Glen Raven Stream Restoration
Mitigation Plan – As-Built Report
Alamance County, NC
Cape Fear 02 River Basin - Contract # D05011-1

Submitted to:

Ecosystem Enhancement PROGRAM

NCDENR-EEP, 1652 Mail Service Center, Raleigh, NC 27699-1652

June 2007

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EXECUTIVE SUMMARY

The Glen Raven Stream Restoration Site is a full-delivery project that has been developed for the North Carolina Ecosystem Enhancement Program (EEP). The goals of the project include improving water quality, restoring aquatic habitat, and improving riparian habitat. These goals will be accomplished by achieving the following objectives: establishing a stable stream channel, creating a heterogeneous stream bed with distinct pool and riffle features, and planting a riparian buffer with site-appropriate native trees and shrubs.

The site is located 1.5 miles northwest of Burlington, North Carolina in Alamance County. It is situated within the 03030002 (Cape Fear 02) Watershed Cataloging Unit (8-digit HUC) and is in a portion of the NCDWQ Priority Sub-basin 03-06-02. The EEP identifies this 8-digit HUC as a Targeted Local Watershed. The project site is part of an approximately 60-acre parcel owned by Catherine Paris Chandler, William S. Chandler, Catherine Preston Chandler and Margaret Chandler-Salinger. The primary land use on the subject property prior to restoration was rangeland. The project restored and enhanced an unnamed tributary to the Haw River (UTHR) and two of its tributaries (UT1 and UT2). The UTHR is a second-order stream that flows south to north through the subject property and is bisected by Gerringer Road. UT1 is a first-order stream that flows east to west before joining UTHR upstream of Gerringer Road. UT2 is also a first-order stream flowing east to west, but joins UTHR downstream of Gerringer Road. The pre-restoration lengths of UTHR, UT1, and UT2 were 2,855, 520, and 320 linear feet, respectively.

The project restored 3,317 linear feet of channel using a combination of Priority II and III approaches, and enhanced 450 linear feet using a Priority II approach. The priority II restoration established a bankfull channel with a new floodplain, a channel bed at its existing level in an existing gravel layer and the cross-section dimensions necessary to provide stable flow maintenance and sediment transport. The priority III design generally worked within the existing stream corridor/belt width by adjusting the stream dimension and profile. The priority II enhancement included cross-section modifications, the incorporation of defined pools and riffles, and vegetation stabilization. The UTHR was restored to a Rosgen stream type C4, and UT1 and UT2 were restored to stream type B4c. The riparian buffer was planted with native trees and shrubs. The target vegetative community along UTHR was designed after a Piedmont Alluvial Forest. This community shifts towards a Piedmont Levee Forest along UT1 and UT2.

The as-built conditions of the site do not reflect any significant changes from the design. Bedrock was unavoidable in some sections and was used as grade control instead of designed structures in these areas. These changes resulted in minor alterations to the planned profile, but are not anticipated to cause any instability in the stream. Project success will be assessed utilizing the following measurements: stream dimension, pattern, and profile; site photographs, and vegetation sampling. Cross-section and profile measurements should show little or no change from the as-built conditions. If changes do occur, they will be evaluated to determine whether they are minor adjustments associated with settling and increasing stability or whether they indicate movement toward an unstable condition. Riparian vegetation must meet a minimum survival rate of 320 stems/acre after five years. If monitoring indicates that the specified survival rate is not being met, appropriate corrective actions will be developed to include invasive species control, the removal of dead/dying plants and replanting. The site will be monitored beginning in 2007 through 2011 or until the success criteria are achieved. Reports will be submitted to EEP each year.

1.0 PROJECT BACKGROUND

The Glen Raven Stream Restoration Site is located 1.5 miles northwest of Burlington, North Carolina in Alamance County (Figure 1). From Raleigh, proceed west on Interstate-40 (I-40). Continue on I-40 West/ I-85 South after they merge near Hillsborough. Take Exit 148 and turn right towards Burlington. Proceed to the split of NC-54/49 and NC-87/100. Turn right heading northwest on NC-87/100. Proceed to the split of NC-87 & NC-100 in Glen Raven. Turn right and travel north 0.15 miles on NC-87. Make a left onto Power Line Road and proceed 0.7 miles. The project site begins just downstream of the Power Line Road culvert.

1.1 Project Goals and Objectives

Based on the descriptions of former and reference conditions, the restoration goals and objectives for the project site project are as follows:

Restoration Goals:

- Improve water quality by recreating natural conditions of the stream before major anthropogenic disturbances;
- Restoring aquatic habitat to enhance native flora and fauna throughout the stream and banks and,
- Improve riparian habitat to protect the integrity of the restored stream.

Restoration Objectives:

- Establish a stable C4 stream channel on the UTHR and a B4c stream channel on UT1 and UT2,
- Create a heterogeneous stream bed with distinct pool and riffle features and,
- Plant a riparian buffer with site-appropriate native trees and shrubs.

1.2 Project Structure, Restoration Type and Approach

The project site became degraded as a result of agricultural activities (poor grazing management) and human disturbances (removal of riparian vegetation and development in the watershed). As a result, the ecological diversity and water quality of the site were adversely affected. The project restored 3,317 linear feet of channel using a combination of Priority II and III approaches, and enhanced 450 linear feet using a Priority II approach. The Priority II restoration established a bankfull channel with a new floodplain, a channel bed at its existing level in an existing gravel layer and the cross-section dimensions necessary to provide stable flow maintenance and sediment transport. The Priority III design generally worked within the existing stream corridor/belt width by adjusting the stream dimension and profile. Enhancement level I was used with a Priority II approach on 450 linear feet to modify cross-sections, incorporate defined pools and riffles, and stabilize vegetation. The UTHR was restored to a Rosgen stream type C4, and UT1 and UT2 were restored to stream type B4c. The riparian buffer was planted with native trees and shrubs. The target vegetative community along UTHR was designed after a Piedmont Alluvial Forest. This community shifts towards a Piedmont Levee Forest along UT1 and UT2. The design bankfull stage equals the floodplain elevation in the new channel (bank height ratio = 1.0). The stream dimension, pattern, and profile are based on the detailed morphological criteria and hydraulic geometry relationships developed from the reference streams.

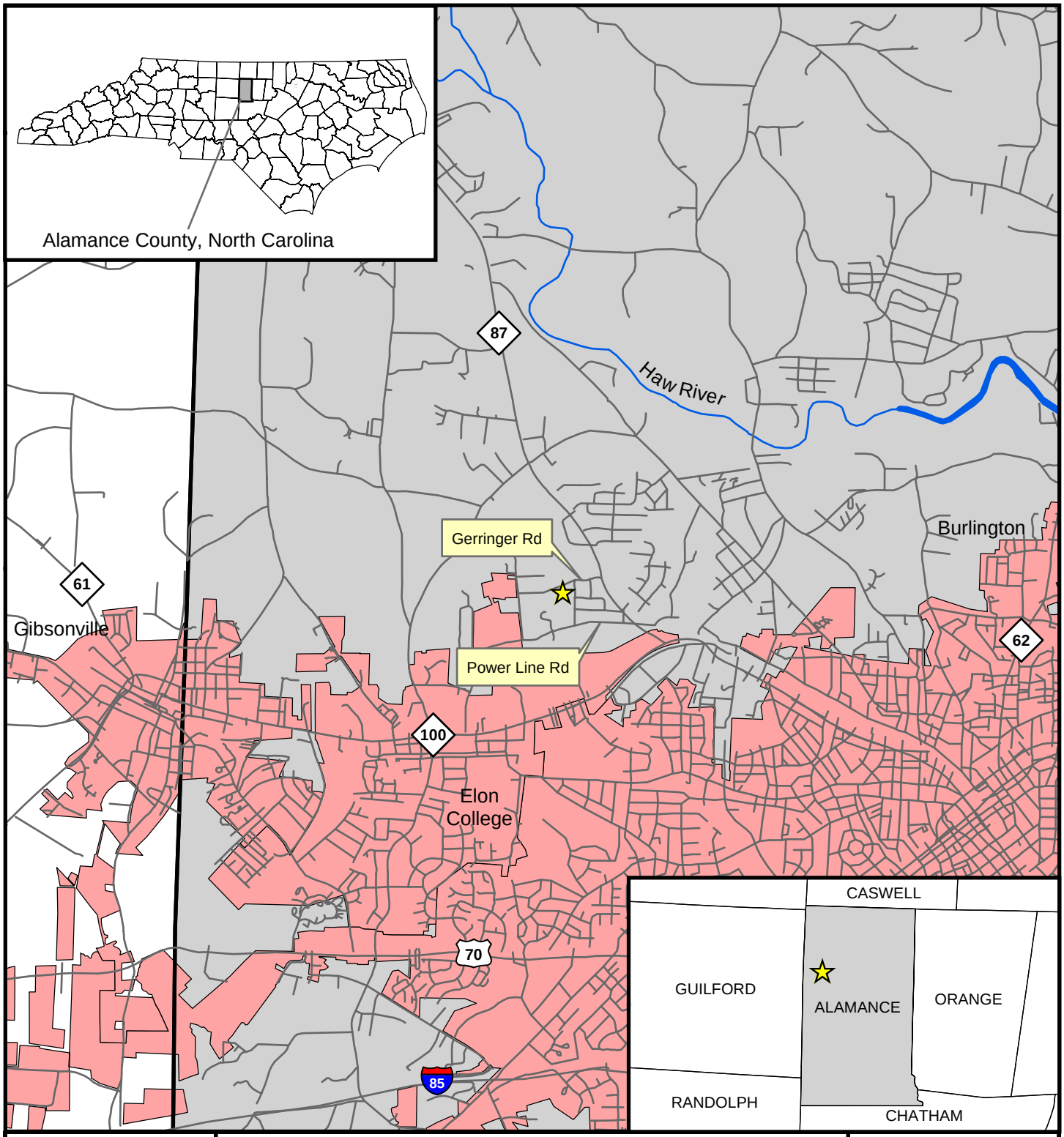


Figure 1. Vicinity Map

- Project Site Location
- Roads
- Major Rivers
- Cities and Towns
- County Boundaries
- Alamance County

N
W E
S

1:63,360
1 inch equals 1 miles

1 0.5 0 1 Miles

KCI TECHNOLOGIES

KCI ASSOCIATES OF NC

ENVIRONMENTAL TECHNOLOGIES AND CONSTRUCTION, INC.

Table 1. Project Restoration Components
Project Name: Glen Raven

Project Segment / Reach ID	Existing Feet/Acres	Type	Approach	As-Built Linear Footage	Eligible Footage*	Mitigation Ratio	Mitigation Units	Stationing
Reach I	300	R	P2	275 lf	275 lf	1.0	275	10+00 - 12+75
Reach II	483	EI	P2	450 lf	446 lf	1.5	297	12+75 - 17+25
Reach III	1,028	R	P2	1,071 lf	1,014 lf	1.0	1,014	17+25 - 27+96
Reach IV	1,045	R	P2	1,059 lf	1,000 lf	1.0	1,000	27+97 - 38+56
Trib 1	524	R	P3	542 lf	501 lf	1.0	501	40+00 - 45+42
Trib 2	315	R	P3	370 lf	318 lf	1.0	318	50+00 - 53+70

Mitigation Unit Summations

Stream (lf)	Riparian Wetland (Ac)	Nonriparian Wetland (Ac)		Total Wetland (Ac)	Buffer (Ac)
3,405	0	0		0	0

R = Restoration P2 = Priority II
EI = Enhancement I P3 = Priority III
*Reflects Easment Exceptions

1.3 Project History, Contacts and Data

The project site watershed drains approximately 697 acres at the downstream project limits. The upper watershed boundary generally follows the Southern Railway alignment (to the south and southeast of the subject property). The southwest boundary extends to Elon College and continues slightly northeast to the intersection of Power Line Road with Walker Road. The western boundary follows Walker Road before turning east to the project limits. NC-87 forms most of the northeast-east drainage boundary. An Anderson Level I classification indicates that the contributing drainage area consists of: urban (43%), forest (37%), agriculture (9%), rangeland (7%), and wetlands/open water (4%) land use/land cover. Project design was completed in October 2006 and construction began in November 2006. Construction was slowed by a wet winter season and ended in April 2007 (Tables 2 & 3). The site is located in an urban setting within the Southern Outer Piedmont ecoregion of the Piedmont physiographic province (Table 4).

Table 2. Project Activity and Reporting History
Project Name: Glen Raven

Activity or Report	Data Collection	Completion or Delivery
Restoration Plan	Jan 06	Aug 06
Final Design - Construction Plans	N/A	Oct 06
Construction	N/A	Apr 07
Temporary seed mix applied to entire project area	N/A	Mar 07
Permanent seed mix applied to entire project area	N/A	Apr 07
Tree plantings completed	N/A	Apr 07
Mitigation Plan / As-Built (Year 0 Monitoring - Baseline)	May 07	May 07

Table 3. Project Contact Table **Project Name: Glen Raven**	
Design Firm	KCI Associates of NC, P.A. Landmark Center II, Suite 220 4601 Six Forks Rd. Raleigh, NC 27609 Contact: Ms. April Helms Phone: (919) 783-9214 Fax: (919) 783-9266
Construction Contractor	KCI Associates of NC, P.A. (ETC) Landmark Center II, Suite 220 4601 Six Forks Rd. Raleigh, NC 27609 Contact: Mr. Dan Kramer Phone: (919) 783-9214 Fax: (919) 783-9266
Planting Contractor	H & J Forest Services PO Box 458 Holly Ridge, NC 28445 Contact: Mr. Brian Jarvenin Phone: (910) 512-6754
Seeding Contractor	N/A
Seed Mix Sources	Evergreen Seed
Nursery Stock Suppliers	International Paper and Cure Nursery
Monitoring Performers	
MY-0 - MY-5	KCI Associates of NC, P.A. Landmark Center, II Suite 220 4601 Six Forks Rd. Raleigh, NC 27609 Contact: Mr. Adam Spiller Phone: (919) 783-9214 Fax: (919) 783-9266

Table 4. Project Background Table **Project Name: Glen Raven**	
Project County	Alamance County
Physiographic Region	Piedmont
Ecoregion	Southern Outer Piedmont
Project River Basin	Cape Fear
USGS HUC for Project and Reference	03030002030010 (Cape Fear) UTHR
	03030002060110 (Cape Fear) Long Branch
	03030002050100 (Cape Fear) UT to Wilkinson
NCDWQ Sub-basin for Project and Reference	03-06-02 (Cape Fear) UTHR
	03-06-05 (Cape Fear) Long Branch
	03-06-04 (Cape Fear) UT to Wilkinson
Drainage Area	697 Acres
Stream Order	Second Order
Watershed Type (Rural, Urban, Developing, etc.)	Developing
Watershed LULC Distribution — Urban	43%
Ag-Row Crop	9%
Ag-Livestock	7%
Forested	37%
Water/Wetlands	4%
Watershed impervious cover (%)	43%
Rosgen Classification of As-built	C4 (UTHR), B4c (UT1, UT2)
Reference Site ID	Long Branch Creek, UT to Wilkinson Creek
NCDWQ Classification for Project	Class C, NSW
Within EEP Watershed Plan?	Yes, Travis, Tickle, and Little Alamance WP
Total project acreage of easement	9.6 Acres
Total vegetated acreage within easement	9.0 Acres
Total planted acreage	9.0 Acres
Dominant Soil Types	Worsham Sandy Loam
Project soil characteristics	Poorly drained soils
% of Project Easement Fenced	0%

2.0 MONITORING PLAN AND METHODOLOGY

2.1 Monitoring Features

Permanent monuments marking monitoring feature locations were established on-site. The beginning and end of each permanent cross-section were marked with rebar set in concrete monuments. Vegetation plots were installed with flagged metal conduit at each corner and flagged PVC pipe at the photo corner. The locations of the permanent photo points are marked in the as-built plan. The stream gauge was installed using permeable PVC pipe and outfitted with a transducer to monitor water surface levels.

2.2 Monitoring Guidelines

Eight permanent cross-sections, four riffle and four pool, were established and will be used to evaluate stream dimension. Pebble counts will be performed at each cross section. Six cross-sections were established on the UTHR, four upstream and two downstream of Gerringer Road. Two additional cross-sections were established on UT1. Cross-sections will be surveyed each year using a total station. Cross-sectional data such as area and width to depth ratio will be calculated for each cross-section. Longitudinal profiles will be conducted for all reaches and tributaries. The profiles will be surveyed with a total station and will record feature changes, water surface levels, and bankfull levels. These data will be used to obtain feature lengths and slopes, pool-to-pool spacing and other longitudinal measurements. The longitudinal profile will also be used to calculate planform measurements. Stem counts of planted trees and shrubs will be conducted in the eight 10m x10m permanent vegetation plots. Visual monitoring of the site will be conducted with annual site walks and with site photos taken from 12 permanent photo points located throughout the site. All aspects of these guidelines will continue through year 5 of monitoring.

2.3 As-Built Conditions

Baseline monitoring data were collected in May 2007. These data include the detailed profile of all reaches and tributaries, eight cross-sections, pebble counts of four riffles and four pools, eight 10m x 10m vegetation plot stem counts, the installation of a stream gauge, and 12 photo points throughout the site (Tables 5, 6, and 7).

The as-built topographic survey was conducted in May 2007. The as-built stream alignment and stream centerline is depicted in the As-Built Plans (Appendix A.) The stream length, to calculate mitigation credit, was based on the length of the as-built stream centerline. The thalweg of the stream was surveyed during the detailed longitudinal profile. The thalweg profile is depicted in the As-Built Detailed Longitudinal Profile (Appendix D.)

Bedrock was unavoidable in some sections and was used as grade control instead of designed structures in these areas. These changes resulted in minor alterations to the planned profile, but are not anticipated to cause any instability in the stream. The discrepancies between the design and as-built can be mostly attributed to this issue. Bedrock outcrops created backwater conditions over multiple riffles and caused water slopes to be lower than anticipated. Yearly monitoring will document conditions in these areas to ensure that they do not lead to instability. Channel beltwidth and meander wavelength show inconsistencies between the design and as-built conditions in tables 5a and 5b. These differences were cause by site constraints associated with easement boundaries and bedrock outcroppings. The following structures were not installed due to the aforementioned bedrock issue: cross vanes at stations 10+81, 30+43, and 35+49 (UTHR), and a riffle grade control structure at station 45+00 (UT1). Alterations from the planting plan included the addition of Buttonbush (*Cephalanthus occidentalis*), and a reduction in the amount of Beautyberry (*Callicarpa americana*) due to supplier shortages.

3.0 SUCCESS CRITERIA

3.1 Channel Stability

To measure stability, cross-section measurements should show little or no change from the as-built cross-sections. If changes do occur, they will be evaluated to determine whether they are minor adjustments associated with settling and increasing stability or whether they indicate movement toward an unstable condition. Annual measurements of the longitudinal profile should indicate stable bedform features with little change from the as-built survey. The pools should maintain their depth with low water surface slopes, while the riffles should remain shallower with steeper water surface slopes. Sediment transport should remain relatively unchanged with respect to aggradation and deposition of sediments.

3.2 Vegetation

Riparian vegetation must meet a minimum survival success rate of 320 stems/acre after five years. If monitoring indicates that the specified survival rate is not being met, appropriate corrective actions will be developed to include invasive species control, the removal of dead/dying plants, and replanting.

3.3 Hydrology

A minimum of two bankfull events must occur in separate years within the five year monitoring period. If stream gauge data reveal that this criteria is not met, KCI will determine the cause.

4.0 MAINTENANCE AND CONTINGENCY PLAN

Any problems that arise will be dealt with accordingly based on the severity of the problem. Site maintenance may include reinstalling coir matting, removing debris from the channel, stabilizing bank erosion with protective structures, or adjusting in-stream structures. All maintenance activities will be documented in the yearly monitoring reports and any major repairs will be completed only after consultation with the EEP.

Table 5a. Baseline UTHR Upstream Summary (10+00 - 27+96)
Project Name: Glen Raven

Parameter	Design		As-built		
Dimension	Min	Max	Min	Mean	Max
Bankfull Width (ft)	15.9		15.0	15.8	16.6
Floodprone Width (ft)	>40			>62	
Bankfull Mean Depth (ft)	1.3		1.4	1.6	1.7
Bankfull Max Depth (ft)	2.4		2.5	2.6	2.7
Bankfull Cross Sectional Area (ft^2)	21.0		21.2	24.7	28.0
Width/Depth Ratio	12.0		9.8	10.2	10.6
Entrenchment Ratio	>2.5			>3.6	
Bank Height Ratio	1.0		1.0	1.0	1.0
Pattern					
Channel Beltwidth (ft)	64	80	40		59
Radius of Curvature (ft)	48	80	26		84
Rc:Bankfull width (ft/ft)	3.0	5.0	1.7		5.3
Meander Wavelength (ft)	80	239	93		199
Meander Width Ratio	5	15	6		13
Profile					
Riffle Length (ft)			3	19.9	51
Riffle Slope (ft/ft)	0.010	0.019	0.001	0.017	0.041
Pool Length (ft)	24	40	5	18	45
Pool Spacing (ft)	40	119	17	76	241
Substrate and Transport Parameters					
SC% / Sa% / G% / C% / B% / Be%			2.5% / 28% / 61% / 5.5% / - / 3.5%		
d16 / d35 / d50 / d84 / d95 / di^p / di^{sp} (mm)			0.8 / 5.0 / 12.1 / 38.5 / 60 / - / -		
Additional Reach Parameters					
Channel length (ft)	1,779		1,796		
Drainage Area (mi^2)	0.77		0.77		
Rosgen Classification	C4		C4		
Sinuosity	1.3		1.1		
Water Surface Slope (ft/ft)	0.0038		0.0048		
BF slope (ft/ft)			0.005		

Table 5b. Baseline UTHR Downstream Summary (27+97 - 38+56)
Project Name: Glen Raven

Parameter	Design		As-built		
Dimension -Riffle	Min	Max	Min	Mean	Max
Bankfull Width (ft)	17.3			20.9	
Floodprone Width (ft)	>43			>70.7	
Bankfull Mean Depth (ft)	1.4			1.3	
Bankfull Max Depth (ft)	2.7			2.5	
Bankfull Cross Sectional Area (ft^2)	25.0			28.0	
Width/Depth Ratio	12.0			15.6	
Entrenchment Ratio	>2.5			>2.5	
Bank Height Ratio	1.0			1.0	
Pattern					
Channel Beltwidth (ft)	69	87	31		64
Radius of Curvature (ft)	52	87	25		84
Rc:Bankfull width (ft/ft)	3.0	5.0	1.2		4.0
Meander Wavelength (ft)	87	260	73		136
Meander Width Ratio	4.0	5.0	3.5		6.5
Profile					
Riffle Length (ft)			7	21	44
Riffle Slope (ft/ft)	0.010	0.019	0.001	0.009	0.029
Pool Length (ft)	26	43	6	11	20
Pool Spacing (ft)	43	130	32	65	152
Substrate and Transport Parameters					
SC% / Sa% / G% / C% / B% / Be%			7% / 58% / 31% / 4% / - / -		
d16 / d35 / d50 / d84 / d95 / di^p / di^{sp} (mm)			0.14 / 0.26 / 0.5 / 28 / 58 / - / -		
Additional Reach Parameters					
Channel length (ft)	1,073		1,059		
Drainage Area (mi^2)	1.1		1.1		
Rosgen Classification	C4		C4		
Sinuosity	1.3		1.1		
Water Surface Slope (ft/ft)	0.0038		0.0032		
BF slope (ft/ft)			0.0042		

Table 5c. Baseline UT1 Summary **Project Name: Glen Raven**					
Parameter	Design		As-built		
Dimension -Riffle	Min	Max	Min	Mean	Max
Bankfull Width (ft)	8.4			10.0	
Floodprone Width (ft)	16.0			24.5	
Bankfull Mean Depth (ft)	0.8			0.9	
Bankfull Max Depth (ft)	1.7			1.6	
Bankfull Cross Sectional Area (ft^2)	7.0			8.7	
Width/Depth Ratio	10.0			11.5	
Entrenchment Ratio	1.9			2.5	
Bank Height Ratio				1.5	
Pattern					
Channel Beltwidth (ft)	17	24	14		22
Radius of Curvature (ft)	8.0	25	12		32
Rc:Bankfull width (ft/ft)	1.0	3.0	1.2		3.2
Meander Wavelength (ft)	38	65	49		95
Meander Width Ratio	4.5	7.7	4.9		9.5
Substrate and Transport Parameters					
SC% / Sa% / G% / C% / B% / Be%			5% / 18% / 65% / 6% / - / 6%		
d16 / d35 / d50 / d84 / d95 / di^p / di^{sp} (mm)			1.2 / 6.5 / 14 / 45 / 71 / - / -		
Additional Reach Parameters					
Channel length (ft)	556		542		
Drainage Area (mi^2)	0.1		0.1		
Rosgen Classification	B4c		B4c		
Sinuosity	1.2		1.1		
Water Surface Slope (ft/ft)	0.009		0.018		
BF slope (ft/ft)			0.018		

Table 5d. Baseline UT2 Summary
Project Name: Glen Raven

Parameter	Design		As-built		
Pattern	Min	Max	Min	Mean	Max
Channel Beltwidth (ft)	17	24	15		17
Radius of Curvature (ft)	8.0	25	24		32
Meander Wavelength (ft)	38	65	85		100
Additional Reach Parameters					
Channel length (ft)	370		370		
Drainage Area (mi^2)	0.1		0.1		
Rosgen Classification	B4c		B4c		
Sinuosity	1.2		1.1		
Water Surface Slope (ft/ft)	0.009		0.025		
BF slope (ft/ft)			0.025		

Table 6. Morphology and Hydraulic Monitoring Summary
Project Name: Glen Raven

Parameter	X-Section 1 Pool	X-Section 2 Riffle	X-Section 3 Pool	X-Section 4 Riffle	X-Section 5 Riffle	X-Section 6 Pool	X-Section 7 Riffle	X-Section 8 Pool
Reach	UTHR (UPS*)	UTHR (UPS)	UTHR (UPS)	UTHR (UPS)	UTHR (DS**)	UTHR (DS)	UT1	UT1
Dimension								
Bankfull Width (ft)	22.7	16.6	20.0	15.0	20.9	26.8	10	14.9
Floodprone Width (ft)	-	>64	-	>62	>71	-	24.9	-
Bankfull Mean Depth (ft)	1.9	1.7	1.5	1.4	1.3	1	0.9	0.9
Bankfull Max Depth (ft)	3.7	2.7	2.9	2.5	2.5	2.9	1.6	2
Bankfull Cross Sectional Area (ft^2)	44.2	28.0	29.6	21.2	28	27.4	8.7	14.1
Bankfull Width/Depth Ratio	-	9.8	-	10.6	15.6	-	11.5	-
Bankfull Entrenchment Ratio	-	>3.6	-	>4	>3	-	2.5	-
Bankfull Bank Height Ratio	-	1	-	1	1	-	1.5	-
Substrate								
d50 (mm)	0.37	17	0.57	7.1	14	0.59	0.5	0.49
d84 (mm)	0.72	31	12	46	45	18	28	20

*Upstream reach of UTHR

**Downstream reach of UTHR

Table 7: Stem counts arranged by plot.
Project Name: Glen Raven

Species	Plots								Initial Totals	Year 1 Totals	Survival %
	1	2	3	4	5	6	7	8			
Shrubs											
Callicarpa americana	4	1							5	-	-
Cephalanthus occidentalis						1			1	-	-
Ilex verticillata	3				1		1		5	-	-
Lindera benzoin			1		1		1		3	-	-
Symphoricarpos orbiculatas	1	1	1		2			1	6	-	-
Trees											
Betula nigra	1				1			2	4	-	-
Cornus amomum					1		1	3	5	-	-
Fraxinus pennsylvanica	1	2	1				6		10	-	-
Juglans nigra				9		4			13	-	-
Platanus occidentalis			3				1		4	-	-
Quercus sp.	1	3							4	-	-
Quercus falcata						2			2	-	-
Quercus michauxii		8	1		2		4	8	23	-	-
Quercus phellos							1		1	-	-
Salix sp.								1	1	-	-
Salix nigra			4	1	2		3		10	-	-
Salix sericea			2	1	1			1	5	-	-
*Unknown**	5	2	11	8	11	6	3	5	51	-	-
Unknown I	4	1		2		1	1		9	-	-
Unknown II			2		1				3	-	-
Unknown III			2						2	-	-

