalf | Upland | >1.8 meters (>6 feet) | Well drained | No | 2 |

*of the 83 acres mapped as Chewacla in the Soil Survey, approximately 42 acres were subsequently mapped in the field as having redoximorphic depletions and concentrations within 12 inches of the soil surface

### 2.3 Hydrology/Hydraulics

The data collected and developed to date indicate that the site's hydrology and hydraulics reflect those characteristically found in piedmont riparian zones. The site falls within the two-year floodplain, and under natural conditions would periodically be inundated by flows from Third Creek. In addition, a series of seeps feed a ditched stream channel at the "backswamp" portion of the floodplain. These seeps and the adjacent floodplain are drained via a series of lateral ditches. Under the current conditions, the berm along Third Creek, the construction of lateral drains, and the ditching of the backswamp stream channel have effectively removed jurisdictional wetland hydrology from most of the site. Additionally, the historic dredging of Third Creek lowered the channel elevation and consequently results in additional loss of groundwater from the levee and proximal floodplain portions of the site (Figure 7).

#### 2.3.1 Groundwater

Groundwater still influences the site to some degree; however, its prevalence on the site has been reduced by the dredging of Third Creek, lateral drains leading to the "backswamp", and the dredging of the "backswamp" stream. Two principal groundwater seeps are found on the site. These seeps discharge from the toe of the upland slopes to the north, which define the limits of the floodplain. These areas have also been ditched to restrict their influence on the adjacent landscape. These ditches suppress groundwater elevations by providing a direct discharge path, limiting groundwater influence on the site.

A detailed evaluation of the site's groundwater hydrology was undertaken. This work included the installation of 10 - 40" and 3 - 20" RDS monitoring gauges (Figure 8) and 13 geotechnical borings. This study determined that the direction of groundwater flow is from the northwest to the southeast with a general southeasterly trend. The lithologic sequence comprising the aquifer is such that the local biotite gniess bedrock is the lower confining unit, lying below a sand aquifer with an average thickness of approximately 14 ft. The upper confining surface clay layer ranges between 3 to 8 ft. thick. When the lower aquifer contacts the upper confining layer, saturated conditions occur. In addition, the upper confining layer acts as an aquitard that inhibits vertical infiltration and in some locations perches lenses of water at the surface. Using data derived from 13 geotechnical boring locations on site and a hydraulic conductivity value for the soil of 56.69 ft./day, the estimated groundwater discharge through the site is 0.51 acre-ft/day.

#### 2.3.2 Surface Water

The site is located on the floodplain of Third Creek and would be inundated under natural conditions by the 2, 10, and 100 year storm events. The extent and duration of this inundation has been substantially reduced by the construction of a berm along Third Creek and a ditch network in the floodplain. Preliminary evaluations indicate that a flow in excess of 2035 cfs (cubic feet per second) is required to overtop the existing berms. Review of the local USGS gauge station data indicates that flows of this magnitude have not occurred between the years of 1940 and 1971. Utilizing the same USGS gauge data and negating the effects of the berm, a flow of 1075 cfs would have overtopped the banks and

| Shepherds Tree Mitigation Plan | Site Hydrology | FIGURE 7 |
|---|---|---|

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Direction of surface water flow

Seep area

Direction of flow in Third Creek

Direction of flow in perennial stream

Direction of flow in ditches

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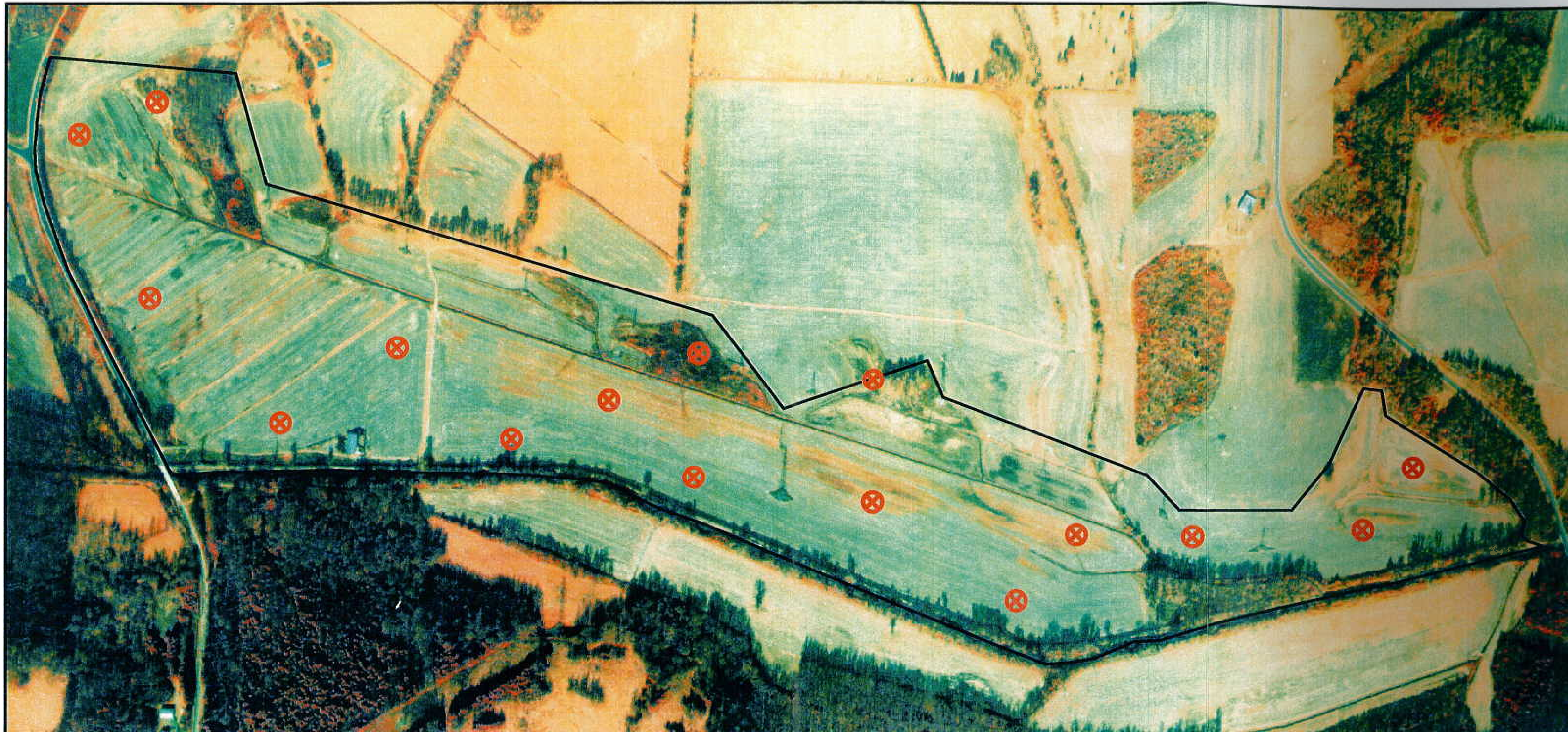

| Shepherds Tree Mitigation Plan | Monitoring Gauge Locations | FIGURE 8 |
| --- | --- | --- |

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⊗ Monitoring Gauge Location

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inundated the site 1.6 times per year. Thus, it can be deduced that the berm on Third Creek has effectively eliminated flooding of the site.

Additional drainage enters the site from two sub-watersheds to the north of the site. These areas constitute approximately 780 acres of drainage area. The effects of these hydrologic inputs have been greatly reduced by the ditching of the stream through the "backswamp" portion of the floodplain. The ditched stream has the capacity to discharge 38 cfs, limiting opportunity for incorporation of this water in the site's water budget.

### 2.3.3 Water Budget

Based on the groundwater and surface water data gathered to date, the water budget for the site is in deficit. All surface inputs are restricted from the site or can be removed from the site at a rate higher than the input. Groundwater influences are present but are also being removed at a high rate.

A site water budget was calculated for existing site conditions that demonstrated insufficient hydrology to meet USACOE criteria for jurisdictional wetland hydrology. Due to surface watercourse derangement such as channel deepening, straightening, and levee building, the frequency of overbank flood events has been essentially eliminated with respect to the site's hydroperiod. The remaining inputs are direct precipitation and surface runoff from a 1.12-square mile drainage area. The water outputs from the site include evapotranspiration, surface water outflow and deep infiltration. A significant factor in site hydrology is the extensive drainage ditch network that functions to both decrease depressional water storage on site and dewater the soil profile.

Water inputs and outputs were calculated for the approximately 160-acre site from historical climatic data for a normal year (1980) and a dry year (1988). As shown in Table 2, both the normal and dry years resulted in negative changes in storage, or a site water deficit. This phenomenon is due largely to surface runoff bypassing the site as a result of the ditch network.

Table 2-Existing Conditions Annual Water Budget Analysis

| Climatic Year | Precipitation (in) | Surface Inflow (in) | Groundwater Inflow (in) | PET (in) | Surface Outflow (in) | Infiltration (in) | Change in Storage (in) |
|---|---|---|---|---|---|---|---|
| 1980 – Normal Year | 46.23 | 12.58 | 0 | 38.63 | 12.74 | 12.48 | -5.04 |
| 1988 – Dry Year | 36.01 | 7.66 | 0 | 38.63 | 7.81 | 12.48 | -15.53 |

Note:
1. Groundwater inflow to the site was not considered in the existing conditions water budget in order to provide a conservative estimate of water available for wetland restoration.
2. Surface outflow was calculated as the sum of surface inflow and lateral ditch drainage since current site conditions cause surface runoff to bypass the site.
3. Infiltration assumes a vertical permeability of $2 \times 10^{-6}$ ft/min.

## 2.4 Assessment of Existing Conditions

An assessment of the site's wetland/stream features was undertaken to determine the type and level of work required to restore the site's natural characteristics. However, the disturbed nature of the site made it difficult to precisely define pre-disturbance conditions.

### 2.4.1 Soils

A detailed soils map was produced from data collected onsite and distributed independently to the regulatory agencies. It documents the perimeters of all areas where a chroma of 2 or less is found within 12 inches of the soil surface, as requested by the USACOE. It also describes the soil profiles found along a 150-foot sampling grid across the site. The map confirms 53.6 acres of restorable wetland soils, net of the Duke Energy rights-of way on the property.

### 2.4.2 Wetlands

The existing jurisdictional wetland areas on site are restricted to seeps at the outer edge of the floodplain. These areas have also been ditched in an attempt to remove water; however, groundwater continues to supply jurisdictional hydrology. All other areas of the site have been drained sufficiently to remove jurisdictional hydrology and have little or no remaining wetland functional value.

