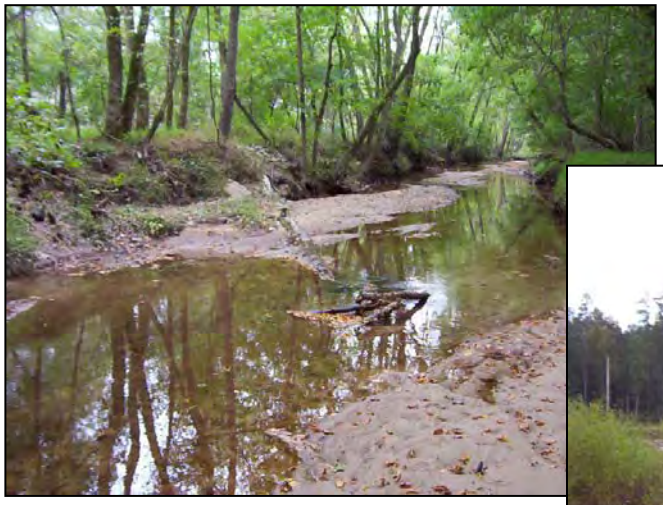
# SANDY CREEK STREAM ENHANCEMENT AND WETLAND RESTORATION SITE

**2006 Annual Monitoring Report (Year 3)**

**Durham County**
**EEP Project No. 322**
**Design Firm: Becky L. Ward Consulting**



**January 2007**

**Prepared for: NCDENR/ ECOSYSTEM ENHANCEMENT PROGRAM**
**1619 Mail Service Center**
**Raleigh, NC 27699-1619**

**Prepared by: ECOSCIENCE CORPORATION**
**1101 Haynes Street, Suite 101**
**Raleigh, NC 27604**

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## 1.0 EXECUTIVE SUMMARY

The Sandy Creek Stream Enhancement and Wetland Restoration Site (Site) was selected to mitigate impacts to Section 404 jurisdictional areas associated with the extension of Martin Luther King, Jr. Parkway (Parkway) between Cook road and Hope Valley Road in Durham County. The impacts of the Parkway on jurisdictional wetlands and non-wetland jurisdictional waters totaled 1.73 acres near Third Fork Creek. The Site provides 3.6 acres of restoration and creation as mitigation for the impacts. The Ecosystem Enhancement Program (EEP) will be using the remaining 1.87 acres as mitigation for other impacts within the Cape Fear River Basin. In addition to the wetland restoration, Sandy Creek has been enhanced with the installation of log vanes. The log vanes are intended to create pool features that will enhance habitat and water quality along 2,700 linear feet of stream.

Site construction and planting was completed in June 2003. The Site was partially replanted In January 2004. The 2006 monitoring report represents the third year of vegetation and hydrological monitoring. The Site must demonstrate both hydrologic and vegetation success for a minimum of five years or until the Site is deemed successful. The following paragraphs summarize the results of the monitoring that has occurred during the third year of monitoring at the Site.

**Vegetation Monitoring**
Vegetation success criteria for the wetland restoration areas include a minimum survival of 260 stems per acre of planted species at the end of Year 5. In addition, six planted species must survive throughout the Site. Four of the five vegetation plots achieved the density criterion for success at the Site. However, since only three planted species were recorded in the aggregated vegetation plots, the Site as a whole fails the diversity criterion.

Low survival of many of the planted species can be attributed to flooding at Plot 4 (located in an on-site pond) and invasive exotics at plot 5. The surviving stems are most likely volunteer individuals of the planted species recruited from the surrounding woods. Initial plantings were previously reported to be largely destroyed by geese, and this event is assumed to be responsible for low species diversity at the site at Year 2. Poor soil composition (Urban land soils occupy approximately 5.5 acres of the Site) is another factor in poor survival.

**Stream Enhancement Monitoring**
The log vanes in Sandy Creek were observed and evaluated for stability and effectiveness. The vanes appear stable with no visible signs of breaching. Vegetation has established on the depositional areas behind the vane arms at many locations. The banks adjacent to all the vanes were stable and showed no evidence of erosion. However, the enhancement of bed form from the installation of these vanes is not currently evident. Based on cursory observations, the high sediment load in the stream has not allowed pools to form behind any of the structures. The thalweg appears to meander from each storm event with no discernable bed features throughout the reach. The permanent cross-section survey and pebble counts show no significant change over the past year.

**Wetland Hydrology Monitoring**
The 2006 hydrologic monitoring results indicate continued hydrologic success within the Site. All three on-site groundwater monitoring gauges exhibited saturation within 12 inches of the ground surface for at least 12.5 percent (consecutive days) of the growing season (March 30 – November 11 or 227 days).

## 2.0 PROJECT BACKGROUND

### 2.1 LOCATION AND SETTING

The Site is located adjacent to Sandy Creek Park (future Sandy Creek Environmental Education Center) in Durham, North Carolina near the intersection of Highway 15-501 Bypass / 15-501 Business (Figure 1). Site directions: from Raleigh, follow I-40 west to Highway 15-501. Take Highway 15-501 north approximately 2 miles. Pass under 15-501 Bypass and turn left onto Tower Boulevard. Take Tower Boulevard until it dead ends at Pickett Road. Turn left. Sandy Creek Road will be on the left directly after crossing over 15-501 Bypass. Take Sandy Creek Road to the end and enter into the Sandy Creek Park. The entrance to the wetland restoration area is accessed by following the greenway trail (Sandy Creek Trail) to a dilapidated bridge crossing over Sandy Creek. The stream enhancement reach begins approximately 1525 feet upstream of the bridge and ends approximately 1175 feet downstream of the bridge at the stream culverts located under Highway 15-501.

### 2.2 MITIGATION STRUCTURE AND OBJECTIVES

The Site occupies areas once used by the defunct New Hope Creek Wastewater Treatment Facility owned by the City of Durham (City). As part of a park and greenway development plan the City Parks and Recreation Department removed existing structures including piping, control buildings, and fencing of the existing sludge drying beds located west of Sandy Creek within the proposed wetland restoration area. Prior to construction of the wetland project, the City had completed phase one of the Sandy Creek Trail, a greenway trail located along the east side of Sandy Creek. Demolition of the treatment plant east of Sandy Creek continued concurrently with the wetland and stream restoration project.

The objectives of this project are to restore habitat and water quality in Sandy Creek and restore the abandoned sludge drying bed locations to riparian wetlands. The restored wetland ecosystem will provide quality habitat and food for wildlife, as well as buffer and water storage benefits within the Sandy Creek watershed.

**Wetland Restoration Activities**

The area proposed for wetland restoration was excavated as an extension of existing ponds and vegetated wetlands located adjacent to the Site (Figure 2, Appendix A). The wetland was designed so that a broad berm set at the elevation of the seasonal high water table of the pond (262.0 feet) separates the restored wetland into two sections. The southern section ties into the grade of the existing wetland and slopes gradually up to the berm. From the berm the ground gradually slopes down to the north into a depression that stores run-off from adjacent slopes and floodwaters from Sandy Creek. In the middle of the depression, an elevated island was constructed to allow for various vegetation assemblages. Following the completion of earthwork the Site was planted with native tree and shrub species.

**Stream Enhancement Activities**

Thirteen log vane structures were placed along 2700 linear feet of Sandy Creek. The log vanes consisted of two hardwood trees, stacked together to form each structure. The logs were secured together with rebar and tied with cables at both ends. Vegetation was planted on the banks to stabilize the disturbance created during installation. Additional modifications to the channel included regrading and stabilizing a small section of bank directly above the culverts located under Highway 15-501 and the removal of fallen trees and debris to improve flow conditions.


EcoScience Corporation
Raleigh, North Carolina

# SITE LOCATION
## Sandy Creek Stream Enhancement and Wetland Restoration Site
Durham County, North Carolina

| | |
|---|---|
| Dwn. by: | MAF |
| Ckd by: | JWG |
| Date: | DEC 2006 |
| Project: | 06-282.03 |

FIGURE 1

| Exhibit Table I. Project Mitigation Structure and Objectives<br>Sandy Creek Stream Enhancement and Wetland Restoration Site / EEP Project No. 322 | | | | | |
|---|---|---|---|---|---|
| **Project Segment or Reach ID** | **Mitigation Type** | **Approach** | **Linear Footage or Acreage** | **Stationing** | **Comments** |
| Reach I | EII | SSS | 2700 linear feet | 00+00 to 27+00 | Primarily achieved with placement of log vanes |
| Wetland Restoration | R | - | 3.6 acres | NA | |

R = Restoration
EI = Enhancement I
EII = Enhancement II
S = Stabilization
P1 = Priority I
P2 = Priority II
P3 = Priority III
SSS = Stream Bank Stabilization

## 2.3 PROJECT HISTORY AND BACKGROUND

| Exhibit Table II. Project Activity and Reporting History<br>Sandy Creek Stream Enhancement and Wetland Restoration Site / EEP Project No. 322 | | | |
|---|---|---|---|
| **Activity Report** | **Scheduled Completion** | **Data Collection Complete** | **Actual Completion or Delivery** |
| Restoration Plan | NA* | NA* | NA* |
| Final Design (90%) | NA* | NA* | NA* |
| Construction | NA* | NA* | Jun 2003 |
| Temporary S&E mix applied to entire project area | NA* | NA* | NA* |
| Permanent seed mix applied to reach/segments | NA* | NA* | NA* |
| Bare Root Seedling Installation | NA* | NA* | NA* |
| Mitigation Plan / As-builts (Year 0 Monitoring – baseline) | NA* | Jun 2003 | Oct 2003 |
| Year 1 Monitoring | NA* | May 2004 | NA* |
| **Site Replanting (portions of Zone 3)** | NA* | NA* | Mid 2004 |
| Year 1 Monitoring re-sampling | NA* | Sep 2004 | Dec 2004 |
| Year 2 Monitoring (Vegetation) | Dec 2005 | Oct 2005 | Dec 2005 |
| Year 2 Monitoring (Groundwater Gauges) | Dec 2005 | Oct 2005 | Dec 2005 |
| Year 3 Monitoring (Vegetation) | Dec 2006 | Nov 2006 | Dec 2006 |
| Year 2 Monitoring (Groundwater Gauges) | Dec 2006 | Nov 2006 | Dec 2006 |

Bolded items represent those events or deliverables that are variable. Non-bolded items represent events that are standard over the course of a typical project.

