Stonebridge Mitigation Project
Moore County, North Carolina

Year 2 Monitoring Report

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1.0 SUMMARY

The Stonebridge Stream Mitigation Project site is located in Moore County, North Carolina, north of the town of Carthage within hydrologic unit 03030003 in the Cape Fear River Basin. This project was identified by EBX-Neuse I, LLC (EBX) as having potential to help meet the compensatory mitigation requirements of the NC Department of Transportation (NCDOT). NCDOT contracted with EBX to perform the mitigation work under Full Delivery Project S-1. A total of 6,120 stream mitigation units (SMU) were generated from this project through stream restoration. All restoration is being monitored for five years to document success. Baseline data on stream morphology and vegetation were collected immediately after construction and planting were complete. This information is documented in the As-Built Report dated April 27, 2006. The As-Built survey is included as Appendix A of this report. Information on stream morphology and vegetation will be collected each year and compared to the baseline data and data from previous monitoring years.

This report details the monitoring data collected during Monitoring Year 2. Collected data included: monthly crest gauge readings, monthly observations of current conditions, vegetation monitoring, benthic macroinvertebrate survey, cross section survey, digital images, and observations of potential problems with stream stability.

With an average of 558 stems per acre, the site is currently on track to achieve the interim success criteria specified in the Mitigation Plan. Areas surrounding vegetation plots 4 and 5 were replanted with 2-year-old trees prior to the start of the 2007 growing season to address high mortality in these plots. Based on 2007 monitoring results, these plots are now on track to meet the specified interim success criteria specified in the Mitigation Plan.

There have been at least three out-of-bank or bankfull events since the project was constructed. The stream morphology remains stable and very little fluvial erosion was observed during the 2007 monitoring season.

Overall, the project is on track to achieve the stream and vegetative success criteria specified in the Mitigation Plan. Due to the severe drought throughout North Carolina, little water was observed to be in the channel during site visits. Habitat has been improved significantly throughout the project. Based on initial observations, site vegetation is expected to succeed and provide riparian habitat, water quality benefits, and cover for the stream system.

2.0 INTRODUCTION

2.1 PROJECT

The project site is located in Moore County, North Carolina, north of the town of Carthage (**Figure 1 & Figure 2**) within hydrologic unit 03030003 in the Cape Fear River Basin. The project site is accessed from the west via Glendon-Carthage Road. The 1,196 acre parcel has been used for agricultural purposes as a cow/calf operation. The surrounding area is rural, covered with a mix of farms, woods and modest home sites. Dominant soil types on this project site include Congaree, Mooshaunee, Pinkston, and Tetotum.

Two unnamed tributaries to Crawley Creek flow across the project site. The streams are referred to in this Annual Report as UT-1 and UT-2. UT-1 has a drainage area of 688 acres and UT-2 of 182 acres. Prior to implementation of the mitigation plan, the streams were in a disturbed condition due to the impacts of unrestricted cattle access, dredging, and other anthropic channel manipulations.

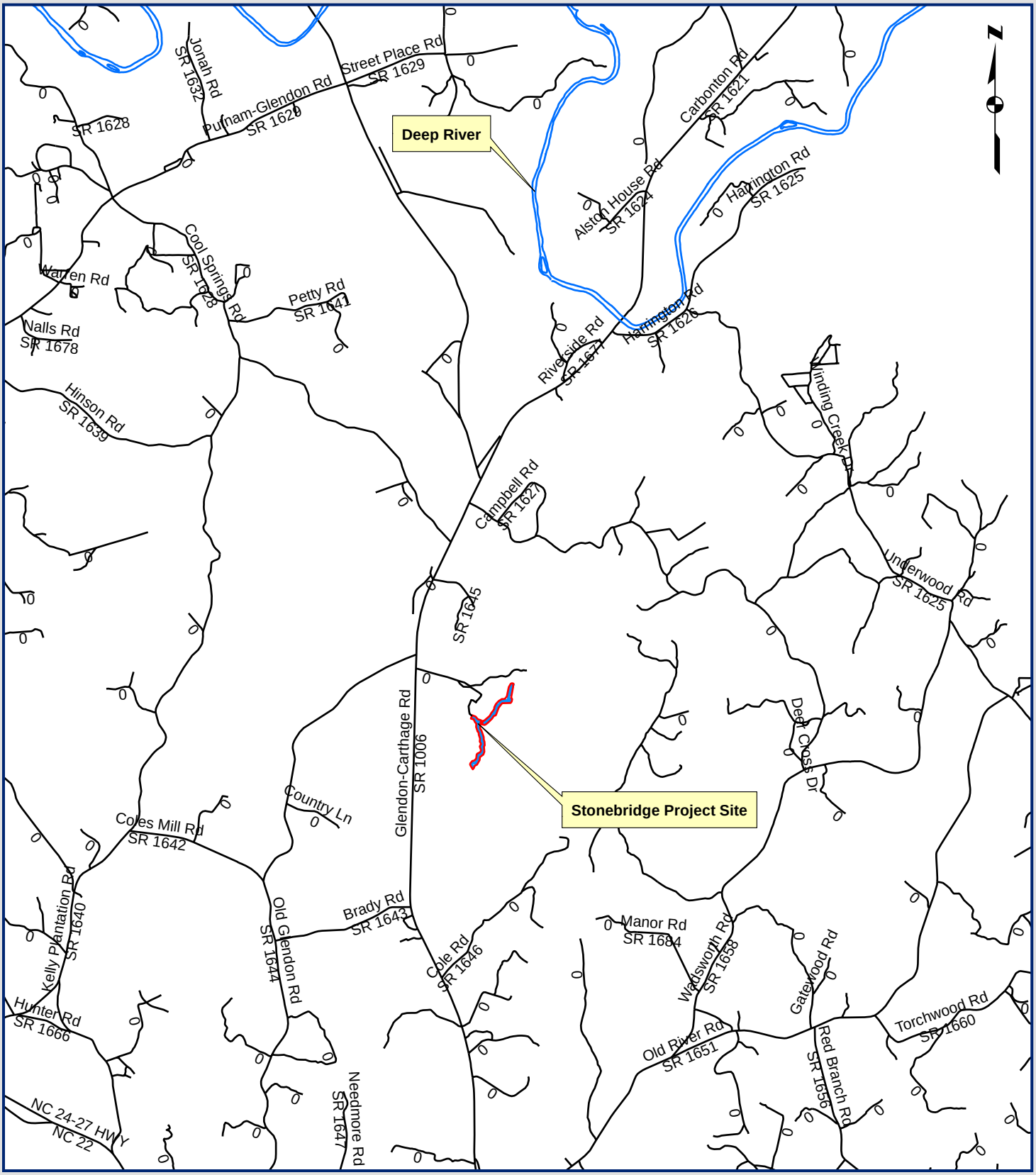


Figure 1.
Stonebridge Stream Mitigation Site
Project Location Map
Moore County, NC

1 inch equals 1 mile

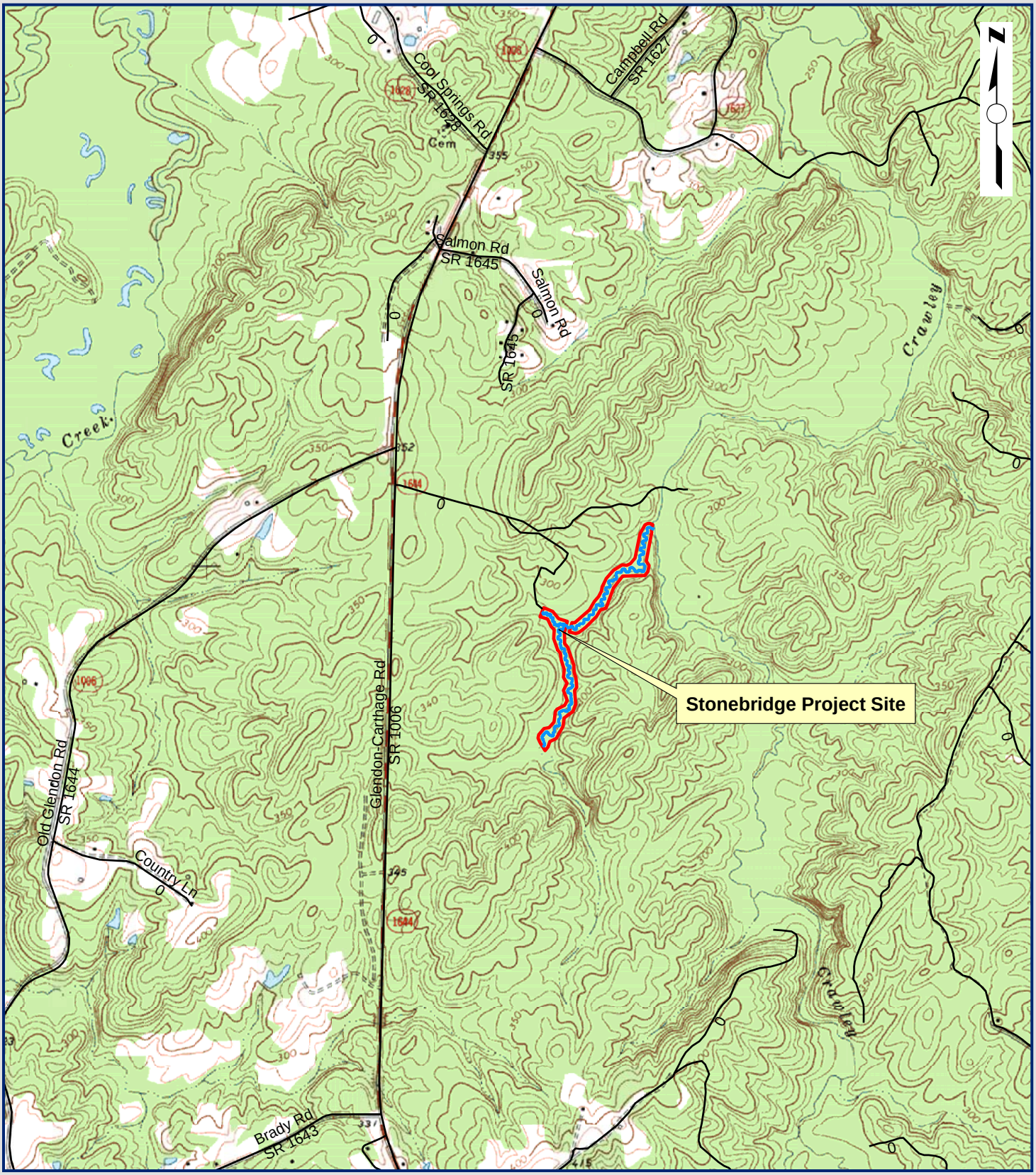
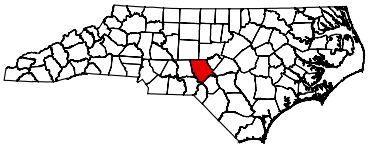


Figure 2.
Stonebridge Stream Mitigation Site
USGS Topographic Map
Moore County, NC

1 inch equals 2,000 feet



UT-1 was the most degraded resource and was the focus of restoration efforts. A total of 5,556 stream mitigation units (SMU) were achieved by restoring plan form, cross section, and profile features on UT-1. This number is derived from the as-built survey of 5,676 linear feet of restored stream length minus 70 feet for a crossing reservation near the middle of the project and minus another 50 feet adjacent to the culvert at the downstream end of the project. UT-1 was restored to a Rosgen Classification of C4/E4.

UT-2 was similarly degraded and flows east-southeast from a small dam, entering UT-1 near the center of the project area. The design for this small tributary yielded an additional 564 linear feet of restored stream. The total SMU's generated from stream restoration on UT-1 and UT-2 are 6,120. The entire easement including UT-1 and UT-2 is entirely fenced in.

2.2 PROJECT PURPOSE

This project was identified by EBX-Neuse I, LLC as having potential to help meet the compensatory mitigation requirements of the NC Department of Transportation (NCDOT) as solicited through the NCDOT Full Delivery Project S-1. The objective of this project is to provide at least 5,556 stream mitigation units (SMU) to the NCDOT through the full delivery process. The mitigation units are to be accomplished through the restoration and enhancement of stream and riparian habitats as defined in the inter-agency Stream Mitigation Guidelines (USACE, 2003).

2.3 PROJECT HISTORY

This project was identified by EBX-Neuse I, LLC in the spring of 2003. The following table outlines the project history and milestones (**Table 1**).

Table 1 Project History and Milestones

Activity or Report	Completion or Delivery
Mitigation Plan	June-05
Final Design	December-05
Construction	February-06
Vegetation Planting	March-06
As-built (Baseline) Report	April-06
Year 2 Monitoring	November-06
Supplemental Vegetation Planting	March-07
Year 2 Monitoring	November -07
Year 3 Monitoring	November -08 (Scheduled)
Year 4 Monitoring	November -09 (Scheduled)
Year 5 Monitoring	November -10 (Scheduled)

Because of high mortality recorded in some monitoring plots, a supplemental planting with 2-year-old trees was performed on a portion of the site near Plots 4 and 5 in 2007. Shallow bedrock was noted around Plot 5 during the supplemental planting.

3.0 VEGETATION

3.1 VEGETATION SUCCESS CRITERIA

Specific and measurable success criteria for plant density within the riparian buffer on the site are based on the recommendations found in the WRP Technical Note and correspondence from

review agencies on mitigation sites recently approved under the Neu-Con Mitigation Banking Instrument. The interim measure of vegetative success for the Stonebridge Mitigation Site will be survival of at least 320 planted stems per acre at the end of the Year 3 monitoring period. The final vegetative success criteria will be the survival of 260 planted trees per acre at the end of Year 5 of the monitoring period (U.S. Army Corps of Engineers et. al. 2003).

Success of riparian vegetation will be evaluated annually through monitoring planted stem survival and photo documentation of vegetation plots. An assessment of the natural regeneration of woody stems and herbaceous cover will also be performed. Up to 20 % of the site species composition may be comprised of volunteers. Remedial action may be required should these volunteers (i.e. loblolly pine (*Pinus taeda)*, red maple (*Acer rubrum)*, sweet gum (*Liquidambar styraciflua)*, etc.) present a problem and exceed 20 % composition.

3.2 DESCRIPTION OF SPECIES AND VEGETATION MONITORING

All vegetation was planted in March 2006 after construction was complete. Bare root native tree and shrub species were planted to establish forested riparian buffers of at least fifty feet on both sides of the restored stream. The plants were selected to establish vertical habitat structure and a diverse mix of species **(Table 2)**. The planted area consists of two zones. The first is a wetter zone predominantly consisting of moist soil species such as green ash (*Fraxinus pennslyvanica*), ironwood (*Carpinus caroliniana*), and elderberry (*Sambucus canadensis*). The second is a drier zone predominantly consisting of more mesic species such as yellow poplar (*Liriodendron tulipifera*) and Northern red oak (*Quercus rubra*). Black locust (*Robinia pseudo-acacia*) was planted as a nurse tree in the upland zone. The initial stocking of riparian plantings across the site was approximately 758 stems per acre. In addition to the riparian plantings, black willow (*Salix nigra*) cuttings bundles were installed on the outside of bends.

Table 2 Planted Tree Species

Common Name	Scientific Name	Wetland Status
Shrubs		
Elderberry	*Sambucus canadensis*	FACW-
Silky Dogwood	*Cornus amomum*	FACW+
Trees		
Black Locust	*Robiinia pseudocacia*	FACU-
Green ash	*Fraxinus pennsylvanica*	FACW
Ironwood	*Carpinus caroliniana*	FAC
Red Oak	*Quercus rubra*	FACU
Red Bud	*Cercis canadensis*	
River Birch	*Betula nigra*	FACW
Sweet Bay	*Magnolia virginica*	
Sycamore	*Platanus occidentalis*	FACW-
Tulip Tree	*Liriodendron tulipifera*	FAC

Fourteen 100 square meter vegetation sampling plots were established at the restoration site to monitor the success of riparian buffer vegetation. The locations of these plots were randomly distributed across the planted portions of the site. The plots cover approximately 2% of the site. The center of each plot is located with a ten-foot section of metal fence post with a white PVC cover. Each planted woody stem was located with a three-foot section of white PVC and identified with an aluminum tag. Planted woody species will be monitored twice per year each

year for the first three years. Herbaceous plant cover will be monitored annually using the notched-boot method. The total numbers of each species planted are listed in **Table 3**.

Because of high mortality and the low stems per acre documented in 2006 for Plots 4 and 5, these portions of the site were planted with 2-year-old trees in the spring of 2007 to supplement the surviving stems per acre. Approximately 600 stems were planted in and around these plots. The stems counts for 2007 reflect both the surviving original live stems and the supplemental stems planted.

3.3 RESULTS OF VEGETATION MONITORING

Stem counts were conducted at each monitoring plot during August 2007 to determine the success rates. All vegetation monitoring plots were evaluated for success and the overall condition of vegetation at the site was assessed. Stem counts were conducted at each monitoring plot during August 2007 to determine the success rates. **Table 4** shows the number of each species of woody plants that were planted at the site and the success rate of those species. The range of surviving planted stems per acre after the second year was 364 to 972, with an average of 558 planted trees per acre surviving at the site. Photos of each vegetation plot were taken at the time of the stem counts (**Appendix C**).