### 2.4.3 Streams

As documented above, all pre-disturbance natural stream channel features on the project site have been eliminated by excavation. Therefore, it was not feasible to collect channel geometric, hydrologic or hydraulic data. A field evaluation of the site was conducted in order to assess general site characteristics such as landscape position, topographic relief, soils and substrate composition, and existing vegetation.

## 2.5 Summary of Existing Conditions

The existing conditions of the project site's vegetation, soils and hydrology are severely impacted due to human alteration of the community structure, soil biogeochemistry and the hydrologic regimes. Most of the native vegetation has been removed from the site and natural succession is being suppressed by row-crop production. The hydrologic regime has been altered via the dredging of Third Creek, the consequent construction of a levee and aggressive ditching of the backswamp areas. Soil series on site include Congaree, Chewacla, Wehadkee, Worsham, Altavista, Wilkes, Lloyd, and Colfax, as well as Udorthents. The Congaree, Chewacla, and Wehadkee series are soils found on the floodplain and were formed by the deposition of recent alluvium. The Chewacla and Wehadkee soils on-site have been impacted by ditching, draining and leveeing. The net effects of these impacts have served to diminish the wetland functions that the site once performed for the watershed.

## 3.0 WETLAND AND STREAM RESTORATION ACTIVITIES
### 3.1 Goals and Objectives

The goal of the Shepherds Tree mitigation project is to re-establish an integrated wetland-stream complex that will restore ecosystem processes, structure, and composition to mitigate for wetland functions and values that have been lost as a result of human induced disturbances in the 030706 sub-basin of the Yadkin River.

A detailed evaluation of the watershed (Basinwide Assessment Report- Yadkin River Basin, DEHNR, June 1997; Yadkin River Basin Technical Report - Wetland Mitigation Site Search, KCI, May 1997)) identified significant losses of functions and values associated with the dredging and berming of the major streams in the Yadkin River Basin. Specifically, the restriction of overbank flooding has allowed for the conversion of the basin's floodplain into agricultural fields, thus promoting the clearing of riparian zones, the channelization of tributary streams and the drainage of adjacent wetlands. These activities have subsequently resulted in the degradation of water quality, wildlife habitat, and flood attenuation capacities, and contributed to habitat fragmentation, loss of wildlife corridors and an overall decrease in regional biodiversity. The goal of the Shepherds Tree site restoration is the re-establishment of a suite of wetland and stream functions and values-natural functions that were historically intact, but during conversion to agricultural production were lost or grossly degraded.

Typical restored functions of the system will include:

- Nutrient removal/transformation
- Flood flow attenuation
- Aquatic and Terrestrial species diversity/abundance

These functions will be restored through:

- Restoration/enhancement of bottomland/swamp hardwood communities.
- Restoration of floodplain/wetland interfaces.
- Restoration of stream channels and drainage patterns.
- Re-establishment of wildlife travel corridors.

Table 3 summarizes the target plant communities, mitigation types and their respective areal extent comprising the Shepherds Tree Mitigation project.

Table 3. Mitigation Type and Extent*

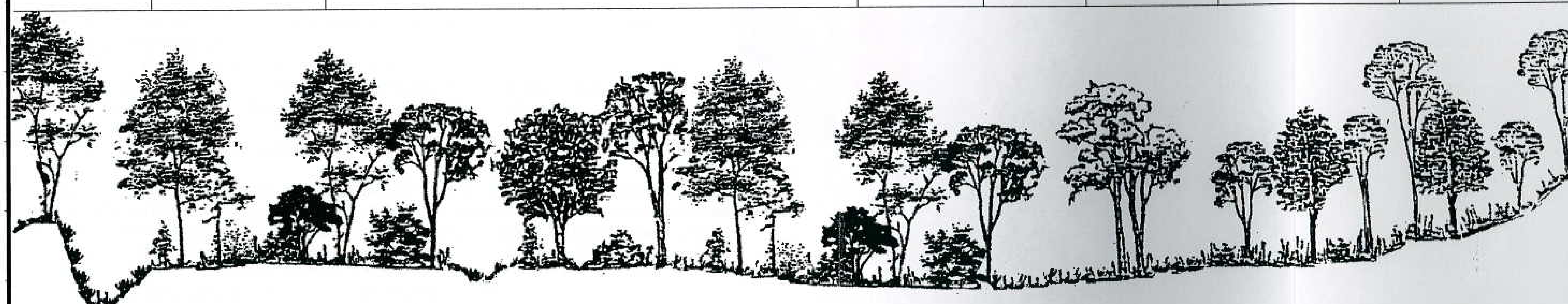
| COMMUNITY TYPE | Restoration | Creation | Preservation |
|---|---|---|---|
| Piedmont/Mountain Bottomland Hardwood Forest | 48.56 ac | 37.71 ac | 0 |
| Piedmont/Mountain Swamp Hardwood Forest | 5 ac | 0 | 0 |
| Low Elevation Seep | 0 | 0 | 4.54 ac |
| Perennial Stream | 11,570 l.f. | 0 | 0 |
| Intermittent Stream | 3,118 l.f. | 0 | 0 |

*The Duke Energy right-of-ways onsite were not included in the mitigation areas, pending a signed agreement with Duke Energy stating the details of the maintenance regime of those areas. With a signed agreement, the mitigation acreages will be adjusted upward to reflect the inclusion of the right-of-way areas (12 ac).

Figure 9 depicts a typical cross section of the anticipated communities.

PROJECT REFERENCE NO. 1298031F

| TARGET ASSOCIATION | PIEDMONT/MOUNTAIN LEVEE FOREST | PIEDMONT/MOUNTAIN BOTTOMLAND FOREST | PIEDMONT/MOUNTAIN SWAMP FOREST | FLOODPLAIN POOL | PIEDMONT/MOUNTAIN SWAMP FOREST | LOW ELEVATION SEEP | MESIC MIXED HARDWOOD FOREST PIEDMONT SUBTYPE |
|---|---|---|---|---|---|---|---|
| SITE SPECIFIC SPECIES | GREEN ASH<br>BOXELDER<br>YELLOW POPLAR<br>SYCAMORE<br>RIVER BIRCH | YELLOW POPLAR<br>CHERRY BARK OAK<br>GREEN ASH<br>WILLOW OAK<br>WATER OAK<br>SHAGBARK HICKORY | CHERRY BARK OAK<br>GREEN ASH<br>WILLOW OAK | BUTTON BUSH<br>PICKERAL WEED<br>DUCK POTATO | CHERRY BARK OAK<br>GREEN ASH<br>WILLOW OAK | WILLOW OAK | WHITE OAK<br>NORTHERN RED OAK<br>YELLOW POPLAR |
| | VARIANT SPECIES | VARIANT SPECIES | VARIANT SPECIES | | VARIANT SPECIES | VARIANT SPECIES | VARIANT SPECIES |
| | SPICE BUSH<br>BUCKEYE<br>YELLOW ROOT<br>ELDERBERRY | SILKY DOGWOOD<br>RED CHOKEBERRY<br>ELDERBERRY<br>VIRGINIA WILLOW | SILKY DOGWOOD<br>BLACK WILLOW<br>ELDERBERRY<br>VIRGINIA WILLOW | | SILKY DOGWOOD<br>BLACK WILLOW<br>ELDERBERRY<br>VIRGINIA WILLOW | SILKY DOGWOOD<br>ELDERBERRY | BLACK CHERRY<br>RED CEDER<br>WINTER BERRY |



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| SOILS | CONGAREE<br>(TYPIC UDIFLUVENTS) | CHEWACLA<br>(FLUVAQUENTIC DYSTROCHREPTS)<br>WEHADKEE<br>(TYPIC FLUVAQUENTS) | WEHADKEE<br>(TYPIC FLUVAQUENTS) | WEHADKEE<br>(TYPIC FLUVAQUENTS) | WEHADKEE<br>(TYPIC FLUVAQUENTS) | WEHADKEE<br>(TYPIC FLUVAQUENTS)<br>INCLUSIONS OF:<br>WORSHAM<br>(TYPIC OCHRAQUULT) | ALTAVISTA<br>(AQUIC HAPUDULT)<br>COLFAX<br>(AQIC FRAGIUDULTS)<br>WILKES<br>(TYPIC HAPLUDALFS) |

DATE OF ORIGINATION : 01-11-99
DRAWN BY : JDG
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| REVISIONS | | |
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TYPICAL COMMUNITY DISTRIBUTION

PROJECT NAME :
SHEPHERDS TREE CONCEPTUAL MITIGATION PLAN

**STATE OF NORTH CAROLINA**
**DEPT. OF TRANSPORTATION**

SHEET TITLE :
**FIGURE 9**

SHEET NO. :
**1 OF 1**

KCI JOB NO. : 1298031F

Approximately 12 acres of Mesic Mixed Hardwood Forest and approximately 6 acres of Levee Forest will be restored onsite. Approximately 10 acres of Levee Forest will be preserved. Four floodplain pools totaling 0.6 ac will be constructed. Additionally, 12 acres of Duke Energy right of way will be planted with a herbaceous mix. Mitigation credit for these areas will be added pending a maintenance agreement with Duke Energy. The upland restoration efforts represent a substantial good-faith effort to restore the site, which the sponsor believes should be considered when final mitigation ratios are determined.

## 3.2 Wetland Restoration

An extrapolation was made, based on topography and geomorphology, of the probable condition of the site before disturbance. From this, a strategy was developed for restoration of bottomland hardwood, swamp hardwood and piedmont/mountain levee alluvial forest community types.

As described previously, the goals and objectives developed for this site target the restoration of key functions that have been degraded or lost due to human disturbances in the basin. These objectives will be achieved through the alteration of the existing site features including:

- Breaching the berm along Third Creek to promote increased flooding.
- Relocation and restoration of existing ditched stream channel on site to develop more natural drainage patterns.
- Removal of lateral drains to reduce off-site drainage.
- Site grading to create wetlands and increase diversity of habitats on floodplain.
- Revegetation of the site with plant species characteristic of the target communities.

### 3.2.1 Hydrology/Hydraulics

Restoration of the hydrology and hydraulics of the site will focus on re-establishment of periodic overbank flooding and reduction in off-site drainage. This will be accomplished through the relocation (plan form and cross section) of the ditched stream channel on site, the removal of lateral drainage ditches and the alteration of the grade on site to restrict drainage (Figure 10A&10B). With the application of the aforementioned actions, the post-restoration water budgets for the site are shown in Tables 4-6.

A post-construction site water budget was modeled using water inflows of precipitation (P) and surface runoff (Si), and water outflows of Thornthwaite potential evapotranspiration (PET), surface outflow (So) and infiltration. Although groundwater discharge has been documented in certain toe-of-slope areas, groundwater exfiltration or inflow (Gi) was not included in order to provide a conservative model of water availability. Water inflows and outflows were calculated on a monthly time step from a maximum wetland water volume (expressed as a depth in inches over a 110-acre site) of 7.8 inches. The annual hydrographs for climatic years 1988 (Dry Year), 1980 (Average Year) and 1989 (Wet Year) depict wetland volume over time and describe the extent of jurisdictional wetland hydrology in each year.