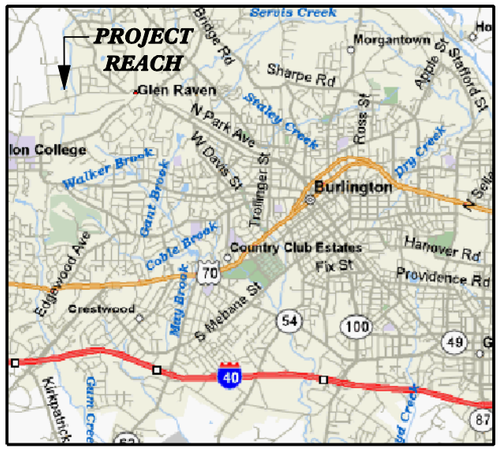
**indicates species unknown, all other unknown species (I, II, and III), are distinct species, however unidentifiable at this time.*

Appendix A

As-Built Plans

CONTRACT #: D05011–1

KCI JOB# : 12054253



VICINITY MAP
NOT TO SCALE

STATE OF NORTH CAROLINA
ECOSYSTEM ENHANCEMENT PROGRAM

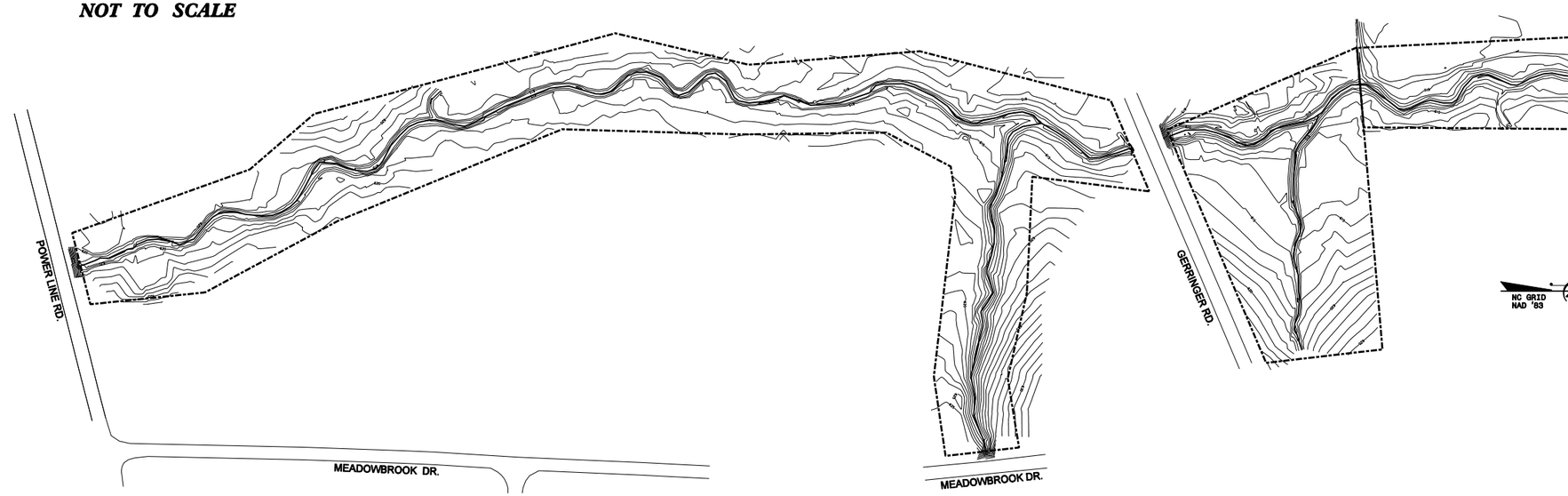
STATE	CONTRACT NUMBER	SHEET NO.	TOTAL SHEETS
N.C.	D05011–1	1	16

SYM.	DESCRIPTION	DATE	APPROVED
	REVISIONS		

ALAMANCE COUNTY

LOCATION: GLEN RAVEN SITE
UNNAMED TRIBUTARIES TO THE HAW RIVER
BURLINGTON, NORTH CAROLINA

TYPE OF WORK: STREAM RESTORATION AND ENHANCEMENT



INDEX OF SHEETS

AS–BUILT PLAN

GRAPHIC SCALES

PLANS: –30 –15 0 30 60
PROFILE (HORIZONTAL): –30 –15 0 30 60
PROFILE (VERTICAL): –4 –2 0 4 8

PROJECT DATA

STREAM RESTORATION LENGTH = 3,317 FEET

STREAM ENHANCEMENT LENGTH = 450 FEET

Prepared In the Office of:

KCI TECHNOLOGIES
ENGINEERS•PLANNERS•ECOLOGISTS
SUITE 220 LANDMARK CENTER II
4601 SIX FORKS RD., RALEIGH, NC

COMPLETION DATE:
MARCH 2007

GARY M. MRYNCZA, PE
PROJECT ENGINEER

ALEX FRENCH / ADAM SPILLER
NATURAL CHANNEL DESIGN

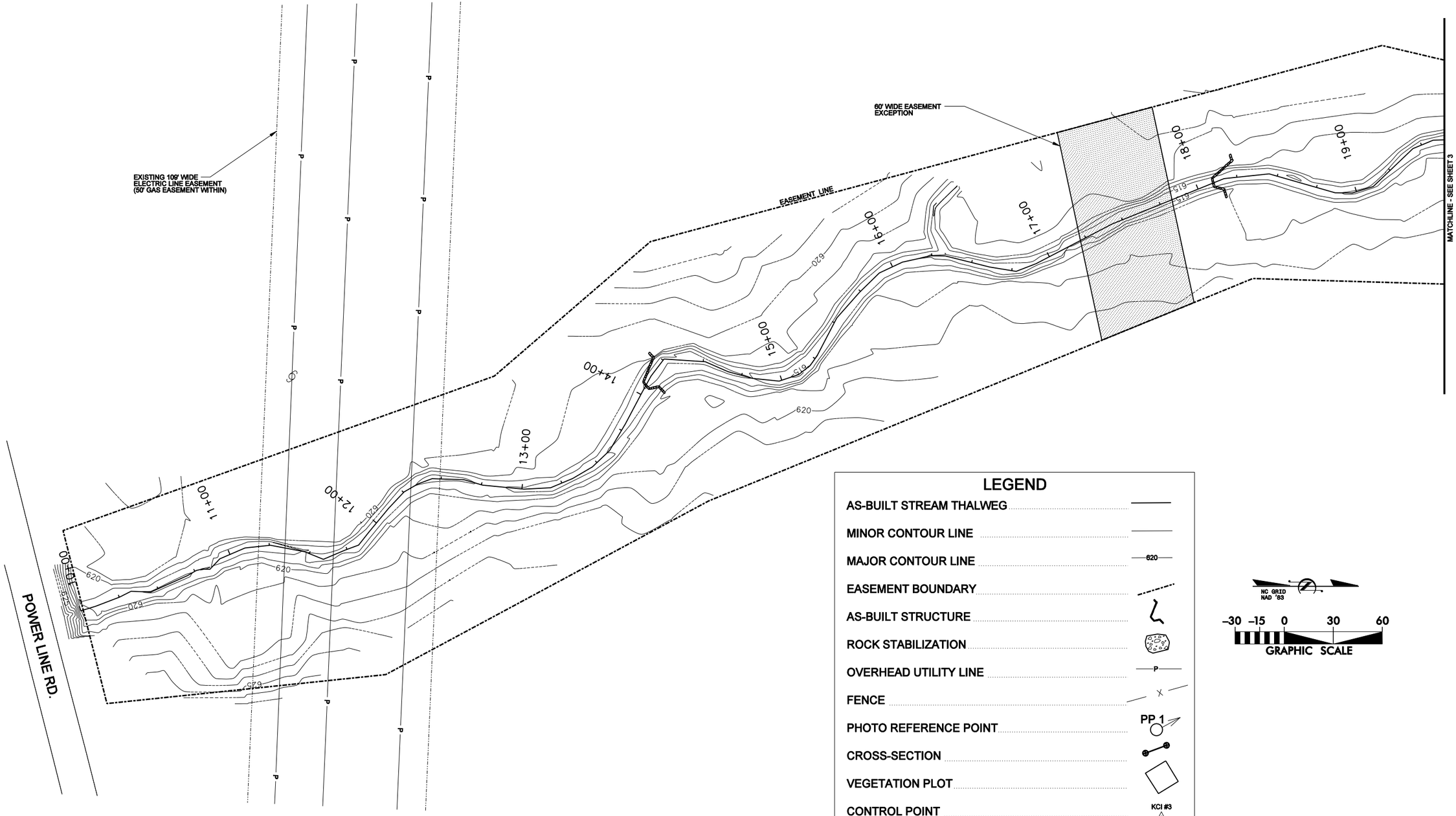
PROJECT ENGINEER

SIGNATURE: ***P.E.***

Prepared for:

Ecosystem Enhancement PROGRAM

GUY PEARCE
CONTRACT ADMINISTRATOR



LEGEND

- AS-BUILT STREAM THALWEG
- MINOR CONTOUR LINE
- MAJOR CONTOUR LINE — 620
- EASEMENT BOUNDARY
- AS-BUILT STRUCTURE
- ROCK STABILIZATION
- OVERHEAD UTILITY LINE — P
- FENCE — X
- PHOTO REFERENCE POINT — PP 1
- CROSS-SECTION
- VEGETATION PLOT
- CONTROL POINT — KCI #3

NC GRID
NAD '83

–30 –15 0 30 60
GRAPHIC SCALE

SYM.	DESCRIPTION	DATE	APPROVED
	REVISIONS		

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GLEN RAVEN - UT TO HAW RIVER STREAM RESTORATION PROJECT

BURLINGTON, ALAMANCE COUNTY, NORTH CAROLINA

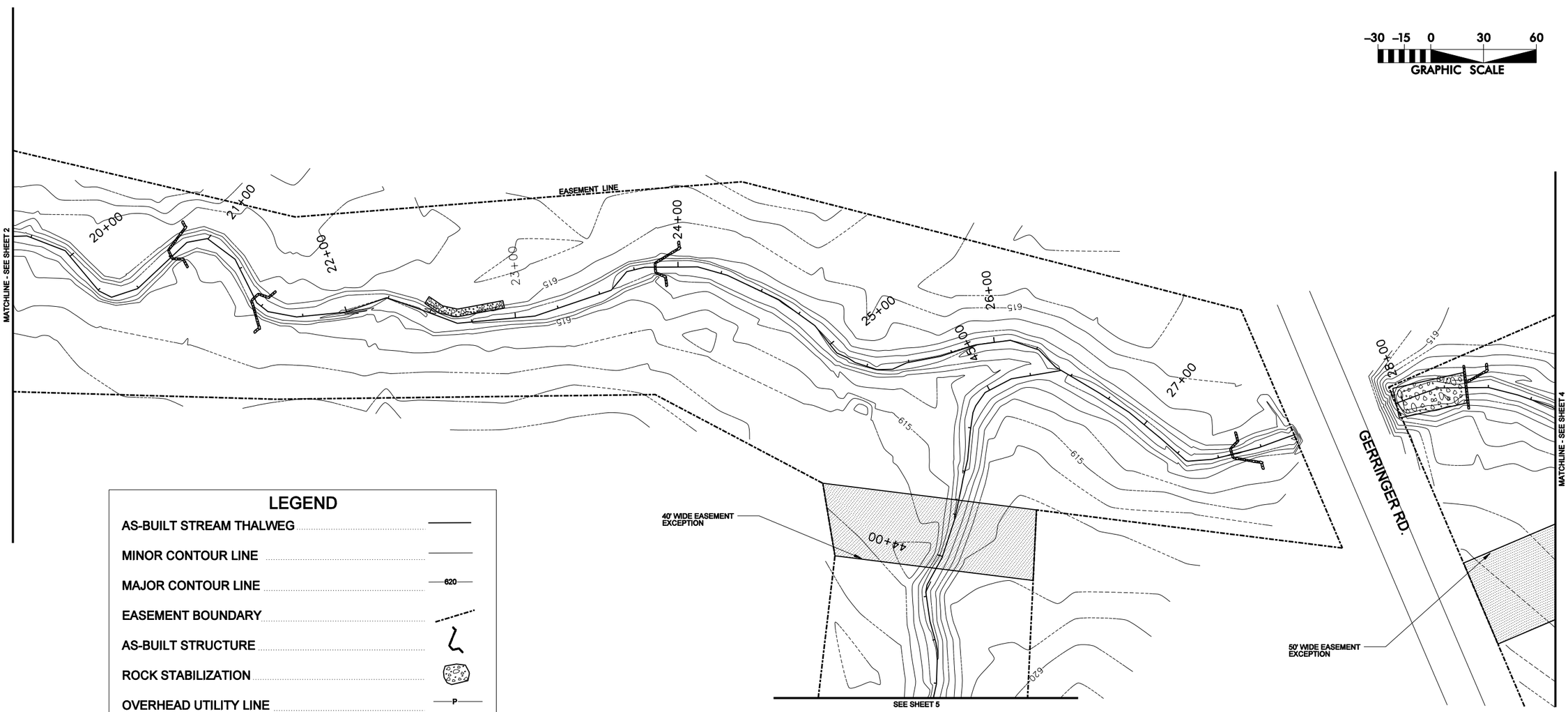
STATION 10+00 TO STATION 19+62

DATE: MAY 2007
SCALE: 1"=30'

AS-BUILT SITE PLAN

NC GRID
NAD '83

–30 –15 0 30 60
GRAPHIC SCALE



LEGEND

- AS-BUILT STREAM THALWEG
- MINOR CONTOUR LINE
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GLEN RAVEN - UT TO HAW RIVER STREAM RESTORATION PROJECT

BURLINGTON, ALAMANCE COUNTY, NORTH CAROLINA

STATION 19+62 TO STATION 28+75

DATE: MAY 2007
SCALE: 1"=30'

AS-BUILT SITE PLAN

SHEET 3 OF 16

NC GRID
NAD '83

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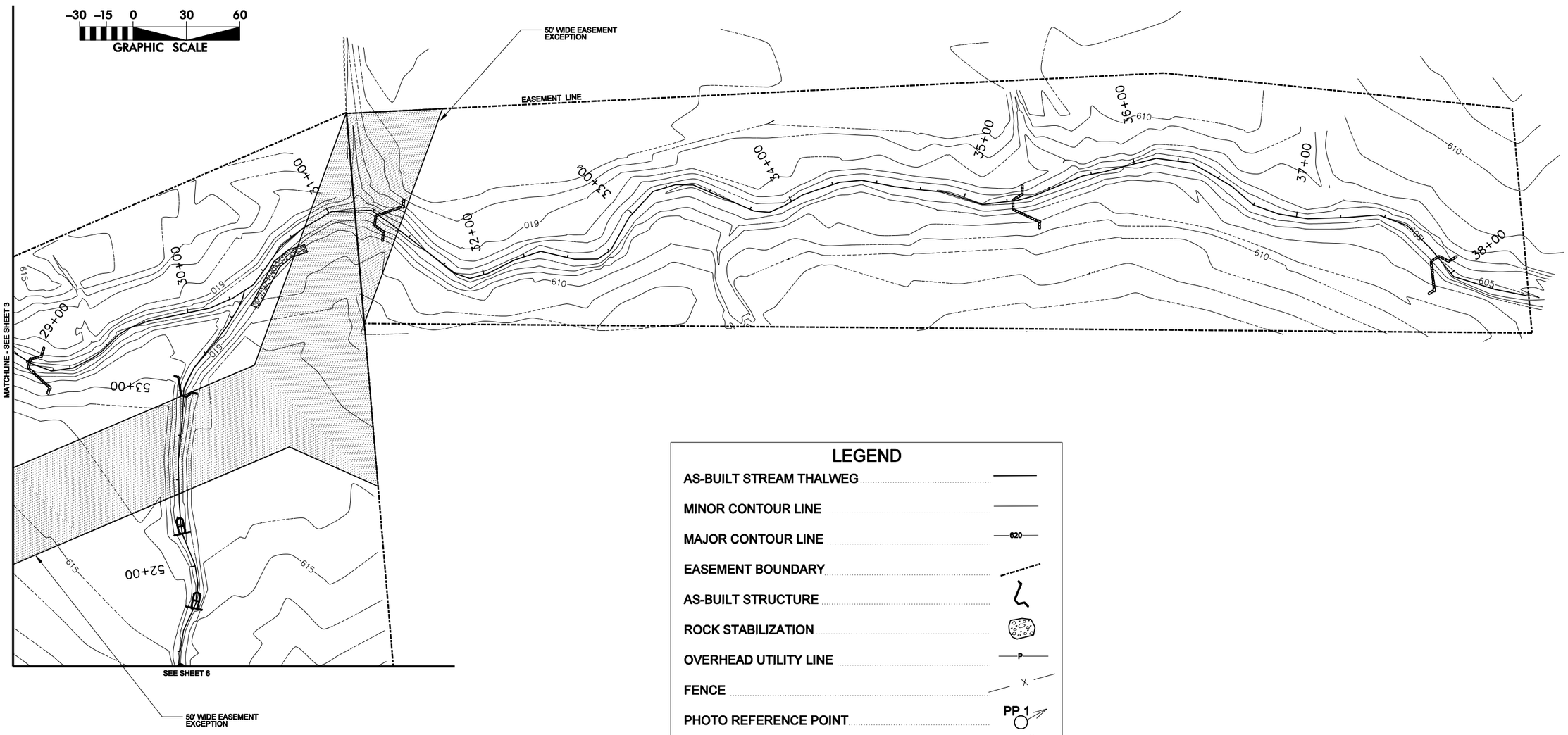
GRAPHIC SCALE



LEGEND

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- CONTROL POINT — KCI #3

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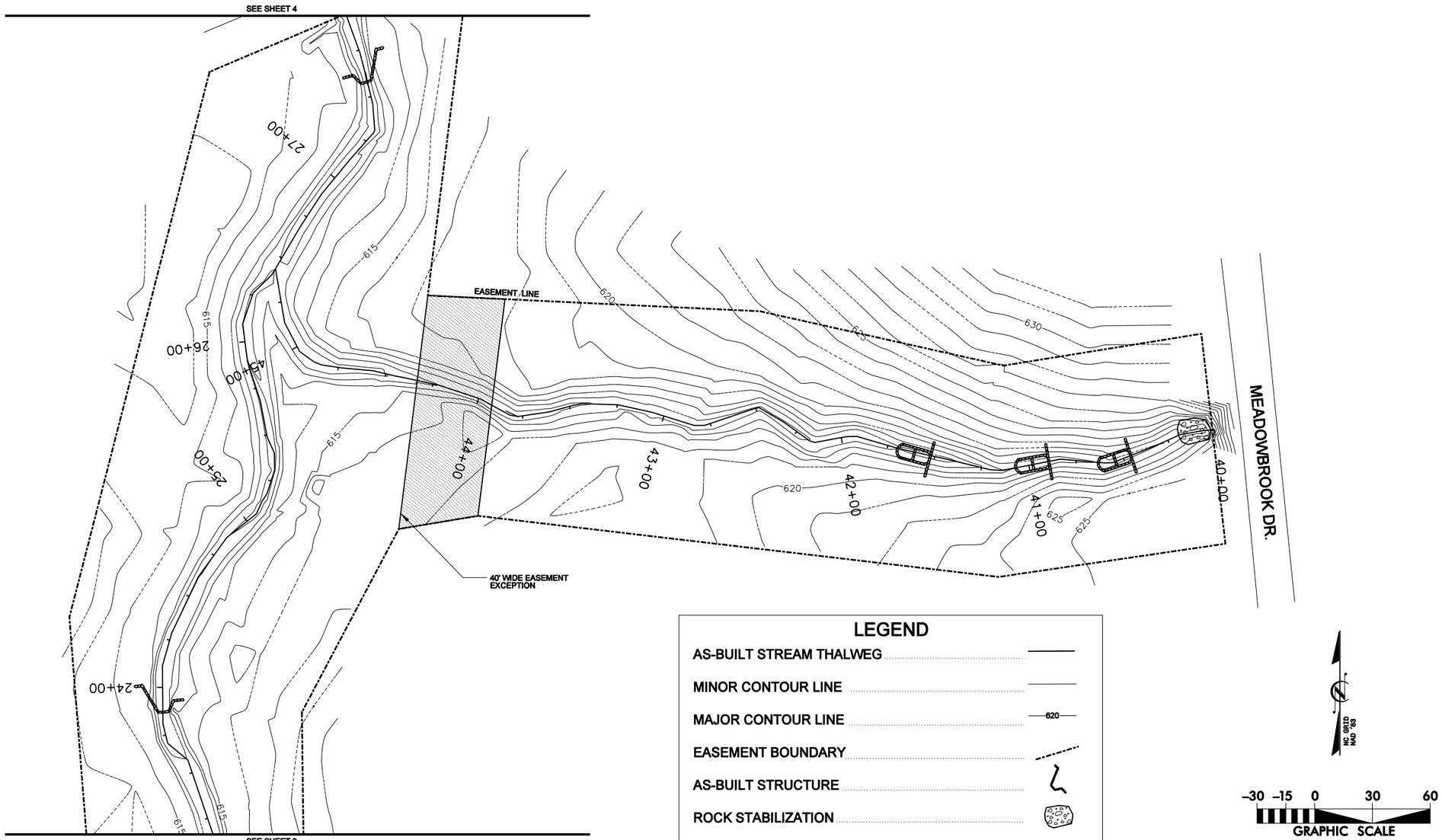
GLEN RAVEN - UT TO HAW RIVER
STREAM RESTORATION PROJECT
BURLINGTON, ALAMANCE COUNTY, NORTH CAROLINA
STATION 28+75 TO STATION 38+52

DATE: MAY 2007
SCALE: 1"=30'

AS-BUILT
SITE PLAN

SHEET 4 OF 16



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BURLINGTON, ALAMANCE COUNTY, NORTH CAROLINA

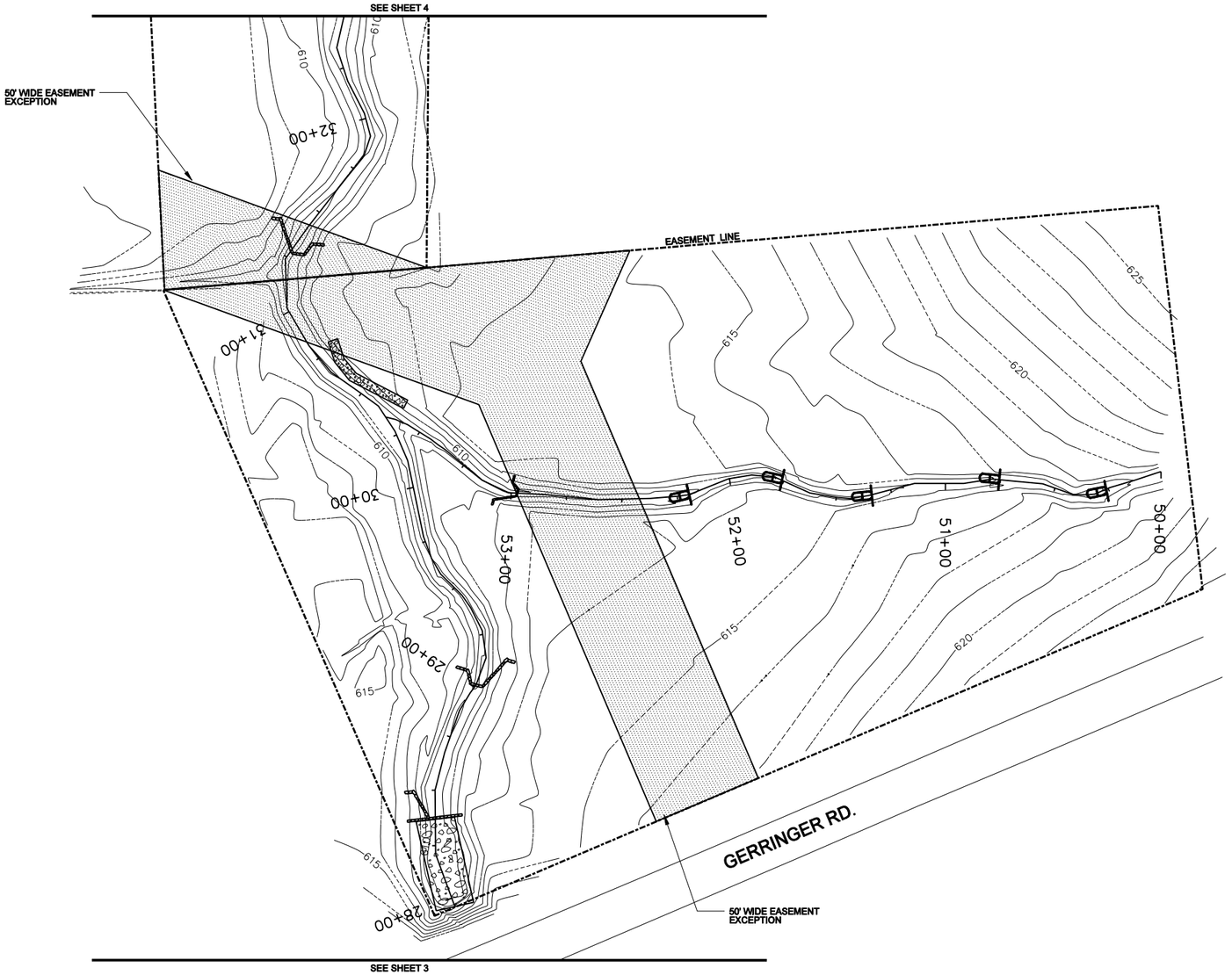
STATION 40+00 TO STATION 45+56

DATE: MAY 2007

SCALE: 1"=30'

AS-BUILT SITE PLAN

SHEET 5 OF 16



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NC GRID NAD '83

–30 –15 0 30 60

GRAPHIC SCALE

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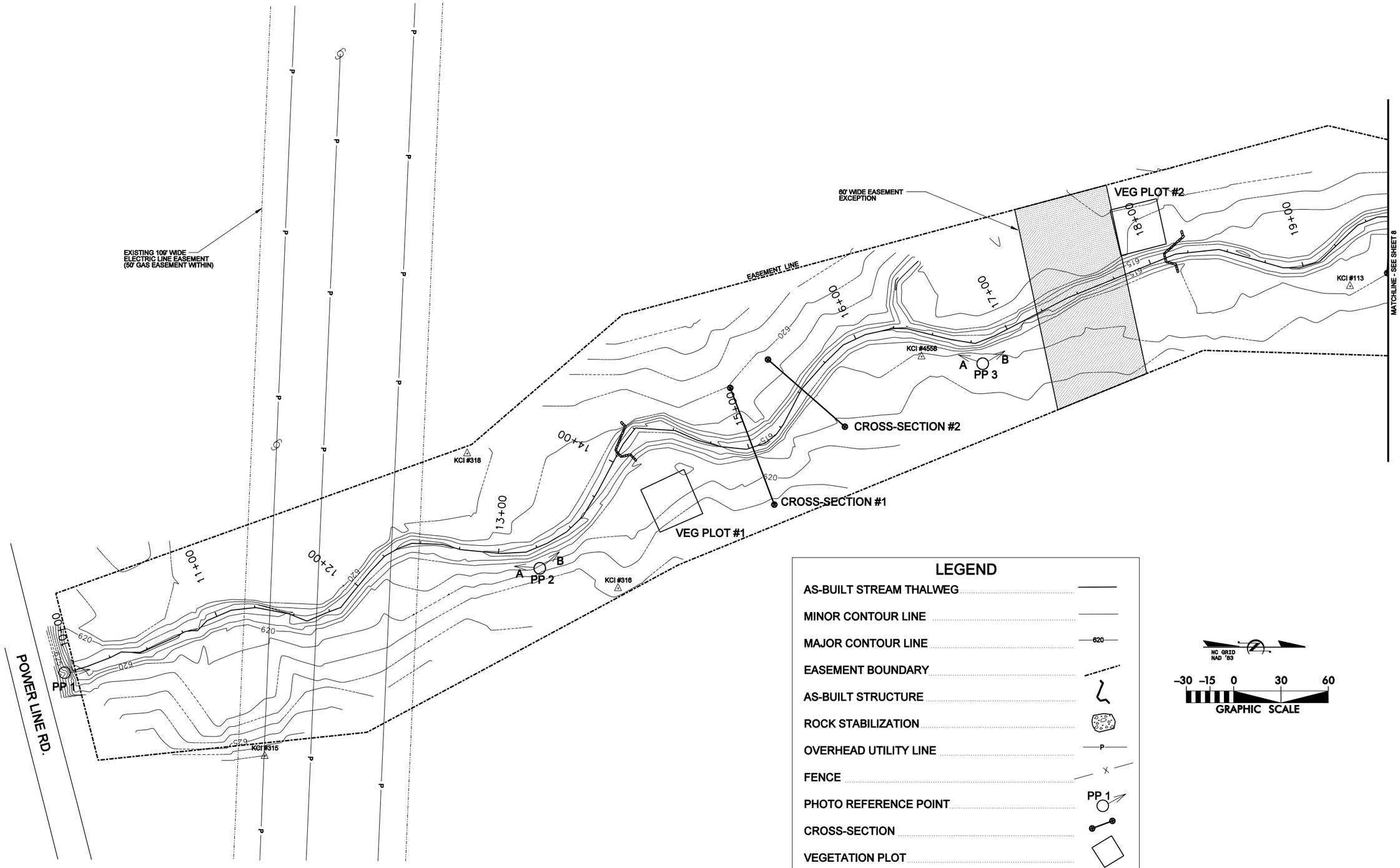
STATION 50+00 TO STATION 53+70

