



<u>Project ID & Status</u>	<u>Project Setting & Background</u>	<u>Project Timeline</u>																
Project Name/Number: Lyle Creek EEP ID: 423 County: Catawba Project Type: Stream Restoration Current Status: 5 Years of Monitoring complete	Basin: Catawba Physiographic Region: Piedmont Drainage Area: 0.47 Impervious cover: <10% USGS Hydro Unit: 03050101 NCDWQ Subbasin: 03-08-32 Thermal Regime: Warm Trout Water: No Designer: Ecoscience	<table border="1"> <thead> <tr> <th>Milestone</th> <th>Date</th> </tr> </thead> <tbody> <tr> <td>Construction Completed</td> <td>2002</td> </tr> <tr> <td>As-built survey</td> <td>2002</td> </tr> <tr> <td>Monitoring Year-1</td> <td>Nov 2003</td> </tr> <tr> <td>Monitoring Year-2</td> <td>July 2004</td> </tr> <tr> <td>Monitoring Year-3</td> <td>Dec 2005</td> </tr> <tr> <td>Monitoring Year-4</td> <td>Sept 2006</td> </tr> <tr> <td>Monitoring Year-5</td> <td>Sept 2007</td> </tr> </tbody> </table>	Milestone	Date	Construction Completed	2002	As-built survey	2002	Monitoring Year-1	Nov 2003	Monitoring Year-2	July 2004	Monitoring Year-3	Dec 2005	Monitoring Year-4	Sept 2006	Monitoring Year-5	Sept 2007
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Project Assets

Segment/Reach	Mitigation Type	Approach	Linear Feet	Stationing (ft)	Comments
Reach 1 UT to Lyle Creek	R	P2	930	0+00-9+30	Channel restoration, in-place with use of grade control and bank protection structures.
Reach 2 UT to Lyle Creek	R	P1	1,137	9+30-20+67	Channel restoration, relocation with use of grade control and bank protection structures.
2 nd UT to Lyle Creek			800	N/A	Area included in conservation easement.

The project is being proposed for closeout and encompasses with 2,067 feet of stream at ratio of 1:1 yielding 2,067 stream mitigation units.

Project Background and Summary

The **Lyle Creek** Mitigation Site was developed by the NC DENR WRP/EEP and constructed in 2002. It is located in Catawba County and consists of 2,067 linear feet of restoration across 2 design reaches that included planting of the riparian buffer and protection of mature vegetation. The project also includes a tributary near the bottom of the project captured in the conservation easement. The upper reach (reach 1) was an incised G/F type stream and was restored in place through installation of a bankfull bench to improve the Bank height and entrenchment ratios (Figure 2). The lower reach (reach 2) was a severally incised G stream with bank height ratios ranging from 2.3-2.6, built off-line in its historical valley location restoring its pattern dimension and profile and re-attaching the bankfull discharge to the relict floodplain.

Goals and Objectives

1. Restore 2,067 feet of an unnamed tributary (UT) to Lyle Creek.
2. Enhance the riparian area by planting native species.
3. Exclude cattle access to the UT to Lyle Creek and 800 linear feet of a secondary unnamed tributary.

Success Criteria

Morphological

- Maintenance of a C/E stream type
- Modest change in W/D ratio
- Maintenance of a W/D ratio ≤ 15
- Bank height ratios < 1.4
- Max depths less than 3
- Entrenchment ratios > 2.2
- Maintenance of overall lateral and vertical stability
(< 0.5 foot in bed or bank movement per year)
- Maintenance of pattern (absence of chute cutoffs)

