Open Springs Mitigation Project
Randolph County, North Carolina

Year 3 Monitoring Report

Prepared for
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1.0 SUMMARY

The Open Springs Stream Mitigation Project site is located in Randolph County, North Carolina, northeast of Ramseur 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 4,835 stream mitigation units (SMU) were generated from this project through restoration and enhancement of stream and riparian habitats. The project is being monitored for five years to determine the success of the restoration and enhancement efforts. 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 July 25, 2005. The As-Built survey is included as Appendix A. Information on stream morphology and vegetation will be collected each year and compared to the baseline data and data from previous monitoring years.

This Annual Report details the monitoring data collected during Monitoring Year 3. Collected data includes: monthly crest gauge readings, monthly observations of current conditions, benthic macroinvertebrate survey, cross sections, digital images, and observations of potential problems with stream stability.

With an average of 547 stems per acre, the overall site has achieved the interim vegetative success criteria and remains on track to achieve the final success criteria at the end of Year 5 as specified in the Mitigation Plan. Ninety-four percent of the site has been covered with herbaceous vegetation. Plots 9 and 10 are areas of concern. The low density in Plot 9 is due in part to the natural regeneration of black willow within this plot. Dry conditions, competition, and possible herbivory may have also contributed to mortality. Control of black willow in Plot 9 and supplemental planting in the vicinity of Plots 9 and 10 are recommended.

The stream morphology is stable with the site experiencing multiple bankfull events again in 2007. Very little fluvial erosion was observed and many of the riffle features are collecting small gravel as expected.

Overall, the project is on track to achieve the stream and vegetation success criteria specified in the Mitigation Plan. 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 Randolph County, North Carolina, northeast of the town of Ramseur (Figure 1 & Figure 2) within hydrologic unit 03030003 in the Cape Fear River Basin. The project site is bound to the north and east by Ferguson Road and Low Bridge Road, respectively.

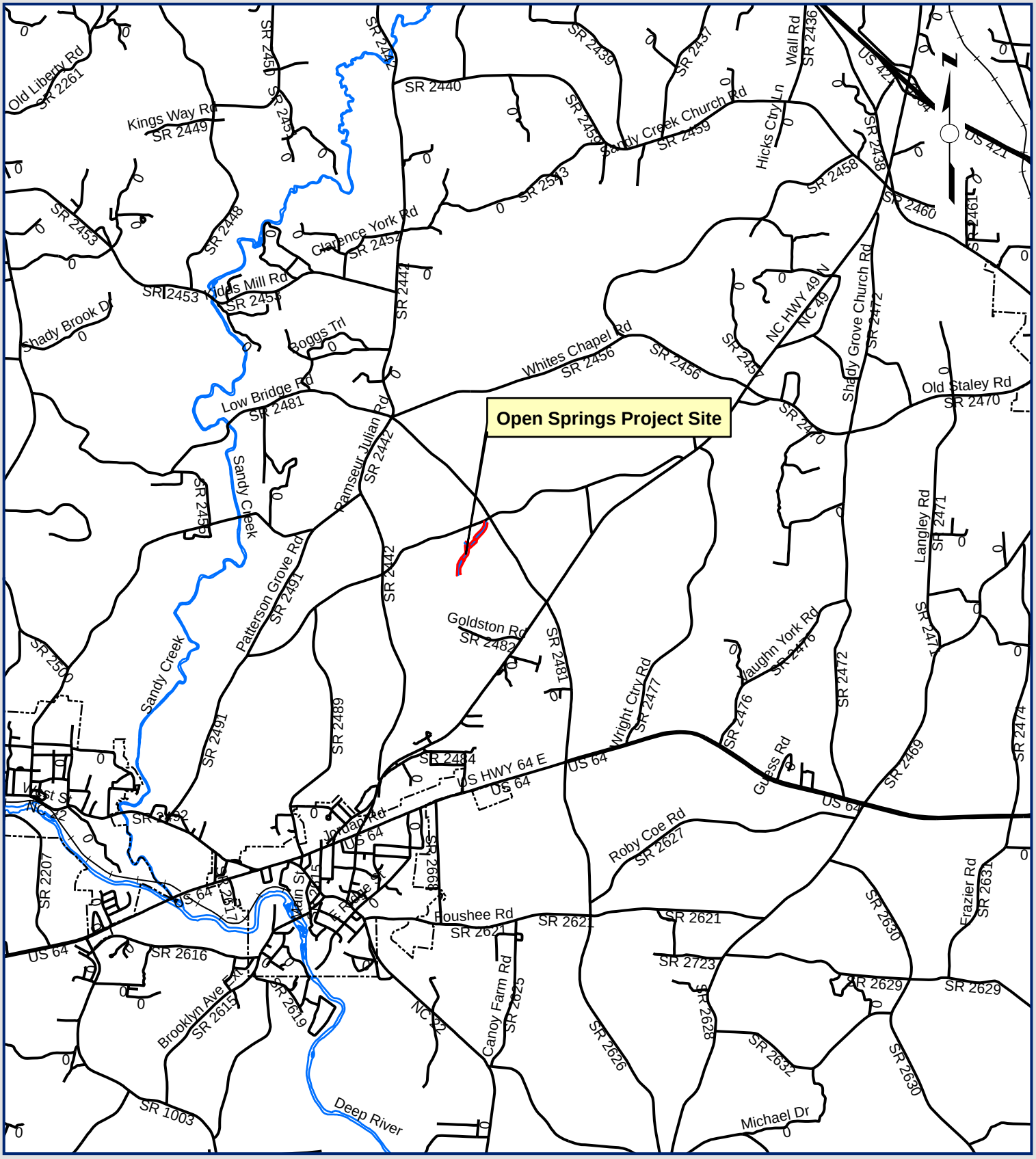
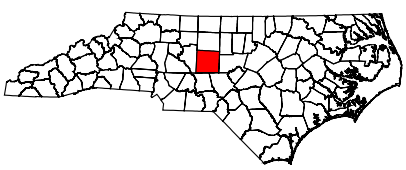


Figure 1.
Open Springs Stream Mititgation Site
Project Location Map
Randolph County, NC

1 inch equals 5,280 feet



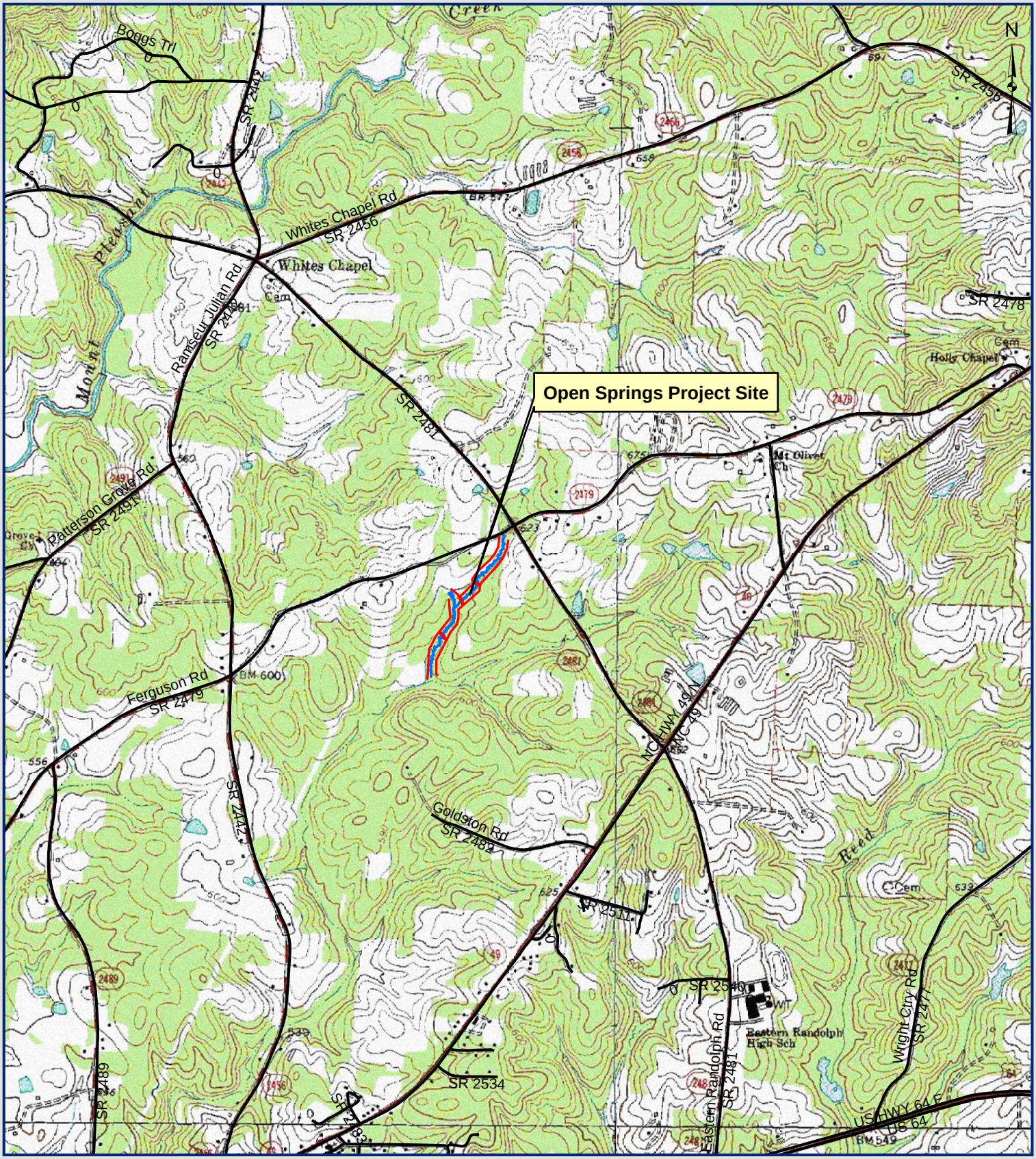
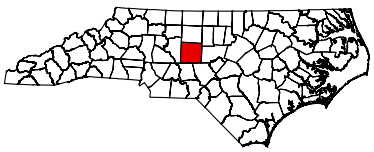


Figure 2.
Open Springs Stream Mititgation Site
USGS Topographic Map
Randolph County, NC

1 inch equals 2,000 feet



2.2 PROJECT PURPOSE

The objective of this project is to provide at least 4,520 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).

Four unnamed tributaries to the Deep River flow across the project site. The streams are referred to in this report as UT-1, UT-2, UT-3 and UT-4. 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. UT-1 was the most degraded resource and was the focus of restoration efforts. A total of 3,202 mitigation units were achieved by restoring plan form, cross section, and profile features on UT-1. In addition, a small tributary enters UT-1 near station 14+50, referred to herein as UT-4. The bed of this tributary was raised to maintain a stable confluence with UT-1. An existing slope discontinuity approximately 175 feet upstream of the confluence was deemed the natural location to tie in grades, and the sinuosity designed for this small tributary yielded an additional 307 linear feet of stream. Therefore, a total of 3,509 SMU were generated from stream restoration on UT-1 and UT-4.

UT-2 is the master stream and, although it has been locally disturbed by cattle, it was in relatively good physical condition. Enhancements to UT-2 include cattle exclusion, localized bank stabilization and debris removal, riparian buffer planting, and control of invasive/exotic vegetation. UT-2 has a total length of 2,397 feet on the subject property. An existing farm crossing was maintained and 53 feet are being held near the east property line to accommodate a future crossing, leaving 2,329 linear feet for stream enhancement. Using the 2.5:1 ratio for Level II stream enhancement (USACE, 2003), 931 SMU were generated from UT-2. UT-3 flows through a regenerated pine plantation and is also in good physical condition. However, the riparian habitat along UT-3 is in poor condition and enhancement efforts included riparian buffer planting to increase diversity and control invasive/exotic vegetation. At the 2.5:1 enhancement ratio, 395 linear feet of UT-3 were enhanced to deliver the total 4,835 SMU.

2.3 PROJECT HISTORY

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's Full Delivery Project S-1. This project was identified by EBX in the spring of 2003. **Table 1** outlines the project history and milestones.

Table 1 Project History and Milestones

Activity or Report	Completion or Delivery
Mitigation Plan	April-04
Final Design	November-04
Construction	April-05
Vegetation Planting	April-05
As-built (Baseline) Report	July-05
Year 1 Monitoring	November-05
Year 2 Monitoring	November-06
Year 3 Monitoring	November-07
Year 4 Monitoring	November-08 (scheduled)
Year 5 Monitoring	November-09 (scheduled)

3.0 VEGETATION

3.1 VEGETATION SUCCESS CRITERIA

The interim measure of vegetative success for the Open Springs 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 five of the monitoring period (U.S. Army Corps of Engineers et. al. 2003). Success of riparian vegetative 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 percent of the site species composition may be comprised of volunteers. Remedial action may be required should these volunteers (i.e. loblolly pine, red maple, sweet gum, etc.) present a problem and exceed 20 percent composition.

3.2 DESCRIPTION OF SPECIES AND VEGETATION MONITORING

All vegetation was planted in April 2005 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 multiple strata 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*) and Silky Dogwood (*Cornus amomum*). The second is a drier zone predominantly consisting of mesic species such as yellow poplar (*Liriodendron tulipifera*) and Slippery Elm (*Ulmus rubra*). The plots were planted at an average density of 693 stems per acre.

Table 2 Planted Tree Species

Common Name	Scientific Name	Wetland Status
Shrubs		
Elderberry	*Sambucus canadensis*	FACW-
Paw Paw	*Asimina triloba*	FAC
Silky Dogwood	*Cornus amomum*	FACW+
Tag alder	*Alnus serrulata*	FACW+
Trees		
Black Gum	*Nyssa sylvatica*	FAC
Black Locust	*Robiinia pseudocacia*	FACU-
Green ash	*Fraxinus pennsylvanica*	FACW
Ironwood	*Carpinus caroliniana*	FAC
Red Oak	*Quercus rubra*	FACU
River Birch	*Betula nigra*	FACW
Slippery Elm	*Ulmus rubra*	FAC
Sycamore	*Platanus occidentalis*	FACW-
Tulip Poplar	*Liriodendron tulipifera*	FAC

To monitor the success of riparian buffer vegetation twelve plots were established on the Open Springs Mitigation Site. The plots cover approximately 2 percent of the site and were designed to be 1/10th of an acre in size. The locations of these plots were randomly distributed across the planted portions of the site. The center of each plot is located with a ten-foot section of metal fence post with a white PVC cover. Within each established plot the planted woody stems were identified with a numbered aluminum tag and marked with a three-foot section of white PVC

pipe. Total numbers of each species planted are listed in **Table 3**. Planted woody species will be monitored twice per year each year for the first three years. Herbaceous plant cover was monitored during the 2007 annual monitoring visit using the notched-boot method.

Table 3 Planted Trees per Plot and Per Acre

Plot #	Trees Planted per Plot	Trees Planted per Acre
Plot 1	18	720
Plot 2	17	680
Plot 3	18	720
Plot 4	20	800
Plot 5	17	680
Plot 6	21	840
Plot 7	19	760
Plot 8	16	640
Plot 9	19	760
Plot 10	10	400
Plot 11	14	560
Plot 12	19	760
Average	17	693

To compensate for the mortality observed in 2006, portions of the site were replanted in March 2007 with 2-year-old trees, and the site was treated with the herbicide Roundup to control fescue. Approximately 1,600 trees were planted around vegetation plots VP 1, VP 2, VP 4, VP 7, VP 9, and VP 12. Tree species planted include those shown in **Table 2** except for slippery elm, tag alder and black gum. Eastern redbud was an additional species planted.

3.3 RESULTS OF VEGETATION MONITORING

All vegetation monitoring plots were evaluated for success (see results in **Table 4**) and the overall condition of vegetation at the site was assessed during August 2007. The site is very dry due to the regional drought conditions. Vegetation across the site appears to be affected, showing yellowing leaves and reduced leaf area which may have contributed to mortality. Despite the drought conditions most plots did not show excessive mortality. Problem areas identified in 2006 were evaluated. Mortality in Plots 3, 4, and 7 appear to have stabilized. Within some of these plots, as well as other plots across the site, a number of green ash stems were observed to be resprouting from the crown. During the previous monitoring period theses resprouted stems were recorded as dead and this resulted in the calculated survival exhibiting an increase from the previous year.

Replanted stems were identified in areas and survival for these plots was calculated by dividing the observed live stems by the sum of the initial stem count and the additional replanted stems. Plots 9 and 10 are areas of concern because the stems per acre are less than the success criteria of 360 stems per acre after 3 years. Plot 9 has less than the 260 stems per acre. The low density in Plot 9 is due in part to a clump of natural regeneration black willow located within this plot. The black willow covers approximately 40 percent of the plot, creating shade and out-competing the planted stems within this plot. An obvious reason for the high mortality in Plot 10 is not readily determined, although this plot is located slightly higher above the channel and may be dryer, also, Plot 10 was planted at a low initial stem density. Both of these plots had high mortality between Year 1 and Year 2 with mortality still occurring. Dry conditions, competition, and possible herbivory may have contributed to mortality. For the site as a whole, the average stem density increased from 455 to 547 stems per acre (**Table 6**). Volunteer species are not out-competing the

Table 4. Stem Counts for Each Species Arranged by Plot.

