

# **As-Built Baseline Monitoring Report FINAL**

## **Hudson Property**

DMS Project ID #: 95361

DMS Contract #: 004638

USACE Action ID# SAW-2012-01394

Beaufort County, North Carolina



### **Submitted: August 2016**

Submitted to/Prepared for:

NC Department of Environment and Natural Resources

Division of Mitigation Services

1652 Mail Service Center

Raleigh, NC 27699-1652



**Prepared by:**

**ALBEMARLE RESTORATIONS, LLC**

**P.O. Box 176**

**Fairfield, NC 27826**

**Tel (252) 333-0249 Fax (252) 926-9983**

# Table of Contents

1.0 Project Goals and Objectives .....	1
2.0 Project Success Criteria .....	1
2.1 Stream Restoration Performance Standards.....	1
2.2 Stream Channel Restoration Performance Standards .....	2
2.3 Planted Vegetation Performance Standards.....	2
3.0 Site Conditions and Description .....	2
4.0 Mitigation Components .....	3
5.0 Design Approach .....	3
6.0 Construction and Planting Timeline .....	3
7.0 Plan Deviations .....	3
8.0 Post Construction Mitigating Factors .....	3
Figure 1 – Vicinity Map.....	5
Appendix A – Background Tables.....	6
Appendix B – CCPV and Photos .....	10
Appendix C – Vegetation Plot Data.....	20
Appendix D – Stream Measurement and Geomorphology Data .....	23
Appendix E – As-Built Plan Sheets .....	44

## **1.0 PROJECT GOALS AND OBJECTIVES**

The project goals of the Hudson property per the approved mitigation plan are as follows:

- Improve and sustain hydrologic connectivity/interaction and storm flow/flood attenuation.
- Reduce nutrient and sediment stressors to the reach and receiving watershed.
- Provide uplift in water quality functions.
- Improve aquatic and terrestrial habitats (complexity, quality).
- Improve and maintain riparian buffer habitat.

The project goals will be addressed through the following project objectives:

- Implement a sustainable, reference-based, rehabilitation of the reach dimension, pattern, and profile to provide needed capacity and competency.
- Support the removal of barriers to anadromous fish movement and to help improve nursery and spawning habitats.
- Strategically install stream structures and plantings designed to maintain vertical and lateral stability and improve habitat diversity/complexity.
- Provide a sustainable and functional bankfull floodplain feature.
- Enhance and maintain hydrologic connection between stream and adjacent floodplain/riparian corridors.
- Utilize the additional width of the swamp runs to provide natural filters for sediment and nutrients and diffuse flow from upstream runoff.
- Install, augment, and maintain appropriate riparian buffer with sufficient density and robustness to support native forest succession.
- Water quality enhancement through riparian forest planting and woody material installation, and increased floodplain interaction/overbank flooding.
- Restore the existing ditched streams to single and multi-thread headwater systems with forested riparian buffers.
- Provide ecologically sound construction techniques that will require minimal grading and disturbance.

## **2.0 PROJECT SUCCESS CRITERIA**

### **2.1 Stream Restoration Performance Standards**

#### **Single Thread Channels (Reaches 1 - 4) and Swamp Run (Reach 5)**

Groundwater monitoring wells are installed in and near the thalweg of all five reaches. The wells are equipped with continuous-reading gauges capable of documenting sustained flow. Per the approved Mitigation Plan, each reach must exhibit water flow for at least 30 consecutive days during years with normal rainfall (demonstrating at least intermittent stream status). All restored channels shall receive sufficient flow through the monitoring period to maintain an Ordinary High Water Mark (OHWM). Field indicators of flow events include a

natural line impressed on the bank; shelving; changes in soil characteristics; destruction of terrestrial vegetation; presence of litter and debris; wracking; vegetation matted down, bent or absent; sediment sorting; leaf litter disturbed or washed away; scour; deposition; bed and bank formation; water staining; or change in plant community. In addition, two overbank flows shall be documented for each reach during the monitoring period using continuously monitored pressure transducers and crest gauges. All collected data and field indicators of water flow shall be documented in each monitoring report. Seven flow monitoring stations are located on Reaches 1 – 4, three are located in Reach 5.

## 2.2 Stream Channel Restoration Stability Performance Standards

### Headwater System (Reach 5)

All stream areas shall remain stable with no areas of excessive erosion such as evidence of bank sloughing or actively eroding banks due to the exceedance in critical bank height and lack of deep rooted stream bank vegetation.

### Single Thread Channels (Reaches 1 - 4)

1. Bank Height Ratio (BHR) shall not exceed 1.2 within restored reaches of the stream channel.
2. Entrenchment Ratio (ER) shall be no less than 2.2 within restored reaches of the stream channel.
3. The stream project shall remain stable and all other performance standards shall be met through two separate bankfull events, occurring in separate years, during the 7-year post construction monitoring period.
4. Three bank pin arrays and 11 cross sections are located on Reaches 1 - 4

## 2.3 Planted Vegetation Performance Standards

1. At least 320 three year-old planted stems/acre must be present after year three. At year five, density must be no less than 260 five year-old planted stems/acre. At year 7, density must be no less than 210 seven year-old planted stems/acre.
2. If this performance standard is met by year 5 and stem density is trending toward success (i.e., no less than 260 five year-old stems/acre) monitoring of vegetation on the site may be terminated provided written approval is provided by the USACE in consultation with the North Carolina Interagency Review Team (NCIRT).
3. Thirteen vegetation plot samples are located within the project area.

## 3.0 SITE CONDITIONS AND DESCRIPTION

The Hudson property is 13.49 acres located in Beaufort County, NC and the Tar-Pamlico River Basin. The majority of the site is used for crop production, primarily corn, soybeans and wheat. As a result of the lowering of local water tables and in some cases the complete elimination of ground and surface water interaction, the degradation of water quality and downstream anadromous fish spawning and nursery habitat has occurred. Hydric soils are present on site, meaning that the pre-existing site conditions

were appropriate for raising the water table and re-establishing normal base flow conditions (See Figure 1 -Vicinity Map).

#### **4.0 MITIGATION COMPONENTS**

Mitigation components are limited to five reaches: Reach 1: 833 lf; Reach 2: 532 lf; Reach 3: 445 lf; Reach 4: 437 lf; Reach 5: 644 lf, for a total restored stream footage of 2,891 linear feet (Table 1).

#### **5.0 DESIGN APPROACH**

A natural design approach was used to restore the natural sinuosity and flow of the headwater streams which existed prior to channelization. Grading was done to decrease sediment load and erosion rate while allowing for floodplain connectivity and storage for overland flow. Banks were graded down to distribute flow velocity and the banks and riparian buffers were planted to stabilize the channel and create habitat. A combination of Priority 1 and Priority II restoration types were used. Where the proposed channels tie into the existing, non-restored channels, Priority II restoration was used.