Hydrological

- 2 bankfull events

Vegetation

- 260 stems/acre target community

Project Vicinity Map

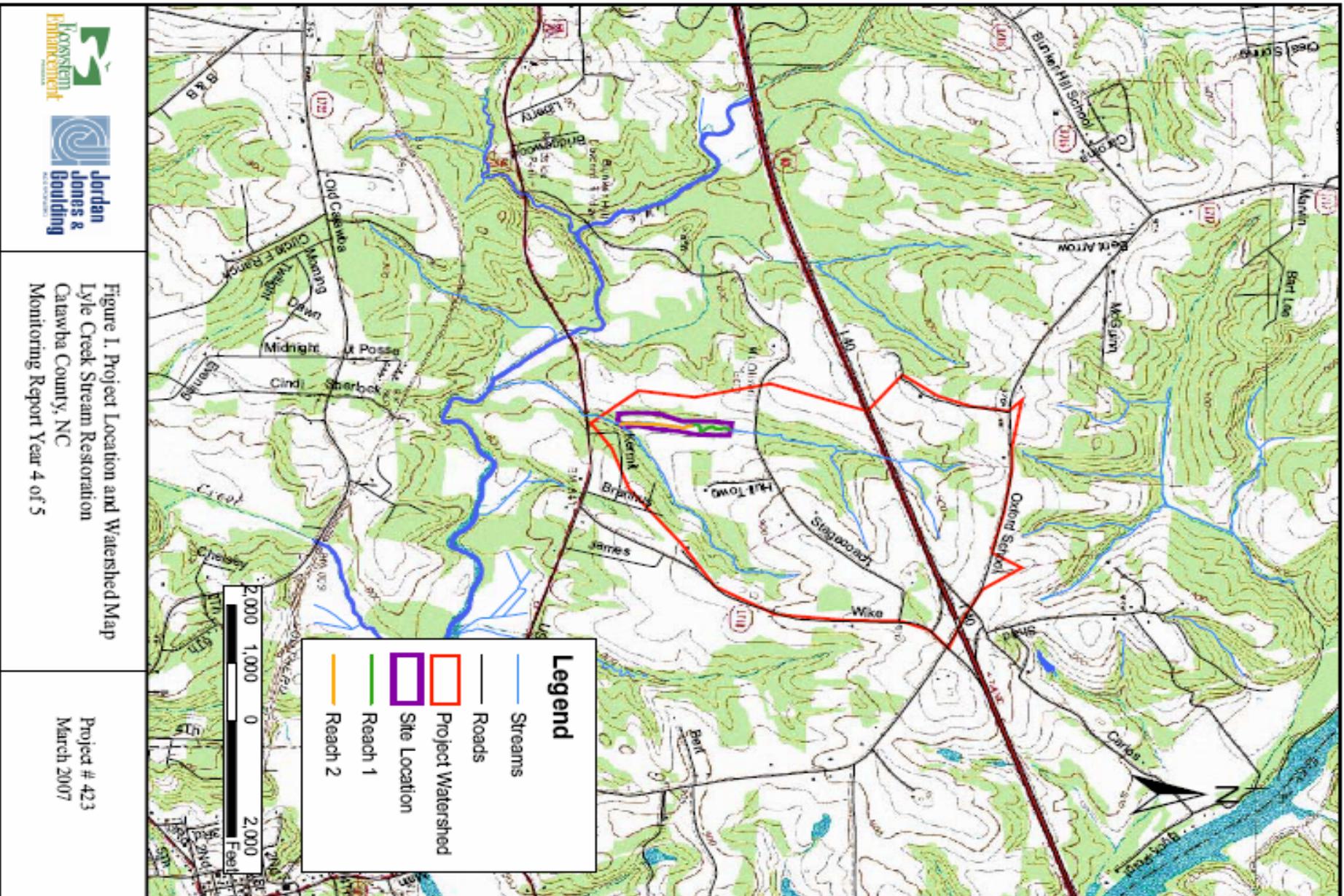