DATE: MAY 2007

SCALE: 1"=30'

AS-BUILT SITE PLAN



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NC GRID
NAD '83

–30 –15 0 30 60

GRAPHIC SCALE

NO.	DESCRIPTION	DATE	APPROVED
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BURLINGTON, ALAMANCE COUNTY, NORTH CAROLINA

STATION 10+00 TO STATION 19+62

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SCALE: 1"=30'

MONITORING LOCATIONS

SHEET 7 OF 16

NC GRID
NAD '83

-30 -15 0 30 60
GRAPHIC SCALE

CROSS-SECTION #3
CROSS-SECTION #4
EASEMENT LINE
20+00
21+00
22+00
23+00
24+00
25+00
26+00
27+00
28+00
615
KCI #4560
KCI #4561
KCI #4555
KCI #4532
KCI #4527
KCI #4564
KCI #4533
A
B
PP 4
PP 5
PP 6
PP 11
VEG PLOT #3
VEG PLOT #4
40' WIDE EASEMENT EXCEPTION
50' WIDE EASEMENT EXCEPTION
GERRINGER RD.
MATCHLINE - SEE SHEET 7
MATCHLINE - SEE SHEET 9
SEE SHEET 10

LEGEND

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BURLINGTON, ALAMANCE COUNTY, NORTH CAROLINA

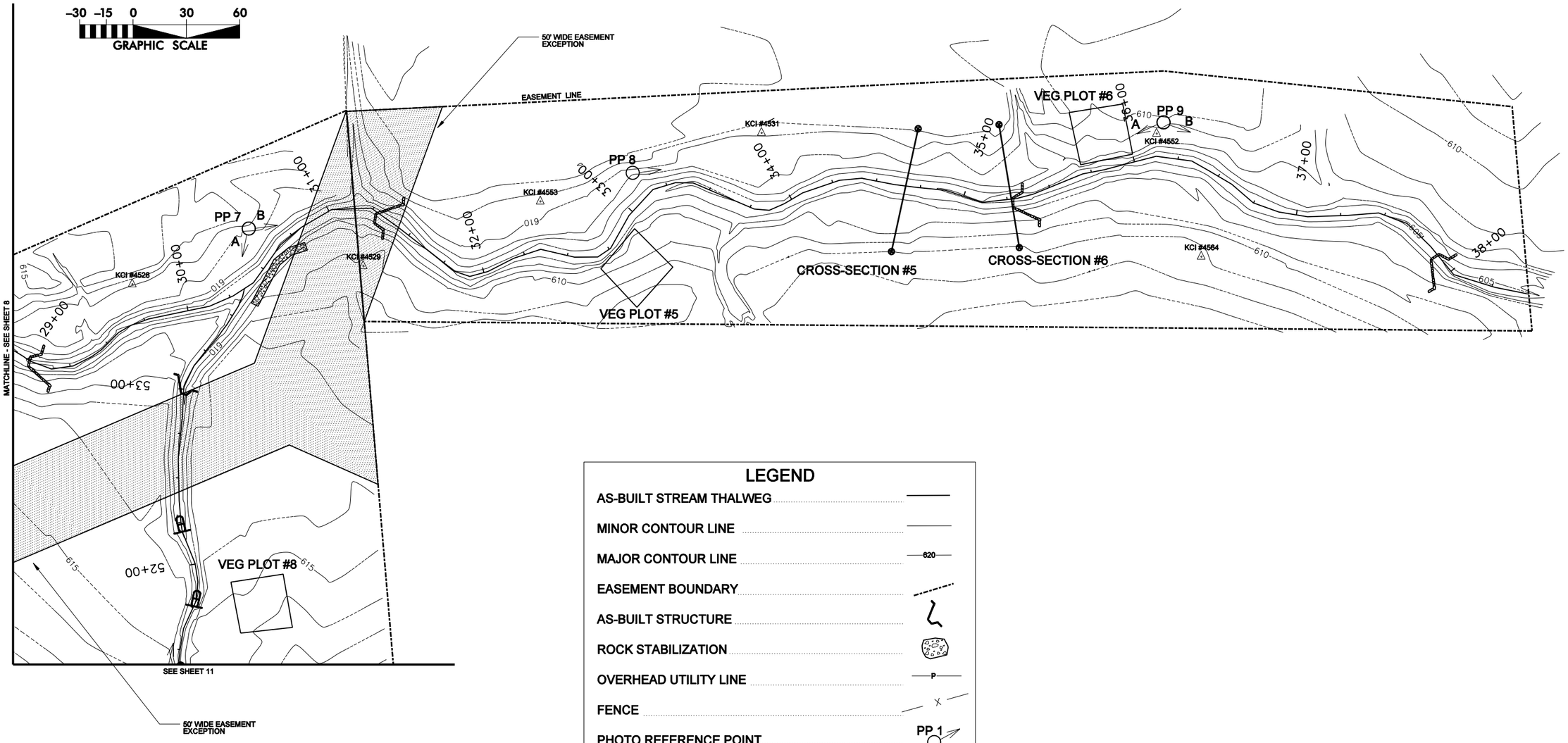
STATION 19+62 TO STATION 28+75

DATE: MAY 2007
SCALE: 1"=30'

MONITORING LOCATIONS

NC GRID
NAD '83

–30 –15 0 30 60
GRAPHIC SCALE



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REVISIONS			
SYM.	DATE	APPROVED	

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STREAM RESTORATION PROJECT
BURLINGTON, ALAMANCE COUNTY, NORTH CAROLINA
STATION 28+75 TO STATION 38+52

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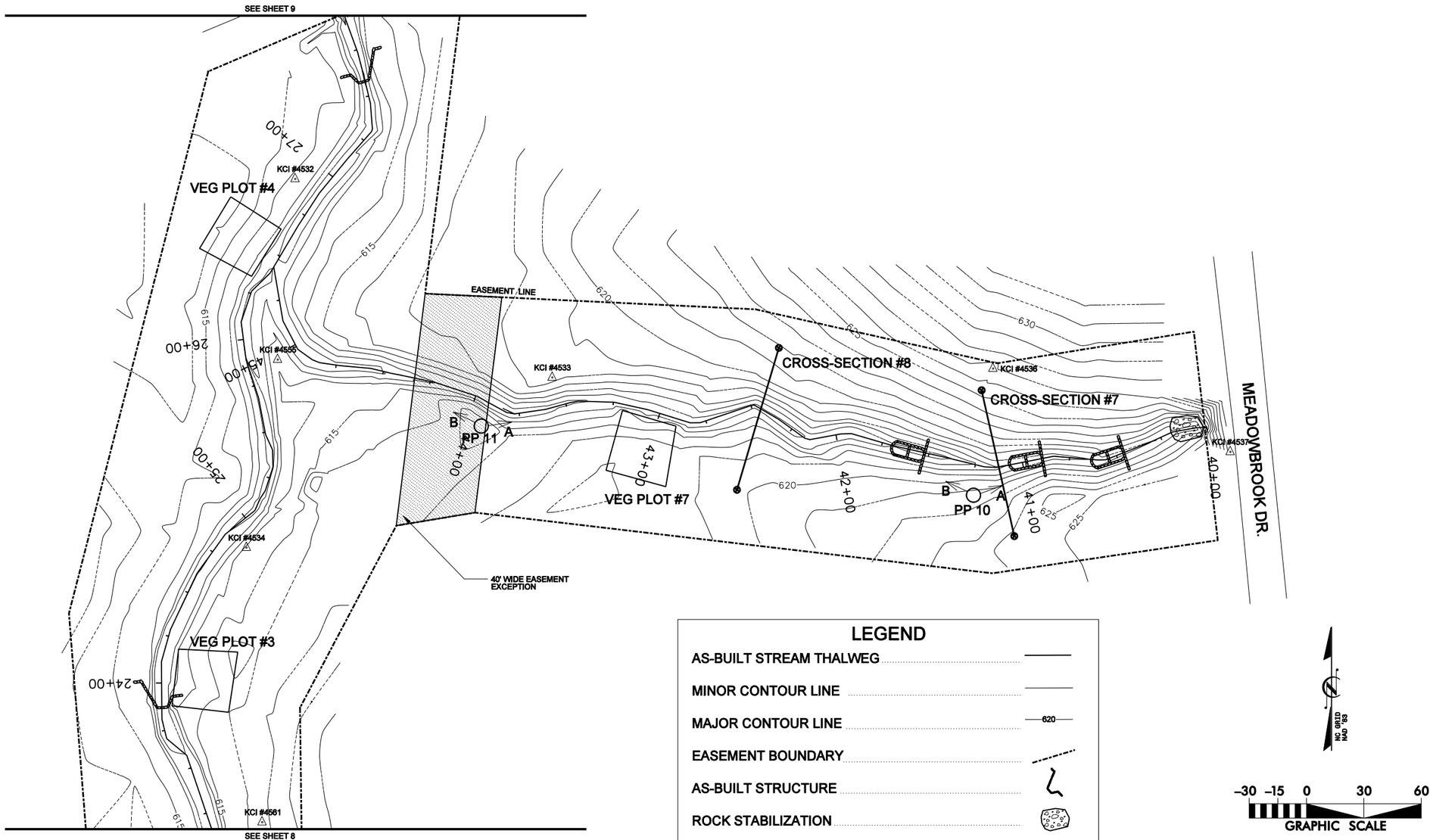
SCALE: 1"=30'

MONITORING LOCATIONS

SHEET 9 OF 16



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NC 6RTD NAD '83

–30 –15 0 30 60

GRAPHIC SCALE

REVISIONS

SYM.	DESCRIPTION	DATE	APPROVED

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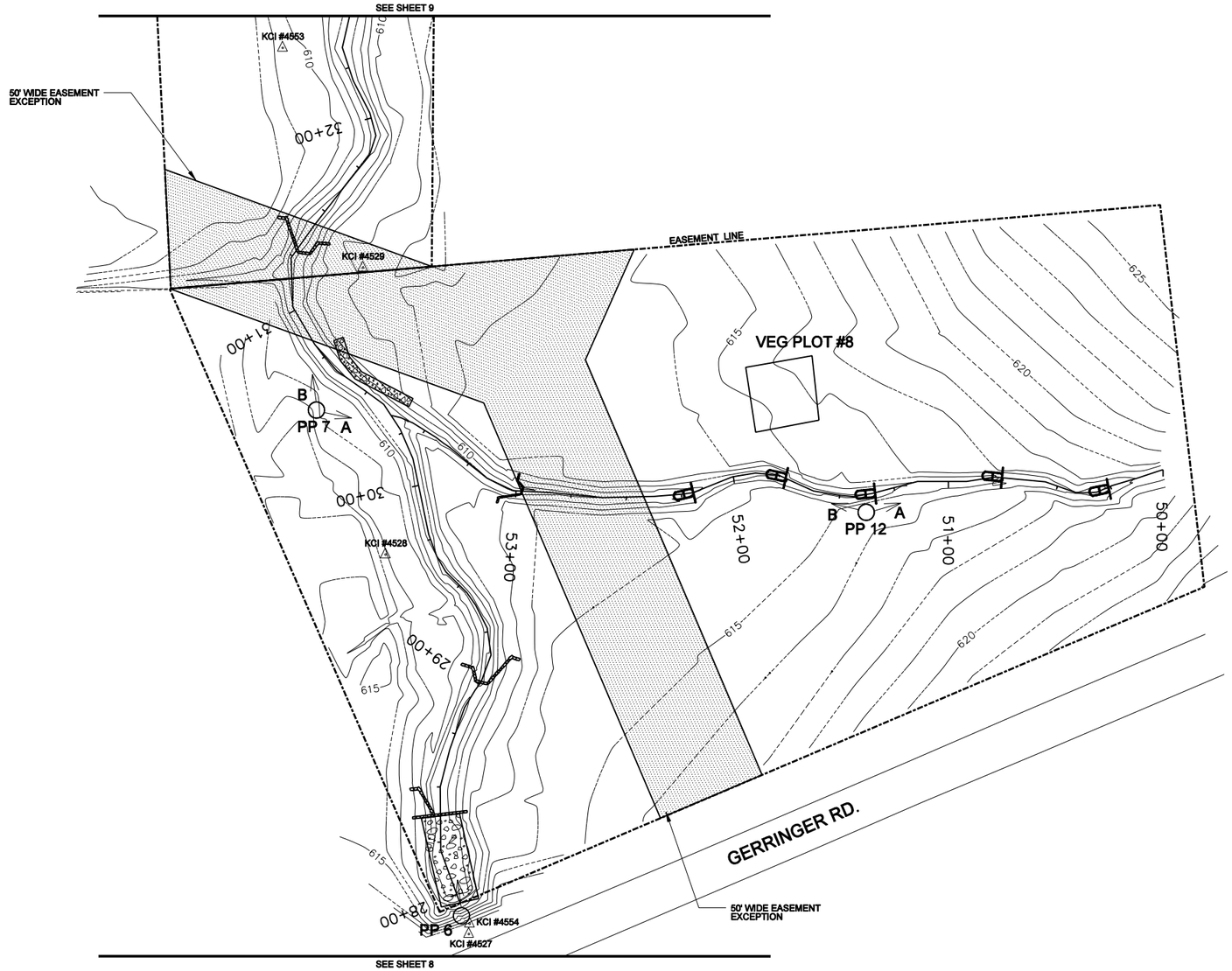
STATION 40+00 TO STATION 45+56

DATE: MAY 2007

SCALE: 1"=30'

MONITORING LOCATIONS

SHEET 10 OF 16



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GRAPHIC SCALE

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STATION 50+00 TO STATION 53+70

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SCALE: 1"=30'

MONITORING LOCATIONS

NC GRID
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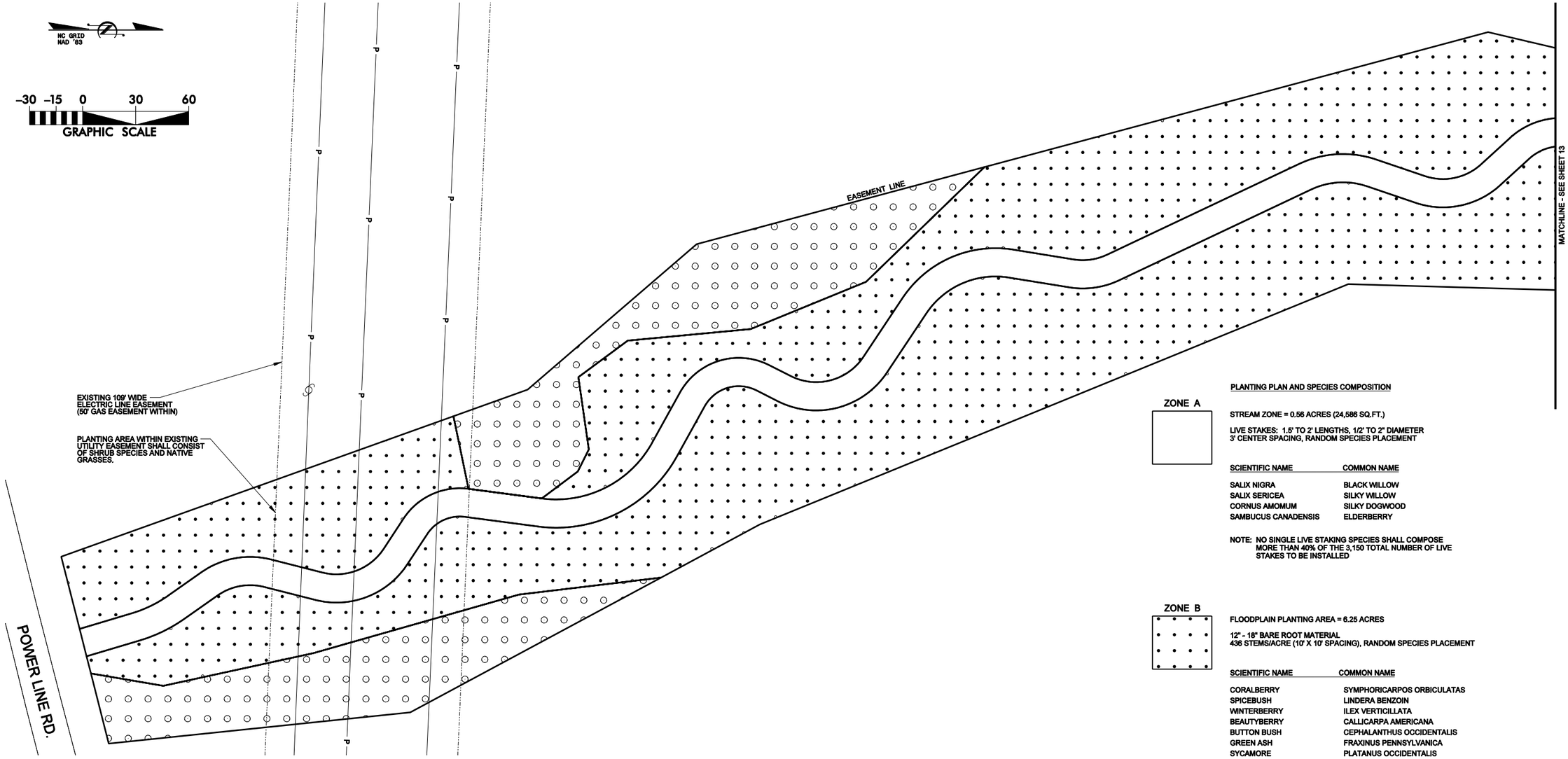
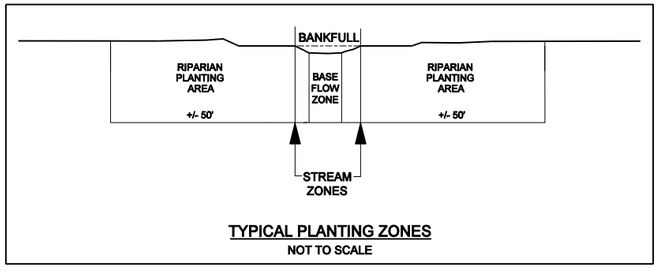
-30 -15 0 30 60
GRAPHIC SCALE





TYPICAL PLANTING ZONES
NOT TO SCALE

ZONE A

PLANTING PLAN AND SPECIES COMPOSITION

STREAM ZONE = 0.56 ACRES (24,586 SQ.FT.)

LIVE STAKES: 1.5' TO 2' LENGTHS, 1/2' TO 2" DIAMETER
3' CENTER SPACING, RANDOM SPECIES PLACEMENT

SCIENTIFIC NAME	COMMON NAME
SALIX NIGRA	BLACK WILLOW
SALIX SERICEA	SILKY WILLOW
CORNUS AMOMUM	SILKY DOGWOOD
SAMBUCUS CANADENSIS	ELDERBERRY

NOTE: NO SINGLE LIVE STAKING SPECIES SHALL COMPOSE MORE THAN 40% OF THE 3,150 TOTAL NUMBER OF LIVE STAKES TO BE INSTALLED

ZONE B

FLOODPLAIN PLANTING AREA = 6.25 ACRES

12" - 18" BARE ROOT MATERIAL
436 STEMS/ACRE (10' X 10' SPACING), RANDOM SPECIES PLACEMENT

SCIENTIFIC NAME	COMMON NAME
CORALBERRY	SYMPHORICARPOS ORBICULATAS
SPICEBUSH	LINDERA BENZOIN
WINTERBERRY	ILEX VERTICILLATA
BEAUTYBERRY	CALLICARPA AMERICANA
BUTTON BUSH	CEPHALANTHUS OCCIDENTALIS
GREEN ASH	FRAXINUS PENNSYLVANICA
SYCAMORE	PLATANUS OCCIDENTALIS
SUGARBERRY	CELTIS LAEVIGATA
RIVER BIRCH	BETULA NIGRA
SWAMP CHESTNUT OAK	QUERCUS MICHAUXII
WILLOW OAK	QUERCUS PHELLOS
PERSIMMON	DIOSPYROS VIRGINIANA

* UNDISTURBED FORESTED AREAS WITHIN PLANTING ZONE WILL NOT BE PLANTED

ZONE C

UPLAND PLANTING AREA = 2.76 ACRES

12" - 18" BARE ROOT MATERIAL
436 STEMS/ACRE (10' X 10' SPACING), RANDOM SPECIES PLACEMENT

SCIENTIFIC NAME	COMMON NAME
CORALBERRY	SYMPHORICARPOS ORBICULATAS
SPICEBUSH	LINDERA BENZOIN
PERSIMMON	DIOSPYROS VIRGINIANA
BLACK WALNUT	JUGLANS NIGRA
SHAGBARK HICKORY	CARYA OVATA
S. RED OAK	QUERCUS FALCATA

* UNDISTURBED FORESTED AREAS WITHIN PLANTING ZONE WILL NOT BE PLANTED

SYM.	DESCRIPTION	DATE	APPROVED

REVISIONS

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BURLINGTON, ALAMANCE COUNTY, NORTH CAROLINA
STATION 10+00 TO STATION 19+62

DATE: MAY 2007
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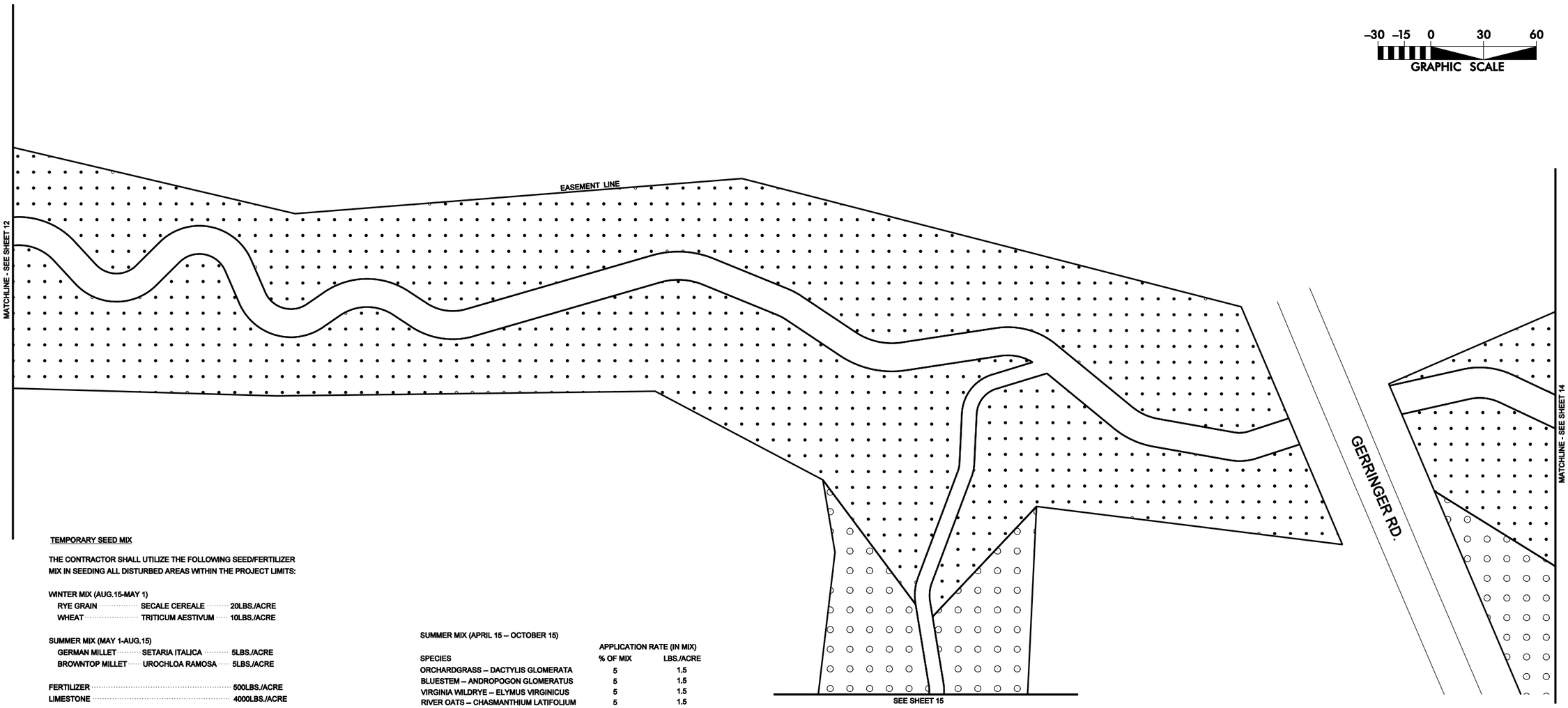
PLANTING PLAN

SHEET 12 OF 16



TEMPORARY SEED MIX

THE CONTRACTOR SHALL UTILIZE THE FOLLOWING SEED/FERTILIZER MIX IN SEEDING ALL DISTURBED AREAS WITHIN THE PROJECT LIMITS:

WINTER MIX (AUG.15-MAY 1)

RYE GRAIN	SECALE CEREALE	20LBS./ACRE
WHEAT	TRITICUM AESTIVUM	10LBS./ACRE

SUMMER MIX (MAY 1-AUG.15)

GERMAN MILLET	SETARIA ITALICA	5LBS./ACRE
BROWNTOP MILLET	UROCHLOA RAMOSA	5LBS./ACRE

FERTILIZER	500LBS./ACRE
LIMESTONE	4000LBS./ACRE

FERTILIZER SHALL BE 10-20-20 ANALYSIS. UPON WRITTEN APPROVAL OF THE SITE SUPERVISOR, A DIFFERENT ANALYSIS OF FERTILIZER MAY BE USED PROVIDED THE 1-2-2 RATIO IS MAINTAINED AND THE RATE OF APPLICATION ADJUSTED TO PROVIDE THE SAME AMOUNT OF PLANT FOOD AS A 10-20-20 ANALYSIS.