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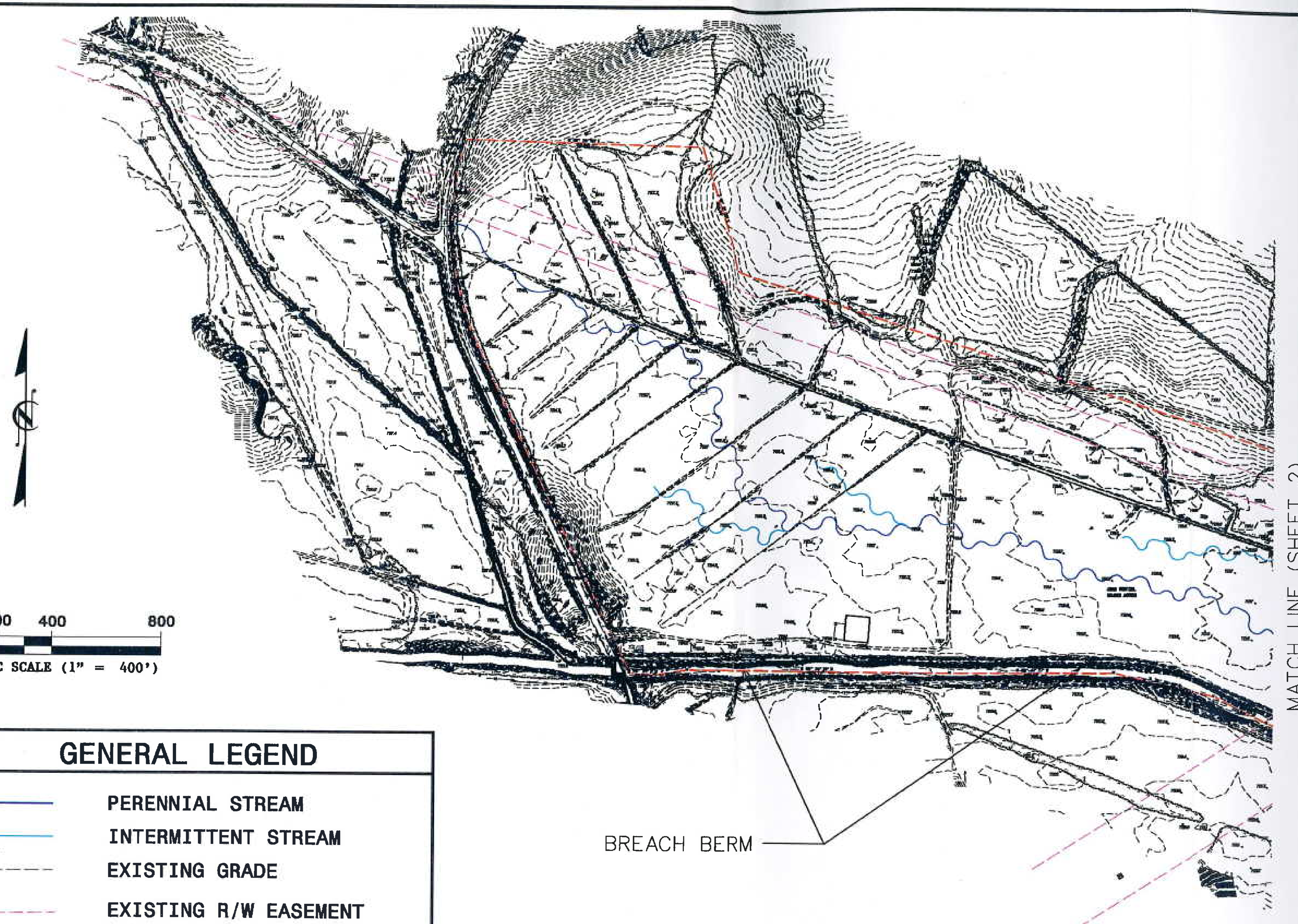
12980031F




## GENERAL LEGEND

| | |
|---|---|
| (dark blue line) | PERENNIAL STREAM |
| (light blue line) | INTERMITTENT STREAM |
| (dashed line) | EXISTING GRADE |
| (pink dashed line) | EXISTING R/W EASEMENT |
| (red dashed line) | SITE BOUNDARY |

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HYDROLOGY
AND
HYDRAULIC
ALTERATIONS

PROJECT NAME :

SHEPHERDS TREE
CONCEPTUAL MITIGATION
PLAN

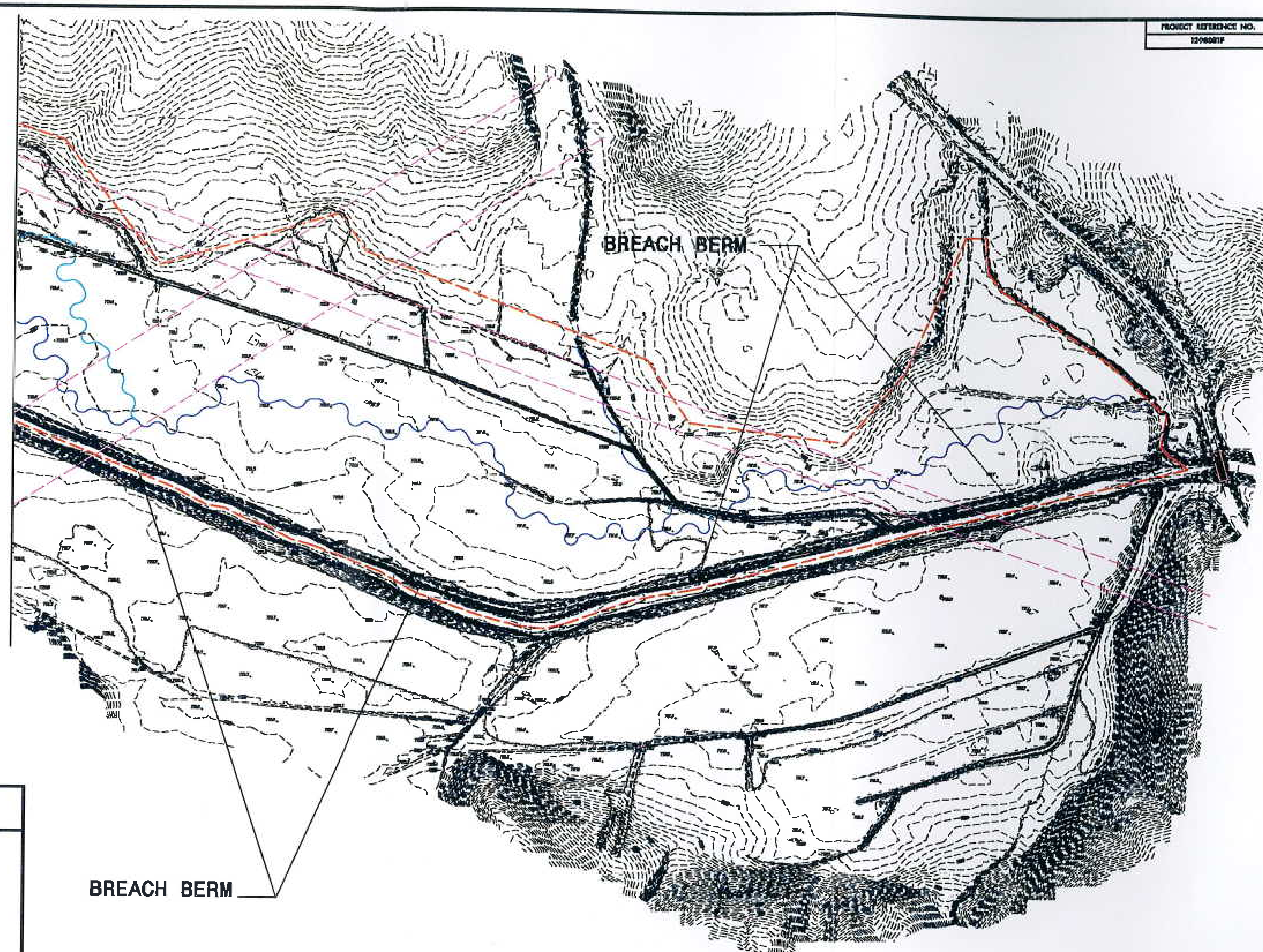
**STATE OF NORTH CAROLINA**
**DEPT. OF TRANSPORTATION**

SHEET TITLE :
FIGURE 10

SHEET NO. :
1 OF 2

KCI JOB NO. : 12980031F

PROJECT REFERENCE NO.
1298031F

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(1" = 400')

## GENERAL LEGEND

- PERENNIAL STREAM
- INTERMITTENT STREAM
- EXISTING GRADE
- EXISTING R/W EASEMENT
- SITE BOUNDARY

| | | | |
|---|---|---|---|
| HYDROLOGY AND HYDRAULIC ALTERATIONS | PROJECT NAME : SHEPHERDS TREE CONCEPTUAL MITIGATION PLAN | STATE OF NORTH CAROLINA DEPT. OF TRANSPORTATION | SHEET TITLE : FIGURE 10 |
| | | | SHEET NO. : 2 OF 2 |
| | | | KCI JOB NO. : 1298031 F |

**Table 4. Post-Restoration Water Budget for a Dry Year***

| *Dry Year* | *Water Inputs* | | | *Water Outputs* | | | Change in Storage | Excess Water | Wetland Volume |
|---|---|---|---|---|---|---|---|---|---|
| **1988** | **P** | **Si** | **Gi** | **PET** | **So** | **Infiltration** | | | |
| Jan-88 | 2.08 | 0.00 | 0.00 | 1.63 | 0.00 | 1.04 | -0.59 | 0.00 | 0.00 |
| Feb-88 | 1.43 | 0.02 | 0.00 | 1.95 | 0.02 | 1.04 | -1.56 | 0.00 | 0.00 |
| Mar-88 | 2.76 | 0.61 | 0.00 | 2.61 | 0.61 | 1.04 | -0.89 | 0.00 | 7.80 |
| Apr-88 | 2.36 | 0.34 | 0.00 | 3.33 | 0.34 | 1.04 | -2.01 | 0.00 | 5.79 |
| May-88 | 2.22 | 0.15 | 0.00 | 4.11 | 0.15 | 1.04 | -2.93 | 0.00 | 2.86 |
| Jun-88 | 2.42 | 6.14 | 0.00 | 4.72 | 6.14 | 1.04 | -3.34 | 0.00 | 0.00 |
| Jul-88 | 3.87 | 2.95 | 0.00 | 4.90 | 2.95 | 1.04 | -2.07 | 0.00 | 0.00 |
| Aug-88 | 3.77 | 0.74 | 0.00 | 4.55 | 0.74 | 1.04 | -1.82 | 0.00 | 0.00 |
| Sep-88 | 6.59 | 9.98 | 0.00 | 3.85 | 9.98 | 1.04 | 1.70 | 0.00 | 1.70 |
| Oct-88 | 3.02 | 1.15 | 0.00 | 2.95 | 1.15 | 1.04 | -0.97 | 0.00 | 0.73 |
| Nov-88 | 3.84 | 0.71 | 0.00 | 2.26 | 0.71 | 1.04 | 0.54 | 0.00 | 1.27 |
| Dec-88 | 1.65 | 0.00 | 0.00 | 1.77 | 0.00 | 1.04 | -1.16 | 0.00 | 0.11 |
| **Annual Totals** | **36.01** | **22.79** | **0.00** | **38.63** | **22.79** | **12.48** | **-15.10** | | |