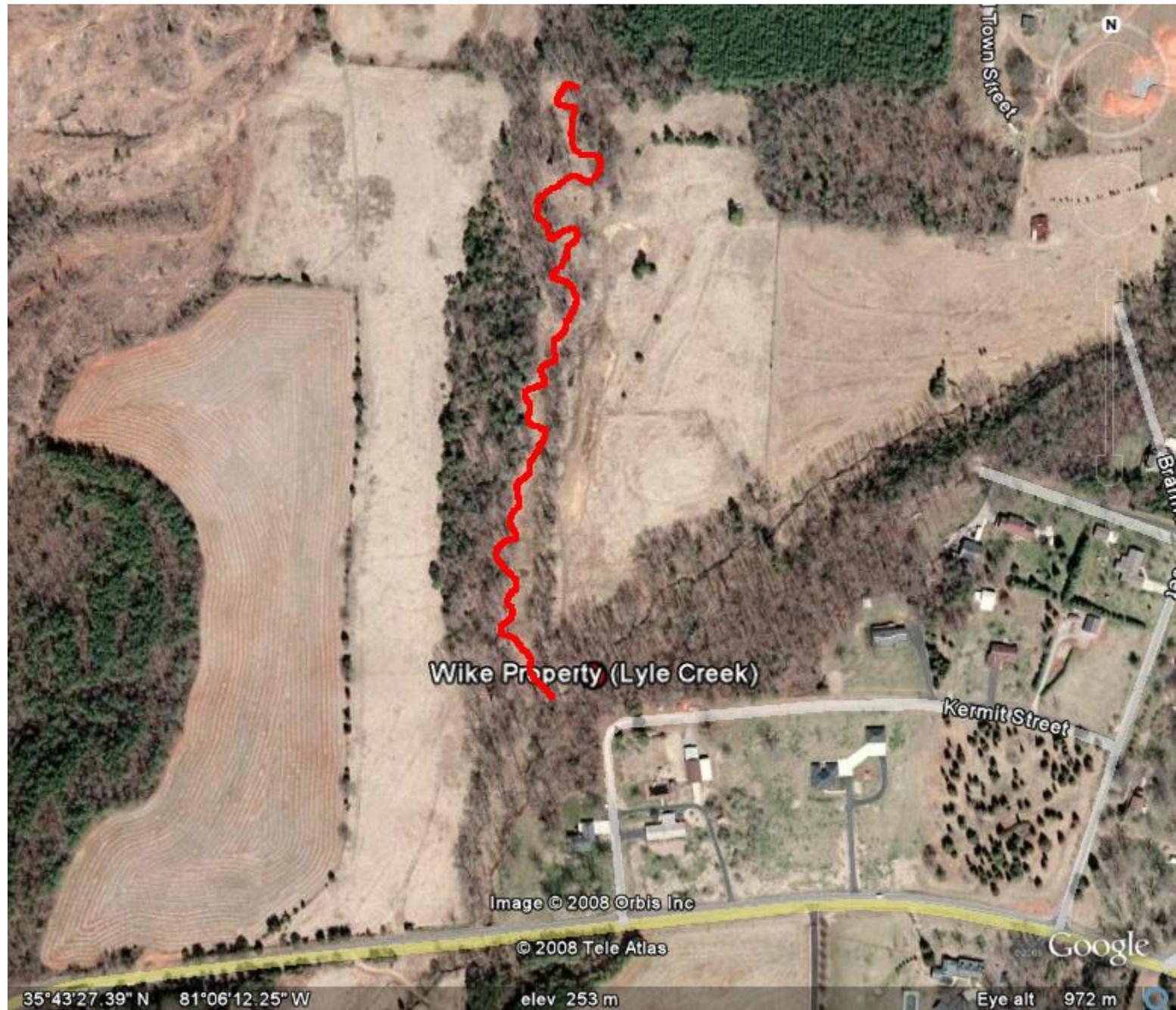
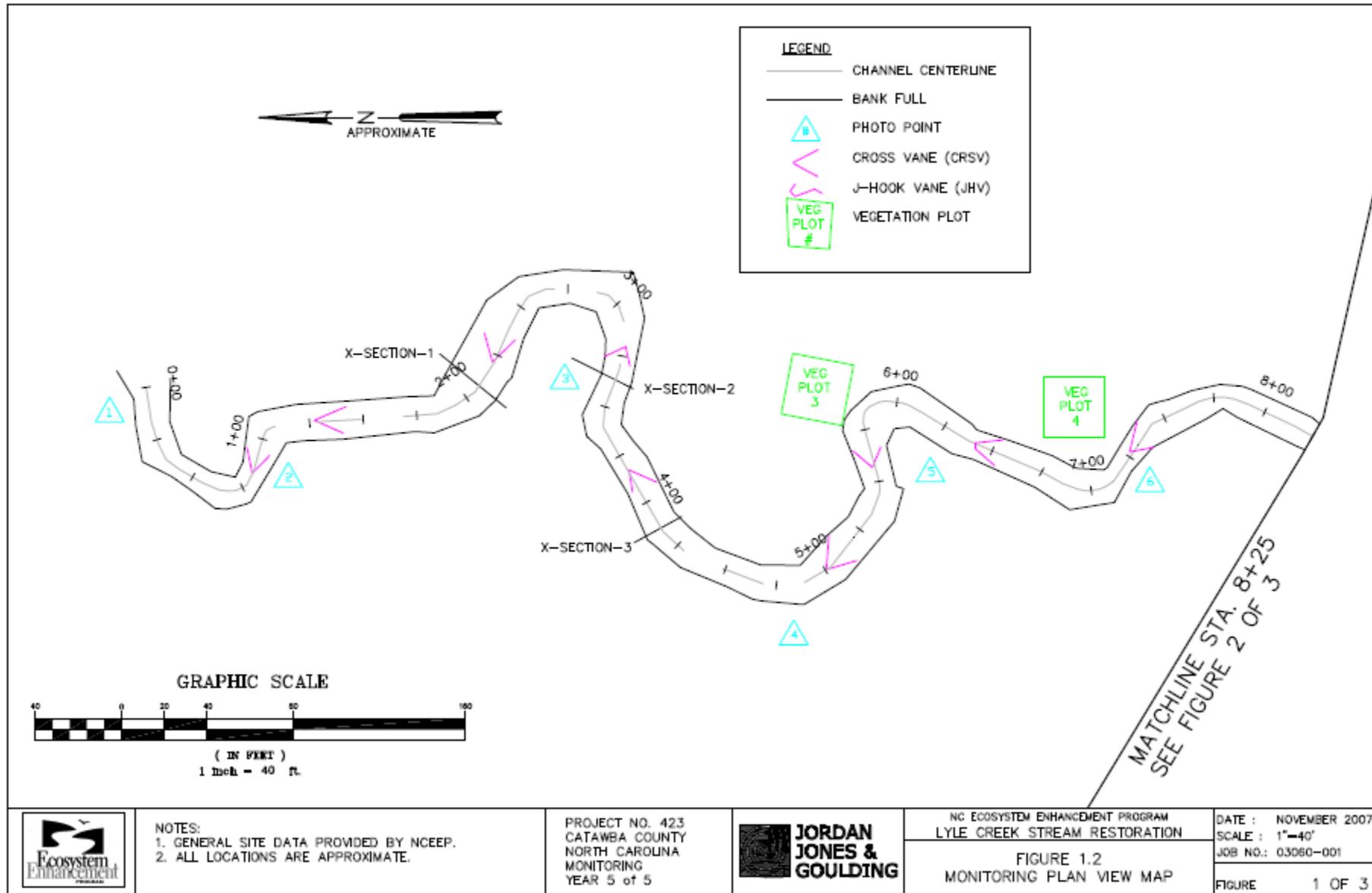
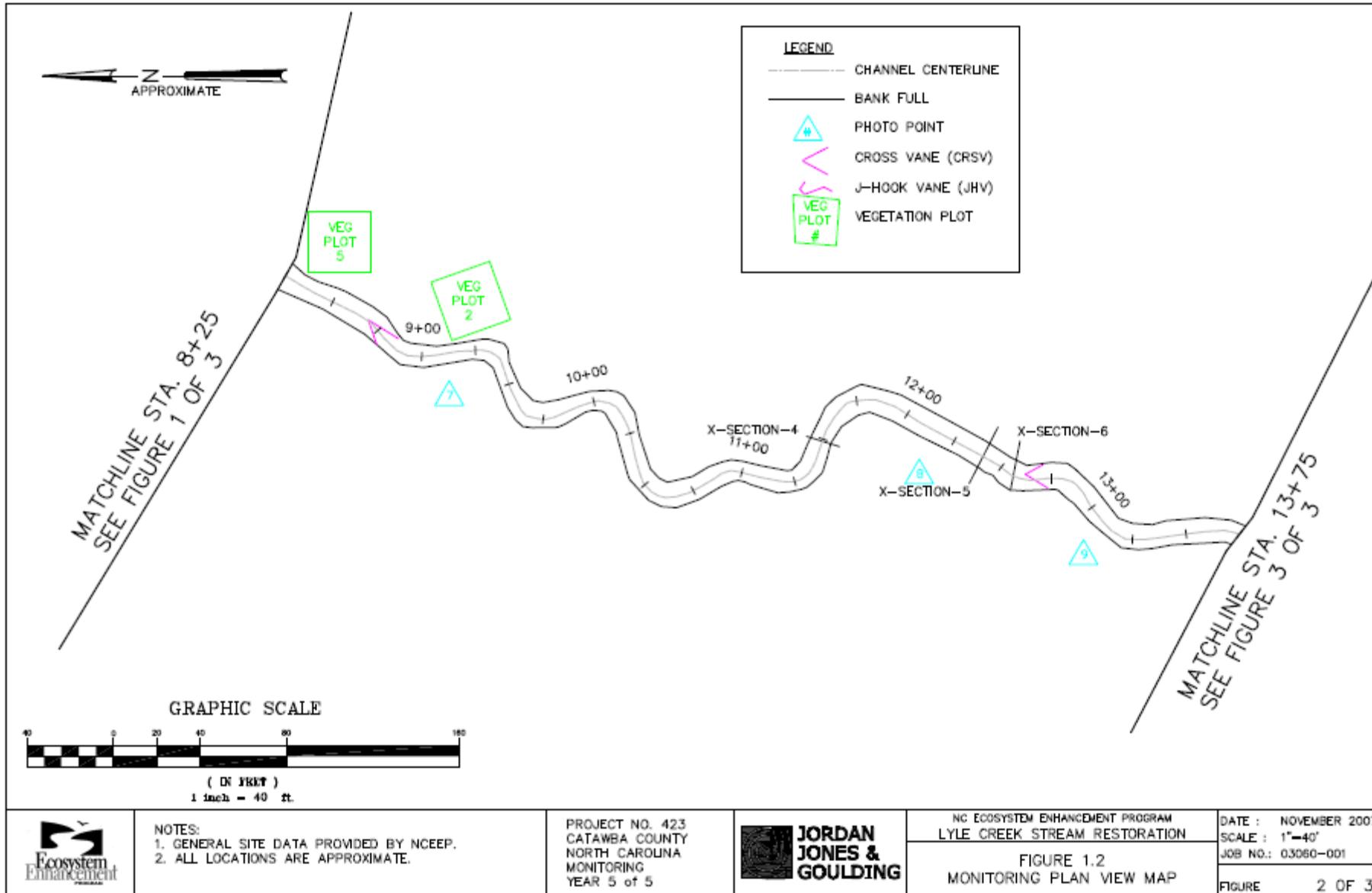


