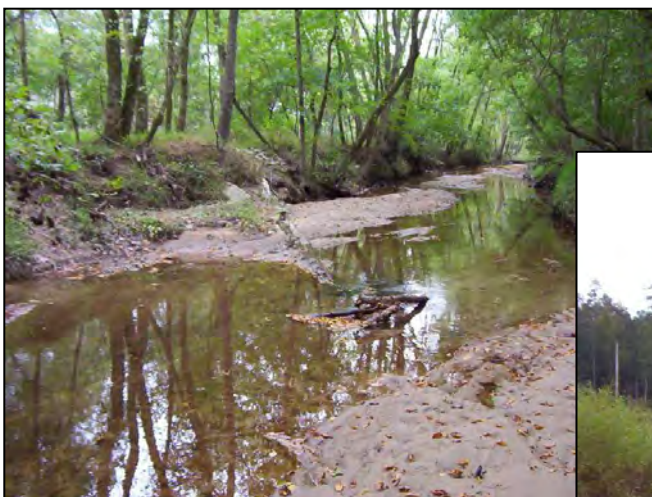


**SANDY CREEK STREAM ENHANCEMENT  
AND WETLAND RESTORATION SITE  
2005 Annual Monitoring Report (Year 2)**

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



**February, 2006**

**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**



## TABLE OF CONTENTS

|       |   |   |
|-------|---|---|
| 1.0   | EXECUTIVE SUMMARY .....                   | 1 |
| 2.0   | PROJECT BACKGROUND.....                   | 2 |
| 2.1   | Location and Setting .....                | 2 |
| 2.2   | Mitigation Structure and Objectives ..... | 2 |
| 2.3   | Project History and Background.....       | 3 |
| 3.0   | PROJECT MONITORING AND RESULTS .....      | 6 |
| 3.1   | VEGETATION ASSESSMENT.....                | 6 |
| 3.1.1 | Soil Data.....                            | 6 |
| 3.1.2 | Vegetation Problem Areas.....             | 6 |
| 3.1.3 | Stem Counts .....                         | 6 |
| 3.2   | STREAM ASSESSMENT .....                   | 8 |
| 3.2.1 | Bank Stability Assessment .....           | 8 |
| 3.2.2 | Stream Problem Areas.....                 | 8 |
| 3.3   | WETLAND ASSESSMENT .....                  | 9 |

## LIST OF FIGURES

|         |                           |            |
|---------|---------------------------|------------|
| Table 1 | Site Location .....       | Appendix A |
| Table 2 | Monitoring Plan View..... | Appendix A |

## LIST OF TABLES

|          |   |        |
|----------|---|--------|
| Table 1  | Project Structure.....                                      | Page 3 |
| Table 2  | Project Activity and Reporting History.....                 | Page 3 |
| Table 3  | Project Contacts.....                                       | Page 4 |
| Table 4  | Project Background.....                                     | Page 5 |
| Table 5  | Preliminary Soil Data .....                                 | Page 6 |
| Table 6  | Vegetation Problem Areas.....                               | Page 6 |
| Table 7  | Stem Counts for Each Species Arranged in Plot.....          | Page 6 |
| Table 8  | Stream Problem Areas.....                                   | Page 8 |
| Table 9  | Categorical Stream Feature Visual Stability Assessment..... | Page 8 |
| Table 10 | Baseline Morphology Summary.....                            | Page 8 |
| Table 11 | Wetland Criteria Attainment .....                           | Page 9 |

APPENDIX A: FIGURES

APPENDIX B: VEGETATION DATA

Vegetation Problem Area (Plan View)

Vegetation Survey Data Tables

Vegetation Problem Area Photos

Wetland Photo Stations

APPENDIX C: STREAM GEOMORPHOLGY DATA

Stream Problem Area (Plan View)

Representative Stream Problem Area Photos

Stream Photo Stations

Cross-Section Plot and Raw Data Tables

Pebble Count Plots and Raw Data Tables

APPENDIX D: WETLAND HYDROLOGY DATA

Monitoring Gauge Hydrographs and Precipitation Graphs

Wetland Problem Area (Plan View)

---

## **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 2005 monitoring report represents the second 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 second 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 five 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 is attributed to permanent flooding and mowing by City of Durham maintenance staff. 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 occupies approximately 5.5 acres of the site) is another factor in poor survival. Maintenance on the Site is scheduled to be performed during Spring of 2006. The maintenance will include grading and planting of appropriate species to help remedy poor vegetation establishment.

### **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 2005 hydrologic monitoring results indicate overall continued hydrologic success within the Site. Two of the 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). The third gauge narrowly missed the success criteria with saturation occurring for 12 percent of the growing season. This particular gauge met the wetland hydrology success criteria

---

during the previous monitoring year. A lower percentage of saturation for all gauges during the 2005 growing season is attributed to an overall drier year than observed in the first year of monitoring.

## **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, Appendix A). 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 1,525 feet upstream of the bridge and ends approximately 1,175 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 project (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 2,700 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.

| <b>Project Segment or Reach ID</b> | <b>Mitigation Type</b> | <b>Approach</b> | <b>Linear Footage or Acreage</b> | <b>Stationing</b> | <b>Comments</b>                                |
|------------------------------------|------------------------|-----------------|----------------------------------|-------------------|--|
| 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

| <b>Activity Report</b>                                     | <b>Scheduled Completion</b> | <b>Data Collection Complete</b> | <b>Actual Completion or Delivery</b> |
|--|-----------------------------|---------------------------------|--------------------------------------|
| 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*                                  |
| <b>Site Replanting (portions of Zone 3)</b>                | 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                             |

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.

| <b>Table 3. Project Contacts</b><br><b>Sandy Creek Stream Enhancement and Wetland Restoration Site / EEP Project No. 322</b> |  |
|--|--|
| <b>Designer</b><br>Becky L. Ward Consulting  | Ms. Becky Ward<br>1512 Eglantyne Court<br>Raleigh, NC 27613<br>(919) 870-0526                  |
| <b>Construction Contractor</b><br>Shamrock Environmental, Inc  | Mr. Greg Kiser<br>6106 Corporate Park Drive<br>Browns Summit, NC 27214<br>(336) 375-1989       |
| <b>Planting Contractor</b>   | NA*  |
| <b>Seeding Contactor</b>   | NA*  |
| Seed Mix Sources   | NA*  |
| Nursery Stock Suppliers  | NA*  |
| <b>Monitoring Performers</b>   | 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.

| <b>Table 4. Project Background</b><br><b>Sandy Creek Stream Enhancement and Wetland Restoration Site / EEP Project No. 322</b> |  |
|--|--|
| Project County   | Durham                                       |
| Drainage Area  | 7.3 square miles to culvert at Bypass 15-501 |
| Impervious cover estimate (%)  | 10 percent                                   |
| Stream Order   | 3 <sup>rd</sup> order                        |
| Physiographic Region   | Piedmont                                     |
| Ecoregion (Griffith and Omernik)   | Triassic Basin                               |
| Rosgen Classification of As-built  | NA   |
| 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                               |
| NCDWQ Sub-basin for Project and Reference  | 03-06-05                                     |
| NCDWQ classification for Project and Reference   | 16-41-1-4                                    |
| 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   |



### 3.0 PROJECT MONITORING AND RESULTS

#### 3.1 VEGETATION ASSESSMENT

##### 3.1.1 Soil Data

| 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

| Feature / Issue                         | Station # / Range                              | Probable Cause   | Photo # |
|---|--|--|---------|
| Poor Tree Establishment and Recruitment | Buffer Areas                                   | Mowing   | 1       |
| Poor Tree Survival                      | Semi-permanent flooded zone: Vegetation Plot 4 | Flooding from pond creation; poor soil composition; mowing | 2       |
| Poor Tree Survival                      | Island: Vegetation Plot 5                      | Poor soils, competition by lespedeza                       | 3       |

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

##### 3.1.3 Stem Counts

The existing five 30-foot by 30-foot plots were relocated. 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.

| Species                          | Plots |    |   |   |   | Year 0 Totals | Year 1 Totals | Year 2 Totals | Percent Survival |
|----------------------------------|-------|----|---|---|---|---------------|---------------|---------------|------------------|
|                                  | 1     | 2  | 3 | 4 | 5 |               |               |               |                  |
| <i>Acer rubrum</i>               |       | 1  | 3 |   |   | 30            | 12            | 4             | 13               |
| <i>Alnus serrulata</i>           |       |    |   |   |   | 1             |               |               | 0                |
| <i>Betula nigra</i>              |       |    |   |   |   | 2             | 5             |               | 0                |
| <i>Carya ovata</i>               |       |    |   |   |   | 4             |               |               | 0                |
| <i>Cephalanthus occidentalis</i> |       |    |   |   |   | 2             |               |               | 0                |
| <i>Fraxinus pennsylvanica</i>    | 68    | 73 | 7 |   |   | 16            | 104           | 148           | 925              |

| Species                        | Plots |   |    |   |   | Year 0<br>Totals | Year 1<br>Totals | Year 2<br>Totals | Percent<br>Survival |
|--------------------------------|-------|---|----|---|---|------------------|------------------|------------------|---------------------|
|                                | 1     | 2 | 3  | 4 | 5 |                  |                  |                  |                     |
| <i>Liriodendron tulipifera</i> |       |   | 1  |   |   | 9                | 2                |                  | 0                   |
| <i>Nyssa sylvatica</i>         |       |   |    |   |   | 5                |                  |                  | 0                   |
| <i>Quercus lyrata</i>          |       |   |    |   |   | 5                | 3                |                  | 0                   |
| <i>Quercus phellos</i>         |       |   | 3  |   |   | 14               | 3                | 3                | 21                  |
| <i>Salix nigra</i>             | 83    | 3 | 16 |   | 6 | 5                | 73               | 108              | 2160                |
| <i>Sambucus canadensis</i>     |       |   |    |   |   | 11               | 1                |                  | 0                   |
| <i>Viburnum nudum</i>          |       |   |    |   |   | 8                | 3                |                  | 0                   |

| Species                        | Plots |   |   |   |   | Year 0<br>Totals | Year 1<br>Totals | Year 2<br>Totals |
|--------------------------------|-------|---|---|---|---|------------------|------------------|------------------|
|                                | 1     | 2 | 3 | 4 | 5 |                  |                  |                  |
| <i>Acer negundo</i>            |       | 1 |   |   |   | 2                |                  | 1                |
| <i>Celtis laevigata</i>        |       | 1 |   |   |   |                  |                  | 1                |
| <i>Cornus amomum</i>           |       |   |   | 2 |   | 2                |                  | 2                |
| <i>Gleditsia triacanthos</i>   |       |   |   |   |   |                  | 1                |                  |
| <i>Liquidambar styraciflua</i> |       |   | 6 |   |   |                  | 1                | 6                |
| <i>Platanus occidentalis</i>   |       |   |   |   |   |                  | 2                | 1                |
| <i>Populus deltoides</i>       |       |   |   |   |   |                  | 2                |                  |
| <i>Ulmus americana</i>         |       |   |   |   |   |                  | 1                |                  |