Species	Plots												Initial Totals	Year 1 Totals	Year 2 Totals	Year 3 Totals	Survival Rate
	1	2	3	4	5	6	7	8	9	10	11	12					
Shrubs																	
Elderberry	1												17	17	0	1	6%
Paw-Paw	1	5				8	1					1	24	24	11	16	67%*
Silky Dogwood			1		3	1		2			1		10	10	8	8	80%
Tag Alder													1	1	0	0	0%
Trees																	
Black Gum		1		1			2								4	4	100%*
Black Locust			4							1		1	5	5	2	6	120%
Green Ash	10	1	2	14	3	5	5	8	3	4	1	3	53	53	48	59	111%
Ironwood	1		4		5		3	5	1	2	12	3	34	34	7	36	106%**
Red Oak			2									2	4	4	2	4	100%
River Birch	2	1		5	1	1	4	1					16	16	18	15	94%
Slippery Elm		2													21	2	10%**
Sycamore		2			3	3							10	10	9	8	80%
Tulip Poplar		1							1		1		34	34	5	3	9%
Total Stems	15	13	13	20	15	18	15	16	5	7	15	10	208	208	135	162	

*These two species were initially misidentified as a single species. Based on Year 1 identification and replanting the survival of black gum/paw-paw is 74 %.
**These two species were initially misidentified as a single species. Based on Year 1 identification and replanting the survival of slippery elm/ironwood is 93 %.

Table 5 Vegetation Plot Species Survival Summary Data

	Stems per Plot												Average
Plots	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	
Baseline	18	17	18	20	17	21	19	16	19	10	14	19	17.3
Year 1	18	17	18	20	17	21	19	16	19	10	14	19	17.3
Year 2	12	12	9	16	15	18	8	16	4	7	14	4	11.3
Year 3	15	13	13	20	15	18	15	16	5	7	15	10	13.5
Trees per Plot	**Percent Survival**												
Year 1	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Year 2	67%	71%	50%	80%	88%	86%	42%	100%	21%	70%	100%	21%	66%
Year 3	71%	68%	62%	95%	88%	86%	71%	100%	24%	64%	107%	38%	73%
Trees per Acre	**Stems per Acre**												
Baseline	729	688	729	810	688	850	769	648	769	405	567	769	702
Year 1	729	688	729	810	688	850	769	648	769	405	567	769	702
Year 2	486	486	364	648	607	729	324	648	162	283	567	162	455
Year 3	607	526	526	810	607	729	607	648	202	283	607	405	547

planted community across the site except in limited areas such as Plot 9, where black willow is affecting survival.

A couple of species were initially misidentified. Black gum was misidentified as pawpaw and slippery elm was misidentified as ironwood. The last two years these species were consistently identified.

Vegetation areas within the project boundary that require further observation are listed in **Table 6**. Photos of vegetation plots are included in **Appendix C**. A few small areas having bare soil exposed still exists, primarily located in discontinuous patches along a narrow band along the cut slopes just above the floodplain. These do not appear to be a significant problem and herbaceous vegetation is beginning to fill in these areas.

Table 6 Vegetation Areas Requiring Observation

Type of Problem	Location/ Station	Probable Cause	Photo ID
Mortality of Planted Woody Species – lack of adequate stems per acres	Vegetation Plot 9	Dry conditions, insects	VP09
Mortality of Planted Woody Species – lack of adequate stems per acres	Vegetation Plot 10	Dry conditions, insects, possible herbivory	VP10

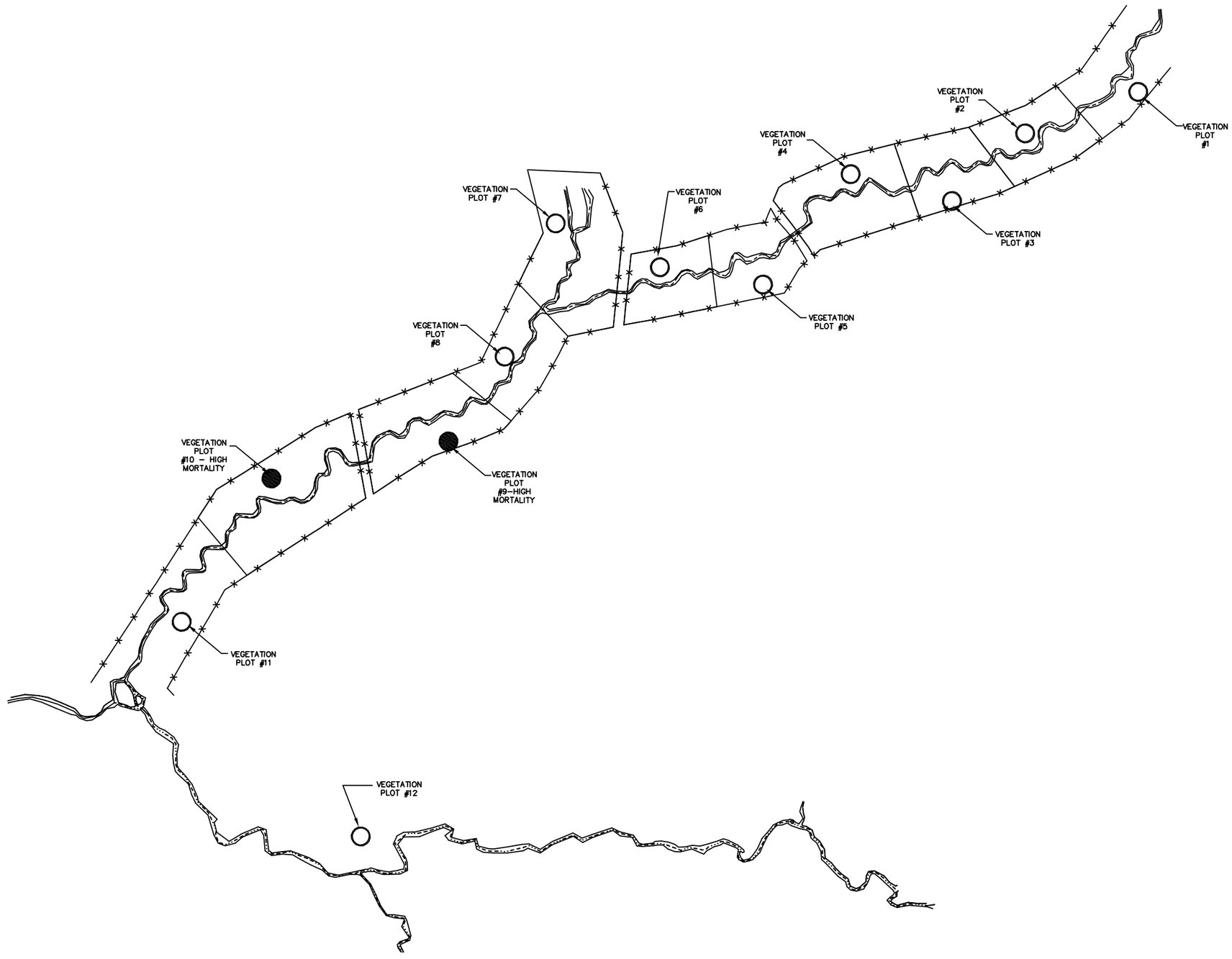
A plan view drawing shows the location of vegetation areas requiring observation and vegetation monitoring plots (**Figure 3**). The drawing shows the locations of the following features:

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

Herbaceous cover was estimated using the notched-boot method. Most of the site has good herbaceous cover and was found on approximately 94 percent of the site utilizing the notched-boot method. The most visible herbaceous vegetation is dog fennel (*Eupatorium capillifolium*), reaching heights of over 6 feet in many places. In addition to dog fennel common herbaceous species included; smartweed (*Polygonum pennsylvanicum*), barnyard grass (*Echinochloa crus-galli*), cutgrass (*Leersia oryzoides*), spiny amaranth (*Amaranthus spinosus*), American burnweed (*Erechtites hieraciifolia*), shortbeard plume grass (*Saccharum brevibarbe*), Carolina horsenettle (*Solanum carolinense*), sawtooth blackberry (*Rubus argutus*), panic grass (*Panicum anceps*), pokeweed *(Phytolacca americana*), Canada goldenrod, (*Solidago Canadensis*), broomsedge (*Andropogon virginicus*), and various grasses. Most of the herbaceous and woody volunteer species noted are common old-field, disturbed site, and early successional species.

3.4 GENERAL VEGETATION OBSERVATIONS

Although the site is generally dry, herbaceous vegetation coverage is good. A few bare or sparsely vegetated areas are still present but do not appear to present a problem. Once normal rainfall resumes this herbaceous cover is expected to rebound quickly. The dominant herbaceous plant visible is dog fennel.



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	REVISIONS	

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DRAWN BY	TRS
APPROVED BY	JMK
FILE NAME	design–layout
DRAWING SCALE	1" = 100'
PROJECT DATE	10/31/06
PROJECT NUMBER	60087.00.RA
PLOT DATE	12/3/07

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BIDDING	
CONSTRUCTION	1–19–05
RECORD DWG.	

OPEN SPRINGS STREAM MITIGATION PLAN
PREPARED FOR
ENVIRONMENTAL BANC & EXCHANGE

YEAR 3 MONITORING
VEGETATION AREAS REQUIRING OBSERVATION
PLAN VIEW

3

Because of the limited rainfall and high temperature, all vegetation on the site is stressed. The recorded plot data indicates that high mortality has not occurred due to these conditions, but continued stress and overwintering may eventually cause mortality in the planted trees.

The site was replanted in March 2007 and newly planted seedlings were observed in some of the plots. Plot VP 9 is becoming dominated by natural regeneration black willow. The cause of mortality in Plot VP 10 is not known but may be related to dry conditions and low initial stem density.

3.5 VEGETATION CONCLUSIONS

Open Springs was planted in nonriverine hardwoods in March 2005. Twelve 1/10th acre vegetation-monitoring plots established were throughout the planting areas.

During the summer of 2007, extreme drought conditions and recorded record high temperatures were experienced. While there is variability from plot to plot, overall the site continues to be on track to meet the final success criteria of 260 trees per acre by the end of year five. Those plots with below average survivability will be evaluated in spring 2008 to determine if additional actions are required. Control of black willow in plot 9 and supplemental planting in the vicinity of Plots 9 and 10 are recommended.

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:

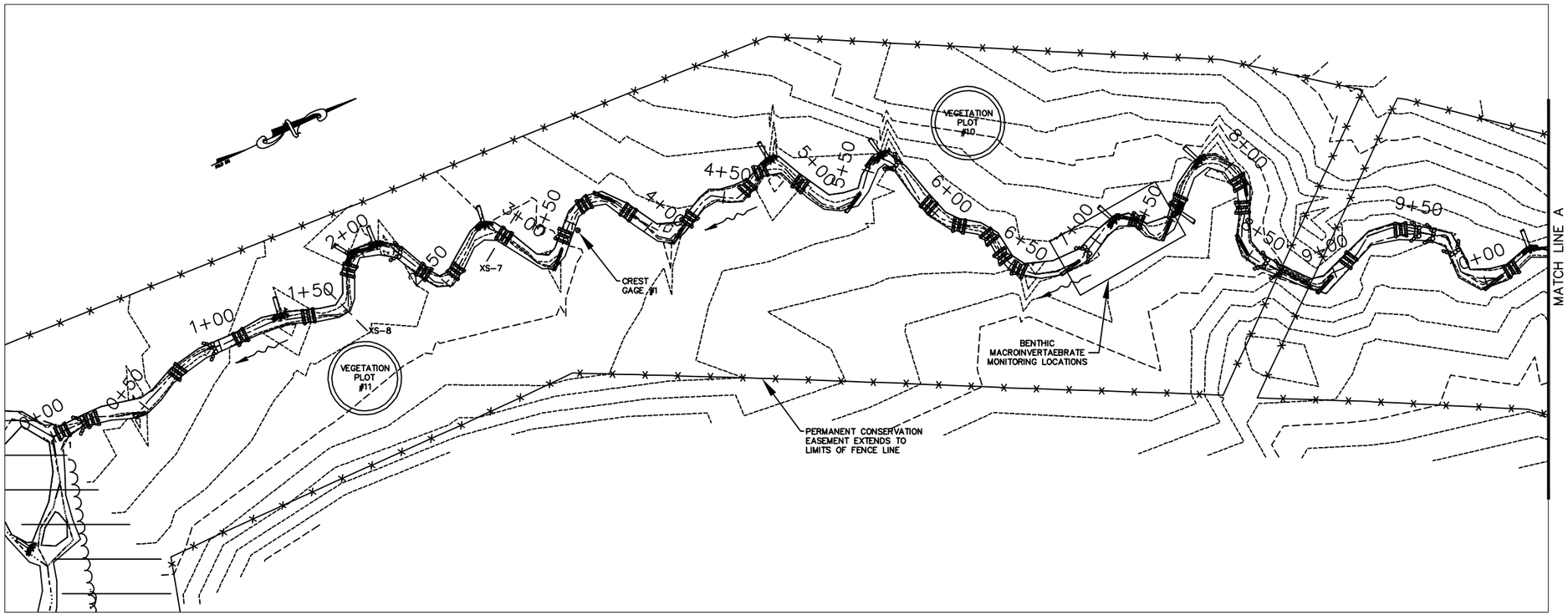
Bankfull Events: Two bankfull flow events must be documented within the five-year monitoring period.

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.



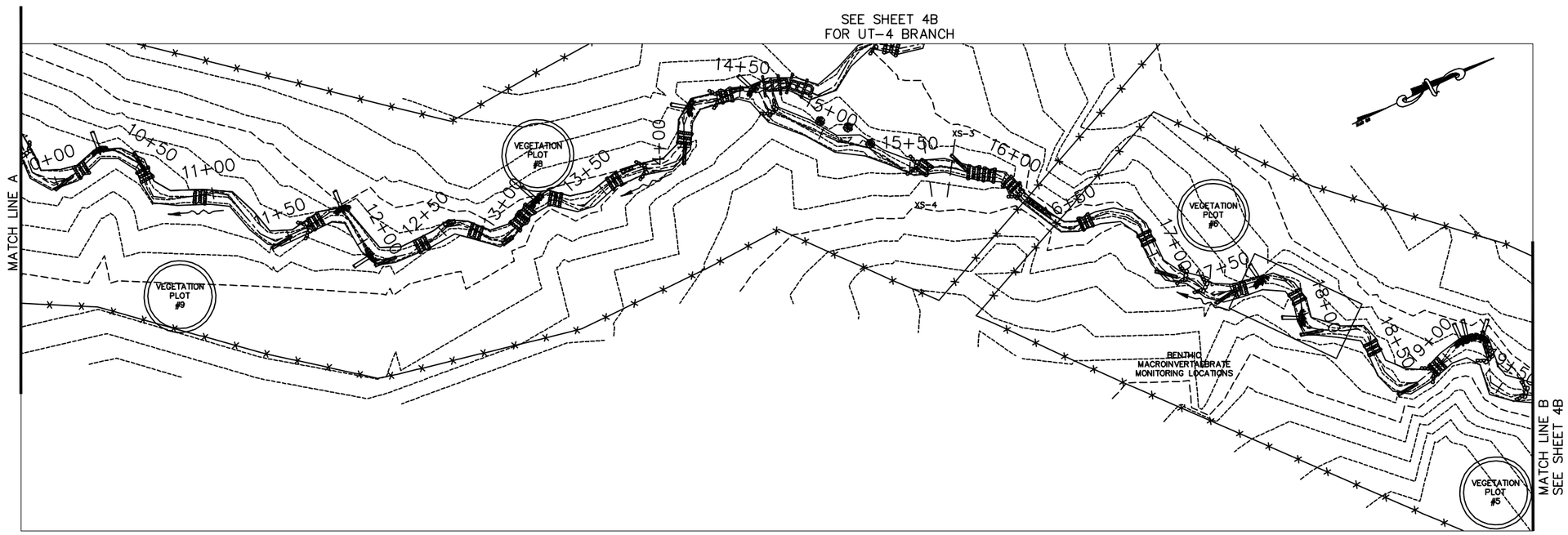
UT–1

LEGEND

EXISTING

- FENCE LINE
- MAJOR CONTOUR
- MINOR CONTOUR
- CENTER OF CHANNEL
- LIMITS OF BANKFULL CHANNEL
- ROOTWAD
- LOG VANE
- CUTTINGS BUNDLE
- CHANNEL PLUG
- LOG TOE PROTECTION
- CULVERT CROSSING
- RIFFLE GRADE CONTROL
- RIFFLE GRADE CONTROL/CROSS WEIR STRUCTURE
- STEP POOL
- CROSS WEIR

SEE SHEET 4B
FOR UT–4 BRANCH



UT–1

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	REVISIONS	

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APPROVED BY	JMK
FILE NAME	design–layout
DRAWING SCALE	1" = 30'
PROJECT DATE	10/31/2006
PROJECT NUMBER	60087.00.RA
PLOT DATE	10/31/06