Table 3 Vegetation Monitoring Plot Species Composition and Survival Data

Species	Plots														Year 1 Totals	Year 2 Totals	Survival Rate
	1	2	3	4	5	6	7	8	9	10	11	12	13	14			
Shrubs																	
Common Elderberry										1						1	
Dogwood, silky		3	4	1	3	7	3	3	2	1	5	3	5	2	41	42	102%
Trees																	
Black Locust	1	1	1	1	3	2		1				1	1	1	12	13	87%
Green Ash	1	1		33	2	3		1		3	2		3	1	19	19	87%
Ironwood	2	2	4	2				2	5		1				20	18	90%
Northern Red Oak	1	1		1		4	1	1			1	2	1		12	14	117%
Redbud		1								2	2			3	10	9	90%
River Birch	3	1	1		3	3	1	3	4		1	2		2	31	24	77%
Sweet Bay		1				1			1			1	2		6	6	100%
Sycamore	1	1	4	2	4	1	6	1	2	5	3		1	1	31	32	103%
Tulip Tree			2			3			1	1	2	3		2	19	14	74%

Table 4 Vegetation Plot Species Survival Summary Data

Summary Data	Stems per Plot														Average
Baseline	16	20	21	16	24	29	14	16	17	19	20	17	14	19	18.7
Year 1	13	13	19	7	14	25	12	13	16	14	17	13	13	15	14.6
Year 2	9	12	16	9	15	24	11	12	15	13	17	12	13	13	13.6
	Percent Survival														
Year 1	81%	65%	90%	44%	58%	86%	86%	81%	94%	74%	85%	76%	93%	79%	78%
Year 2	56%	60%	76%	50%	59%	83%	79%	75%	88%	68%	85%	71%	93%	68%	72%
	Stems per Acre														
Baseline	648	810	850	648	972	1174	567	648	688	769	810	688	567	769	758
Year 1	526	526	769	283	567	1012	486	526	648	567	688	526	526	607	590
Year 2	364	486	648	405	648	972	445	486	607	526	688	486	526	526	558

Areas requiring further observation with respect to vegetation were identified within the project boundary (**Table 5**). During the current monitoring survey, Plot 1 was observed to be a potential problem area due to sparse herbaceous cover. Bare soil is exposed over much of the Plot providing less protection from drying conditions and increasing soil temperature. Areas in the vicinity of Plots 4 and 5 were replanted in March of 2007 to address low survival documented during 2006 monitoring. These plots are now on track to meet the interim success criteria. Photos of vegetation plots are included in **Appendix C**.

Table 5 Vegetation Areas Requiring Observation

Type of Problem	Location/ Station	Probable Cause	Photo ID
Potential mortality of planted woody species.	Vegetation Plot 1	Dry conditions	Photo 9 - VP 1

A plan view drawing of the vegetation areas requiring observation is provided in **Figure 3**. The drawing includes the appropriate information pertaining to vegetation monitoring of the project. The drawing shows the locations of the following features:

- Vegetation monitoring plots
- Vegetation plot photo points
- Locations of any vegetation problem areas.
- Symbology to represent vegetative problem types

Volunteer species will also be monitored throughout the five year monitoring period. **Table 6** shows the most commonly found woody volunteer species. Volunteer species were less obvious. This is most likely because of decreased germination, vigor, and survival due to the drought. The greater herbaceous cover also obscures smaller individuals.

Table 6 Volunteer Tree Species

Scientific Name	Common Name	FAC Status
Liquidambar styraciflua	Sweetgum	FAC+
Acer rubrum	Red Maple	FAC
Diospyros virginiana	Persimmon	FAC

3.4 GENERAL VEGETATION OBSERVATIONS

Despite the unusually dry summer, survival in most plots is good and a number of stems were noted to be resprouting. Plots were observed to be generally dry and the planted stems showed signs of drought stress. Stems have fewer leaves and many have a yellowish coloration with browning. The lack of rainfall may have exacerbated the mesic conditions which would lead to desiccation of moderately hydrophytic species. The river birch and tulip tree species survival appear to be most affected, showing a 23 and 26 percent reduction in survival, respectively, since Year 1.

STONEBRIDGE STREAM MITIGATION SITE
VEGETATION AREAS REQUIRING OBSERVATION

NC GRID
NAD 83

VEGETATION PLOT #1
HIGH MORTALITY

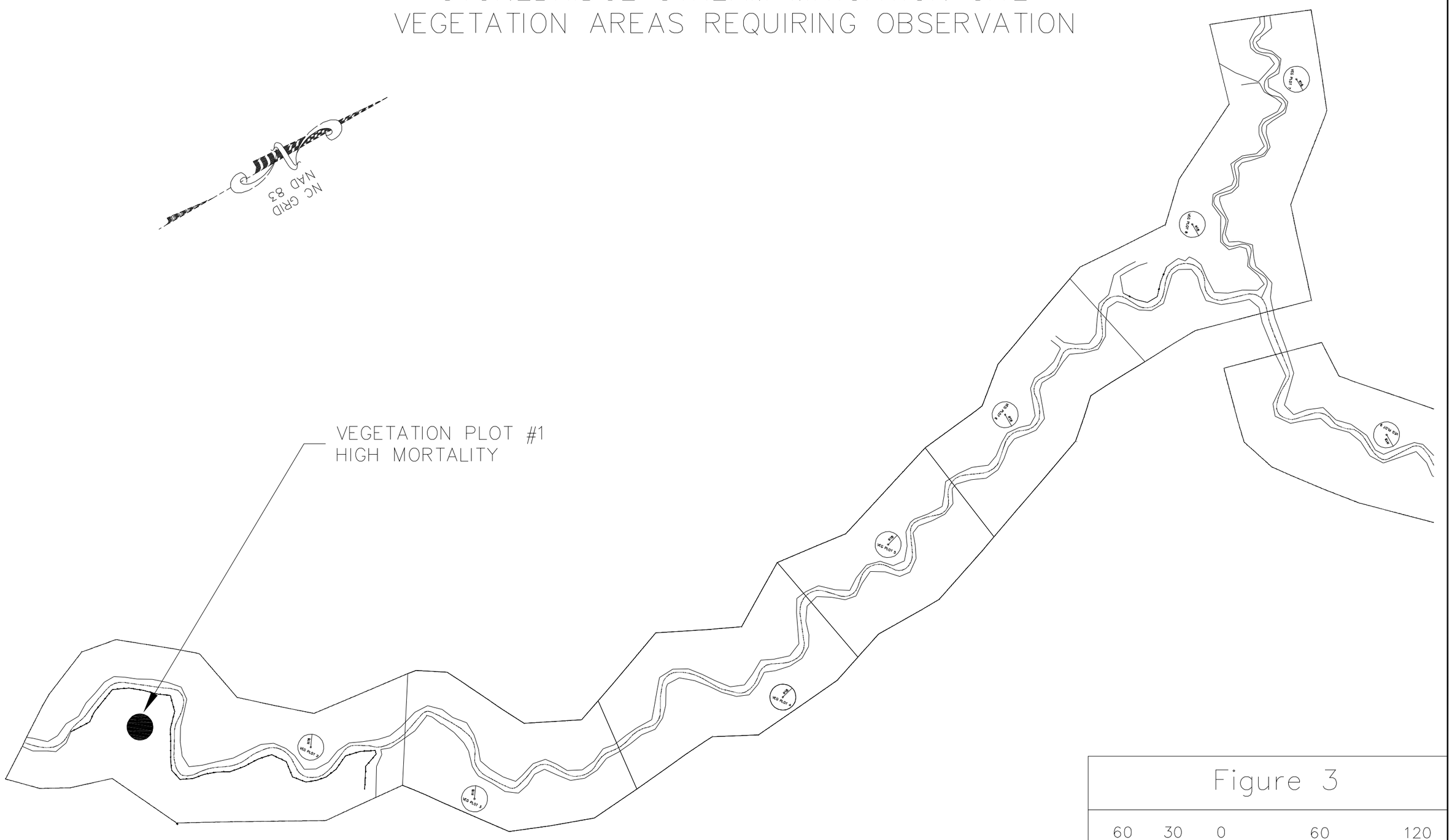


Figure 3

60 30 0 60 120

SCALE (FT)

The project overall has developed an adequate amount of herbaceous vegetation that consists of dog fennel (*Eupatorium capillifolium)*, poke berry (*Phytolacca Americana)*, horse weed (*Conyza Canadensis)*, pigweed (*Amaranthus spinosus)*, smartweed (*Polygonum pensylvanicum)*, fireweed (*Erechtites hieraciifolia)*, goldenrod (*Solidago Canadensis)*, and various grasses. Most of these species are old field and early successional. The herbaceous vegetation across the site is reduced in size and vigor because of the dry conditions. Overall, the herbaceous vegetation is not out-competing the planted community, although competition for the limited moisture this year may have contributed to mortality. The current drought conditions may impact the survival over the winter months.

3.5 VEGETATION CONCLUSIONS

This site was planted in March 2006 to create a riparian buffer along the restored channel. Bare root native trees and shrubs were planted in two zones, one wetter and the other more mesic. In addition, black willow live stakes were installed on the outside meander bends. There were fourteen 100 square meter plots established throughout the planting areas. The site was planted at an initial density of 798 stems per acre. Areas surrounding vegetation Plots 4 and 5 were replanted with 2-year-old trees at the start of the 2007 growing season to address high mortality in these plots. The 2007 vegetation monitoring documented an average tree density of 558 stems per acre. Plot 1 is currently near the interim success criteria of 360 stems per acre, having recorded 364 stems per acre. Overall, Stonebridge is on trajectory for meeting the interim success criteria of 320 trees per acre by the end of Year 3, and the final success criteria of 260 trees per acre by the end of Year 5.

4.0 STREAM MONITORING

4.1 SUCCESS CRITERIA

As stated in the Mitigation Plan, the stream restoration success criteria for the site include the following:

Bankfull Events: Two bankfull flow events must be documented within the five-year monitoring period.

Cross sections: There should be little change in as-built cross sections. Cross sections shall be classified using the Rosgen stream classification method, and all monitored cross sections should fall within the quantitative parameters defined for "E" or "C" type channels.

Longitudinal Profiles: The longitudinal profiles should show that the bedform features are remaining stable, e.g. they are not aggrading or degrading. Bedforms observed should be consistent with those observed in "E" and "C" type channels.

Photo Reference Stations: Photographs will be used to subjectively evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation and effectiveness of erosion control measures.

Benthic Macroinvertebrate and Fish Sampling: Sampling of benthic macroinvertebrates and fish within the restored stream channel shall be conducted for the first three years of post-restoration monitoring.

Plan view drawings of the project site are provided in **Figures 4a and 4b**. The drawings include the appropriate information pertaining to monitoring of the project. These drawings show the locations of the following features:

- Bankfull channel limits
- Centerline of channel
- Easement boundary

STONEBRIDGE STREAM MITIGATION SITE
OVERALL MONITORING PLAN VIEW

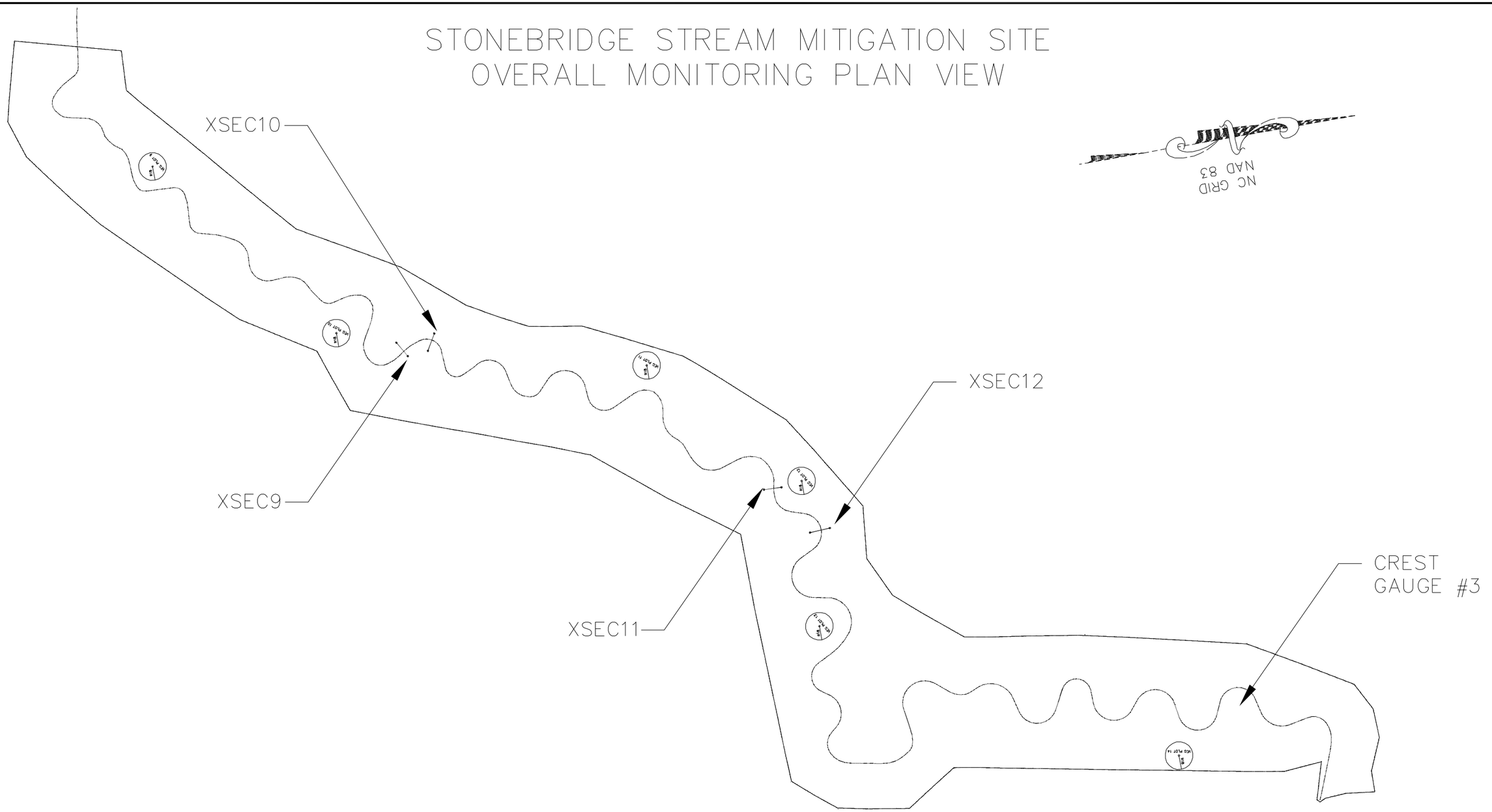


Figure 4b

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- Fencing
- Road crossings
- Root wads
- Log vanes
- Cuttings bundles
- Channel plugs
- Log toe protection
- Riffle grade control
- Cross weir structures
- Step pool structures
- Tributaries

The drawings show locations of monitoring activities as well. These include:

- Cross section survey locations
- Crest gauge locations
- Vegetation plots
- Benthic macroinvertebrate monitoring locations

4.2 STREAM MORPHOLOGY MONITORING PLAN

Along UT-1 and UT-2 a natural channel design approach was applied to develop stable hydraulic geometry parameters. Construction began in October 2005 and was completed in February 2006. The rebuilding of the channel established stable cross-sectional geometry, increased plan form sinuosity, and restored streambed diversity to improve benthic habitat. Approximately 6,120 linear feet of stream restoration has been constructed.

Cross Sections
The mitigation plan for the Stonebridge Stream Mitigation Project requires twelve permanent cross sections to be monitored along the restored tributaries UT-1 and UT-2. The cross sections were established during monitoring set-up in evenly distributed pairs of one riffle and one pool per 1,000 linear feet of restored stream. Locations of cross sections are specified in **Figures 4a and 4b**. The cross section surveys and photographs are shown in Appendix B. Each cross section will be surveyed annually including measurements of floodplain, top of bank, bankfull, inner berm, edge of water, and thalweg. In addition, any fluvial features present will be documented.

Longitudinal Profile
Longitudinal profiles will be surveyed in years one, three, and five of the monitoring period. The cumulative length of the measured profiles will be at least 3,000 linear feet. Features measured will include thalweg, inverts of in-stream structures, water surface, bankfull and top of low bank.

Hydrology
Three crest gauges were installed at the site: one on UT-1 near the downstream end of the project and one each on UT-2 and UT-1 immediately above the confluence (see locations in **Figures 4a and 4b**). Crest gauges will be checked monthly to document high flows. During each visit, a determination will be made if an out-of-bank event has occurred since the prior visit. During the gauge inspections, any high water marks or debris lines will be documented and photographed.

4.3 STREAM MORPHOLOGY MONITORING RESULTS

Photographs were taken throughout the monitoring season to document the evolution of the restored stream channel (see **Appendix C**). Herbaceous vegetation is moderately dense along the restored stream. The channel was dry during the latter part of the growing season, making it difficult to take photographs of the stream channel itself. Pools have maintained a variety of depths and habitat qualities, depending on the location and type of scour features (logs, root wads, transplants, etc.). During the early portion of the growing season, a consistent stream flow was present during the monthly site visits.