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

- |  |  |
|--|--|
| <i>Andropogon virginicus</i> (broomsedge)          | <i>Ludwigia alternifolia</i> (seedbox)       |
| <i>Aster dumosus</i> (frost aster)                 | <i>Pluchea</i> sp. (marsh fleabane)          |
| <i>Carex</i> spp. (sedges)                         | <i>Polygonum</i> sp. (smartweed)             |
| <i>Cyperus strigosus</i> (straw-colored flatsedge) | <i>Scirpus cyperinus</i> (woolgrass bulrush) |
| <i>Eleocharis</i> sp. (spikerush)                  | <i>Solidago</i> sp. (goldenrod)              |
| <i>Eupatorium capillifolium</i> (dog fennel)       | <i>Sorghum halapense</i> (Johnson grass)     |
| <i>Juncus effusus</i> (soft rush)                  | <i>Typha latifolia</i> (common cattail)      |
| <i>Lespedeza cuneata</i> (sericea lespedeza)       |  |

### 3.2 STREAM ASSESSMENT

#### 3.1.1 Bank Stability Assessment

A detailed BEHI and NBS assessment are required in years 3 and 5, post construction. This monitoring report represents the second year monitoring, therefore no assessment was conducted.

#### 3.1.2 Stream Problem Areas

| <b>Feature Issue</b>      | <b>Station Numbers</b> | <b>Suspected Cause</b>                        | <b>Photo Number</b> |
|---------------------------|------------------------|---|---------------------|
| Aggradation/Bar Formation | 00+00 to 27+00         | Excessive sediment load from upstream sources | 1                   |

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

| <b>Feature</b> | <b>Initial</b> | <b>MY-01</b> | <b>MY-02</b> | <b>MY-03</b> | <b>MY-04</b> | <b>MY-05</b> |
|----------------|----------------|--------------|--------------|--------------|--------------|--------------|
| A. Riffles     | NA*            | NA*          | 0%           |              |              |              |
| B. Pools       | NA*            | NA*          | 0%           |              |              |              |
| C. Thalweg     | NA*            | NA*          | 0%           |              |              |              |
| D. Meanders    | NA*            | NA*          | 100%         |              |              |              |
| E. Bed General | NA*            | NA*          | 0%           |              |              |              |
| F. Log Vanes   | NA*            | NA*          | 100%         |              |              |              |

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

| <b>Parameter</b>             | <b>Cross-Section 1</b> |                |            |            |            |
|------------------------------|------------------------|----------------|------------|------------|------------|
|                              | <b>MY1</b>             | <b>MY2</b>     | <b>MY3</b> | <b>MY4</b> | <b>MY5</b> |
| <b>Dimension</b>             |                        |                |            |            |            |
| BF Width (ft)                | NA*                    | <b>28.8</b>    |            |            |            |
| Floodprone Width (ft)        | NA*                    | <b>&gt;500</b> |            |            |            |
| BF Cross Sectional Area (ft) | NA*                    | <b>75.1</b>    |            |            |            |
| BF Mean Depth (ft)           | NA*                    | <b>2.6</b>     |            |            |            |
| Width/Depth Ratio (ft)       | NA*                    | <b>11</b>      |            |            |            |
| Entrenchment Ratio (ft)      | NA*                    | <b>&gt;2.2</b> |            |            |            |
| Wetted Perimeter (ft)        | NA*                    | <b>32.7</b>    |            |            |            |
| Hydraulic Radius (ft)        | NA*                    | <b>2.3</b>     |            |            |            |
| Substrate                    |                        |                |            |            |            |
| d50 (mm)                     | <b>0.61</b>            | <b>0.58</b>    |            |            |            |
| d84 (mm)                     | <b>1.5</b>             | <b>0.98</b>    |            |            |            |

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

### 3.3 WETLAND ASSESSMENT

| Table 11. 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  | G1      | ✓ (27%)                       | 23% of growing season | P1                 | ✓ (7550)                                | 2                          | Failed because of lack of diversity |
| 1  | G3      | (12%)                         |                       | P2                 | ✓ (3850)                                | 3                          |                                     |
| 1  | G4      | ✓ (31%)                       |                       | P3                 | ✓ (1500)                                | 5                          |                                     |
| REF  | G2      | ✓ (27%)                       |                       | P4                 | (0)                                     | 0                          |                                     |
|  |         |                               | P5                    | ✓ (300)            | 1                                       |                            |                                     |

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

## **APPENDIX A**

### **FIGURES**



**Site Location**

1 mi. 0 1 mi. 4 mi.  
 1:144,000

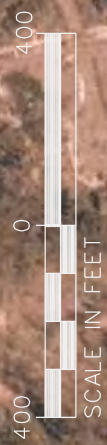
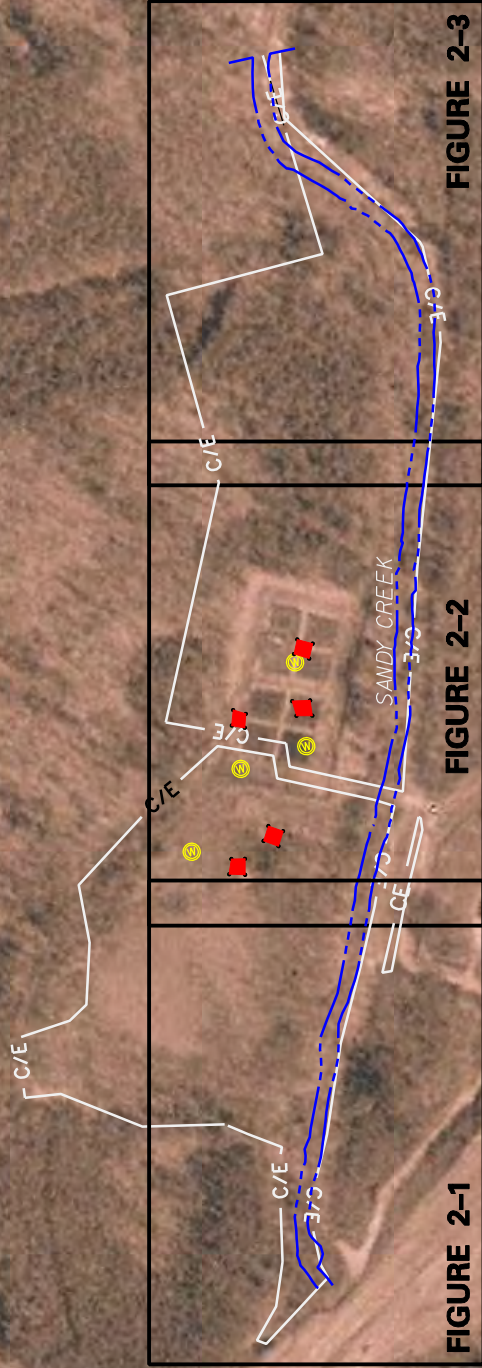
Source: 1997 North Carolina Atlas and Gazetteer, p.39.



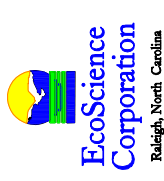
**SITE LOCATION**  
**Sandy Creek Stream Enhancement**  
**and Wetland Restoration Site**  
 Durham County, North Carolina

|          |           |                               |
|----------|-----------|-------------------------------|
| Dwn. by: | MAF       | <b>FIGURE</b><br><br><b>1</b> |
| Ckd by:  | JWG       |                               |
| Date:    | DEC 2005  |                               |
| Project: | 05-243.02 |                               |

- C/E - CONSERVATION EASEMENT
-  VEGETATION MONITORING PLOT
-  MONITORING GAUGE LOCATION
-  EXISTING STREAM



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



**EcoScience Corporation**  
Raleigh, North Carolina



**Ecosystem Enhancement PROGRAM**

Client: **Sandy Creek Stream Enhancement and Wetland Restoration Site**

Project: **SHEET INDEX**

**EEP Project No. 322**

DURHAM COUNTY, NORTH CAROLINA

|                  |     |           |           |
|------------------|-----|-----------|-----------|
| Drawn By:        | JDG | Date:     | DEC 2005  |
| Checked By:      | JWG | Scale:    | 1" = 400' |
| ESC Project No.: |     | 05-243.03 |           |

**LEGEND**

|  |                            |
|--|----------------------------|
|  | CONSERVATION EASEMENT      |
|  | EXISTING STREAM            |
|  | TOE OF CHANNEL             |
|  | VEGETATION MONITORING PLOT |
|  | MONITORING GAUGE           |
|  | PHOTOGRAPH LOCATION        |
|  | EXISTING WETLAND BOUNDARY  |
|  | EXISTING SANITARY SEWER    |
|  | EXISTING TREE LINE         |
|  | LOG VANE                   |