**Table 5. Post-Restoration Water Budget for an Average Year***

| *Avg. Year* | *Water Inputs* | | | *Water Outputs* | | | Change in Storage | Excess Water | Wetland Volume |
|---|---|---|---|---|---|---|---|---|---|
| **1980** | **P** | **Si** | **Gi** | **PET** | **So** | **Infiltration** | | | |
| Jan-80 | 4.62 | 3.73 | 0.00 | 1.63 | 3.73 | 1.04 | 1.95 | 0.00 | 1.95 |
| Feb-80 | 1.47 | 0.00 | 0.00 | 1.95 | 0.00 | 1.04 | -1.52 | 0.00 | 0.00 |
| Mar-80 | 6.98 | 2.71 | 0.00 | 2.61 | 2.71 | 1.04 | 3.33 | 0.00 | 7.80 |
| Apr-80 | 3.42 | 1.23 | 0.00 | 3.33 | 1.23 | 1.04 | -0.95 | 0.00 | 6.85 |
| May-80 | 3.84 | 4.19 | 0.00 | 4.11 | 4.19 | 1.04 | -1.31 | 0.00 | 5.54 |
| Jun-80 | 4.57 | 11.42 | 0.00 | 4.72 | 11.42 | 1.04 | -1.19 | 0.00 | 4.35 |
| Jul-80 | 4.30 | 4.81 | 0.00 | 4.90 | 4.81 | 1.04 | -1.64 | 0.00 | 2.71 |
| Aug-80 | 4.32 | 4.08 | 0.00 | 4.55 | 4.08 | 1.04 | -1.27 | 0.00 | 1.44 |
| Sep-80 | 5.38 | 4.83 | 0.00 | 3.85 | 4.83 | 1.04 | 0.49 | 0.00 | 1.93 |
| Oct-80 | 3.25 | 0.18 | 0.00 | 2.95 | 0.18 | 1.04 | -0.74 | 0.00 | 1.19 |
| Nov-80 | 3.16 | 0.27 | 0.00 | 2.26 | 0.27 | 1.04 | -0.14 | 0.00 | 1.05 |
| Dec-80 | 0.92 | 0.00 | 0.00 | 1.77 | 0.00 | 1.04 | -1.89 | 0.00 | 0.00 |
| **Annual Totals** | **46.23** | **37.45** | **0.00** | **38.63** | **37.45** | **12.48** | **-4.88** | | |

**Table 6. Post-Restoration Water Budget for a Wet Year***

| *Wet Year* | *Water Inputs* | | | *Water Outputs* | | | Change in Storage | Excess Water | Wetland Volume |
|---|---|---|---|---|---|---|---|---|---|
| **1989** | **P** | **Si** | **Gi** | **PET** | **So** | **Infiltration** | | | |
| Jan-89 | 1.94 | 0.04 | 0.00 | 1.63 | 0.04 | 1.04 | -0.73 | 0.00 | 7.07 |
| Feb-89 | 5.71 | 2.06 | 0.00 | 1.95 | 2.06 | 1.04 | 2.72 | 1.99 | 7.80 |
| Mar-89 | 4.50 | 0.63 | 0.00 | 2.61 | 0.63 | 1.04 | 0.85 | 0.85 | 7.80 |
| Apr-89 | 3.36 | 0.06 | 0.00 | 3.33 | 0.06 | 1.04 | -1.01 | 0.00 | 6.79 |
| May-89 | 4.93 | 2.71 | 0.00 | 4.11 | 2.71 | 1.04 | -0.22 | 0.00 | 6.57 |
| Jun-89 | 5.06 | 3.02 | 0.00 | 4.72 | 3.02 | 1.04 | -0.70 | 0.00 | 5.87 |
| Jul-89 | 7.60 | 17.92 | 0.00 | 4.90 | 17.92 | 1.04 | 1.66 | 0.00 | 7.53 |
| Aug-89 | 2.46 | 0.94 | 0.00 | 4.55 | 0.94 | 1.04 | -3.13 | 0.00 | 4.40 |
| Sep-89 | 6.99 | 12.40 | 0.00 | 3.85 | 12.40 | 1.04 | 2.10 | 0.00 | 6.50 |
| Oct-89 | 5.75 | 13.09 | 0.00 | 2.95 | 13.09 | 1.04 | 1.76 | 0.46 | 7.80 |
| Nov-89 | 3.04 | 0.04 | 0.00 | 2.26 | 0.04 | 1.04 | -0.26 | 0.00 | 7.54 |
| Dec-89 | 3.98 | 3.49 | 0.00 | 1.77 | 3.49 | 1.04 | 1.17 | 0.91 | 7.80 |
| **Annual Totals** | **55.32** | **56.39** | **0.00** | **38.63** | **56.39** | **12.48** | **4.21** | | |

*Assumptions:

1. Model assumes surface runoff flow through the site (i.e.,Si=So) with 5 years in 10 overbank flooding in late winter/early spring from restored stream onsite, and occasional, intermittent overbank flooding from Third Creek.
2. Assumes 6 inches of surface storage on wetland mitigation areas after flooding.
3. Assumes 1.8 inches storage in upper 12 inches of silty clay loam surface soil (using a specific yield of 0.15 for silty clay loam, 0.15 X 12 inches of soil=1.8 inches of water).
4. Total wetland volume=7.8 inches, from above.
5. When wetland volume is <0, water level is below 12-inch jurisdictional soil depth.
6. Surface inputs (Si)=total surrounding watershed inflow to mitigation site.
7. Total watershed area=~1,288ac, total area of mitigation areas=~110ac.

Figures 11-13 graphically depict the Wetland Volume (inches) vs. Date for Tables 2-4 respectively.