Very few problems with stream morphology were observed during the monitoring field visit. Photos of each structure taken during August 2007 are included in **Appendix C**. The locations of each structure (with numbers that correspond to the photos) are shown on a plan view in **Appendix C**.

A plan view drawing of the stream areas requiring observation is provided in **Figures 5a -5d**. The drawings show the locations of the following features:

- As-built stream centerline and bankfull limits
- In-stream structures (e.g. root wads and log vanes)
- Locations of any stream channel problem areas

Table 7 below gives a description of each stream area requiring further observation, the station where the problem occurs and the photo number for the problem area.

Table 7 Stream Areas Requiring Observation

Feature Issue	Station Numbers	Suspected Cause	Photo Number
Log toe rolled into channel.	56+25	Improper installation	SPA1
Right bank erosion	46+90	Caused by deer and sparse vegetation	SPA2
Debris jam	32+50	Fallen tree blocking water flow	SPA3
Left bank erosion	30+60	Sparse vegetation	SPA4
Log vane exposed	24+85	High velocity flows, and degradation	SPA5
Grade control structure head cut	21+60	Improper installation	SPA6
Log vane exposed	13+75	High velocity flows, and degradation	SPA7

4.3.1 Cross Sections

The cross sections were surveyed during the Year 2 monitoring activities in August 2007. The As-Built cross-section surveys are shown with the Year 1 and Year 2 monitoring cross section surveys in **Appendix B**. There is very little difference between the As-Built and Year 1 cross sections and monitoring Year 2 cross sections.

4.3.2 Longitudinal Profile

A longitudinal profile survey was not conducted in Year 2. The previous profile and cross sections indicated there has been very little adjustment to the stream profile or dimension since construction.

STONEBRIDGE STREAM MITIGATION SITE
STREAM AREAS REQUIRING OBSERVATION

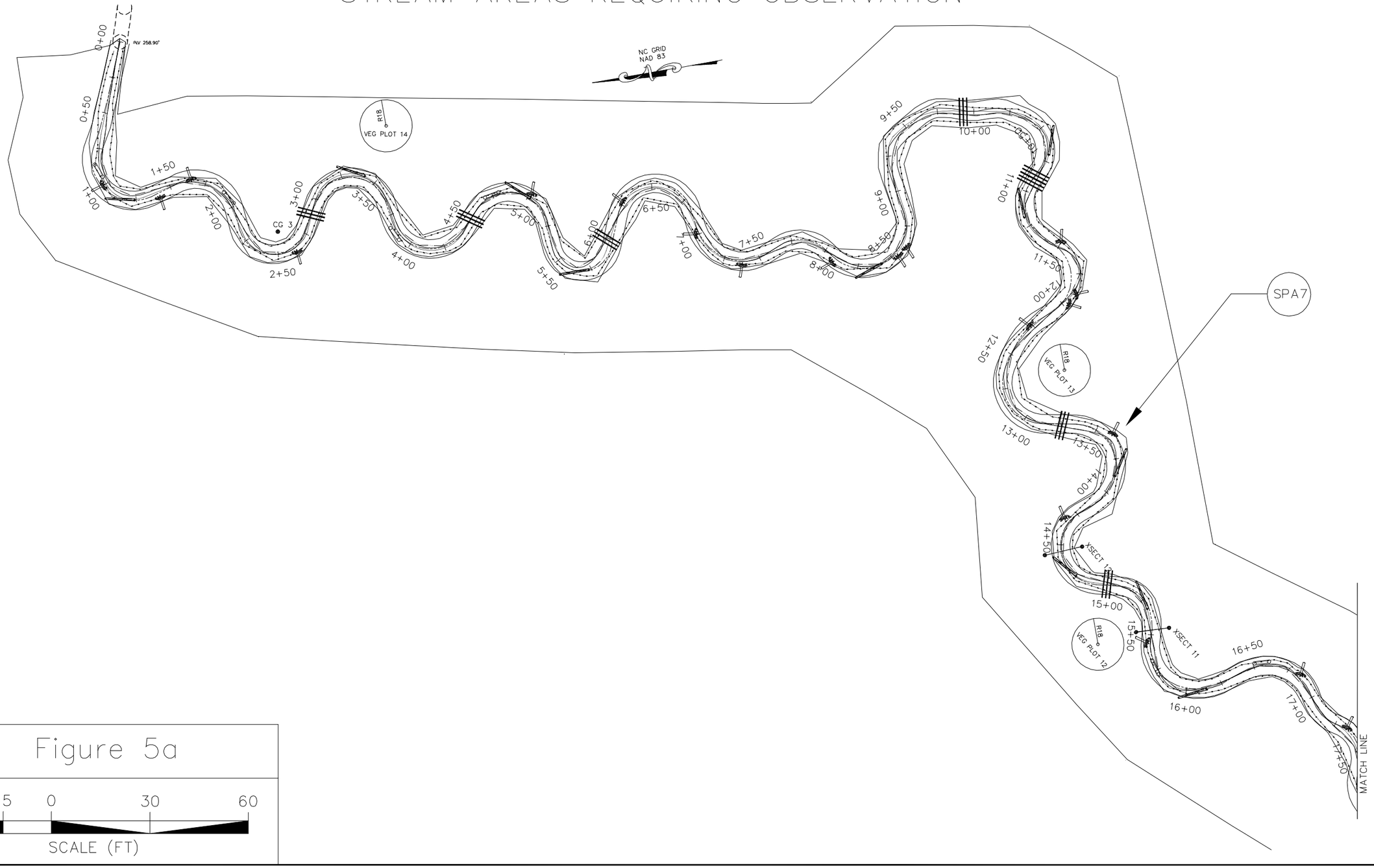

Figure 5a

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STONEBRIDGE STREAM MITIGATION SITE
STREAM AREAS REQUIRING OBSERVATION

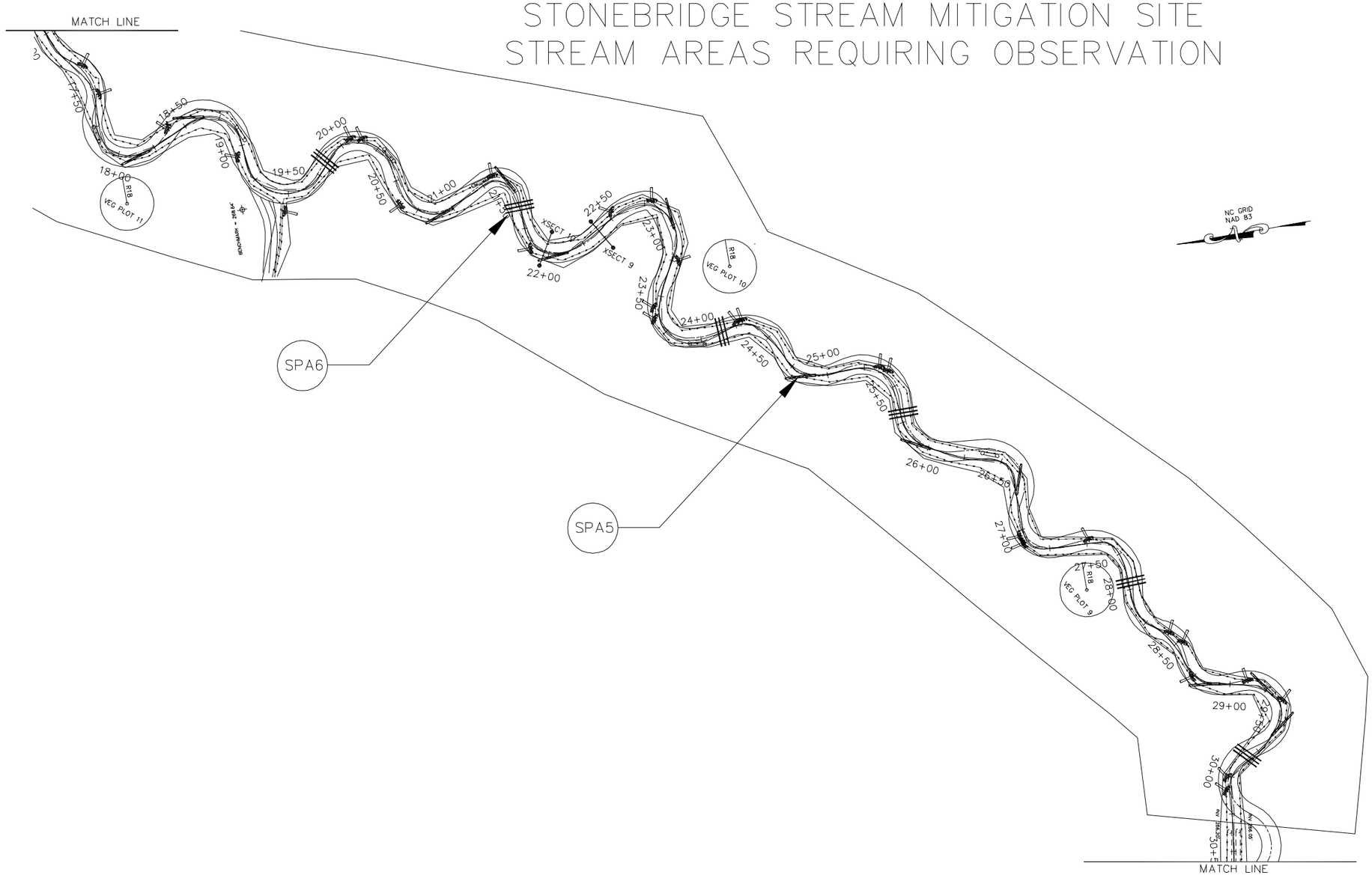

Figure 5b

30 15 0 30 60

SCALE (FT)

STONEBRIDGE STREAM MITIGATION SITE
STREAM AREAS REQUIRING OBSERVATION

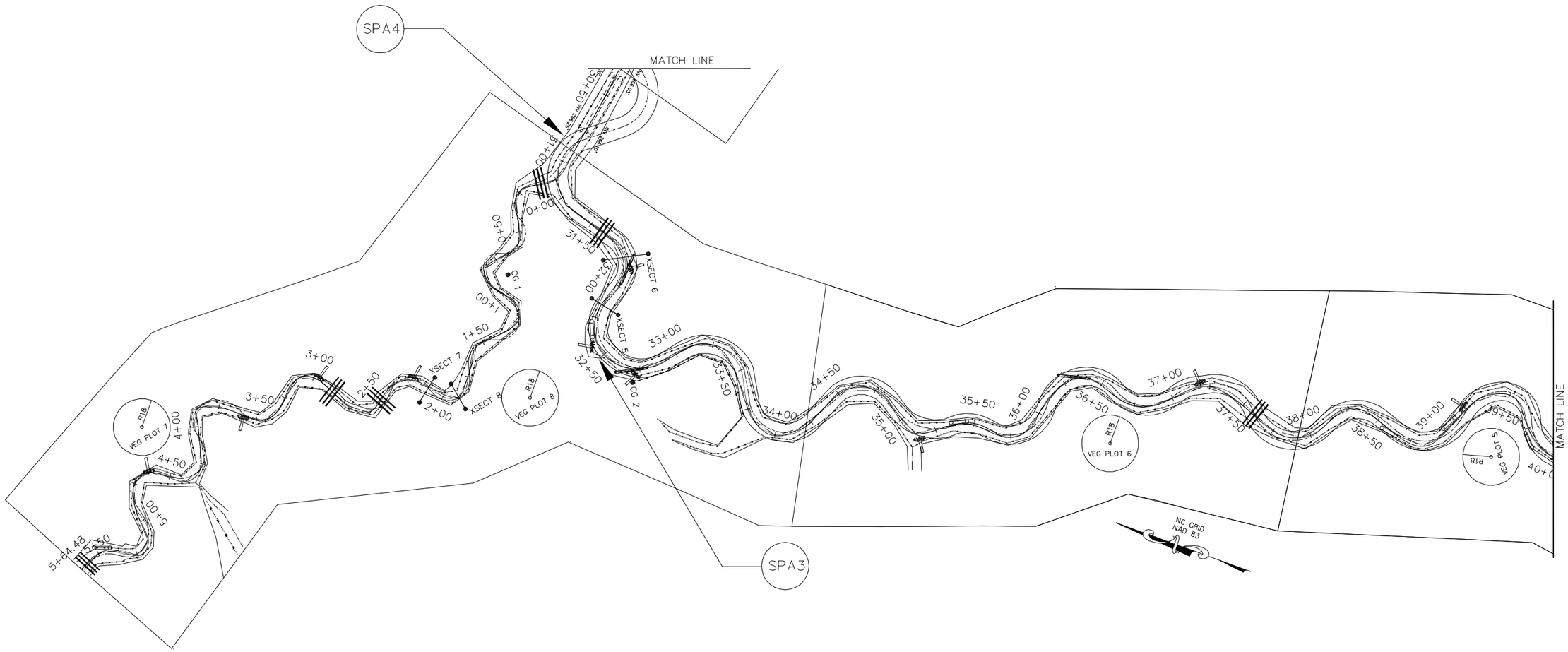

Figure 5c

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SCALE (FT)

STONEBRIDGE STREAM MITIGATION SITE
STREAM AREAS REQUIRING OBSERVATION

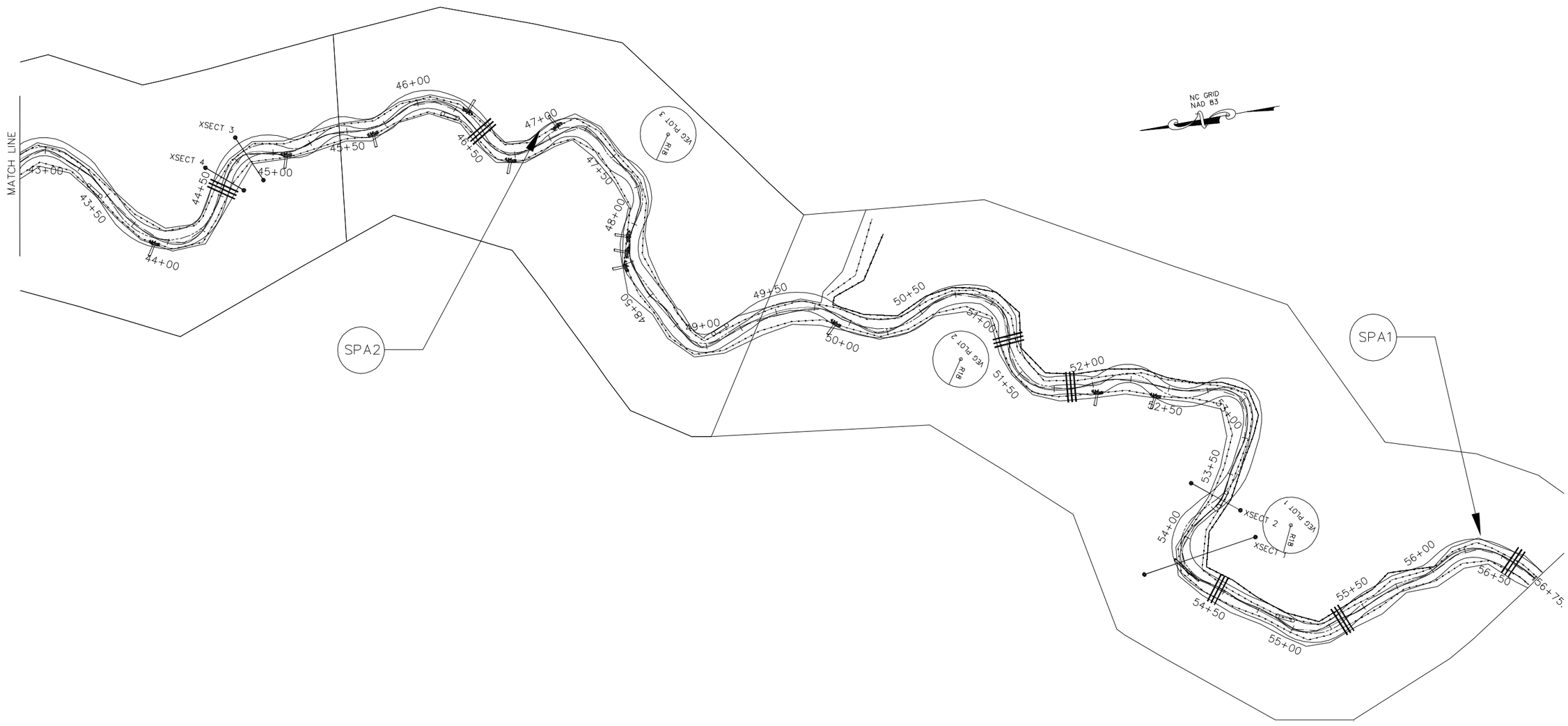

Figure 5d

30 15 0 30 60

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4.3.3 Hydrology

During each visit to the site, the crest gauges were read and reset. This was done March - October of 2007. At least three out-of-bank or bankfull events occurred during this period on UT-2 and four out-of-bank events on UT-1. Crest gauge data are included in **Table 8**. Weather data were collected from a nearby weather station—Carthage Water Treatment Plant and the Moore County Airport. The data are summarized in **Table 9** and indicate that conditions were very dry during the months of May through October.