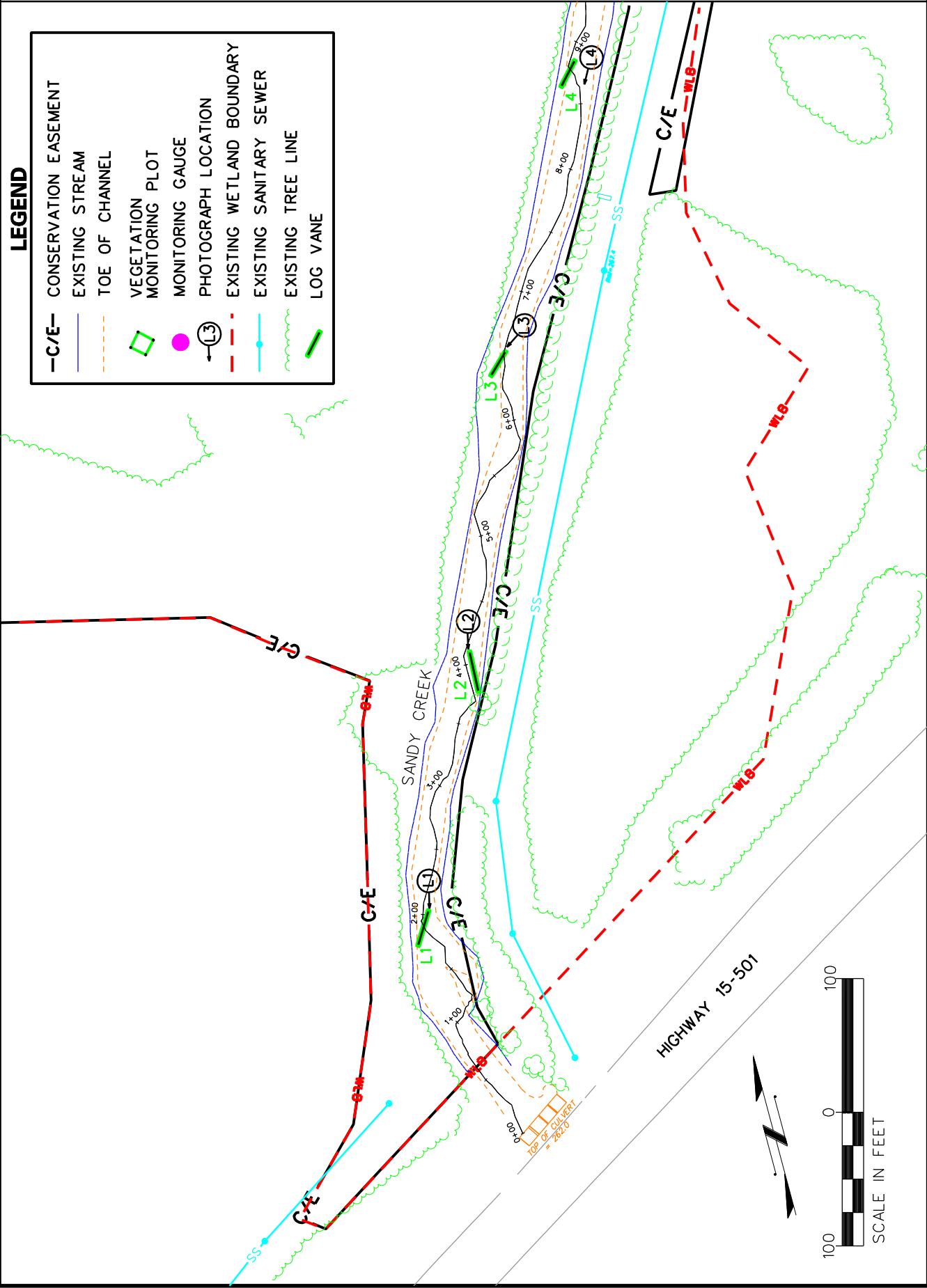
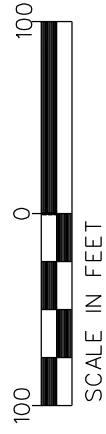
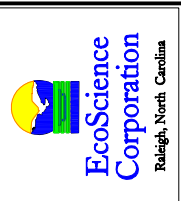


FIGURE  
**2-1**

|                  |           |
|------------------|-----------|
| Date:            | DEC 2005  |
| Down By:         | JDG       |
| Scale:           | 1" = 100' |
| Chk By:          | JWG       |
| ESC Project No.: | 05-243.03 |

**MONITORING PLAN VIEW**  
**Sandy Creek Stream Enhancement and Wetland Restoration Site**  
**EEP Project No. 322**  
 DURHAM COUNTY, NORTH CAROLINA

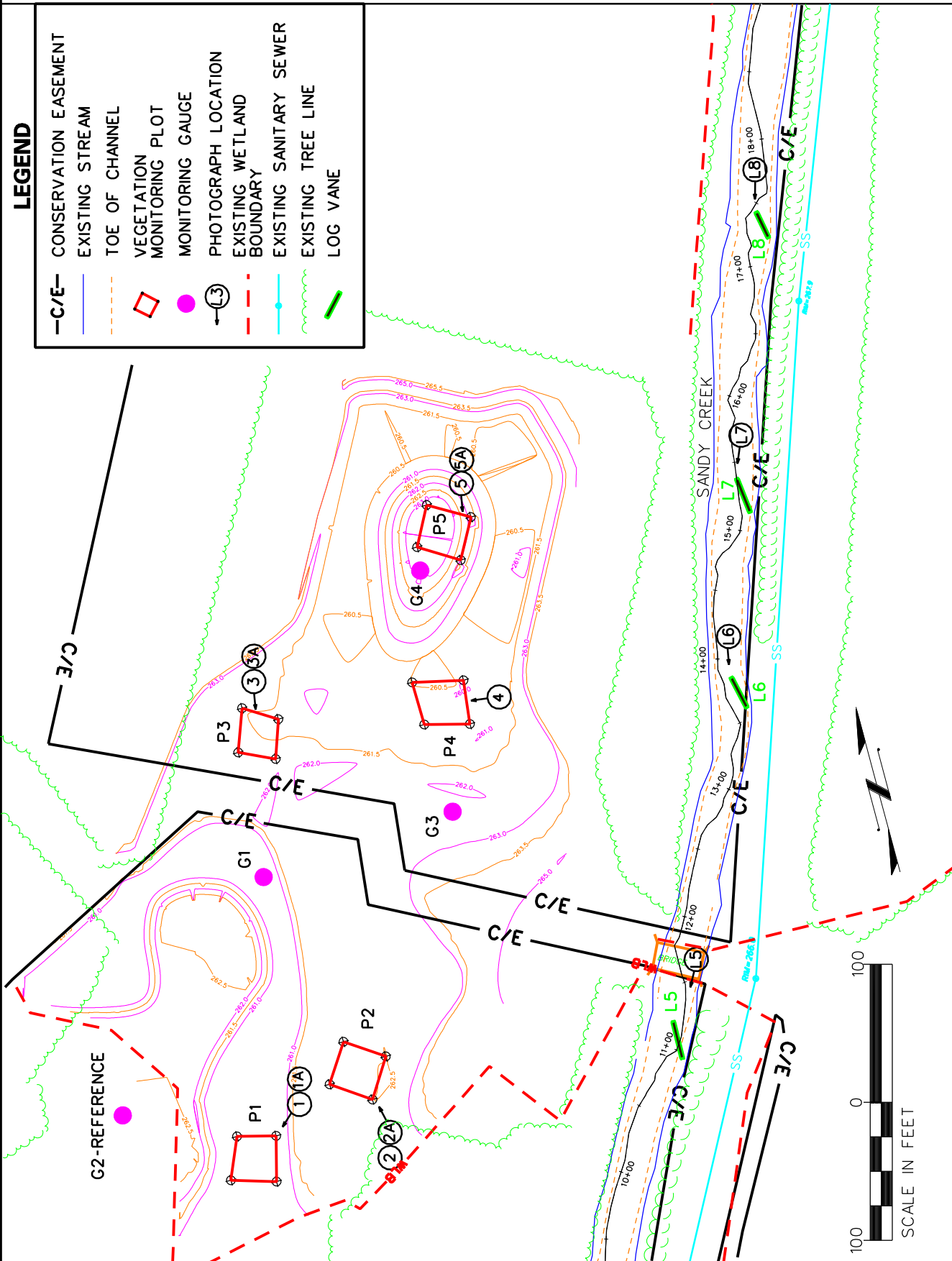


HIGHWAY 15-501



**LEGEND**

|       |                            |
|-------|----------------------------|
| -C/E- | CONSERVATION EASEMENT      |
| —     | EXISTING STREAM            |
| - - - | TOE OF CHANNEL             |
| □     | VEGETATION MONITORING PLOT |
| ●     | MONITORING GAUGE           |
| ⊙     | PHOTOGRAPH LOCATION        |
| - - - | EXISTING WETLAND BOUNDARY  |
| —     | EXISTING SANITARY SEWER    |
| —     | EXISTING TREE LINE         |
| —     | LOG VANE                   |



|                  |     |           |           |
|------------------|-----|-----------|-----------|
| Down By:         | JDG | Date:     | DEC 2005  |
| Chk By:          | JWG | Scale:    | 1" = 100' |
| ESC Project No.: |     | 05-243.03 |           |