#### **6.0 CONSTRUCTION AND PLANTING TIMELINE**

Construction commenced in December 2014 with the installation of recommended erosion control practices and was completed in May 2015. Planting was officially concluded in early January 2016. (Table 2 – Project History Table)

The construction sequence was as follows:

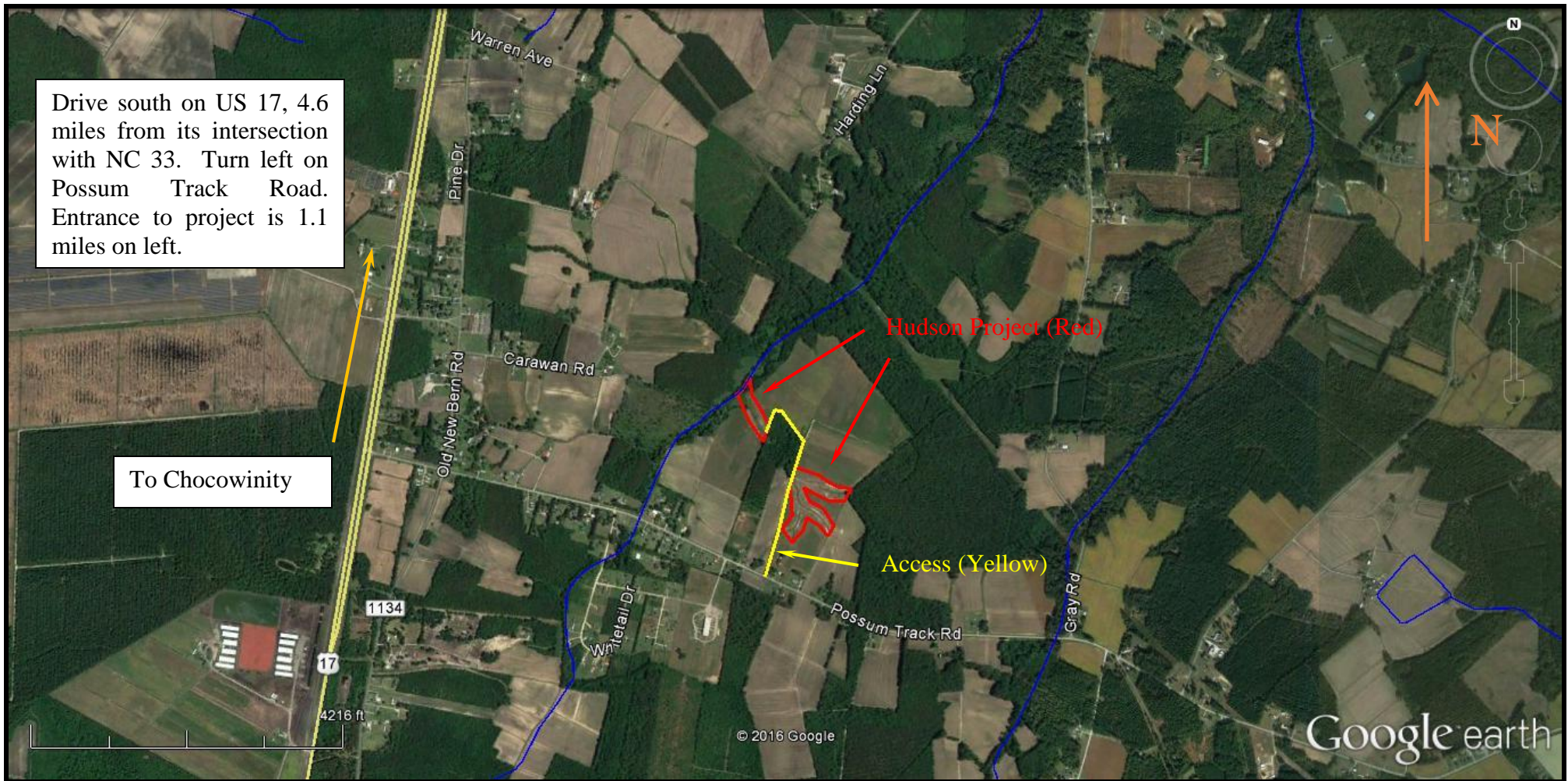
1. Conduct channel grading to raise channel elevation and reconnect floodplain.
2. Install in-stream structure (riffle grade control structure with embedded woody branches, low gradient log drop structures, and soil lifts) in accordance with approved restoration plans (Sheets D14-15).
3. Install soils stabilization matting and E & S seeding along all graded.
4. Seed stream restoration reaches with the permanent wetland seed mixture as specified in the restoration plans (Sheet P-1).
5. Install live stakes where specified on the approved stream restoration plans.
6. As-built and baseline monitoring surveys were completed. Nine monitoring wells were installed along with 13 vegetative monitoring plots (minimum of .02 acres in size).
7. Tree planting was completed in January 2016. All planting was done in accordance with the approved restoration plan.

#### **7.0 PLAN DEVIATIONS**

There were no significant deviations between construction plans and the As-built conditions.

#### **8.0 POST-CONSTRUCTION MITIGATING FACTORS**

Due to abnormally high amounts of rainfall during the winter of 2014-15, all restoration activities were suspended from December 14, 2014 through March 23, 2015. This caused changes to the construction sequence and set back reforestation activities. Refer to Table 2 for the actual timeline.



**Figure 1 - Vicinity Map**  
Hudson Stream Mitigation Project  
DMS Project #95361  
Beaufort County, NC

# **APPENDIX A**

## Background Tables

<b>Table 1: Project Components and Mitigation Credits</b> Hudson Property, Beaufort County EEP Project Number: 95361									
<b>Mitigation Credits</b>									
	Stream		Riparian wetland		Non-riparian wetland		Buffer	Nitrogen Nutrient Offset	Phosphorous Nutrient Offset
Type	R	RE	R	RE	R	RE			
Totals	2,891								
<b>Project Components</b>									
Project Component or Reach ID	Stationing/Location		Existing Footage/Acreage		Approach (PI, PII etc.)		Restoration or Restoration Equivalent	Restoration Footage or Acreage	Mitigation Ratio
Reach 1			766 LF		PI			833 LF	1:1
Reach 2			516 LF		PI/PII			532 LF	1:1
Reach 3			611 LF		PI/PII			445 LF	1:1
Reach 4			503 LF		PI/PII			437 LF	1:1
Reach 5			689 LF		PI			644 LF	1:1
Total			3,085 LF					2,891 LF	
<b>Component Summation</b>									
Restoration Level	Stream (linear feet)		Riparian Wetland (acres)		Non-riparian Wetland (acres)		Buffer (square feet)	Upland (acres)	
			Riverine	Non-riverine					
Restoration	2,891 LF								
Enhancement									
Enhancement I									
Enhancement II									
Creation									
Preservation									
<b>BMP Elements</b>									
Element	Location				Purpose/Function		Notes		
FB	Adjacent to stream				Buffer		100 feet on either side of stream centerline		