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OPEN SPRINGS STREAM MITIGATION PLAN
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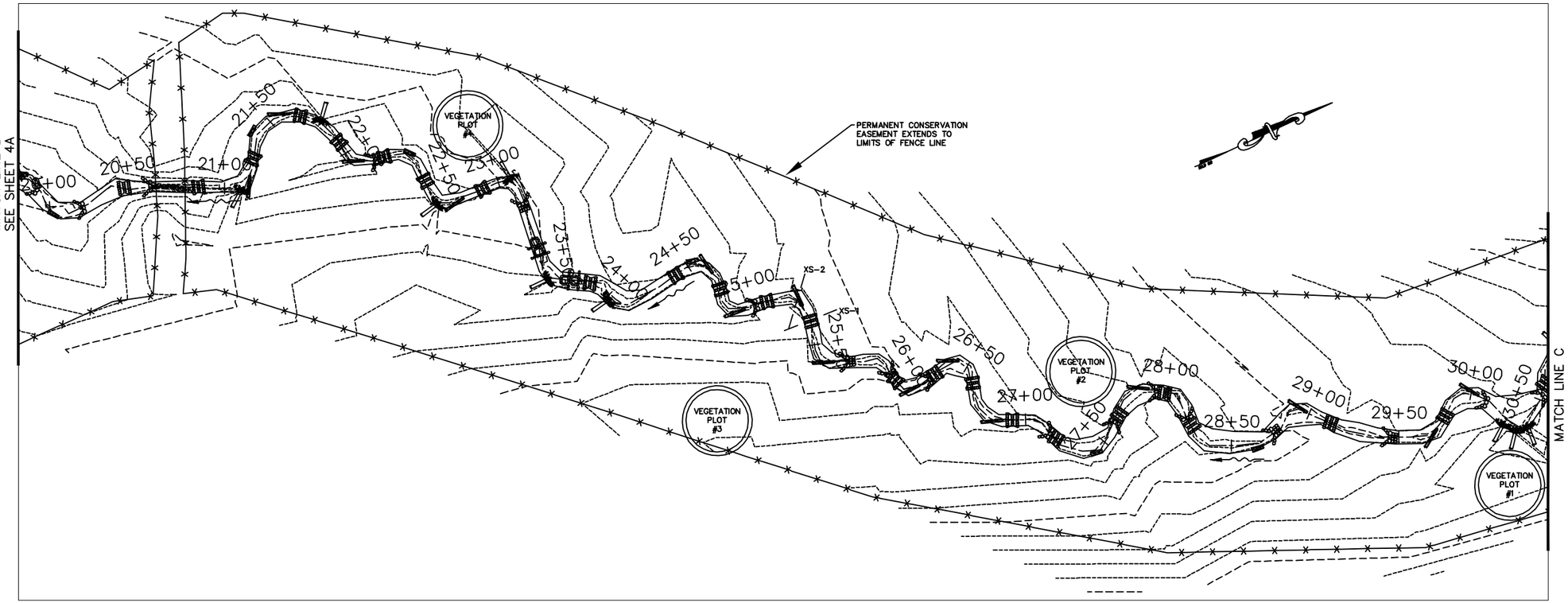
YEAR 3 MONITORING
PLAN VIEW

4A



UT–1

LEGEND

EXISTING

- FENCE LINE
- MAJOR CONTOUR
- MINOR CONTOUR
- CENTER OF CHANNEL
- LIMITS OF BANKFULL CHANNEL
- ROOTWAD
- LOG VANE
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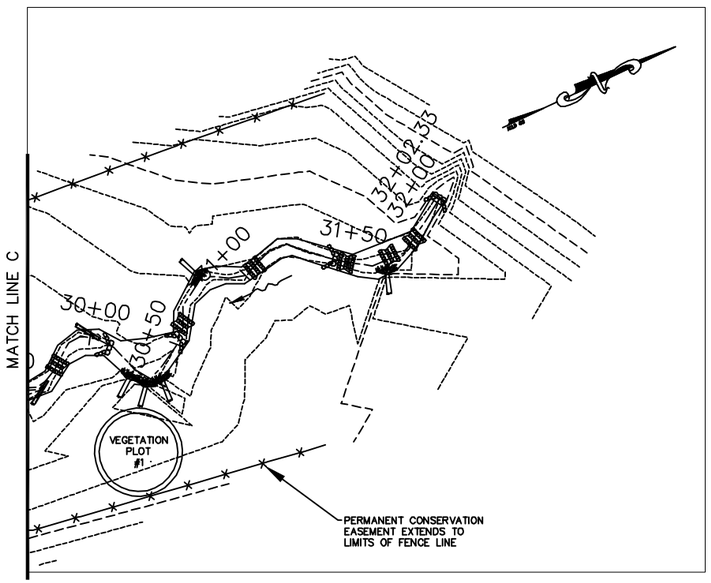
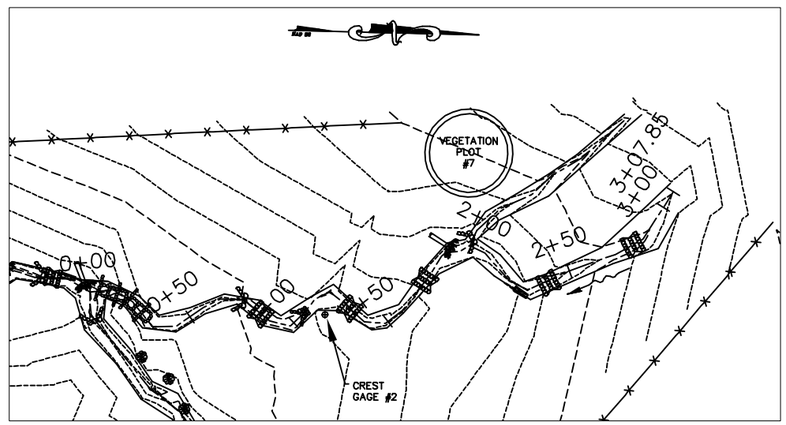
- CULVERT CROSSING
- RIFFLE GRADE CONTROL
- RIFFLE GRADE CONTROL/CROSS WEIR STRUCTURE
- STEP POOL
- CROSS WEIR



UT–1



UT–4

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PROJECT DATE	10/31/2006
PROJECT NUMBER	60087.00.RA
PLOT DATE	10/31/06

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OPEN SPRINGS STREAM MITIGATION PLAN
PREPARED FOR
ENVIRONMENTAL BANC & EXCHANGE

YEAR 3 MONITORING
PLAN VIEW

4B

4.2 STREAM MORPHOLOGY MONITORING PLAN

Along UT-1 and UT-4 a natural channel design approach was applied to develop stable hydraulic geometry parameters. Construction began in February 2005 and was completed in April 2005. The rebuilding of the channel established stable cross-sectional geometry, increased plan form sinuosity, and restored riffle-pool sequences and other streambed diversity to improve benthic habitat. Approximately 3,510 linear feet of stream restoration has been constructed.

4.2.1 Cross Sections

The mitigation plan for the Open Springs project requires eight permanent cross sections to be monitored along the restored tributaries UT-1 and UT-4. 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 on **Figures 4a and 4b**. 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.

4.2.2 Longitudinal Profile

Longitudinal profiles will be surveyed in years one, three, and five of the monitoring period. UT-4 will be surveyed for its entire length. Profiles along UT-1 will be measured at three representative sections, each comprising approximately 900 linear feet. 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.

4.2.3 Hydrology

Two crest gauges were installed at the site, one on UT-1 near the downstream end of the project and one on UT-4 near the UT-1 confluence (see locations on **Figures 4a and 4b**). Crest gauges will be checked at least quarterly. 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. 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. The locations and photos of each area requiring observation are shown in **Figure 5a and 5b**. Throughout the project, many riffle structures were covered with vegetation. Many of the riffle features are collecting small gravel as expected. Some minor siltation was observed, especially in the pool features, along UT-1. **Table 7** lists stream areas requiring further observation, station, description, and photo number of the noted area.

A plan view drawing of the stream problem areas is provided in **Figure 5**. The drawings show the locations of the following features:

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

4.3.1 Cross Sections

The cross sections were surveyed during Year 3 monitoring activities in August 2007. Year 3 monitoring cross sections are shown with baseline cross sections, Year 1 and Year 2 monitoring cross sections in **Appendix B**. Year 3 exhibited very little difference between the baseline, Year 1, and Year 2 monitoring cross sections.

Table 7 Stream Areas Requiring Observation

Feature Issue	Station Numbers	Suspected Cause	Photo Number
Vegetation in channel	Throughout Channel	Siltation	SPA1
Right bank erosion (no repair needed)	25+50	Sparse vegetation	SPA2
Floodplain vegetation	24+00 – 25+00	Sparse vegetation	SPA3
Floodplain vegetation	22+50 – 23+50	Sparse vegetation	SPA4
Left bank erosion (no repair needed)	20+25	Sheet flow	SPA5
Floodplain vegetation	13+00 – 14+00	Sparse vegetation	SPA6
Floodplain vegetation	5+90	Sparse vegetation	SPA7

4.3.2 Longitudinal Profile

The baseline longitudinal profiles were derived from the As-Built survey data. Profiles were resurveyed during Year 3 monitoring activities in August 2007. The Year 3 monitoring profile is shown with the baseline profile in **Appendix B**. There is very little difference between the baseline profile and the monitoring Year 3 profile.

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 five out-of-bank or bankfull events occurred during this period on UT-1 and four on UT-4. Crest gauge data are included in **Table 8**. Weather data were collected from a nearby weather station - Asheboro 2 W (310286). 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

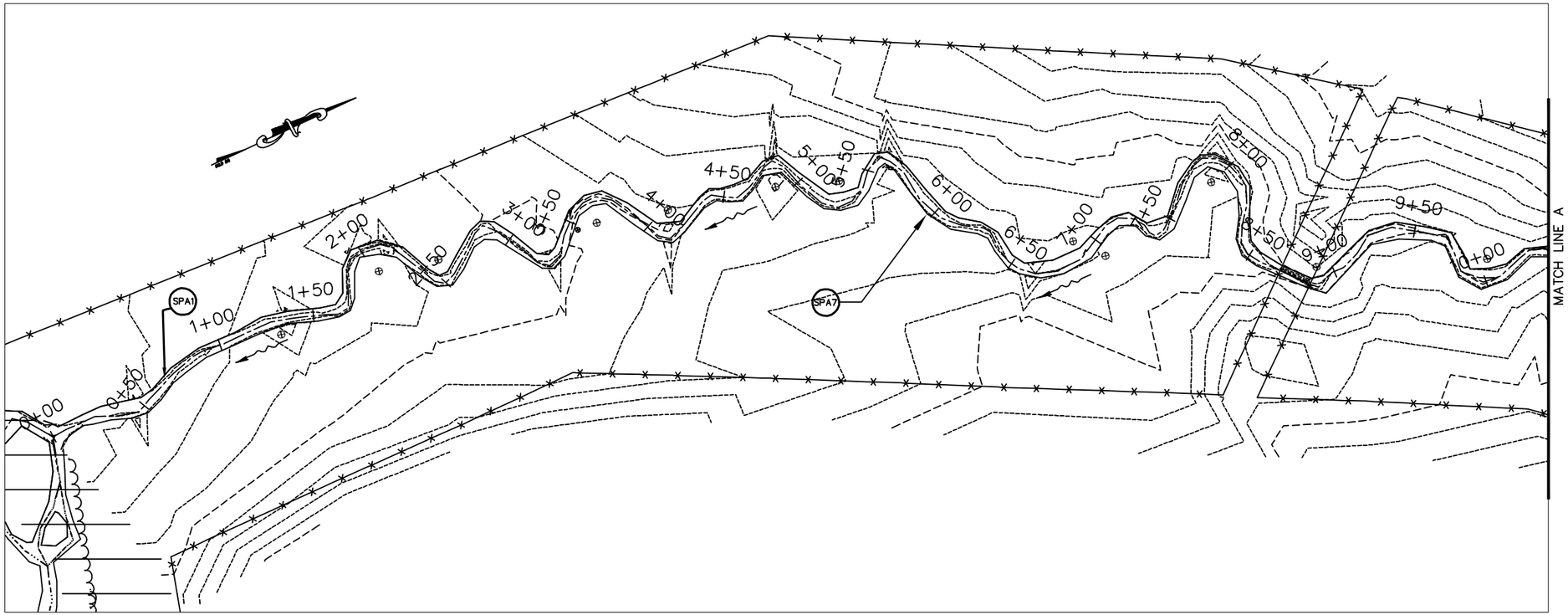
Date of Data Collection	Crest Gauge 1 Reading (UT-1)	Crest Gauge 2 Reading (UT-4)
March-07	0.70	0.80
April-07	0.85	1.60
May-07	0.00	0.00
June-07	0.80	0.00
July-07	0.34	0.25
August-07	0.60	0.60
September-07	0.00	0.00
October-07	0.00	0.00
November-07	1.15	2.30

Table 9 County and On-site Rainfall Data

Month	Average	Normal Limits		Asheboro Precipitation	On-Site Precipitation	Accumulated Rainfall Deficit
		30 Percent	70 Percent			
January	4.44	3.17	5.6	3.02	---	-1.42
February	3.71	2.51	4.63	3.48	---	-1.65
March	4.27	3.06	5.01	2.58	---	-3.34
April	3.49	2.31	4.42	4.45	---	-2.38
May	4.25	2.8	5.46	1.17	---	-5.46
June	3.97	2.39	4.67	3.88	2.98	-5.55
July	4.12	2.52	4.61	1.7	1.82	-7.97
August	4.26	2.95	5.14	1.99	1.60	-10.24
September	4.31	2.39	6.13	1.22	0.55	-13.33
October	3.59	1.82	4.07	0.03	0.25	-16.89
November	3.16	2.11	3.8	0.25	7.97	-19.80
December	3.26	2.32	3.93	---	---	---
Total	46.83	30.35	57.47	23.52	15.17	---

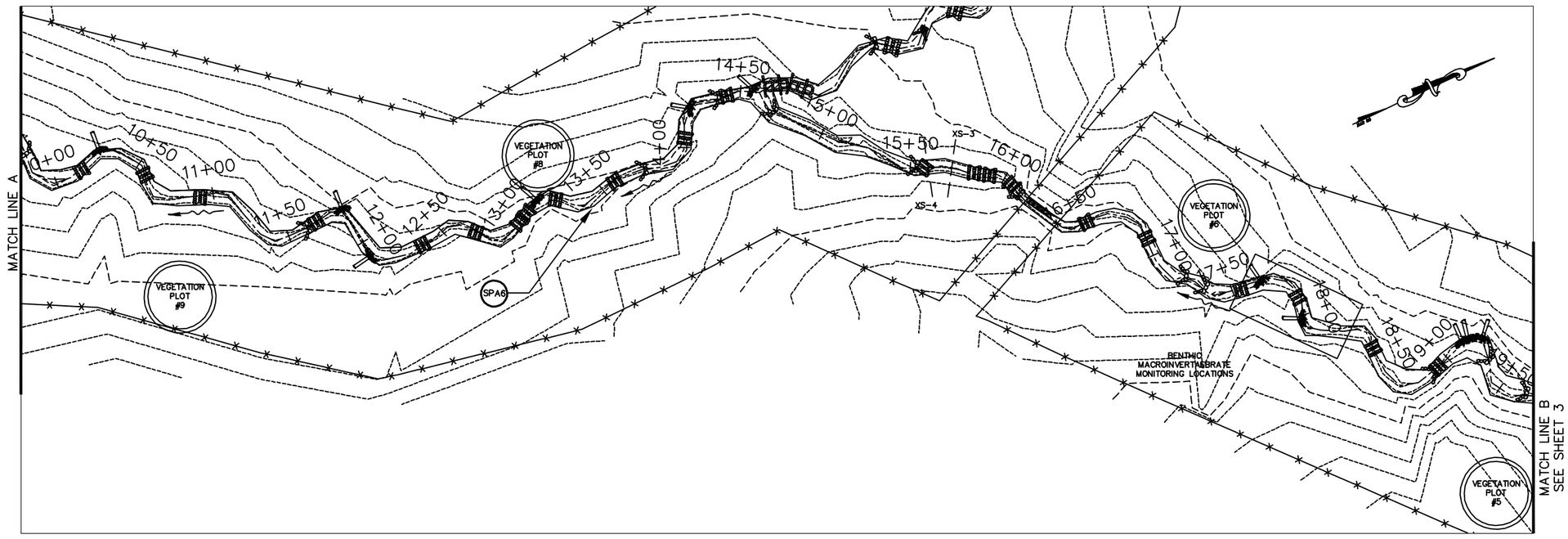
The entire state of North Carolina experienced increasingly severe drought conditions throughout 2007, with some areas experiencing the lowest average stream flows on record. The first signs of drought began in February in the western part of the state. By early spring, abnormally dry conditions had 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 percent 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 Open Springs restoration site experienced drought conditions consistent with state-wide trends. Rainfall levels at the Asheboro monitoring station, near the Open Springs site, fluctuated



UT–1

SEE SHEET 5B FOR
UT–4 BRANCH



UT–1

LEGEND

EXISTING

- FENCE LINE
- MAJOR CONTOUR
- MINOR CONTOUR
- CENTER OF CHANNEL
- LIMITS OF BANKFULL CHANNEL
- ROOTWAD
- LOG VANE
- CUTTINGS BUNDLE
- CHANNEL PLUG
- LOG TOE PROTECTION
- CULVERT CROSSING
- RIFFLE GRADE CONTROL
- RIFFLE GRADE CONTROL/CROSS WEIR STRUCTURE
- STEP POOL
- CROSS WEIR
- BARE SPOT ON FLOODPLAIN

0 15 30 60 120
SCALE

558

REV. NO.	DESCRIPTION	DATE
	REVISIONS	

PROJECT MANAGER	MSE
DRAWN BY	TRS
APPROVED BY	JMK
FILE NAME	design–layout
DRAWING SCALE	1" = 30'
PROJECT DATE	05/31/2005
PROJECT NUMBER	30440.00.RA
PLOT DATE	12/03/07

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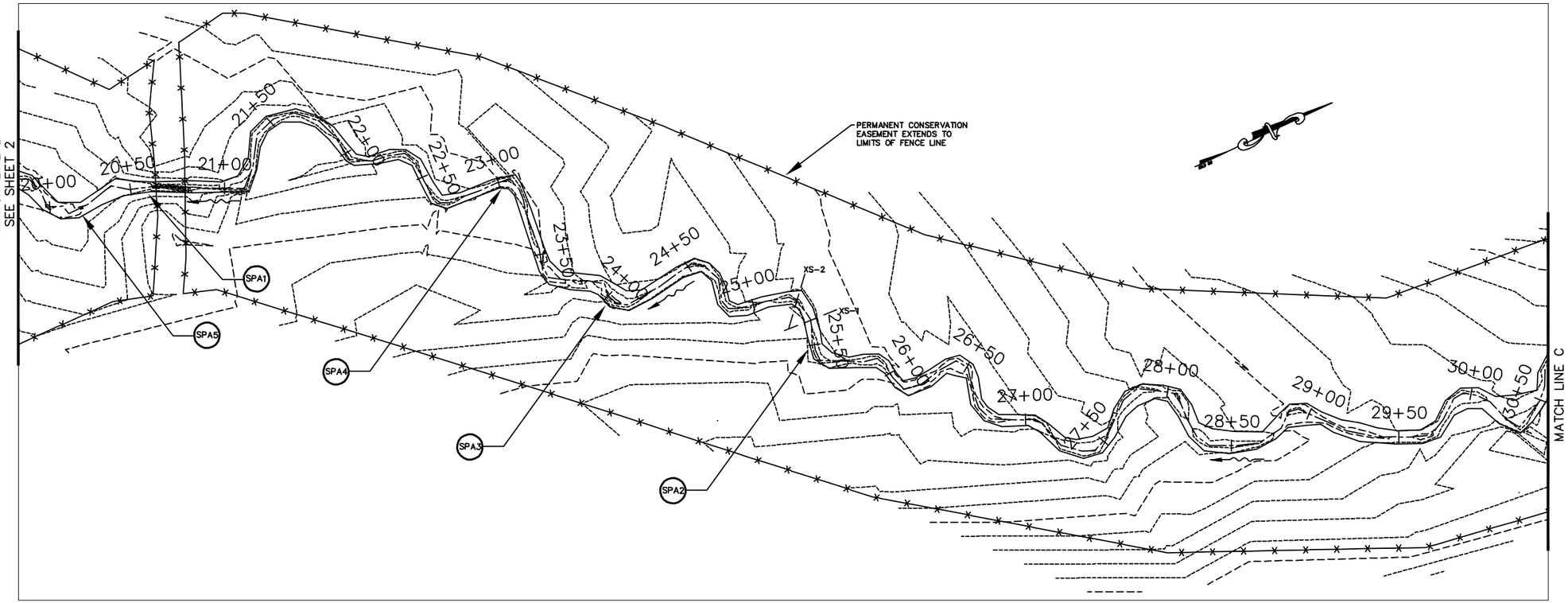
BIDDING	
CONSTRUCTION	1–19–05
RECORD DWG.	