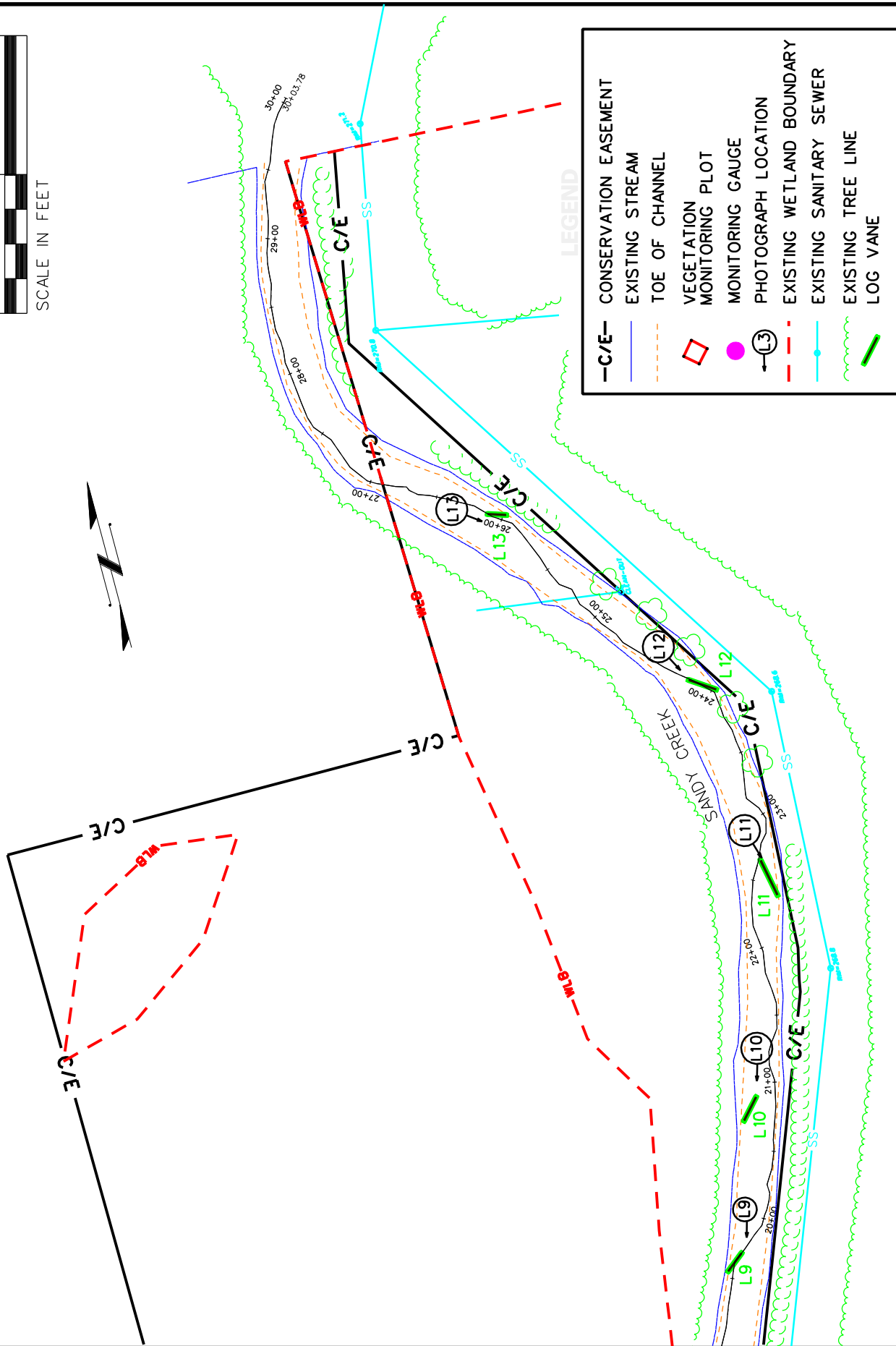
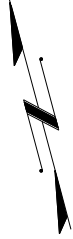
**MONITORING PLAN VIEW**  
**Sandy Creek Stream Enhancement and Wetland Restoration Site**

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



Client: EcoSystem Enhancement  
 Project: Sandy Creek Stream Enhancement and Wetland Restoration Site

MATCH SHEET 2-2



**LEGEND**

|       |                            |
|-------|----------------------------|
| -C/E- | CONSERVATION EASEMENT      |
| —     | EXISTING STREAM            |
| - - - | TOE OF CHANNEL             |
| ◻     | VEGETATION MONITORING PLOT |
| ●     | MONITORING GAUGE           |
| →     | PHOTOGRAPH LOCATION        |
| - - - | EXISTING WETLAND BOUNDARY  |
| —     | EXISTING SANITARY SEWER    |
| ~     | EXISTING TREE LINE         |
| ▬     | LOG VANE                   |

|  |   |  |                             |
|--|---|--|-----------------------------|
|  | <b>MONITORING PLAN VIEW</b><br><b>Sandy Creek Stream Enhancement and Wetland Restoration Site</b> | Date: DEC 2005<br>Scale: 1" = 100'<br>ESC Project No.: 05-243.03 | FIGURE<br><b>2-3</b>        |
|  |   | Project:   | Down By: JDG<br>Ckd By: JWG |

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

**APPENDIX B**

**VEGETATION DATA**



**Sandy Creek Stream and Wetland Restoration Site  
Year 2 Monitoring**

Data collected 10/14/05

0.02-acre plots

|                           | Plots |      |      |   |     | Year 2 Total | Survival % | Year 1 Total | Year 0 Total |
|---------------------------|-------|------|------|---|-----|--------------|------------|--------------|--------------|
|                           | 1     | 2    | 3    | 4 | 5   |              |            |              |              |
| Acer rubrum               |       | 1    | 3    |   |     | 4            | 13         | 12           | 30           |
| Alnus serrulata           |       |      |      |   |     |              | 0          |              | 1            |
| Betula nigra              |       |      |      |   |     |              | 0          | 5            | 2            |
| Carya ovata               |       |      |      |   |     |              | 0          |              | 4            |
| Cephalanthus occidentalis |       |      |      |   |     |              | 0          |              | 2            |
| Fraxinus pennsylvanica    | 68    | 73   | 7    |   |     | 148          | 925        | 104          | 16           |
| Liriodendron tulipifera   |       |      | 1    |   |     |              | 0          | 2            | 9            |
| Nyssa sylvatica           |       |      |      |   |     |              | 0          |              | 5            |
| Quercus lyrata            |       |      |      |   |     |              | 0          | 3            | 5            |
| Quercus phellos           |       |      | 3    |   |     | 3            | 21         | 3            | 14           |
| Salix nigra               | 83    | 3    | 16   |   | 6   | 108          | 2160       | 73           | 5            |
| Sambucus canadensis       |       |      |      |   |     |              | 0          | 1            | 11           |
| Viburnum nudum            |       |      |      |   |     |              | 0          | 3            | 8            |
|                           | 151   | 77   | 30   | 0 | 6   | 263          |            | 206          | 112          |
| Density                   | 7550  | 3850 | 1500 | 0 | 300 |              |            |              |              |
| Average density           | 2640  |      |      |   |     |              |            |              |              |

| Volunteers              | Plots |   |   |   |   | Year 2 Total | Year 1 Total | Year 0 Total |
|-------------------------|-------|---|---|---|---|--------------|--------------|--------------|
|                         | 1     | 2 | 3 | 4 | 5 |              |              |              |
| Acer negundo            |       | 1 |   |   |   | 1            |              | 2            |
| Celtis laevigata        |       | 1 |   |   |   | 1            |              |              |
| Cornus amomum           |       |   |   | 2 |   | 2            |              | 2            |
| Gleditsia triacanthos   |       |   |   |   |   |              | 1            |              |
| Liquidambar styraciflua |       |   | 6 |   |   | 6            | 1            |              |
| Platanus occidentalis   |       |   |   |   |   | 1            | 2            |              |
| Populus deltoides       |       |   |   |   |   |              | 2            |              |
| Ulmus americana         |       |   |   |   |   |              | 1            |              |
|                         | 0     | 2 | 6 | 2 | 0 | 11           | 7            | 4            |

| Herbaceous species       | Plots |      |      |    |      |
|--------------------------|-------|------|------|----|------|
|                          | 1     | 2    | 3    | 4  | 5    |
| Andropogon virginicus    |       |      | 5%   |    |      |
| Aster dumosus            |       |      | 2.5% |    |      |
| Carex spp.               | 10%   | 10%  |      |    | 0.5% |
| Cyperus strigosus        | 10%   | 0.5% | 2.5% |    |      |
| Eleocharis sp.           | 1%    | 0.5% | 1%   |    |      |
| Eupatorium capillifolium |       | 0.5% |      |    | 2%   |
| Juncus effusus           | 15%   | 10%  | 15%  |    | 5%   |
| Lemna sp.                |       |      |      | 2% |      |
| Lespedeza cuneata        |       | 5%   | 10%  |    | 85%  |
| Ludwigia alternifolia    |       |      | 2.5% |    |      |
| Pluchea sp.              |       |      | 0.5% |    |      |
| Polygonum sp.            | 5%    | 1%   | 1%   |    |      |
| Scirpus cyperinus        | 5%    | 5%   | 35%  |    | 2%   |
| Solidago sp.             |       | 1%   |      |    | 5%   |
| Sorghum halapense        | 2.5%  | 10%  | 1%   |    | 2%   |
| Typha latifolia          | 2.5%  |      | 0.5% |    |      |
|                          | 51%   | 44%  | 77%  | 2% | 102% |

## 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 October 14, 2005, after two seasons of growth on site.



## Vegetation Plot 2 – Sandy Creek Wetland Restoration

Photo 2



Photo 2A



The above pictures were taken on October 14, 2005, after two seasons of growth on site.

## Vegetation Plot 3 – Sandy Creek Wetland Restoration

Photo 3



Photo 3A



The above pictures were taken on October 14, 2005, after two seasons of growth on site.