*NA – Historical project documents necessary to provide this data were unavailable at the time of this report submission.

| Exhibit Table III. Project Contacts<br>Sandy Creek Stream Enhancement and Wetland Restoration Site / EEP Project No. 322 | |
|---|---|
| **Designer**<br><br>Becky L. Ward Consulting | Ms. Becky Ward<br>1512 Eglantyne Court<br>Raleigh, NC 27613<br>(919) 870-0526 |
| **Construction Contractor**<br><br>Shamrock Environmental, Inc | Mr. Greg Kiser<br>6106 Corporate Park Drive<br>Browns Summit, NC 27214<br>(336) 375-1989 |
| **Planting Contractor** | NA* |
| **Seeding Contactor** | NA* |
| Seed Mix Sources | NA* |
| Nursery Stock Suppliers | NA* |
| **Monitoring Performers** | EcoScience Corporation<br>1101 Haynes Street, Suite 101<br>Raleigh, NC 27604<br>(919) 828-3433 |
| Stream Monitoring POC | Jens Geratz |
| Vegetation Monitoring POC | Elizabeth Scherrer |
| Wetland Monitoring POC | Craig Terwilliger |

*NA – Historical project documents necessary to provide this data were unavailable at the time of this report submission.

| Exhibit Table IV. Project Background<br>Sandy Creek Stream Enhancement and Wetland Restoration Site / EEP Project No. 322 | |
|---|---|
| Project County | Durham |
| Drainage Area | 7.3 square miles to culvert at Bypass 15-501 |
| Impervious cover estimate (%) | 10 percent |
| Stream Order | 3rd order |
| Physiographic Region | Piedmont |
| Ecoregion (Griffith and Omernik) | Triassic Basin |
| Rosgen Classification of As-built | NA (Enhancement only) |
| Cowardin Classification | Stream (R3UB2) |
| | Wetlands (PFO1) |
| Dominant soil types | Stream - Chewacla and Wehadkee soils (Ch) |
| | Wetlands - Urban Land (Ur) |
| SCO #ID | 010542301 |
| USGS HUC for Project and Reference | 03030002060110 / NA |
| NCDWQ Sub-basin for Project and Reference | 03-06-05 / NA |
| NCDWQ classification for Project and Reference | C, NSW / NA |
| Any portion of any project segment 303d listed? | No |
| Any portion of any project segment upstream of a 303d listed segment? | No |
| Reasons for 303d listing or stressor | NA |
| Percent of project easement fenced | None |

*NA – Historical project documents necessary to provide this data were unavailable at the time of this report submission.

## 3.0 PROJECT MONITORING AND RESULTS

### 3.1 VEGETATION ASSESSMENT

#### 3.1.1 Soil Data

| Exhibit Table V. Preliminary Soil Data<br>Sandy Creek Stream Enhancement and Wetland Restoration Site / EEP Project No. 322 | | | |
|---|---|---|---|
| **Series** | **Max Depth (in.)** | **% Clay on Surface** | **OM %** |
| Mayodan sandy loam (MfC, MfD) | 60 | 5-20 | 0.5-2 |
| Chewacla and Wehadkee soils (Ch) | 80 | 5-20 | 1-5 |
| Urban land (Ur) | -- | -- | -- |
| White Store sandy loam (WsC) | 50 | 5-20 | 0.5-2 |

#### 3.1.2 Vegetation Problem Areas

| Exhibit Table VI. Vegetative Problem Areas | | | |
|---|---|---|---|
| | | | |
| **Feature / Issue** | **Station # / Range** | **Probable Cause** | **Photo #** |
| Bare Floodplain | Vegetation Plot 4 | Flooding from pond creation; | 4 |
| Poor Survival | Vegetation Plot 5 | Invasive exotics | 5, 5a |

A vegetation problem area plan view and photos are provided in Appendix B.

#### 3.1.3 Stem Counts

Plots are marked with 1.25-inch PVC pipes. Stem counts were conducted for all woody species, including volunteer species. An inventory of planted species is given in Exhibit Table VII. A tally of volunteer woody species is listed in Exhibit Table VIIa. Success criteria include a minimum survival of 260 stems per acre of planted species at the end of Year 5. In addition, 6 planted species must survive throughout the site.

| Exhibit Table VIIa: Stem Counts for Each Species Arranged by Plot | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **Plots** | | | | | **Year 3 Totals** | Year 0 Totals | Year 1 Totals | Year 2 Totals | **Survival %** |
| | 1 | 2 | 3 | 4 | 5 | | | | | |
| *Acer rubrum* | | | 4 | | | **4** | 30 | 12 | 4 | **13** |
| *Alnus serrulata* | | | | | | **0** | 1 | | | **0** |
| *Betula nigra* | | | | | | **0** | 2 | 5 | | **0** |
| *Carya ovata* | | | | | | **0** | 4 | | | **0** |
| *Cephalanthus occidentalis* | | | | | | **0** | 2 | | | **0** |
| *Fraxinus pennsylvanica* | 89 | 32 | 7 | | | **128** | 16 | 104 | 148 | **800** |
| *Liriodendron tulipifera* | | | | | | **0** | 9 | 2 | | **0** |
| *Nyssa sylvatica* | | | | | | **0** | 5 | | | **0** |
| *Quercus lyrata* | | | | | | **0** | 5 | 3 | | **0** |
| *Quercus phellos* | | | | | | **0** | 14 | 3 | 3 | **21** |
| *Salix nigra* | 67 | 10 | 5 | | 6 | **88** | 5 | 73 | 108 | **1760** |
| *Sambucus canadensis* | | | | | | **0** | 11 | 1 | | **0** |
| *Viburnum nudum* | | | | | | **0** | 8 | 3 | | **0** |

Low survival of many of the planted species can be attributed to flooding at Plot 4 (located in an on-site pond) and invasive exotics at plot 5. The surviving stems are most likely volunteer individuals of the planted species recruited from the surrounding woods. Initial plantings were previously reported to be largely destroyed by geese, and this event is assumed to be responsible for low species diversity at the site at Year 2. Poor soil composition (Urban land soils occupy approximately 5.5 acres of the Site) is another factor in poor survival. High occurrences of *Fraxinus pennsylvanica* and *Salix nigra* are likely due to volunteer individuals of planted species. The original planted species could not be differentiated from the volunteers for any identified species in Table 7.

Plot 4 is the only vegetation plot to fail the density criterion for success at the Site. However, since only three planted species were recorded in the aggregated vegetation plots, the Site as a whole fails the diversity criterion.

| Exhibit Table VIIb. Stem Counts for Volunteer Species Arranged by Plot | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Species | **Plots** | | | | | **Year 3 Totals** | Year 0 Totals | Year 1 Totals | Year 2 Totals |
| | 1 | 2 | 3 | 4 | 5 | | | | |
| *Acer negundo* | | 1 | | | | **1** | 2 | | 1 |
| *Celtis laevigata* | | 1 | | | | **1** | | | 1 |
| *Cornus amomum* | | | | 2 | | **2** | 2 | | 2 |
| *Gleditsia triacanthos* | | | | | | | | 1 | |
| *Liquidambar styraciflua* | | | 6 | | | **6** | | 1 | 6 |
| *Platanus occidentalis* | | | | | | | | 2 | 1 |
| *Populus deltoides* | | | | | | | | 2 | |
| *Ulmus americana* | | | | | | | | 1 | |

An inventory of herbaceous species on the site was also taken. Dominant herbaceous species over the site as a whole are listed below:

*Andropogon virginicus* (broomsedge)
*Aster dumosus* (frost aster)
*Boehmeria cylindrica* (false nettle)
*Carex* spp. (sedges)
*Cyperus strigosus* (straw-colored flatsedge)
*Eleocharis* sp. (spikerush)
*Eupatorium capillifolium* (dog fennel)
*Juncus effusus* (soft rush)
*Lespedeza cuneata* (sericea lespedeza)
*Ludwigia alternifolia* (seedbox)
*Pluchea* sp. (marsh fleabane)
*Polygonum saggitatum*. (tearthumb)
*Polygonum* sp. (smartweed)
*Scirpus cyperinus* (woolgrass bulrush)
*Solanum carolinense* (horsenettle)
*Solidago* sp. (goldenrod)
*Sorghum halapense* (Johnson grass)
*Typha latifolia* (common cattail)

## 3.2 STREAM ASSESSMENT

### 3.2.1 Bankfull Events

| Exhibit Table VIII. Verification of Bankfull Events<br>Sandy Creek Stream Enhancement and Wetland Restoration Site / EEP Project No. 322 | | | |
|---|---|---|---|
| **Date of Data Collection** | **Date of Occurence** | **Method** | **Photo Number** |
| 01/12/07 | 12/26/06 | Photographed evidence on-site | 1,2 |

### 3.2.2 Bank Stability Assessment

| Exhibit Table IX. BEHI and Sediment Export Estimates<br>Sandy Creek Stream Enhancement and Wetland Restoration Site / EEP Project No. 322 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Time Point** | **Segment/ Reach** | **Linear Feet** | **Extreme** | | **Very High** | | **High** | | **Moderate** | | **Low** | | **Very Low** | | **Sediment Export** |
| | | | **ft** | **%** | **ft** | **%** | **ft** | **%** | **ft** | **%** | **ft** | **%** | **Ft** | **%** | **Tons/year** |
| 3rd year monitoring | Reach 1 Above Bridge | 1770 | -- | -- | -- | -- | -- | -- | 1770 | 100 | -- | -- | -- | -- | 63.4 |
| 3rd year monitoring | Reach 2 Below Bridge | 1093 | -- | -- | -- | -- | -- | -- | 1015 | 93 | 75 | 7 | -- | -- | 42.6 |
| 3rd year monitoring | Project Total | 2863 | -- | -- | -- | -- | -- | -- | 2785 | 97 | 75 | 3 | -- | -- | 106.0 |

### 3.2.3 Stream Problem Areas

| Exhibit Table X. Stream Problem Areas<br>Sandy Creek Stream Enhancement and Wetland Restoration Site / EEP Project No. 322 | | | |
|---|---|---|---|
| **Feature Issue** | **Station Numbers** | **Suspected Cause** | **Photo Number** |
| Aggradation/Bar Formation | 00+00 to 27+00 | Excessive sediment load from upstream sources | 3 |

A stream problem area plan view and photos of problem areas are provided in Appendix C.

| Exhibit Table XI. Categorical Stream Feature Visual Stability Assessment<br>Sandy Creek Stream Enhancement and Wetland Restoration Site / EEP Project No. 322<br>Segment/Reach: 2,700 feet | | | | | | |
|---|---|---|---|---|---|---|
| **Feature** | **Initial** | **MY-01** | **MY-02** | **MY-03**** | **MY-04** | **MY-05** |
| A. Riffles | NA* | NA* | 0% | 0% | | |
| B. Pools | NA* | NA* | 0% | 0% | | |
| C. Thalweg | NA* | NA* | 0% | 0% | | |
| D. Meanders | NA* | NA* | 100% | 100% | | |
| E. Bed General | NA* | NA* | 0% | 0% | | |
| F. Log Vanes | NA* | NA* | 100% | 100% | | |

*NA – Historical project documents necessary to provide this data were unavailable at the time of this report submission.