OPEN SPRINGS STREAM MITIGATION PLAN
PREPARED FOR
ENVIRONMENTAL BANC & EXCHANGE

YEAR 3 MONITORING
STREAM AREAS REQUIRING OBSERVATION

5A



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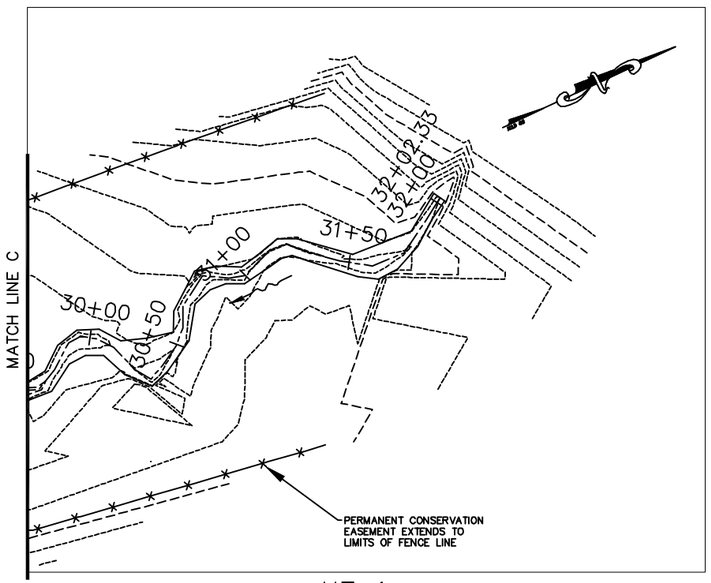

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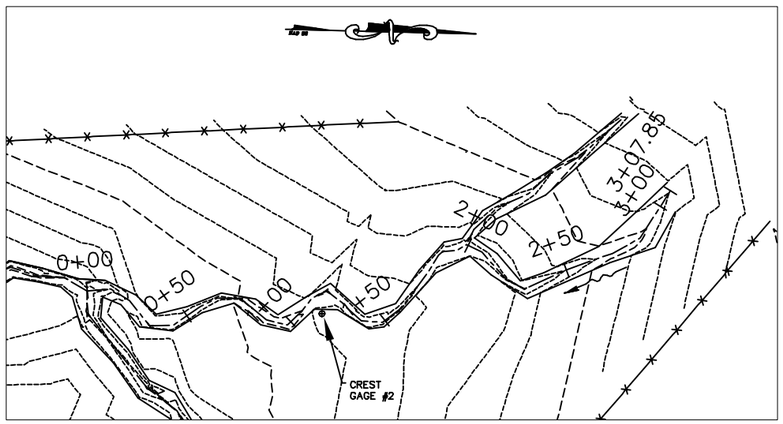

UT-4

LEGEND

EXISTING

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- MAJOR CONTOUR
- MINOR CONTOUR
- CENTER OF CHANNEL
- LIMITS OF BANKFULL CHANNEL
- ROOTWAD
- LOG VANE
- CUTTINGS BUNDLE
- CHANNEL PLUG
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- CULVERT CROSSING
- RIFFLE GRADE CONTROL
- RIFFLE GRADE CONTROL/CROSS WEIR STRUCTURE
- STEP POOL
- CROSS WEIR
- BARE SPOT ON FLOODPLAIN

0 15 30 60 120
SCALE

558

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	REVISIONS	

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APPROVED BY	JMK
FILE NAME	YEAR1.DWG
DRAWING SCALE	1" = 30'
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PROJECT NUMBER	30440.00.RA
PLOT DATE	12/03/07

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OPEN SPRINGS STREAM MITIGATION PLAN
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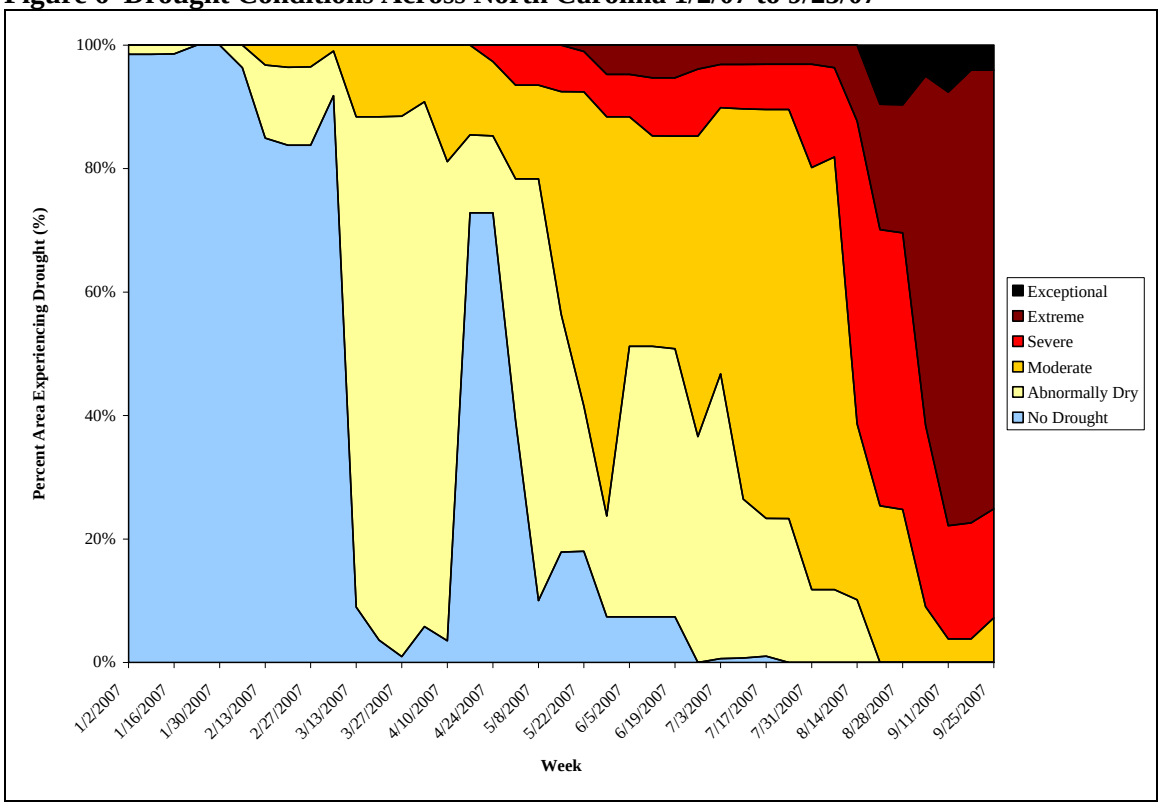
YEAR 3 MONITORING
STREAM AREAS REQUIRING OBSERVATION

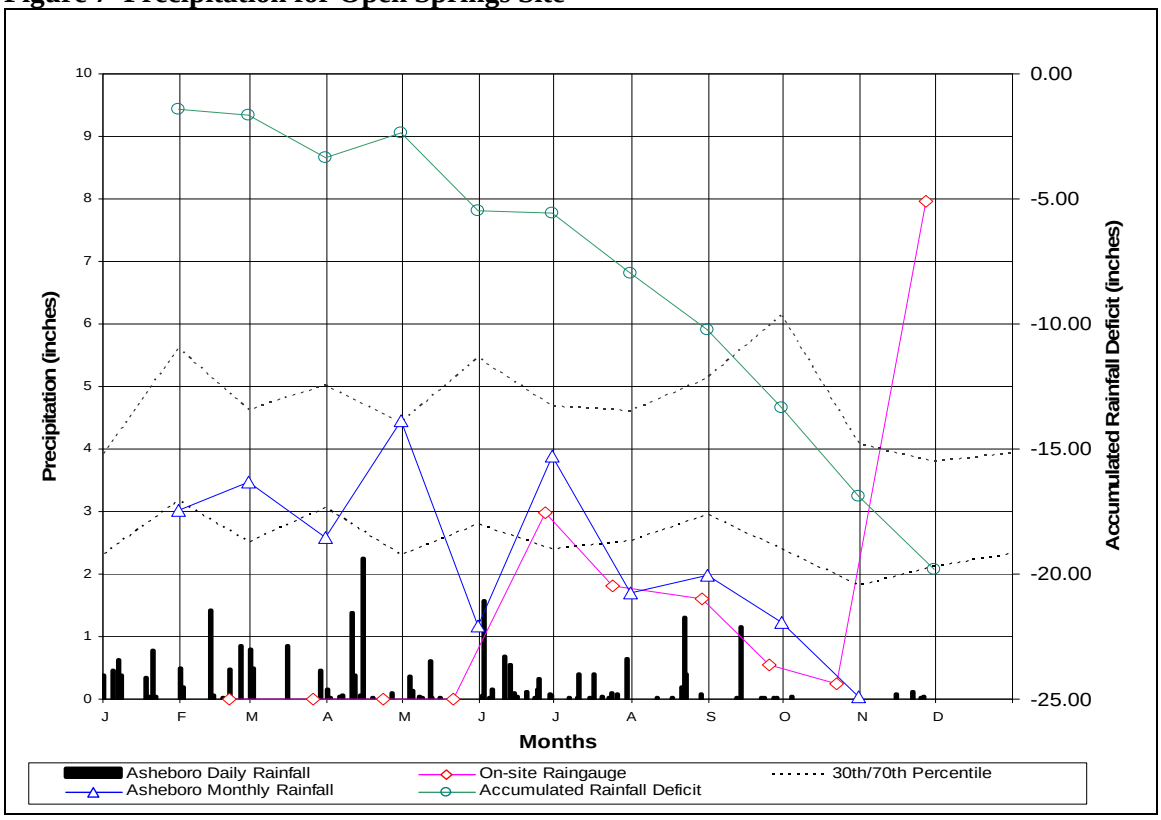
5B

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



between normal and slightly less than normal for much of the spring and summer (**Fig. 7 and Table 9**). In May the site received only 1.7 inches of rain, 3.08 inches below average. July and August also saw below-normal precipitation levels of 1.7 and 1.99 inches, respectively. The accumulated rainfall deficit—the difference between the long-term average and the observed monthly precipitation levels, aggregated monthly—began at -1.42 inches in January and fell to -3.34 in March. The deficit recovered slightly in April before declining steadily to -10.24 inches in August. Persistent and worsening drought conditions severely impacted vegetative growth at the Open Springs restoration site.

Figure 7 Precipitation for Open Springs Site



4.4 BENTHIC MACROINVERTEBRATE SURVEY RESULTS

Benthic macroinvertebrates were collected at two locations along the restoration reach and at one reference reach location in May 2007. The North Carolina Division of Water Quality (NCDWQ) Qual-4 method was utilized. In addition to benthic sampling, NCDWQ habitat assessment forms were completed at each monitoring station. Samples were preserved in alcohol and later identified to the lowest possible taxonomic level by an aquatic ecologist. **Tables 10-12** list the taxa encountered, relative abundance, and tolerance values. 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 pollution intolerant.

Taxa richness and abundance was similar to 2006 monitoring in both the restoration reaches and reference stream. Taxa assemblage changed significantly most likely due to drought conditions and a change in the time of year sampling was conducted between 2006 and 2007. The majority of taxa collected in the restoration reaches were small younger larvae or small adult beetles, indicating a lack of water during some time period prior to sampling. In addition, most taxa collected in 2007 were depositional species that can survive in deeper pools that are less likely to dry up during low flow periods.

4.4.1 Station 1

The upstream sampling station is located approximately 100 feet upstream of the upper culvert crossing and received a habitat assessment score of 59 out of 100 possible points. At the time of sampling, the channel had only intermittent pools of water due to a recent drought. The macroinvertebrate assemblage at this site reflects the intermittency of this portion of the Open Springs site (**Table 10**).

4.4.2 Station 2

The downstream sampling station is located approximately 100 feet downstream of the lower culvert crossing and received a habitat score of 63 out of 100 possible points. At the time of sampling, this portion of Open Springs had minimal flow. The organisms collected were larger than in the upstream reach indicating the presence of in-channel water for a longer duration. The majority of taxa collected are pollution intolerant (**Table 11**).

4.4.3 Reference Reach

The reference reach is located on an unnamed tributary of Tick Creek approximately six miles south of Siler City on Siler City-Glendon Road. The reference reach received a habitat score of 57 out of 100 possible points. Taxa encountered were generally pollution tolerant (**Table 12**).

Table 10. Station 1 Upstream Benthic Macroinvertebrate Data May 2007

Order	Family	Genus Species	Tolerance Value	No.
Coleoptera	Haliplidae	*Haliplus spp*	8.7	1
Coleoptera	Dytiscidae	*Hydroporus spp*	8.6	2
Hemiptera	Corixidae	*Corixidae*	9	5
Diptera	Culcidae	*Culex spp*	10	3
Decapoda	Cambaridae	*Cambarus spp*	7.6	1
			Total Number of Organisms	12
			Total Number of Taxa	5
			Total Number of EPT	0

Table 11. Station 2 Benthic Macroinvertebrate September 2006

Order	Family	Genus Species	Tolerance Value	No.
Odonata	Caliopterygidae	*Caliopteryx spp*	7.8	2
Odonata	Libellulidae	*Libellula spp*	9.6	2
Odanata	Coanagrionidae	*Argia spp*	8.2	4
Trichoptera	Hydropsychidae	*Cheumatopsyche spp*	6.2	1
Gastrapoda	Planorbidae	*Planorbidae*	NA	6
Gastrapoda	Physidae	*Physella spp*	8.8	2
			Total Number of Organisms	17
			Total Number of Taxa	6
			Total Number EPT	1

Table 12. Reference Reach Benthic Macroinvertebrate Data September 2006

Order	Family	Genus Species	Tolerance Value	No.
Coleoptera	Hydroptilidae	*Cymbiuodyta spp*	NA	13
Coleoptera	Dytiscidae	*Hjydroporus spp*	8.6	1
Plecoptera	Perlidae	*Perlesta placida*	4.7	4
Gastrapoda	Physidae	*Physella spp*	8.8	3
Diptera	Chironomidae	*Conchapelopia Group*	8.4	7
			Total Number of Organisms	28
			Total Number of Taxa	5
			Total Number of EPT	4

4.5 STREAM CONCLUSIONS

Currently the restored streams on Open Springs Mitigation Site are stable and performing to design. All structures are secure and stable with minimal erosion. Stream banks are well vegetated. Little fluvial erosion was observed. Multiple bankfull events were recorded during the 2007 monitoring year. The site has achieved the success criteria of two bankfull events within five years as specified in the Mitigation Plan.

5.0 OVERALL CONCLUSIONS AND RECOMMENDATIONS

Data collected during monitoring for Year 3 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 2006 Monitoring Report documented that five of the twelve vegetation plots have had notable mortality, and supplemental planting with 2-year-old trees was completed in March 2007 in these areas. The areas in the vicinity of Plot 9 and Plot 10 continue to be of concern based on 2007 monitoring results documenting stem densities in these plots below the interim success criteria. Several isolated bare areas on the floodplain were observed, however, 94 percent of the site is covered with herbaceous vegetation.