Table 8 Crest Gauge Data

Date of Data Collection	Crest Gauge 1 Reading (ft)	Crest Gauge 2 Reading (ft)	Crest Gauge 3 Reading (ft)
March-07	2.50	1.70	3.70
April-07	0.35	1.40	0.75
May-07	1.20	0	3.6
June-07	0	0	0
July-07	0	0	0
August-07	0	0	0
September-07	0	0	0
October-07	0	0	0
November-07	0.25	0.90	0

Table 9 Comparison of Normal Rainfall to Observed Rainfall

Month	Historic Average	Normal Limits		Carthage Precipitation	On-Site Precipitation	Rainfall Deficit
		30 Percent	70 percent			
January-07	4.51	3.44	5.43	6.26	---	1.75
February-07	3.54	2.39	4.24	1.6	---	-0.19
March-07	4.65	3.52	5.64	1.91	Installed	-2.93
April-07	3.08	1.93	4.17	3.5	2.85	-2.51
May-07	4.06	2.65	4.86	0.67	1.40	-5.9
June-07	4.18	2.36	5.16	5.29	2.20	-4.79
July-07	5.37	3.06	6.70	1.25	2.48	-8.91
August-07	4.65	3.22	5.57	1.25	0.60	-12.31
September-07	4.45	3.23	6.24	1.12	2.31	-14.25
October-07	3.54	1.86	4.73	0.00	0.08	-17.79
November-07	3.47	2.20	4.52	0.43	5.65	-20.83
December-07	3.38	2.28	4.04			

The entire state of North Carolina experienced increasingly severe drought conditions throughout 2007, with some areas experiencing the lowest average stream flows on record. The first signs of drought began in February in the western part of the state. By early spring, abnormally dry conditions had spread across the state, and the western edge of the state began to see "moderate" drought conditions. From late spring through the summer, conditions steadily worsened. By August, 98% of North Carolina's land area was designated as

being in either "severe", "extreme", or "exceptional" drought. Additionally, lowest-ever average stream flows were recorded at 13 monitoring stations in August, including 9 in central North Carolina, two in the mountains, and two on the coastal plain. Nearly the entire state was categorized as experiencing "extreme" drought in September, with the southwest portion of the state categorized as experiencing "exceptional" drought. **Figure 6** depicts the increasing severity of the drought throughout the year.

The Stonebridge restoration site experienced drought conditions consistent with state-wide trends. The Carthage monitoring station, near the Stonebridge site, received above-normal rainfall in January (**Figure 7 and Table 9**). Precipitation levels then fell to 1.94 and 2.74 inches below average in February and March, respectively. Precipitation levels were normal in April, but fell to 0.67 inches in May—3.39 inches below average. In June, rainfall was slightly above normal. From July through November, the site again received below-normal precipitation levels. The accumulated rainfall deficit—the difference between the long-term average and the observed monthly precipitation levels, aggregated monthly—began at -1.75 inches in January and fell steadily to -20.83 inches in November, recovering only slightly in April and June. Persistent and worsening drought conditions severely impacted vegetative growth at the Stonebridge restoration site.

Figure 6 Drought Conditions Across North Carolina
1/2/07 to 9/25/07

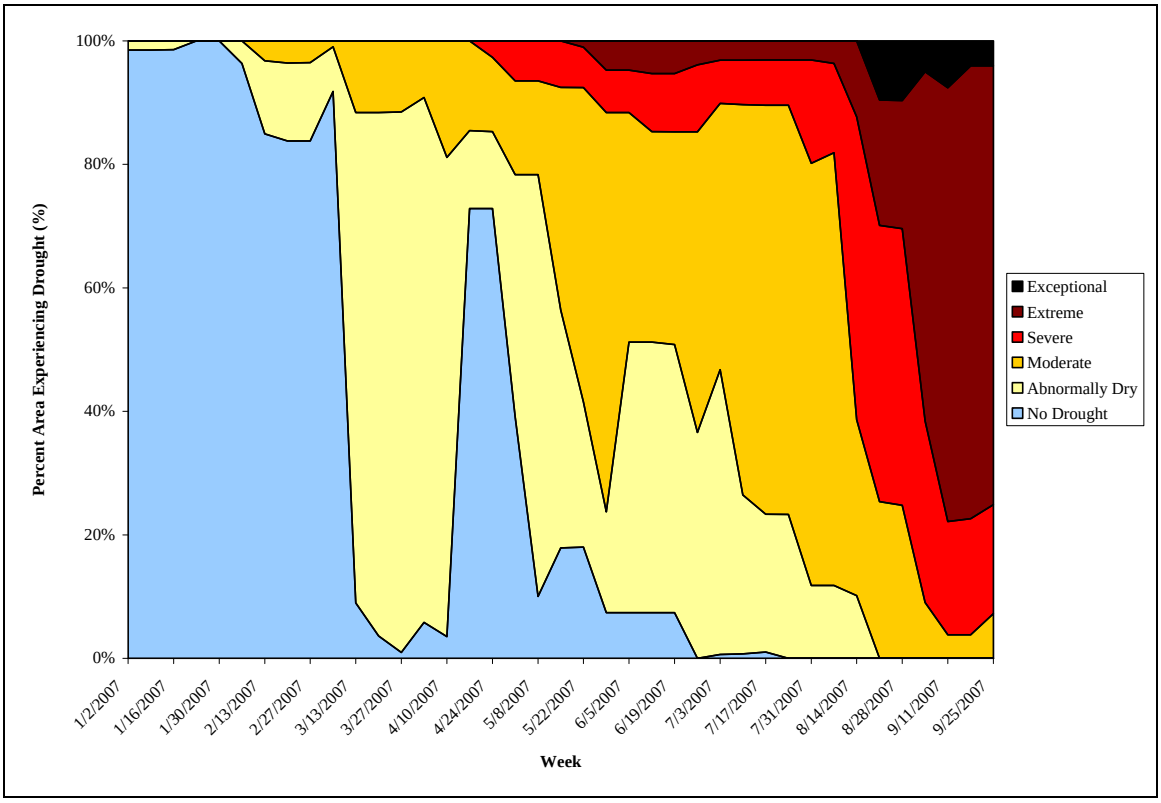
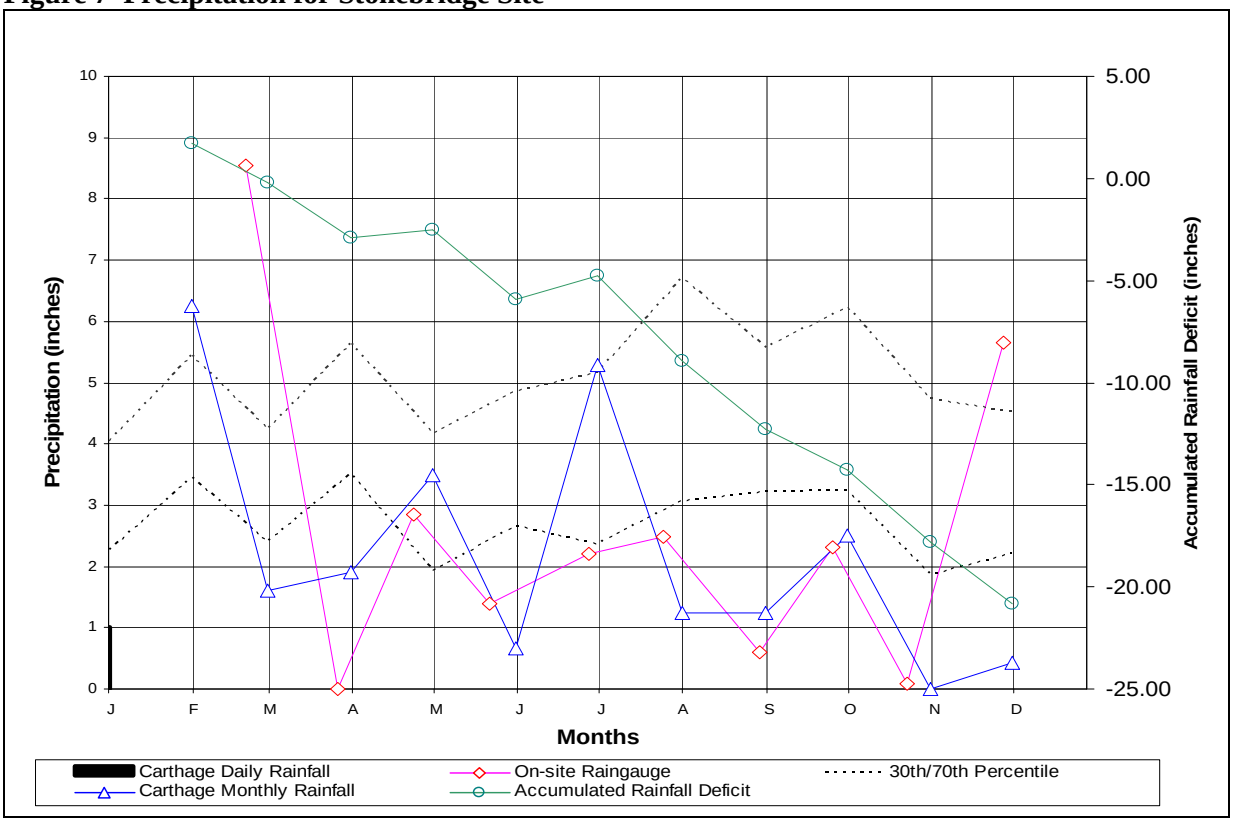


Figure 7 Precipitation for Stonebridge Site



4.4 BENTHIC MACROINVERTEBRATE SURVEY RESULTS

Benthic macroinvertebrates were collected at one site along the restoration reach in October 2007. The North Carolina Division of Water Quality (NCDWQ) Qual-4 collection method was utilized to sample the stream. In addition to benthic sampling, an NCDWQ habitat assessment form was completed and the reach received a score of 53 out of 95 possible points. The benthos sample was preserved in alcohol and later identified to the lowest possible taxonomic level by an aquatic ecologist.

Macroinvertebrates could not be collected at the reference site because it was dry at the time of sampling. The restoration reach exhibited intermittent flows throughout the summer due to the 2007 drought. A recent rain event contributed to the minimal flow seen at Stonebridge when collections were made. Because of the intermittent flow scenarios throughout the summer, very few macroinvertebrates were collected at the site. Most of the macroinvertebrates collected are stagnant flow species. **Table 10** lists the taxa encountered, relative abundance, and tolerance values of macroinvertebrates collected at Stonebridge. The NCDWQ Standard Operating Procedures for Benthic Macroinvertebrates (2006) assigns tolerance values for common macroinvertebrates in North Carolina. Tolerance values range from 0 to 10 with low scores indicating species that are intolerant to pollution, sediments, or other disturbances.

Table 10. Benthic Macroinvertebrate Data October 2007

Order	Family	Genus Species	Tolerance Value	No.
Hemiptera	Corixidae		9	5
Coleoptera	Hydroptillidae	*Tropisternus* spp	9.7	2
Coleoptera	Dytiscidae	*Ilybius* spp	NA	1
Isopoda	Asellidae	*Caecidotea* sp	9.1	3
Diptera	Culcidae	*Culex* spp	10	11
			Total Number of Organisms	22
			Total Number of Taxa	5
			Total Number of EPT	0

4.5 STREAM CONCLUSIONS

The restored stream channel has remained stable and is providing the intended habitat and hydrologic functions. All monitored cross sections for 2007 show very little adjustment in stream dimension. Several bankfull events were recorded during the 2007 monitoring season exceeding the requirement of two bankfull events within five years.

5.0 OVERALL CONCLUSIONS AND RECOMMENDATIONS

Data collected during Year 2 monitoring, and observations of conditions at the site indicate that the project is currently successful and on track to achieve the success criteria specified in the Mitigation Plan. The vegetation is generally surviving well.

The stream morphology is stable. Very little fluvial erosion was observed. Sedimentation that has occurred in the stream channel is minor and does not need to be addressed at this time. Removal of the debris jam at station 32+50 is recommended to help reduce channel blockage and reduce bank erosion. The log toe at station 56+25 should also be repaired by removing it out of the channel and replacing it to design specifications. At station 21+60, a head cut has developed just downstream of the grade control structure which needs to be repaired as well.

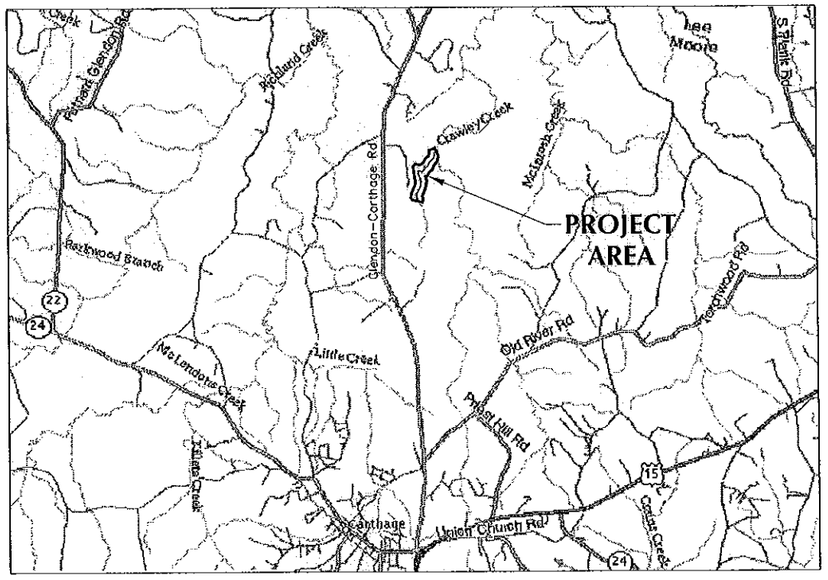
Overall, the project is on track to achieve the stream and vegetative success criteria specified in the Mitigation Plan. Habitat has been improved significantly through this project. Fluvial erosion has been eliminated so that the project site no longer contributes sediment to the receiving stream. Based on initial observations, site vegetation is expected to succeed and provide riparian habitat, water quality benefits, and cover for the stream system

APPENDIX A

As-Built Survey

STONEBRIDGE STREAM AS-BUILT PLANS

APRIL 2006



VICINITY MAP
NTS

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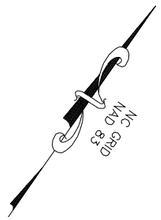
EBX



I, MARK W. YARBROUGH, HEREBY CERTIFY THAT THE TOPOGRAPHIC AND PLANIMETRIC AS-BUILT INFORMATION SHOWN ON THIS MAP WAS DRAWN UNDER MY SUPERVISION FROM AN ACTUAL FIELD SURVEY PERFORMED UNDER MY SUPERVISION; THAT THE ORIGINAL FIELD DATA WAS OBTAINED BETWEEN MARCH 7, 2006 AND APRIL 20, 2006; THAT THE MAPPING ERROR AS REPRESENTED BY CONTOUR LINES PLOTTED HEREON, IF APPLICABLE, DOES NOT EXCEED 1/2 OF THE CONTOUR INTERVAL OVER 90% OF THE SURVEY AREA; THAT THE HORIZONTAL DATUM IS BASED ON NAD 83 AND THE VERTICAL DATUM IS BASED ON NGVD 88 DATUM; THAT THE HORIZONTAL AND VERTICAL DATUM WERE OBTAINED FROM 2 HOUR STATIC GPS SESSIONS USING L1/L2 GPS RECEIVERS AND THE POST PROCESSING WAS OBTAINED THROUGH NOAA OPUS (ONLINE POSITIONING USER SERVICE). WITNESS MY ORIGINAL SIGNATURE, REGISTRATION NUMBER AND SEAL THIS 25TH DAY OF APRIL, 2006 A.D.

MARK W. YARBROUGH L-3396 DATE

100 0 50 100 200
1 inch = 100ft.