**The riffles, pools, thalweg, and bed features at Sandy Creek are continuously changing due to the sandy composition of the streambed. None of these features are considered visually stable.

| Exhibit Table XIII. Morphology and Hydraulic Monitoring Summary<br>Sandy Creek Stream Enhancement and Wetland Restoration Site / EEP Project No. 322 | | | | | |
|---|---|---|---|---|---|
| **Parameter** | **Cross-Section 1** | | | | |
| **Dimension** | **MY-01** | **MY-02** | **MY-03** | **MY-04** | **MY-05** |
| **BF Width (ft)** | NA* | **28.8** | **29.5** | | |
| **Floodprone Width (ft)** | NA* | **>500** | **>500** | | |
| **BF Cross Sectional Area (ft)** | NA* | **75.1** | **92.7** | | |
| **BF Mean Depth (ft)** | NA* | **2.6** | **3.1** | | |
| **Width/Depth Ratio (ft)** | NA* | **11** | **9.4** | | |
| **Entrenchment Ratio (ft)** | NA* | **>2.2** | **>2.2** | | |
| **Wetted Perimeter (ft)** | NA* | **32.7** | **34.0** | | |
| **Hydraulic Radius (ft)** | NA* | **2.3** | **2.7** | | |
| **Substrate** | | | | | |
| **d50 (mm)** | **0.61** | **0.58** | **0.58** | | |
| **d84 (mm)** | **1.5** | **0.98** | **0.98** | | |

*NA – Historical project documents necessary to provide this data were unavailable at the time of this report submission.

## 3.3 WETLAND ASSESSMENT

| Exhibit Table XIV. Wetland Criteria Attainment<br>Sandy Creek Stream Enhancement and Wetland Restoration Site / EEP Project No. 322 | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Tract** | **Well ID** | **Well Hydrology Threshold Met?** | **Tract Mean** | **Vegetation Plot ID** | **Vegetation Density Met (260 stems/acre)** | **Diversity Met? (6 species)** | **Tract Mean** |
| 1 | A | ✓ (13%) | 15% of growing season | P1 | ✓ (7800) | 2 | Failed because of lack of diversity |
| 1 | B | ✓ (13%) | | P2 | ✓ (2100) | 4 | |
| 1 | C | ✓ (19%) | | P3 | ✓ (800) | 5 | |
| REF | Ref Site | (4%) | | P4 | (0) | 0 | |
| | | | | P5 | ✓ (300) | 1 | |

A wetland problem area plan view is provided in Appendix D.

**Appendix A**
(Click here)

# APPENDIX A

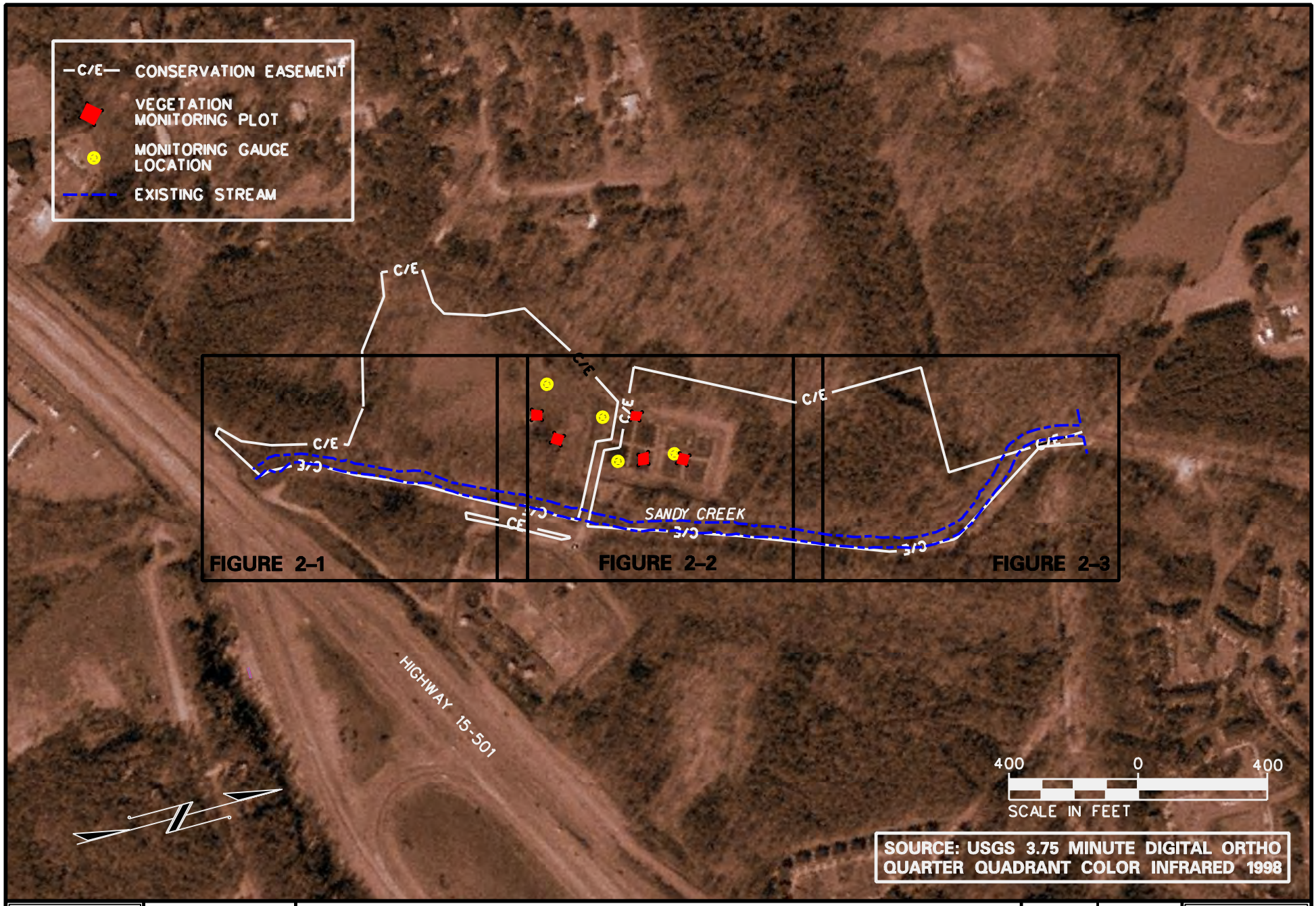
# FIGURES


EcoScience Corporation
Raleigh, North Carolina

# SITE LOCATION
## Sandy Creek Stream Enhancement and Wetland Restoration Site
Durham County, North Carolina

| | |
|---|---|
| Dwn. by: | MAF |
| Ckd by: | JWG |
| Date: | DEC 2006 |
| Project: | 06-282.03 |

FIGURE 1




EcoScience Corporation
Raleigh, North Carolina

Client: Ecosystem Enhancement Program

Project:

# SHEET INDEX

## Sandy Creek Stream Enhancement and Wetland Restoration Site

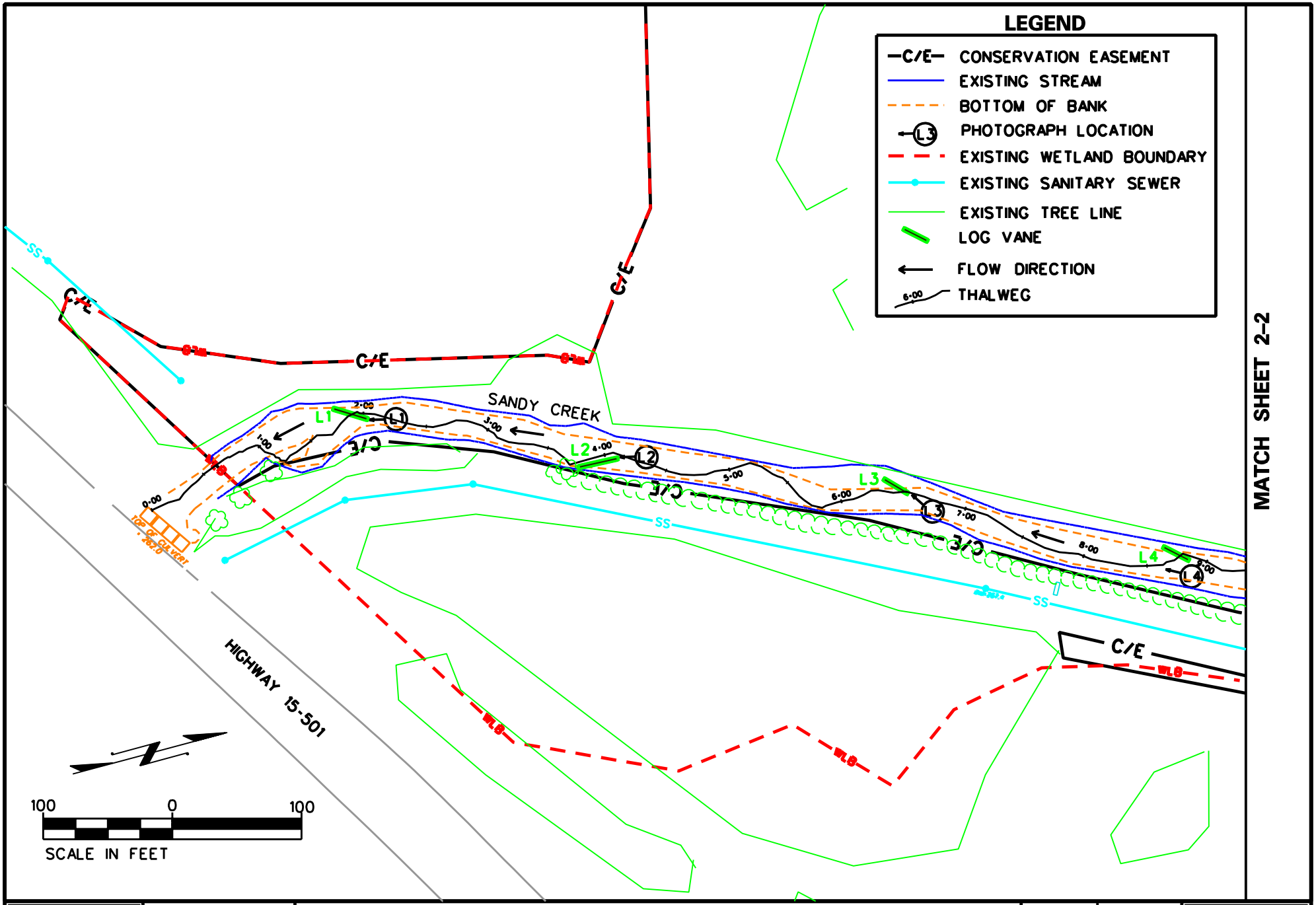
**EEP Project No. 322**

DURHAM COUNTY, NORTH CAROLINA

| | |
|---|---|
| Dwn By: GWN | Date: DEC 2006 |
| Ckd By: JWG | Scale: 1" = 400' |
| ESC Project No.: 06.282.03 | |