The stream morphology at the site is generally stable and very little fluvial erosion was observed. Many of the riffle features are collecting small gravel as expected. Some minor siltation was observed, especially in several of the pool features. Actions for stream morphology are not warranted at this time. Any sedimentation that has occurred is minor and does not need to be addressed at this time.

Actions to be undertaken prior to the start of the 2008 growing season to improve vegetation conditions at the site include seeding and mulching areas on the flood plains where herbaceous vegetation could be improved and supplemental planting areas in the vicinity of Vegetation Plots 9 and 10.

Overall, the project is on track to achieve the specified stream and vegetative success criteria. 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

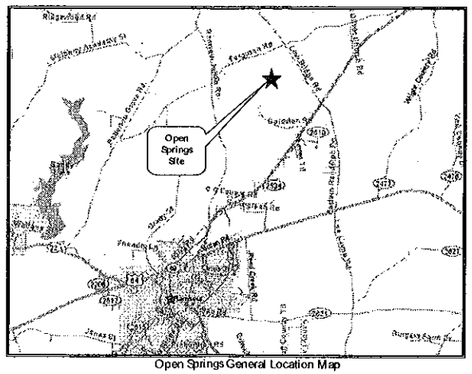
observations, site vegetation is expected to succeed and provide riparian habitat, water quality benefits, and cover for the stream system.

APPENDIX A

As-Built Survey

OPEN SPRINGS STREAM
AS-BUILT PLANS

July 07, 2005



Open Springs General Location Map

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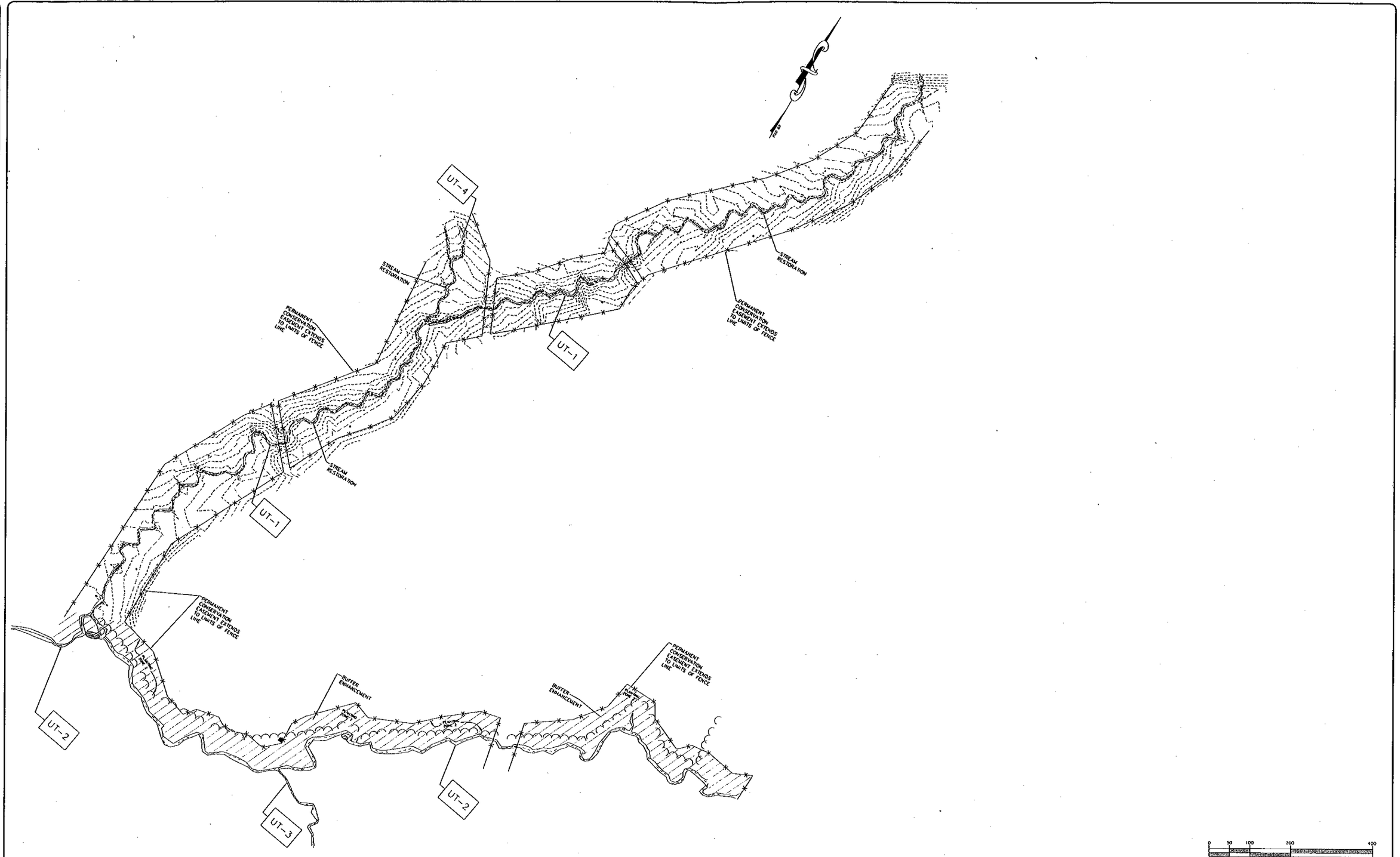

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APPROVED BY: JMK	PROJECT NUMBER: 30440.00.RA
FILE NAME: design-layout	PLOT DATE: 07/26/05

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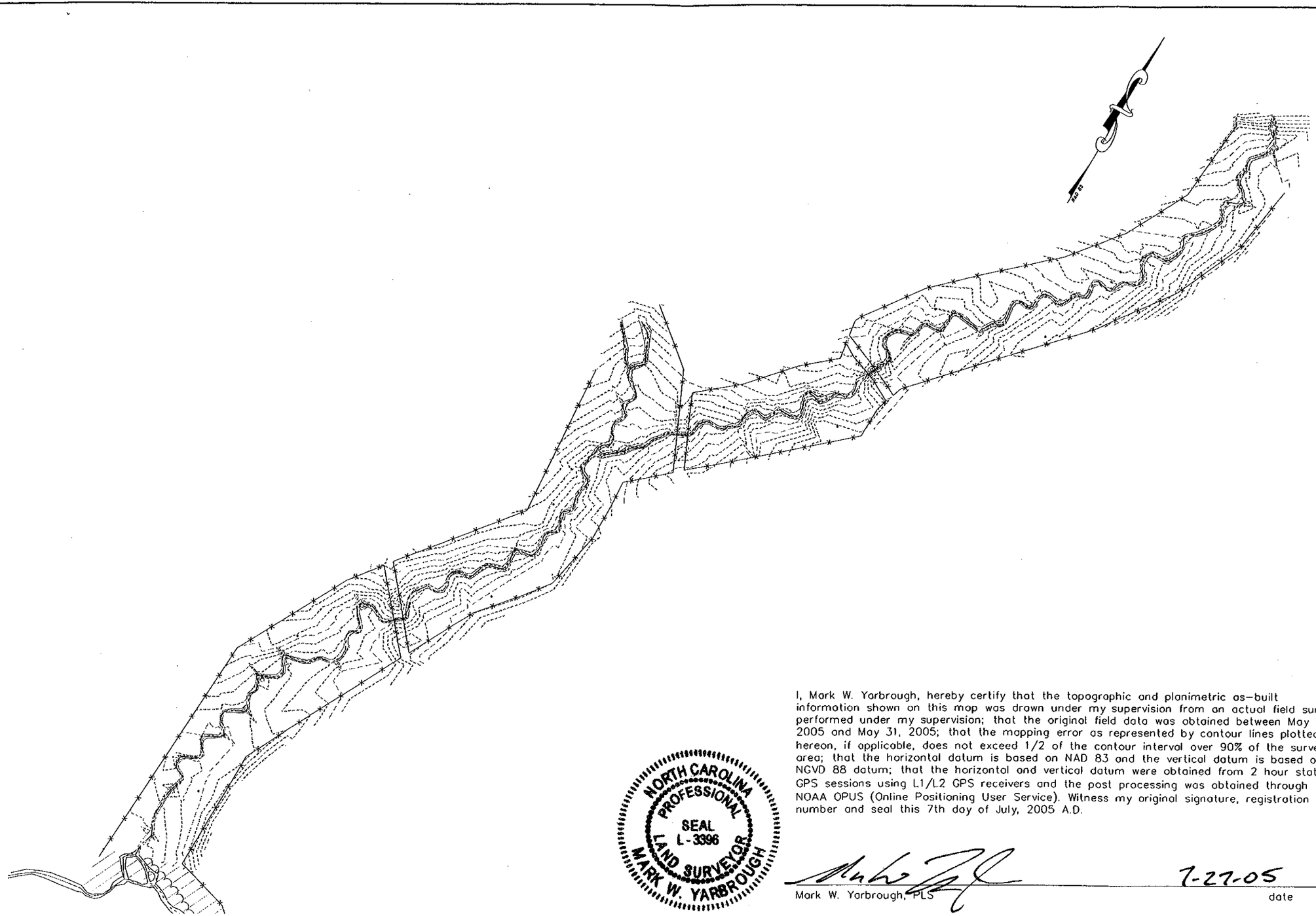
OPEN SPRINGS STREAM MITIGATION PLAN
PREPARED FOR
ENVIRONMENTAL BANC & EXCHANGE

OPEN SPRINGS ASBUILT PLANS
PROJECT SITE

1/6



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 May 18, 2005 and May 31, 2005; 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 7th day of July, 2005 A.D.

NORTH CAROLINA PROFESSIONAL SEAL L-3396 LAND SURVEYOR MARK W. YARBROUGH

Mark W. Yarbrough, PLS — 7-27-05 date

0 40 80 160 320
SCALE

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APPROVED BY	JMK
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PROJECT NUMBER	30440.00.RA
PLOT DATE	07/26/05

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CONSTRUCTION	1-19-05
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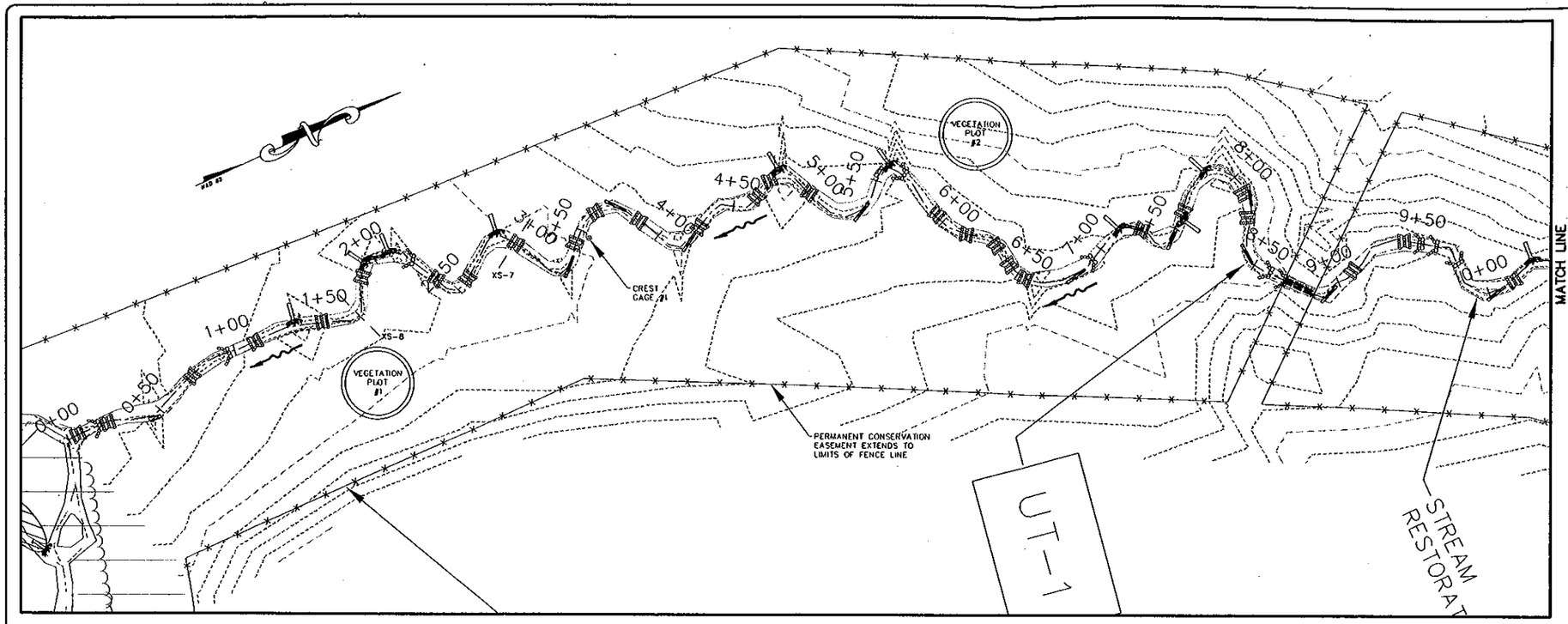
OPEN SPRINGS STREAM MITIGATION PLAN
PREPARED FOR
ENVIRONMENTAL BANC & EXCHANGE

OPEN SPRINGS ASBUILT PLANS
STREAM MITIGATION AS-BUILT SURVEY

2/6



UT-1

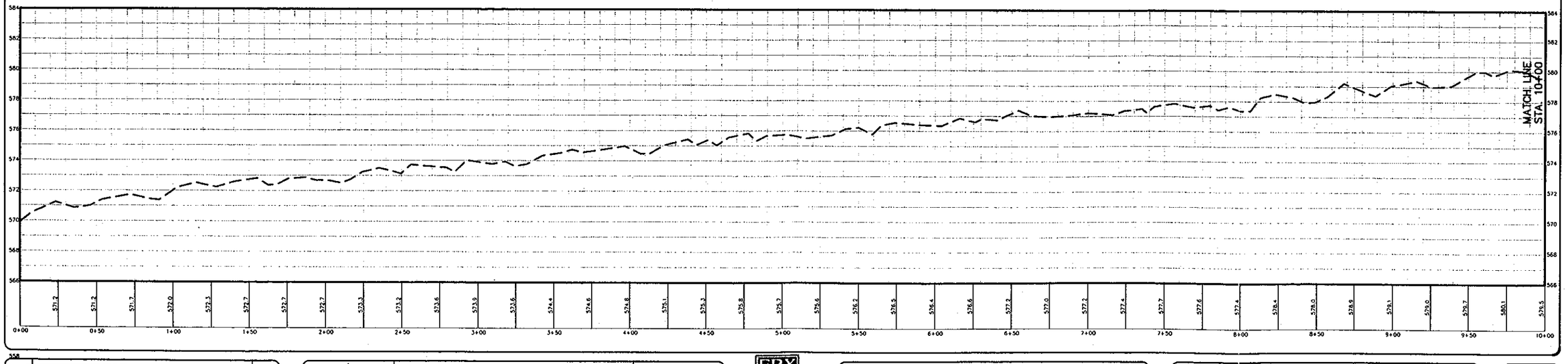
LEGEND

EXISTING

- FENCE LINE
- MAJOR CONTOUR
- MINOR CONTOUR
- CENTER OF CHANNEL
- LIMITS OF BANKFULL CHANNEL
- ROOTWAD
- LOG VANE
- CUTTINGS BUNDLE
- CHANNEL PLUG
- LOG TOE PROTECTION
- CULVERT CROSSING
- RIFFLE GRADE CONTROL
- RIFFLE GRADE CONTROL/CROSS WEIR STRUCTURE
- STEP POOL
- CROSS WEIR

0 15 30 60 120
HORZ SCALE

0 3 6 12
VERT SCALE



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DRAWING SCALE	1" = 30'
PROJECT DATE	05/31/2005
PROJECT NUMBER	3046.00.RA
PLOT DATE	07/26/05

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CONSTRUCTION	1-19-05
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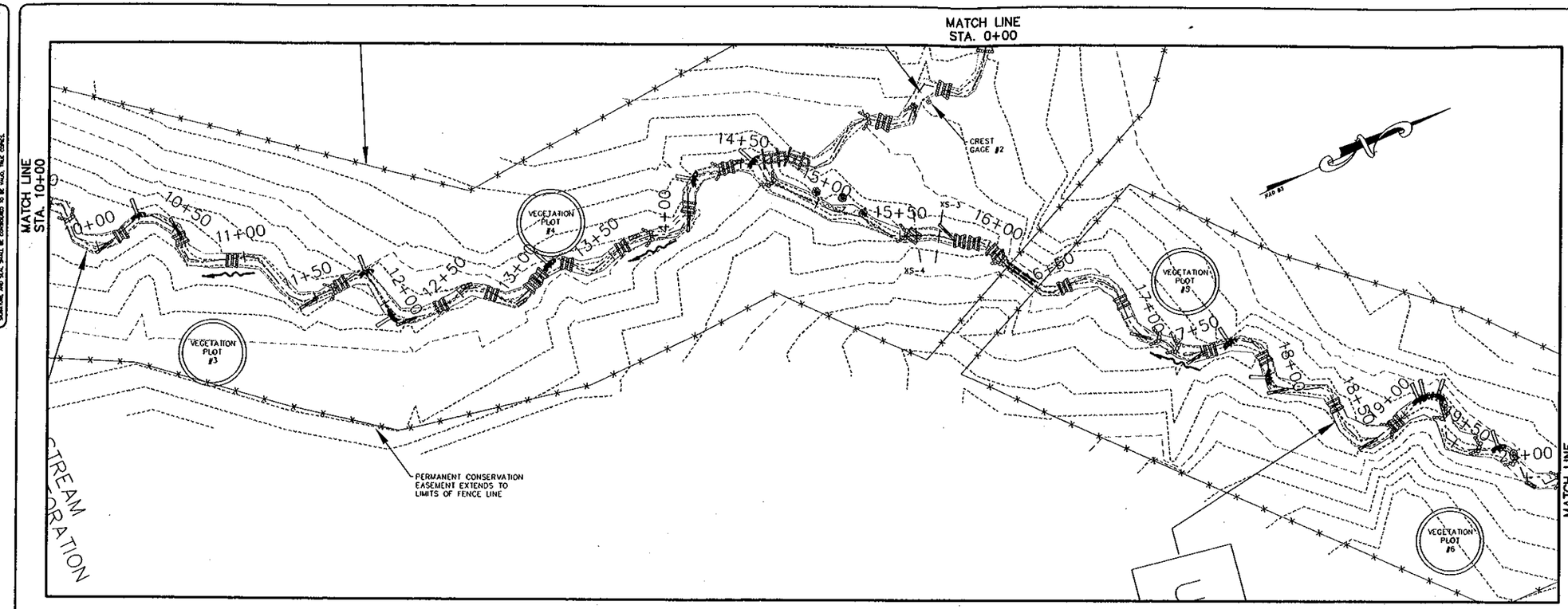
OPEN SPRINGS STREAM MITIGATION PLAN
PREPARED FOR
ENVIRONMENTAL BANC & EXCHANGE