PERMANENT SEED MIX

THE CONTRACTOR SHALL UTILIZE THE FOLLOWING SEED MIX AND FERTILIZER SPECIFICATION IN ALL AREAS INSIDE THE RIPARIAN BUFFER ZONES, INCLUDING THE STREAM BANKS:

WINTER MIX (OCTOBER 15 -- APRIL 15)

SPECIES	APPLICATION RATE (IN MIX) % OF MIX	LBS./ACRE
ORCHARDGRASS -- DACTYLIS GLOMERATA	5	1.5
BLUESTEM -- ANDROPOGON GLOMERATUS	5	1.5
VIRGINIA WILDRYE - ELYMUS VIRGINICUS	5	1.5
RIVER OATS -- CHASMANTHIUM LATIFOLIUM	5	1.5
PURPLE LOVE GRASS -- ERAGROSTIS SPECTABILIS	5	1.5
DEERTONGUE -- DICHANTHELIUM CLANDESTINUM	25	7.5
SWITCHGRASS -- PANICUM VIRGATUM	25	7.5
RYE GRAIN -- SECALE CEREALE	25	7.5
TOTALS	100	30

SUMMER MIX (APRIL 15 -- OCTOBER 15)

SPECIES	APPLICATION RATE (IN MIX) % OF MIX	LBS./ACRE
ORCHARDGRASS -- DACTYLIS GLOMERATA	5	1.5
BLUESTEM -- ANDROPOGON GLOMERATUS	5	1.5
VIRGINIA WILDRYE -- ELYMUS VIRGINICUS	5	1.5
RIVER OATS -- CHASMANTHIUM LATIFOLIUM	5	1.5
PURPLE LOVE GRASS -- ERAGROSTIS SPECTABILIS	5	1.5
DEERTONGUE -- PANICUM CLANDESTINUM	25	7.5
SWITCHGRASS -- PANICUM VIRGATUM	25	7.5
PEARL MILLET -- PENNISETUM GLAUCOMA	25	7.5
TOTALS	100	30

FERTILIZER AND LIMESTONE SHALL BE APPLIED AT THE RATE OF 500LBS./ACRE AND 4000LBS./ACRE, RESPECTIVELY. FERTILIZER SHALL BE 10-20-20 ANALYSIS. UPON WRITTEN APPROVAL OF THE SITE SUPERVISOR, A DIFFERENT ANALYSIS OF FERTILIZER MAY BE USED PROVIDED THE 1-2-2 RATIO IS MAINTAINED AND THE RATE OF APPLICATION ADJUSTED TO PROVIDE THE SAME AMOUNT OF PLANT FOOD AS A 10-20-20 ANALYSIS.

MULCHING

SEEDED AREAS ARE TO BE PROTECTED BY SPREADING STRAW MULCH UNIFORMLY TO FORM A CONTINUOUS BLANKET (75% COVERAGE = 2 TONS/ACRE) OVER SEEDED AREAS. CONTRACTOR MAY PROPOSE ALTERNATE METHODS OF SEED, FERTILIZER AND LIMING (HYDRO-SEEDING) UPON SUBMISSION TO THE ENGINEER OF CALCULATIONS SHOWING THE EQUIVALENCY OF THE PROPOSED METHOD.

ZONE A — STREAM ZONE PLANTING AREA

ZONE B — FLOODPLAIN PLANTING AREA

ZONE C — UPLAND PLANTING AREA

REVISIONS				
	DESCRIPTION	DATE	APPROVED	
B	REVISIONS PER DLR COMMENTS	OCT 2006		

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BURLINGTON, ALAMANCE COUNTY, NORTH CAROLINA

STATION 19+62 TO STATION 28+75

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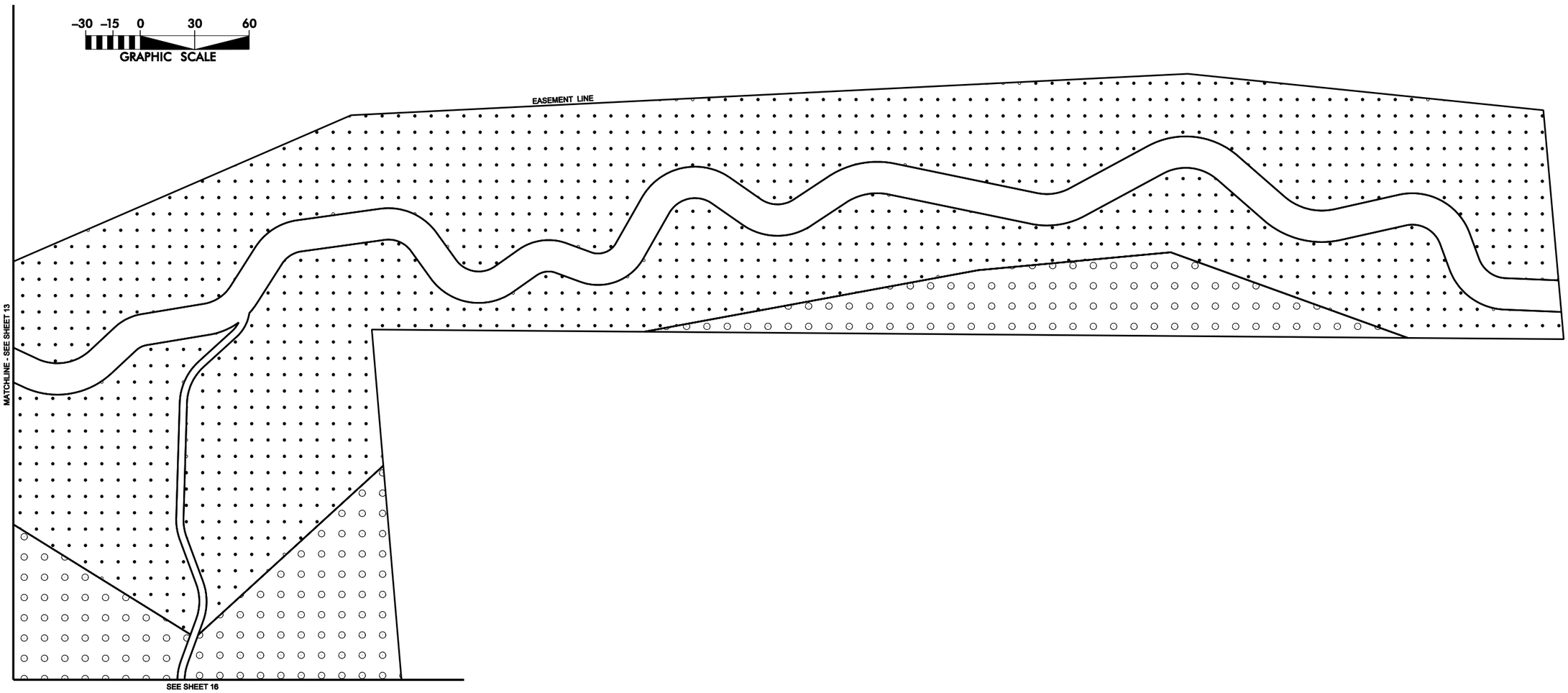
PLANTING PLAN

SHEET 13 OF 16

NC GRID
NAD '83

–30 –15 0 30 60
GRAPHIC SCALE



ZONE A
STREAM ZONE PLANTING AREA

ZONE B
FLOODPLAIN PLANTING AREA

ZONE C
UPLAND PLANTING AREA

REVISIONS

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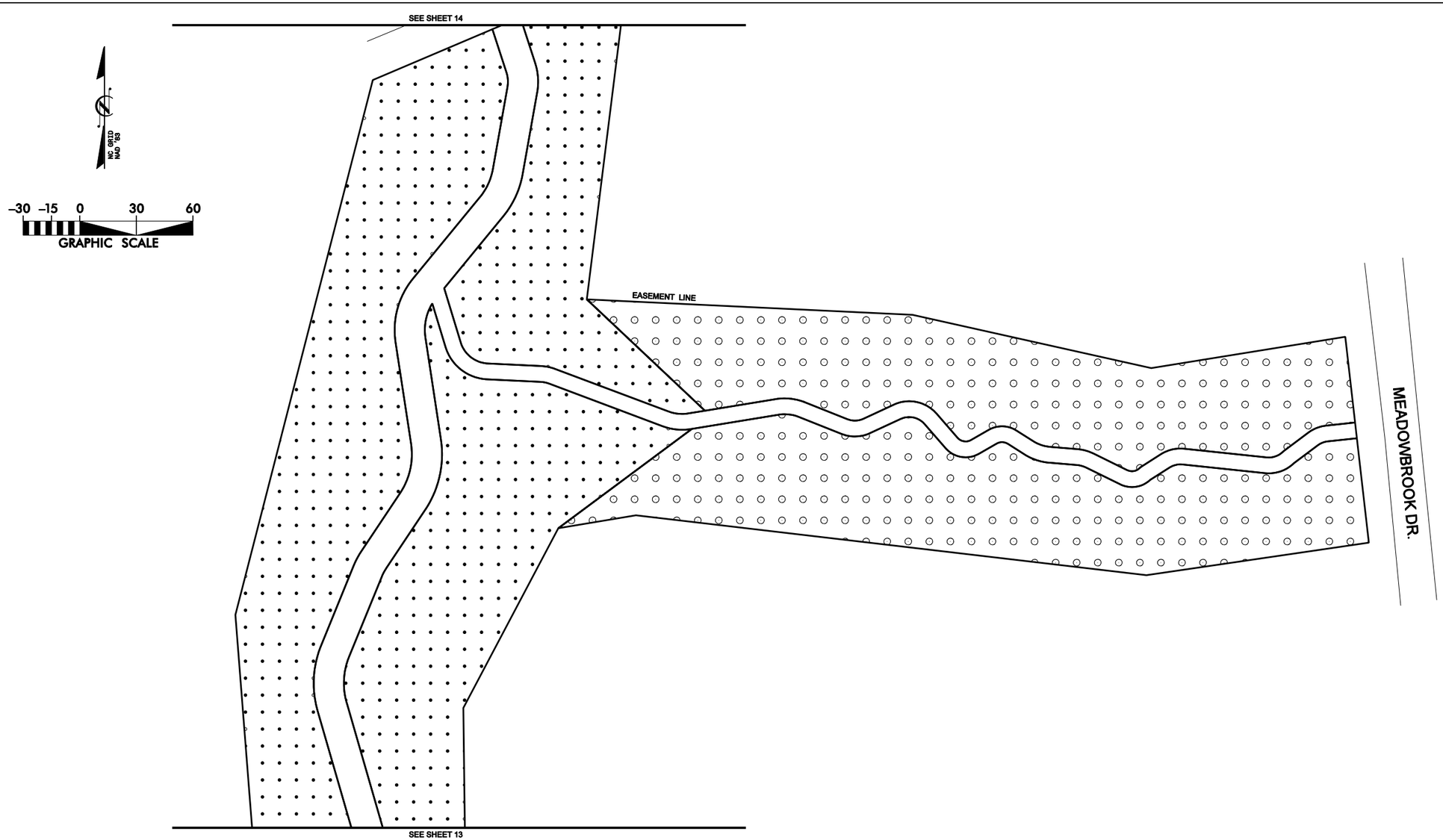

ZONE A — STREAM ZONE PLANTING AREA

ZONE B — FLOODPLAIN PLANTING AREA

ZONE C — UPLAND PLANTING AREA

SYM.	DESCRIPTION	DATE	APPROVED

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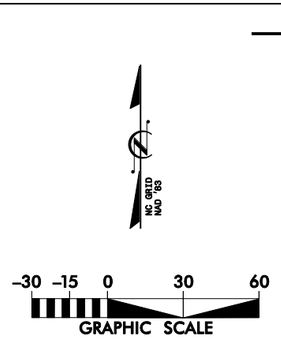

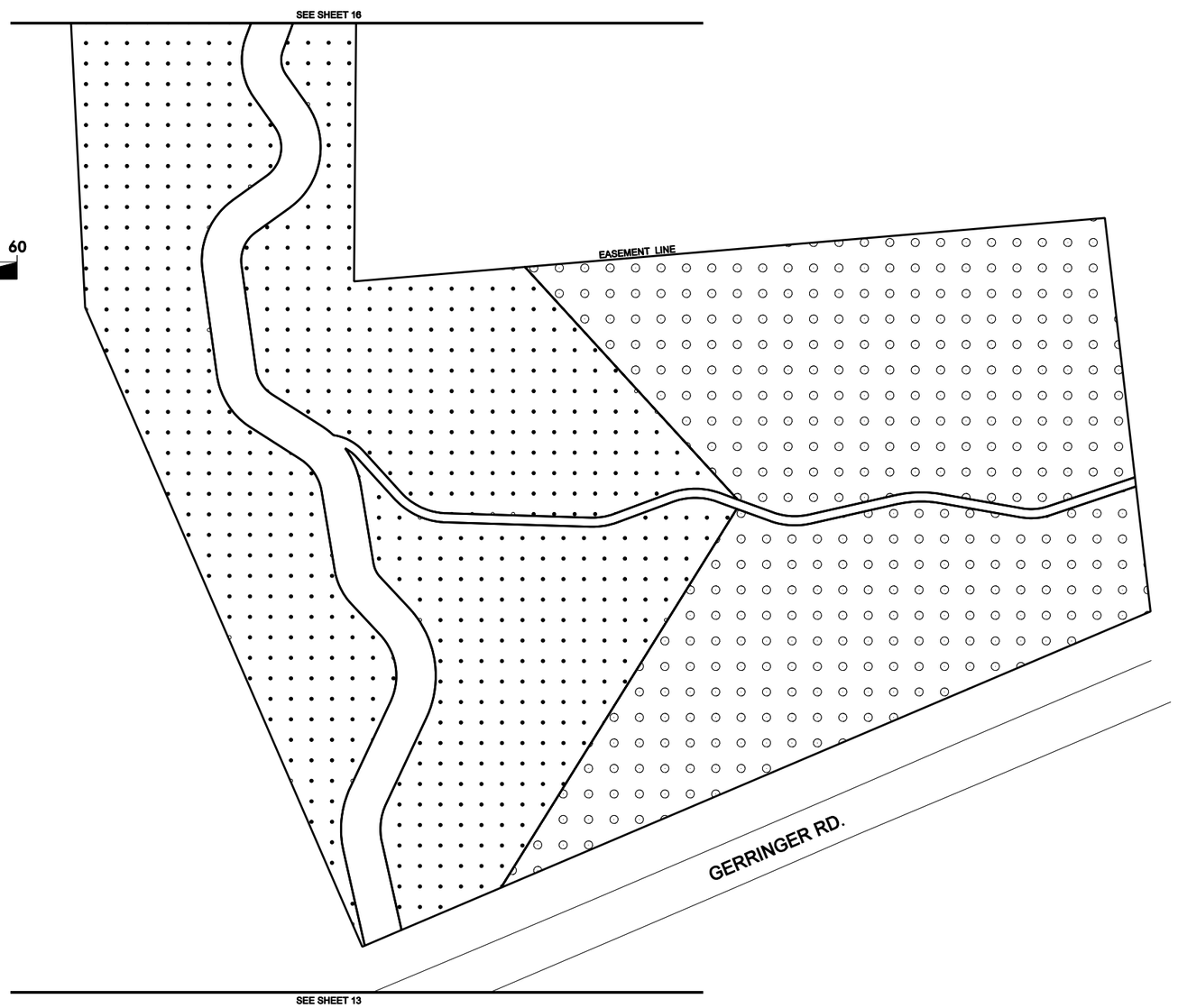

ZONE A

STREAM ZONE PLANTING AREA

ZONE B

FLOODPLAIN PLANTING AREA

ZONE C

UPLAND PLANTING AREA

REVISIONS

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PLANTING PLAN

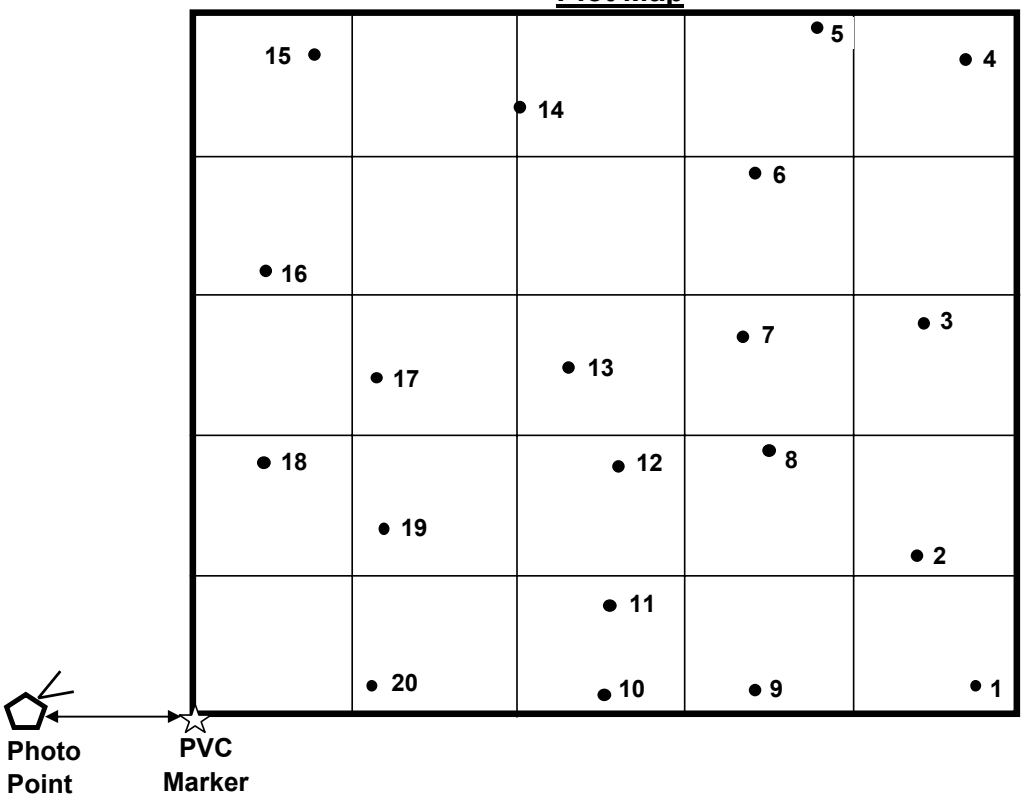
Appendix B

As-Built Vegetation Monitoring Plot Data Sheets

Vegetation Monitoring Worksheet

Site: Glen Raven **Plot:** 1 **Date:** 4/30/2007

Plot Map



ID	Species	Height (m)	Vigor	Comment
1	*Quercus sp.*	0.61	2	
2	Unknown I	0.62	3	
3	Unknown	0.42	2	
4	Beautyberry (*Callicarpa americana)*	0.62	2	
5	Coralberry (*Symphoricarpos obiculatas*)	0.69	4	
6	*Quercus sp.*	0.62	3	
7	Winterberry (*Ilex verticillata*)	0.19	4	
8	Unknown I	0.43	3	
9	River Birch (*Betula nigra)*	0.67	4	
10	Green Ash (*Fraxinus pennsylvanica*)	0.35	2	
11	Beautyberry (*Callicarpa americana)*	0.48	4	
12	Winterberry (*Ilex verticillata*)	0.25	3	
13	Unknown	0.63	2	
14	Unknown	0.50	3	
15	Beautyberry (*Callicarpa americana)*	0.50	2	
16	Beautyberry (*Callicarpa americana)*	0.50	2	
17	Unknown I	0.45	2	
18	Winterberry (*Ilex verticillata*)	0.20	3	
19	Unknown I	0.43	3	
20	Unknown	0.60	3	

Vigor: 4=excellent, 3=good, 2=weak, 1=unlikely to survive year

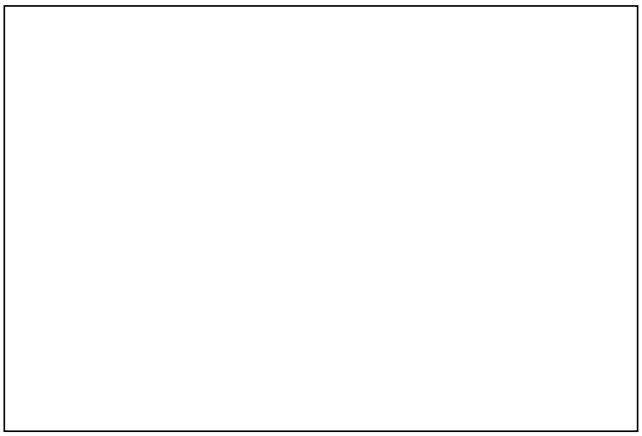
Species	Percent of Total
Quercus sp.	10.0%
Coralberry (*Symphoricarpos obiculatas*)	5.0%
River Birch (*Betula nigra*)	5.0%
Green Ash (*Fraxinus pennsylvanica*)	5.0%
Beautyberry (*Callicarpa americana*)	20.0%
Winterberry (*Ilex verticillata*)	15.0%
Unknown I	20.0%
Unknown	20.0%

Density:

Total Number of Trees **20** / **0.025 acres** = **800** **trees / acre**

Survivability:

Total Number of Trees **20** / **20 trees** **x** **100** = **100** **% survivability**



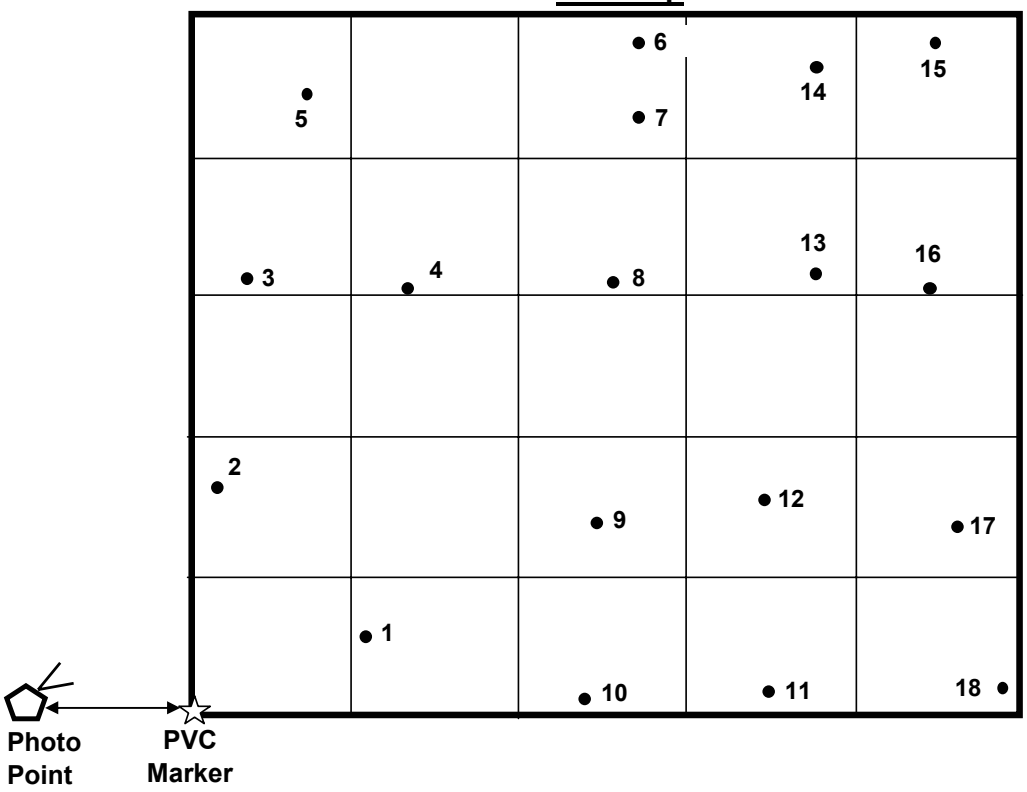
Previous

Current

Vegetation Monitoring Worksheet

Site: Glen Raven **Plot:** 2 **Date:** 4/30/2007

Plot Map



ID	Species	Height (m)	Vigor	Comment
1	Winterberry (*Ilex verticillata*)	0.38	4	
2	Swamp Chestnut Oak (*Quercus michauxii*)	0.47	3	
3	Unknown I	0.58	4	
4	Coralberry (*Symphoricarpos obiculatas*)	0.57	4	
5	*Quercus sp.*	0.36	3	
6	*Quercus sp.*	0.60	3	
7	*Quercus sp.*	0.62	2	
8	Swamp Chestnut Oak (*Quercus michauxii*)	0.51	3	
9	Swamp Chestnut Oak (*Quercus michauxii*)	0.53	3	
10	Swamp Chestnut Oak (*Quercus michauxii*)	0.59	4	
11	Unknown	0.60	2	
12	Swamp Chestnut Oak (*Quercus michauxii*)	0.57	4	
13	Green Ash (*Fraxinus pennsylvanica*)	0.59	4	
14	Green Ash (*Fraxinus pennsylvanica*)	0.54	3	
15	Unknown	0.30	1	
16	Swamp Chestnut Oak (*Quercus michauxii*)	0.53	4	
17	Swamp Chestnut Oak (*Quercus michauxii*)	0.56	4	
18	Swamp Chestnut Oak (*Quercus michauxii*)	0.51	3	

Vigor: 4=excellent, 3=good, 2=weak, 1=unlikely to survive year

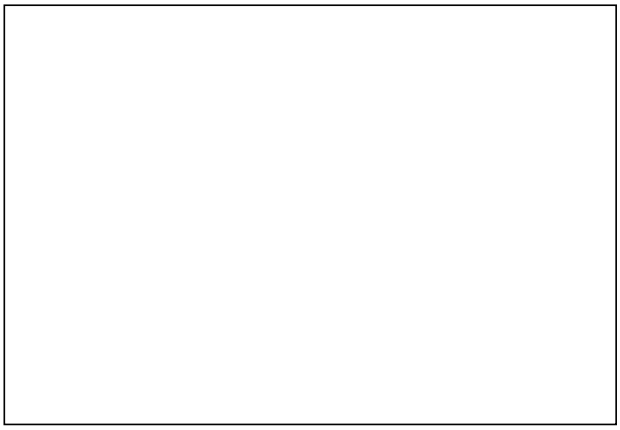
Species	Percent of Total
Green Ash (*Fraxinus pennsylvanica*)	11.1%
Winterberry (*Ilex verticillata*)	5.6%
Swamp Chestnut Oak (*Quercus michauxii*)	44.4%
Coralberry (*Symphoricarpos obiculatas*)	11.1%
Unknown	5.6%
Unknown I	5.6%
Quercus sp.	16.7%

Density:

Total Number of Trees **18** / **0.025 acres** = **720** **trees / acre**

Survivability:

Total Number of Trees **18** / **18 trees** **x** **100** = **100** **% survivability**