## Vegetation Plot 4 – Sandy Creek Wetland Restoration

Photo 4



The above picture was taken on October 14, 2005, after two 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

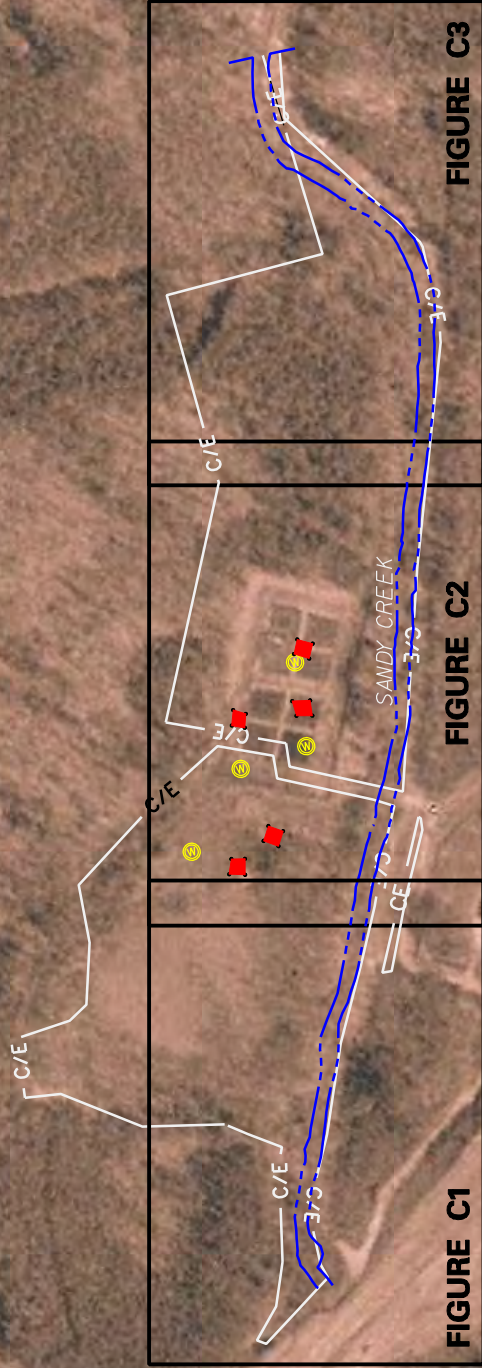


The above pictures were taken on October 14, 2005, after two seasons of growth on site.

**APPENDIX C**

**STREAM GEOMORPHOLOGY DATA**

- C/E - CONSERVATION EASEMENT
-  VEGETATION MONITORING PLOT
-  MONITORING GAUGE LOCATION
-  EXISTING STREAM



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



Client: **Ecosystem Enhancement Program**

Project: **Sandy Creek Stream Enhancement and Wetland Restoration Site**

**SHEET INDEX**

**EEP Project No. 322**

DURHAM COUNTY, NORTH CAROLINA

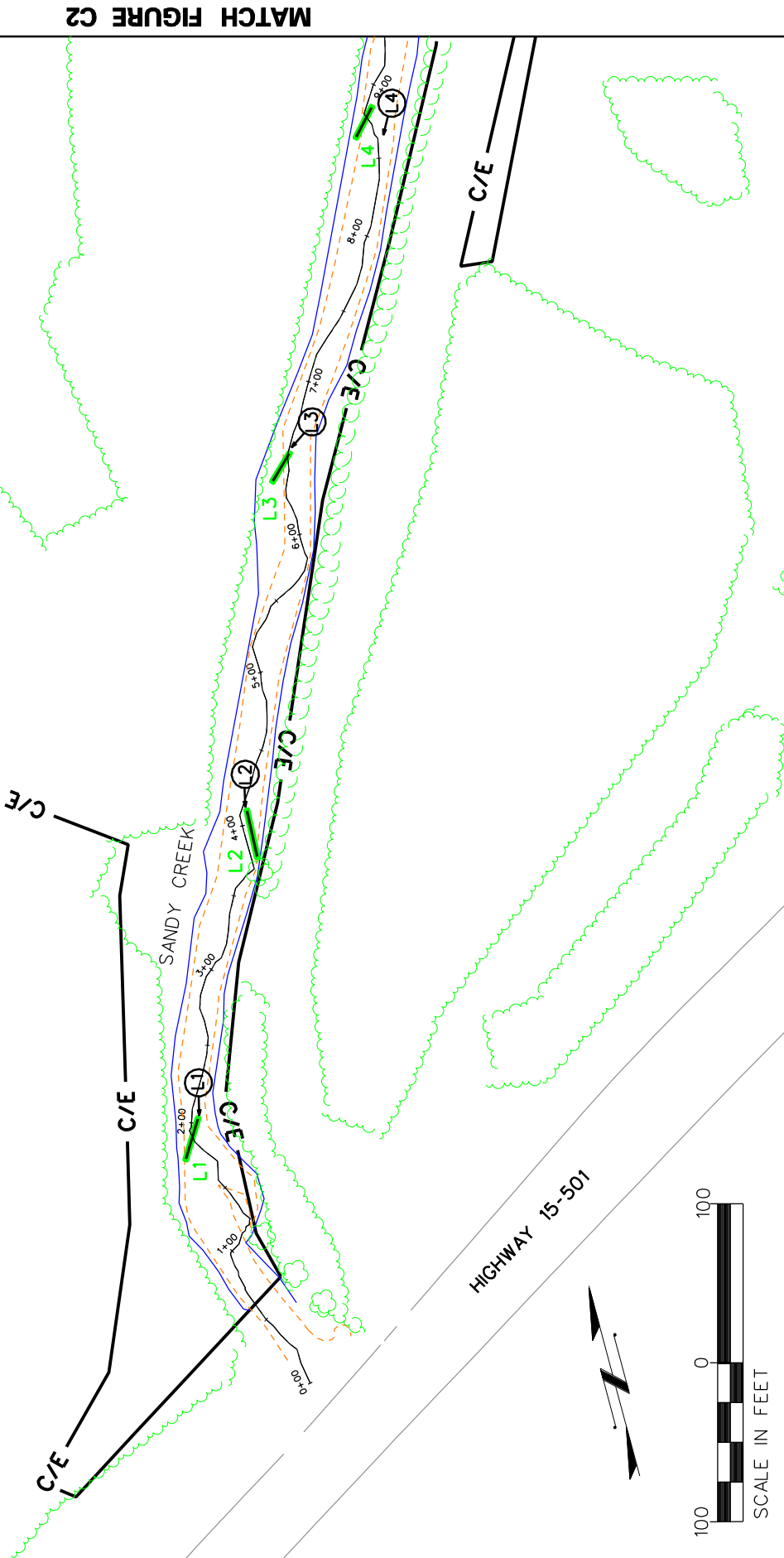
|                  |     |           |           |
|------------------|-----|-----------|-----------|
| Drawn By:        | JDG | Date:     | DEC 2005  |
| Checked By:      | JWG | Scale:    | 1" = 400' |
| ESC Project No.: |     | 05-243.03 |           |


FIGURE

**C**


**LEGEND**

- C/E- CONSERVATION EASEMENT
- EXISTING STREAM
- - - TOE OF CHANNEL
- ~ ~ ~ EXISTING TREE LINE
- ⊙ PHOTOGRAPH LOCATION
- █ LOG VANE (FUNCTIONAL)





**EcoScience Corporation**  
Raleigh, North Carolina



**Ecosystem Enhancement**  
PROCESSES

**STREAM PROBLEM AREAS**  
**Sandy Creek Stream Enhancement and Wetland Restoration Site**  
**EEP Project No. 322**  
 DURHAM COUNTY, NORTH CAROLINA

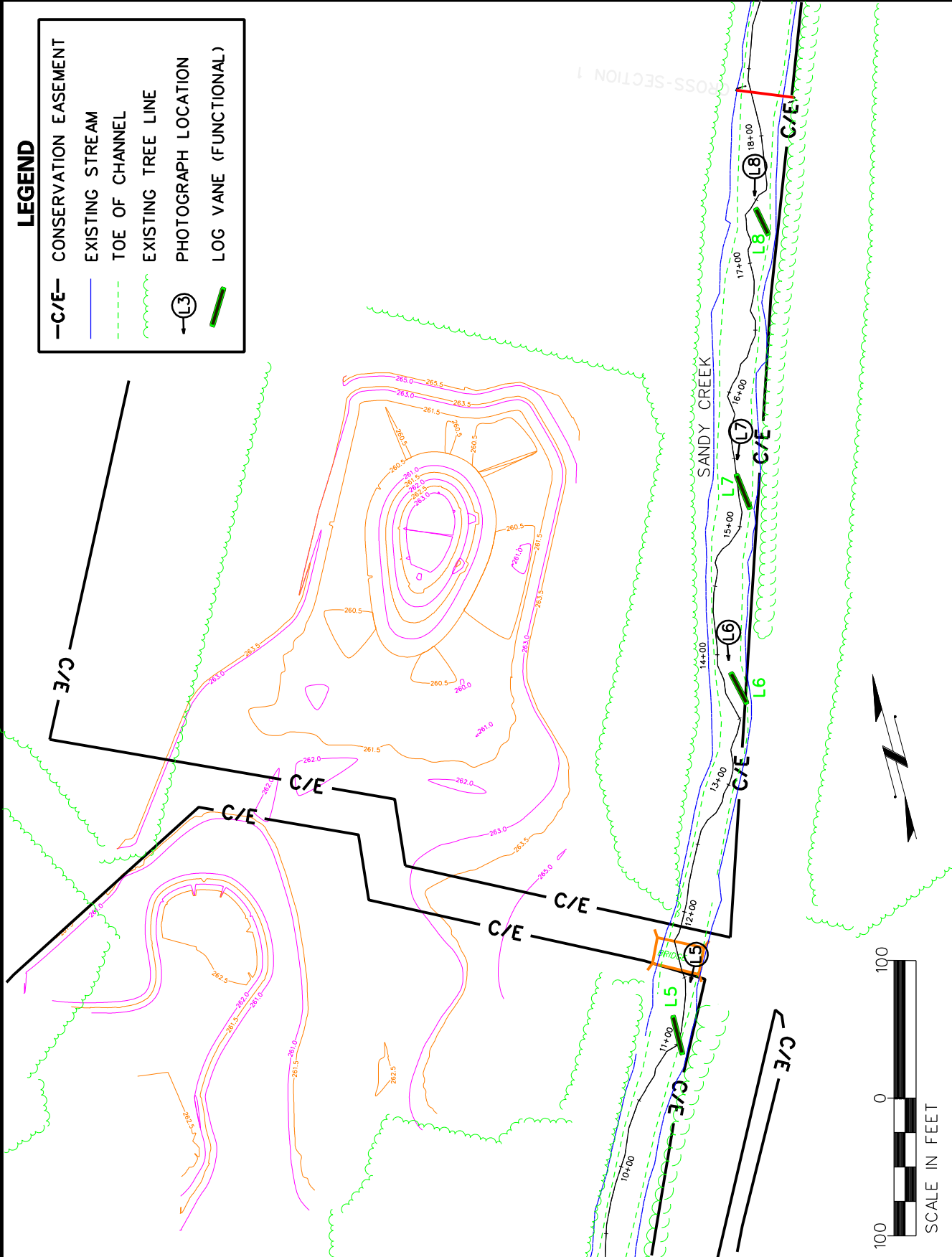
|                  |     |        |           |
|------------------|-----|--------|-----------|
| Down By:         | JDG | Date:  | DEC 2005  |
| Chk'd By:        | JWG | Scale: | 1" = 100' |
| ESC Project No.: |     |        | 05-243.03 |
| FIGURE           |     |        | <b>C1</b> |