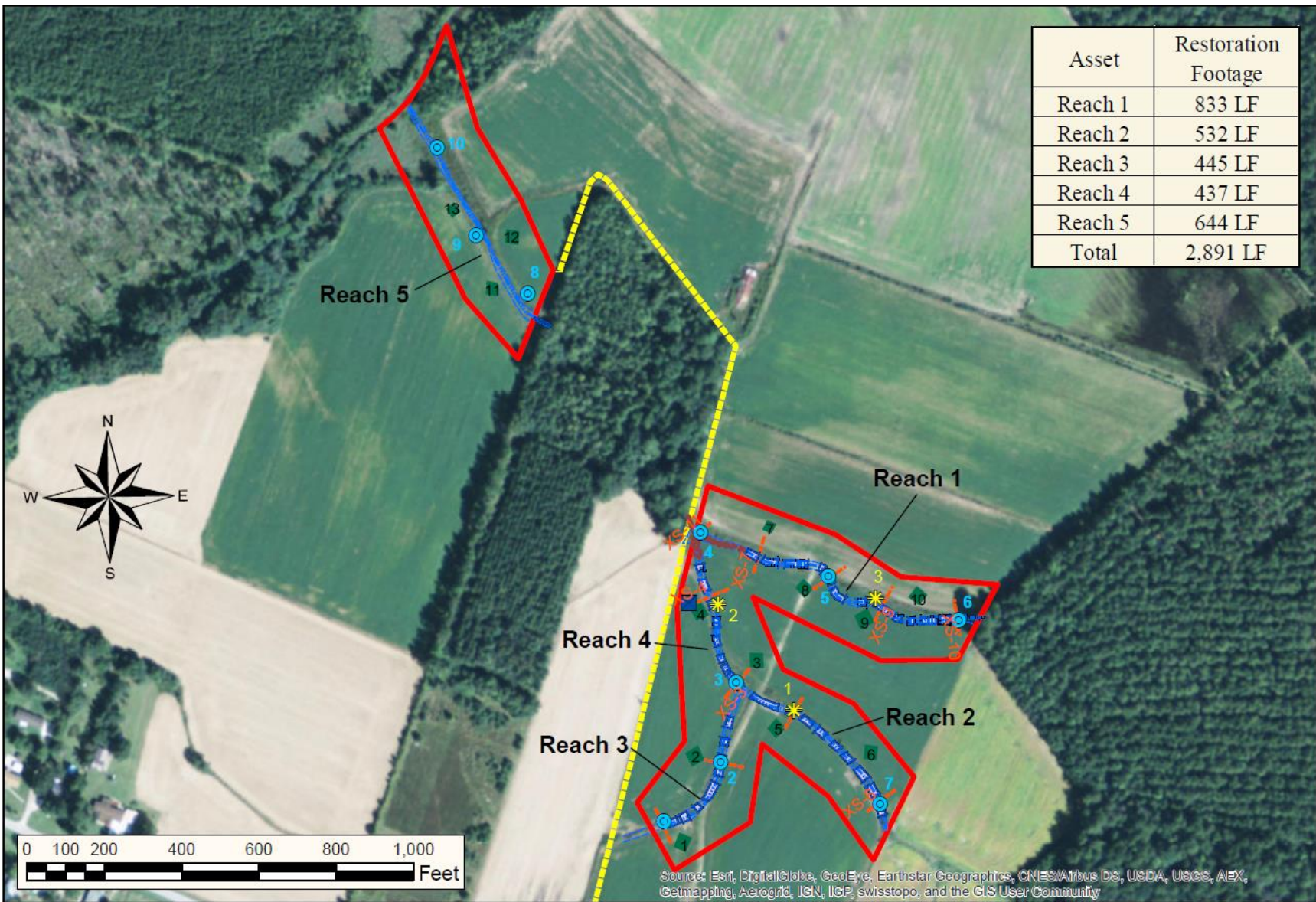


<b>Table 2: Project Activity and Reporting History Hudson Property- EEP Project Number 95361</b>		
<b>Activity, Deliverable, or Milestone</b>	<b>Data Collection Complete</b>	<b>Actual Completion or Delivery</b>
Project Institution	N/A	June 2012
Mitigation Plan	July 2014	Oct 2014
Permits Issued	March 2013	May 2014
Final Design Construction	March 2013	May 2014
Construction	N/A	May 2015
Containerized, Bare Root, and B&B Planting	N/A	January 2016
Baseline Monitoring Document (Year 0 - Baseline)	January 2016	August 2016
Year 1 Monitoring		
Year 2 Monitoring		
Year 3 Monitoring		
Year 4 Monitoring		
Year 5 Monitoring		

<b>Table 3: Project Contacts Hudson Property- EEP Project Number: 95361</b>	
Primary Project Design POC	Ecotone, Inc. Scott McGill (410) 420-2600 P.O. Box 5, Jarrettsville, MD 21084
Construction Contractor POC	Riverside Excavation, Inc. Car Baynor (252) 943-8633
Survey Contractor POC	True Line Surveying Curk Lane (919) 359-0427
Planting and Seeding Contractor POC	Carolina Silvics, Inc. Mary Margaret McKinney (252) 482-8491 908 Indian Trail Road, Edenton, NC 27932
Seed Mix Sources	Ernst Conservation Seeds, LLP, Meadville, PA
Nursery Stock Suppliers	Carolina Silvics, Inc.
Monitoring Performers Stream and Vegetation POC	Ecotone, Inc. Scott McGill (410) 420-2600 P.O. Box 5, Jarrettsville, MD 21084

<b>Table 4: Project information</b>					
<b>Hudson Property- EEP Project Number: 95361</b>					
Project name	HUDSON PROPERTY				
County	BEAUFORT				
Project Area (ac)	13.4 AC				
Project Coordinates (Lat and Long)	77° 06" 13.62' W / 35° 26" 53.20' N				
<b>4.1 Project Watershed Summary Information</b>					
Physiographic province	INNER COASTAL PLAIN				
River basin	TAR-PAMLICO RIVER BASIN				
USGS Hydrologic Unit 8-digit	03020104	USGS Hydrologic Unit 14-digit	03020104010010		
DWQ Sub-basin	CHOCOWINITY CREEK – HORSE BRANCH				
Project Drainage Area (acres)	190.86				
Project Drainage Area Percentage of Impervious Area	1.2 % (2.24 acres)				
CGIA Land Use Classification	2.01.01.07 Annual Row Crop Rotation				
<b>4.2 Reach Summary Information</b>					
Parameters	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5
Length of reach (linear feet)	766	516	611	503	689
Valley classification	VIII	VIII	VIII	VIII	VIII
Drainage area (acres)	40.51	74.63	35.21	150.35	190.86
NCDWR stream identification score	20.75	20.75	20.75	20.75	28
NCDWR Water Quality Classification	C;NSW	C;NSW	C;NSW	C;NSW	C;NSW
Morphological Description (stream type)	G5-G6	G5-G6	G5-G6	G5-G6	G5-G6
Evolutionary trend	Early (CEM)	Early (CEM)	Early (CEM)	Early (CEM)	Early (CEM)
Underlying mapped soils	GoA & CrB	CrB & Ly	CrB & Ly	CrB	CrB & Me
Drainage class	MW	MW & SP	MW & SP	MW	MW & P
Soil Hydric status	Non-Hydric	Non-Hydric	Non-Hydric	Non-Hydric	Hydric
Slope (ft/ft)	0.009	0.006	0.008	0.004	0.003
FEMA classification	N/A	N/A	N/A	N/A	AE/X
Native vegetation community	Pasture/Crop	Pasture/Crop	Pasture/Crop	Pasture/Crop	Pasture/Crop
Percent composition of exotic invasive vegetation	N/A	N/A	N/A	N/A	N/A
<b>4.3 Regulatory Considerations</b>					
Regulation	Applicable?	Resolved?	Supporting Documents		
Waters of the United States – Section 404	YES	YES			
Waters of the United States – Section 401	YES	YES			
Endangered Species Act	NO	YES			
Historic Preservation Act	NO	YES			
Coastal Zone Management Act (CZMA)/ Coastal Area Management Act (CAMA)	NO	YES			
FEMA Floodplain Compliance	NO	YES			
Essential Fisheries Habitat	NO	YES			