OPEN SPRINGS ASBUILT PLANS
UT-1 STA. 0+00 TO STA. 10+00

3/6



UT-1

LEGEND

EXISTING

- FENCE LINE
- MAJOR CONTOUR
- MINOR CONTOUR
- CENTER OF CHANNEL
- LIMITS OF BANKFULL CHANNEL

- ROOTWAD
- LOG VANE
- CUTTINGS BUNDLE
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- CULVERT CROSSING
- RIFFLE GRADE CONTROL
- RIFFLE GRADE CONTROL/CROSS WEIR STRUCTURE
- STEP POOL
- CROSS WEIR

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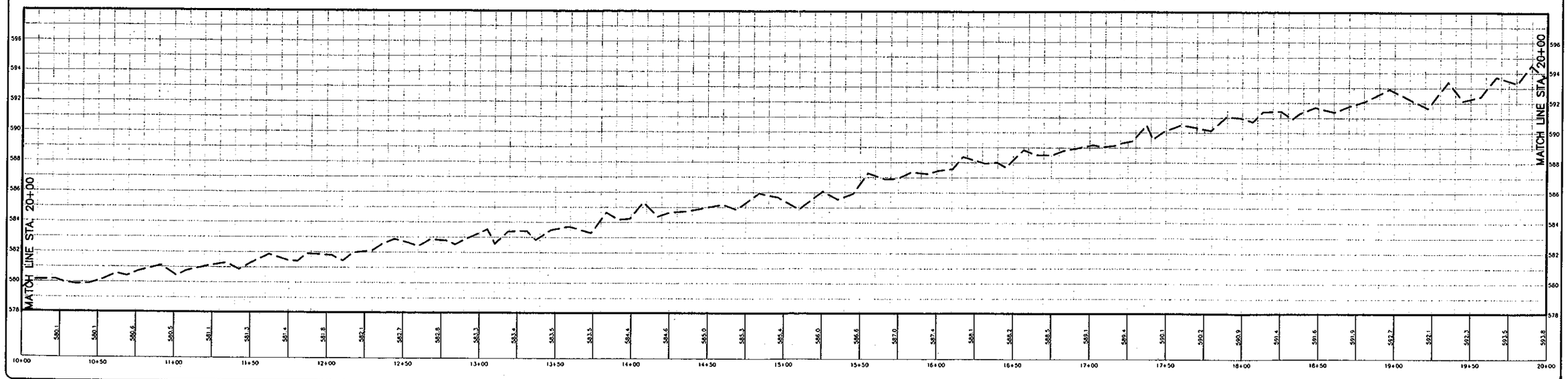
VERT SCALE: 0 3 6 12



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PROJECT NUMBER	30440.00.RA
PLOT DATE	07/28/05

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CONSTRUCTION	1-19-06
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OPEN SPRINGS STREAM MITIGATION PLAN
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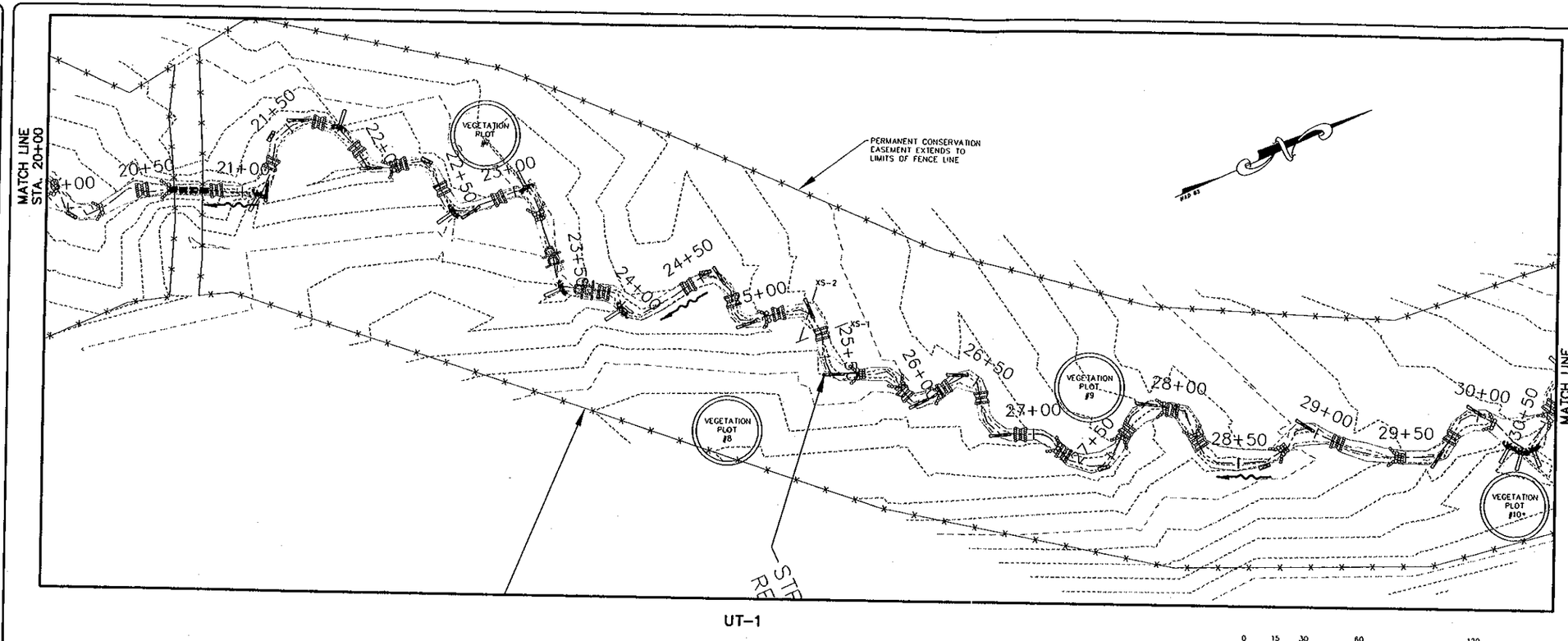
OPEN SPRINGS ASBUILT PLANS

UT-1 STA. 10+00 TO STA. 20+00



UT-1

LEGEND

EXISTING

- FENCE LINE
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- CENTER OF CHANNEL
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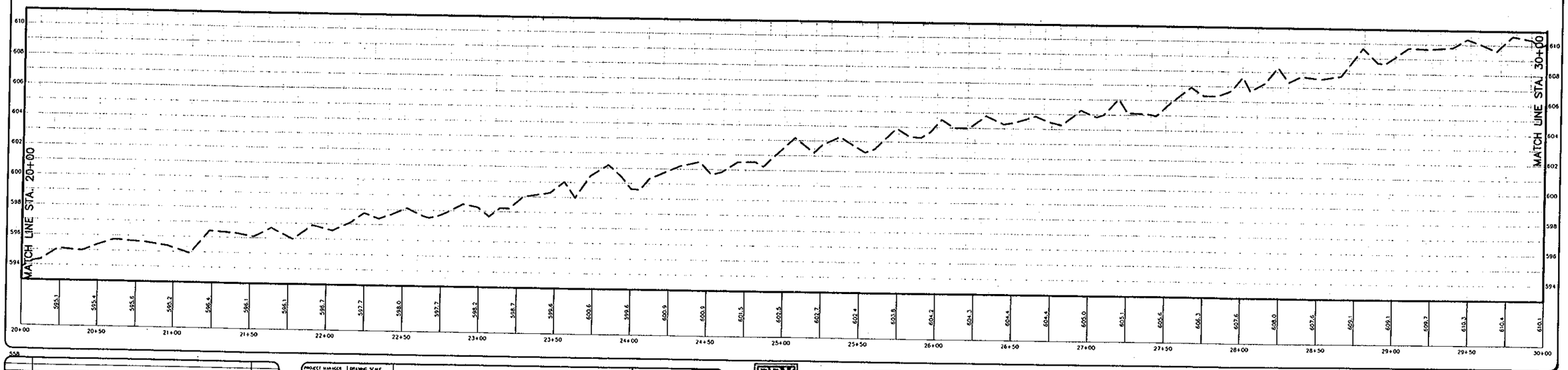
- RIFFLE GRADE CONTROL/CROSS WEIR STRUCTURE
- STEP POOL
- CROSS WEIR

HORZ SCALE: 0, 15, 30, 60, 120

VERT SCALE: 0, 3, 6, 12



REV. NO.	DESCRIPTION REVISIONS	DATE

PROJECT MANAGER	MSE
DRAWN BY	TRS
APPROVED BY	JMK
PLT TIME	design-layout
DRAWING SCALE	1" = 30'
PROJECT DATE	05/31/2005
PROJECT NUMBER	30440.00.RA
PLOT DATE	07/26/05

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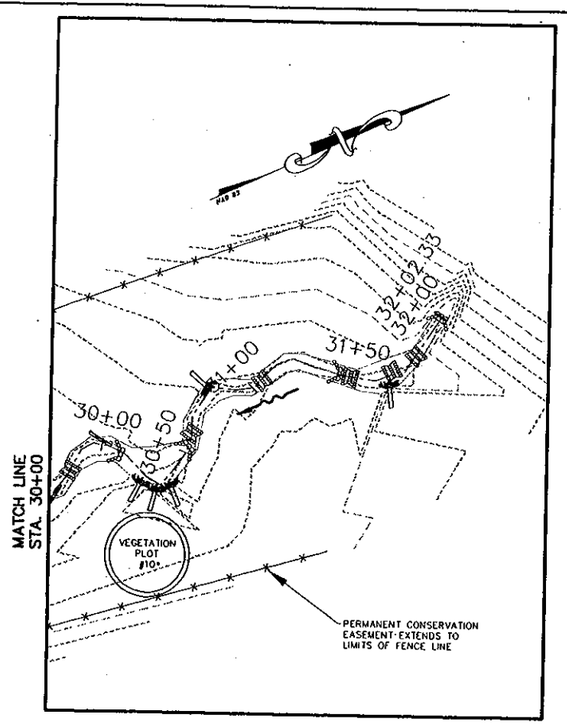
South Carolina
Georgia
Florida

RELEASED FOR	DATE
APPROVALS	
BIDDING	
CONSTRUCTION	1-19-05
RECORD DWG.	

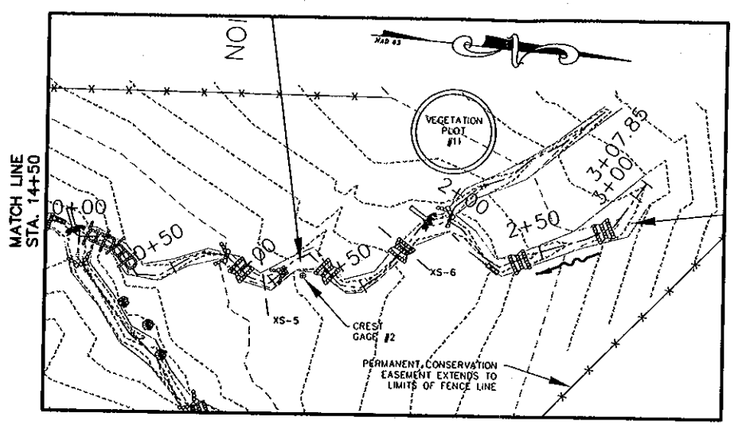
EBX

OPEN SPRINGS STREAM MITIGATION PLAN
PREPARED FOR
ENVIRONMENTAL BANC & EXCHANGE

OPEN SPRINGS ASBUILT PLANS
UT-1 STA. 20+00 TO STA. 30+00



UT-1



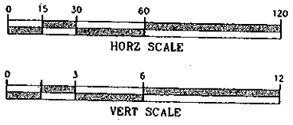
UT-4

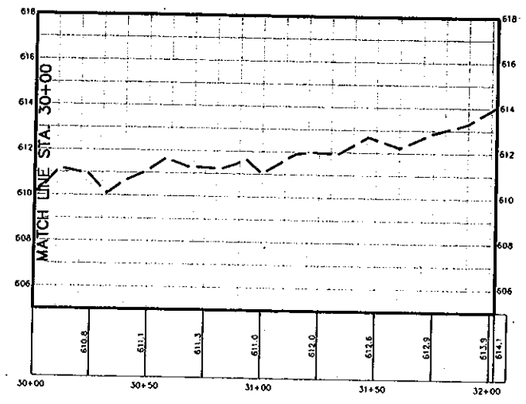
LEGEND

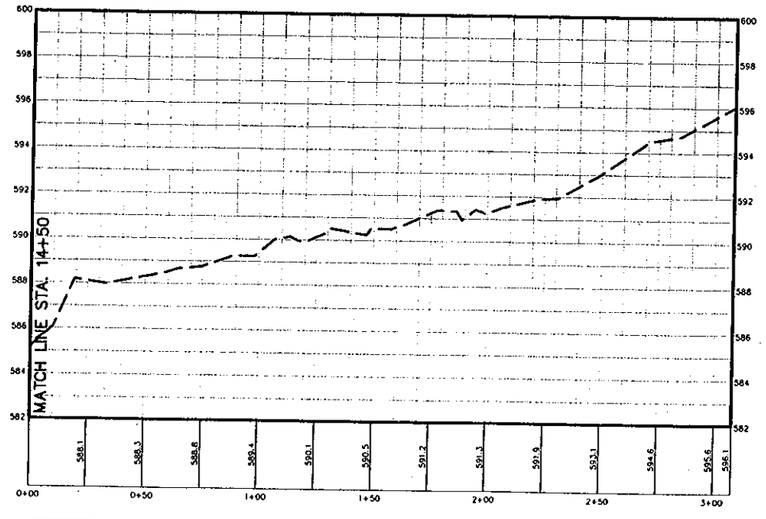
EXISTING

- FENCE LINE
- MAJOR CONTOUR
- MINOR CONTOUR
- CENTER OF CHANNEL
- LIMITS OF BANKFULL CHANNEL

- ROOTWAD
- LOG VANE
- CUTTINGS BUNDLE
- CHANNEL PLUG
- LOG TOE PROTECTION
- CULVERT CROSSING
- RIFFLE GRADE CONTROL
- RIFFLE GRADE CONTROL/CROSS WEIR STRUCTURE
- STEP POOL
- CROSS WEIR







REV. NO.	DESCRIPTION	DATE
	REVISIONS	

PROJECT MANAGER	MSE
DRAWN BY	TRS
APPROVED BY	JMK
FILE NAME	design-layout
DRAWING SCALE	1" = 30'
PROJECT DATE	05/31/2005
PROJECT NUMBER	3044.00.RA
AS OF DATE	07/28/05

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EBX

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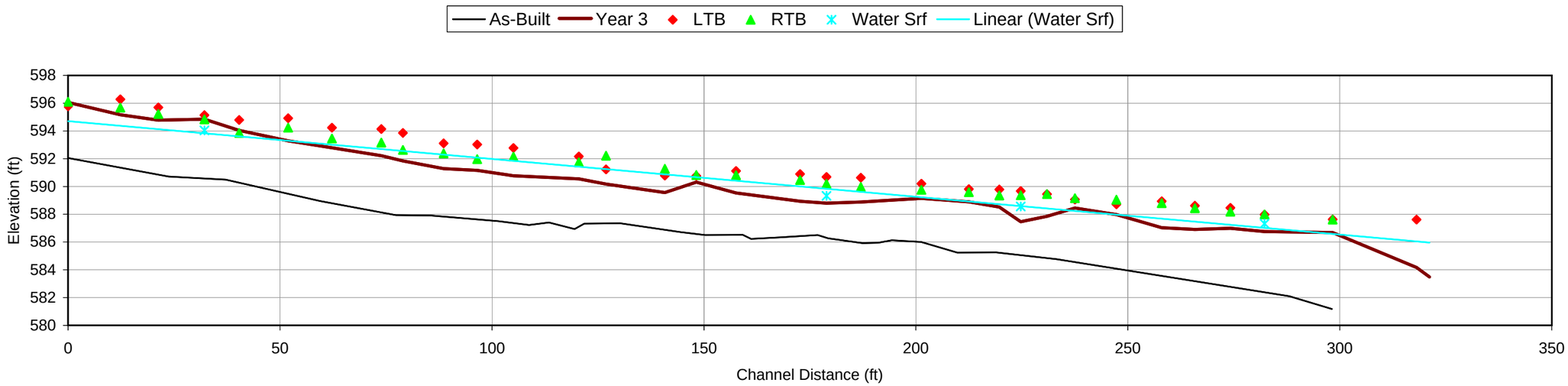
OPEN SPRINGS ASBUILT PLANS
UT-1 STA. 30+00 TO STA. 32+02.33
UT-4 STA. 0+00 TO STA. 3+07.85