MATCH FIGURE C3

MATCH FIGURE C1

**LEGEND**

- CONSERVATION EASEMENT
- EXISTING STREAM
- TOE OF CHANNEL
- EXISTING TREE LINE
- PHOTOGRAPH LOCATION
- LOG VANE (FUNCTIONAL)



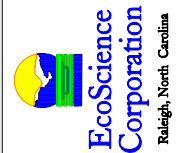
**STREAM PROBLEM AREAS**  
**Sandy Creek Stream Enhancement and Wetland Restoration Site**

EPP Project No. 322

DURHAM COUNTY, NORTH CAROLINA

Project:

Client:



Drawn By: JDG

Date: DEC 2005

Checked By: JWJ

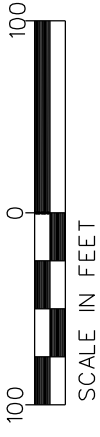
Scale: 1" = 100'

ESC Project No.: 05-243.03

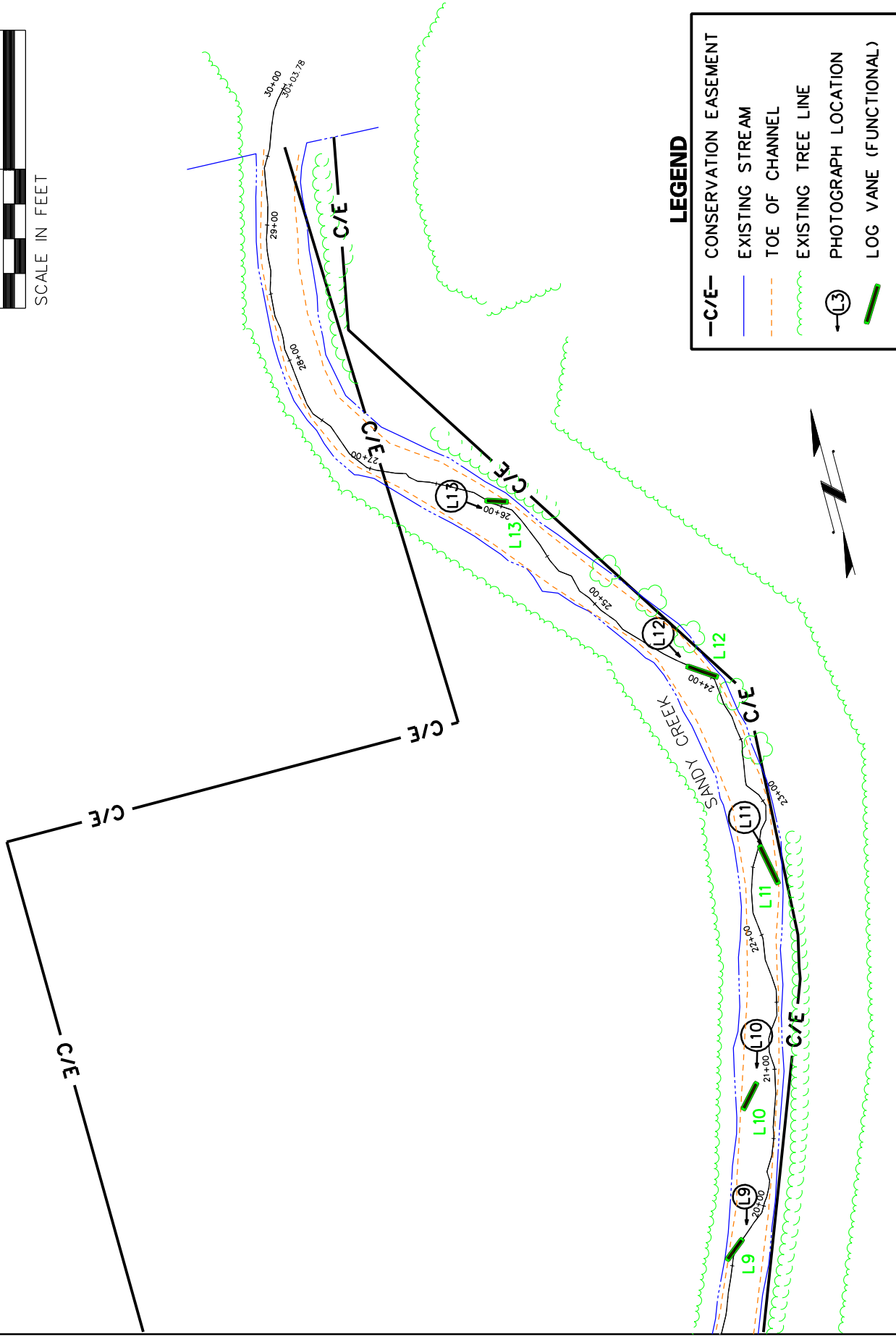
FIGURE

**C2**



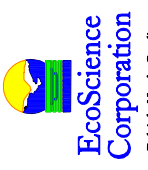



MATCH FIGURE C2



**LEGEND**

- C/E—** CONSERVATION EASEMENT
- EXISTING STREAM
- - -** TOE OF CHANNEL
- ~~~~~** EXISTING TREE LINE
- ⊙-L3** PHOTOGRAPH LOCATION
- LOG VANE (FUNCTIONAL)

|  |   |  |                       |                                   |
|--|---|--|-----------------------|-----------------------------------|
|  <p><b>EcoScience Corporation</b><br/>Raleigh, North Carolina</p> |  <p><b>Ecosystem Enhancement</b></p> | <p>Project: <b>Stream Problem Areas</b><br/><b>Sandy Creek Stream Enhancement and Wetland Restoration Site</b></p> |                       | <p>FIGURE <b>C3</b></p>           |
|  |   | <p>Client:</p>   | <p>Date: DEC 2005</p> |                                   |
| <p>EEP Project No. 322</p> <p>DURHAM COUNTY, NORTH CAROLINA</p>  |   | <p>Checked By: JWJ</p>   |                       | <p>ESC Project No.: 05-243.03</p> |

## REPRESENTATIVE STREAM PROBLEM AREA

Photo 1. Excessive sediment load from upstream sources.



Sandy Creek Stream Enhancement (Log Vanes)

Log Vane #1, Station 2 + 04



October 14, 2005

Log Vane #2, Station 4 + 12



October 14, 2005

Sandy Creek Stream Enhancement (Log Vanes)

Log Vane #3, Station 6 + 55



October 14, 2005

Log Vane #4, Station 8 + 88



October 14, 2005

Sandy Creek Stream Enhancement (Log Vanes)