FIGURE

**2**




EcoScience Corporation
Raleigh, North Carolina

Client: Ecosystem Enhancement Program

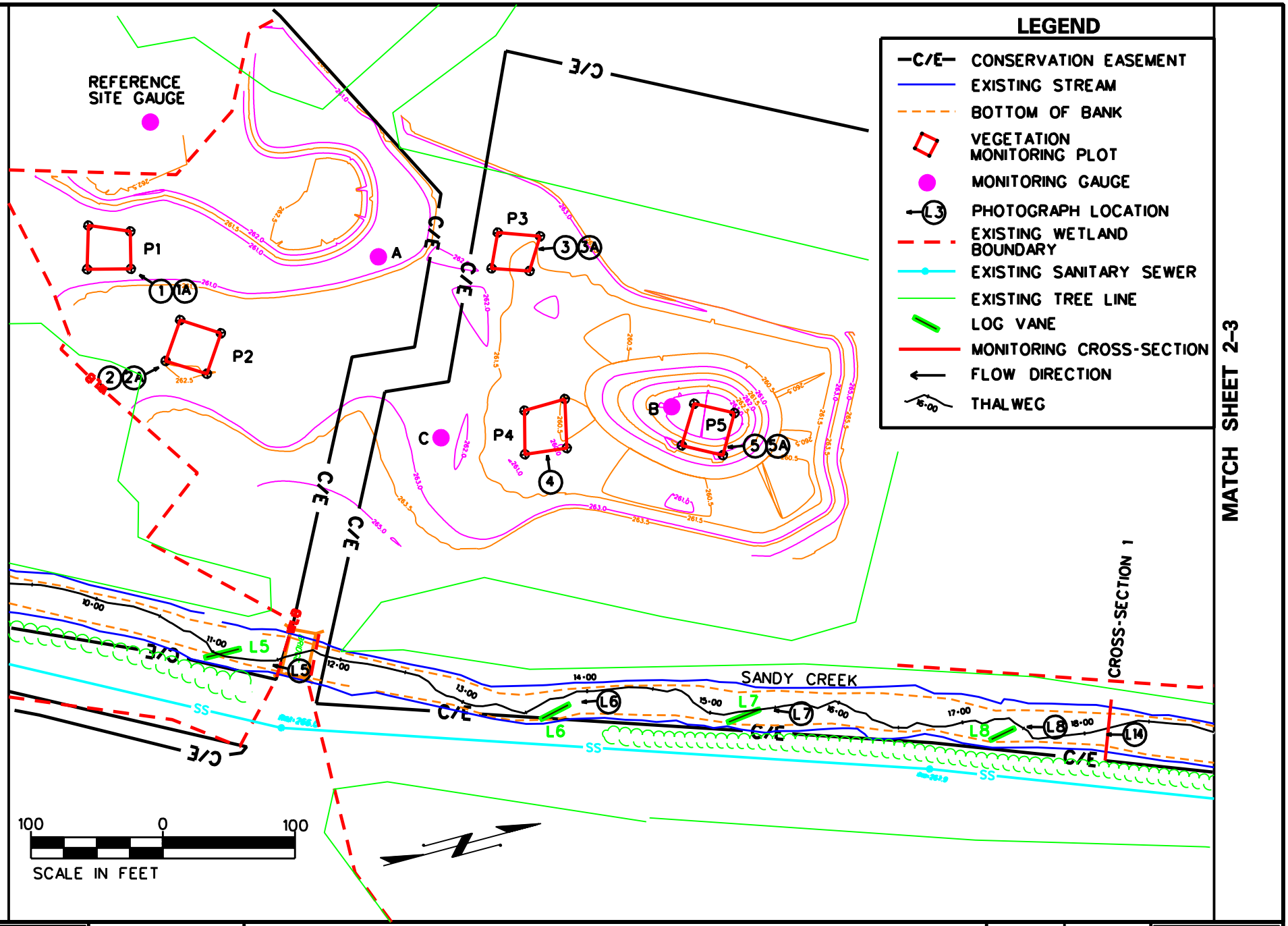
Project:

# MONITORING PLAN VIEW
## Sandy Creek Stream Enhancement and Wetland Restoration Site

**EEP Project No. 322**
DURHAM COUNTY, NORTH CAROLINA

| | |
|---|---|
| Dwn By: GWN | Date: JAN 2007 |
| Ckd By: JWG | Scale: 1" = 100' |
| ESC Project No.: 06.282.03 | |

FIGURE
**2-1**




EcoScience Corporation
Raleigh, North Carolina

Client: Ecosystem Enhancement Program

Project:

# MONITORING PLAN VIEW

## Sandy Creek Stream Enhancement and Wetland Restoration Site

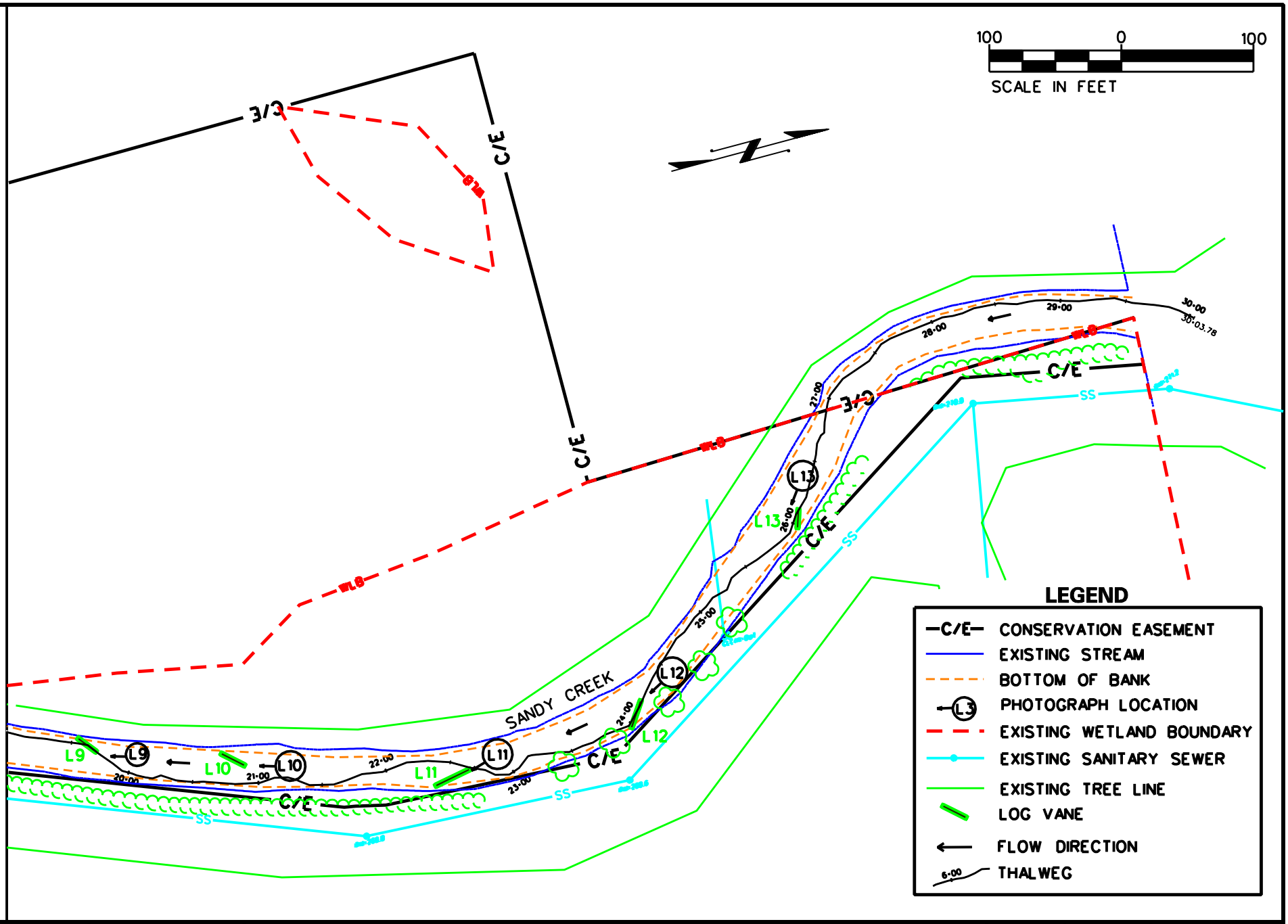
## EEP Project No. 322

DURHAM COUNTY, NORTH CAROLINA

| Dwn By: | Date: |
|---|---|
| GWN | JAN 2007 |
| Ckd By: | Scale: |
| JWG | 1" = 100' |
| ESC Project No.: | |
| 06-282.03 | |

FIGURE

2-2




EcoScience Corporation
Raleigh, North Carolina

Client: Ecosystem Enhancement Program

Project:

# MONITORING PLAN VIEW
## Sandy Creek Stream Enhancement and Wetland Restoration Site

**EEP Project No. 322**

DURHAM COUNTY, NORTH CAROLINA

| Dwn By: | Date: |
|---|---|
| GWN | JAN 2007 |
| Ckd By: | Scale: |
| JWG | 1" = 100' |
| ESC Project No.: | |
| 06-282.03 | |

FIGURE
2-3

**Appendix B**
(Click here)

# APPENDIX B

# VEGETATION DATA

60 0 60
SCALE IN FEET

SOURCE: USGS 3.75 MINUTE DIGITAL ORTHO QUARTER QUADRANT COLOR INFRARED 1998

* PLANTING ZONES SHOWN ARE APPROXIMATE. ZONE ACREAGES PROVIDED BY BECKY L. WARD CONSULTING, AS-BUILT AND MONITORING REPORT, SEPT. 2003.

## LEGEND

- C/E — CONSERVATION EASEMENT
- EXISTING STREAM
- L6 — PHOTOGRAPH LOCATION
- VEGETATION MONITORING PLOT (Criteria Not Met)
- EXISTING WETLAND BOUNDARY
- EXISTING TREE LINE

PLANTING ZONES *

- ZONE 1 (0.60 ac.)
- ZONE 2 (1.14 ac.)
- ZONE 3 (1.86 ac.)
- ZONE 8 (1.12 ac.)