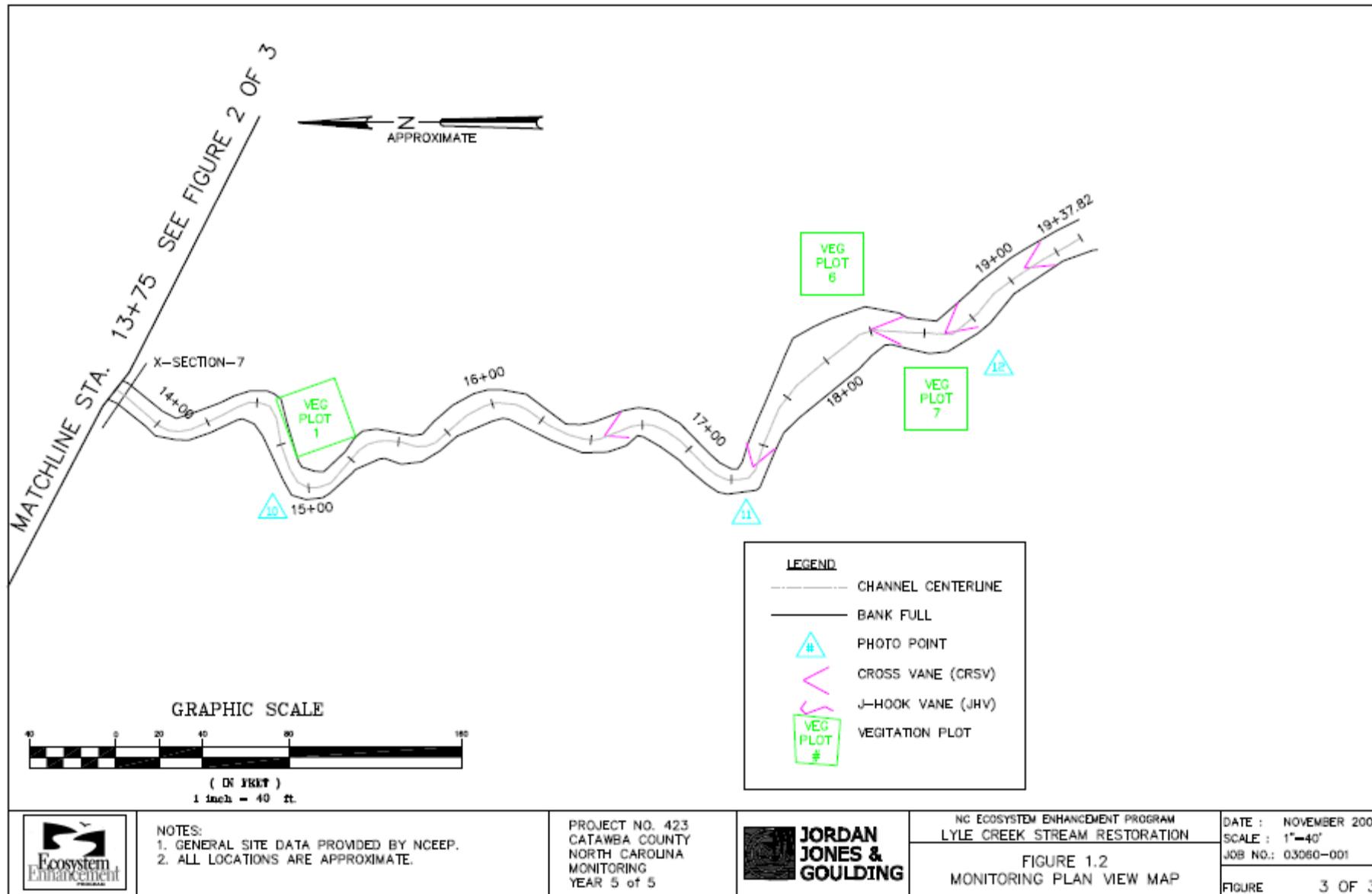
Figure 1. Project Location and Watershed Map
Lyle Creek Stream Restoration
Catawba County, NC
Monitoring Report Year 4 of 5