Log Vane #5, Station 10 + 99



October 14, 2005

Log Vane #6, Station 13 + 83



October 14, 2005

Sandy Creek Stream Enhancement (Log Vanes)

Log Vane #7, Station 15 + 39



October 14, 2005

Log Vane #8, Station 17 + 45



October 14, 2005

Sandy Creek Stream Enhancement (Log Vanes)

Log Vane #9, Station 19 + 72



October 14, 2005

Log Vane #10, Station 20 + 91



October 14, 2005

Sandy Creek Stream Enhancement (Log Vanes)

Log Vane #11, Station 22 + 66



October 14, 2005

Log Vane #12, Station 24 + 20



October 14, 2005



Sandy Creek Stream Enhancement (Log Vanes) & Permanent Cross

Log Vane #13, Station 26 + 12



October 14, 2005

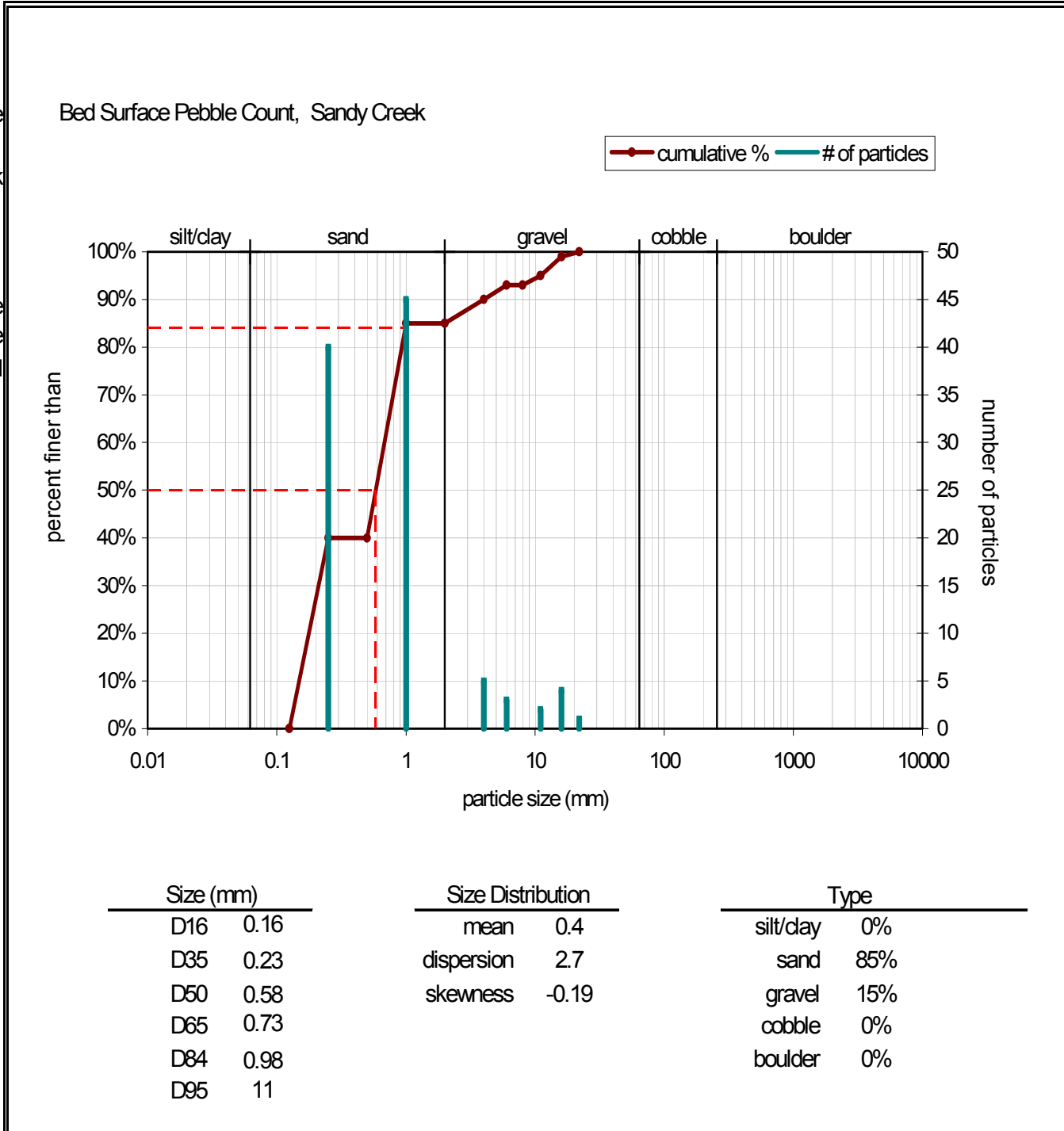
Permanent Cross-Section 18 + 25, Viewed Looking Downstream



October 19, 2005



| Bed Surface <span style="float: right;">▼</span> |                 |       |
|--|-----------------|-------|
| Material   | Size Range (mm) | Count |
| silt/clay  | 0 - 0.062       |       |
| very fine sand                                   | 0.062 - 0.125   |       |
| fine sand  | 0.125 - 0.25    | 40    |
| medium sand                                      | 0.25 - 0.5      |       |
| coarse sand                                      | 0.5 - 1         | 45    |
| very coarse sand                                 | 1 - 2           |       |
| very fine gravel                                 | 2 - 4           | 5     |
| fine gravel                                      | 4 - 6           | 3     |
| fine gravel                                      | 6 - 8           |       |
| medium gravel                                    | 8 - 11          | 2     |
| medium gravel                                    | 11 - 16         | 4     |
| coarse gravel                                    | 16 - 22         | 1     |
| coarse gravel                                    | 22 - 32         |       |
| very coarse gravel                               | 32 - 45         |       |