P1 P2 P3 P4 P5

C/E

SANDY CREEK

EcoScience Corporation
Raleigh, North Carolina

REVISIONS

Client: Ecosystem Enhancement Program

Project:
**SANDY CREEK STREAM ENHANCEMENT AND WETLAND RESTORATION SITE**

**EEP Project No. 322**
DURHAM COUNTY, NORTH CAROLINA

Title:
**VEGETATION PROBLEM AREAS**

| Dwn By: | Date: |
|---|---|
| GWN | DEC 2006 |
| Ckd By: | Scale: |
| JWG | 1"=60' |

ESC Project No.: 06-282.03

FIGURE
**B**

**Sandy Creek Stream and Wetland Restoration Site**
**Year 3 Monitoring**
Data collected 8/23/06
0.02-acre plots

| | Plots | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **Year 3 Total** | **Survival %** | **Year 2 Total** | **Year 1 Total** | **Year 0 Total** |
| **Acer rubrum** | | | 4 | | | **4** | **13** | 4 | 12 | 30 |
| **Alnus serrulata** | | | | | | **0** | **0** | | | 1 |
| **Betula nigra** | | | | | | **0** | **0** | | 5 | 2 |
| **Carya ovata** | | | | | | **0** | **0** | | | 4 |
| **Cephalanthus occidentalis** | | | | | | **0** | **0** | | | 2 |
| **Fraxinus pennsylvani** | 89 | 32 | 7 | | | **128** | **800** | 148 | 104 | 16 |
| **Liriodendron tulipifera** | | | | | | **0** | **0** | | 2 | 9 |
| **Nyssa sylvatica** | | | | | | **0** | **0** | | | 5 |
| **Quercus lyrata** | | | | | | **0** | **0** | | 3 | 5 |
| **Quercus phellos** | | | | | | **0** | **0** | 3 | 3 | 14 |
| **Salix nigra** | 67 | 10 | 5 | | 6 | **88** | **1760** | 108 | 73 | 5 |
| **Sambucus canadensis** | | | | | | **0** | **0** | | 1 | 11 |
| **Viburnum nudum** | | | | | | **0** | **0** | | 3 | 8 |
| | 156 | 42 | 16 | 0 | 6 | **220** | | 263 | 206 | 112 |
| **Density** | 7800 | 2100 | 800 | 0 | 300 | | | | | |
| **Average density** | 2200 | | | | | | | | | |

| **Volunteers** | Plots | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **Year 3 Total** | **Year 2 Total** | **Year 1 Total** | **Year 0 Total** |
| **Acer negundo** | 1 | 1 | | | | **2** | | | 2 |
| **baccharis** | 4 | | 1 | | | **5** | | | |
| **Celtis laevigata** | | | | | | **0** | | | |
| **Cornus amomum** | | 1 | | 3 | | **4** | | | 2 |
| **Gleditsia triacanthos** | | | | | | **0** | | 1 | |
| **Liquidambar styraciflua** | | | 8 | | | **8** | | 1 | |
| **Pinus taeda** | | | 7 | | | **7** | | 0 | |
| **Platanus occidentalis** | | 1 | | | | **1** | | 2 | |
| **Populus deltoides** | | | | | | **0** | | 1 | |
| **Ulmus americana** | | | | | | **0** | | | |
| | 4 | 2 | 16 | 3 | 0 | **27** | 0 | 5 | 2 |

**REPRESENTATIVE VEGETATION PROBLEM AREAS**

Photo 1. Poor Tree Establishment and Recruitment

Photo 2. Poor Tree Survival

Photo 3. Poor Tree Survival

Vegetation Plot 1 – Sandy Creek Wetland Restoration

Photo 1

Photo 1A

The above pictures were taken on August 23, 2006, after three seasons of growth on-site.

Vegetation Plot 2 – Sandy Creek Wetland Restoration

Photo 2

Photo 2A

The above pictures were taken on August 23, 2006, after three seasons of growth on-site.

Vegetation Plot 3 – Sandy Creek Wetland Restoration

Photo 3

Photo 3A

The above pictures were taken on August 23, 2006, after three seasons of growth on-site.

Vegetation Plot 4 – Sandy Creek Wetland Restoration

Photo 4

The above picture was taken on August 23, 2006, after three seasons of growth on-site. The water remained in this area throughout the year.

Vegetation Plot 5 – Sandy Creek Wetland Restoration

Photo 5

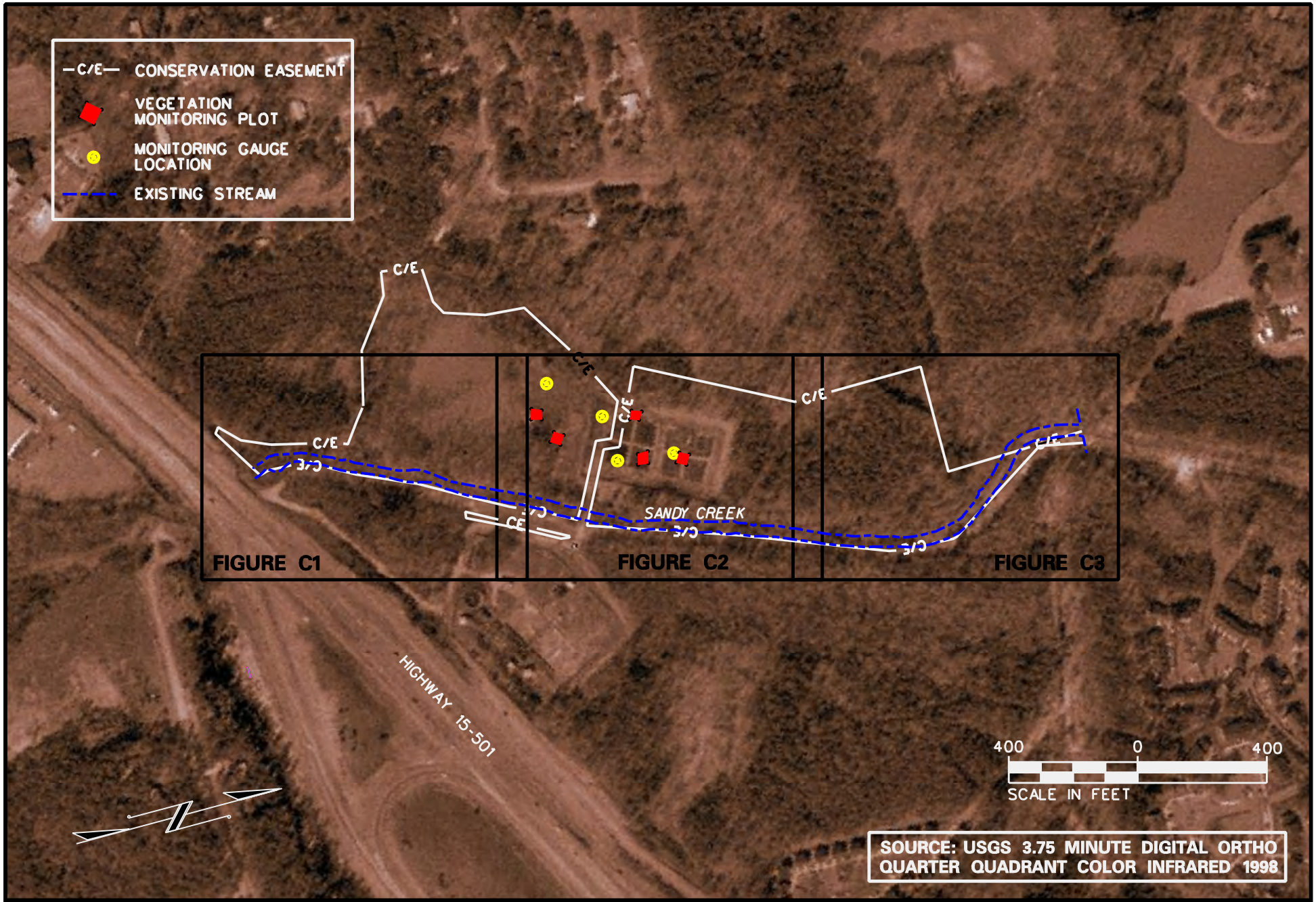
Photo 5A

The above pictures were taken on August 23, 2006, after three seasons of growth on-site.

**Appendix C**
(Click here)

# APPENDIX C

# STREAM GEOMORPHOLOGY DATA




EcoScience Corporation
Raleigh, North Carolina

Client: Ecosystem Enhancement Program

Project:

# SHEET INDEX

## Sandy Creek Stream Enhancement and Wetland Restoration Site

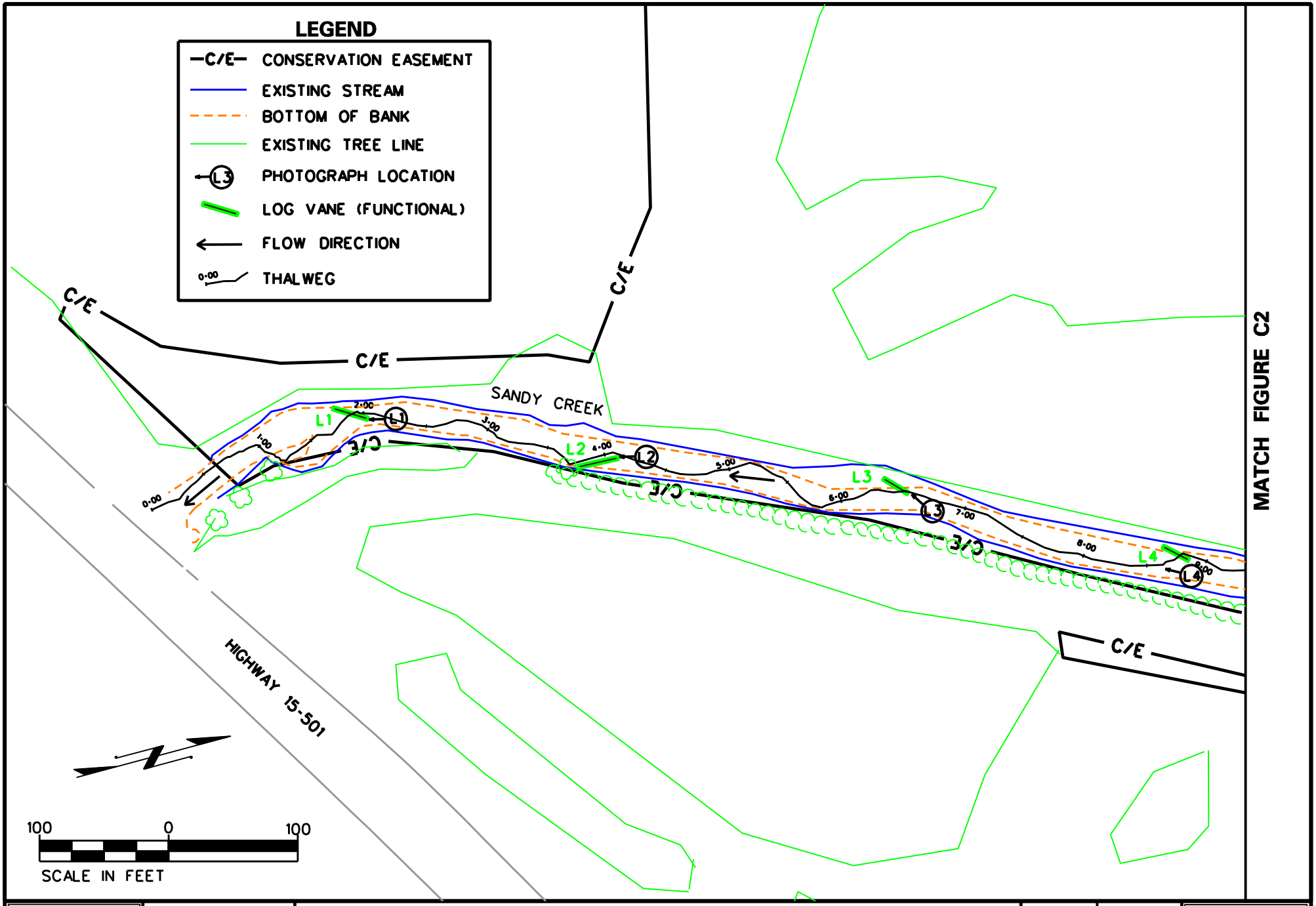
**EEP Project No. 322**

DURHAM COUNTY, NORTH CAROLINA

| | |
|---|---|
| Dwn By: GWN | Date: DEC 2006 |
| Ckd By: JWG | Scale: 1" = 400' |
| ESC Project No.: 06-282.03 | |