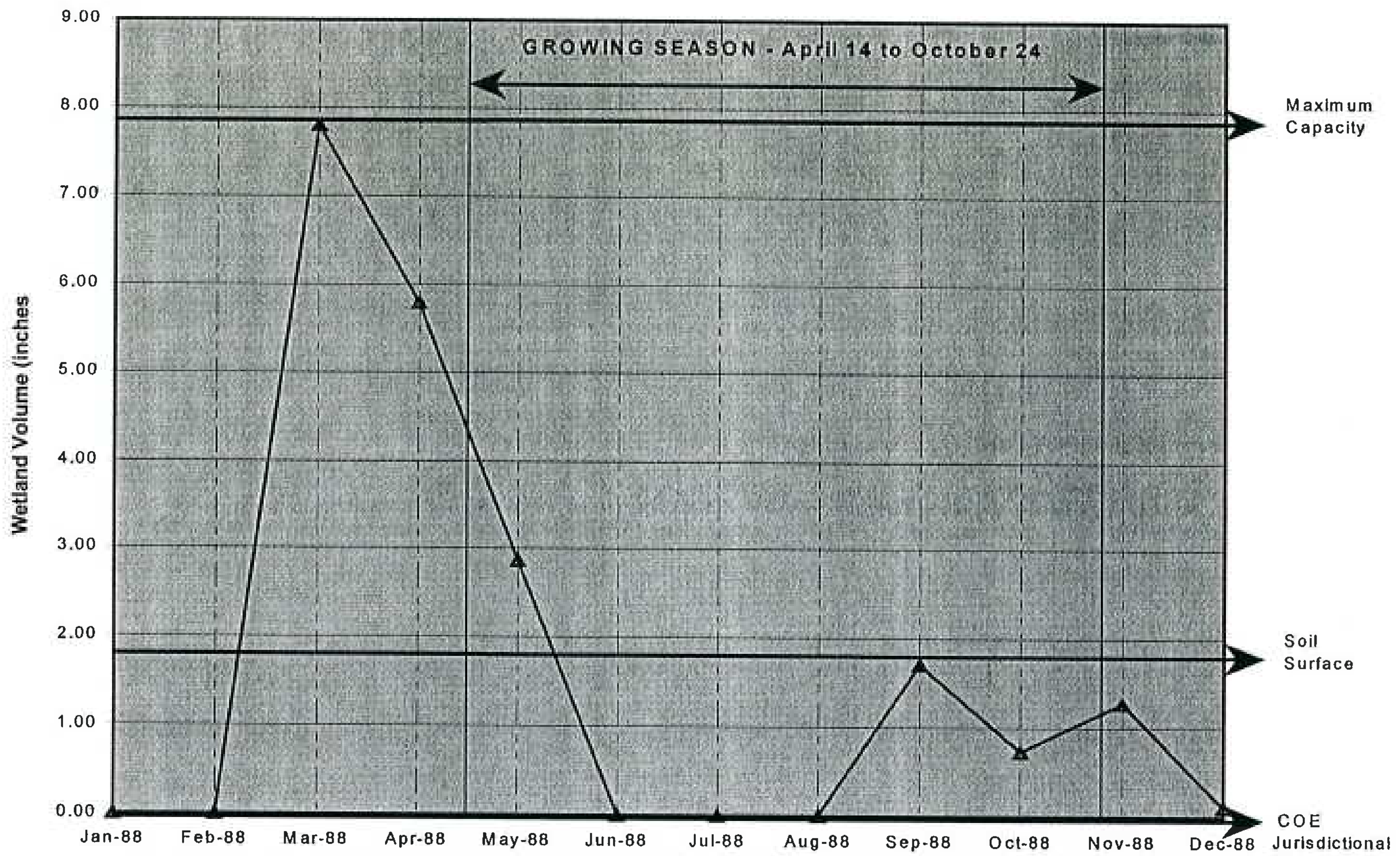


Figure 11. Shepherds Tree Wetland Compensation Site- Dry Year (1988) Hydrograph

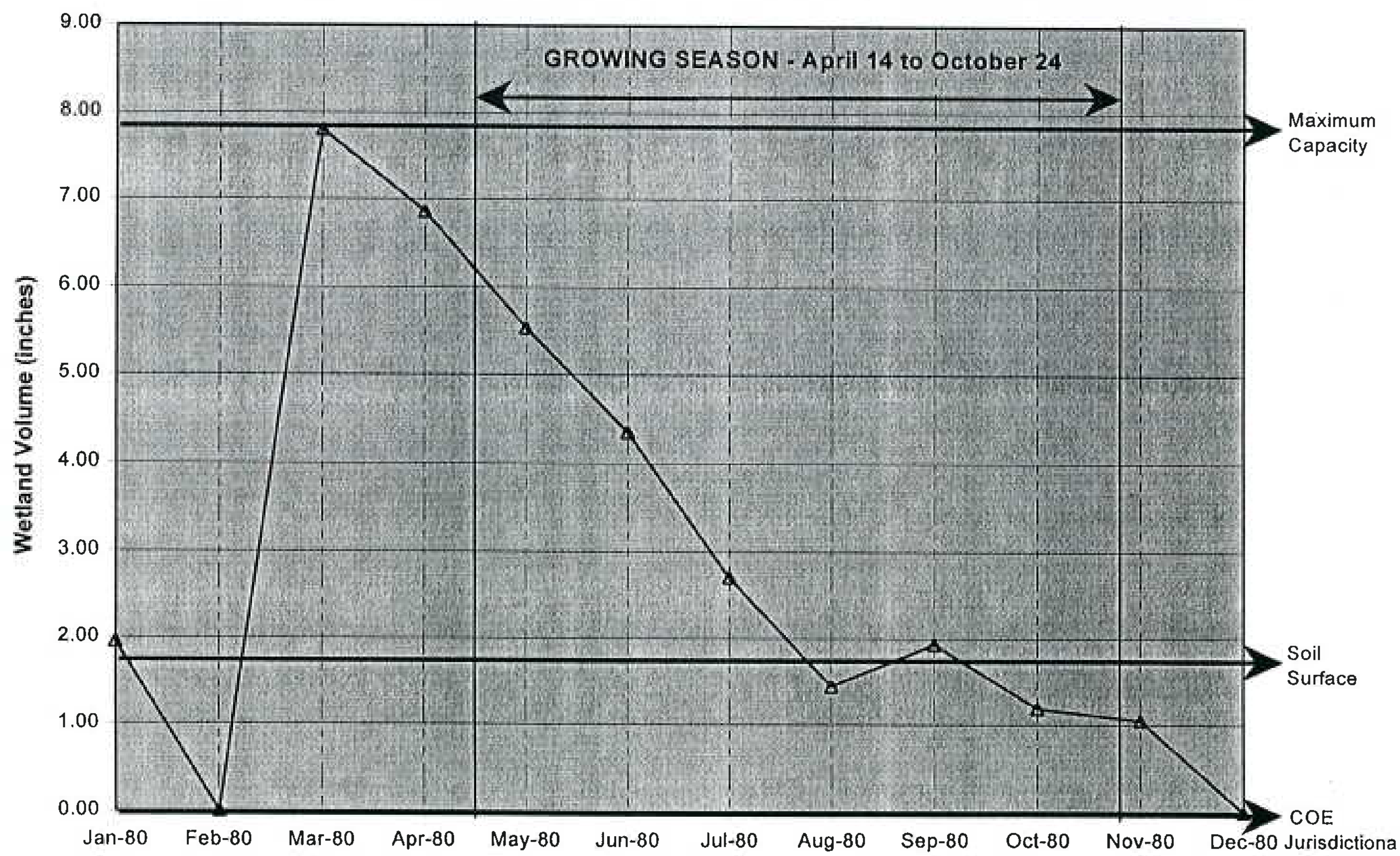


Figure 12 Shepherds Tree Wetland Mitigation Site Average Year (1980) Hydrograph

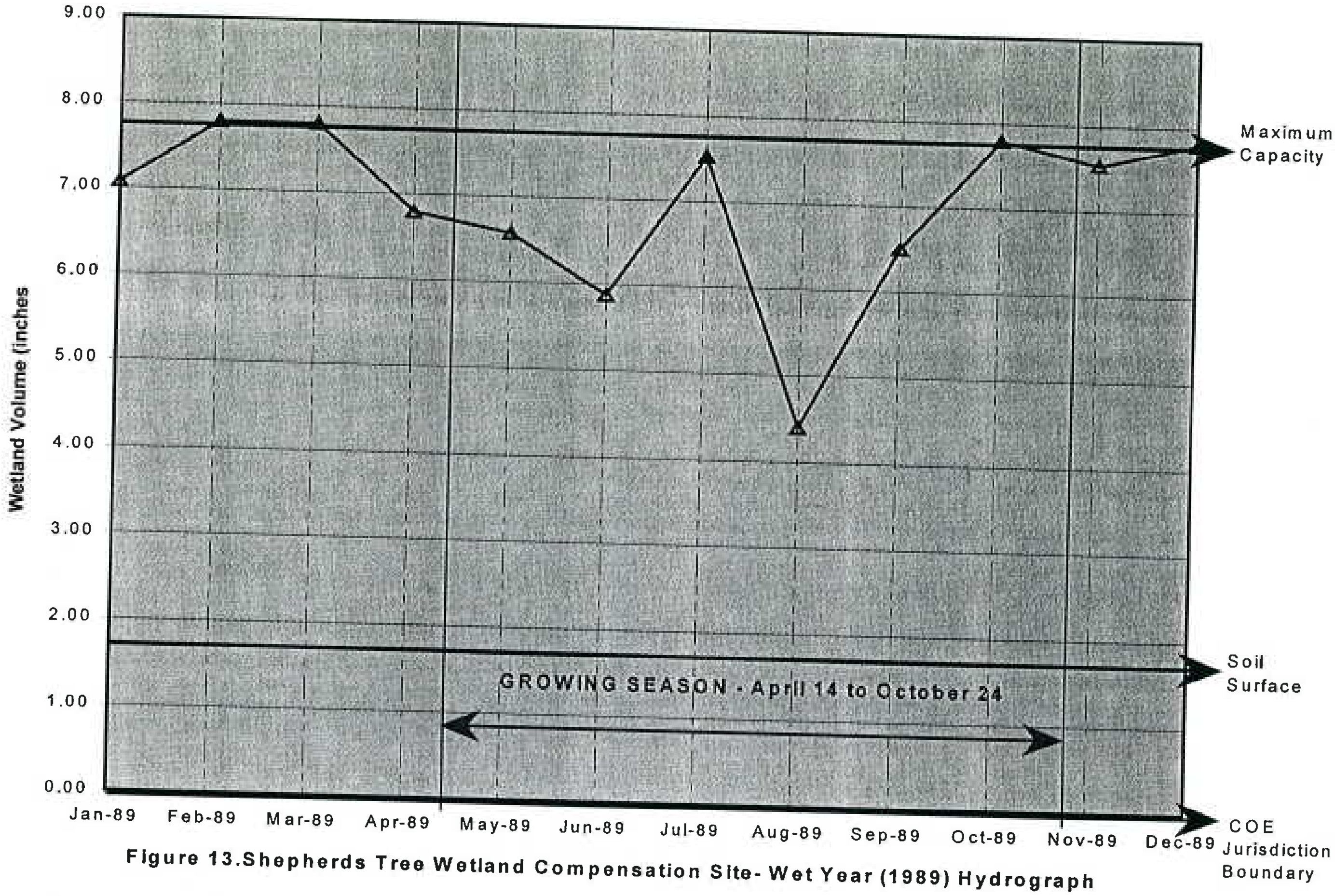


**Figure 13.Shepherds Tree Wetland Compensation Site- Wet Year (1989) Hydrograph**

**Berm Breaching**: The berm adjacent to Third Creek varies from 8 to 15 feet above the stream invert. Based on preliminary calculations, this feature restricts access to the floodplain for flows up to 2075 cfs (Figure 14). In order to allow flooding of the site for flows above bank full (1075cfs), removal of portions of the berm sufficient to allow Third Creek to access its floodplain will be necessary. Four to six breaches will be established and stabilized. Additional breaches may be added to achieve the goal of periodic flooding without excessive deposition of alluvial materials.

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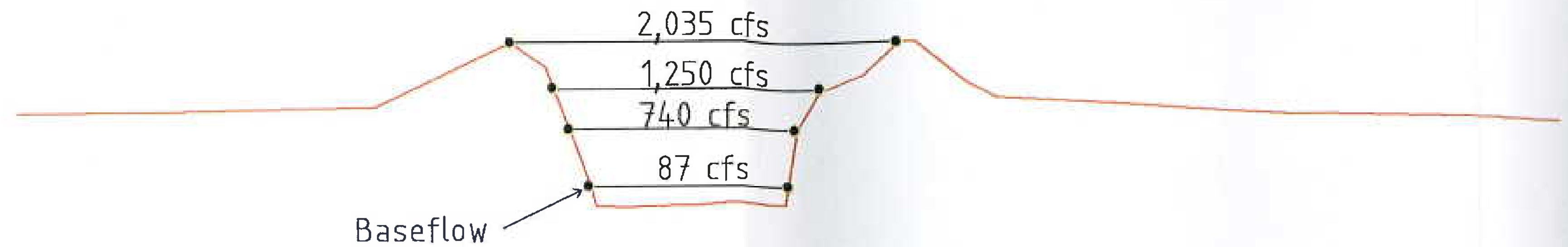


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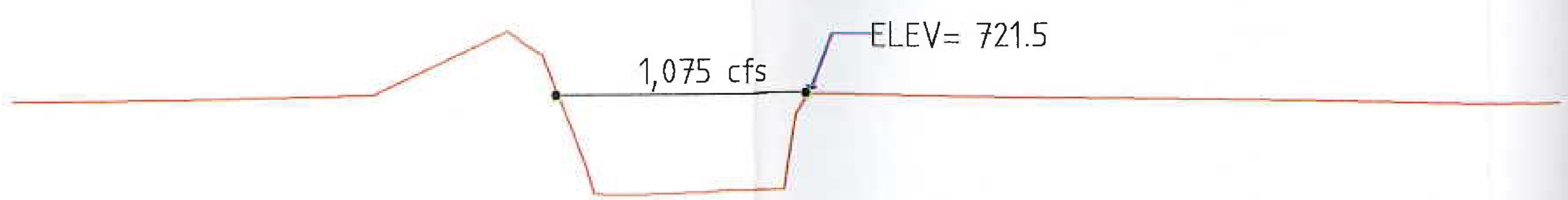


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THIRD CREEK
DISCHARGE
ELEVATIONS

PROJECT NAME :
SHEPHERDS TREE
CONCEPTUAL MITIGATION
PLAN

STATE OF NORTH CAROLINA
DEPT. OF TRANSPORTATION

SHEET TITLE :
FIGURE 14

SHEET NO. :
1 OF 1

KCI JOB NO. : 1298031 F

**Channel/Drainage Alteration**: The stream channel in the swale portion of the site has undergone significant straightening and deepening to increase drainage of the site. This drainage was supplemented by lateral ditches to drain a high groundwater table and adjacent seeps. The network of channels has the capacity to discharge stormwater and groundwater off the site at 38 cfs. Relocation of the channel and removal of the lateral drains is a critical component to restoring the hydraulic integrity of the site. Based on the relief of the site and anticipated discharge, an "E" channel will be designed to replace the existing channel and will inter-connect the proposed communities. At the confluence of this channel and the additional drainage to the north, a "C" channel is anticipated to maintain a stable form (a more detailed description of channel morphology is found in section 3.3). All lateral ditches will be grubbed and filled.