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APPROVED BY	ME
FILE NAME	as-built.dwg
DRAWING SCALE	1" = 100'
PROJECT DATE	03/30/2004
PROJECT NUMBER	3024600RA
PLOT DATE	10/4/07

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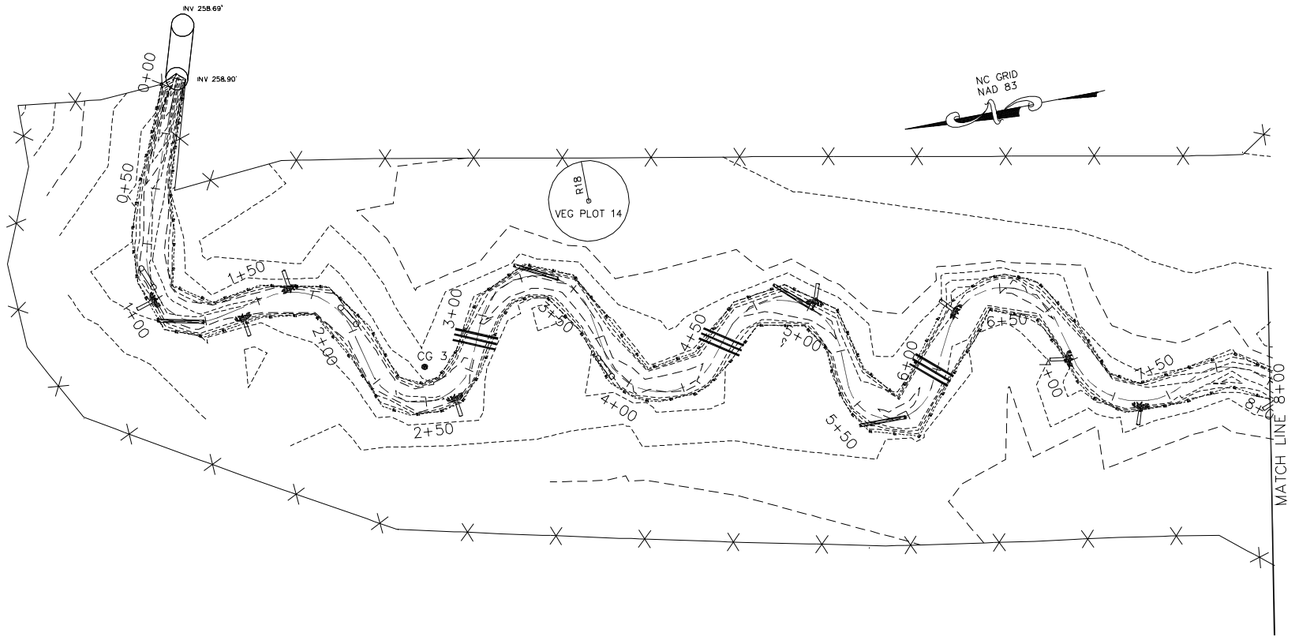
STONEBRIDGE AS-BUILT PLANS
STREAM MITIGATION AS-BUILT SURVEY



LEGEND

- CENTER OF CHANNEL
- FENCE (LIMITS OF CONSERVATION EASMENT)
- MAJOR CONTOUR
- MINOR CONTOUR
- ROOTWAD
- LOG VANE
- LOG GRADE CONTROL
- LOG TOE PROTECTION
- CREST GAUGE
- SEMI-PERMANENT CROSS-SECTION

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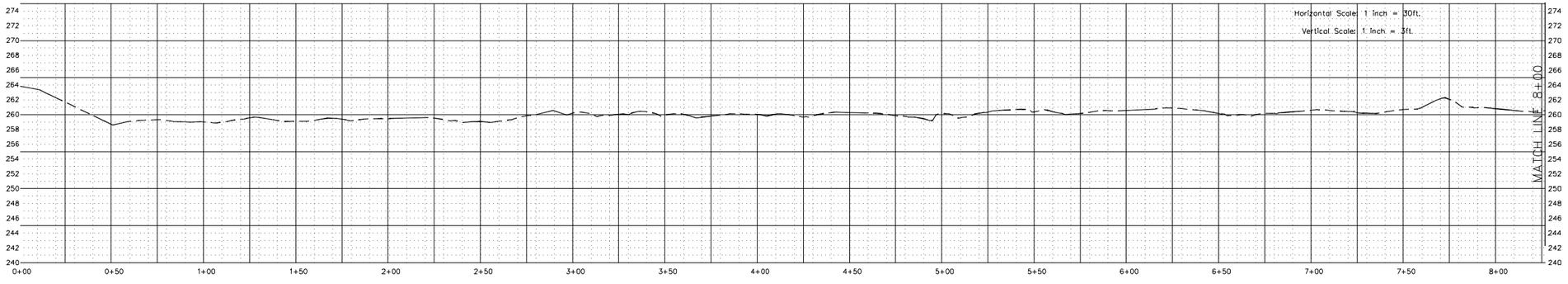
1 inch = 30ft.



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PROJECT DATE	03/30/2004
PROJECT NUMBER	3024600RA
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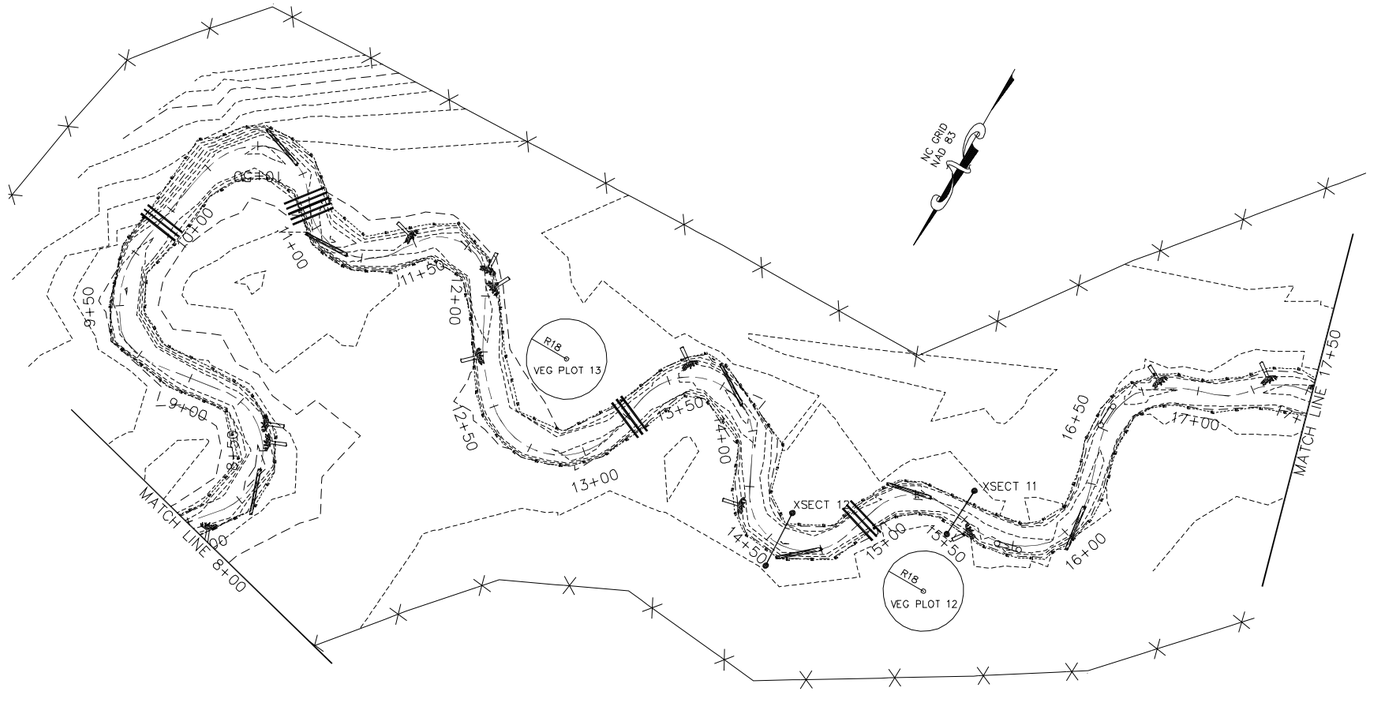
STONEBRIDGE AS-BUILT PLANS
UT-1 STA. 0+00 TO STA. 8+00



LEGEND

- CENTER OF CHANNEL
- FENCE (LIMITS OF CONSERVATION EASMENT)
- MAJOR CONTOUR
- MINOR CONTOUR
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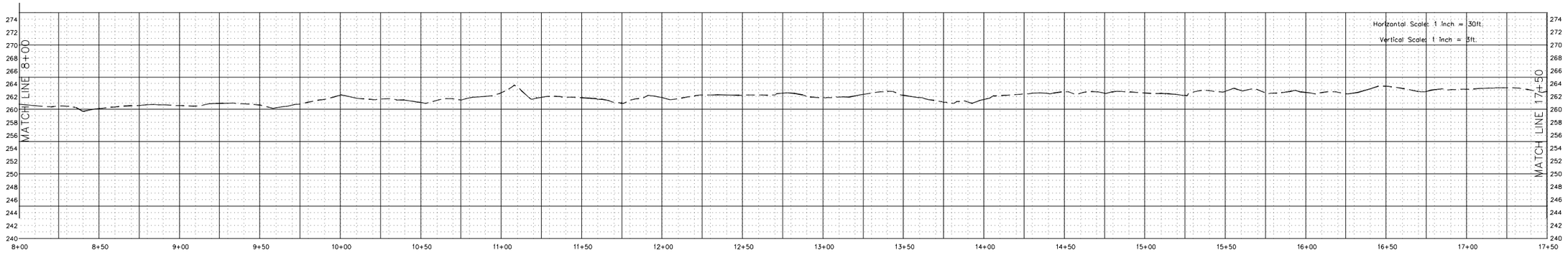
- LOG VANE
- LOG GRADE CONTROL
- LOG TOE PROTECTION
- CREST GAUGE
- SEMI-PERMANENT CROSS-SECTION

30 0 15 30 60
1 inch = 30ft.



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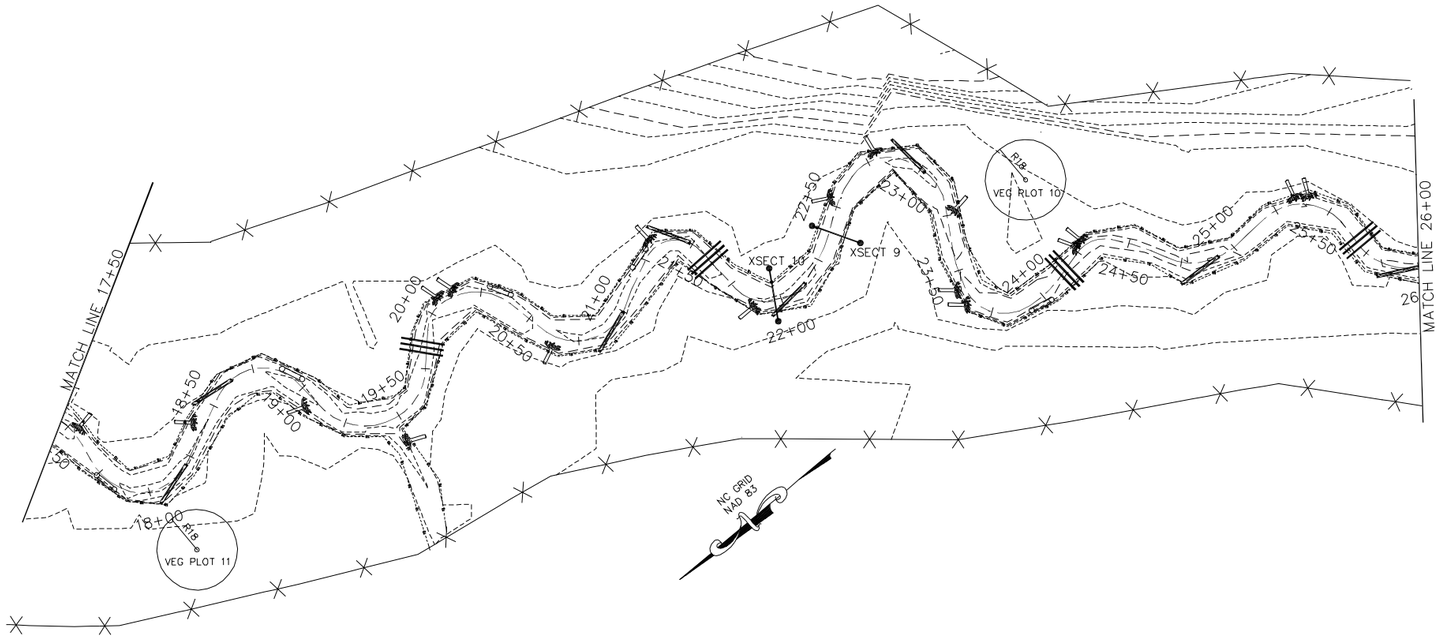
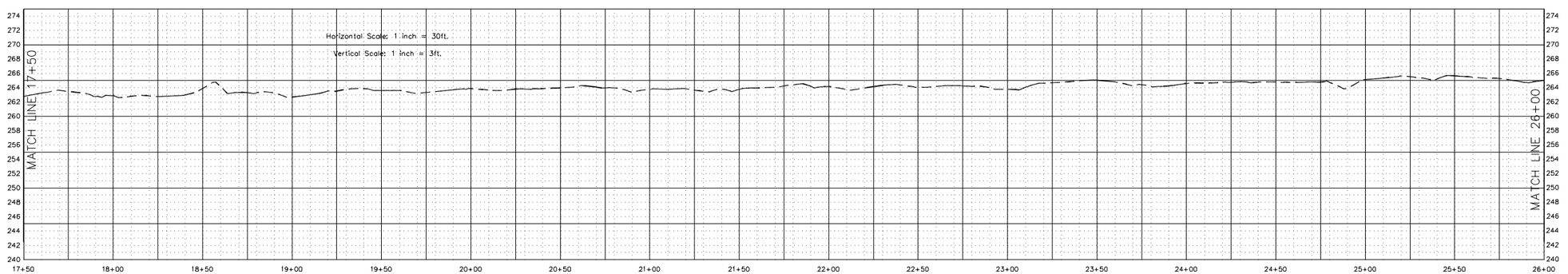
STONEBRIDGE AS-BUILT PLANS
UT-1 STA. 8+00 TO 17+50



LEGEND

- CENTER OF CHANNEL
- FENCE (LIMITS OF CONSERVATION EASMENT)
- MAJOR CONTOUR
- MINOR CONTOUR
- ROOTWAD
- LOG VANE
- LOG GRADE CONTROL
- LOG TOE PROTECTION
- CREST GAUGE
- SEMI-PERMANENT CROSS-SECTION

30 0 15 30 60
1 inch = 30ft.



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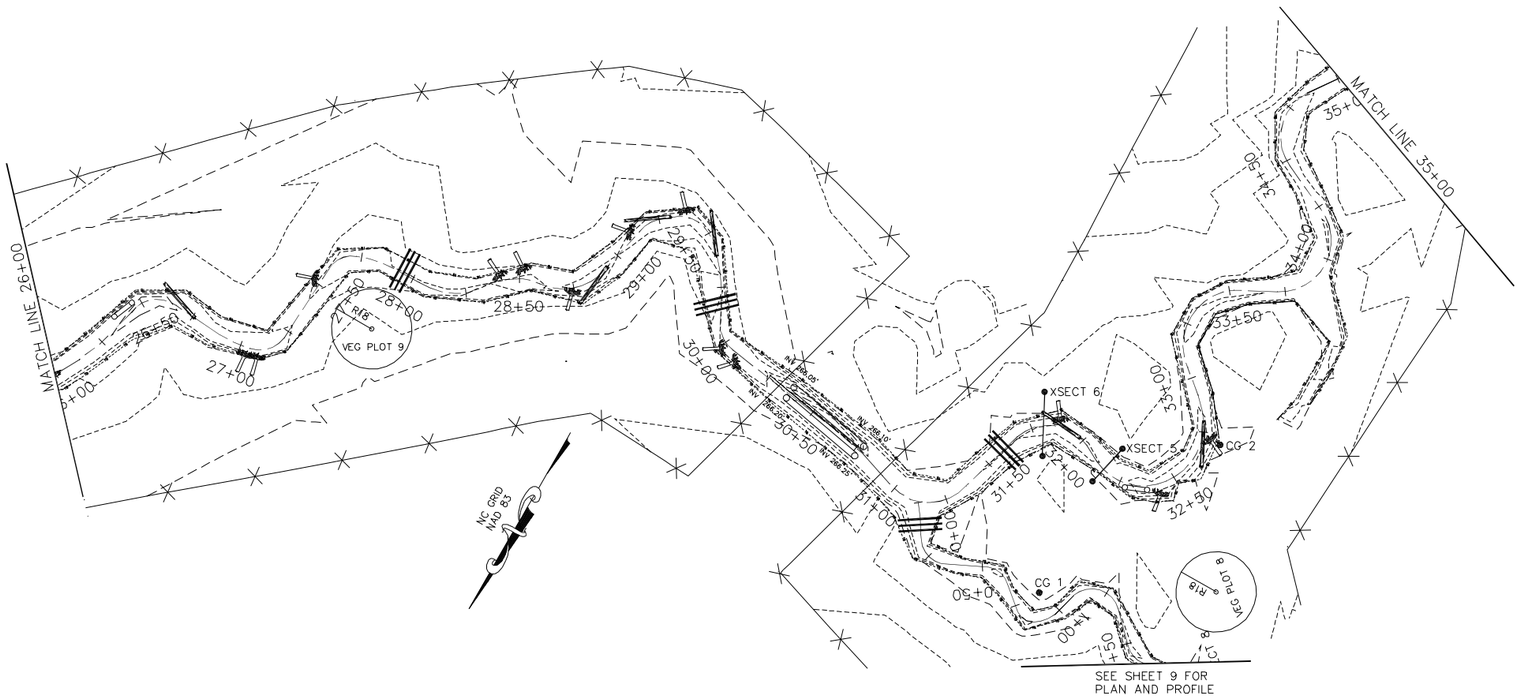
UT-1 STA. 17+50 TO 26+00



LEGEND

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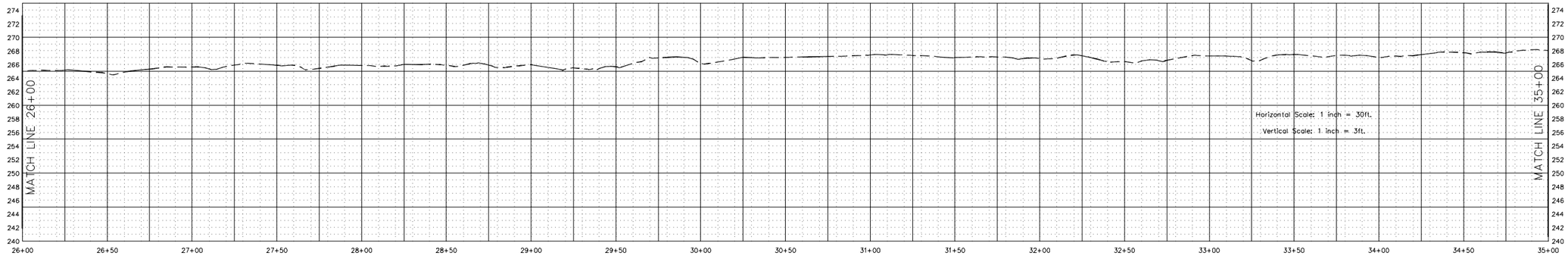
- FENCE (LIMITS OF CONSERVATION EASMENT)
- MAJOR CONTOUR
- MINOR CONTOUR
- ROOTWAD
- LOG VANE
- LOG GRADE CONTROL
- LOG TOE PROTECTION
- CREST GAUGE
- SEMI-PERMANENT CROSS-SECTION

30 0 15 30 60
1 inch = 30ft.