To access site from RT 40, take exit 138 and turn south onto Wyke Road. Turn right onto Stagecoach Road. Continue on Stagecoach for about 1 mile at which point the road will cross UT to Lyle Creek. The restoration project is located about 1,000 feet downstream from Stagecoach Road.









Pre-Construction Site Conditions (June 2001)



Post-Construction Site Conditions– May 2007 Photos



Morphological Stability

The data were collected by 4 different monitoring performers spanning the As-built phase through Year-5 and the collection of these data were hampered by the ability of one performer to locate some of the prior performers monuments for cross-sections. In addition, methods for survey evolved and changed over the monitoring period and it was determined that different performer's used different methods such as sight and laser levels with tapes or total station, which uses a fixed longitudinal stationing. In any case these factors undoubtedly introduced variability into the morphological overlays. Some channel adjustment did occur, but monumenting and methodological factors definitely had some impact on the data presentation. Cross-sections 1, 4 and 7 had to be reset when a new monitoring firm was introduced in late 2005 to complete 2006 and 2007. The amount is hard to state with certainty, but in the case of cross-sections, it appeared to be more of an issue of the cross-sectional aperture shifting in the XY space, while with the longitudinal profile it appeared to be stationing issues from differences between the sight/laser level and total station survey methods. The methodological policies were put in place within the last 2 years to minimize this for future projects, but some of these earlier projects were impacted by these factors to a larger extent than others. Additional variability was introduced by bankfull calls being made in the field each year as opposed to establishing a fixed bankfull datum from which all calculations were to be derived. However, the dimensional morphological measurements for riffles were re-examined for each year with a fixed bankfull datum and the variables (e.g. max depths and width, area) were recalculated.