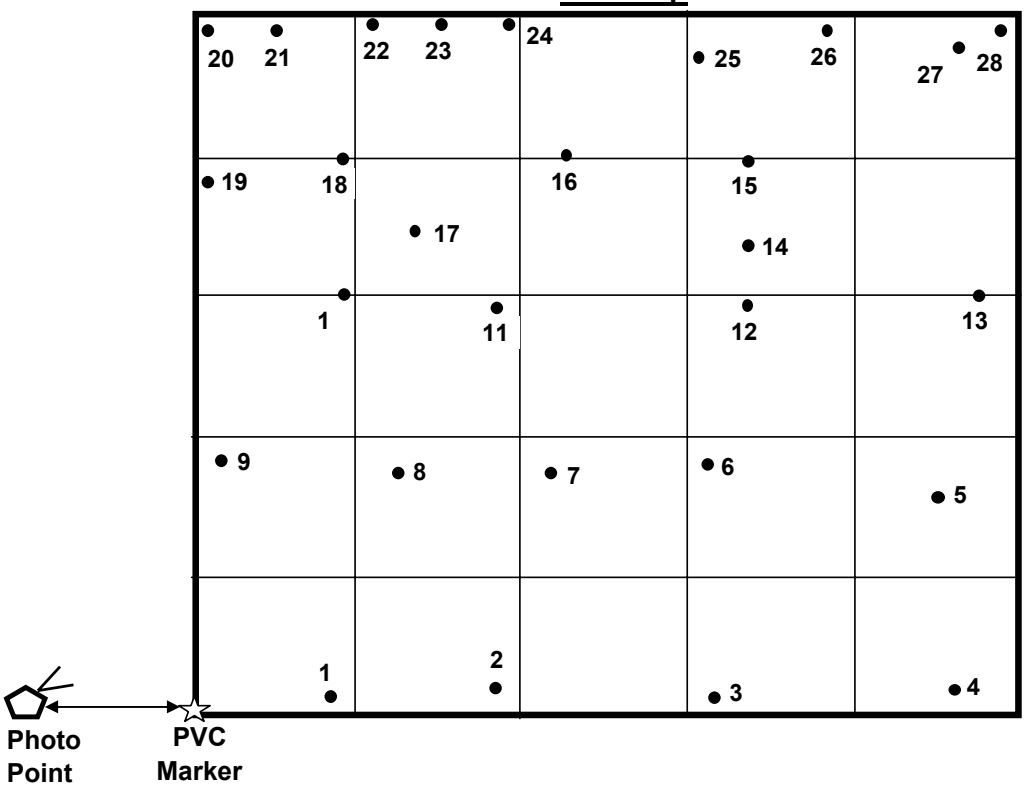
Previous

Current

Vegetation Monitoring Worksheet

Site: Glen Raven **Plot:** 3 **Date:** 4/30/2007

Plot Map



ID	Species	Height (m)	Vigor	Comment
1	Unknown II	0.40	2	
2	Unknown	0.45	2	
3	Unknown II	0.34	2	
4	Unknown	0.67	2	
5	Unknown III	0.49	3	
6	Unknown II	0.55	4	
7	Unknown	0.57	2	
8	Unknown	0.61	2	
9	Unknown	0.57	2	
10	Swamp Chestnut Oak (*Quercus michauxii*)	0.22	3	
11	Unknown	0.65	2	
12	Unknown	0.58	2	
13	Unknown	0.61	2	
14	Spicebush (*Lindera benzoin)*	0.45	4	
15	Sycamore (*Platanus occidentalis)*	0.55	3	
16	Sycamore (*Platanus occidentalis)*	0.58	3	
17	Coralberry (*Symphoricarpos orbiculatas)*	0.63	4	
18	Sycamore (*Platanus occidentalis)*	0.55	2	
19	Green Ash (*Fraxinus pennsylvanica)*	0.61	3	
20	Black Willow (*Salix nigra)*	0	4	Live Stake
21	Black Willow (*Salix nigra)*	0	4	Live Stake
22	Black Willow (*Salix nigra)*	0	4	Live Stake
23	Unknown	0	2	Live Stake
24	Unknown	0	2	Live Stake
25	Black Willow (*Salix nigra)*	0	4	Live Stake
26	Silky Willow (*Salix sericea)*	0	4	Live Stake
27	Silky Willow (*Salix sericea)*	0	4	Live Stake
28	Unknown	0	2	Live Stake

Vigor: 4=excellent, 3=good, 2=weak, 1=unlikely to survive year

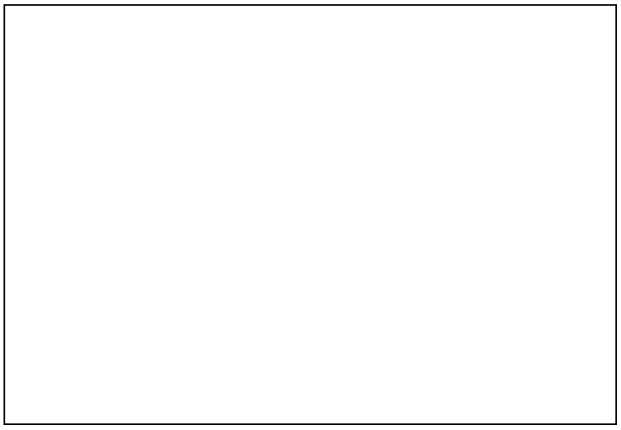
Species	Percent of Total
Spicebush (*Lindera benzoin*)	3.6%
Swamp Chestnut Oak (*Quercus michauxii*)	3.6%
Sycamore (*Platanus occidentalis*)	10.7%
Coralberry (*Symphoricarpos orbiculatas*)	3.6%
Green Ash (*Fraxinus pennsylvanica*)	3.6%
Black Willow (*Salix nigra*)	14.3%
Silky Willow (*Salix sericea*)	7.1%
Unknown	39.3%
Unknown II	10.7%
Unknown III	3.6%

Density:

Total Number of Trees **28** / **0.025 acres** = **1,120** **trees / acre**

Survivability:

Total Number of Trees **28** / **28 trees** x **100** = **100** **% survivability**



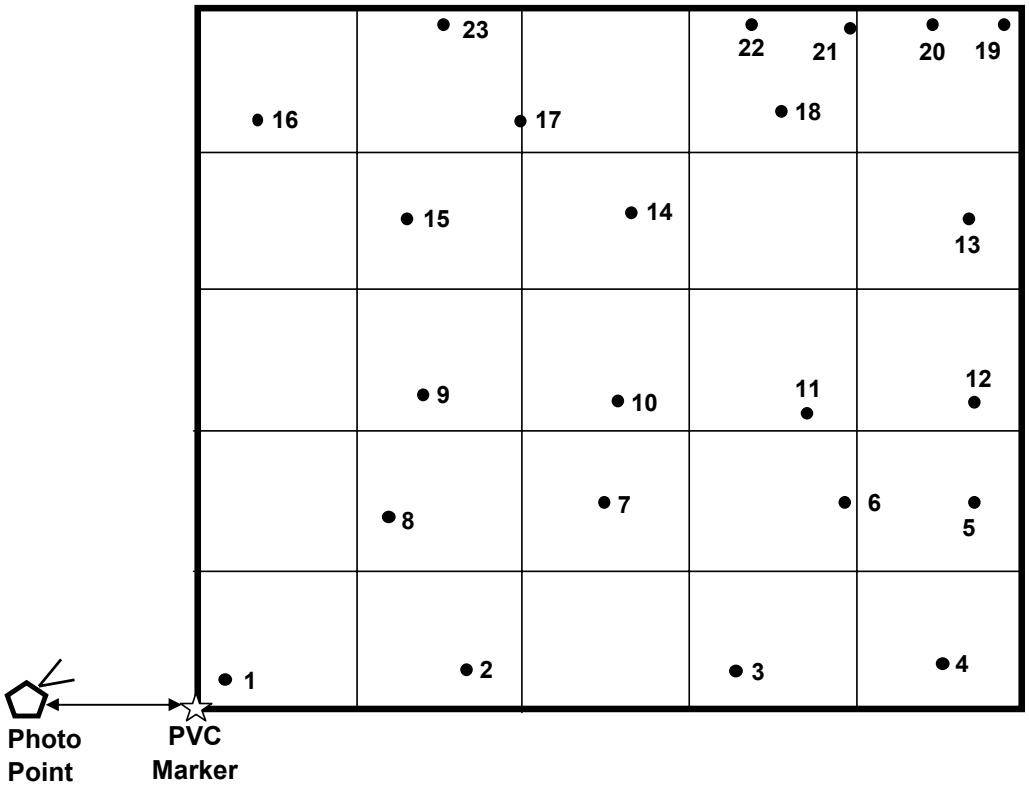
Previous

Current

Vegetation Monitoring Worksheet

Site: Glen Raven **Plot:** 4 **Date:** 4/30/2007

Plot Map



ID	Species	Height (m)	Vigor	Comment
1	Unknown	0.33	2	
2	Black Walnut (*Juglans nigra)*	0.31	3	
3	Black Walnut (*Juglans nigra)*	0.36	3	
4	Unknown	0.58	2	
5	Unknown	0.37	2	
6	Black Walnut (*Juglans nigra)*	0.52	3	
7	Black Walnut (*Juglans nigra)*	0.42	3	
8	Black Walnut (*Juglans nigra)*	0.30	3	
9	Shagbark Hickory (*Carya ovata)*	0.15	3	
10	Black Walnut (*Juglans nigra)*	0.30	3	
11	Unknown I	0.57	4	
12	Shagbark Hickory (*Carya ovata)*	0.14	3	
13	Unknown I	0.59	3	
14	Unknown	0.38	3	
15	Unknown	0.70	2	
16	Black Walnut (*Juglans nigra)*	0.32	4	
17	Black Walnut (*Juglans nigra)*	0.20	3	
18	Black Walnut (*Juglans nigra)*	0.40	4	
19	Unknown	0	2	Live Stake
20	Unknown	0	2	Live Stake
21	Silky Willow (*Salix sericea)*	0	3	Live Stake
22	Black Willow (*Salix nigra)*	0	4	Live Stake
23	Unknown	0	2	Live Stake

Vigor: 4=excellent, 3=good, 2=weak, 1=unlikely to survive year

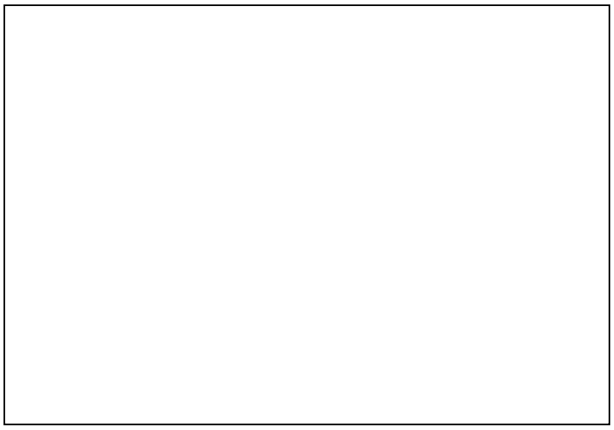
Species	Percent of Total
Black Walnut (*Juglans nigra*)	39.1%
Shagbark Hickory (*Carya ovata*)	8.7%
Silky Willow (*Salix sericea*)	4.3%
Black Willow (*Salix nigra*)	4.3%
Unknown	34.8%
Unknown I	8.7%

Density:

Total Number of Trees **23** / **0.025 acres** = **920** **trees / acre**

Survivability:

Total Number of Trees **23** / **23 trees** **x** **100** = **100** **% survivability**



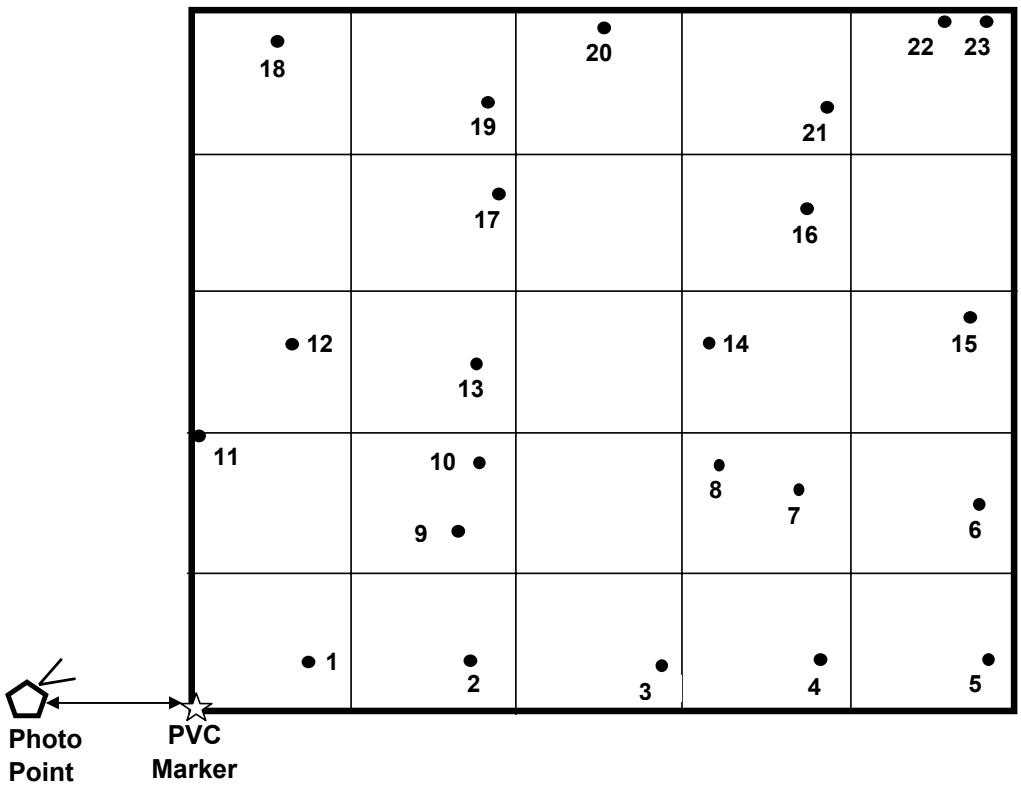
Previous

Current

Vegetation Monitoring Worksheet

Site: Glen Raven **Plot:** 5 **Date:** 4/30/2007

Plot Map



ID	Species	Height (m)	Vigor	Comment
1	Unknown	0.23	2	
2	River Birch *(Betula nigra)*	0.74	3	
3	Unknown	0.25	2	
4	Unknown	0.31	2	
5	Unknown	0.42	2	
6	Unknown	0.58	3	
7	Coralberry *(Symphoricarpos orbiculatas)*	0.53	4	
8	Unknown	0.59	2	
9	Coralberry *(Symphoricarpos orbiculatas)*	0.67	4	
10	Unknown	0.46	2	
11	Unknown	0.56	2	
12	Unknown II	0.39	2	
13	Swamp Chestnut Oak (*Quercus michauxii*)	0.52	3	
14	Swamp Chestnut Oak (*Quercus michauxii*)	0.43	4	
15	Unknown	0.62	2	
16	Unknown	0.39	2	
17	Unknown	0.71	2	
18	Black Willow *(Salix nigra)*	0	4	Live Stake
19	Winterberry *(Ilex verticulata)*	0.25	3	
20	Silky Willow *(Salix sericea)*	0	4	Live Stake
21	Spicebush *(Lindera benzoin)*	0.40	3	
22	Black Willow *(Salix nigra)*	0	3	Live Stake
23	Silky Dogwood (*Cornus amomum)*	0	3	Live Stake

Vigor: 4=excellent, 3=good, 2=weak, 1=unlikely to survive year

Species	Percent of Total
River Birch (*Betula nigra*)	4.3%
Coralberry (*Symphoricarpos orbiculatas*)	8.7%
Black Willow (*Salix nigra*)	8.7%
Swamp Chestnut Oak (*Quercus michauxii*)	8.7%
Winterberry (*Ilex verticulata*)	4.3%
Silky Willow (*Salix sericea*)	4.3%
Silky Dogwood (*Cornus amomum*)	4.3%
Spicebush (*Lindera benzoin*)	4.3%
Unknown	47.8%
Unknown II	4.3%

Density:

Total Number of Trees **23** / **0.025 acres** = **920** **trees / acre**

Survivability:

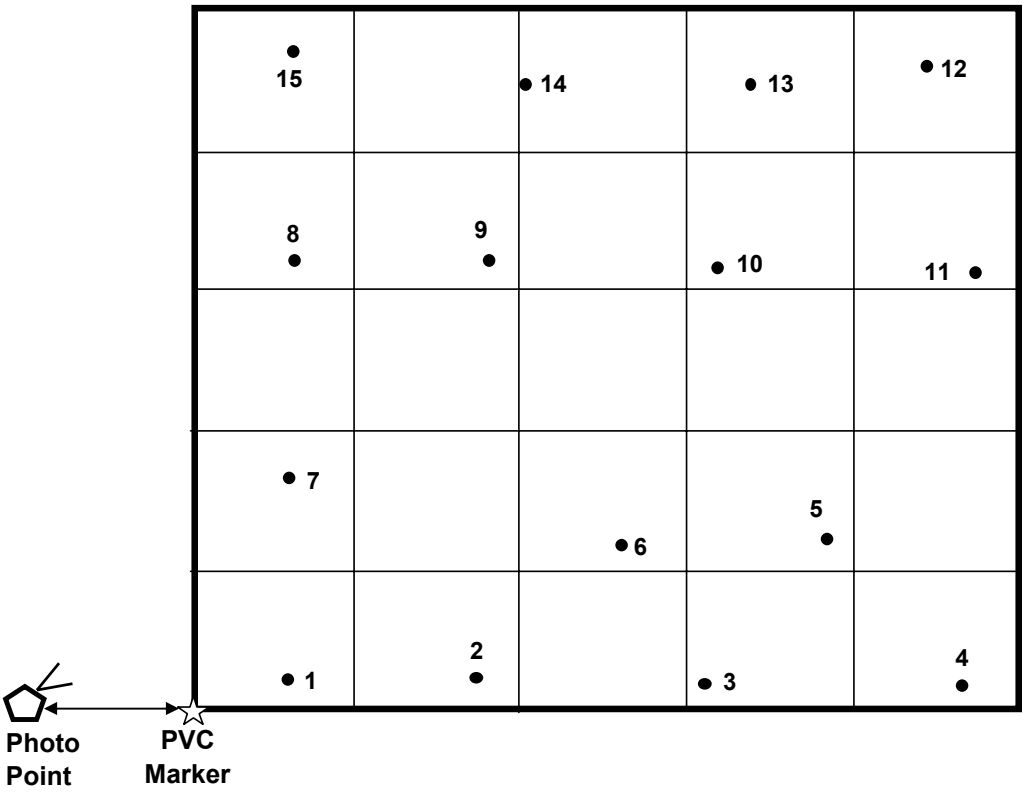
Total Number of Trees **23** / **23 trees** **x** **100** = **100** **% survivability**

Previous **Current**

Vegetation Monitoring Worksheet

Site: Glen Raven **Plot:** 6 **Date:** 4/30/2007

Plot Map



ID	Species	Height (m)	Vigor	Comment
1	Unknown	0.38	2	
2	Black Walnut (*Juglans nigra*)	0.42	3	
3	Unknown I	0.32	3	
4	Unknown	0.28	2	
5	Black Walnut (*Juglans nigra*)	0.34	3	
6	Southern Red Oak (*Quercus falcata*)	0.58	3	
7	Shagbark Hickory (*Carya ovata*)	0.11	4	
8	Unknown	0.38	2	
9	Black Walnut (*Juglans nigra*)	0.23	3	
10	Unknown	0.37	2	
11	Unknown	0.70	2	
12	Black Walnut (*Juglans nigra*)	0.45	3	
13	Unknown	0.13	1	
14	Buttonbush (*Cephalanthus occidentalis*)	0.43	4	
15	Southern Red Oak (*Quercus falcata*)	0.38	2	

Vigor: 4=excellent, 3=good, 2=weak, 1=unlikely to survive year

Species	Percent of Total
Black Walnut (*Juglans nigra*)	26.7%
Southern Red Oak (*Quercus falcata*)	13.3%
Shagbark Hickory (*Carya ovata*)	6.7%
Buttonbush (*Cephalanthus occidentalis*)	6.7%
Unknown	40.0%
Unknown I	6.7%

Density:

Total Number of Trees **15** / **0.025 acres** = **600** **trees / acre**

Survivability:

Total Number of Trees **15** / **15 trees** **x** **100** = **100** **% survivability**

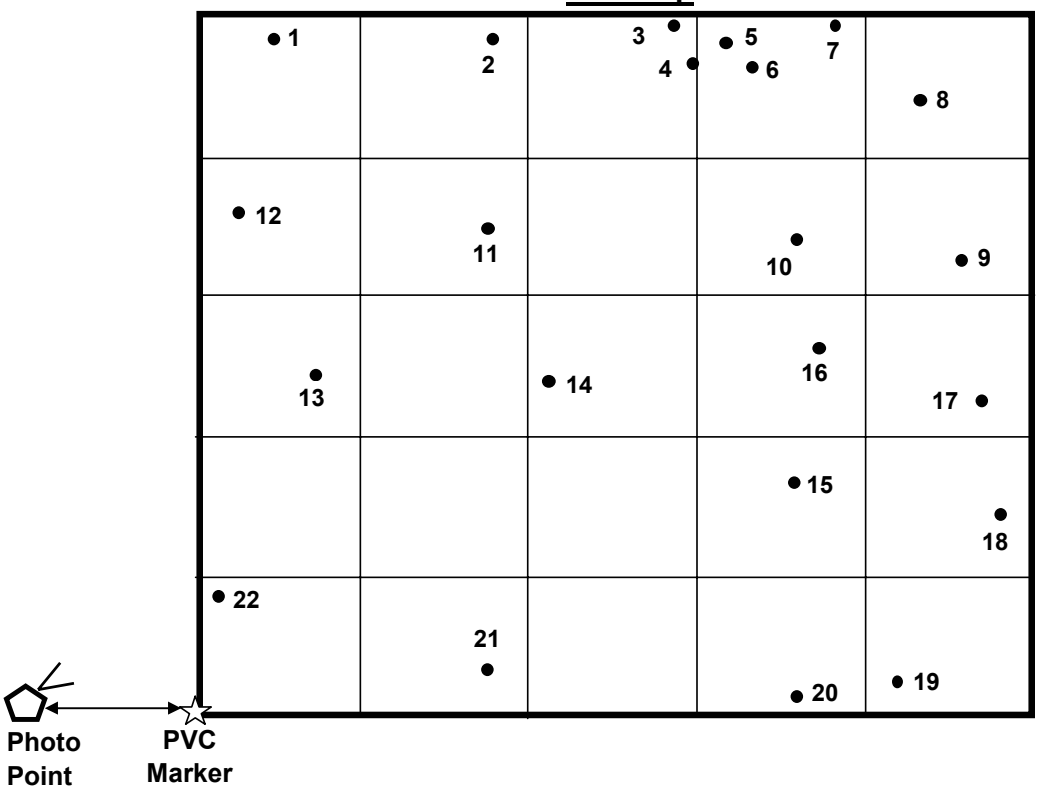
Previous

Current

Vegetation Monitoring Worksheet

Site: Glen Raven **Plot:** 7 **Date:** 4/30/2007

Plot Map



ID	Species	Height (m)	Vigor	Comment
1	Willow Oak (*Quercus phellos*)	0.57	4	
2	Swamp Chestnut Oak (*Quercus michauxii*)	0.70	4	
3	Unknown	0	2	Live Stake
4	Black Willow (*Juglans nigra*)	0	3	Live Stake
5	Black Willow (*Juglans nigra*)	0	4	Live Stake
6	Black Willow (*Juglans nigra*)	0	4	Live Stake
7	Silky Dogwood (*Cornus amomum*)	0	4	Live Stake
8	Winterberry (*Ilex verticulata*)	0.27	2	
9	Green Ash (*Fraxinus pennsylvanica*)	0.51	3	Browsed
10	Green Ash (*Fraxinus pennsylvanica*)	0.51	3	Browsed
11	Green Ash (*Fraxinus pennsylvanica*)	0.59	3	
12	Swamp Chestnut Oak (*Quercus michauxii*)	0.55	3	
13	Green Ash (*Fraxinus pennsylvanica*)	0.62	3	Browsed
14	Unknown	0.60	2	
15	Green Ash (*Fraxinus pennsylvanica*)	0.48	3	
16	Swamp Chestnut Oak (*Quercus michauxii*)	0.54	3	
17	Green Ash (*Fraxinus pennsylvanica*)	0.53	2	
18	Unknown	0.51	2	
19	Spicebush (*Lindera benzoin*)	0.31	3	
20	Swamp Chestnut Oak (*Quercus michauxii*)	0.51	4	
21	Unknown I	0.40	2	
22	Green Ash (*Fraxinus pennsylvanica*)	0.59	3	

Vigor: 4=excellent, 3=good, 2=weak, 1=unlikely to survive year

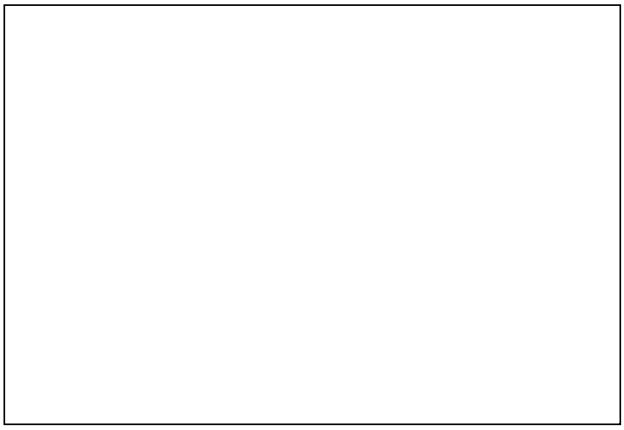
Species	Percent of Total
Willow Oak (*Quercus phellos*)	4.5%
Green Ash (*Fraxinus pennsylvanica*)	31.8%
Swamp Chestnut Oak (*Quercus michauxii*)	18.2%
Black Willow (*Juglans nigra*)	13.6%
Silky Dogwood (*Cornus amomum*)	4.5%
Winterberry (*Ilex verticulata*)	4.5%
Spicebush (*Lindera benzoin*)	4.5%
Unknown	13.6%
Unknown I	4.5%

Density:

Total Number of Trees **22** / **0.025 acres** = **880** **trees / acre**

Survivability:

Total Number of Trees **22** / **22 trees** **x** **100** = **100** **% survivability**



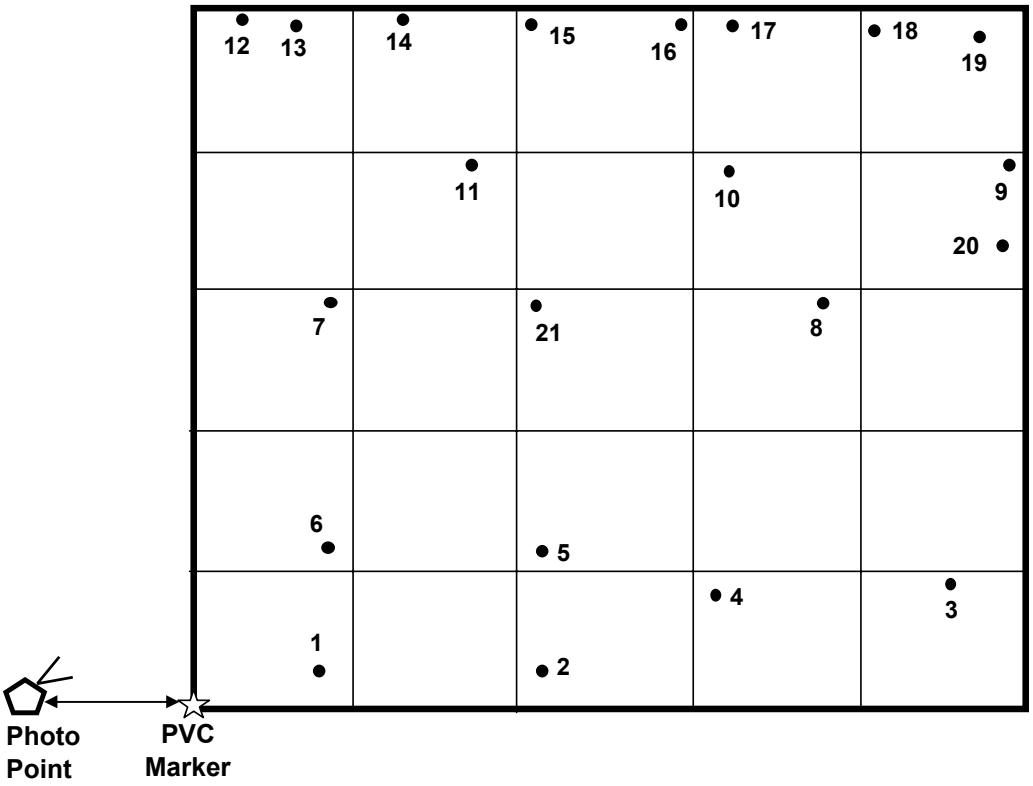
Previous

Current

Vegetation Monitoring Worksheet

Site: Glen Raven **Plot:** 8 **Date:** 4/30/2007

Plot Map



ID	Species	Height (m)	Vigor	Comment
1	River Birch (*Betula nigra*)	0.62	4	
2	Unknown	0.48	2	
3	River Birch (*Betula nigra*)	0.55	4	
4	Swamp Chestnut Oak (*Quercus michauxii*)	0.36	3	
5	Swamp Chestnut Oak (*Quercus michauxii*)	0.58	3	
6	Swamp Chestnut Oak (*Quercus michauxii*)	0.67	4	
7	Swamp Chestnut Oak (*Quercus michauxii*)	0.62	3	
8	Swamp Chestnut Oak (*Quercus michauxii*)	0.39	3	
9	Swamp Chestnut Oak (*Quercus michauxii*)	0.54	3	
10	Swamp Chestnut Oak (*Quercus michauxii*)	0.52	3	
11	Swamp Chestnut Oak (*Quercus michauxii*)	0.60	3	
12	Unknown	0	2	Live Stake
13	Unknown	0	2	Live Stake
14	Silky Dogwood (*Cornus amomum*)	0	2	Live Stake
15	Silky Dogwood (*Cornus amomum*)	0	3	Live Stake
16	Silky Willow (*Salix sericea*)	0	3	Live Stake
17	Silky Dogwood (*Cornus amomum*)	0	2	Live Stake
18	Unknown	0	2	Live Stake
19	*Salix sp.*	0	2	Live Stake
20	Unknown	0.57	2	
21	Coralberry (*Symphoricarpos orbiculatas*)	0.5	2	