**Grade Alteration**: The topographic variability across the site has been greatly reduced over the last 70 to 100 years due to row crop production. In addition, the entrenchment of Third Creek has influenced the groundwater elevations in the 100' to 300' zone bordering the creek. Restoration of the pre-disturbance profile of Third Creek to re-establish hydrology within this zone would be impractical for both legal and engineering reasons. However, the floodplain grades in this zone can be altered to increase the hydrologic influence from Third Creek based on its existing profile. Grade modifications adjacent to Third Creek are proposed to re-establish a hydrologic interface sufficient to support a Piedmont/Mountain Levee Forest community.

Based on the soils mapping data collected, wetland creation areas adjacent to the restoration areas will be excavated from 6" to 12" to bring hydric soil horizons within 12" of the soil surface and to prolong the hydroperiod of those areas. The hydric nature of the soil profiles in these areas indicate that these areas may have been jurisdictional wetlands at some point historically, before channel migration, channel alteration and site conversion took place. The soil profile evidence of extended hydroperiod within 12" of the soil surface points to the feasibility of these areas for wetland creation. The creation areas are shown in Figure 15.

Additionally, final grading on the site will be undertaken to restore the natural floodplain microtopography and depressions that have been lost due to decades of tillage for agricultural production. Pools and hummocks will be interspersed throughout the system to add diversity and aid in water retention. These pools will vary from 6" to 24" in depth and 0.1 to 0.5 acres in size and will be incorporated as features of the wetland creation areas.

### 3.2.2 Soils

Results of the soil nutrient analysis are listed in Table 7. The site has been in agricultural production for over a century, with likely annual fertilizer applications in more recent years, producing a residual nutrient base from the fertilizer amendments over this extended period. Additionally, the site is located on a floodplain, with relatively high natural inputs of moisture and nutrients. Given these two facts, the site has more than sufficient natural fertility for good hardwood growth.

| TABLE 7 – SOIL NUTRIENT ANALYSIS | | | |
|---|---|---|---|
| **Analysis** | **Soil Series Composite Sample** | | |
| | **Congaree** | **Chewacla** | **Wehadkee** |
| Calcium (mg/100cc) | 42.2 | 74.4 | 130 |
| Copper (mg/100cc) | 0.179 | 0.302 | 0.414 |
| Magnesium (mg/100cc) | 11.3 | 24.2 | 39.1 |
| Manganese (mg/100cc) | 10.4 | 3.78 | 5.97 |
| Phosphorus (mg/100cc) | ND* | ND* | ND* |
| Potassium (mg/100cc) | 8.08 | 4.47 | 10.1 |
| Sodium (mg/100cc) | ND* | 1.70 | 1.14 |
| Zinc (mg/100cc) | 0.034 | 0.095 | 0.342 |
| pH | 4.73 | 5.11 | 6.02 |
| Acidity (Exchangeable) (meq/100cc) | 1.37 | 1.03 | 0.796 |
| Cation Exchange Capacity (meq/100cc) | 4.61 | 6.85 | 10.8 |
| Base Saturation | 70.4% | 85.0% | 92.6% |
| Carbon | 0.57% | 1.28% | 3.07% |
| Hydrogen | 0.47% | 0.52% | 0.50% |
| Nitrogen | 0.077% | 0.140% | 0.189% |

*ND = Not Detected

### 3.2.3 Vegetative Communities

Re-establishment of vegetative communities on site will rely almost entirely on re-introduction of the proposed species through planting and seeding. The proposed communities include: Piedmont/Mountain Levee Forest, Piedmont/Mountain Bottomland Forest, Piedmont/Mountain Swamp Forest, Floodplain Pool, Low Elevation Seep, Mesic Mixed Hardwood Forest (Figure 15). In order to accommodate vegetation height restrictions associated with the easements for the power lines that traverse the site, herbaceous vegetation will be utilized in these areas.

The distribution of the vegetative communities on site has been established based upon an analysis of on-site features, the anticipated anaerobic gradient, and the desired functional goals and objectives. Overall, there is a transition zone from Piedmont/Mountain Levee Forest near Third Creek to Piedmont/Mountain Bottomland Forest over the majority of the floodplain. Piedmont/Mountain Swamp Forest community species will be restored in Wehadkee soils areas (See Fig. 5). Floodplain Pools will be located within the Piedmont/Mountain Bottomland Forest creation areas immediately adjacent to the restoration areas. These pools will hold water during the early spring and serve as breeding grounds for amphibians. They will dry out during the summer months. In addition, Mesic Mixed Hardwood Forest will be restored along upland slopes.

The community-planting plan described below provides a guide for the vegetative re-establishment of the targeted communities. If available, the following species will be planted:

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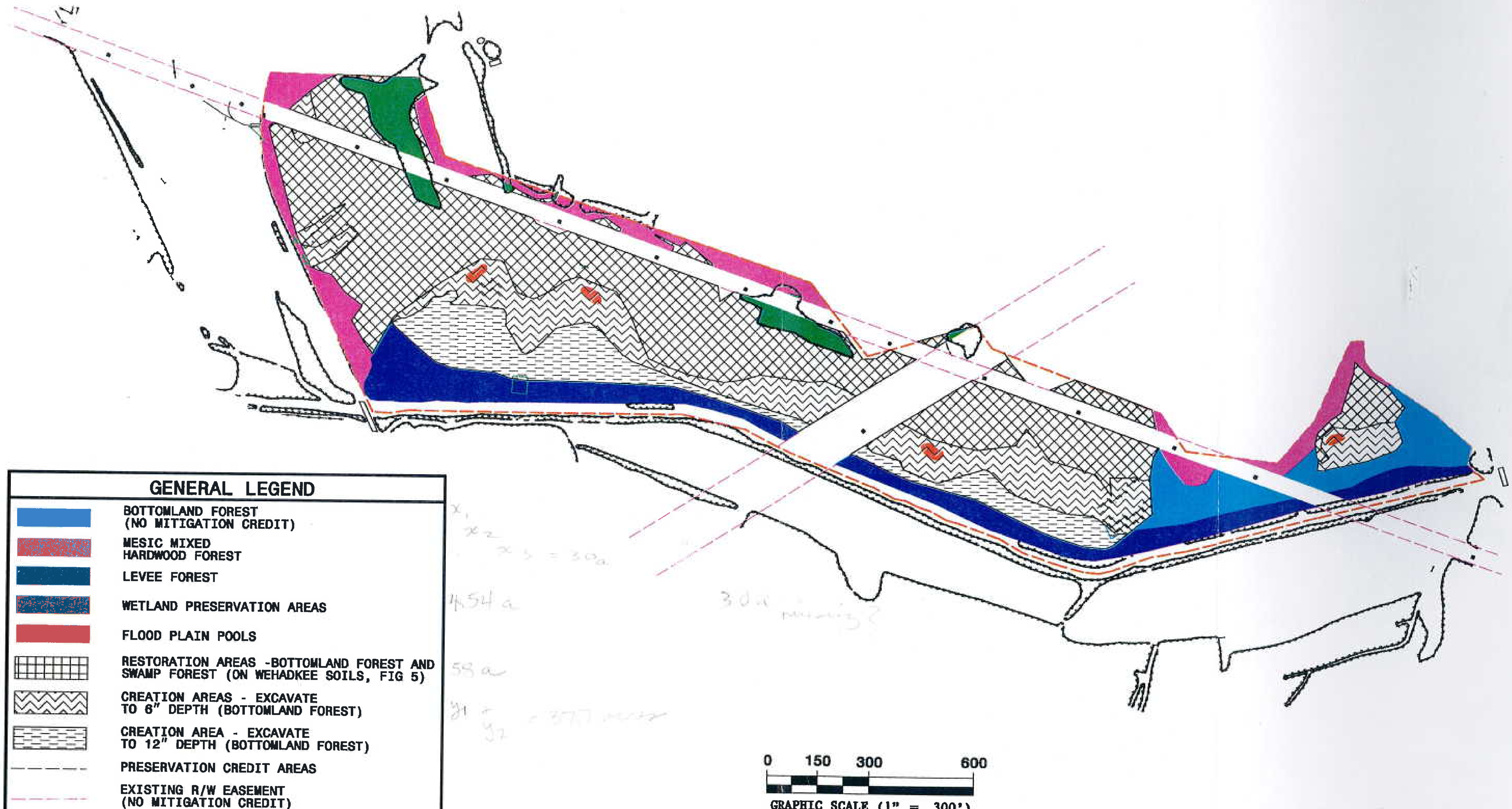


## GENERAL LEGEND

- BOTTOMLAND FOREST (NO MITIGATION CREDIT)
- MESIC MIXED HARDWOOD FOREST
- LEVEE FOREST
- WETLAND PRESERVATION AREAS
- FLOOD PLAIN POOLS
- RESTORATION AREAS -BOTTOMLAND FOREST AND SWAMP FOREST (ON WEHADKEE SOILS, FIG 5)
- CREATION AREAS - EXCAVATE TO 6" DEPTH (BOTTOMLAND FOREST)
- CREATION AREA - EXCAVATE TO 12" DEPTH (BOTTOMLAND FOREST)
- PRESERVATION CREDIT AREAS
- EXISTING R/W EASEMENT (NO MITIGATION CREDIT)
- SITE BOUNDARY

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PLANT COMMUNITIES

PROJECT NAME :

SHEPHERDS TREE
PROPOSED MITIGATION SITE

STATE OF NORTH CAROLINA
DEPT. OF TRANSPORTATION

SHEET TITLE :

FIGURE 15

SHEET NO. :

**Piedmont/Mountain Levee Forest**

Species:

| Scientific Name | Common Name |
|---|---|
| *Fraxinus pennsylvanica* | green ash |
| *Liriodendron tulipifera* | yellow poplar |
| *Platanus occidentalis* | sycamore |
| *Betula nigra* | river birch |
| *Quercus nigra* | water oak |
| *Carpinus caroliniana* | American hornbeam |
| *Acer negundo* | box elder |