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PROJECT DATE	03/30/2004
PROJECT NUMBER	3024600RA
PLOT DATE	10/4/07

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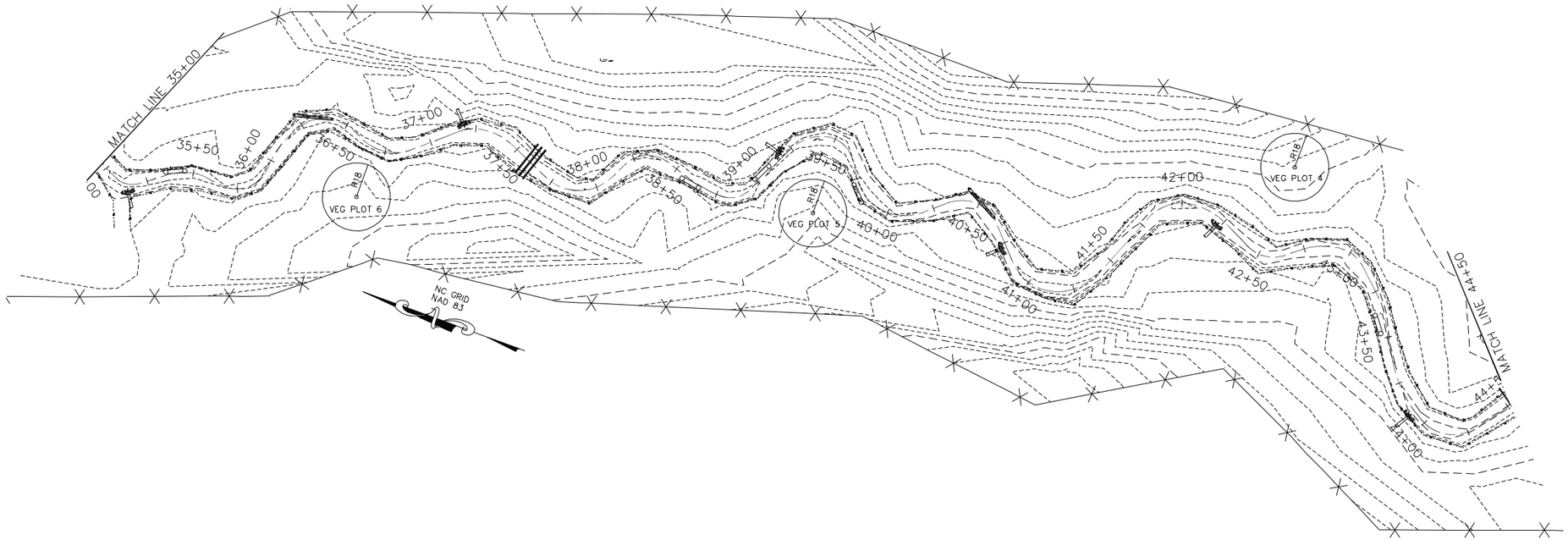
STONEBRIDGE AS-BUILT PLANS
UT-1 STA. 26+00 TO 35+00



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- ROOTWAD
- LOG VANE
- LOG GRADE CONTROL
- LOG TOE PROTECTION
- CREST GAUGE
- SEMI-PERMANENT CROSS-SECTION

30 0 15 30 60
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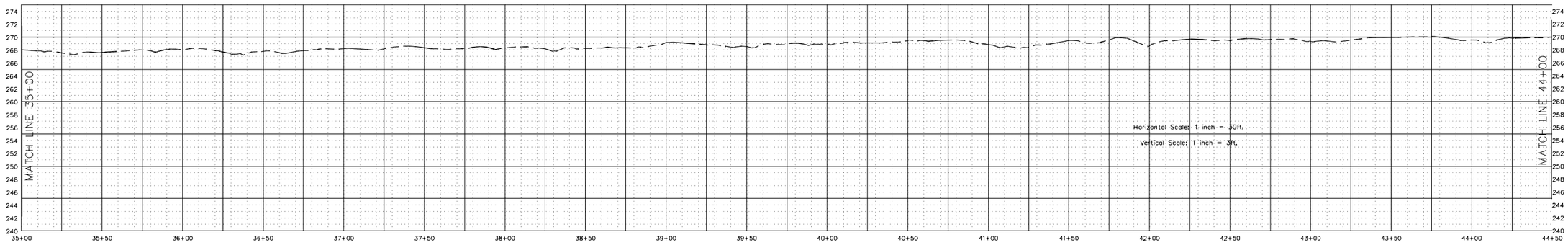

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PROJECT NUMBER	3024600RA
PLOT DATE	10/4/07

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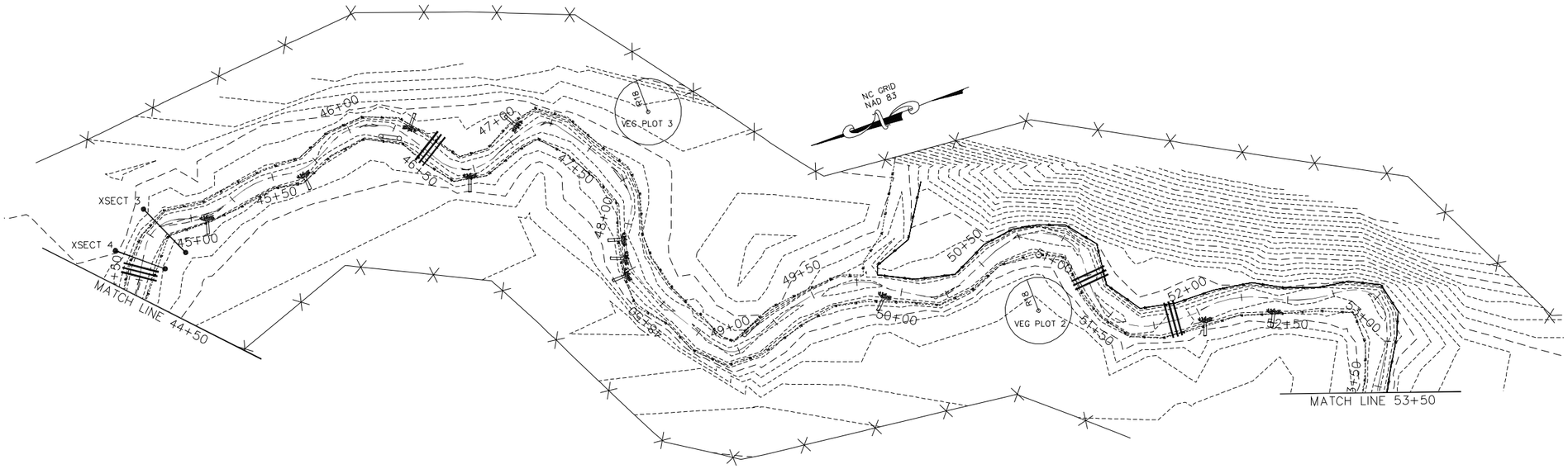
UT-1 STA. 35+00 TO 44+00



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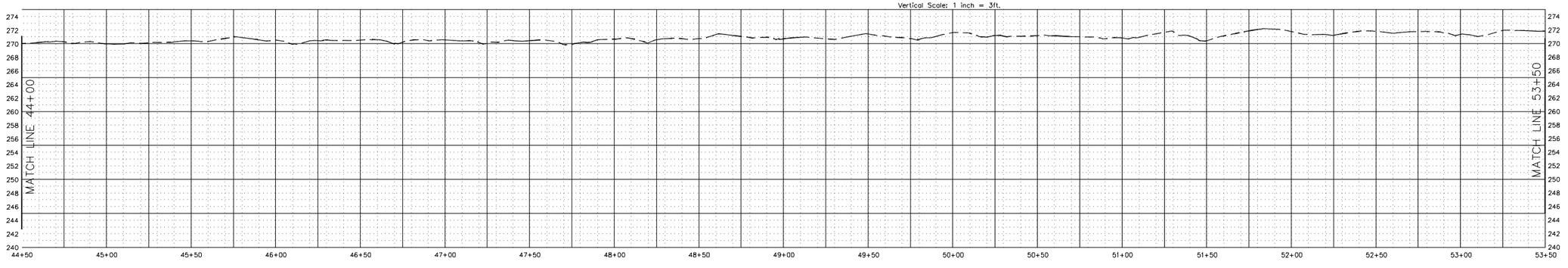
- MAJOR CONTOUR
- MINOR CONTOUR
- ROOTWAD
- LOG VANE
- LOG GRADE CONTROL
- LOG TOE PROTECTION
- CREST GAUGE
- SEMI-PERMANENT CROSS-SECTION

30 0 15 30 60
1 inch = 30ft.

Horizontal Scale: 1 inch = 30ft.
Vertical Scale: 1 inch = 3ft.



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PROJECT DATE	03/30/2004
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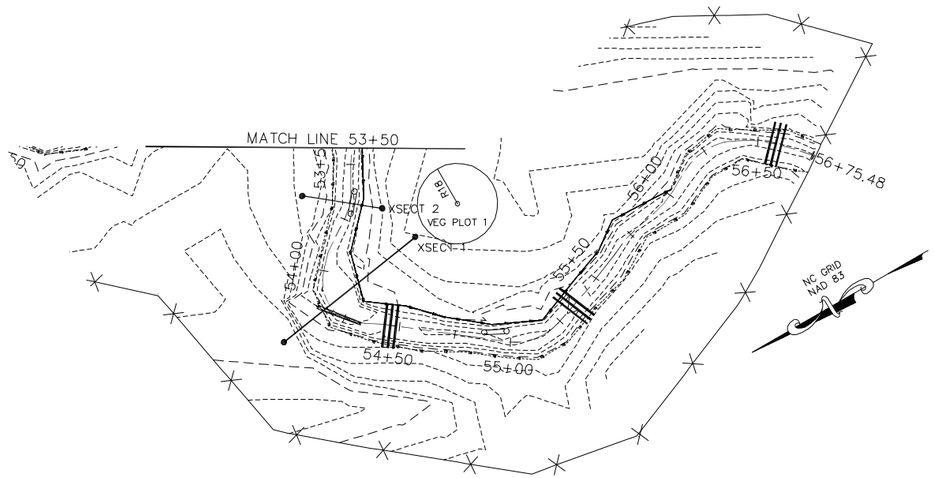
STONEBRIDGE AS-BUILT PLANS
UT-1 STA. 44+00 TO 53+50



LEGEND

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- FENCE (LIMITS OF CONSERVATION EASMENT)
- MAJOR CONTOUR
- MINOR CONTOUR
- ROOTWAD
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- LOG TOE PROTECTION
- CREST GAUGE
- SEMI-PERMANENT CROSS-SECTION

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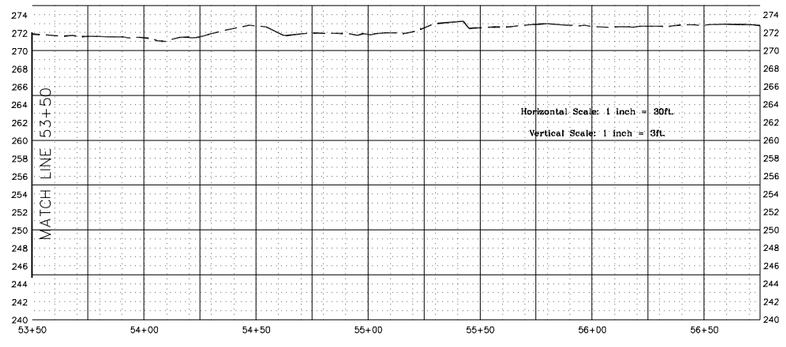
1 inch = 30ft.



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PROJECT NUMBER	
PLOT DATE	10/4/07

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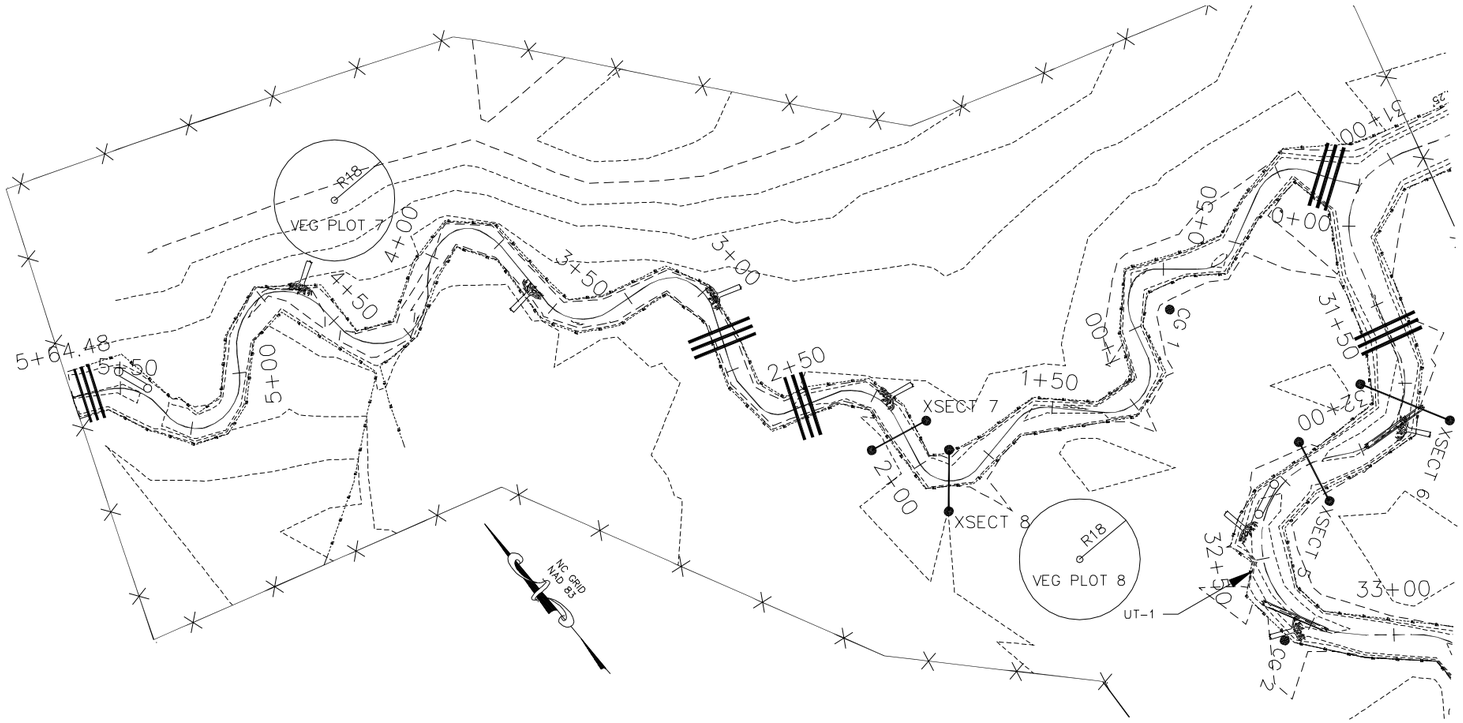
STONEBRIDGE AS-BUILT PLANS
UT-1 STA. 53+50 TO 56+75

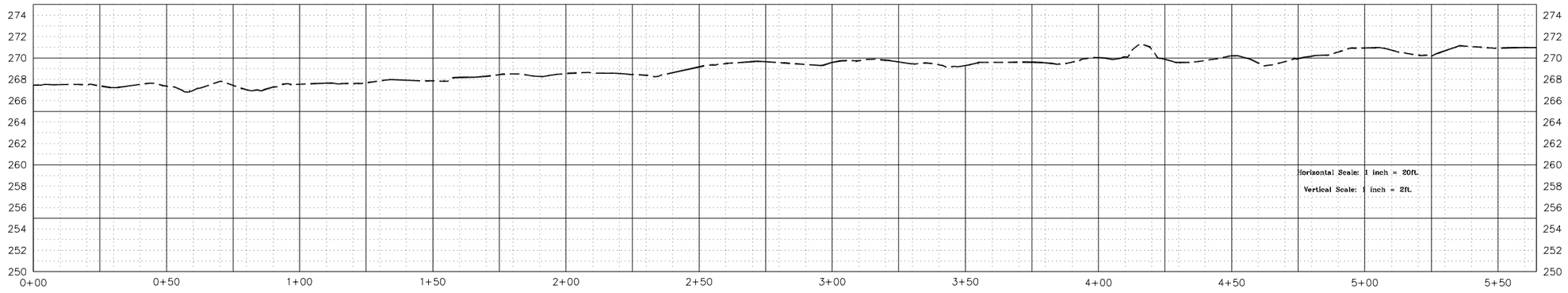


LEGEND

- CENTER OF CHANNEL
- FENCE (LIMITS OF CONSERVATION EASEMENT)
- MAJOR CONTOUR
- MINOR CONTOUR
- ROOTWAD
- LOG VANE
- LOG GRADE CONTROL
- LOG TOE PROTECTION
- CREST GAUGE
- SEMI-PERMANENT CROSS-SECTION

20 0 10 20 40

1 inch = 20ft.