Vigor: 4=excellent, 3=good, 2=weak, 1=unlikely to survive year

Species	Percent of Total
River Birch (*Betula nigra*)	9.5%
Swamp Chestnut Oak (*Quercus michauxii*)	38.1%
Silky Dogwood (*Cornus amomum*)	14.3%
Silky Willow (*Salix sericea*)	4.8%
Salix sp.	4.8%
Coralberry (*Symphoricarpos orbiculatas*)	4.8%
Unknown	23.8%

Density:

Total Number of Trees **21** / **0.025 acres** = **840** **trees / acre**

Survivability:

Total Number of Trees **21** / **21 trees** **x** **100** = **100** **% survivability**

Previous **Current**

Appendix C

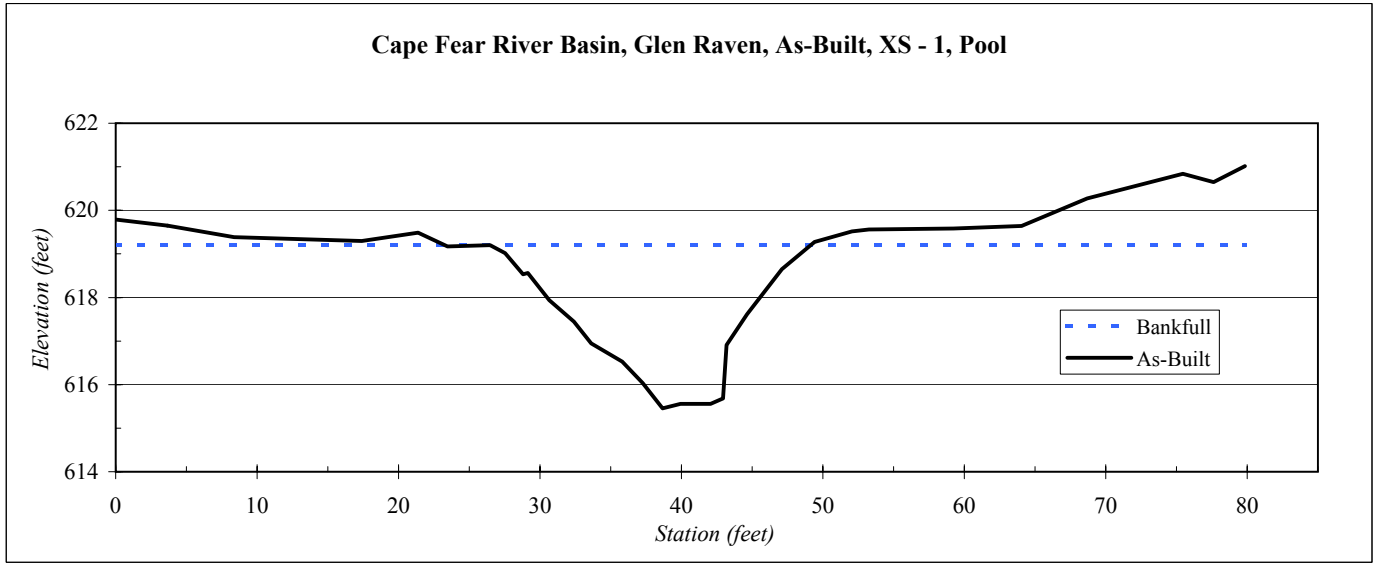
As-Built Cross Sections and Pebble Counts

River Basin:	Cape Fear
Watershed:	Glen Raven, As-Built
XS ID	XS - 1, Pool
Drainage Area (sq mi):	1.09
Date:	5/2/2007
Field Crew:	A. Spiller, B. Roberts

Station	Elevation
0.00	619.8
3.66	619.7
8.37	619.4
17.40	619.3
21.38	619.5
23.45	619.2
26.48	619.2
27.54	619.0
28.80	618.5
29.14	618.6
30.66	617.9
32.40	617.4
33.61	616.9
35.82	616.5
37.25	616.0
38.66	615.5
39.92	615.6
42.06	615.6
42.94	615.7
43.20	616.9
44.65	617.6
47.10	618.7
49.41	619.3
52.06	619.5
53.26	619.6
59.22	619.6
64.06	619.6
68.69	620.3
75.45	620.8
77.62	620.6
79.83	621.0

SUMMARY DATA	
Bankfull Elevation:	619.2
Bankfull Cross-Sectional Area:	44.2
Bankfull Width:	22.7
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	3.7
Mean Depth at Bankfull:	1.9
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-

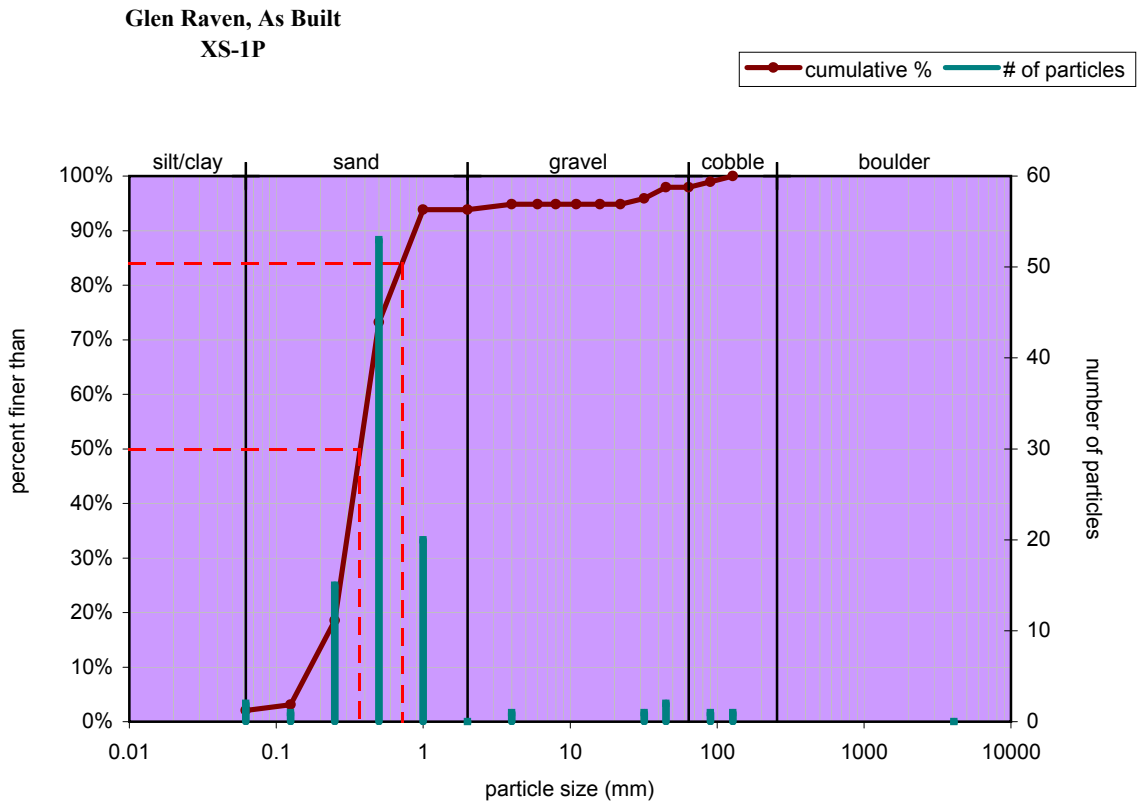
Stream Type	C4



Pool

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**2**
very fine sand	0.062 - 0.125	**1**
fine sand	0.125 - 0.25	**15**
medium sand	0.25 - 0.5	**53**
coarse sand	0.5 - 1	**20**
very coarse sand	1 - 2	**0**
very fine gravel	2 - 4	**1**
fine gravel	4 - 6	
fine gravel	6 - 8	
medium gravel	8 - 11	
medium gravel	11 - 16	
coarse gravel	16 - 22	
coarse gravel	22 - 32	**1**
very coarse gravel	32 - 45	**2**
very coarse gravel	45 - 64	
small cobble	64 - 90	**1**
medium cobble	90 - 128	**1**
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	**0**
total particle count:		97
bedrock ----------		**3**
clay hardpan ----------		
detritus/wood ----------		
artificial ----------		
total count:		100

Note: XS-1



Size (mm)	
D16	0.22
D35	0.31
D50	0.37
D65	0.45
D84	0.72
D95	23

Size Distribution	
mean	0.4
dispersion	1.8
skewness	0.04

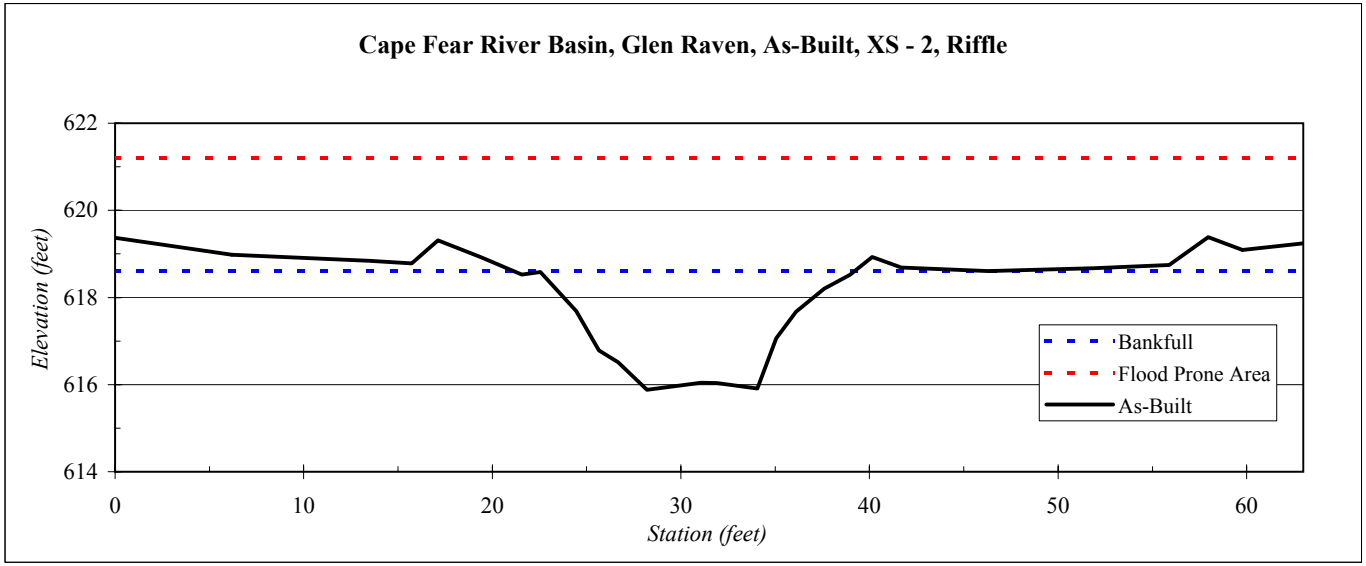
Type	
silt/clay	2%
sand	89%
gravel	4%
cobble	2%
boulder	0%
bedrock	3%

River Basin:	Cape Fear
Watershed:	Glen Raven, As-Built
XS ID	XS - 2, Riffle
Drainage Area (sq mi):	1.09
Date:	5/2/2007
Field Crew:	A. Spiller, B. Roberts

Station	Elevation
0.00	619.4
6.20	619.0
13.50	618.8
15.73	618.8
17.12	619.3
19.42	618.9
21.57	618.5
22.54	618.6
24.44	617.7
25.65	616.8
26.67	616.5
28.20	615.9
29.79	616.0
31.08	616.0
31.92	616.0
34.05	615.9
35.05	617.1
36.11	617.7
37.60	618.2
38.95	618.5
40.15	618.9
41.68	618.7
46.30	618.6
51.91	618.7
55.90	618.7
57.97	619.4
59.77	619.1
64.93	619.3

SUMMARY DATA	
Bankfull Elevation:	618.6
Bankfull Cross-Sectional Area:	28.0
Bankfull Width:	16.6
Flood Prone Area Elevation:	621.2
Flood Prone Width:	>64.9
Max Depth at Bankfull:	2.7
Mean Depth at Bankfull:	1.7
W / D Ratio:	9.8
Entrenchment Ratio:	>3.6
Bank Height Ratio:	1.0

Stream Type	C4



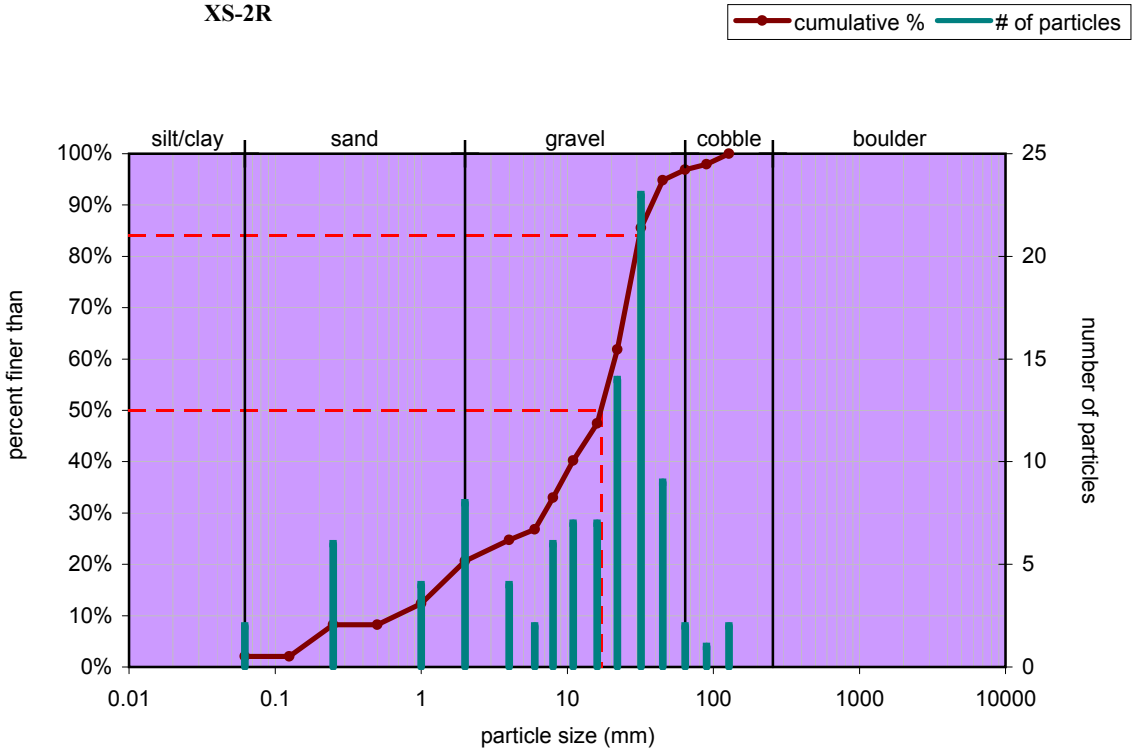
Riffle

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**2**
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	**6**
medium sand	0.25 - 0.5	
coarse sand	0.5 - 1	**4**
very coarse sand	1 - 2	**8**
very fine gravel	2 - 4	**4**
fine gravel	4 - 6	**2**
fine gravel	6 - 8	**6**
medium gravel	8 - 11	**7**
medium gravel	11 - 16	**7**
coarse gravel	16 - 22	**14**
coarse gravel	22 - 32	**23**
very coarse gravel	32 - 45	**9**
very coarse gravel	45 - 64	**2**
small cobble	64 - 90	**1**
medium cobble	90 - 128	**2**
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	

total particle count:	97
bedrock ----------	**3**
clay hardpan ----------	
detritus/wood ----------	
artificial ----------	
total count:	100

Note: XS-2

Glen Raven, As Built
XS-2R



Size (mm)		
D16	1.4	3.4
D35	8.7	12
D50	17	17
D65	23	20
D84	31	29
D95	46	39

Size Distribution	
mean	6.6
dispersion	7.0
skewness	-0.35

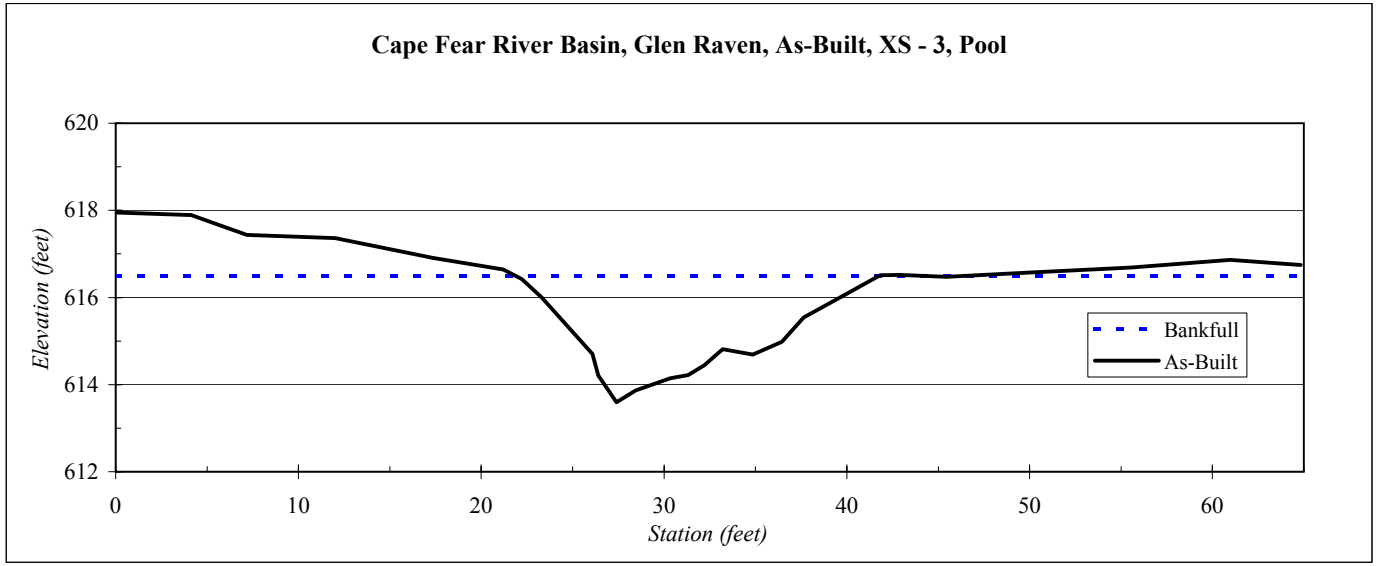
Type	
silt/clay	2%
sand	18%
gravel	74%
cobble	3%
boulder	0%
bedrock	3%

River Basin:	Cape Fear
Watershed:	Glen Raven, As-Built
XS ID	XS - 3, Pool
Drainage Area (sq mi):	1.09
Date:	5/7/2006
Field Crew:	K. Knight, B. Roberts

Station	Elevation
0.00	618.0
4.12	617.9
7.17	617.4
12.00	617.4
17.36	616.9
21.21	616.6
22.22	616.4
23.30	616.0
24.99	615.2
26.09	614.7
26.40	614.2
27.40	613.6
28.45	613.9
30.35	614.1
31.33	614.2
32.21	614.4
33.20	614.8
34.85	614.7
36.45	615.0
37.63	615.5
39.90	616.1
41.83	616.5
42.93	616.5
45.42	616.5
49.85	616.6
55.5	616.7
61.0	616.87
64.8	616.74

SUMMARY DATA	
Bankfull Elevation:	616.5
Bankfull Cross-Sectional Area:	29.6
Bankfull Width:	20.0
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	2.9
Mean Depth at Bankfull:	1.5
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-

Stream Type	C4



Pool

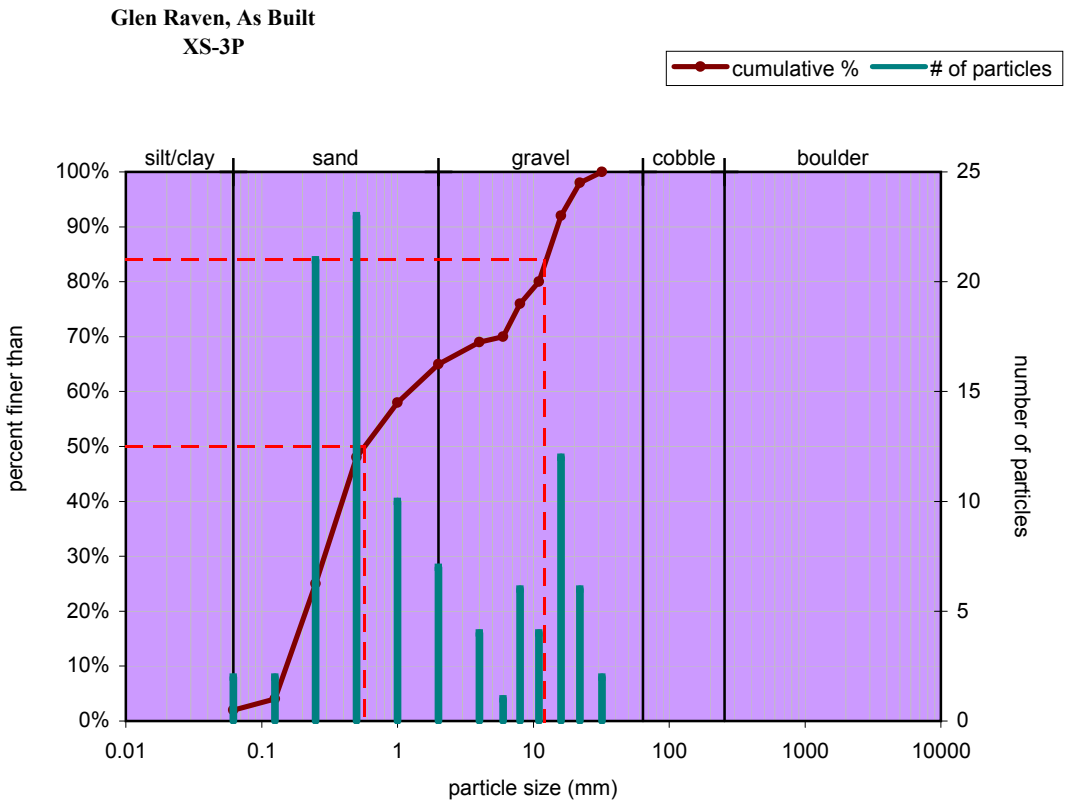
Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**2**
very fine sand	0.062 - 0.125	**2**
fine sand	0.125 - 0.25	**21**
medium sand	0.25 - 0.5	**23**
coarse sand	0.5 - 1	**10**
very coarse sand	1 - 2	**7**
very fine gravel	2 - 4	**4**
fine gravel	4 - 6	**1**
fine gravel	6 - 8	**6**
medium gravel	8 - 11	**4**
medium gravel	11 - 16	**12**
coarse gravel	16 - 22	**6**
coarse gravel	22 - 32	**2**
very coarse gravel	32 - 45	
very coarse gravel	45 - 64	
small cobble	64 - 90	
medium cobble	90 - 128	
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	

total particle count: 100

bedrock ----------	
clay hardpan ----------	
detritus/wood ----------	
artificial ----------	

total count: 100

Note: XS-3



Size (mm)	
D16	0.19
D35	0.34
D50	0.57
D65	2
D84	12
D95	19

Size Distribution	
mean	1.5
dispersion	12.0
skewness	0.32

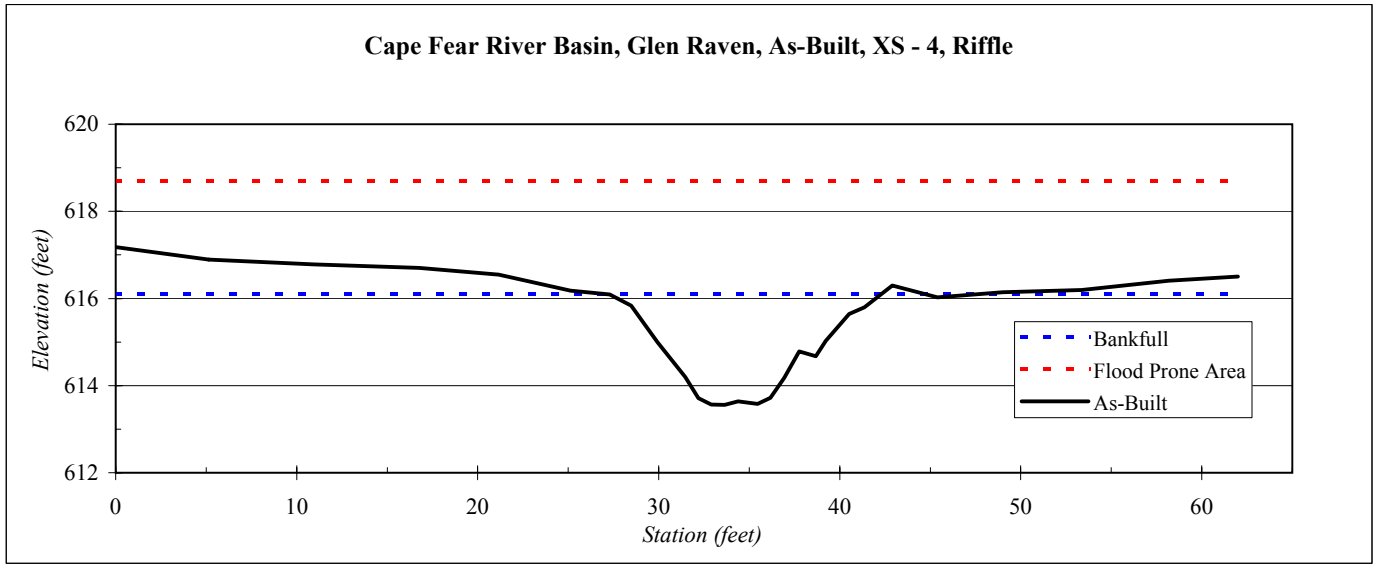
Type	
silt/clay	2%
sand	63%
gravel	35%
cobble	0%
boulder	0%

River Basin:	Cape Fear
Watershed:	Glen Raven, As-Built
XS ID	XS - 4, Riffle
Drainage Area (sq mi):	1.09
Date:	5/7/2006
Field Crew:	K. Knight, B. Roberts

Station	Elevation
0.0	617.18
5.1	616.89
10.9	616.78
16.8	616.70
21.2	616.55
25.1	616.18
27.3	616.09
28.5	615.83
29.9	615.00
31.5	614.19
32.2	613.71
32.9	613.56
33.6	613.56
34.4	613.64
35.5	613.58
36.2	613.72
36.9	614.18
37.8	614.78
38.7	614.67
39.2	615.03
40.5	615.64
41.4	615.80
42.9	616.30
45.4	616.03
49.0	616.14
53.4	616.20
58.2	616.41
62.0	616.50

SUMMARY DATA	
Bankfull Elevation:	616.1
Bankfull Cross-Sectional Area:	21.2
Bankfull Width:	15.0
Flood Prone Area Elevation:	618.7
Flood Prone Width:	>62
Max Depth at Bankfull:	2.5
Mean Depth at Bankfull:	1.4
W / D Ratio:	10.6
Entrenchment Ratio:	>4
Bank Height Ratio:	1.0