**APPENDIX B: CURRENT CONDITION PLAN VIEW AND  
AS-BUILT PHOTOS**



*Albemarle Restorations, LLC*

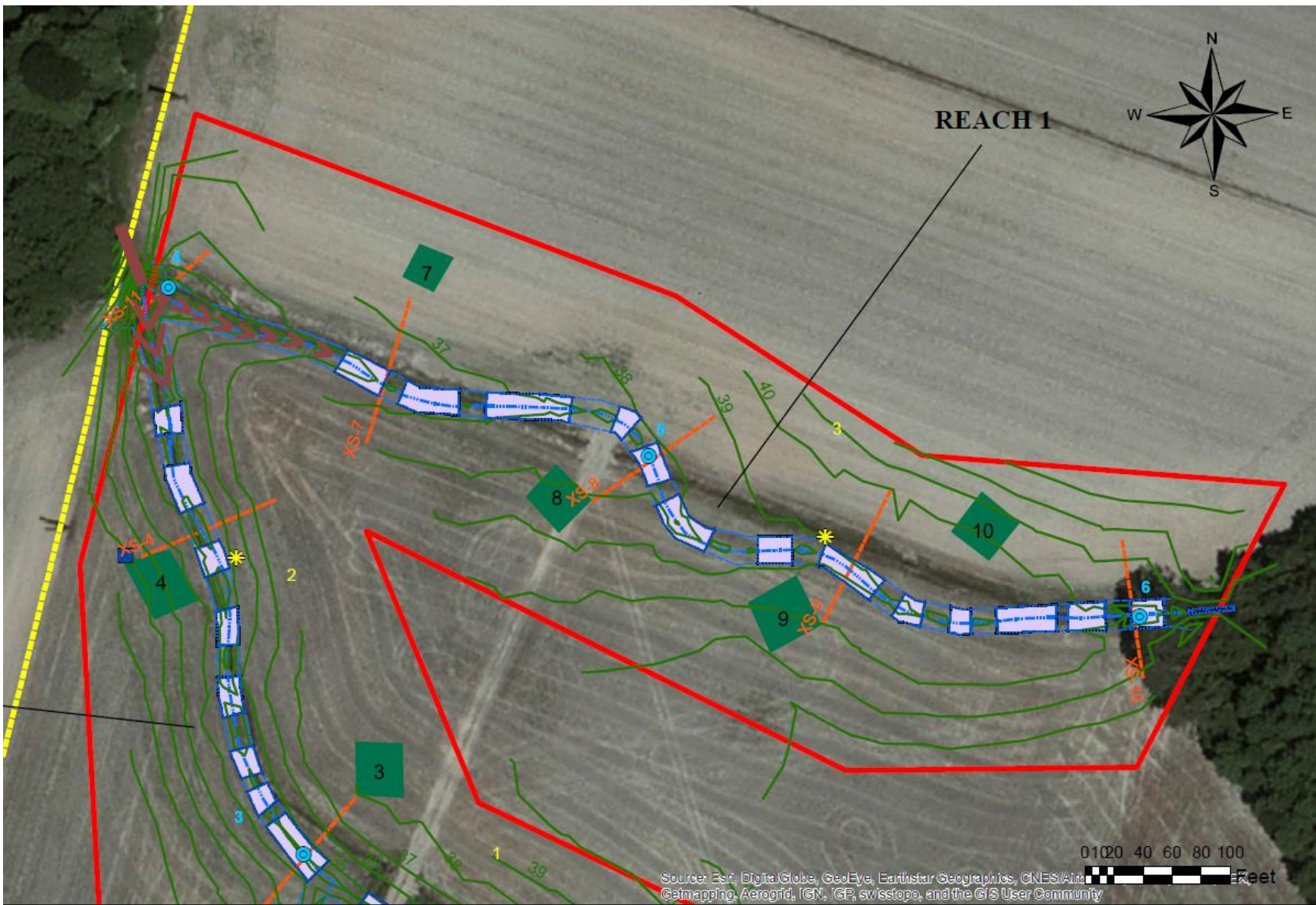
Wetland Restoration  
Stream Restoration  
Wildlife Habitat

Prepared by:  
THE TRUST FOR  
TOMORROW

Hudson Stream Restoration Project  
Current Condition Plan View  
Project # 95361  
Aug. 5, 2016

- Flow Monitoring Station
- Rain Gauge
- Bank Pin Array
- Vegetated Plot Sample
- Woody Riffles
- LogDrops
- Cross Sections
- Centerline of stream
- Stream top of bank
- Easement Boundary
- Access Road





*Albemarle Restorations, LLC*

Wetland Restoration  
Stream Restoration  
Wildlife Habitat

Partially by  
THE TRULER BUCK  
TOWNSHIP

**Hudson Stream Restoration Project**  
Current Condition Plan View  
Project # 95361  
Aug. 5, 2016

- |                         |                  |                      |
|-------------------------|------------------|----------------------|
| Flow Monitoring Station | Woody Riffles    | Centerline of stream |
| Rain Gauge              | Log Drops        | Stream top of bank   |
| Bank Pin Array          | Cross Sections   | Easement Boundary    |
| Vegetated Plot Sample   | Asbuilt Contours | Access Road          |





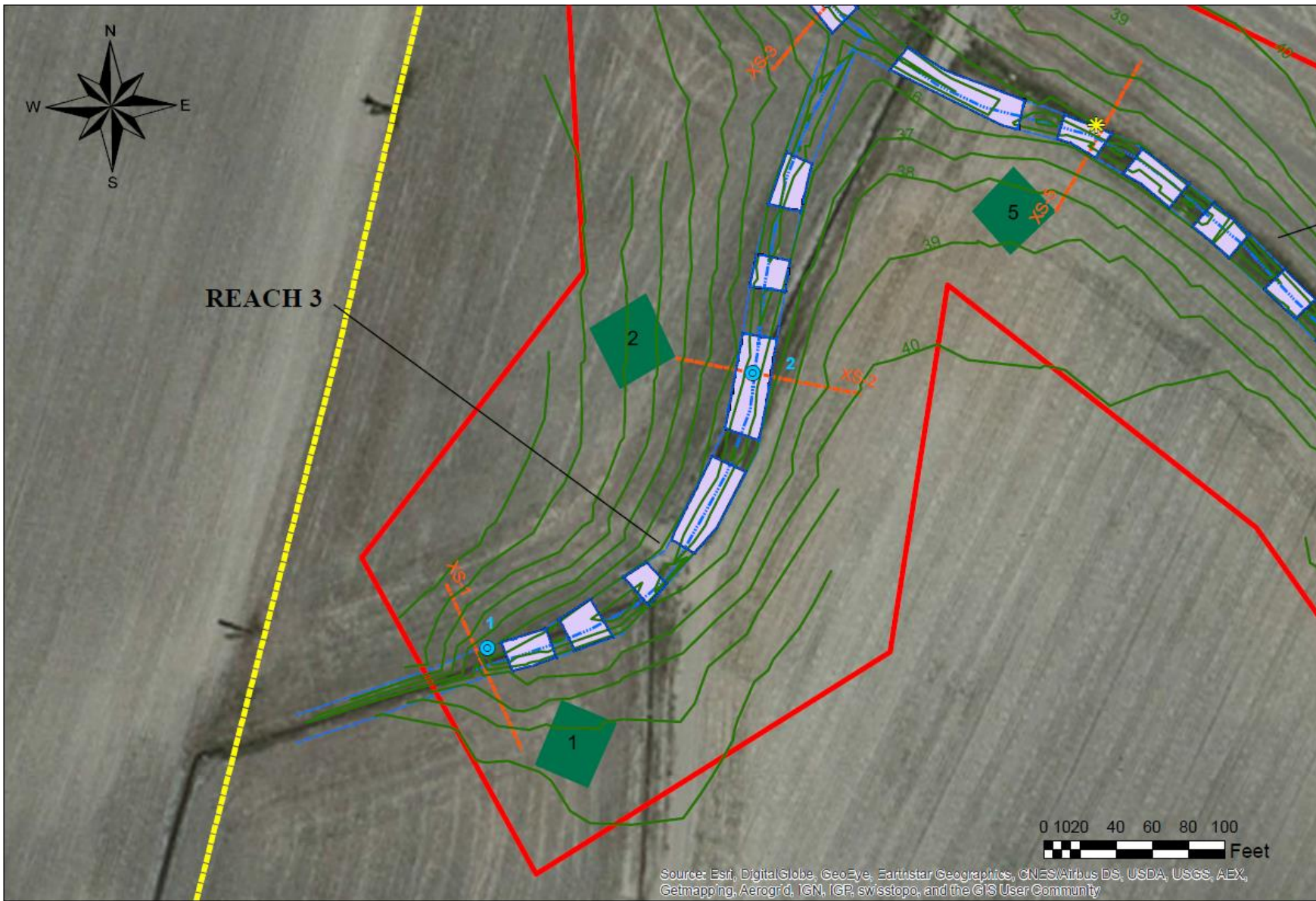
*Albemarle Restorations, LLC*

Wetland Restoration  
Stream Restoration  
Wildlife Habitat

**Hudson Stream Restoration Project**  
**Current Condition Plan View**  
 Project # 95361  
 Aug. 5, 2016

	Flow Monitoring Station		Woody Riffles		Centerline of stream
	Rain Gauge		Log Drops		Stream top of bank
	Bank Pin Array		Cross Sections		Easement Boundary
	Vegetated Plot Sample		Asbuilt Contours		Access Road