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PROJECT NUMBER: 3024600RA
PLOT DATE: 10/4/07

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CARTHAGE, NORTH CAROLINA

STONEBRIDGE AS-BUILT PLANS

UT-2 STA. 0+00 TO 5+64

STONEBRIDGE STREAM MITIGATION SITE
OVERALL MONITORING PLAN VIEW

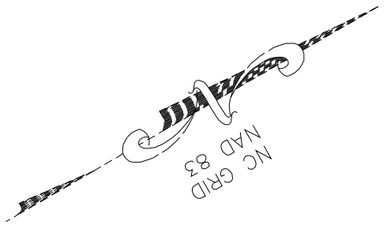


Figure 4a

100 50 0 100 200

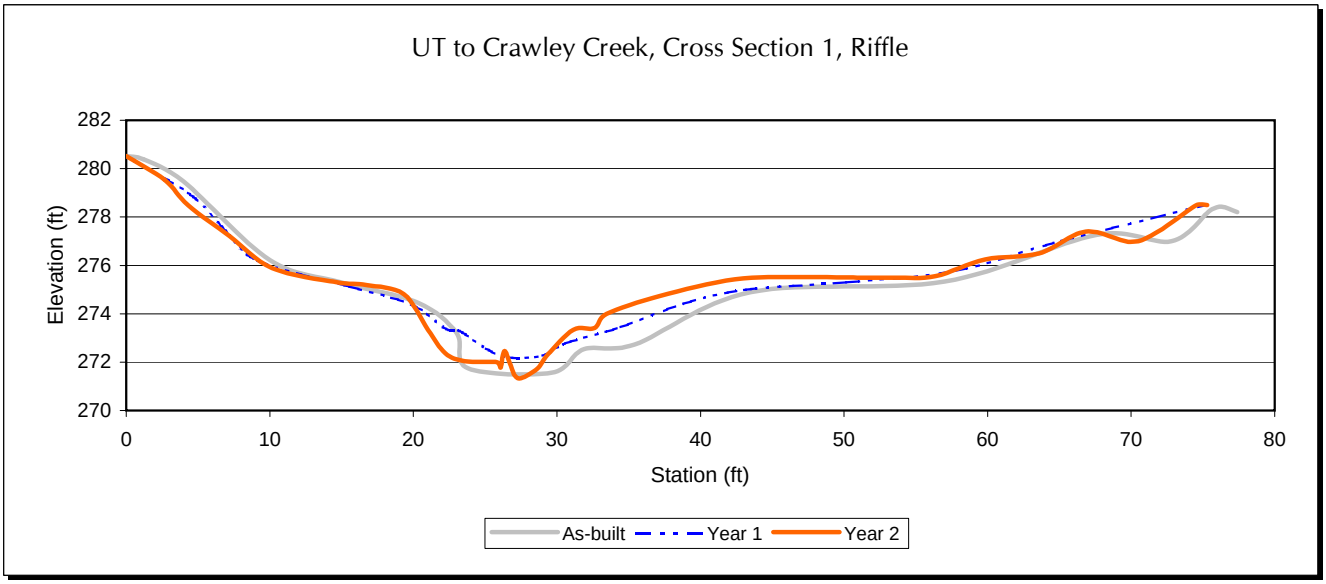
SCALE (FT)