Stream Type	C4



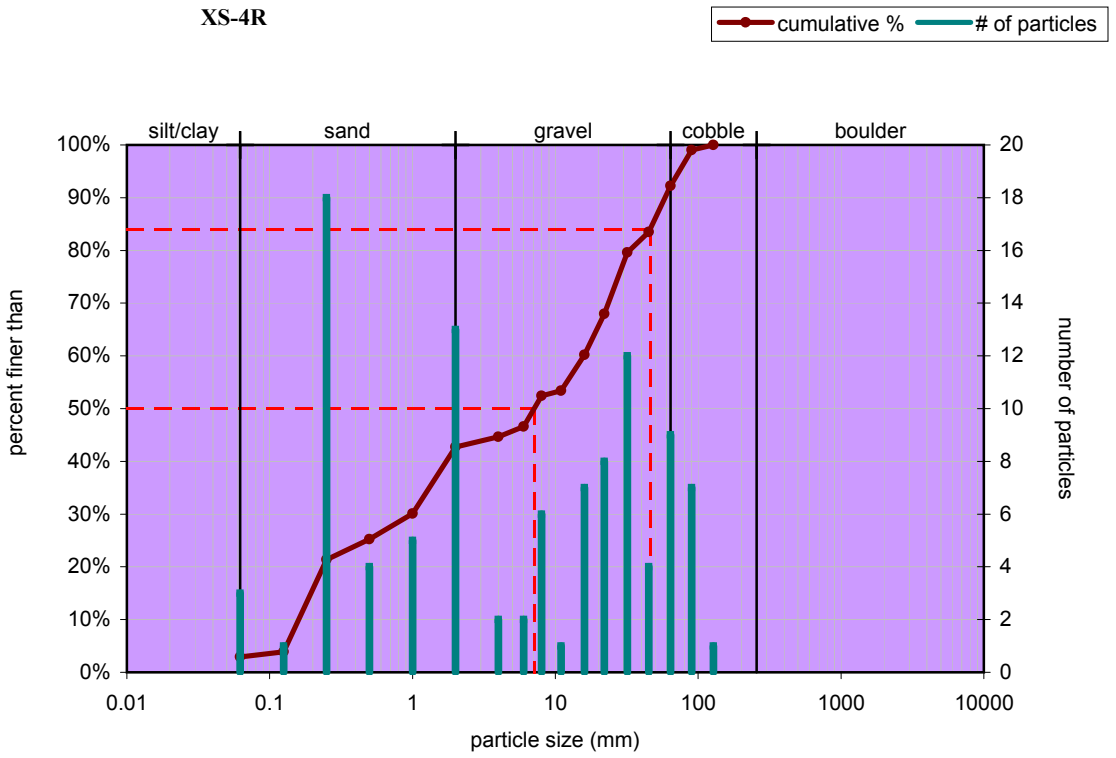
Riffle

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**3**
very fine sand	0.062 - 0.125	**1**
fine sand	0.125 - 0.25	**18**
medium sand	0.25 - 0.5	**4**
coarse sand	0.5 - 1	**5**
very coarse sand	1 - 2	**13**
very fine gravel	2 - 4	**2**
fine gravel	4 - 6	**2**
fine gravel	6 - 8	**6**
medium gravel	8 - 11	**1**
medium gravel	11 - 16	**7**
coarse gravel	16 - 22	**8**
coarse gravel	22 - 32	**12**
very coarse gravel	32 - 45	**4**
very coarse gravel	45 - 64	**9**
small cobble	64 - 90	**7**
medium cobble	90 - 128	**1**
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	

total particle count:	103
bedrock ----------	**4**
clay hardpan ----------	
detritus/wood ----------	
artificial ----------	
total count:	107

Note: XS-4

Glen Raven, As Built
XS-4R



Size (mm)		
D16	0.2	3.4
D35	1.3	12
D50	7.1	17
D65	19	20
D84	46	29
D95	74	39

Size Distribution	
mean	3.0
dispersion	21.0
skewness	-0.24

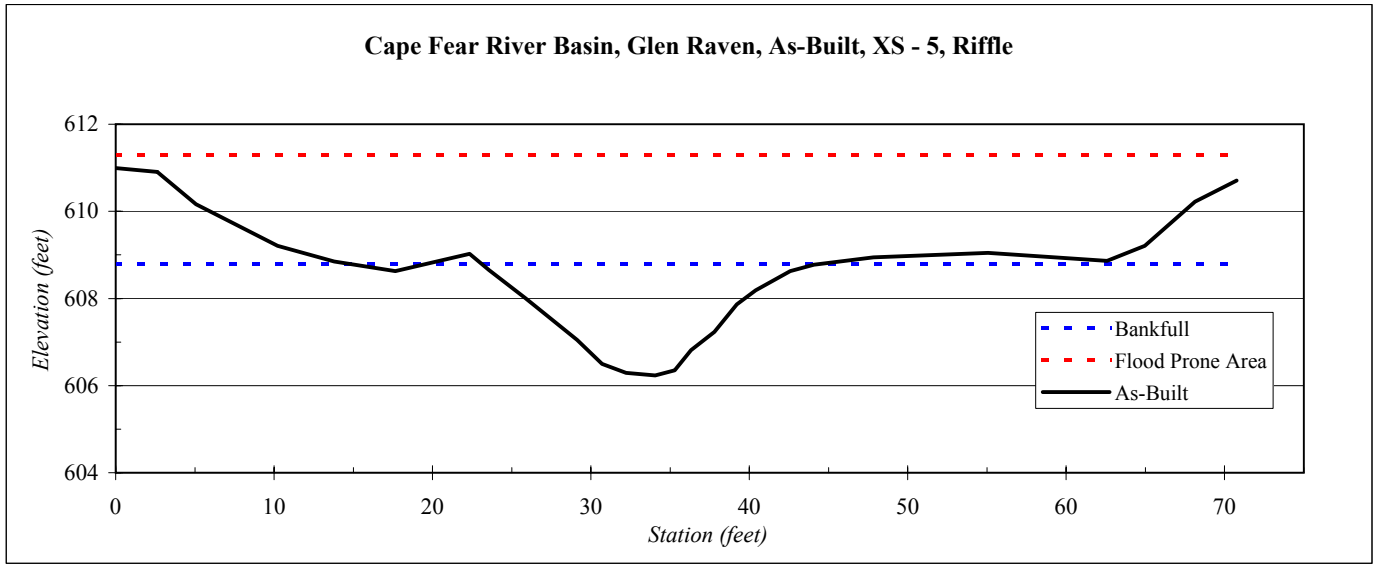
Type	
silt/clay	3%
sand	38%
gravel	48%
cobble	7%
boulder	0%
bedrock	4%

River Basin:	Cape Fear
Watershed:	Glen Raven, As-Built
XS ID	XS - 5, Riffle
Drainage Area (sq mi):	1.09
Date:	5/14/2007
Field Crew:	A. Spiller, B. Roberts

Station	Elevation
0.0	611.0
2.6	610.9
5.1	610.2
10.2	609.2
13.8	608.8
17.7	608.6
22.3	609.0
23.6	608.7
25.9	608.0
29.1	607.1
30.7	606.5
32.2	606.3
34.1	606.2
35.3	606.3
36.3	606.8
37.8	607.2
39.2	607.9
40.4	608.2
42.6	608.6
44.1	608.8
47.8	608.9
55.1	609.0
62.6	608.9
65.0	609.2
68.1	610.2
70.7	610.7

SUMMARY DATA	
Bankfull Elevation:	608.8
Bankfull Cross-Sectional Area:	28.0
Bankfull Width:	20.9
Flood Prone Area Elevation:	611.3
Flood Prone Width:	>70.7
Max Depth at Bankfull:	2.6
Mean Depth at Bankfull:	1.3
W / D Ratio:	15.6
Entrenchment Ratio:	>3
Bank Height Ratio:	1.0

Stream Type	C4



Riffle

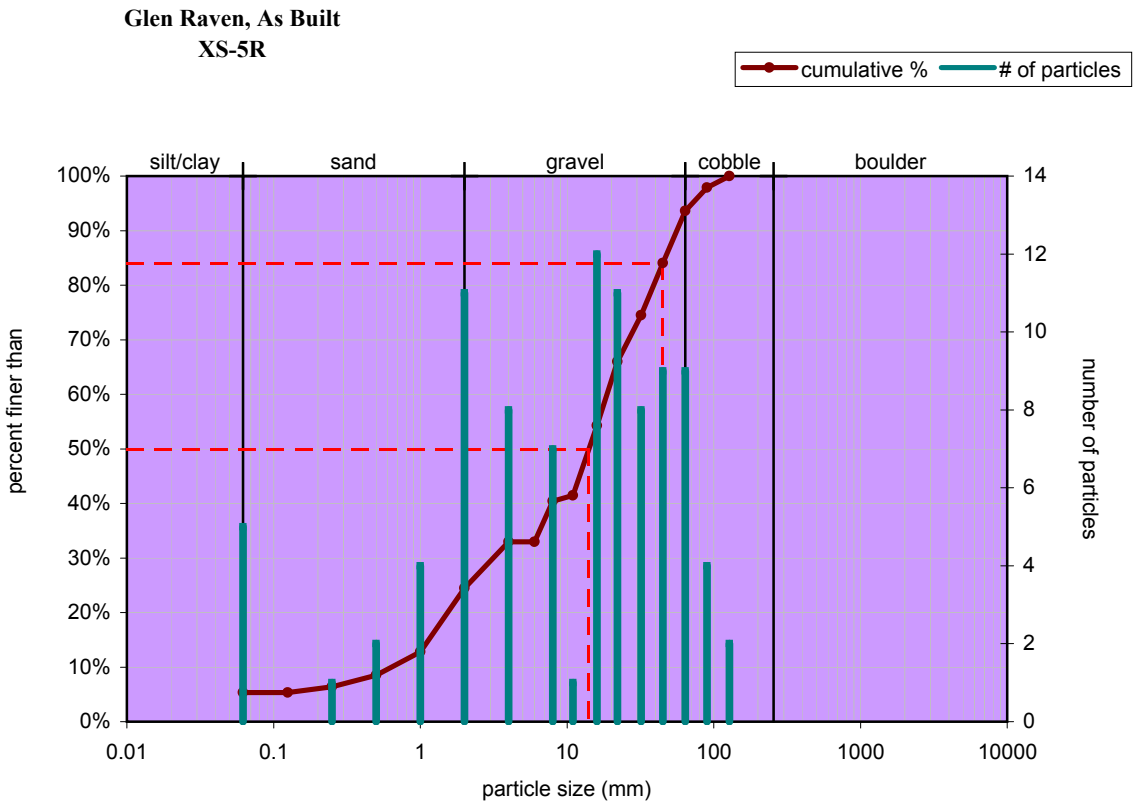
Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**5**
very fine sand	0.062 - 0.125	
fine sand	0.125 - 0.25	**1**
medium sand	0.25 - 0.5	**2**
coarse sand	0.5 - 1	**4**
very coarse sand	1 - 2	**11**
very fine gravel	2 - 4	**8**
fine gravel	4 - 6	
fine gravel	6 - 8	**7**
medium gravel	8 - 11	**1**
medium gravel	11 - 16	**12**
coarse gravel	16 - 22	**11**
coarse gravel	22 - 32	**8**
very coarse gravel	32 - 45	**9**
very coarse gravel	45 - 64	**9**
small cobble	64 - 90	**4**
medium cobble	90 - 128	**2**
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	

total particle count: 94

bedrock ----------	**6**
clay hardpan ----------	
detritus/wood ----------	
artificial ----------	

total count: 100

Note: XS-5



Size (mm)	
D16	1.2
D35	6.5
D50	14
D65	21
D84	45
D95	71

Size Distribution	
mean	7.3
dispersion	7.4
skewness	-0.22

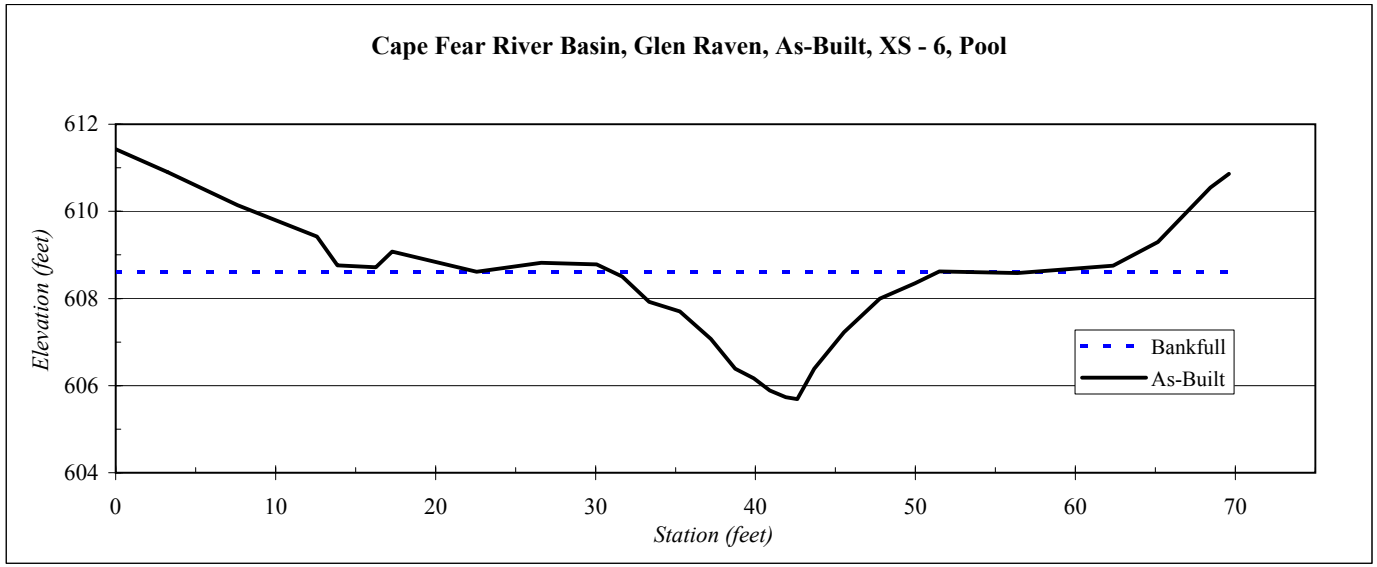
Type	
silt/clay	5%
sand	18%
gravel	65%
cobble	6%
boulder	0%
bedrock	6%

River Basin:	Cape Fear
Watershed:	Glen Raven, As-Built
XS ID	XS - 6, Pool
Drainage Area (sq mi):	1.09
Date:	5/14/2007
Field Crew:	A. Spiller, B. Roberts

Station	Elevation
0.0	611.4
3.3	610.9
7.6	610.1
12.6	609.4
13.9	608.8
16.3	608.7
17.3	609.1
22.6	608.6
26.6	608.8
30.1	608.8
31.7	608.5
33.4	607.9
35.3	607.7
37.2	607.1
38.7	606.4
39.9	606.2
40.9	605.9
41.9	605.7
42.6	605.7
43.7	606.4
45.5	607.2
47.8	608.0
50.0	608.3
51.5	608.6
56.4	608.6
62.4	608.8
65.1	609.3
68.4	610.5
69.6	610.9

SUMMARY DATA	
Bankfull Elevation:	608.6
Bankfull Cross-Sectional Area:	27.4
Bankfull Width:	26.8
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	2.9
Mean Depth at Bankfull:	1.0
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-

Stream Type	C4



Pool

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**16**
very fine sand	0.062 - 0.125	**13**
fine sand	0.125 - 0.25	**14**
medium sand	0.25 - 0.5	**5**
coarse sand	0.5 - 1	**6**
very coarse sand	1 - 2	**9**
very fine gravel	2 - 4	**3**
fine gravel	4 - 6	**3**
fine gravel	6 - 8	**1**
medium gravel	8 - 11	**7**
medium gravel	11 - 16	**4**
coarse gravel	16 - 22	**6**
coarse gravel	22 - 32	**5**
very coarse gravel	32 - 45	**6**
very coarse gravel	45 - 64	**1**
small cobble	64 - 90	
medium cobble	90 - 128	
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	

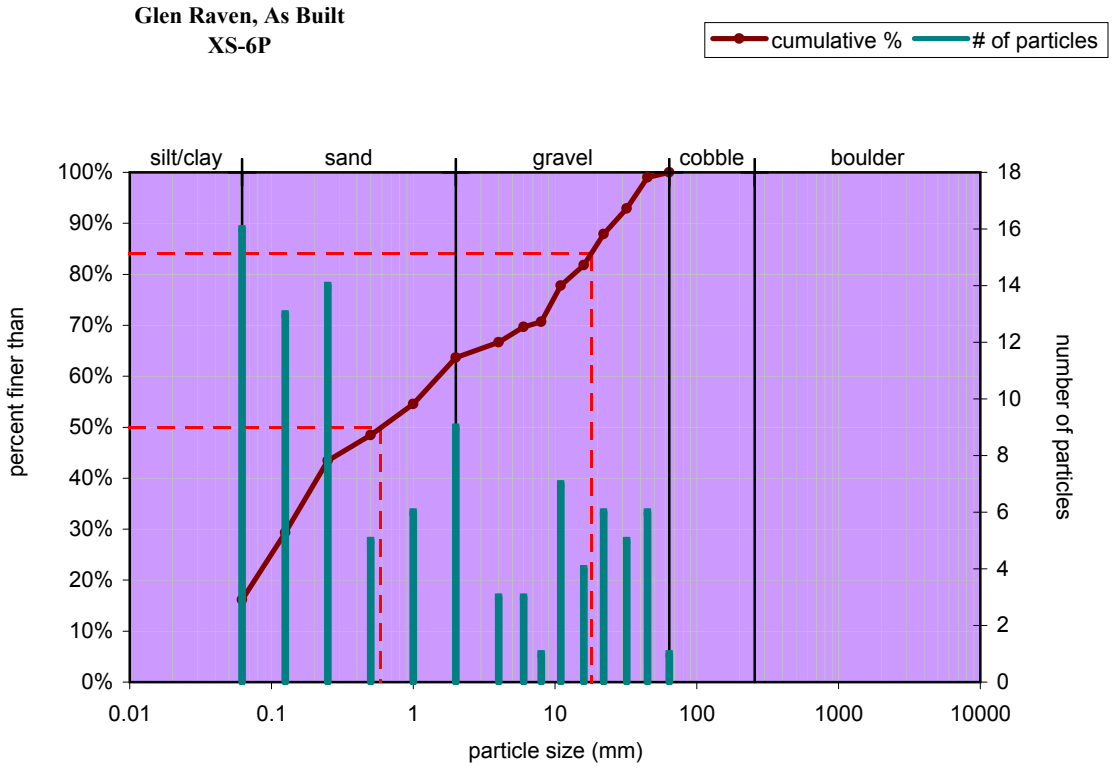
total particle count: 99

bedrock ----------	**1**
clay hardpan ----------	
detritus/wood ----------	
artificial ----------	

total count: 100

Note: XS-6

Glen Raven, As Built
XS-6P



Size (mm)		
D16	0.062	3.4
D35	0.17	12
D50	0.59	17
D65	2.7	20
D84	18	29
D95	36	39

Size Distribution	
mean	1.1
dispersion	20.0
skewness	0.16

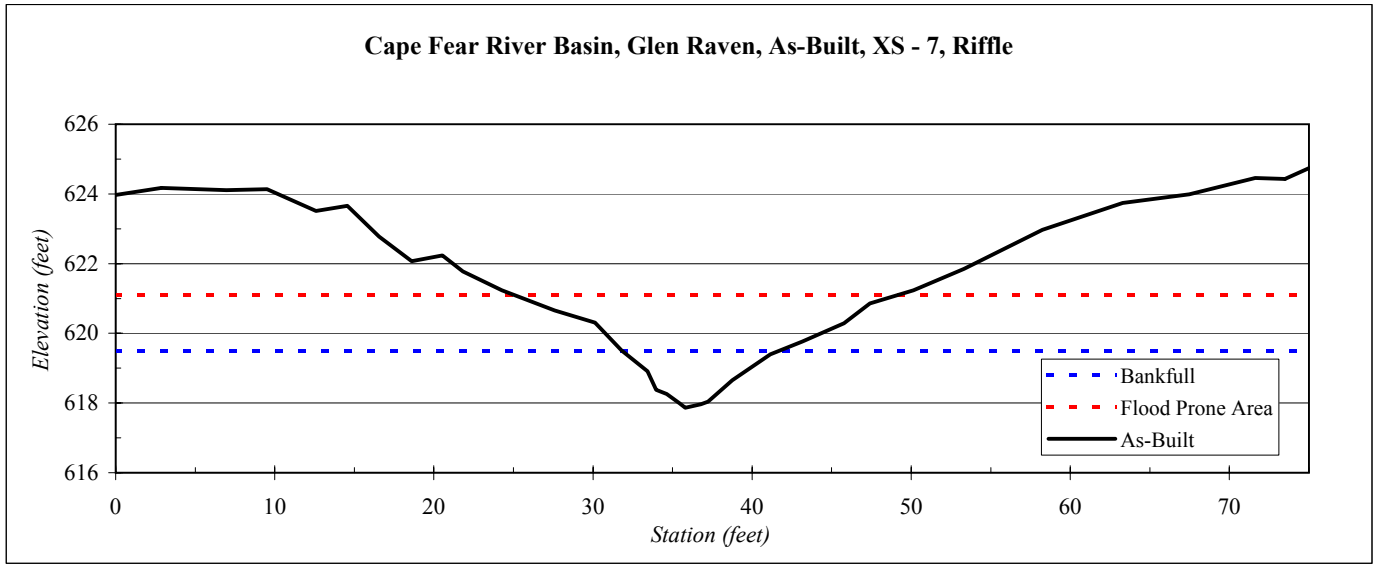
Type	
silt/clay	16%
sand	47%
gravel	36%
cobble	0%
boulder	0%
bedrock	1%

River Basin:	Cape Fear
Watershed:	Glen Raven, As-Built
XS ID	XS - 7, Riffle
Drainage Area (sq mi):	1.09
Date:	5/8/2006
Field Crew:	K. Knight, B. Roberts

Station	Elevation
0.0	624.0
2.9	624.2
7.0	624.1
9.5	624.1
12.6	623.5
14.6	623.7
16.5	622.8
18.6	622.1
20.5	622.2
21.8	621.8
24.3	621.2
27.6	620.7
30.1	620.3
31.8	619.5
33.4	618.9
34.0	618.4
34.6	618.3
35.4	618.0
35.8	617.9
36.8	618.0
37.2	618.0
38.8	618.7
41.2	619.4
43.2	619.8
45.8	620.3
47.4	620.9
50.1	621.2
53.3	621.8
58.3	623.0
63.3	623.7
67.5	624.0
71.6	624.5
73.5	624.4
77.3	625.21

SUMMARY DATA	
Bankfull Elevation:	619.5
Bankfull Cross-Sectional Area:	8.7
Bankfull Width:	10.0
Flood Prone Area Elevation:	621.1
Flood Prone Width:	24.9
Max Depth at Bankfull:	1.6
Mean Depth at Bankfull:	0.9
W / D Ratio:	11.5
Entrenchment Ratio:	2.5
Bank Height Ratio:	1.0

Stream Type	B4c



Riffle

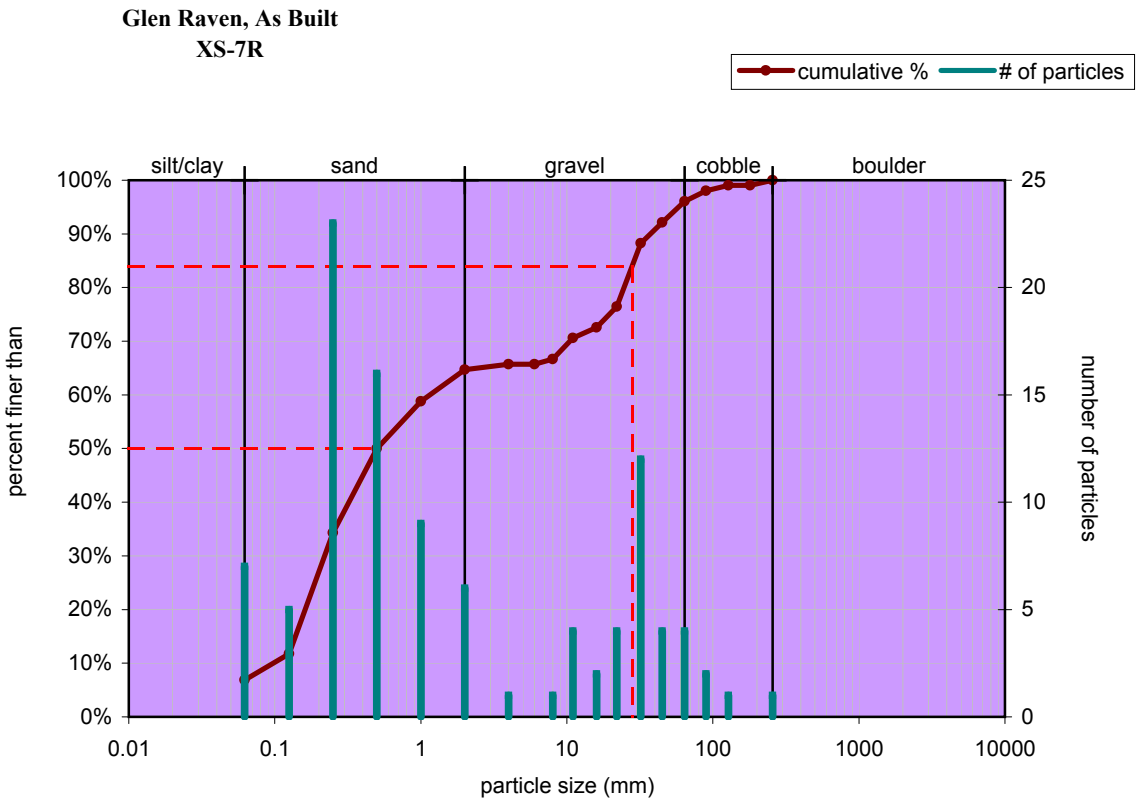
Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**7**
very fine sand	0.062 - 0.125	**5**
fine sand	0.125 - 0.25	**23**
medium sand	0.25 - 0.5	**16**
coarse sand	0.5 - 1	**9**
very coarse sand	1 - 2	**6**
very fine gravel	2 - 4	**1**
fine gravel	4 - 6	
fine gravel	6 - 8	**1**
medium gravel	8 - 11	**4**
medium gravel	11 - 16	**2**
coarse gravel	16 - 22	**4**
coarse gravel	22 - 32	**12**
very coarse gravel	32 - 45	**4**
very coarse gravel	45 - 64	**4**
small cobble	64 - 90	**2**
medium cobble	90 - 128	**1**
large cobble	128 - 180	
very large cobble	180 - 256	**1**
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	

total particle count: 102

bedrock ----------	
clay hardpan ----------	
detritus/wood ----------	
artificial ----------	

total count: 102

Note: XS-7



Size (mm)	
D16	0.14
D35	0.26
D50	0.5
D65	2.5
D84	28
D95	58

Size Distribution	
mean	2.0
dispersion	29.8
skewness	0.39

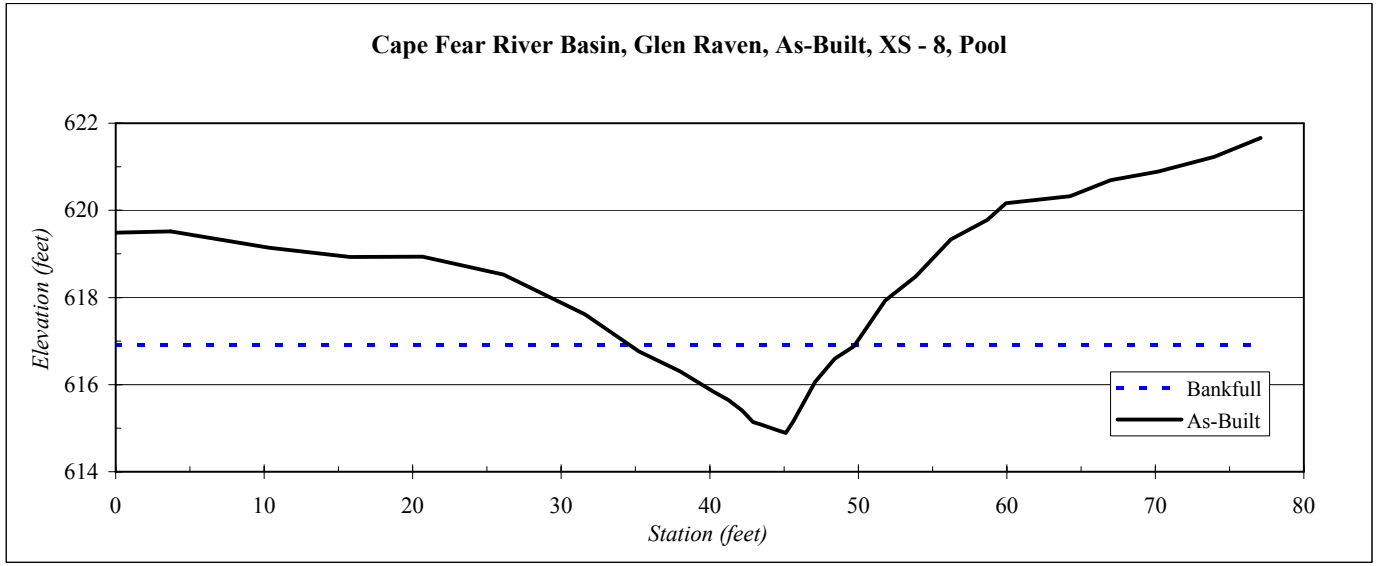
Type	
silt/clay	7%
sand	58%
gravel	31%
cobble	4%
boulder	0%