*Albemarle Restorations, LLC*

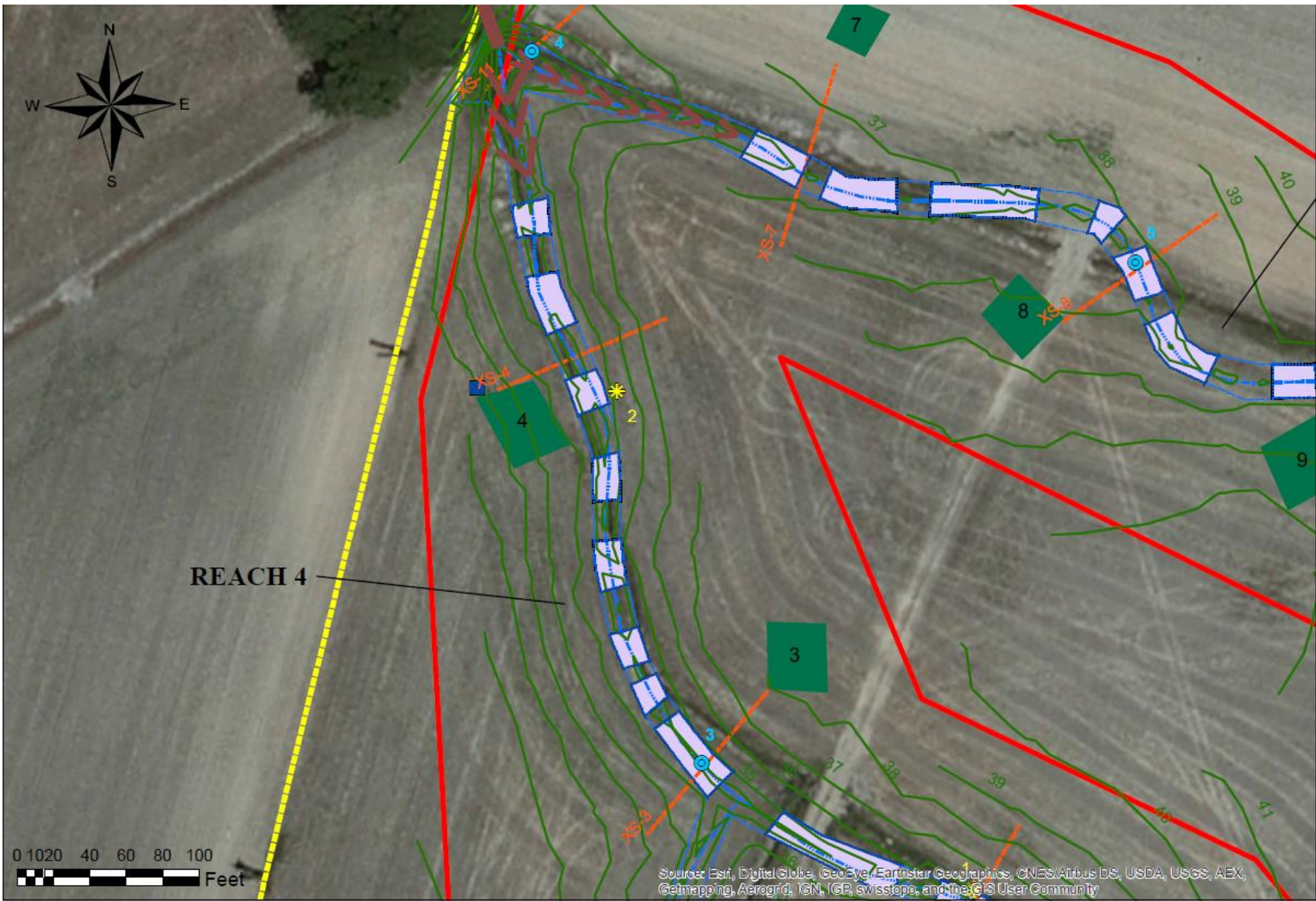
Wetland Restoration  
Stream Restoration  
Wildlife Habitat

Presented by  
THE TRIBUTARY  
COUNCIL

Hudson Stream Restoration Project  
Current Condition Plan View  
Project # 95361  
Aug. 5, 2016

- |                         |                  |                      |
|-------------------------|------------------|----------------------|
| Flow Monitoring Station | Woody Riffles    | Centerline of stream |
| Rain Gauge              | LogDrops         | Stream top of bank   |
| Bank Pin Array          | Cross Sections   | Easement Boundary    |
| Vegetated Plot Sample   | Asbuilt Contours | Access Road          |





*Albemarle Restorations, LLC*

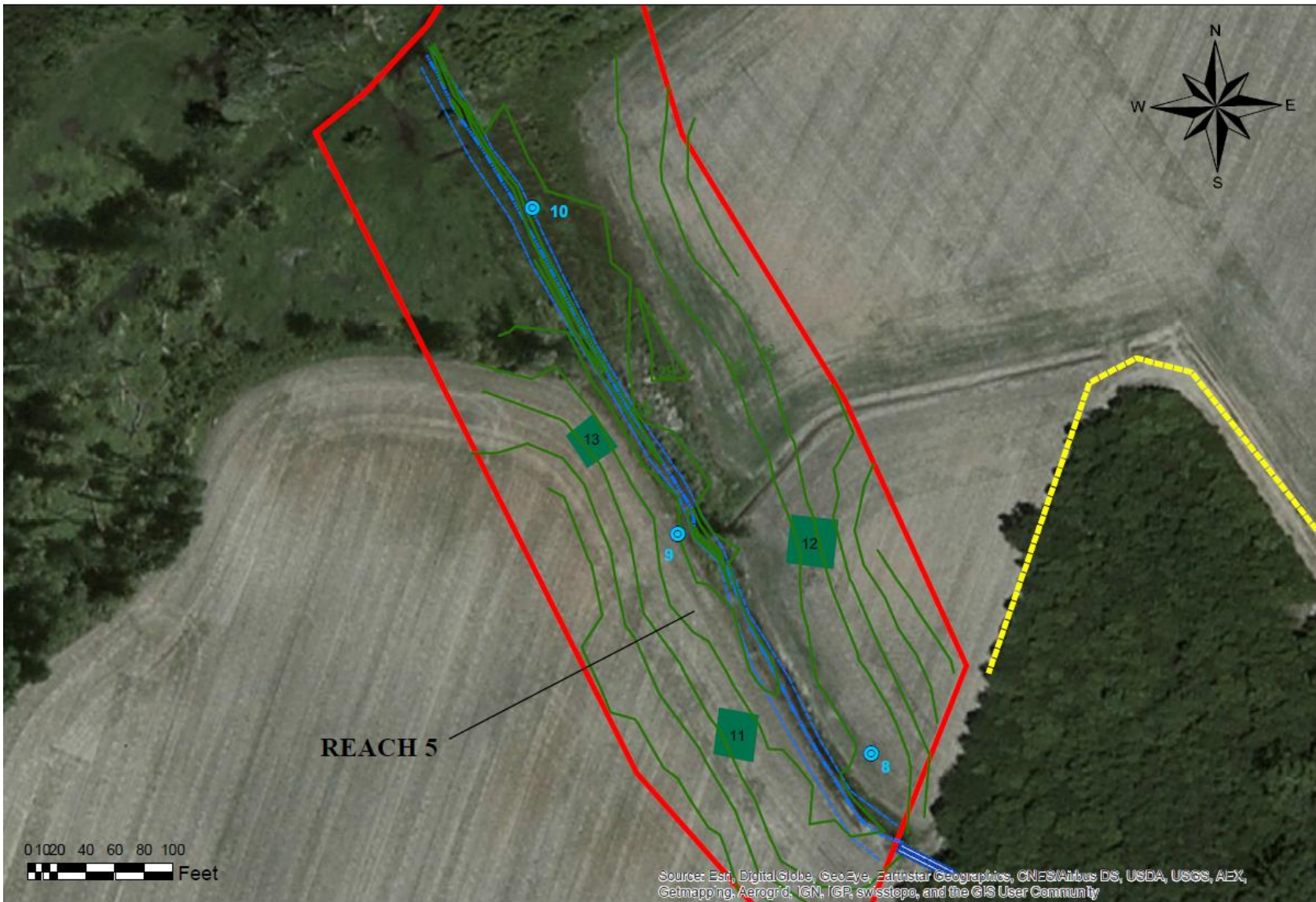
Wetland Restoration  
Stream Restoration  
Wildlife Habitat