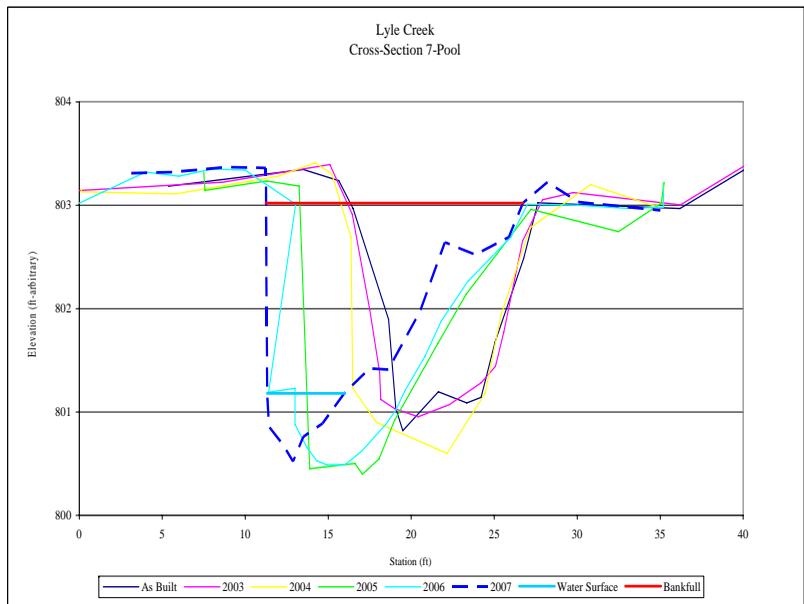
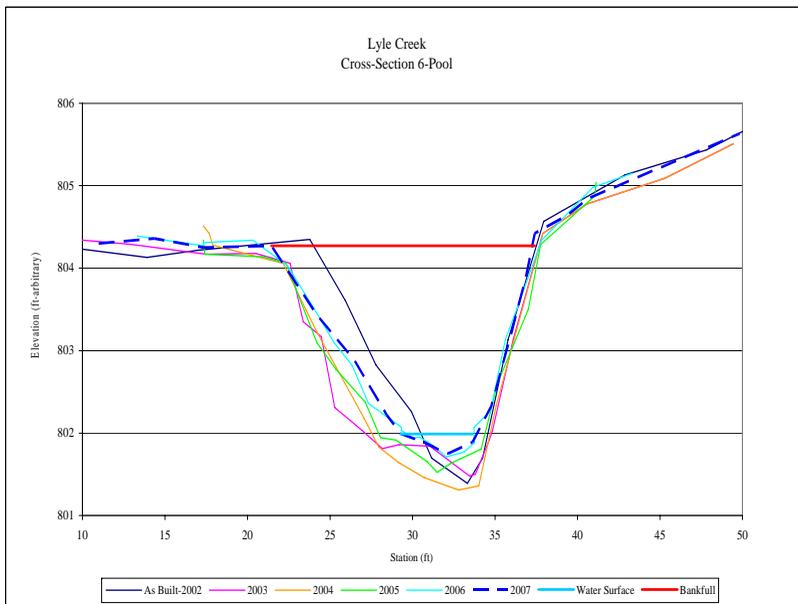
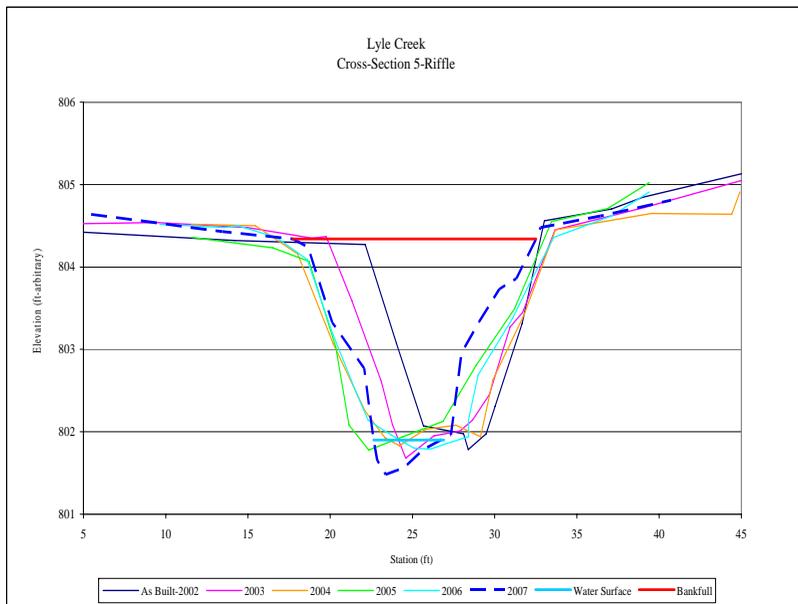
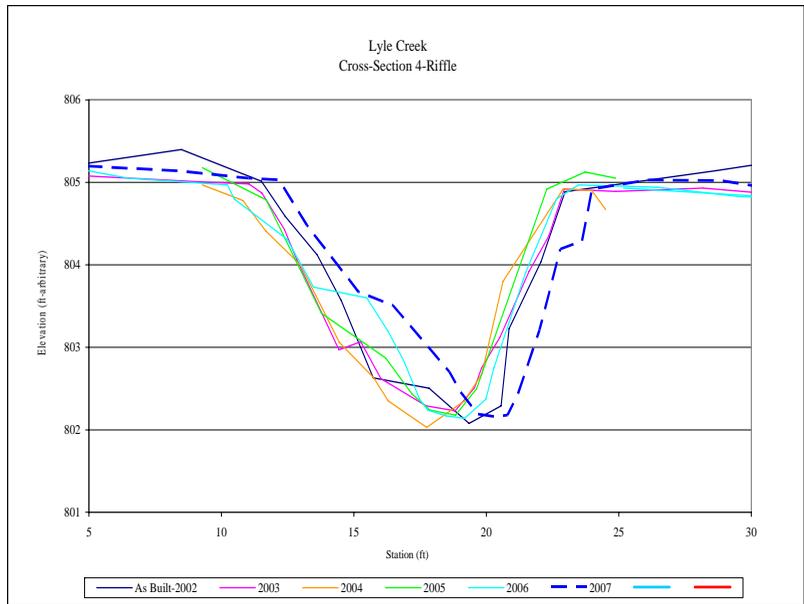
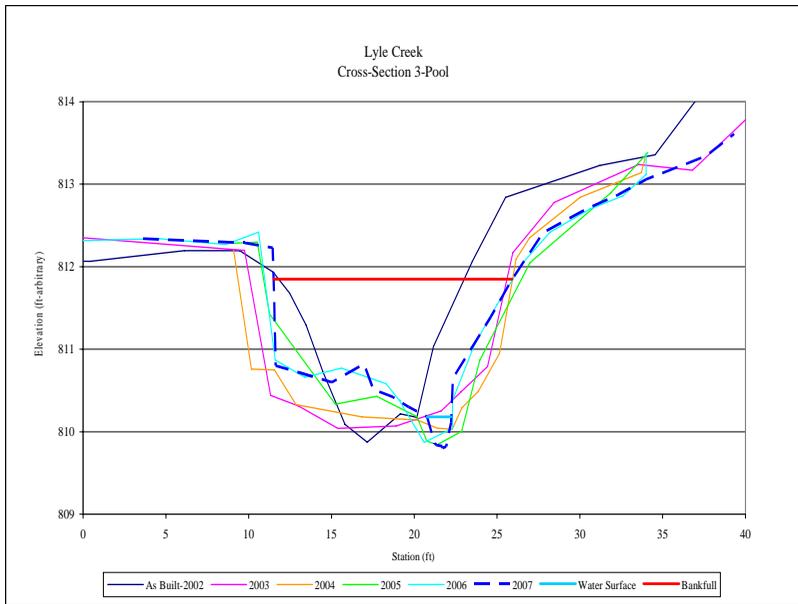
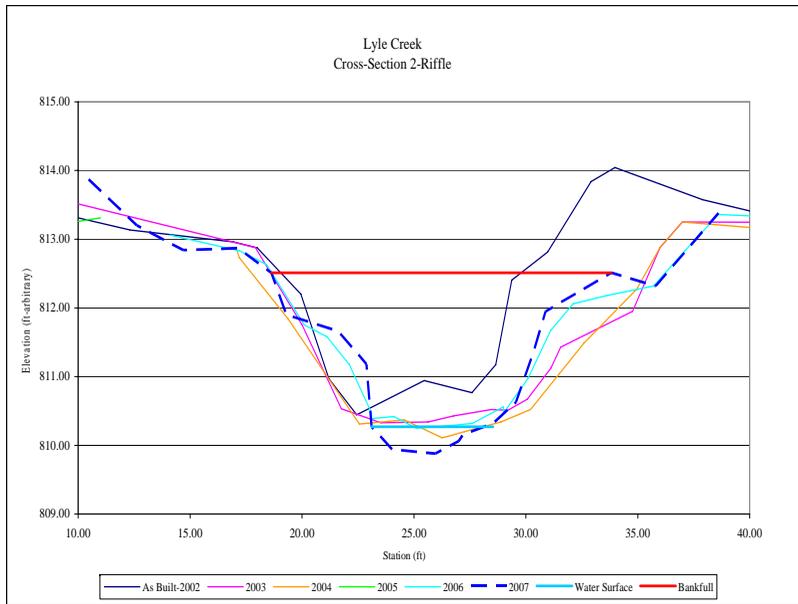
Dimension