FIGURE

**C**




EcoScience Corporation
Raleigh, North Carolina

Client: Ecosystem Enhancement Program

Project:

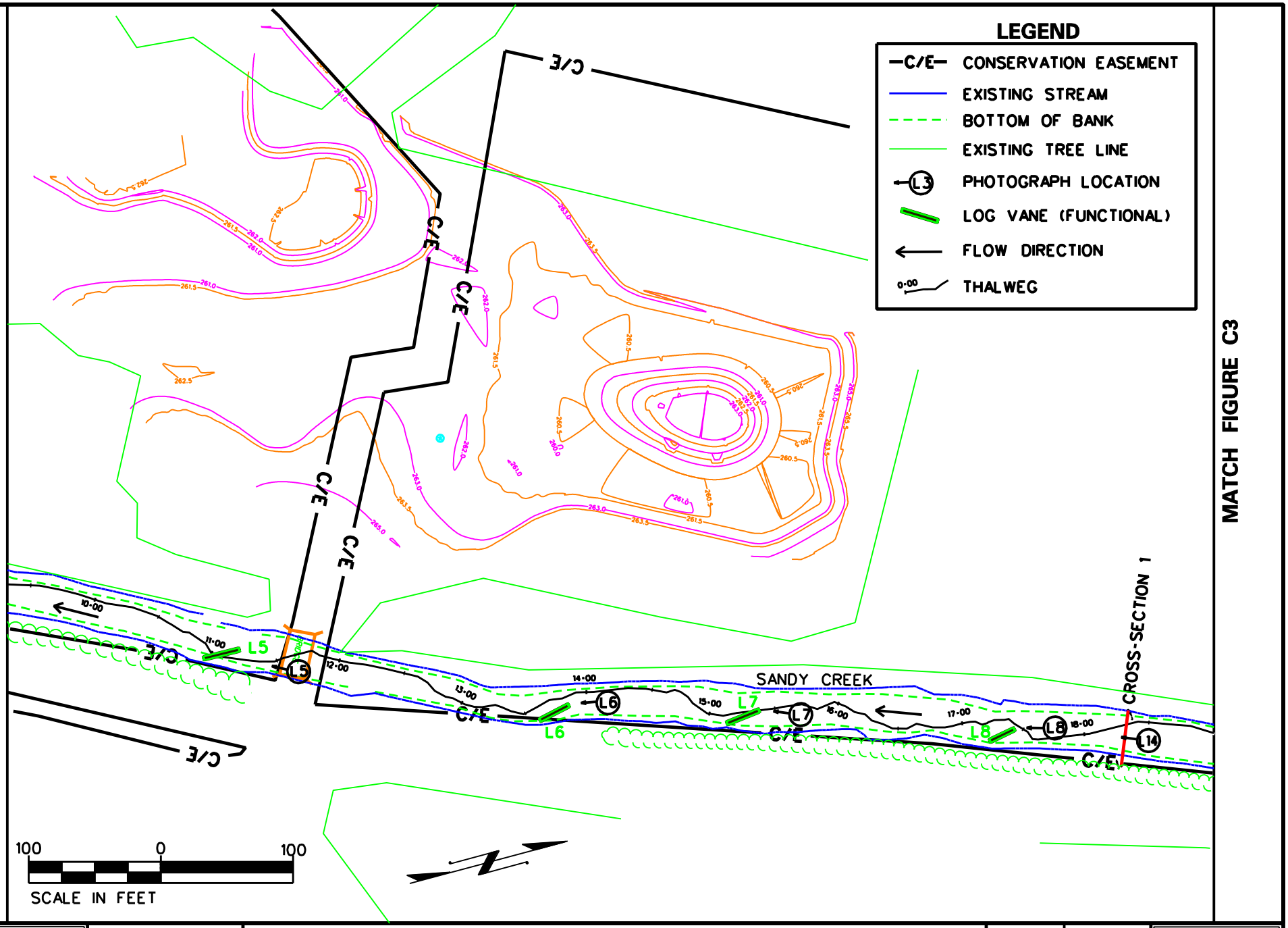
# STREAM PROBLEM AREAS
## Sandy Creek Stream Enhancement and Wetland Restoration Site

**EEP Project No. 322**

DURHAM COUNTY, NORTH CAROLINA

| | |
|---|---|
| Dwn By: GWN | Date: FEB 2007 |
| Ckd By: JWG | Scale: 1"= 100' |
| ESC Project No.: 06-282.03 | |

FIGURE
**C1**




EcoScience Corporation
Raleigh, North Carolina

Client: Ecosystem Enhancement Program

Project:

# STREAM PROBLEM AREAS

## Sandy Creek Stream Enhancement and Wetland Restoration Site

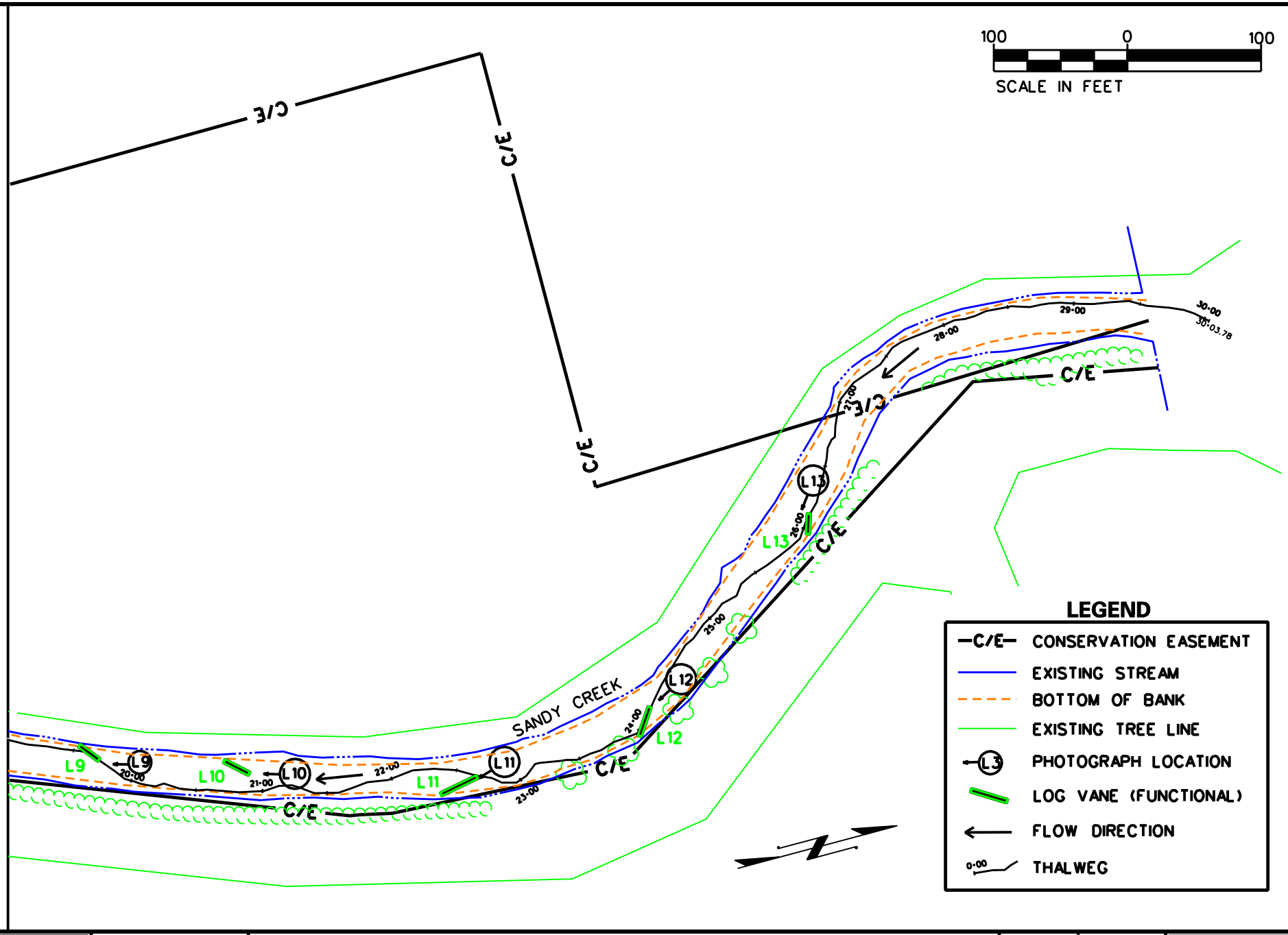
**EEP Project No. 322**

DURHAM COUNTY, NORTH CAROLINA

| | |
|---|---|
| Dwn By: GWN | Date: FEB 2007 |
| Ckd By: JWG | Scale: 1" = 100' |
| ESC Project No.: 06-282.03 | |

FIGURE

**C2**




EcoScience Corporation
Raleigh, North Carolina

Client: Ecosystem Enhancement Program

Project:

# STREAM PROBLEM AREAS

## Sandy Creek Stream Enhancement and Wetland Restoration Site

**EEP Project No. 322**

DURHAM COUNTY, NORTH CAROLINA

| | |
|---|---|
| Dwn By: GWN | Date: FEB 2007 |
| Ckd By: JWG | Scale: 1" = 100' |
| ESC Project No.: 06-282.03 | |

FIGURE

**C3**

## Verification of Bankfull Events

Photo 1. Sediment layer covering adjacent greenway path after a bankfull event

January 12, 2007

Photo 2. Sediment deposited at top of bank following a bankfull event

January 12, 2007

## Stream Problem Areas

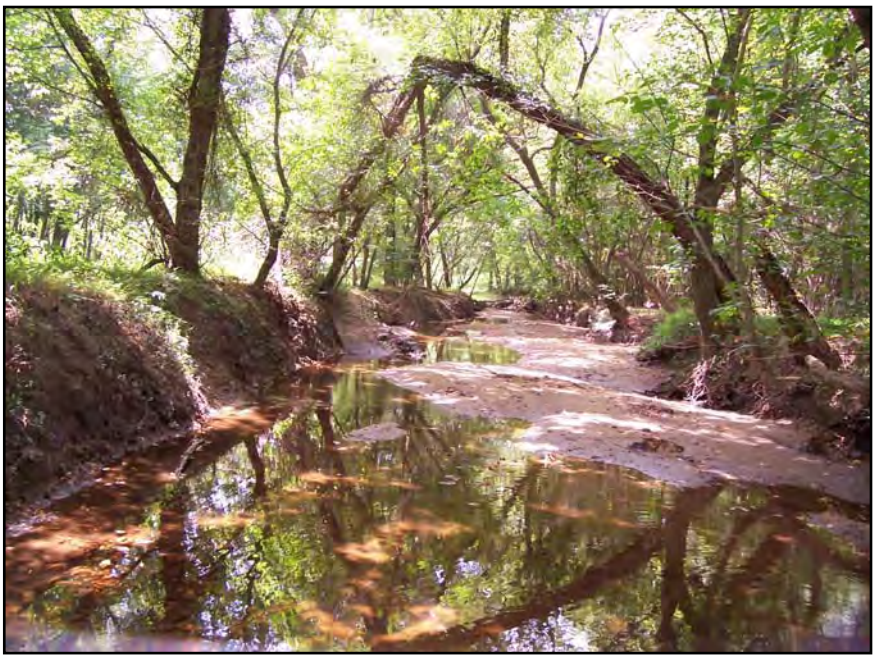
Photo 3. Excessive sediment load from upstream sources.