**Hudson Stream Restoration Project**  
**Current Condition Plan View**  
 Project # 95361  
 Aug. 5, 2016

- |                         |                  |                      |
|-------------------------|------------------|----------------------|
| Flow Monitoring Station | Woody Riffles    | Centerline of stream |
| Rain Gauge              | Log Drops        | Stream top of bank   |
| Bank Pin Array          | Cross Sections   | Easement Boundary    |
| Vegetated Plot Sample   | Asbuilt Contours | Access Road          |







*Albemarle Restorations, LLC*

Wetland Restoration  
Stream Restoration  
Wildlife Habitat



**Hudson Stream Restoration Project**  
**Current Condition Plan View**  
 Project # 95361  
 Aug. 5, 2016

FLOW Monitoring Station	Woody Riffles	Centerline of stream
Rain Gauge	LogDrops	Stream top of bank
Bank Pin Array	Cross Sections	Easement Boundary
Vegetated Plot Sample	Asbuilt Contours	Access Road





Photo 1: Cross section near culvert at convergence of Reach 1&2



Photo 2: As-Built cross section on Reach 2



Photo 3: View South along Reach 3



Photo 4: Cross section on Reach 4



Photo 5: View northwest on Reach 5



Photos 6: View southeast on Reach 5

## **Appendix C: Vegetation Plot Data**

EEP Project Code 95361. Project Name: Hudson

			Current Plot Data (MY0 2016)														
Scientific Name	Common Name	Species Type	95361-01-0001			95361-01-0002			95361-01-0003			95361-01-0004			95361-01-0005		
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Liriodendron tulipifera	tuliptree	Tree	4	4	4	3	3	3	4	4	4	1	1	1	3	3	3
Platanus occidentalis	American sycamore	Tree	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3
Quercus alba	white oak	Tree	2	2	2	3	3	3				4	4	4			
Quercus bicolor	swamp white oak	Tree	4	4	4	2	2	2							1	1	1
Quercus michauxii	swamp chestnut oak	Tree															
Quercus nigra	water oak	Tree	1	1	1										2	2	2
Quercus phellos	willow oak	Tree	2	2	2				2	2	2	5	5	5	5	5	5
<b>Stem count</b>			17	17	17	12	12	12	10	10	10	13	13	13	14	14	14
<b>size (ares)</b>			1			1			1			1			1		
<b>size (ACRES)</b>			0.02			0.02			0.02			0.02			0.02		
<b>Species count</b>			6	6	6	4	4	4	3	3	3	4	4	4	5	5	5
<b>Stems per ACRE</b>			688	688	688	486	486	486	405	405	405	526	526	526	567	567	567

EEP Project Code 95361. Project Name: Hudson

			Current Plot Data (MY0 2016)														
Scientific Name	Common Name	Species Type	95361-01-0006			95361-01-0007			95361-01-0008			95361-01-0009			95361-01-0010		
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Liriodendron tulipifera	tuliptree	Tree	2	2	2										13	13	13
Platanus occidentalis	American sycamore	Tree	2	2	2	12	12	12	5	5	5	2	2	2			
Quercus alba	white oak	Tree															
Quercus bicolor	swamp white oak	Tree				1	1	1				2	2	2			
Quercus michauxii	swamp chestnut oak	Tree							1	1	1				2	2	2
Quercus nigra	water oak	Tree							5	5	5	5	5	5			
Quercus phellos	willow oak	Tree	7	7	7	4	4	4	2	2	2	3	3	3	2	2	2
<b>Stem count</b>			11	11	11	17	17	17	13	13	13	12	12	12	17	17	17
<b>size (ares)</b>			1			1			1			1			1		
<b>size (ACRES)</b>			0.02			0.02			0.02			0.02			0.02		
<b>Species count</b>			3	3	3	3	3	3	4	4	4	4	4	4	3	3	3
<b>Stems per ACRE</b>			445	445	445	688	688	688	526	526	526	486	486	486	688	688	688

EEP Project Code 95361. Project Name: Hudson

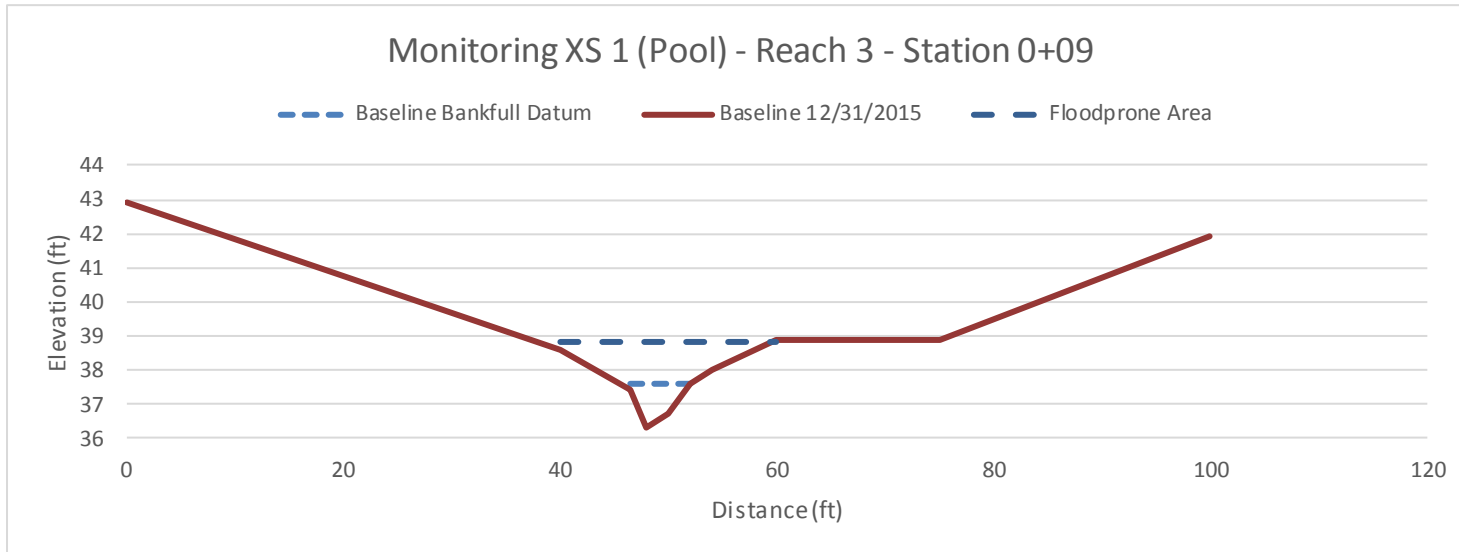
Scientific Name	Common Name	Species Type	Current Plot Data (MYO 2016)									Annual Means		
			0004638-01-0011			0004638-01-0012			0004638-01-0013			MYO (2016)		
			PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T	PnoLS	P-all	T
Liriodendron tulipifera	tuliptree	Tree	2	2	2	1	1	1				33	33	33
Platanus occidentalis	American sycamore	Tree	8	8	8	3	3	3	4	4	4	54	54	54
Quercus alba	white oak	Tree				2	2	2	5	5	5	16	16	16
Quercus bicolor	swamp white oak	Tree	2	2	2	7	7	7				19	19	19
Quercus michauxii	swamp chestnut oak	Tree	1	1	1	4	4	4	5	5	5	13	13	13
Quercus nigra	water oak	Tree	3	3	3	2	2	2				18	18	18
Quercus phellos	willow oak	Tree				1	1	1				33	33	33
<b>Stem count</b>			16	16	16	20	20	20	14	14	14	186	186	186
<b>size (ares)</b>			1			1			1			13		
<b>size (ACRES)</b>			0.02			0.02			0.02			0.32		
<b>Species count</b>			5	5	5	7	7	7	3	3	3	7	7	7
<b>Stems per ACRE</b>			647	647	647	809	809	809	567	567	567	579	579	579