Upper Reach

The projects dimension exhibited some localized instability through the course of the monitoring period. The riffle cross-section (cross-section 2) for the upper reach exhibited some widening and an aerial increase after construction, however this one cross-section was not representative and was placed in a short riffle just downstream and within the influence of a large crossvane. This was placed way down in the glide essentially in the riffle and in 2003-2005 this riffle appeared to undergo deepening and widening typical of a pool downstream of a structure. This practice is not longer typical in designs today. The data from 2007 indicates a stabilizing trend in the form of narrowing of the cross-section below the top of bank. The upper reach was also subjected to sands and fine material from the watershed and banks above the project. During some points in the monitoring period there was aggradation in the features that was evident, but the majority of these features (96%) were described as sufficiently deep in 2006 and 2007.

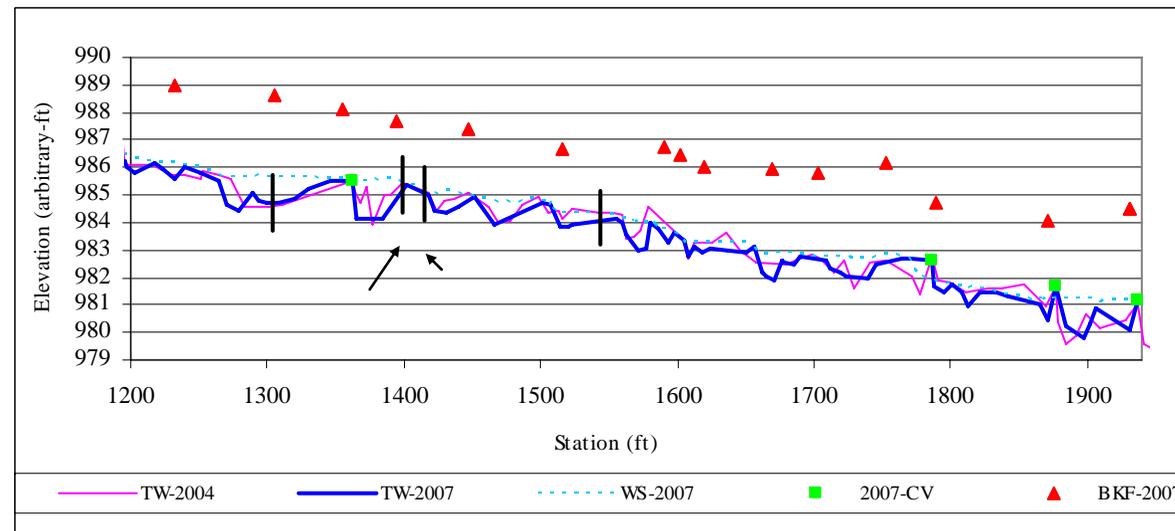
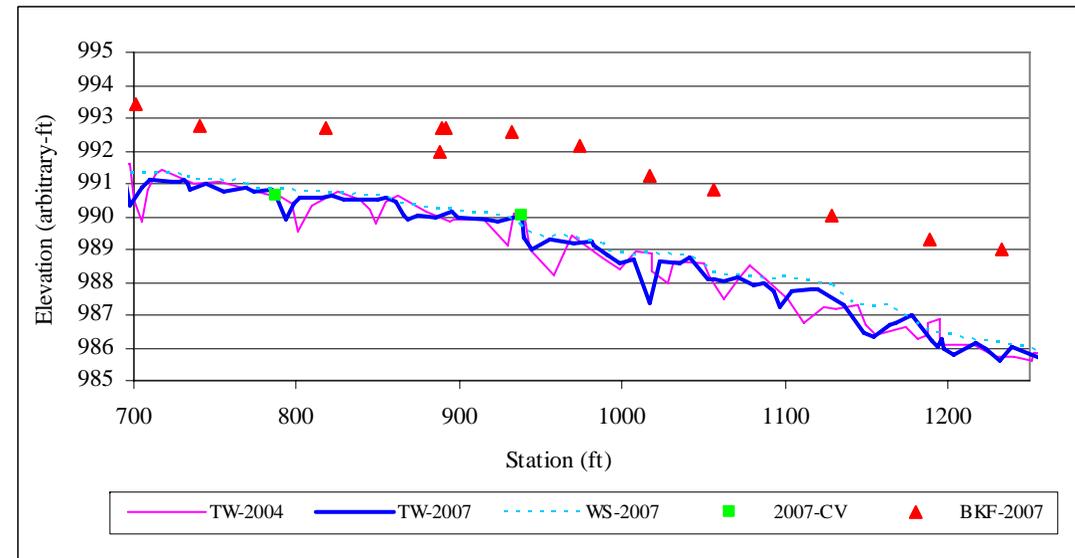
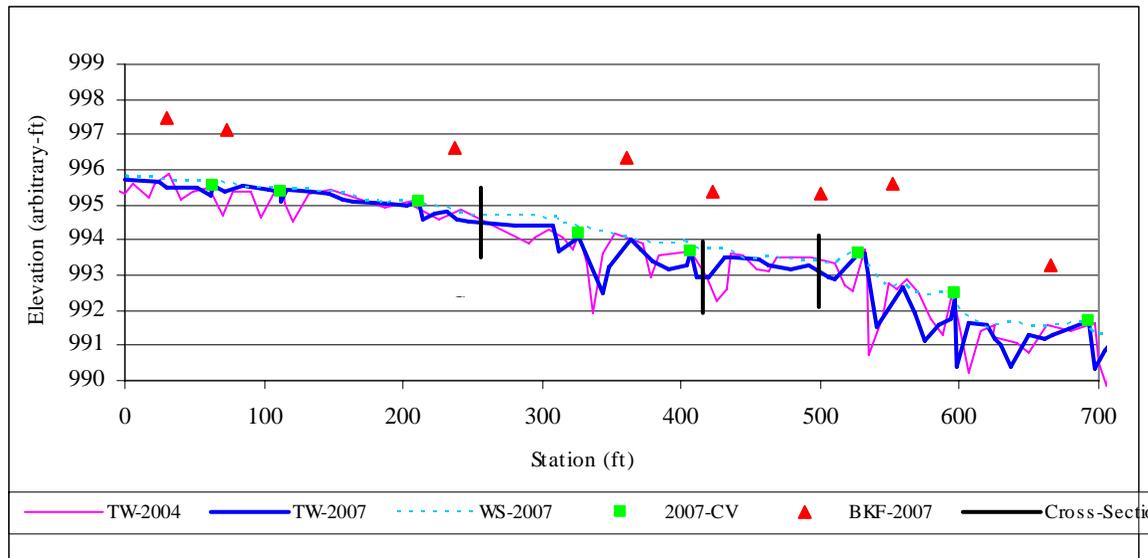
Lower Reach.

The lower reach was subjected to more stress than the upper reach in that there was more bank erosion, especially the lower 200 feet. The highly sinuous nature of this reach and the valley slope applied pressure on this reach, which exhibited some longitudinal bed migration, where riffles were being pushed downstream and the meander below would experience some erosion (~ 16% of the reach), but this appears to have slowed and arrested. The riffles in this reach exhibited some widening in 2004 ad 2005, but have exhibited narrowing below the top of bank in 2006 and 2007with the advancement of vegetation (See Figure below). This reach was also subjected to a headcut, which brought the channel bed down ~0.5 feet. These areas of instability have not changed appreciably in the last 3 years and it is believed that the mature trees that were maintained on the site and incorporated into design, where possible have achieved an equilibrium with the tight curvatures and the tighter E channel cross-section.



Profile

The aforementioned methodological differences prompted the monitoring consultant to utilize data from 2004 and 2007 to describe the stability of the projects profile. These two years utilized a total station with a fixed CAD stationing (see Figure) that permitted consistent comparison. The profile over this time period has generally maintained distinctiveness of the bed, with the exception of the top 100 feet, which is the transition point for the fine material that is entering the reach from the watershed above. Approximately 97% of the pools and 75% of the riffles have maintained their respective forms based on the 2007 visual assessment. The profile over this period has exhibited no systemic changes in elevation. However, there was a small headcut in the lower reach, and some of the aforementioned bed feature migration, which has since arrested.



Substrate

While there is coarse material in the channel, the pebble counts conducted at the projects cross-sections indicates that fine material entering the system has prevented further coarsening. It is possible with the re-narrowing of the channel that shear will increase in these cross-sections and maintain a coarser substrate distribution in the future. Interestingly, up until the drought peak in 2007, the benthos improved steadily, indicating the substrate and the habitat may have been in sufficient abundance and distribution to support a healthier benthic community (see benthos discussion below).