| very coarse gravel                               | 45 - 64         |       |
| small cobble                                     | 64 - 90         |       |
| medium cobble                                    | 90 - 128        |       |
| large cobble                                     | 128 - 180       |       |
| very large cobble                                | 180 - 256       |       |
| small boulder                                    | 256 - 362       |       |
| small boulder                                    | 362 - 512       |       |
| medium boulder                                   | 512 - 1024      |       |
| large boulder                                    | 1024 - 2048     |       |
| very large boulder                               | 2048 - 4096     |       |
| total particle count:                            |                 | 100   |
| bedrock  | _____           |       |
| clay hardpan                                     | _____           |       |
| detritus/wood                                    | _____           |       |
| artificial                                       | _____           |       |
| total count:                                     |                 | 100   |
| Note: _____                                      |                 |       |

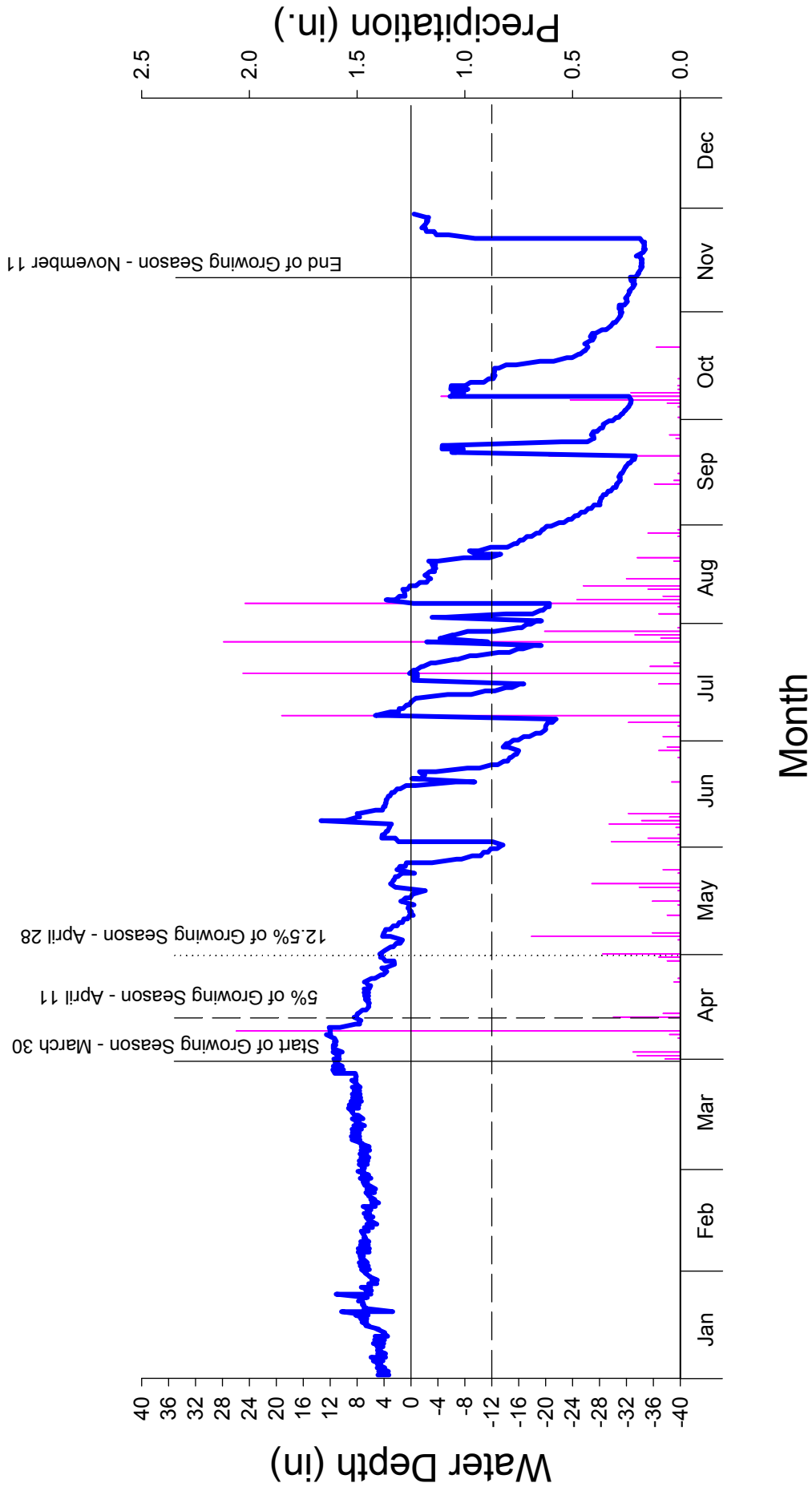


**APPENDIX D**

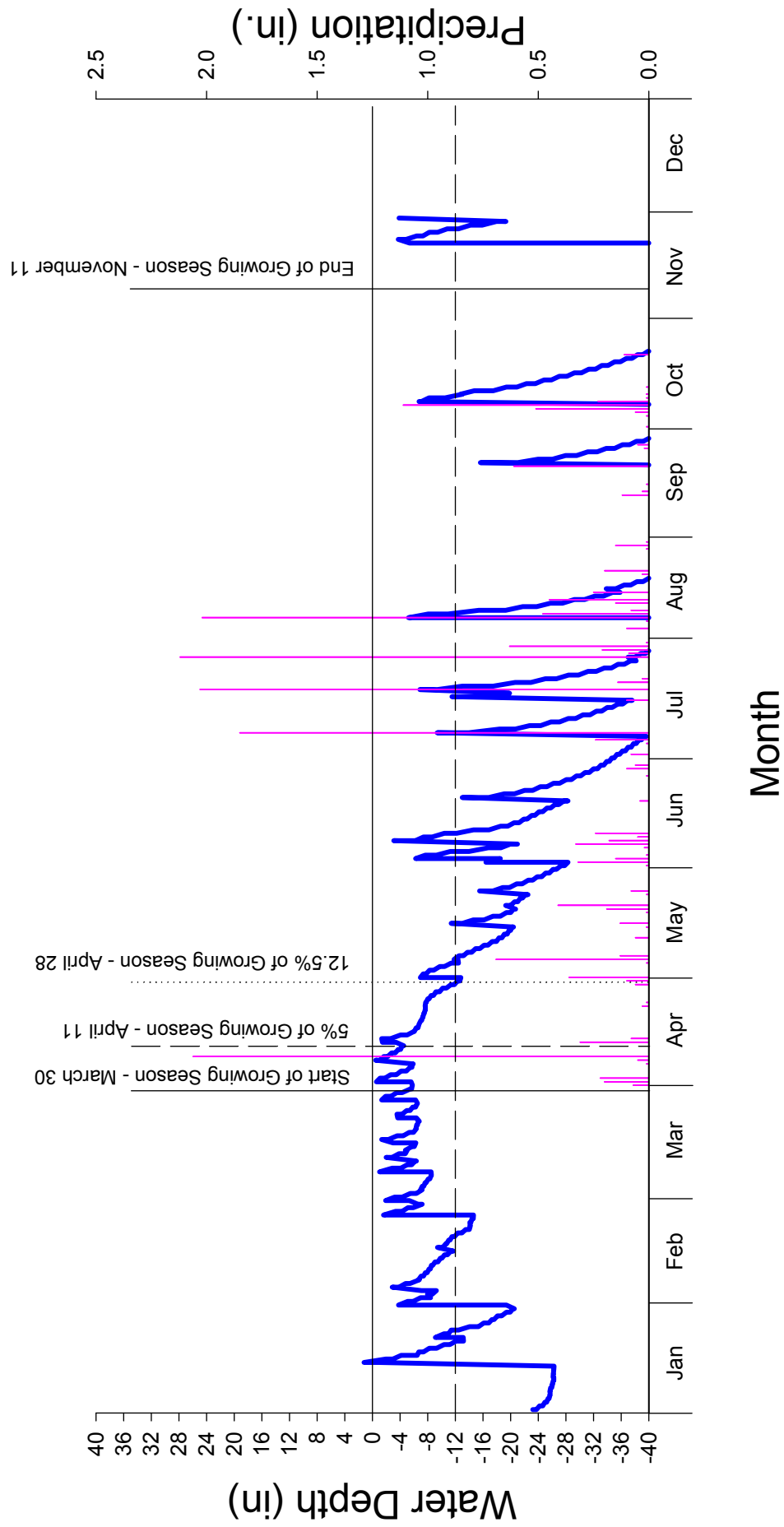
**WETLAND HYDROLOGY DATA**



# Sandy Creek 2005 Monitoring Gauge A - N3CF7A65

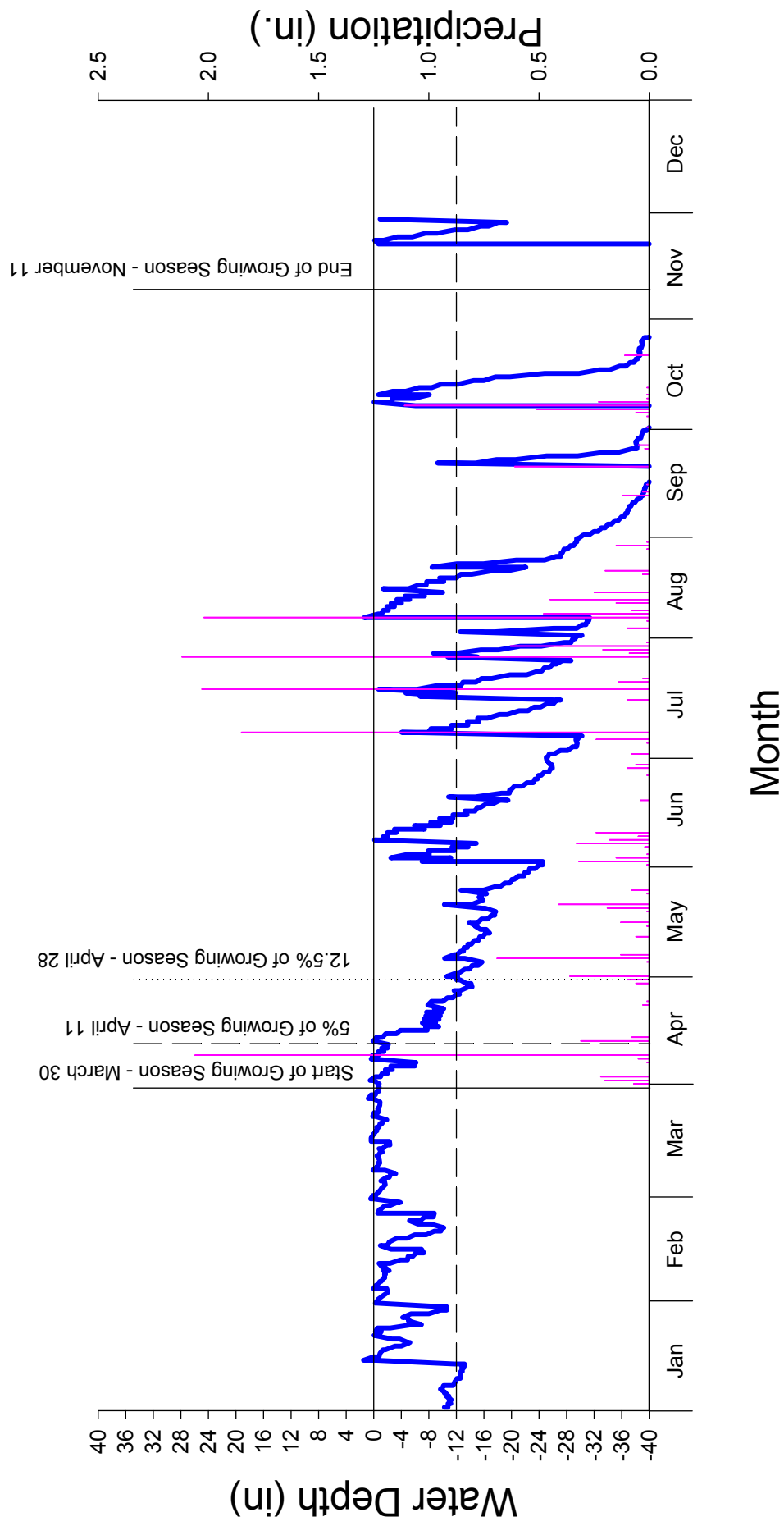


# Sandy Creek 2005 Monitoring Gauge B- N3CF79C5



\* Breaks indicate > 40" below the ground surface

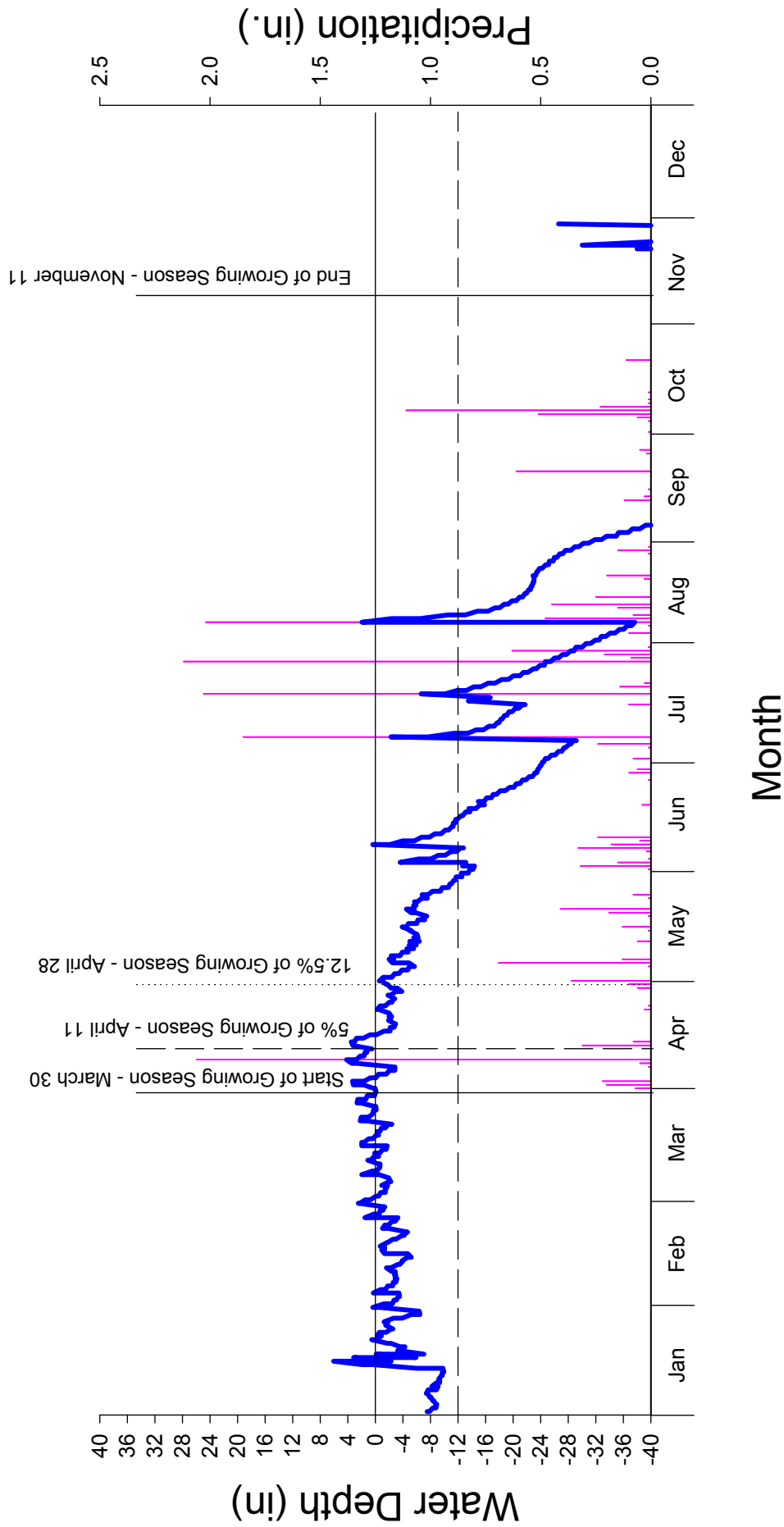
# Sandy Creek 2005 Monitoring Gauge C - N3CF7AB6



\* Breaks indicate > 40" below the ground surface



# Sandy Creek 2005 Monitoring Gauge Reference Site - N3CF7AEC



\* Breaks indicate > 40" below the ground surface