**Color for Density**

- Exceeds requirements by 10%
- Exceeds requirements, but by less than 10%
- Fails to meet requirements, by less than 10%
- Fails to meet requirements by more than 10%

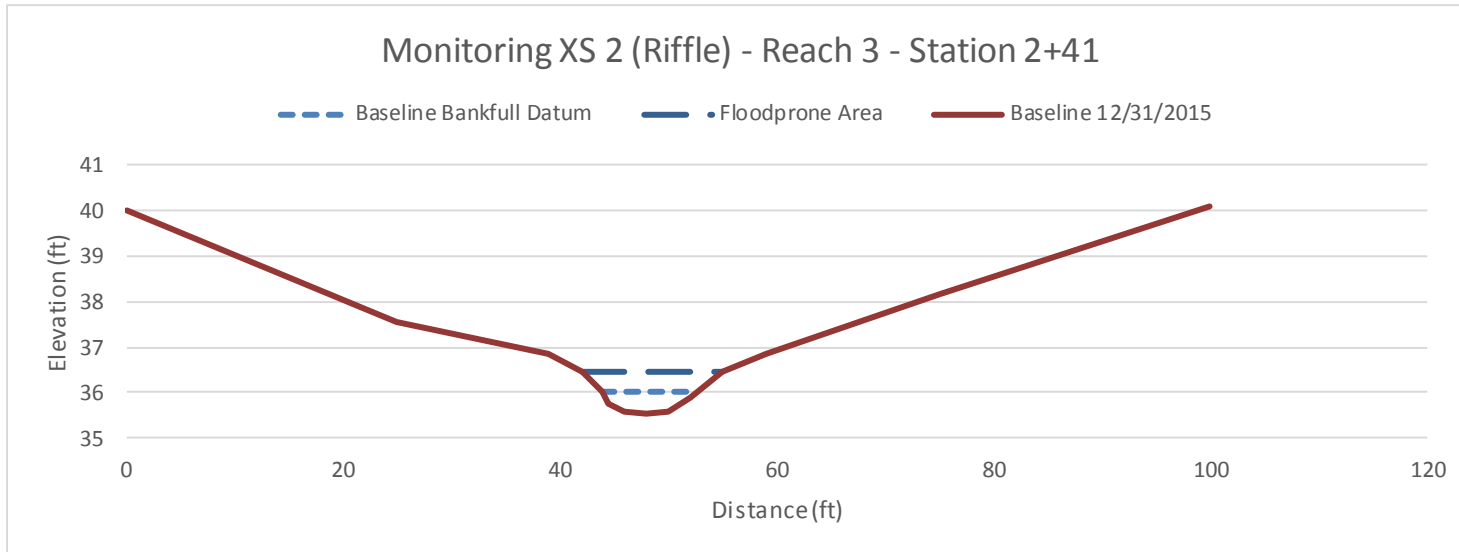
## **Appendix D: Stream Measurement and Geomorphology Data**





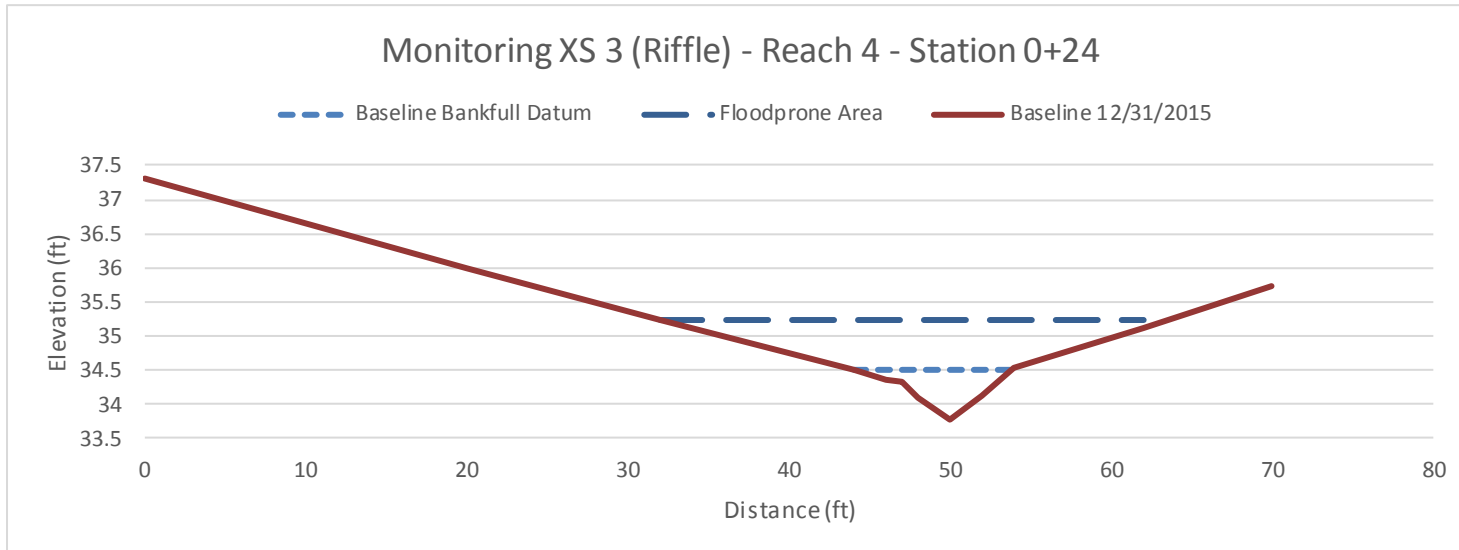
Station	Elevation
0	42.91
25	40.23
40	38.61
46.5	37.43
48	36.33
50	36.74
52	37.57
54	38
60	38.86
75	38.86
100	41.93

SUMMARY DATA	
Bankfull Elevation	37.57
Bankfull Cross Sectional Area	4
Bankfull Width	6.3
Floodprone Area Elevation	38.81
Floodprone Width	21.5
Max Depth at Bankfull	1.24
Mean Depth at Bankfull	0.64
W / D Ratio	9.8
Entrenchment Ratio	3.64
Bank Height Ratio	1



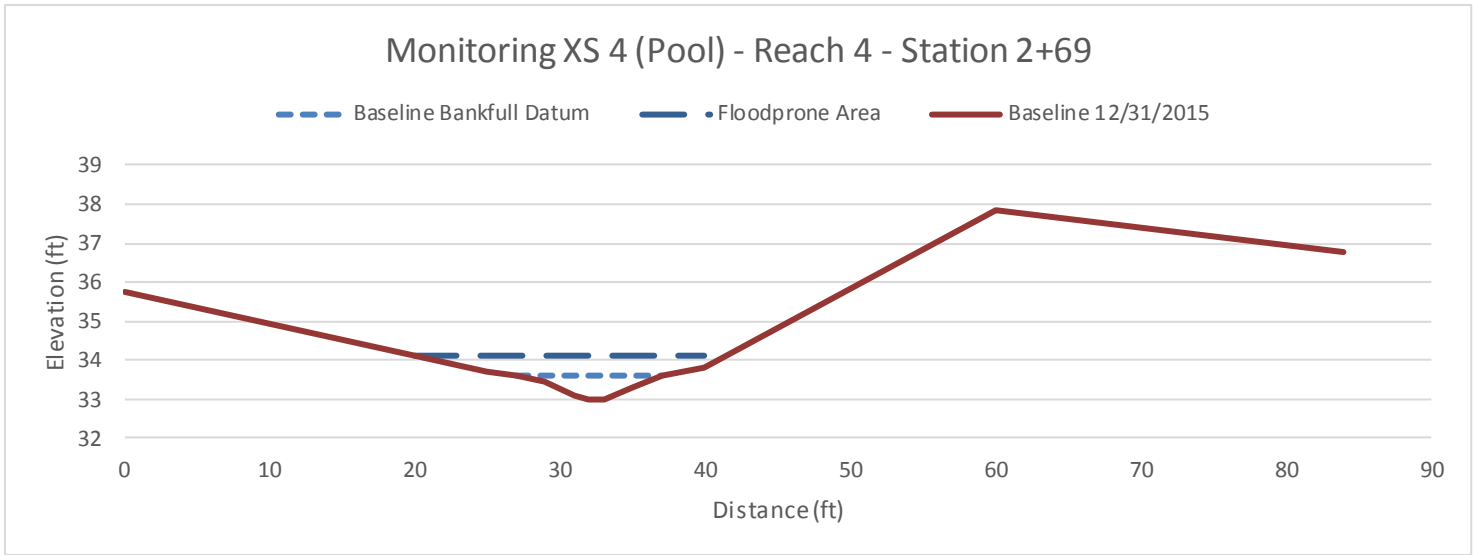
Station	Elevation
0	40.02
25	37.56
39	36.84
42	36.45
44	36
44.5	35.75
46	35.6
48	35.55
50	35.57
52	35.89
55	36.45
59	36.84
75	38.17
100	40.1