River Basin:	Cape Fear
Watershed:	Glen Raven, As-Built
XS ID	XS - 8, Pool
Drainage Area (sq mi):	1.09
Date:	5/8/2006
Field Crew:	K. Knight, B. Roberts

Station	Elevation
0.0	619.5
3.7	619.5
10.3	619.1
15.8	618.9
20.7	618.9
26.1	618.5
31.6	617.6
35.2	616.8
38.0	616.3
40.3	615.8
41.3	615.6
42.2	615.4
42.9	615.1
43.4	615.1
44.4	615.0
45.1	614.9
45.6	615.2
47.1	616.1
48.4	616.6
49.7	616.9
51.8	617.9
53.9	618.5
56.2	619.3
58.7	619.8
59.9	620.2
64.3	620.3
67.0	620.7
70.2	620.9
74.0	621.2
77.1	621.7

SUMMARY DATA	
Bankfull Elevation:	616.9
Bankfull Cross-Sectional Area:	14.1
Bankfull Width:	14.9
Flood Prone Area Elevation:	-
Flood Prone Width:	-
Max Depth at Bankfull:	2.0
Mean Depth at Bankfull:	0.9
W / D Ratio:	-
Entrenchment Ratio:	-
Bank Height Ratio:	-

Stream Type	B4c



Pool

Material	Size Range (mm)	Count
silt/clay	0 - 0.062	**7**
very fine sand	0.062 - 0.125	**5**
fine sand	0.125 - 0.25	**23**
medium sand	0.25 - 0.5	**15**
coarse sand	0.5 - 1	**4**
very coarse sand	1 - 2	**2**
very fine gravel	2 - 4	**3**
fine gravel	4 - 6	**4**
fine gravel	6 - 8	**6**
medium gravel	8 - 11	**2**
medium gravel	11 - 16	**7**
coarse gravel	16 - 22	**8**
coarse gravel	22 - 32	**12**
very coarse gravel	32 - 45	**1**
very coarse gravel	45 - 64	
small cobble	64 - 90	
medium cobble	90 - 128	
large cobble	128 - 180	
very large cobble	180 - 256	
small boulder	256 - 362	
small boulder	362 - 512	
medium boulder	512 - 1024	
large boulder	1024 - 2048	
very large boulder	2048 - 4096	

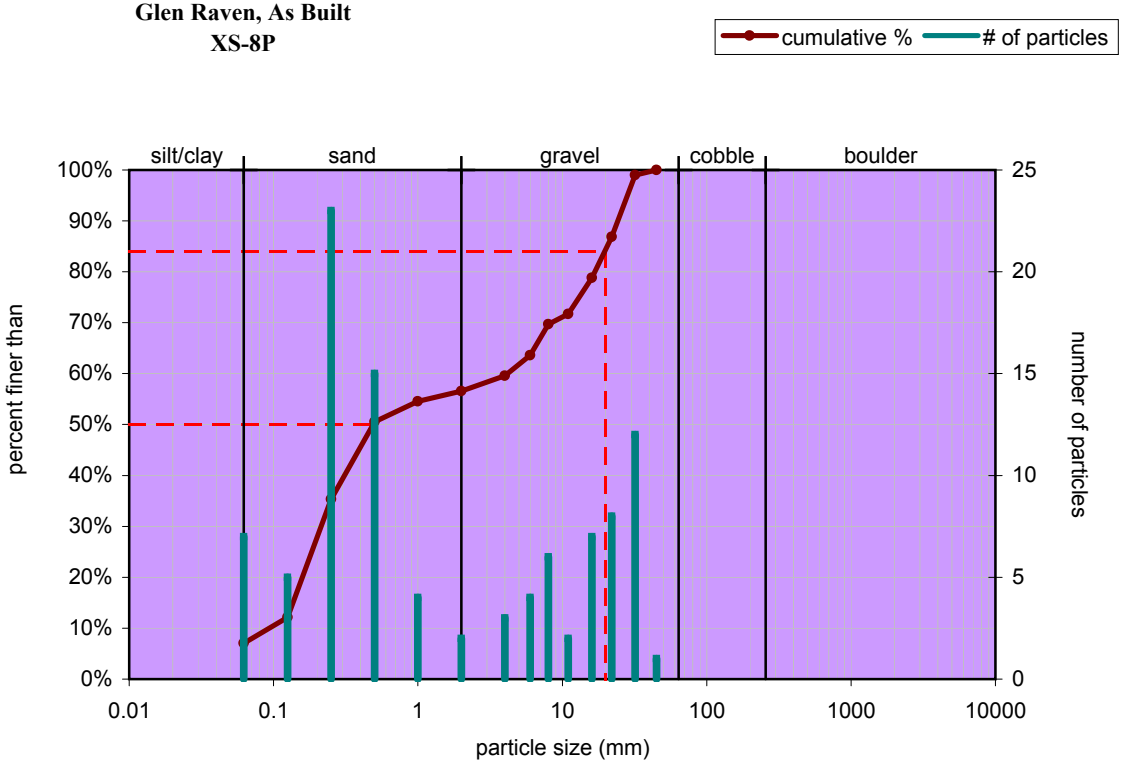
total particle count: 99

bedrock ----------	**1**
clay hardpan ----------	
detritus/wood ----------	
artificial ----------	

total count: 100

Note: XS-8

Glen Raven, As Built
XS-8P



Size (mm)		
D16	0.14	3.4
D35	0.25	12
D50	0.49	17
D65	6.4	20
D84	20	29
D95	28	39

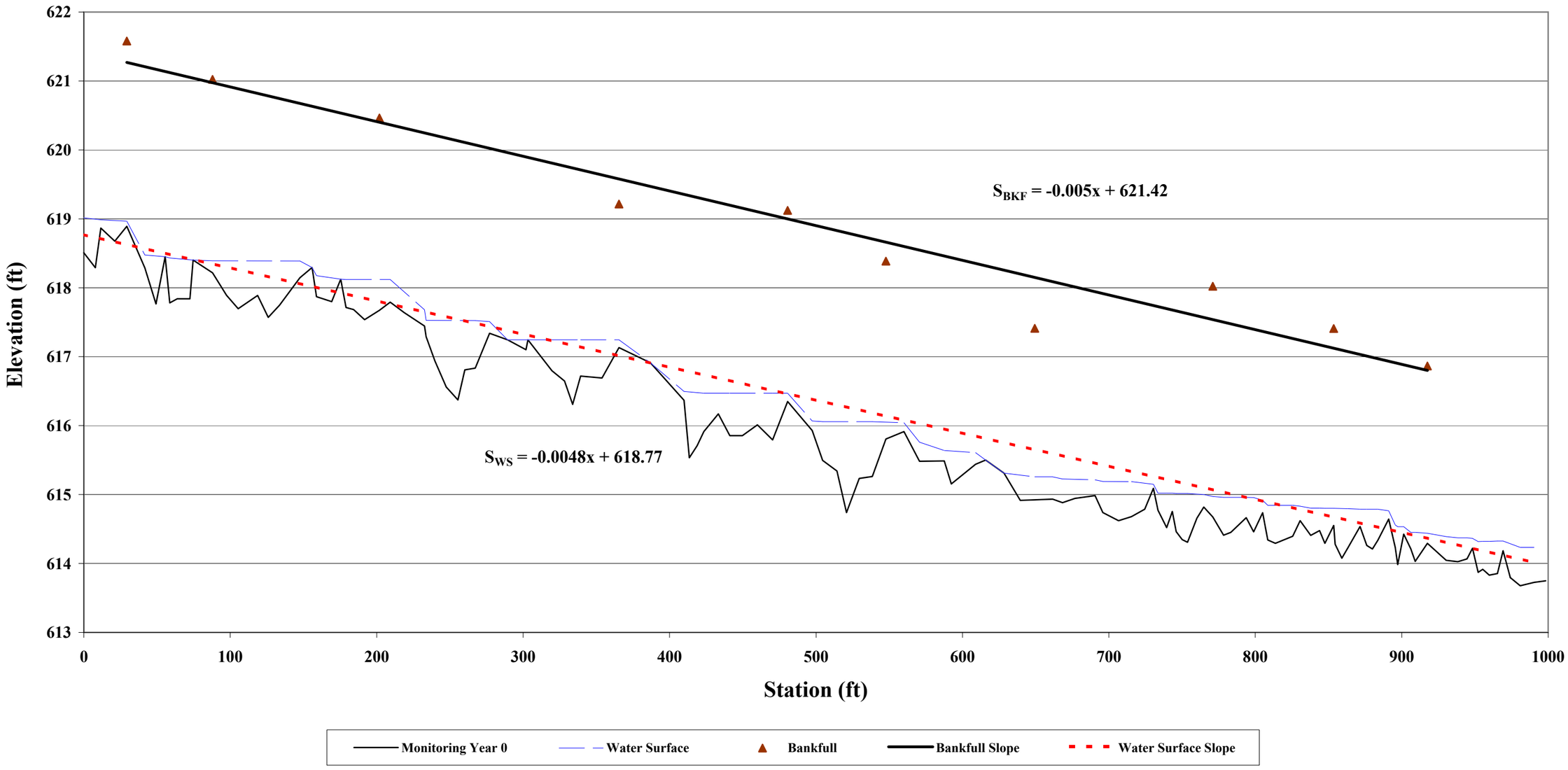
Size Distribution	
mean	1.7
dispersion	22.2
skewness	0.36

Type	
silt/clay	7%
sand	49%
gravel	43%
cobble	0%
boulder	0%
bedrock	1%

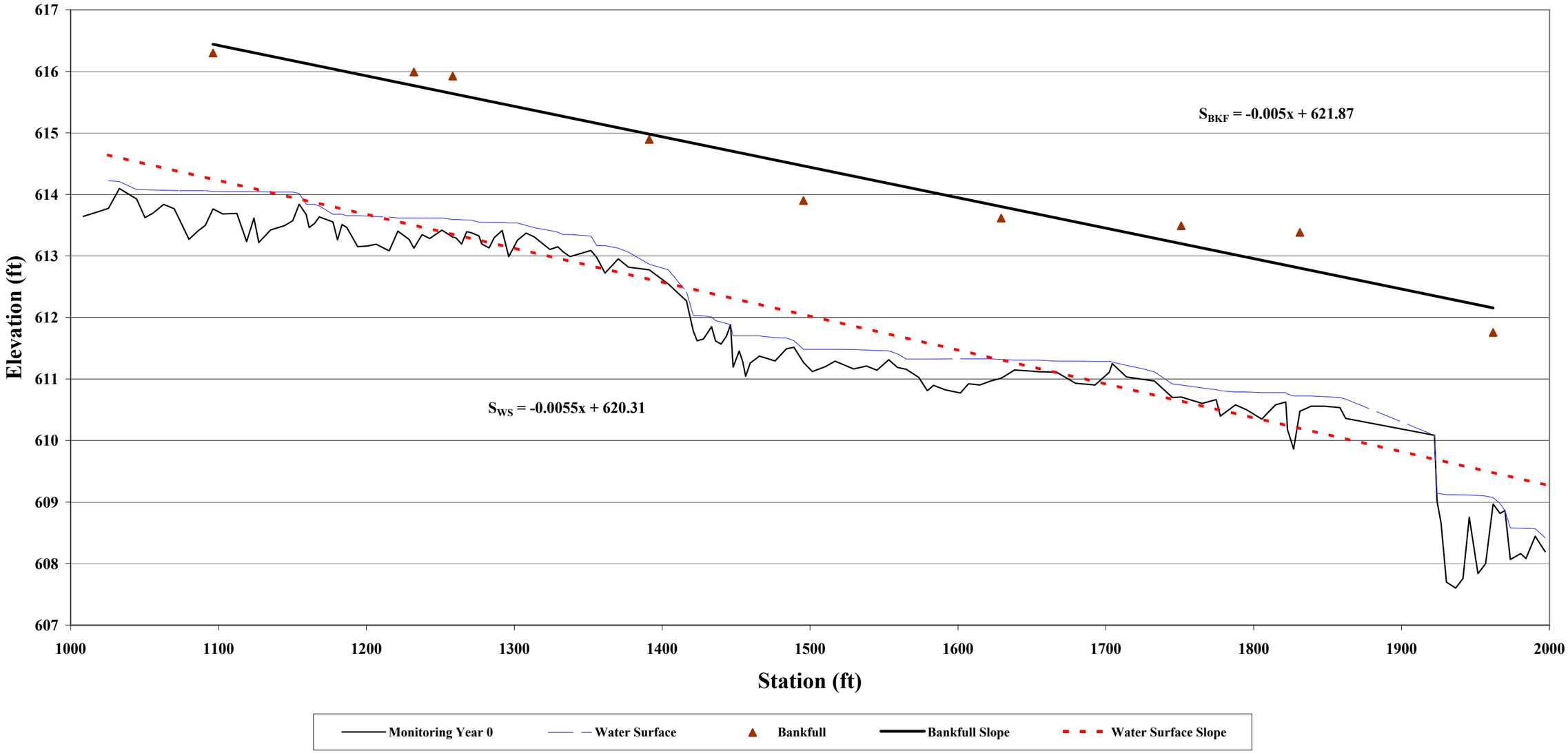
Appendix D

As-Built Detailed Longitudinal Profile

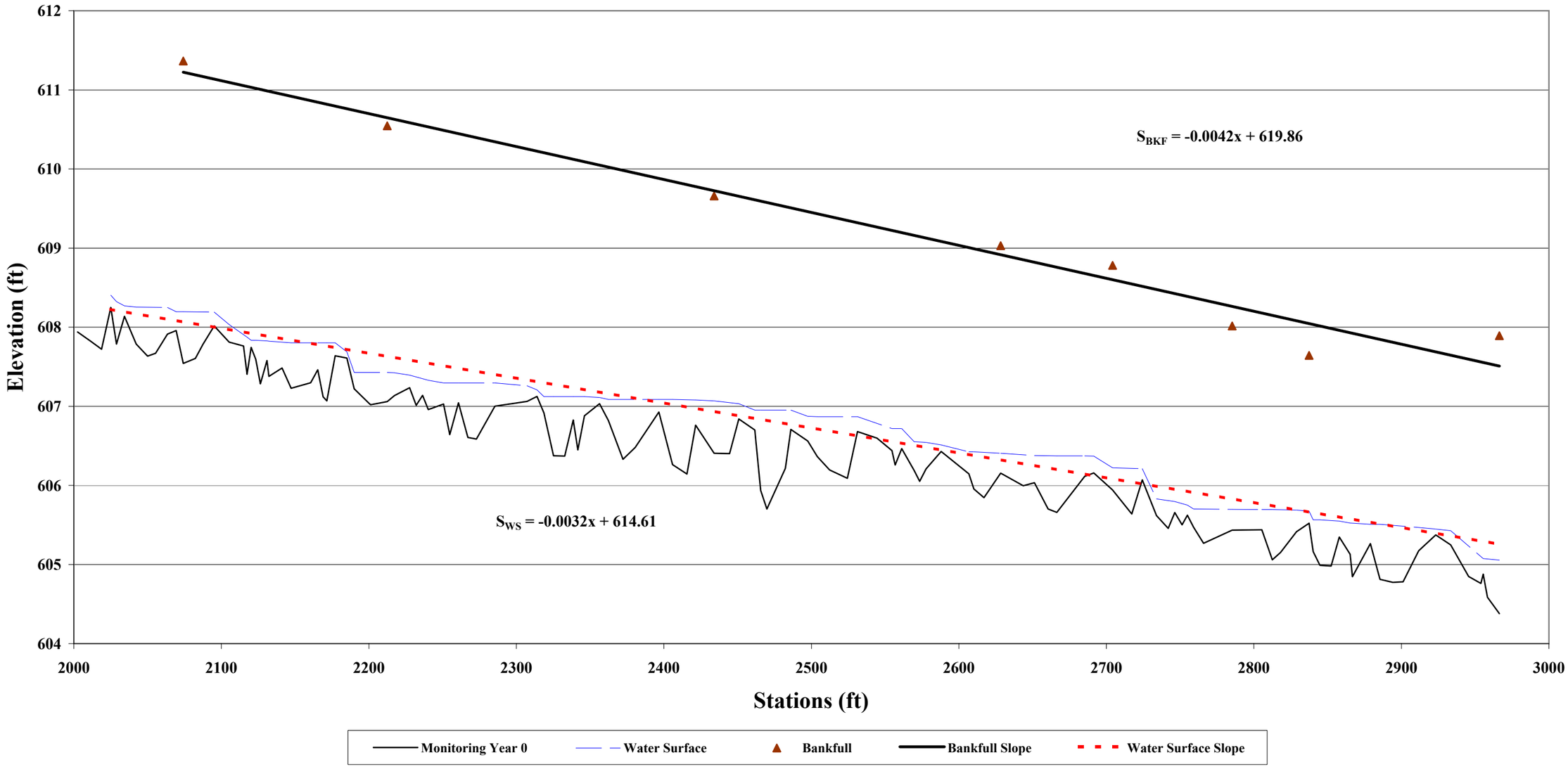
Longitudinal Profile
UTHR As-Built
Stations 10+00 - 20+00



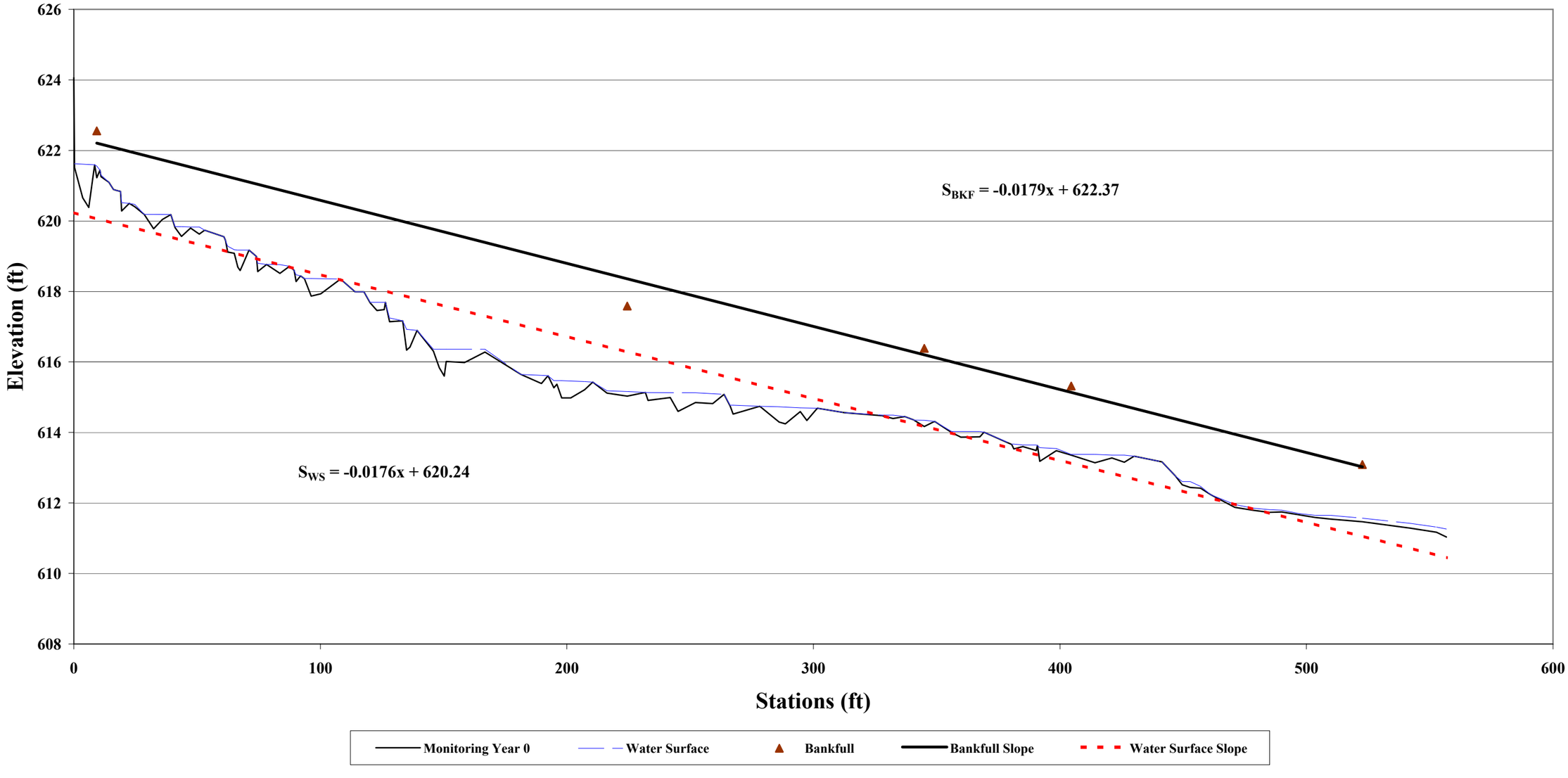
Longitudinal Profile
UTHR As-Built
Stations 20+00 - 29+00



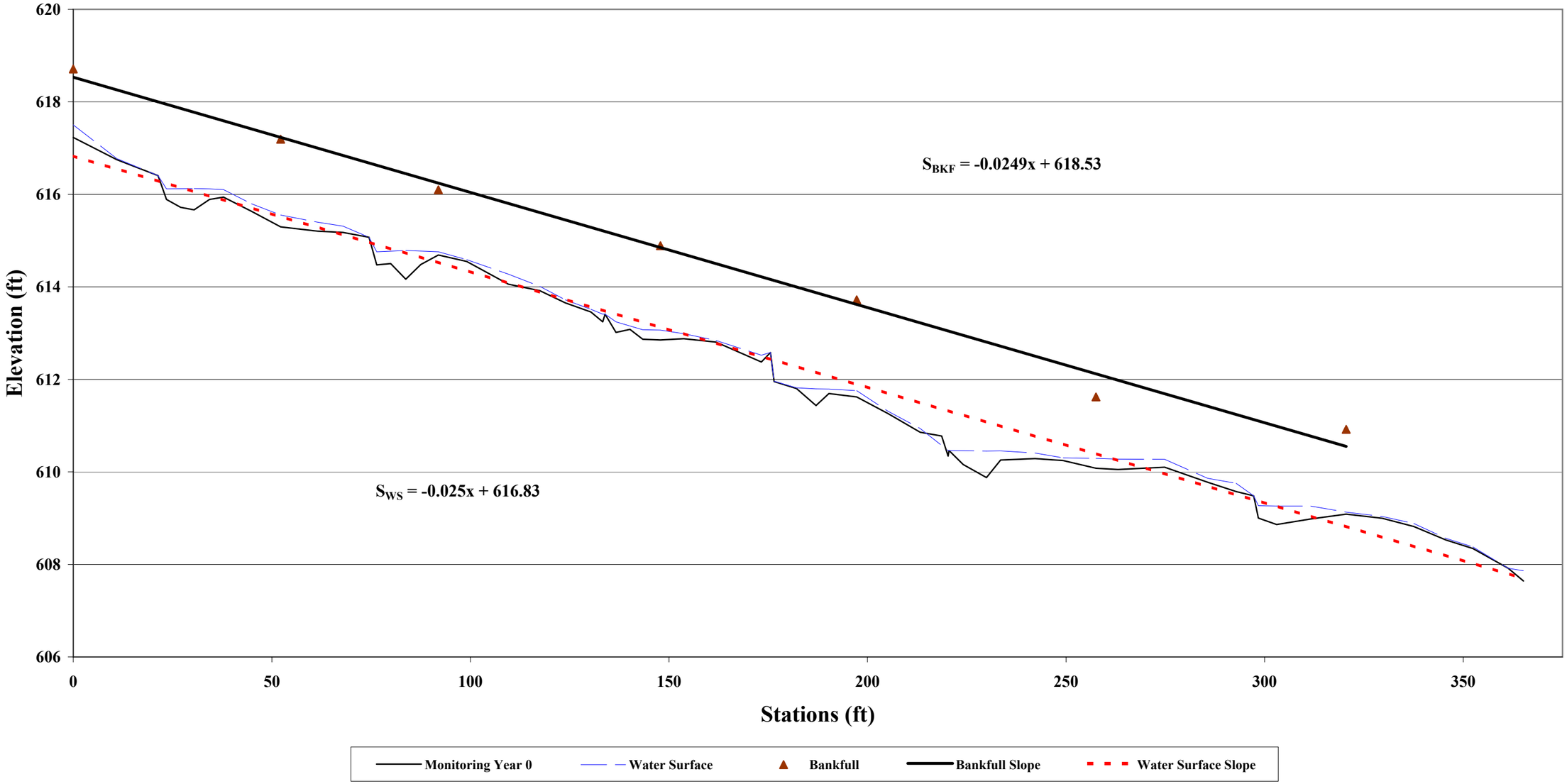
Longitudinal Profile
UTHR As-Built
Stations 29+00 - 38+50



Longitudinal Profile
UT1 As-Built
Stations 40+00 - 45+50



Longitudinal Profile
UT2 As-Built
Stations 50+00 - 53+75



Appendix E

Permanent Photo Station Photos

Photo Point 1: View looking north from Power Line Road. 5/14/07 – As-Built

Photo Point 2a: View looking south near station 13+25. 5/14/07 – As-Built

Photo Point 2b: View looking north near station 13+25. 5/14/07 – As-Built

Photo Point 3a: View looking south near station 16+75. 5/14/07 – As-Built

Photo Point 3b: View looking north toward vegetation plot #2. 5/14/07 – As-Built

Photo Point 4a: View looking south near station 22+75. 5/14/07 – As-Built

Photo Point 4b: View looking north toward vegetation plot #3. 5/14/07 – As-Built

Photo Point 5: View looking south from Gerringer Road culvert. 5/14/07 – As-Built

Photo Point 6: View looking north from Gerringer Road culvert. 5/14/07 – As-Built

Photo Point 7a: View looking south at confluence of UT2 and UTHR. 5/14/07 - As-Built

Photo Point 7b: View looking north near station 31+15. 5/14/07 – As-Built

Photo Point 8: View looking south near vegetation plot #7. 5/14/07 – As-Built

Photo Point 9a: View looking north toward vegetation plot #8. 5/14/07 – As-Built

Photo Point 9b: View looking north toward end of project. 5/14/07 – As-Built

Photo Point 10a: View looking upstream on UT1 near station 41+25. 5/14/07 – As-Built

Photo Point 10b: View looking downstream on UT1 near station 41+25. 5/14/07 – As-Built

Photo Point 11a: View looking east on UT1 with vegetation plot #4 on right. 5/14/07 – As-Built

Photo Point 11b: View looking downstream on UT1, before it enters UTHR. 5/14/07 – As-Built

Photo Point 12a: View looking upstream on UT2. 5/14/07 – As-Built

Photo Point 12b: View looking downstream on UT2 before it enters UTHR. 5/14/07 – As Built