## Sandy Creek Stream Enhancement Photo Stations

Photo Station 1: Log Vane #1 (Station 2 + 04)

August 23, 2006

Photo Station 2: Log Vane #2 (Station 4 + 12)



August 23, 2006

## Sandy Creek Stream Enhancement Photo Stations

Photo Station 3: Log Vane #3 (Station 6 + 55)

August 23, 2006

Photo Station 4: Log Vane #4 (Station 8 + 88)

August 23, 2006

## Sandy Creek Stream Enhancement Photo Stations

Photo Station 5: Log Vane #5 (Station 10 + 99)

August 23, 2006

Photo Station 6: Log Vane #6 (Station 13 + 83)

August 23, 2006

## Sandy Creek Stream Enhancement Photo Stations

Photo Station 7: Log Vane #7 (Station 15 + 39)

August 23, 2006

Photo Station 8: Log Vane #8 (Station 17 + 45)

August 23, 2006

## Sandy Creek Stream Enhancement Photo Stations

Photo Station 9: Log Vane #9 (Station 19 + 72)

August 23, 2006

Photo Station 10: Log Vane #10 (Station 20 + 91)

August 23, 2006

## Sandy Creek Stream Enhancement Photo Stations

Photo Station 11: Log Vane #11 (Station 22 + 66)

January 12, 2007

Photo Station 12: Log Vane #12 (Station 24 + 20)

August 23, 2006

## Sandy Creek Stream Enhancement Photo Stations

Photo Station 13: Log Vane #13 (Station 26 + 12)

August 23, 2006

Photo Station 14: Permanent Cross-Section (18 + 25) Viewed Looking Downstream

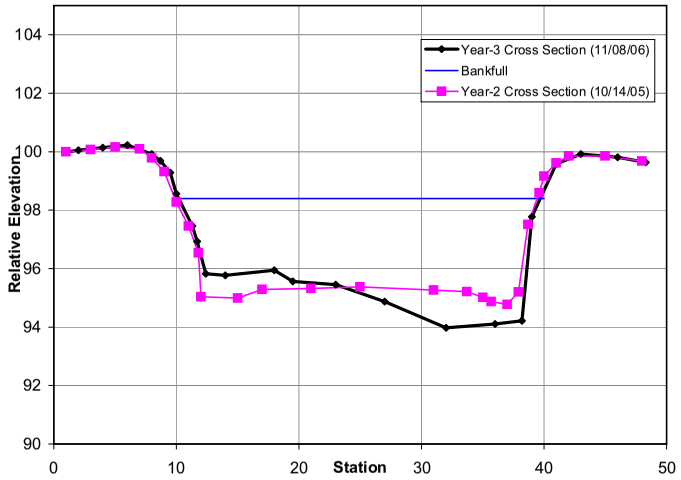
November 9, 2006

| Survey Data | | | |
|---|---|---|---|
| Station | | Elevation | Feature |
| 1.1 | | 100 | LPIN |
| 2 | | 100.05 | |
| 4 | | 100.14 | |
| 6 | | 100.23 | |
| 8 | | 99.92 | |
| 8.7 | | 99.69 | |
| 9.5 | | 99.29 | |
| 10 | | 98.56 | |
| 11.3 | | 97.46 | |
| 11.7 | | 96.93 | |
| 12.4 | | 95.82 | |
| 14 | | 95.77 | |
| 18 | | 95.94 | |
| 19.5 | | 95.56 | |
| 23 | | 95.45 | |
| 27 | | 94.87 | |
| 32 | | 93.97 | |
| 36 | | 94.11 | |
| 38.2 | | 94.21 | |
| 39 | | 97.77 | |
| 41 | | 99.58 | |
| 43 | | 99.92 | |
| 46 | | 99.81 | |
| 48.3 | | 99.64 | RPIN |

| Summary Data | |
|---|---|
| Bankful Cross-Sectional Area | 92.7 |
| Bankfull Width | 29.5 |
| Bankfull Mean Depth | 3.1 |
| Bankful Max Depth | 4.4 |
| Width/Depth Ratio | 9.4 |
| Entrenchment Ratio | >2.2 |
| Classification | E5 |

Cross Section

Cross-Section 1 - Looking Downstream




Cross-Section Photos

Cross-section, upstream looking downstream

Cross-section, downstream looking upstream

**Title** Cross-Section 1

| Project | Sandy Creek Stream and Wetland Restoration Site, Durham County | Project # | 322 |
|---|---|---|---|
| | | Figure | Cross-Section Appendix C |

| Survey Date | Survey Weather | Field Team | Location |
|---|---|---|---|
| 11/8/06 | Sunny | Michael Gloden, Craig Terwilliger | Station 18+25 |

**Appendix D**
(Click here)

# APPENDIX D

# WETLAND HYDROLOGY DATA

SOURCE: USGS 3.75 MINUTE DIGITAL ORTHO QUARTER QUADRANT COLOR INFRARED 1998

REFERENCE SITE GAUGE

A

B

C

C/E

SANDY CREEK

9.00 10.00 11.00 12.00 13.00 14.00 15.00 16.00 17.00

60 0 60

SCALE IN FEET

## LEGEND

- C/E — CONSERVATION EASEMENT
- EXISTING STREAM
- TOE OF CHANNEL
- EXISTING WETLAND
- GAUGE LOCATION % of growing season *
- > 12.5%
- < 5%

EcoScience Corporation
Raleigh, North Carolina

REVISIONS

Client: Ecosystem Enhancement Program

Project:
**SANDY CREEK STREAM ENHANCEMENT AND WETLAND RESTORATION SITE**

**EEP Project No. 322**
DURHAM COUNTY, NORTH CAROLINA

Title:
**WETLAND PROBLEM AREAS**

| Dwn By: | Date: |
|---|---|
| GWN | DEC 2006 |
| Ckd By: | Scale: |
| JWG | 1"=60' |