APPENDIX B

Cross Section Data

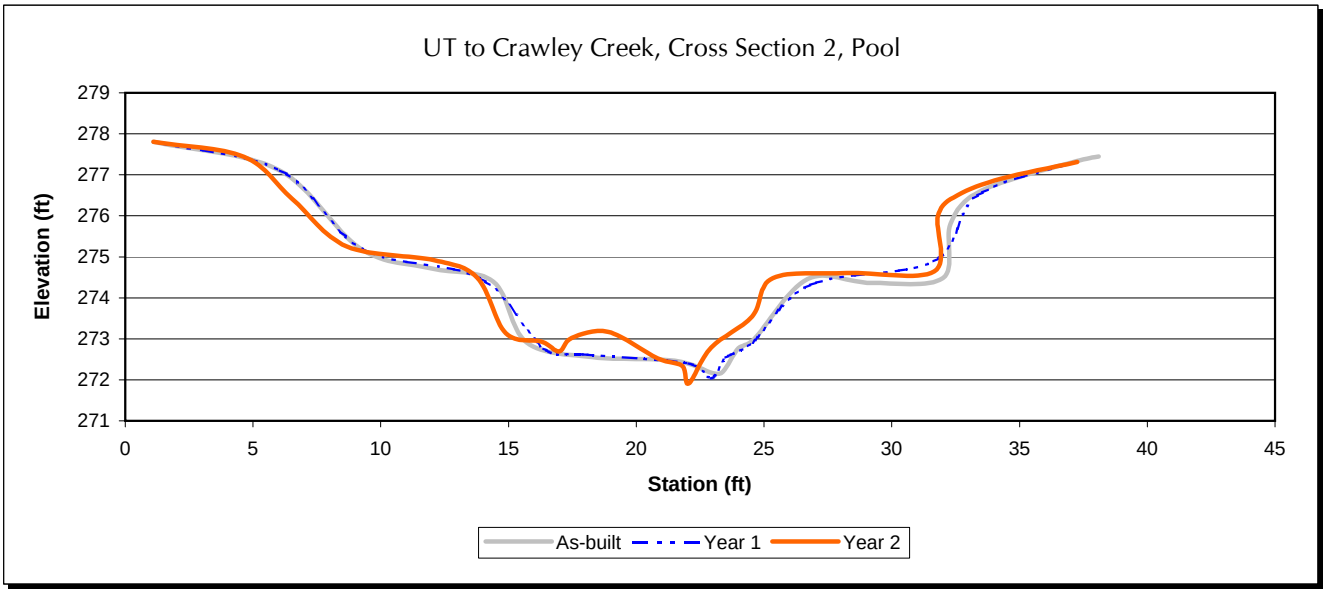
Left Bank

Right Bank



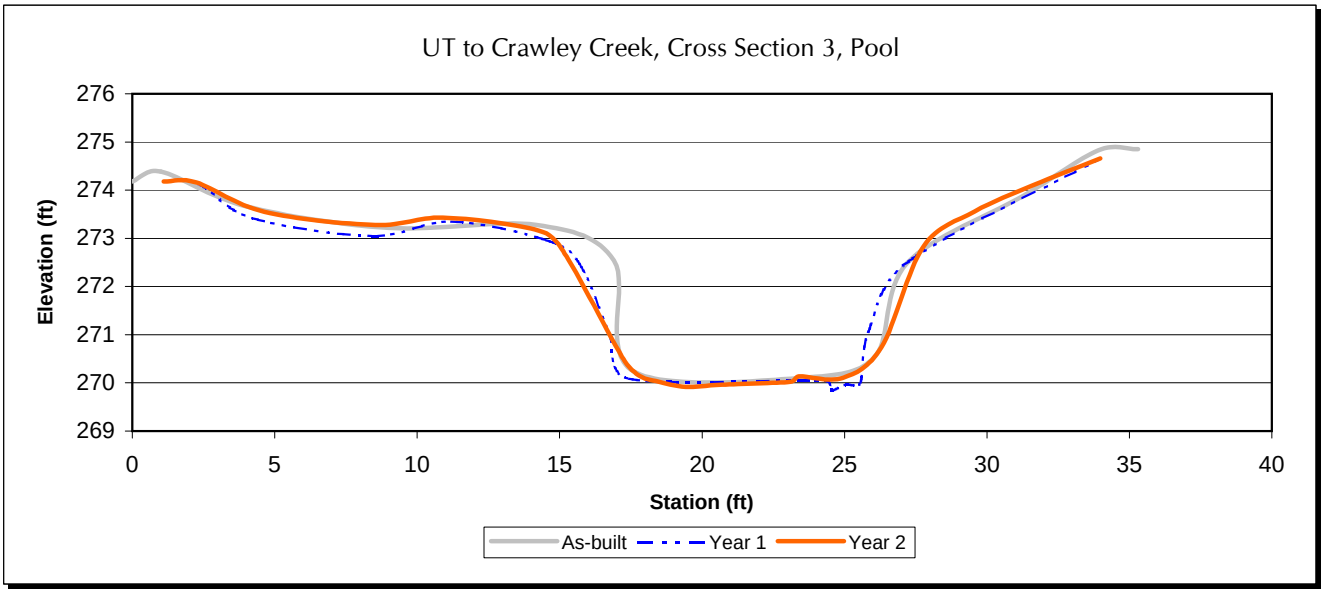
Left Bank

Right Bank



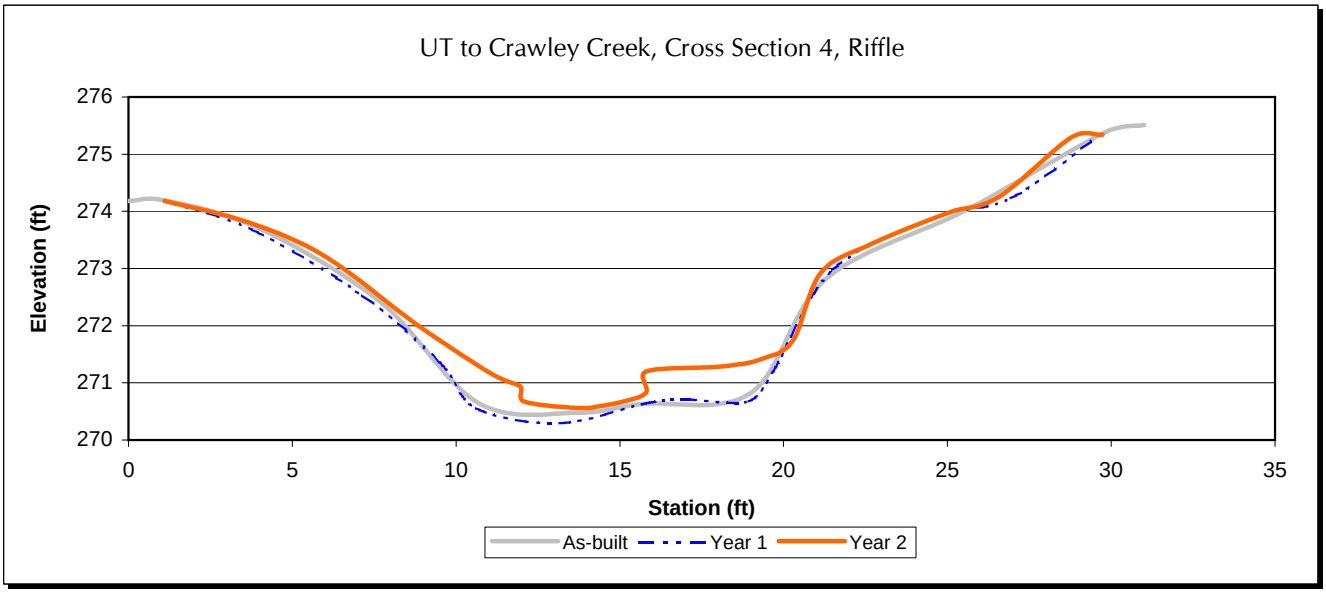
Left Bank

Right Bank



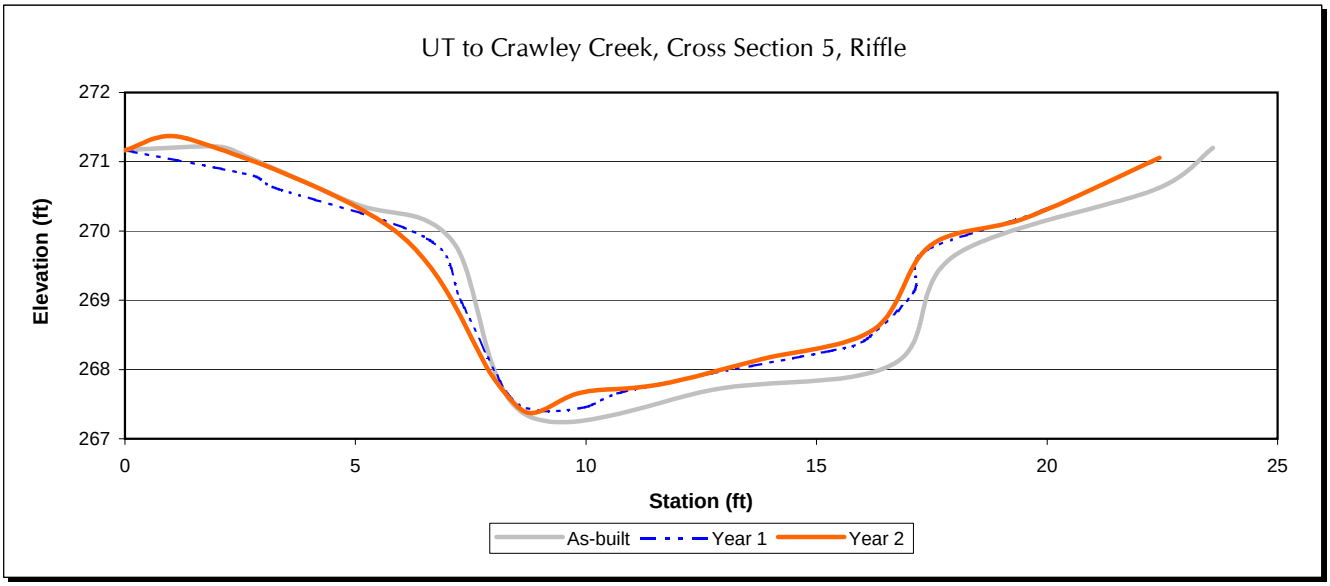
Left Bank

Right Bank



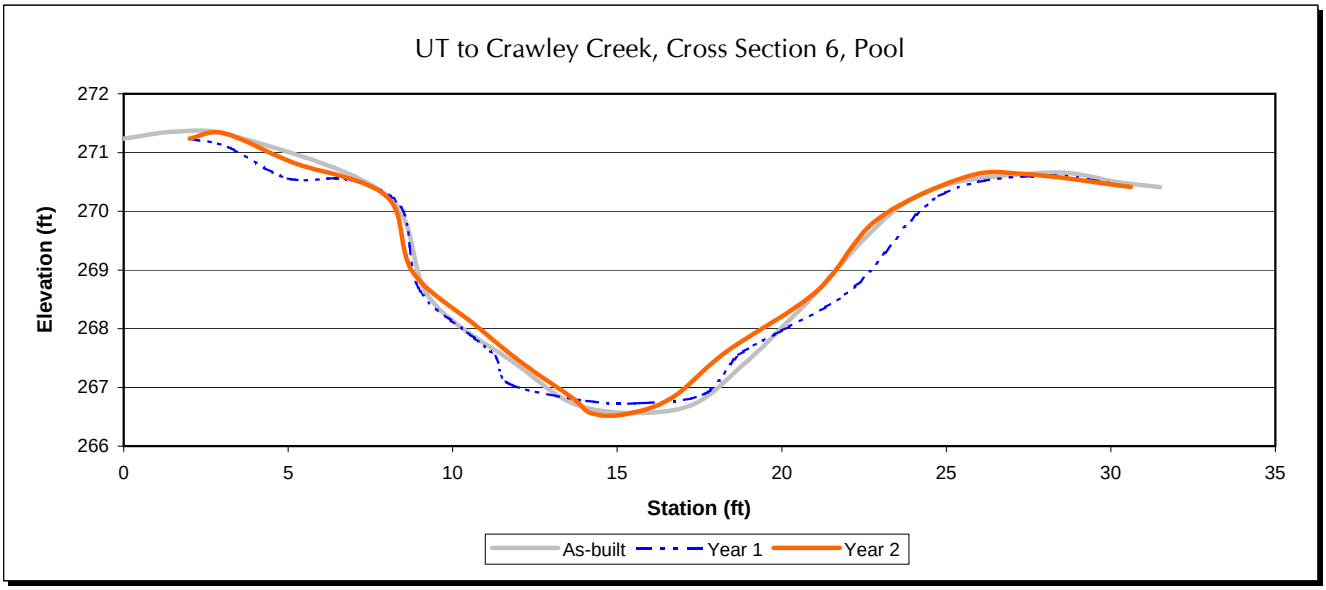
Left Bank

Right Bank



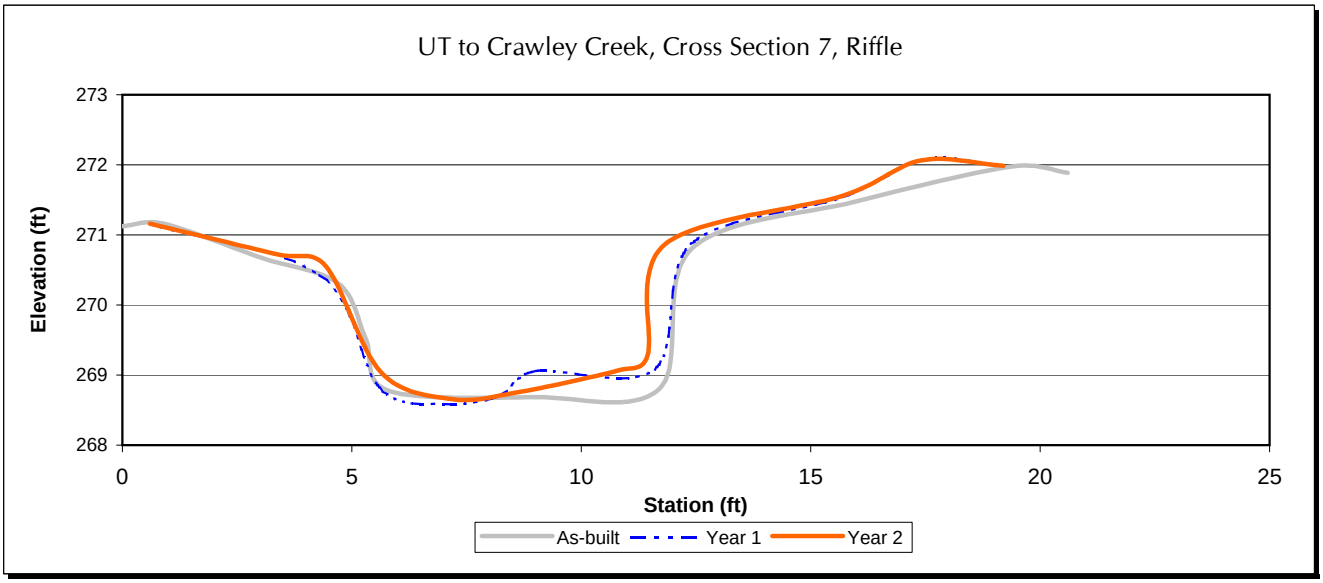
Left Bank

Right Bank



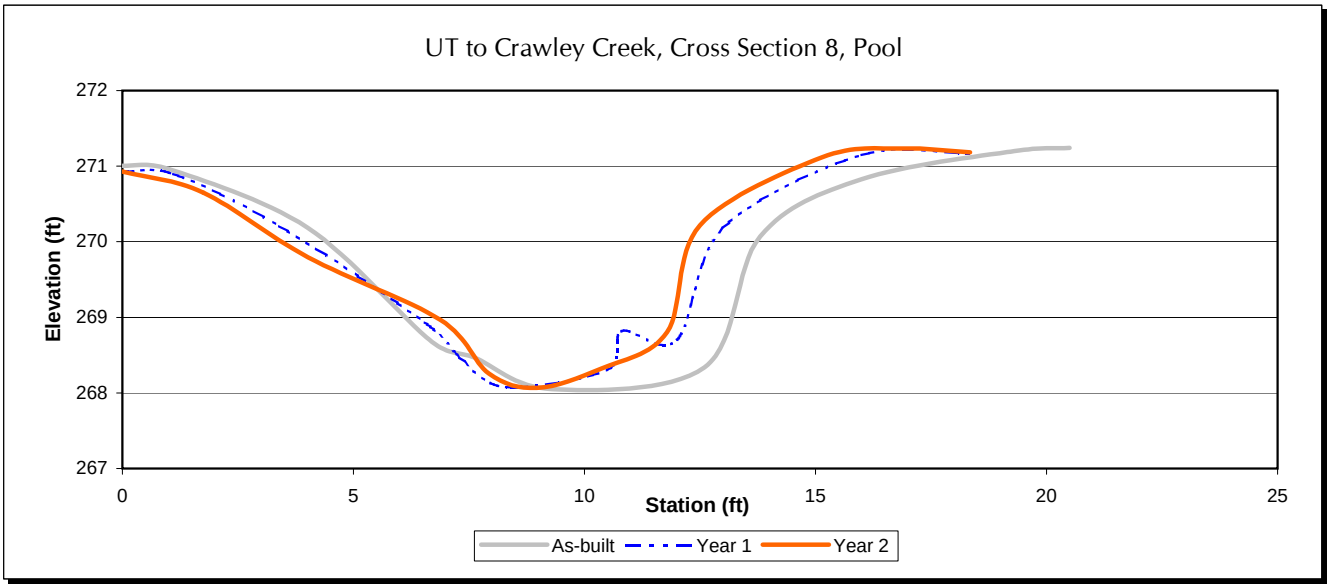
Left Bank

Right Bank



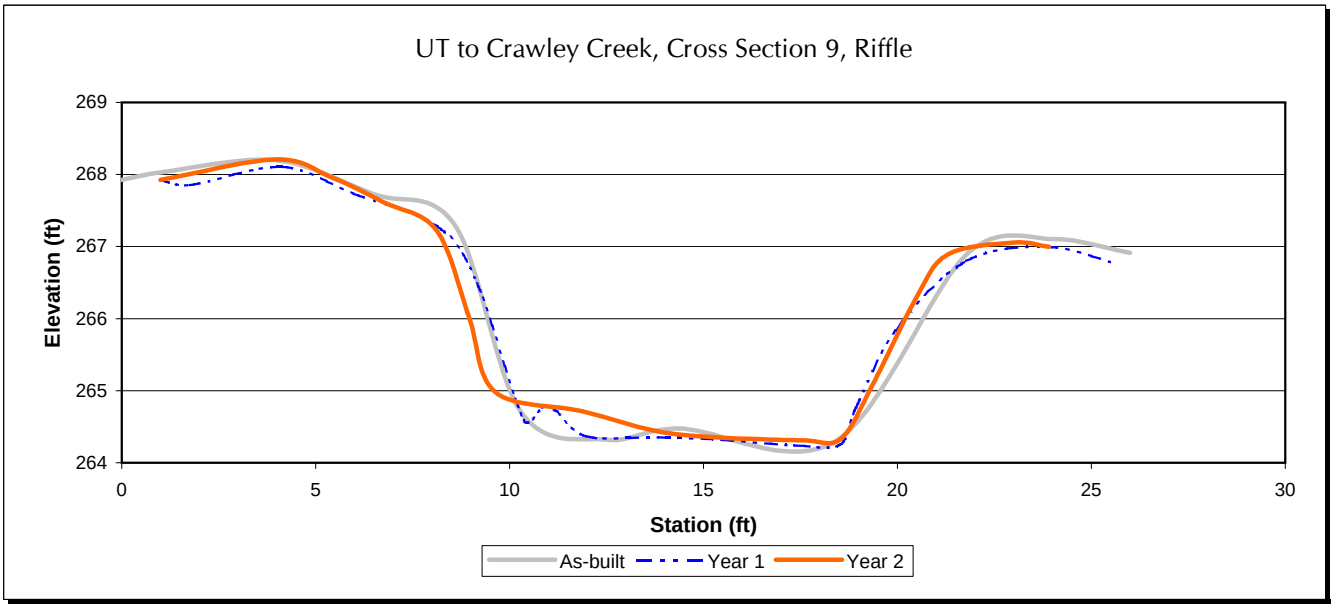
Left Bank

Right Bank



Left Bank

Right Bank



Left Bank

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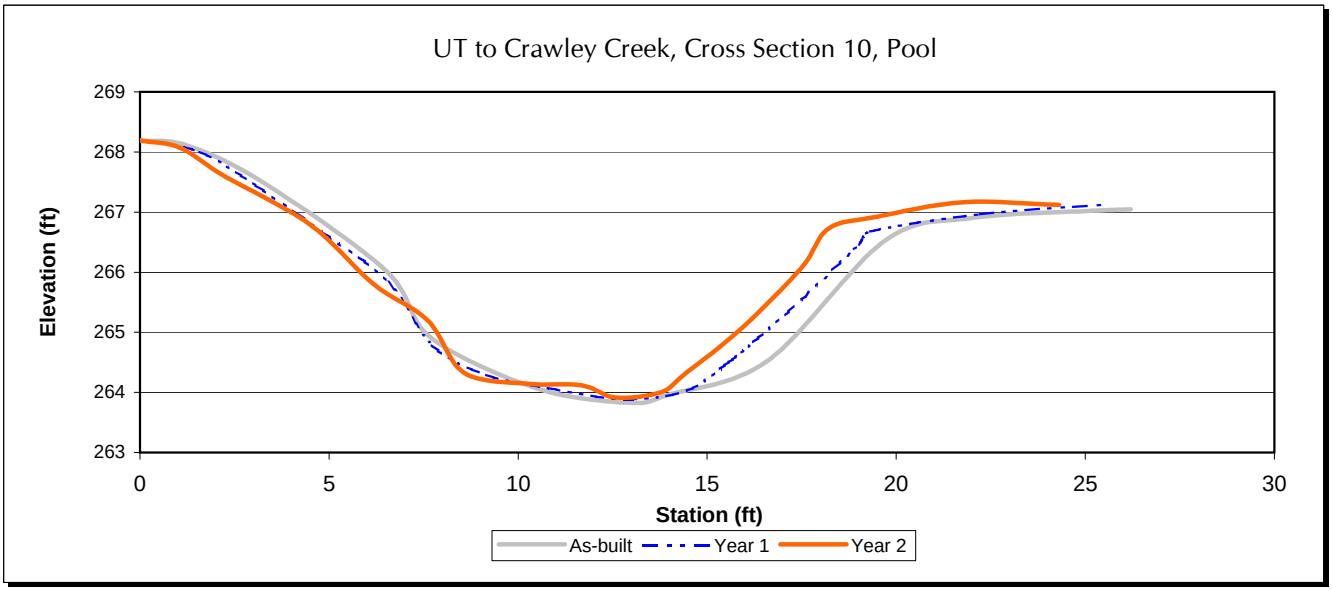
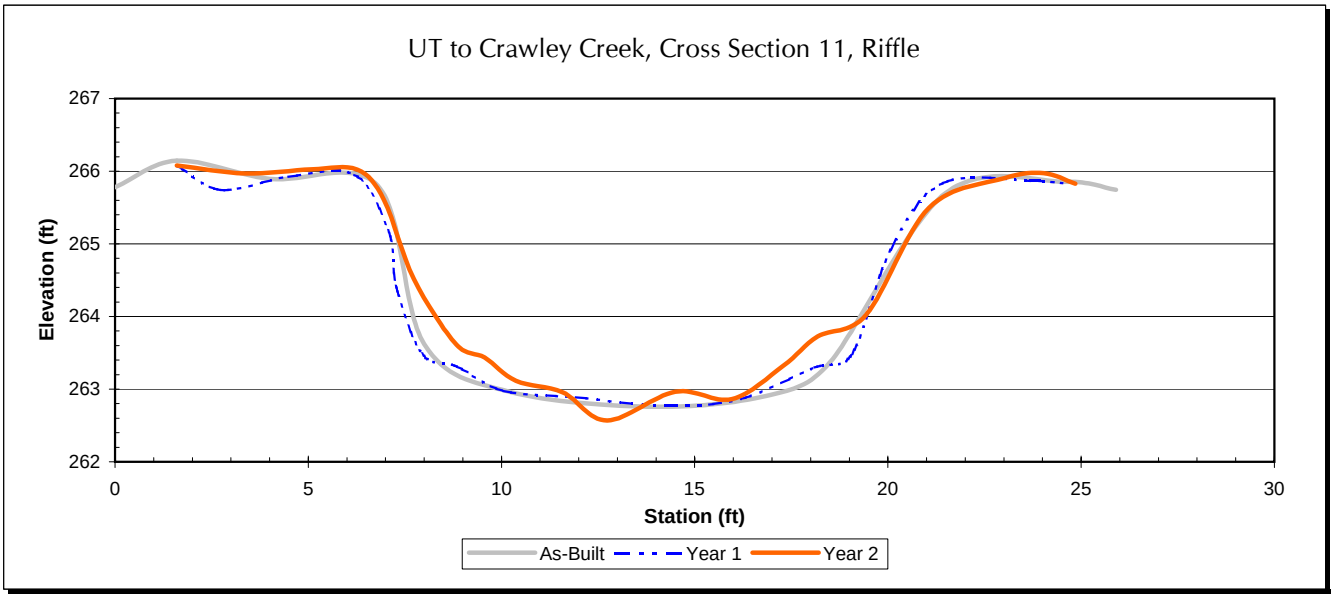


Left Bank

Right Bank



Left Bank

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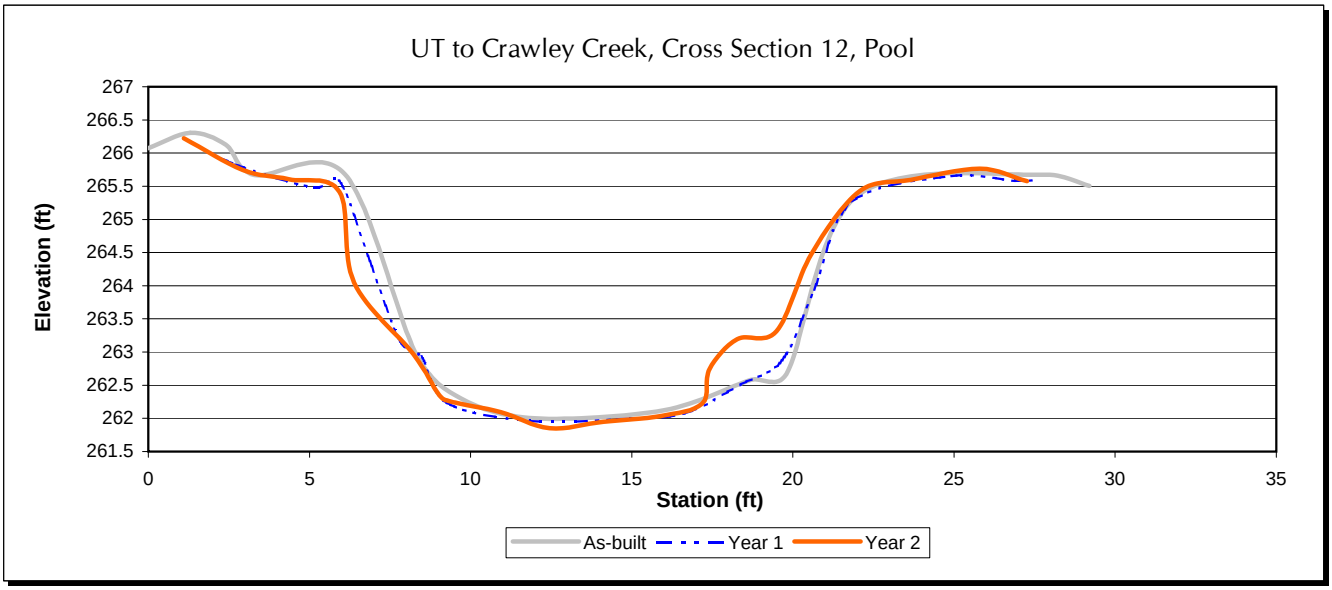

APPENDIX C

2007 Site Photos

Photo 1. Log vane structure at STA 26+00 -looking downstream.

Photo 2. Log ramp structure at station 10+90 - looking downstream.

Photo 3. Ford crossing-looking downstream; debris collected on fence from high flows at STA 7+75.

Photo 4. Log Toe at station 49+10 –looking downstream.

Photo 5. Stream channel with well vegetated banks-looking downstream at STA 48+75.

Photo 6. Rootwad on left bank at station 8+00-looking downstream.

Photo 7. Downstream end of the project-looking downstream.

Photo 8. Upstream end of UT-2 – looking upstream; vegetation in channel.

Photo 9. Vegetation Plot #1.

Photo 10. Vegetation Plot #2.

Photo 11. Vegetation Plot #3.

Photo 12. Vegetation Plot #4.

Photo 13. Vegetation plot #5.

Photo 14. Vegetation plot #6.

Photo 15. Vegetation plot #7.

Photo 16. Vegetation plot #8.

Photo 17. Vegetation plot #9.

Photo 18. Vegetation plot #10.

Photo 19. Vegetation plot #11.

Photo 20. Vegetation plot #12.

Photo 21. Vegetation plot #13.

Photo 22. Vegetation plot #14.

Photo 23. SPA 1. Log toe on right bank at STA 56+25; rolled into channel.

Photo 24. SPA 2. Right bank erosion caused by deer and sparse vegetation at STA 46+90.

Photo 25. SPA 3. Debris jam caused by fallen tree at STA 32+50 – looking downstream.

Photo 26. SPA 4. Left bank erosion at upstream end of culvert STA 30+60.

Photo 27. SPA 5. Log vane at STA 24+85-looking downstream; US end of log vane is exposed.

Photo 28. SPA 6. Grade control structure at STA 21+60-looking upstream; structure is not performing properly and has formed a head cut behind the structure.

Photo 29. SPA 7. Log vane at STA 13+75 -looking downstream; US end of log vane is exposed.