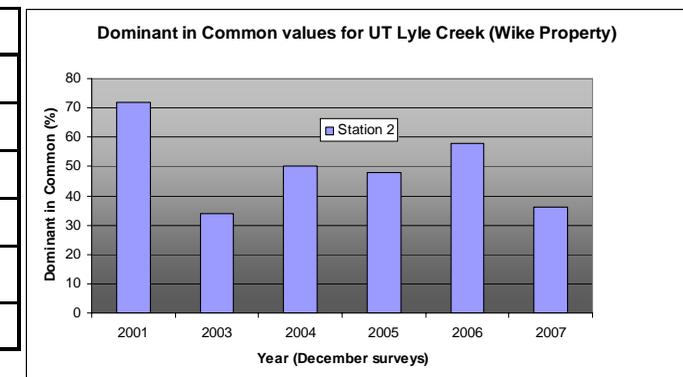
Structures

Many of the 17 structures on the site were documented by the monitoring performer as having some form of back arm scour or minor piping. Most of these in EEPs estimation were so minor that they did not warrant cataloging. Refined criteria and guidance are being developed to further standardize the visual observations that are performed in the field to provide greater consistency and limit false positive and false negatives in these assessments. However, there were some serious structural issues at the bottom of the project, where the bottom most crossvane was completely cut around and collapsed. The structures above these were described as stressed, but holding grade.

Instream Biological Assessments of the Benthos

The site was monitored by David Penrose of DWQ and NCSU from 2001 through 2007 to assess the macrobenthic invertebrate community. The data indicated that the community at the sampling location within the restored area was recovering steadily since construction and had achieved levels approaching the upstream reference location. In 2007 most metrics for both sites indicated decreases. This was thought to be a result of the very low base flows in relation to the drought.

Metric/Date	UT Lyle Cr. #1, Reference						UT Lyle Cr. #2, Restored					
	12/01	12/03	12/04	12/05	12/06	12/07	12/01	12/03	12/04	12/05	12/06	12/07
Total Taxa Richness	44	45	30	40	42	23	51	30	32	36	39	23
EPT Taxa Richness	16	22	14	21	21	12	17	9	14	15	17	10
EPT Abundance	94	114	71	104	97	63	84	33	51	79	72	25
Dominant in Common Index (%)*	-	-	-	-	-	-	72%	34%	50%	48%	58%	36%
# Indicator Taxa	10	10	12	14	16	9	7	4	8	6	14	5



Summary of Stream Data

The site has experienced some stressors due to the sinuous nature of the channel, especially in the steeper and more confined valley in the lower reach, but the data indicate that these adjustments have mostly stabilized and there are indications in the dimensional data that the channel is narrowing up below the bankfull elevation and possibly building an inner berm. These areas of instability seem to have reached an equilibrium with the surrounding vegetation. The site experienced multiple bankfull events. One event was recorded via crest gauge in both 2006 and 2007. The crest gauge was installed in 2005, but the site was exposed to other events during the monitoring period as noted by alluvium and wrack on prior visits, including the remnants of hurricanes Ivan and Frances in Fall 2004.

The project met most of the specific morphological success criteria in the approved mitigation plan cited on page 2. All of the morphological success criteria were met with the exception of the requirement that the substrates D50 exceed 2 mm and some instances of lateral migration. This is believed to be the result of upstream fines imported to the system even under low flow conditions. As the channel continues to narrow it should produce a more effective removal of fines.

The lateral migration of some meander bends, especially in the earlier part of monitoring period were greater than the criteria allowed as well, but the site appears to have reached equilibrium with the large vegetation that was accommodated in the design. The vane structure at the bottom of the project has exhibited complete failure, but those above it are mainlining grade. All of the other morphological and hydrologic criteria were met and therefore the project is proposed for closeout at this time.

2008 Lyle Creek Vegetation Data

Summary

The data in table 1 suggests substantial mortality of planted stems has occurred in years 1-4. However, after evaluating the site and reviewing the 3 different monitoring approaches that were applied during years 1-4, EEP believes the data is inconsistent and does not reflect the actual condition of the woody vegetation within the easement. The data in table 2 more accurately characterizes the current condition of the buffer with an average planted stem density of 549.2 stems per acre in year 6. Moreover, table 2 indicates no mortality occurred between years 5 and 6, and the vigor was determined to be predominantly excellent (74%) in year 6 with the most dominant of 24 species being *Betula nigra*.

Table 1

Stem Counts Per Acre By Plot							
MY	CY	Ave	Plots				
			1	2	3	4	
Y1	2002	630.0					Transects (8'x600') (0.11 acre) (10%)
Y2	2003	70.0	0	40	240	0	NCSU Quads
Y3	2004	70.0	0	40	240	0	NCSU Quads
Y3	2004	607.0	1174	243	405		2002 Plots Established by Designer (3)
Y4	2005	404.7	567	243	405		2002 Plots Established by Designer (3)
Y5	2006	See Table 2 CVS-EEP Protocol Project Summary					
Y6	2007	See Table 2 CVS-EEP Protocol Project Summary					

Table 2

Project/Status		Requirments/Approach				Living Stems						Species		Vigor										
name	year	req'd stems	plots	Sampling Dates		Planted & Natural Total Live	Planted				Excl. Live Stake	#	Most Dominant Species (most stems per project)	% of stems	4	3	2	1	0	unlike to surv year	dead	miss	unkn	other
				Start	End		per acre	diff to req	mortality	per acre														
Lyle Creek	4	288	7	09/27/06	09/28/06	2220.0	549.2	229.2	0.0%	549.2	229.2	23	Betula nigra	33.1%	25%	49%	20%	5%						
Lyle Creek	5	260	7	09/24/07	09/25/07	1948.3	549.2	229.2	0.0%	549.2	229.2	24	Betula nigra	36.8%	74%	8%	13%	1%				4%		

Vegetation Plot Photos



1. Monitoring Plot 1



2. Monitoring Plot 2



3. Monitoring Plot 3



4. Monitoring Plot 4



5. Monitoring Plot 5



6. Monitoring Plot 6



7. Monitoring Plot 7

Photos were taken during the vegetation Assessment Conducted September 27-28, 2006