Planting Density: 680 Stems per acre
Comments: bare root seedlings

**Piedmont/Mountain Bottomland Forest**

Species:

| Scientific Name | Common Name |
|---|---|
| *Liriodendron tulipifera* | yellow poplar |
| *Quercus michauxi* | swamp chestnut |
| *Quercus falcata* var. *pagodaefolia* | cherrybark oak |
| *Fraxinus pennsylvanica* | green ash |
| *Acer negundo* | box elder |

Planting Density: 680 Stems per acre
Comments: bare root seedlings

**Piedmont/Mountain Swamp Forest**

Species:

| Scientific Name | Common Name |
|---|---|
| *Quercus falcata* var. *pagodaefolia* | cherrybark oak |
| *Fraxinus pennsylvanica* | green ash |
| *Quercus phellos* | willow oak |
| *Quercus michauxi* | swamp chestnut |

Planting Density: 680 Stems per acre
Comments: bare root seedlings

**Floodplain Pool**

Species:

| Scientific Name | Common Name |
|---|---|
| *Alnus serrulata* | tag alder |
| *Cephalanthus occidentalis* | buttonbush |

Planting Density: 400 Stems per acre

| | |
|---|---|
| Comments: | bare root seedlings, planted on outer perimeter of pool. |

**Mesic Mixed Hardwood Forest**

| Species: | **Scientific Name** | **Common Name** |
|---|---|---|
| | *Quercus alba* | white oak |
| | *Quercus rubra* | northern red oak |
| | *Liriodendron tulipifera* | yellow poplar |

| | |
|---|---|
| Planting Density: | 680 Stems per acre |
| Comments: | bare root seedlings. |

**Areas within the Duke Power Easements**

| Species: | **Scientific Name** | **Common Name** |
|---|---|---|
| | *Panicum virgatum* | switchgrass |
| | *Dactylis glomerata* | orchardgrass |
| | *Lespedeza striata* | kobe lespedeza |
| | *Echinochloa crusgalli* | japanese millet |

### 3.3 Stream Restoration

The historic stream network on the site likely provided interconnecting series of perennial and intermittent fluvial features that provided a variety of habitat and water quality benefits. Historic impacts have replaced all natural fluvial features on the site with excavated drainage ditches and berms. The disturbed features provide little or no ecological value and have resulted in a lowering of the groundwater table, water quality degradation, and aquatic and riparian habitat loss. The stream restoration component of this mitigation plan is intended to restore the network of streams and channels that may have once connected the site. Restoring the water quality, habitat and flood cycling functions of the system, and complimenting the natural community types proposed are also components of the stream restoration (Figure 16A & 16B).

Restoration will include on-site re-establishment of perennial and intermittent channels in conjunction with the wetlands restoration. Work will involve channel planform and cross-section modifications, bank stabilization, in-stream feature development and riparian corridor establishment. The stream on the west side of Triplett Road will be relocated onto the site, adding 1.03 square miles of drainage and a perennial discharge to the proposed stream network. This stream is believed to historically flow through the site but was channelized and relocated into its current position adjacent to Triplett Road.

Activities to restore a stable planform, pattern and profile to the perennial and intermittent streams on site are proposed for the subject project. The removal of lateral ditches and the relocation of the primary perennial channel that transects the site are proposed to restore natural channel conditions indicative of an "E5" channel.

### 3.3.1 Planform, Profile, and Cross-section

Morphologic dimensionless ratio design criteria were developed using an analog design or reference reach methodology. An analog design strategy involves using data derived from a channel similar to the project stream when features of the project stream are not longer useful due to disturbance. The objective is to base design improvement of a channel in an undesirable condition upon observed desirable conditions within a similar channel type. Channel dimensions, pattern and profile are measured on a stable reference site and used to develop quantitative dimensionless ratios from which the restoration design is based.

A level II stream classification, according to the methodologies outlined in Applied River Morphology (Rosgen, 1996), was performed on a selected reference reach. For this project, the selected reference site is located in the Pee Dee National Wildlife Refuge. Selection of this site is appropriate due to its association with bottomland hardwood communities and similarity of geographic characteristics (i.e. geology, landscape position, topographic relief, watershed land use and land cover) of the project site. The resulting design criteria in which the final design will be developed can be found in Table 8.

| PROJECT REFERENCE NO. |
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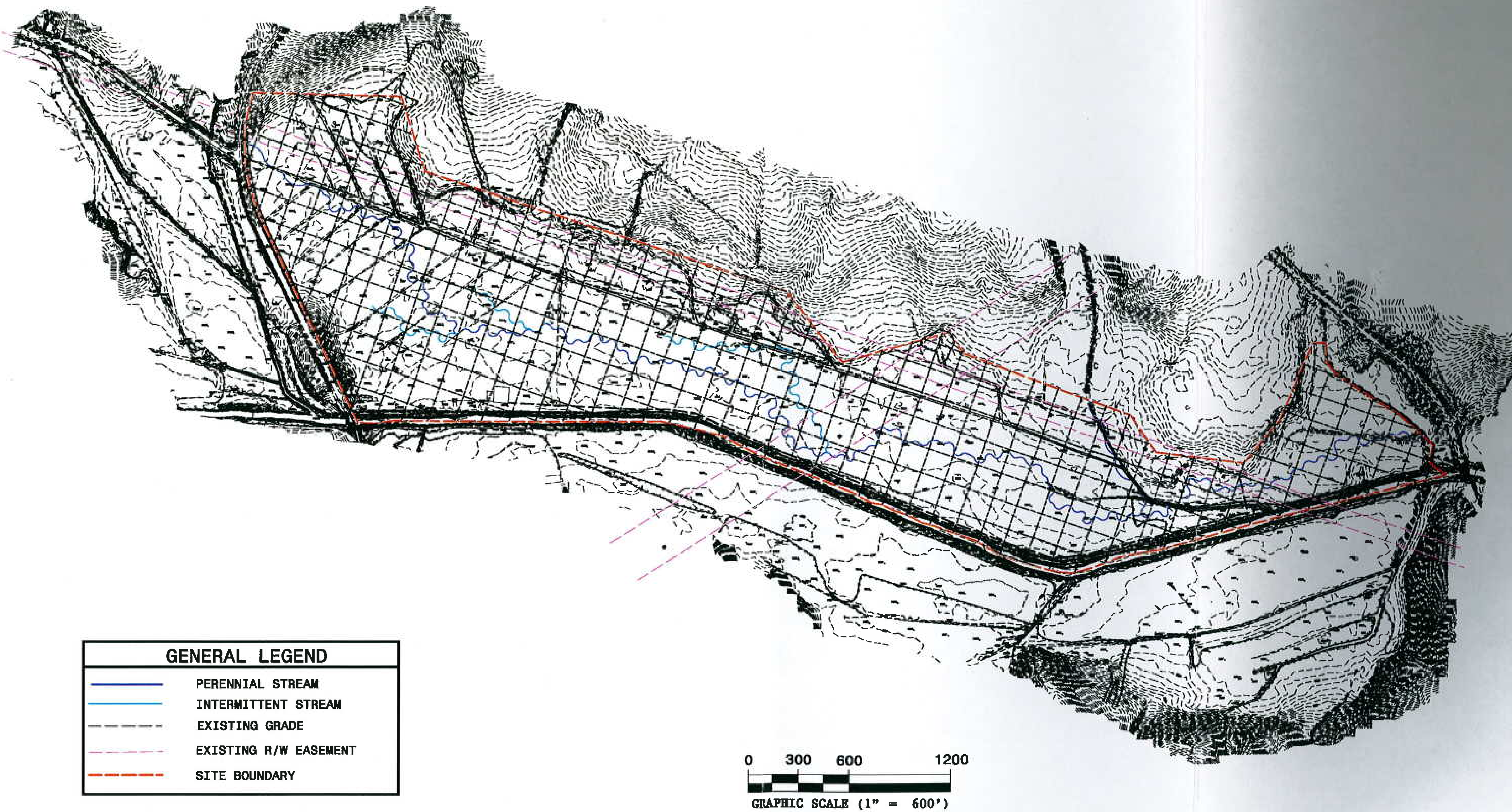


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| DRAWN BY : - | | | SHEET TITLE : FIGURE 16 |
| CHECKED BY : - | | | SHEET NO. : 1 OF 1 |
| | | | KCI JOB NO. : 1298031F |

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| 6 | - | |

| Table 8 - *MORPHOLOGICAL DESIGN CRITERIA* | | | | |
|---|---|---|---|---|
| | ***Variables*** | **Project Site Existing Channel*** | **Reference Reach** | **Project Site Restored Reach**** |
| | Stream Type | | E5 | E5 |
| | Drainage Area ($mi^2$) | | 0.37 | 1.03 |
| | Bankfull Width ($W_{bkf}$) | | 6.8-7.4' | 10.2' |
| | Bankfull Mean Depth ($d_{bkf}$) | | 1.31' | 1.85' |
| | Bankfull Cross-Sectional Area ($A_{bkf}$) ($ft^2$) | | 9.0-9.6 | 18.7 |
| | Width/Depth Ratio ($W_{bkf}/d_{bkf}$) | | 5.2-5.6 | 5.4 |
| | Bankfull Max Depth ($d_{mbkf}$) | | 1.63-1.79' | 2.7' |
| | Width of Floodprone Area ($W_{fpa}$) | | > 100' | > 100' |
| | Entrenchment Ratio (ER) | | > 10.0 | > 5.0 |
| | Channel Materials (D50) (mm) | | Fine Sand | Fine Sand |
| | Water Surface Slope (S) | | 0.49-0.64% | 0.40% |
| | Sinuosity (K) | | 1.36 | 1.3-1.5 |
| *Dimension* | Pool Depth (dp) | | 1.9-2.8' | 2.7-3.1' |
| | Riffle Depth (dr) | | 1.11-1.57' | 1.6-2.2' |
| | Ratio - Max. Pool Depth:Mean Bkf. Depth | | 1.65 | 1.65 |
| | Bankfull mean velocity (u) (ft./sec.) | | 3.2-3.5 | 3.6 |
| | Bankfull discharge (Q) (CFS) | | 30.7-31.6 | 68.0-70.0 |
| *Pattern* | Meander Length ($L_m$) | | 77-100.7' | 114-138' |
| | Radius of Curvature ($R_c$) | | 13.1-22.3' | 19.5-30.6' |
| | Belt Width ($W_{blt}$) | | 51-92' | 85' |
| | Meander Width Ratio (MWR) | | 5.2-12.5 | 4.2 |
| | Ratio- Rad. of Curv.:Bkf Width ($R_c/W_{bkf}$) | | 1.93-3.03 | 1.93-3.03 |
| | Ratio- Meander Length:Bkf Width ($L_m/W_{bkf}$) | | 11.3-13.7 | 11.3-13.7 |
| *Profile* | Valley Slope (ft./ft.) | | 0.57% | 0.18% |
| | Water Surface Slope (ft./ft.) | | 0.42% | .15-.17% |
| | Riffle Slope (ft./ft.) | | 0.6-2.0% | .6-2.0% |
| | Pool Slope (ft./ft.) | | 0.08-0.18% | .08-.018% |
| | Pool to Pool Spacing (ft.) | | 26-65' | 57-69 |
| | Pool Length (ft.) | | 13-22' | 20'-29' |
| | Ratio - Pool Slope:Water Surface Slope | | 0.19-0.43 | 0.19-0.43 |
| | Ratio - Pool to Pool Spacing:Bkf width | | 6.8 | 2.82-3.42 |

* Existing stream channel on site has no representative features due to extensive human disturbance.