6/6

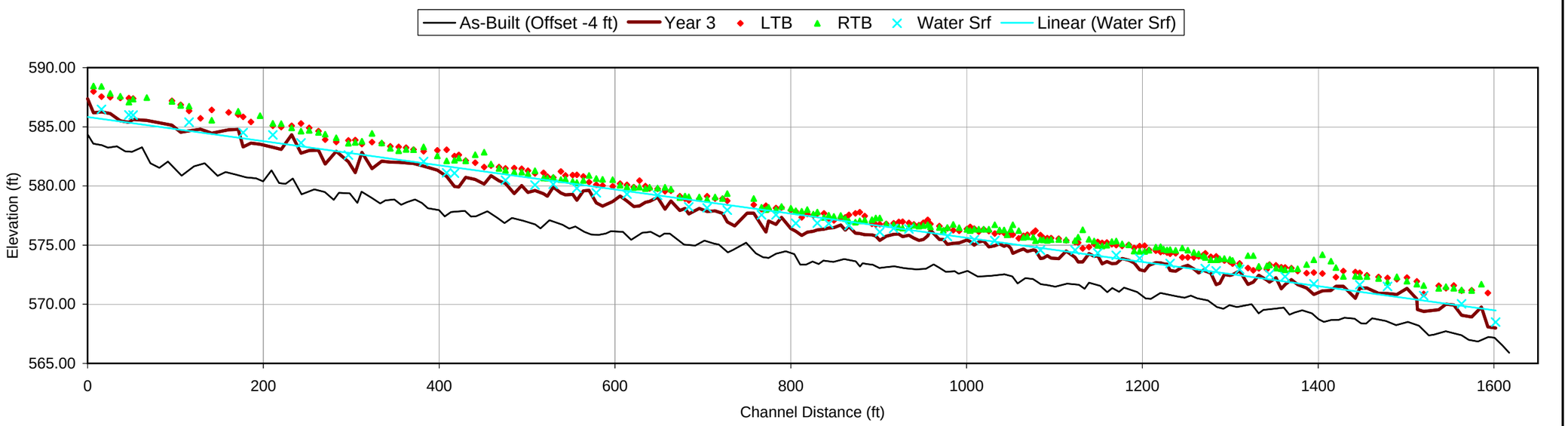
APPENDIX B

Profile and Cross Section Data

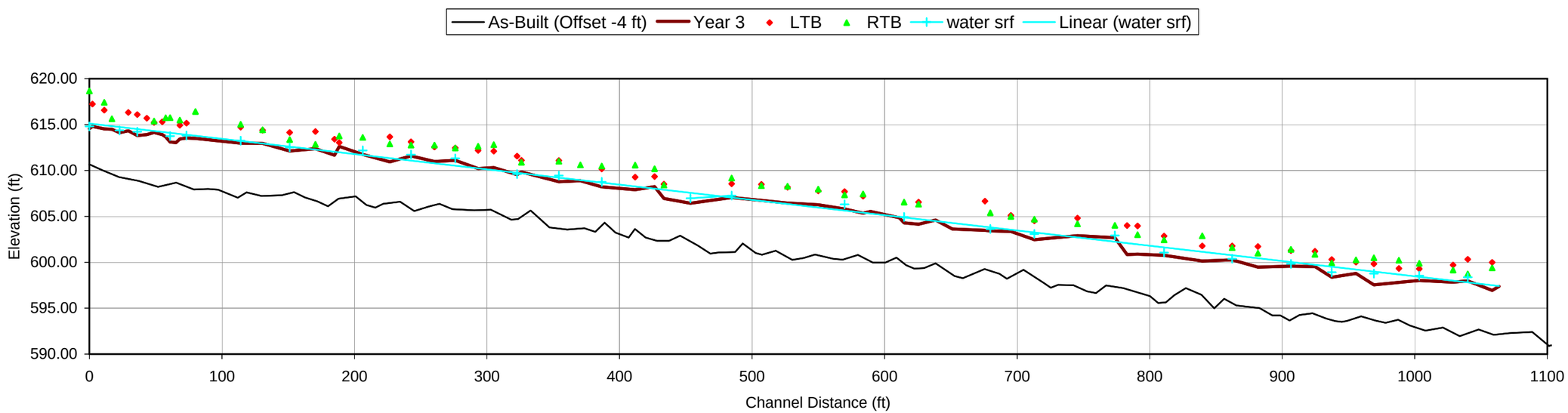
Open Springs
UT-4 Station 0+00 - 3+07.85