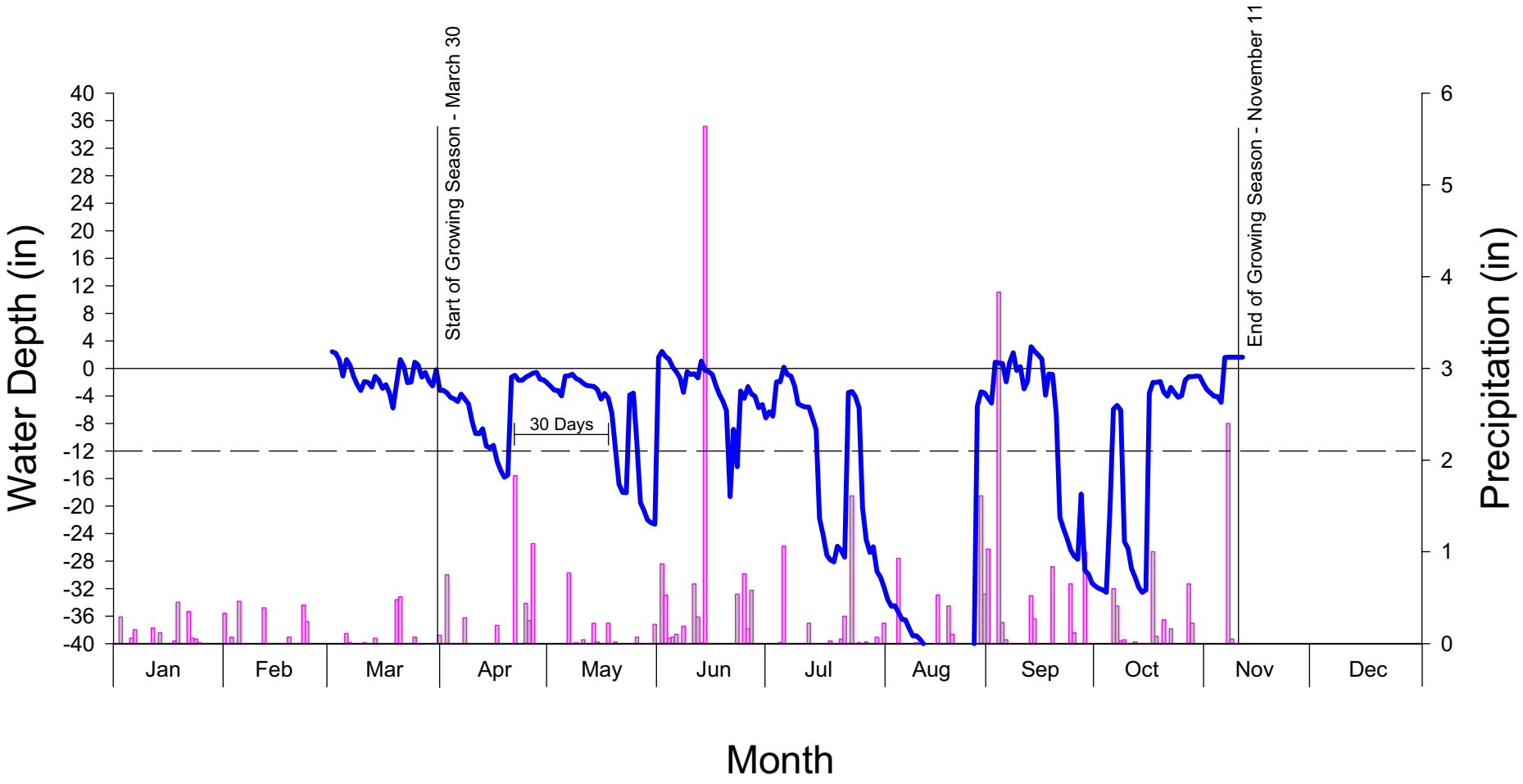
ESC Project No.: 06-282.03

FIGURE
**D**

# Sandy Creek

## 2006

## Monitoring Gauge A - N3CF7A65

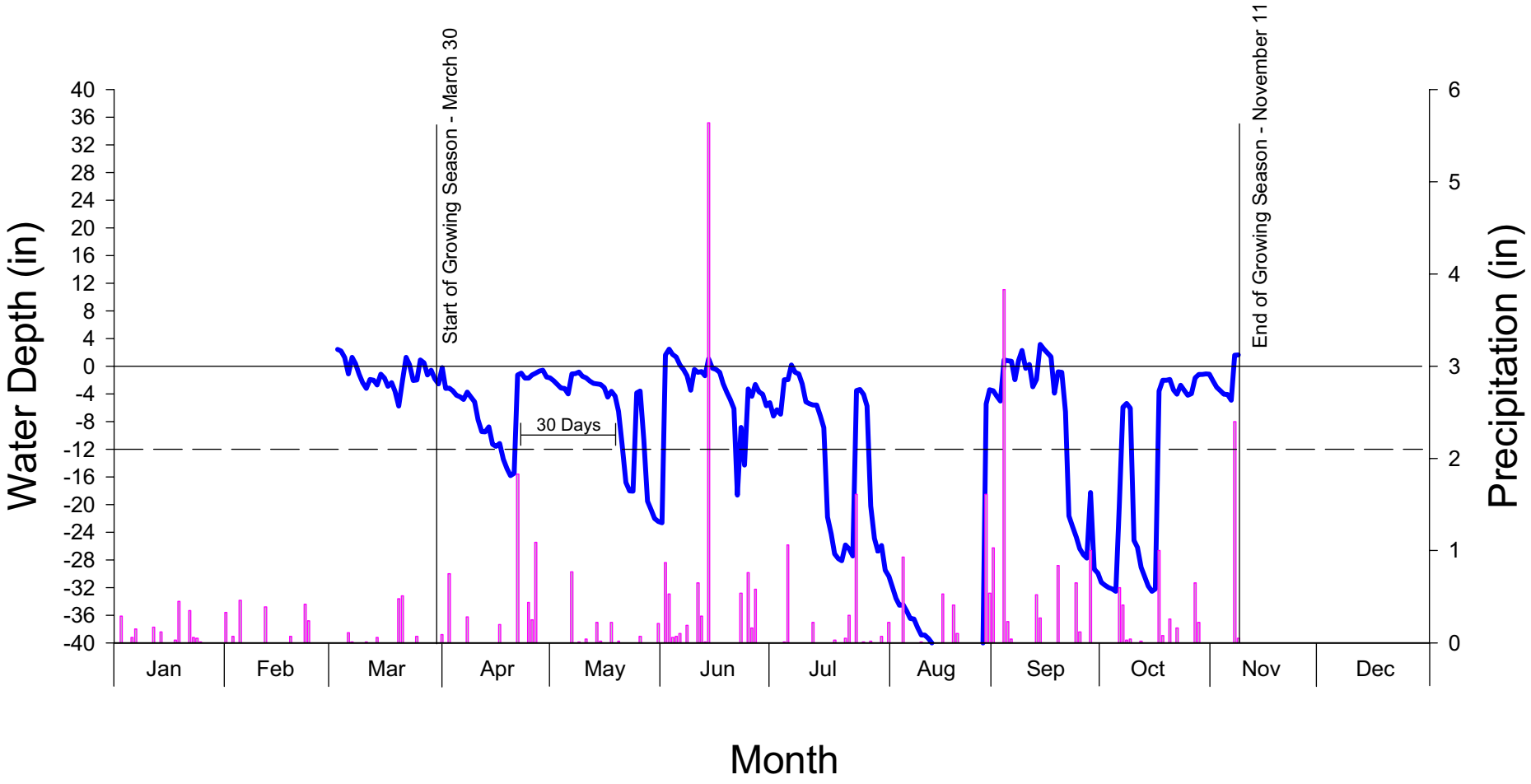



* Breaks indicate > 40" below the ground surface

# Sandy Creek

## 2006

## Monitoring Gauge B- N3CF79C5

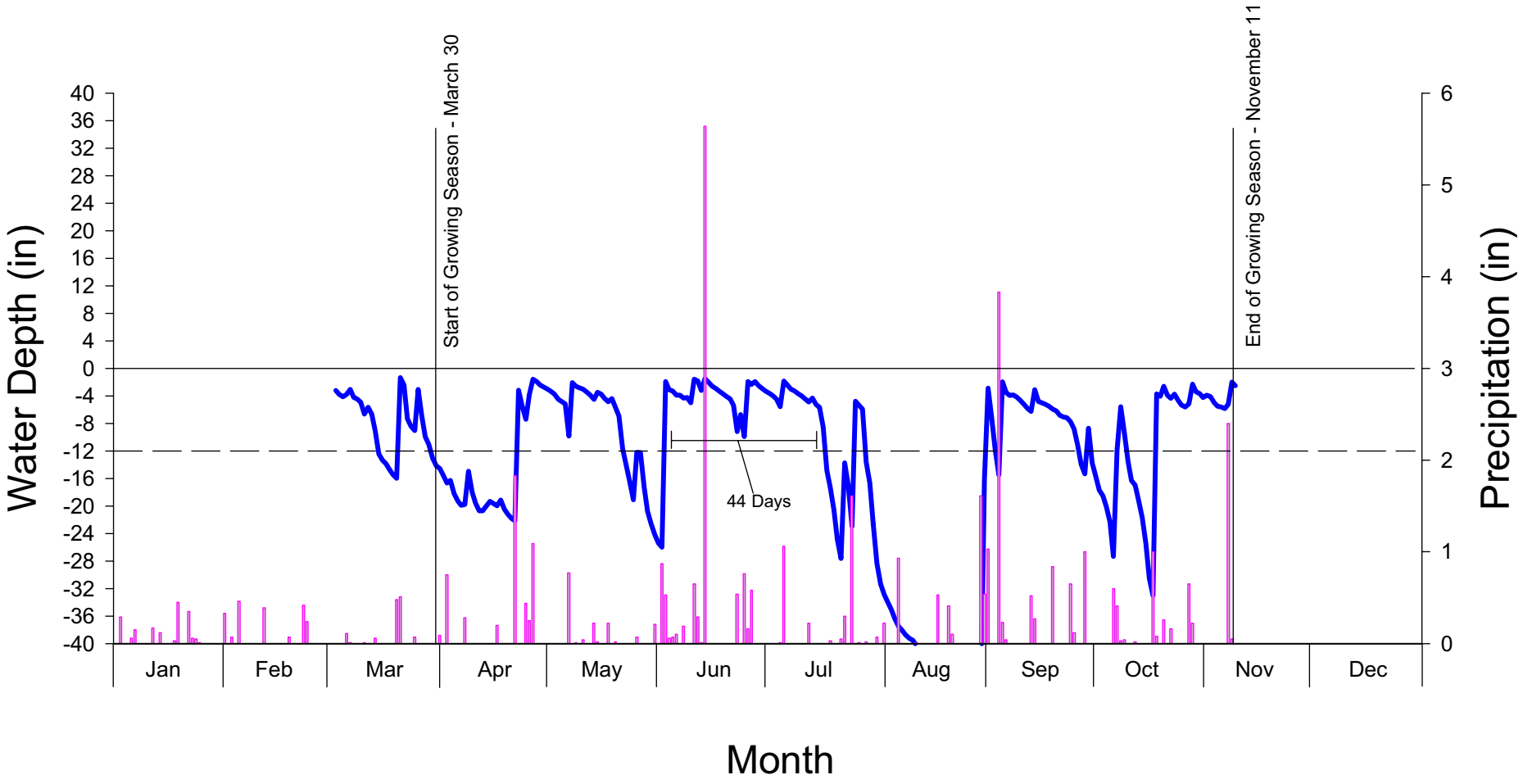



* Breaks indicate > 40" below the ground surface

# Sandy Creek

## 2006

## Monitoring Gauge C - N3CF7AB6

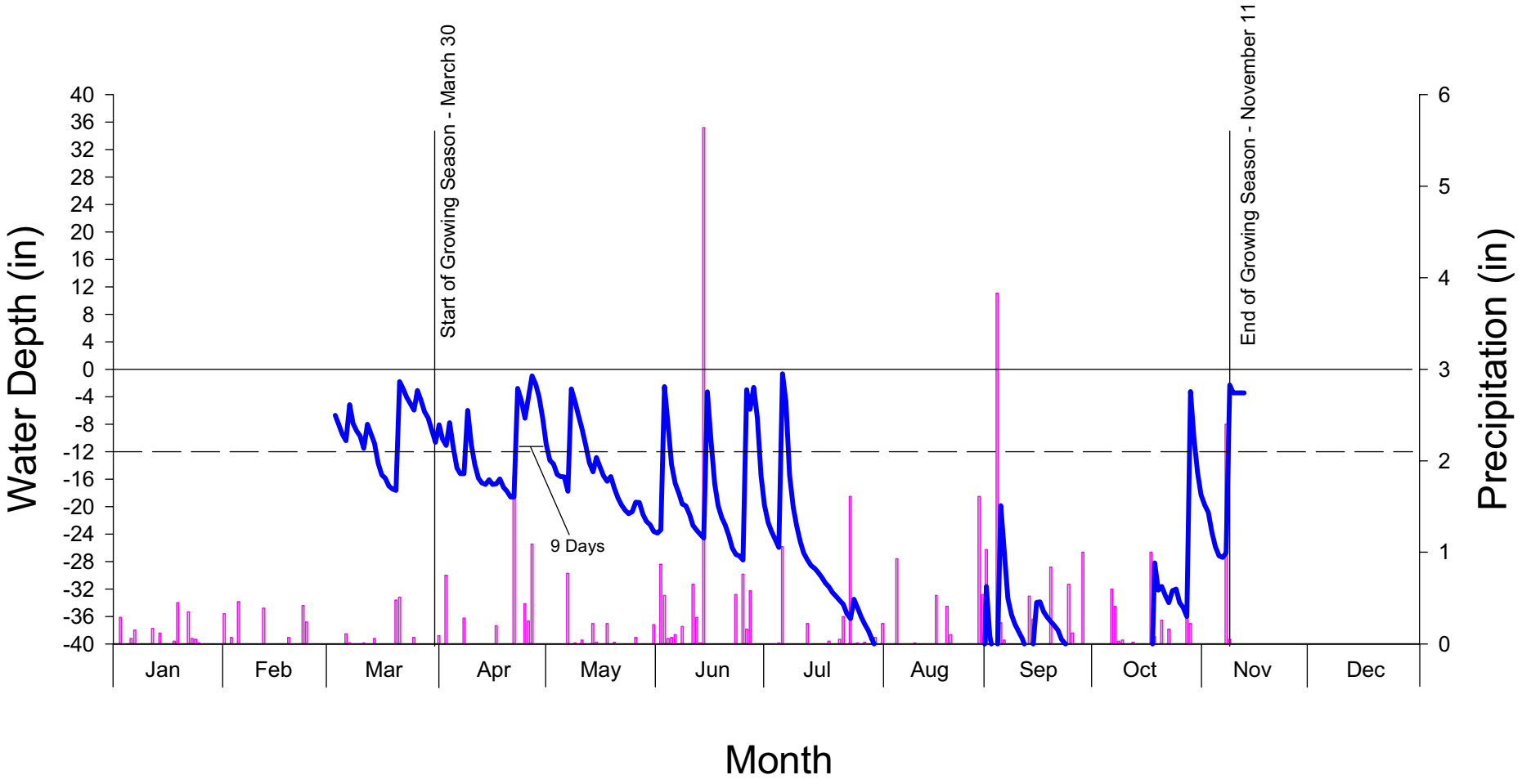



* Breaks indicate > 40" below the ground surface

# Sandy Creek

## 2006

## Monitoring Gauge Reference Site - N3CF7AEC




* Breaks indicate > 40" below the ground surface