** Ratios and dimensions to be adjusted to compensate for additional drainage of downstream component

### 3.3.2 Bank Stabilization

Bank stabilization of the restored streams will rely exclusively on appropriate geomorphic design supplemented by bioengineering, as opposed to structural and bio-technical techniques. Utilizing live plant materials and degradable erosion control fabrics, this technology serves to establish good initial stability, while allowing for gradual channel deformation and geometry adjustment resulting from dynamic fluvial processes. Numerous types and combinations of bioengineering techniques are available for bank stabilization. The preliminary restoration design illustrates some types that may be most appropriate for application to this site.

### 3.3.3 Riparian Vegetation Establishment

Re-establishment of riparian vegetation will consist of planting and seeding in the riparian zone of each channel to provide additional habitat and water quality in the riparian zone. The materials installed in these zones will be in addition to any required bioengineering needed to stabilize the channel itself. The riparian zones of the restored streams will be a sub-component of the overall community type in which they are found. The zone of riparian influence for vegetation establishment will be:

| | |
|---|---|
| Perennial | 30' |
| Intermittent | 15' |

Within these zones, the following planting plan will be utilized to establish a dense planting of shrubs and trees to provide habitat and water quality value as the site evolves. If available, the following species will be planted:

**Trees**

| Species: | **Scientific Name** | **Common Name** |
|---|---|---|
| | *Betula nigra* | river birch |

**Shrubs**

| Species: | **Scientific Name** | **Common Name** |
|---|---|---|
| | *Cornus amomum* | silky dogwood |
| | *Salix nigra* | black willow |
| | *Sambucus canadensis* | elderberry |
| | *Itea virginica* | Virginia willow |

Planting Density: 680 Stems per acre

Comments: All trees should be 12"-18" bare root material or live stakes where appropriate.
All shrubs should be 12"-18" bare root material or live stakes where appropriate.

## 4.0 WETLAND AND STREAM MANAGEMENT ACTIVITIES

### 4.1 Construction Sequencing

| Activity | Status/Anticipated Completion date |
|---|---|
| Site acquisition | Completed |
| Preliminary site preparation | On-going |
| Site design | On-going |
| Site construction | Summer 2001 |
| Site planting | Spring 2002 |

An "as built" report will be submitted to the COE within 90 days of the completion of planting and gauge installation and will include elevations, photographs, gauge locations, and a description of initial species composition by community and sampling plot locations. Included within the report will be a list of species planted, planting densities and a total number of stems in the mitigation area. This information will form the basis for further monitoring and evaluation.

### 4.2 Monitoring and Success Criteria

The monitoring program will be implemented to document system development and progress towards achieving mitigation goals and objectives. Vegetative data will be correlated with the appropriate hydrologic data from the groundwater monitoring gauges to determine if these objectives are being met. If, after the completion of five growing seasons, jurisdictional status has not been achieved where desired, or the desired vegetation has not been established, NCDOT will implement appropriate corrective measures. The stream restoration and stabilization techniques implemented and the wetland communities established will be monitored to determine if the criteria for success have been achieved. Photographs will be taken once a year at the permanent photograph stations.

#### 4.2.1 Hydrology

The success of a wetland mitigation project is largely driven by the hydrology of the site, which incorporates groundwater elevation with surface water flows to maintain soil saturation for a defined period of time. The Army Corps of Engineers in the 1987 Manual define an area a wetland if the soil is ponded, flooded, or saturated within 12 inches of the surface, for at least 8% of the growing season (15 days) in a normal year. A "normal" year, based on NRCS climatological data for Iredell County, must receive an annual rainfall of between 42 and 49 inches. Hydrologic success will be considered if the COE criteria is met.

In order to determine if the COE criteria are achieved, automated groundwater monitoring gauges will be installed in each post-mitigation community type. These gauges will be provided and maintained by the NCDOT to monitor hydrologic fluctuations in the water table. Gauge installation will follow the COE standard methods (WRP Technical Note HY-IA3.1, August 1993). In order to determine if the annual rainfall is "normal" for the given year, rainfall amounts will be tallied using data obtained from the closest NOAA gauge station, or a rain gauge will be installed onsite. Hydrologic monitoring will continue for 5 years following the construction of the wetland mitigation.

### 4.2.2 Vegetation

Recovery and restoration of the vegetation on a wetland mitigation site is dependent upon hydrology and soil saturation. Vegetative succession is also influenced by active planting of vegetation as well as volunteer encroachment. The success criteria will incorporate the assumption that exact species composition and other natural changes cannot be strictly controlled under natural conditions.

#### 4.2.2.1 Tree Seedlings

NCDOT will monitor the wetland mitigation areas for five years following construction. A 320 stems per acre survival criterion for planted seedlings and natural recruitment of target species will be used to determine success for the first three years. The required survival criterion will decrease by 10% per year after the third year of vegetation monitoring (i.e., for an expected 290 stems per acre for year 4, and 260 stems per acre for year 5).

#### 4.2.2.2 Shrubs

NCDOT will monitor the site for five years. A 320 stems per acre survival criterion for planted seedlings and natural recruitment of target species will be used to determine success for the first three years. The required survival criterion will decrease by 10% per year after the third year of vegetation monitoring (i.e., for an expected 290 stems per acre for year 4, and 260 stems per acre for year 5).

Prior to planting, the mitigation area will be inspected for proper elevation and soil suitability. Permanent vegetation sampling plots 50'x50' and photograph stations will be established within each community type. Beginning at the end of the first growing season, and each subsequent year, species composition and density will be evaluated between August and November for five subsequent years. Remedial action will be taken as needed to rectify problems throughout the monitoring period.

#### 4.2.2.3 Stream Areas

The monitoring plan establishes the methodology for measuring physical and biological parameters of the restored stream and for evaluating the success of the restoration based on the results of the monitoring data. NCDOT will monitor the streams in accordance with USACE protocol. Additionally, monitoring will follow the most recent internal guidance from the North Carolina Department of Environment and Natural Resources (NCDENR), specifically NCDENR's **Internal Technical Guide for Streamwork in North Carolina** (Version 3.0, April 2001) and the **Interim, Internal Technical Guide: Benthic Macroinvertebrate Monitoring Protocols for Compensatory Stream Restoration Projects** (NC Division of Water Quality, 401/Wetlands Unit, May 2001).

# 5.0 OTHER ECOLOGICAL AND NON-ECOLOGICAL CONCERNS

## 5.1 Historical/Archaeological

Available records were reviewed by the North Carolina Department of Cultural Resources on December 14, 1998 to determine the presence of historic preservation sites or sites of archaeological importance on or near the subject site. No structures of historical or archaeological importance listed on the National Register of Historic Places (NRHP) were noted on the subject property or adjacent areas. However, two surveyed archaeological sites were noted adjacent to the subject site. The sites are significant enough to warrant further investigation according to David Brook, Deputy State Historic Preservation Officer, NC Department of Cultural Resources.

The archaeological survey that was recommended by NC Cultural Resources was completed in April 1999. As result of the recommended pedestrian survey and test pit excavations, a total of seven prehistoric archaeological sites were identified within the boundaries of the site. Six of the seven identified archaeological sites did not meet requirements to be recommended eligible for the NRHP. However, one of the seven archaeological sites was recommended as eligible for the NRHP. The site earthwork plans were reviewed and amended to avoid all areas of archaeological concern. Through the identification of the archaeological sites and the avoidance of earthwork within those identified areas, it is not anticipated that the project will impact any cultural / archaeological resources.

## 5.2 Utilities/Easements

Deed records of the subject property were reviewed at the Iredell County Register of Deeds Office on December 8, 1998. The Shepherds Tree site has Duke Power right of way (ROW) easements associated with two high-tension transmission lines which intersect within the subject site boundaries. The easement widths vary from 100 feet to 270 feet depending on the size of the transmission lines. Access to the towers can not be denied; however, trees and shrubs may be planted within the easement if they do not exceed 15 feet in height at maturity (Appendix 3). A review of the pertinent deed and plat information regarding the right of way easements associated with transmission lines that intersect the property was conducted on 1/21/99. The deed and plat information was provided by Duke Energy (Appendix 4).

NCDOT has been in contact with Duke Energy and is currently developing a memorandum of agreement regarding the maintenance of the power line easements across the site. A preliminary memorandum of agreement has been established which establishes the maintenance guidelines for these areas.

- The broad scale application of herbicide in the right of ways will not be conducted.
- Low volume foliar application of herbicide will be allowed to control volunteer trees, invasive species and excessive vegetation growth within the right of way, to the extent necessary to preserve the integrity and reliability of the line.

- Removal of trees adjacent to the right of way will be restricted to only those that may impact the power line if felled.
- Mowing in the right of ways will be restricted to that required for maintenance of existing lines and construction of new facilities.
- In the event of an emergency Duke Energy reserves the right to conduct operations as necessary to resolve the situation.

### 5.3 Rare, Threatened, and Endangered Species (RTE)

Available records were reviewed at the North Carolina Department of Parks and Recreation, Natural Heritage Program, on December 14, 1998 to determine the presence of any rare, threatened, or endangered (RTE) species on or near the subject property. Currently no records of RTE species have been observed. However, after restoration portions of the site may be suitable habitat for the bog turtle (*Clemmys muhlenbergi)*, a state endangered species.

## 6.0 DISPENSATION OF PROPERTY

NCDOT is in the process of soliciting conservation groups and natural resource agencies (public or private) for final dispensation of its properties. However, until an acceptable agreement can be reached with an appropriate recipient of the property, ownership of the mitigation site will remain with NCDOT. Deed restrictions will be included upon transfer to a recipient to insure that the property remains as conservation land in perpetuity. In any event, NCDOT accepts responsibility at the present time for development and long term management of the site.

# REFERENCES


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