Open Springs
UT-1 Station 0+00 - 16+00

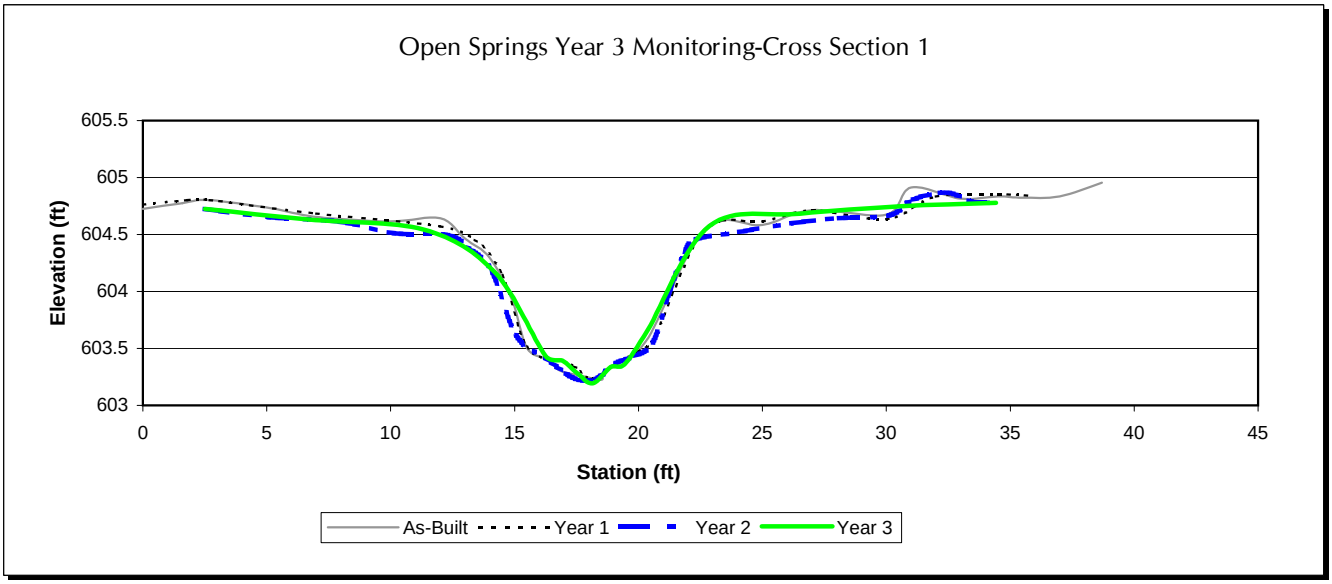


Open Springs
UT-1 Station 21+50 - 32+02.33



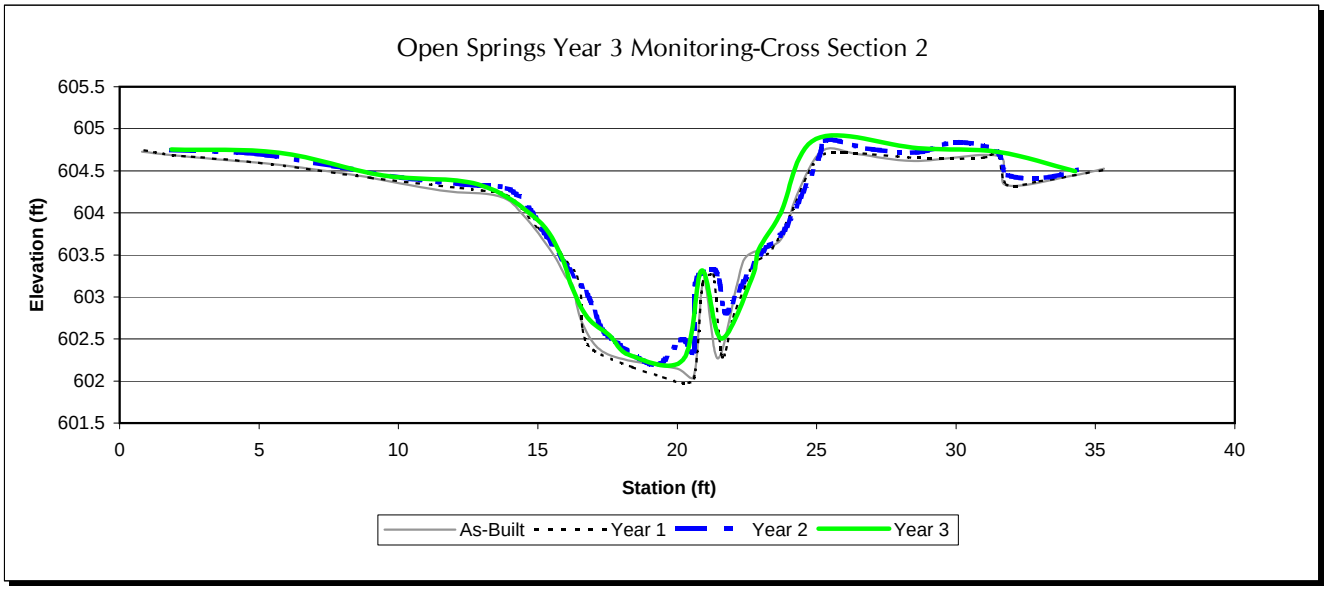
Left bank

Right bank



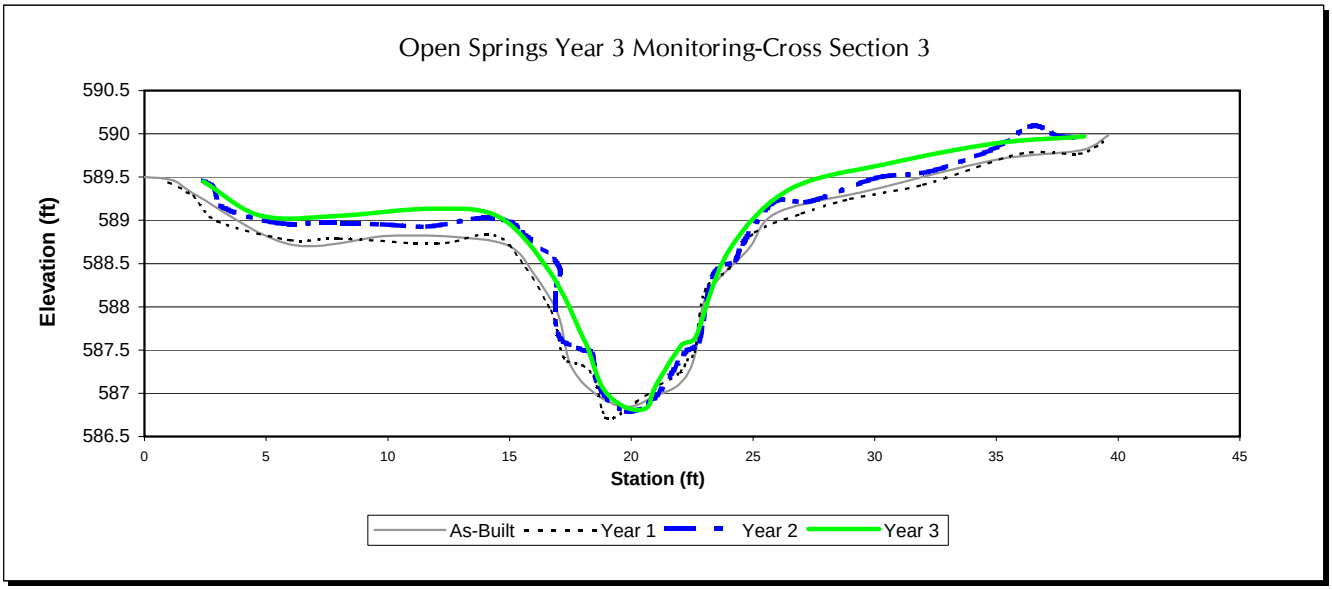
Left bank

Right bank



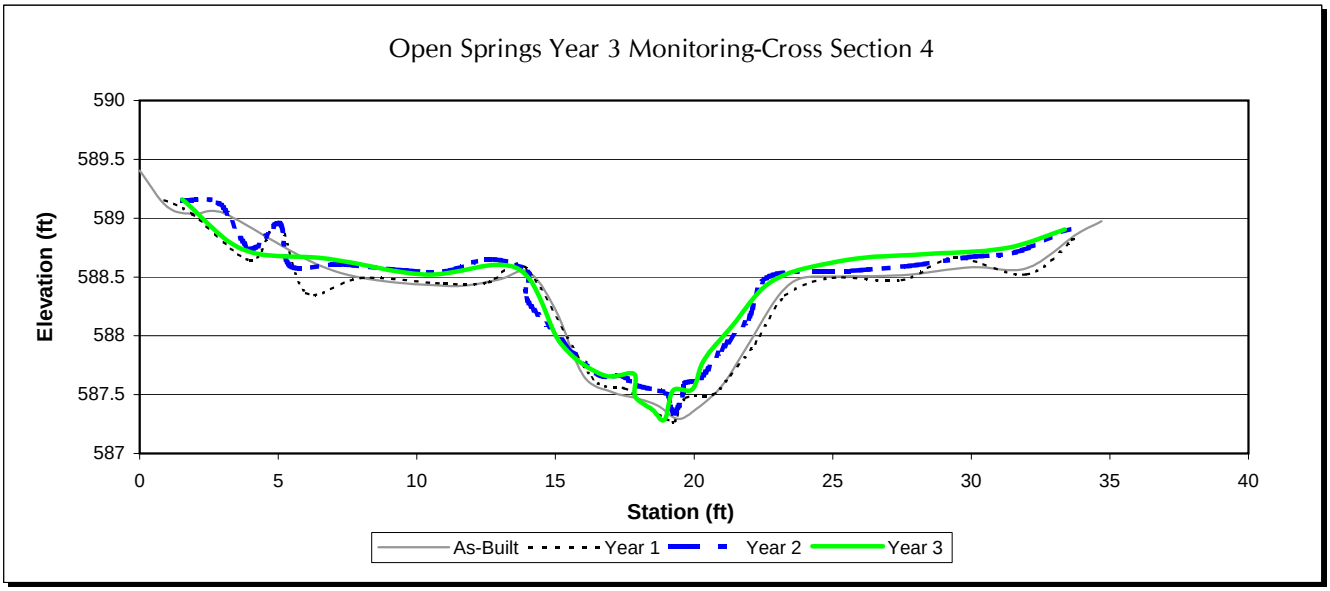
Left bank

Right bank



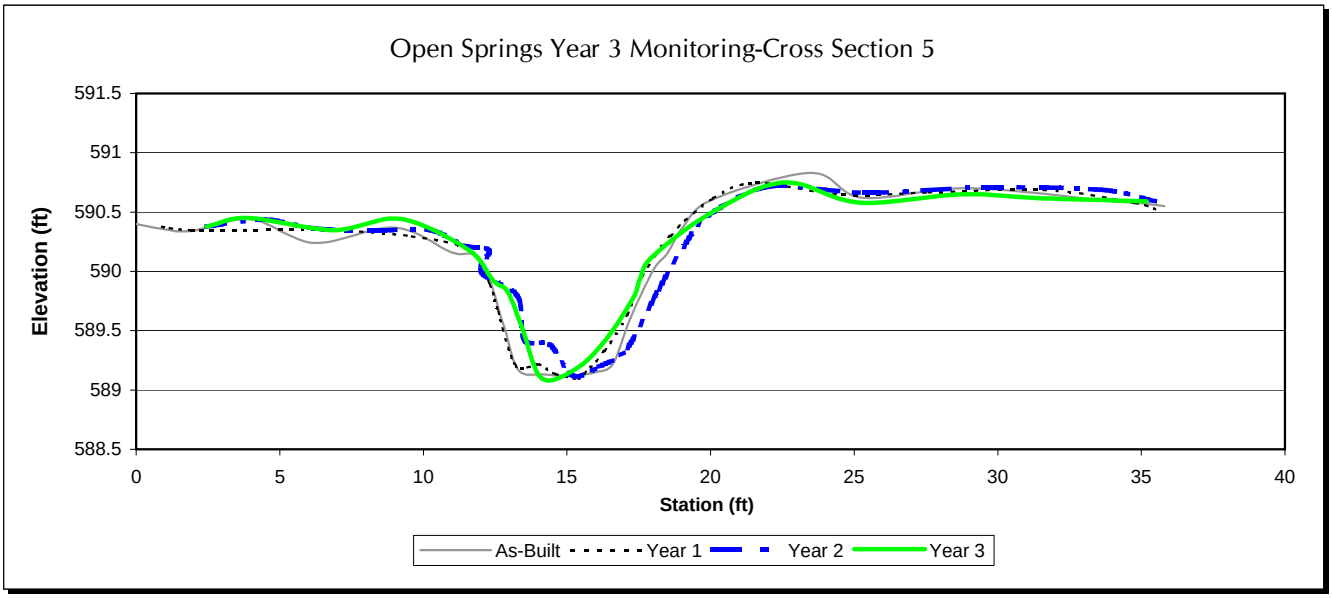
Left bank

Right bank



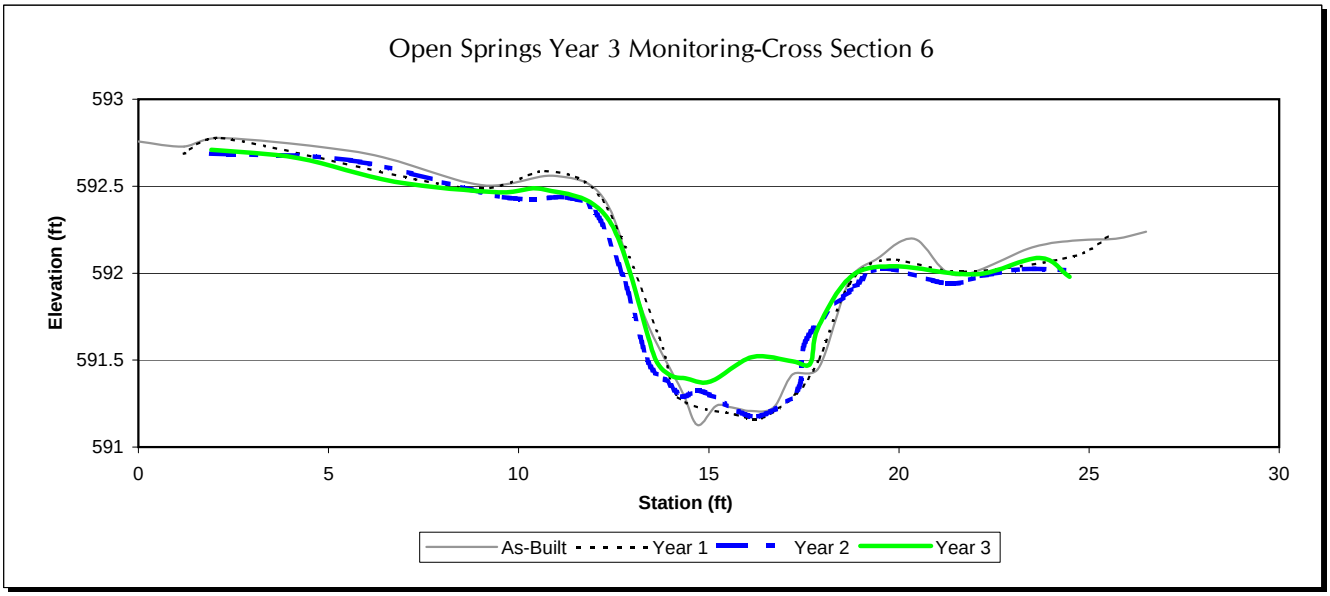
Left bank

Right bank



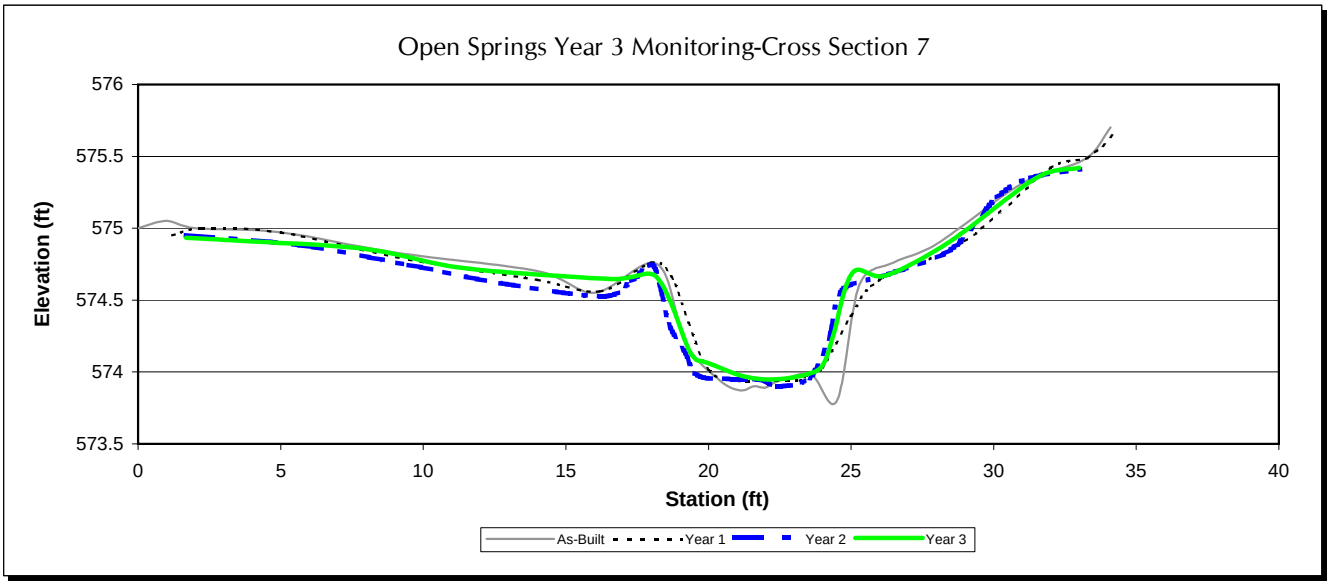
Left bank

Right bank



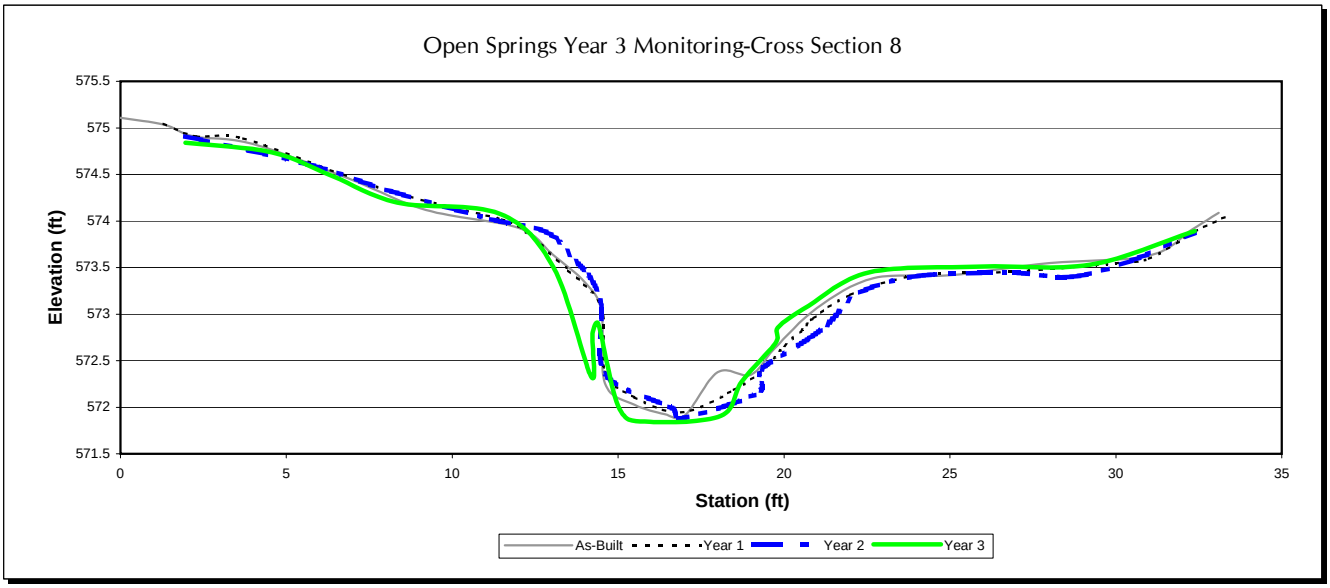
Left bank

Right bank



Left bank

Right bank



APPENDIX C

2007 Site Photos

Photo 1. Rock cross vane - looking downstream at STA 31+50.

Photo 2. Log vane on left bank at STA 30+00 - looking downstream.

Photo 3. Rock cross vane at STA 25+00 - looking upstream.

Photo 4. Log vane on right bank at STA 28+00 - looking downstream.

Photo 5. Root wad on left bank at STA 21+00 - looking downstream.

Photo 6. Rock cross vane at STA 14+75 - looking upstream.

Photo 7. Culvert at STA 20+60 - looking upstream.

Photo 8. Grade control structure with well vegetated banks at STA 3+40 - looking downstream.

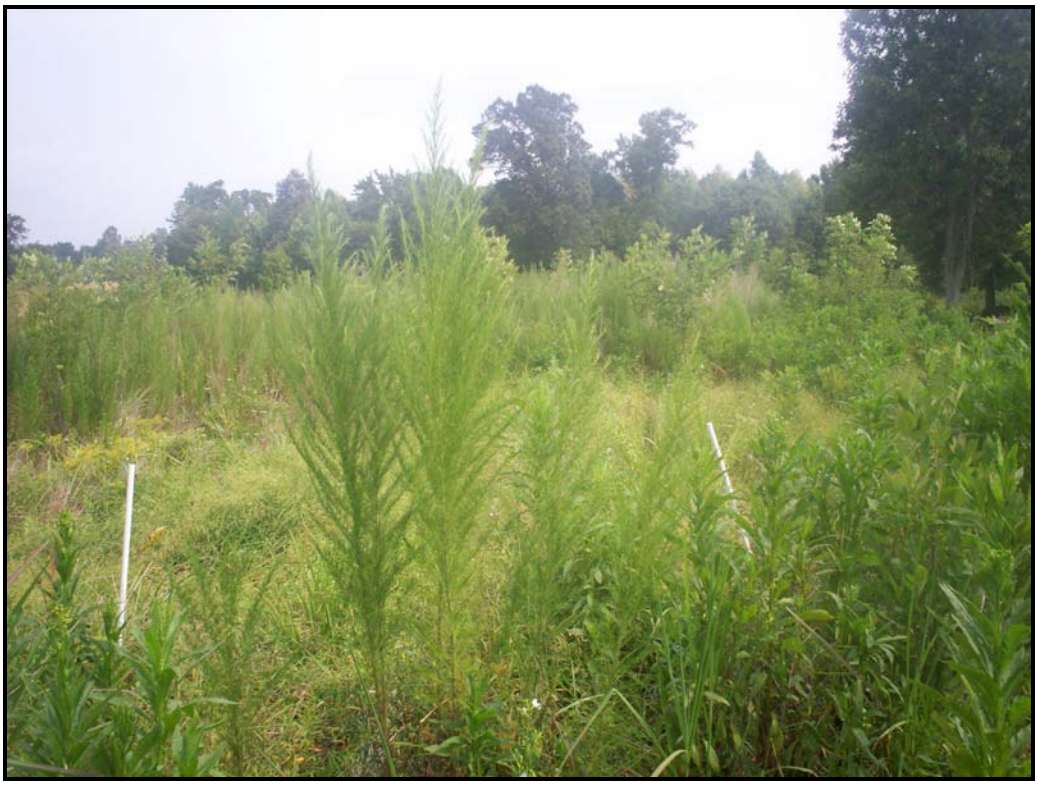


Photo 9. Vegetation Plot #1.

Photo 10. Vegetation Plot #2.

Photo 11. Vegetation Plot #3.

Photo 12. Vegetation Plot #4.

Photo 13. Vegetation Plot #5.

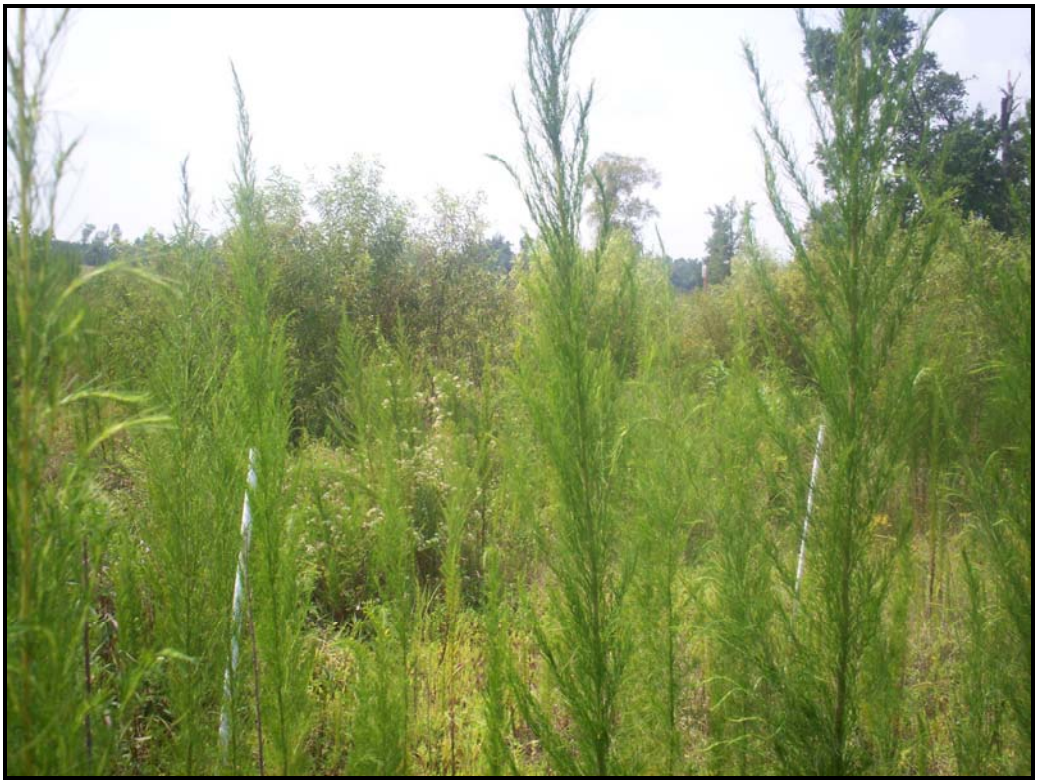


Photo 14. Vegetation Plot #6.

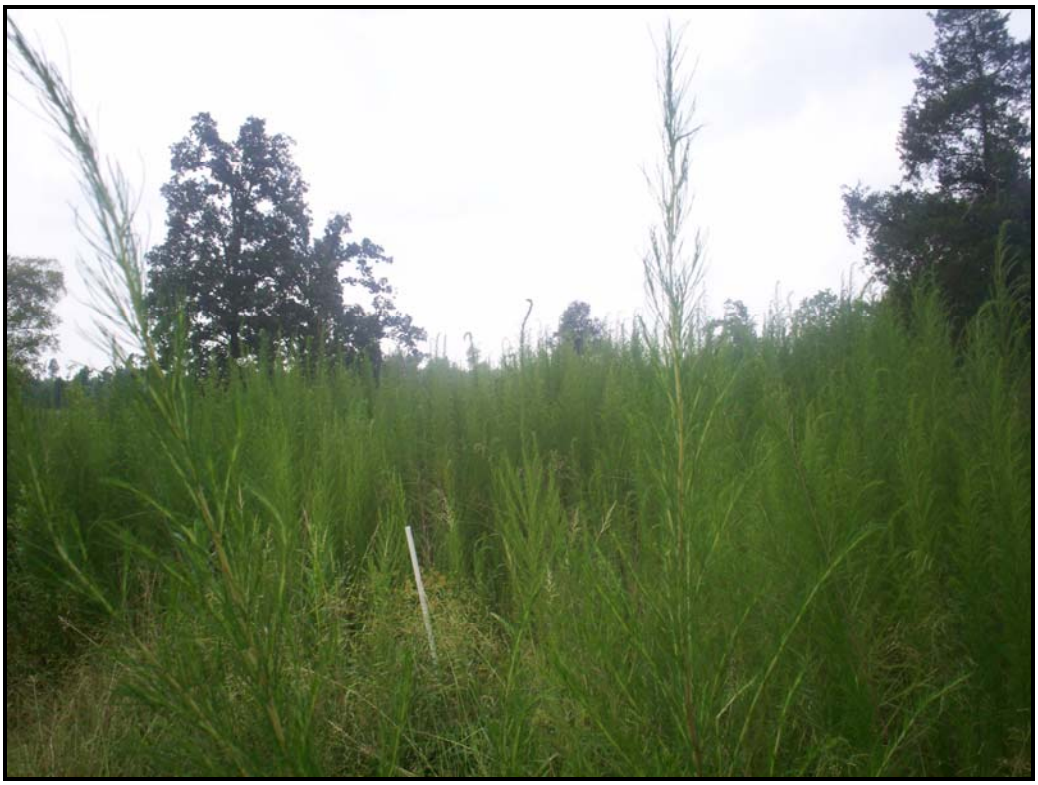


Photo 15. Vegetation Plot #7.

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. SPA 1. A common condition along the reach is vegetation in the channel caused by siltation or minor aggradation.

Photo 22. SPA 2. Right bank erosion due to sparse vegetation at STA 25+50.

Photo 23. SPA 3. Sparse floodplain vegetation at STA 24+00 – 25+00.

Photo 24. SPA 4. Sparse floodplain vegetation at STA 22+50 – 23+50.

Photo 25. SPA 5. Minor left bank erosion occurring behind rip rap STA 20+25.

Photo 26. SPA 6. Sparse floodplain vegetation at STA 13+00 – 14+00.

Photo 27. SPA 7. Sparse floodplain vegetation at STA 5+90.