SUMMARY DATA	
Bankfull Elevation	36.4
Bankfull Cross Sectional Area	7.07
Bankfull Width	12.5
Floodprone Area Elevation	37.25
Floodprone Width	32.9
Max Depth at Bankfull	0.85
Mean Depth at Bankfull	0.57
W / D Ratio	21.95
Entrenchment Ratio	2.63
Bank Height Ratio	1



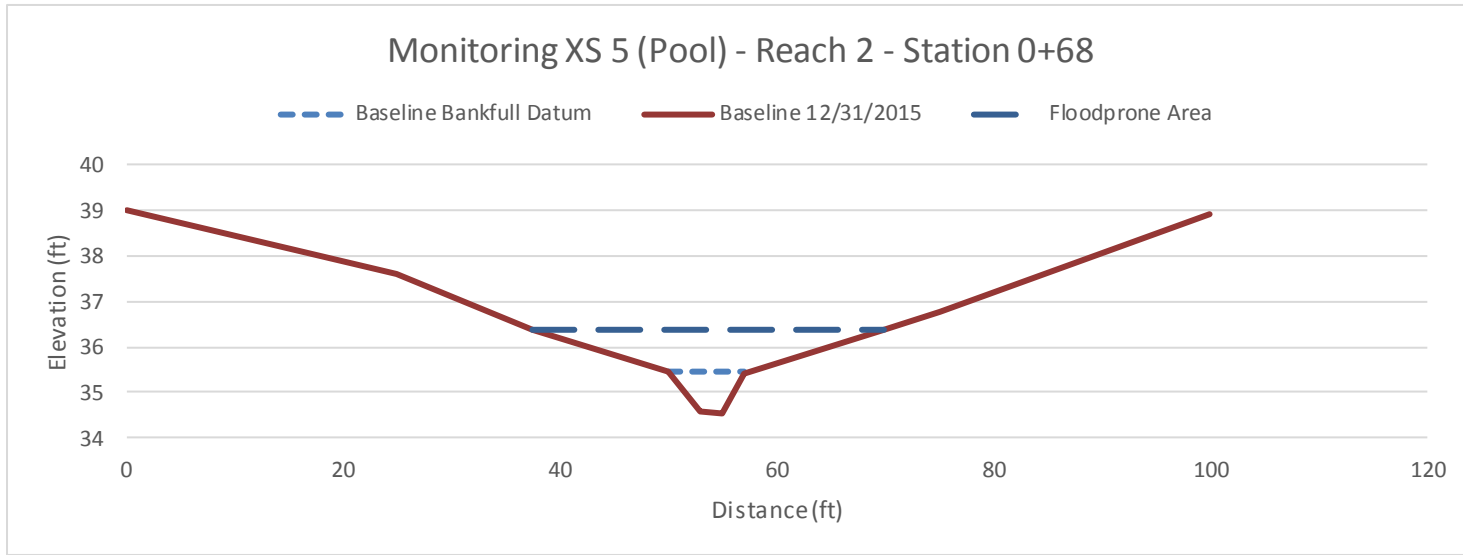
Station	Elevation
0	37.3
20	35.99
32	35.245
44	34.5
46	34.36
47	34.34
48	34.1
50	33.76
52	34.13
54	34.52
62	35.13
70	35.74

SUMMARY DATA	
Bankfull Elevation	34.5
Bankfull Cross Sectional Area	3.17
Bankfull Width	9.9
Floodprone Area Elevation	35.25
Floodprone Width	31.36
Max Depth at Bankfull	0.74
Mean Depth at Bankfull	0.32
W / D Ratio	30.9
Entrenchment Ratio	3.17
Bank Height Ratio	1



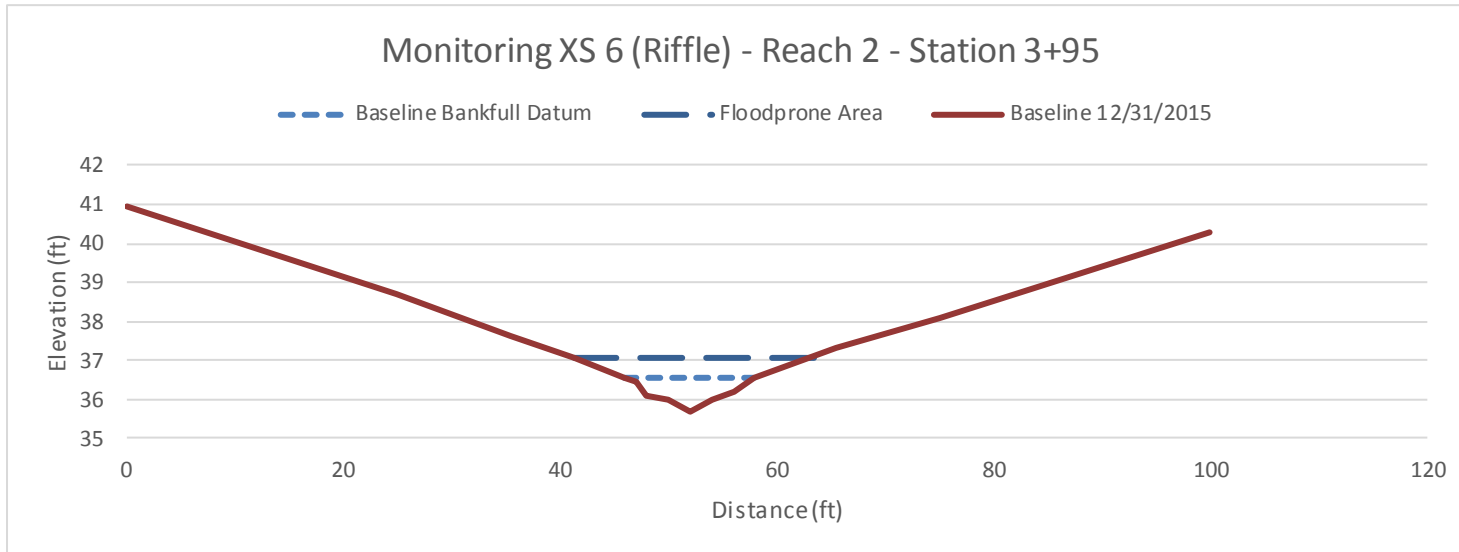
Station	Elevation
0	35.73
20	34.09
25	33.69
27	33.62
29	33.43
31	33.1
32	33
33	33
35	33.29
37	33.6
40	33.78
60	37.87
84	36.78

SUMMARY DATA	
Bankfull Elevation	33.6
Bankfull Cross Sectional Area	3.19
Bankfull Width	9.79
Floodprone Area Elevation	34.2
Floodprone Width	23.4
Max Depth at Bankfull	0.6
Mean Depth at Bankfull	0.33
W / D Ratio	29.67
Entrenchment Ratio	2.39
Bank Height Ratio	1



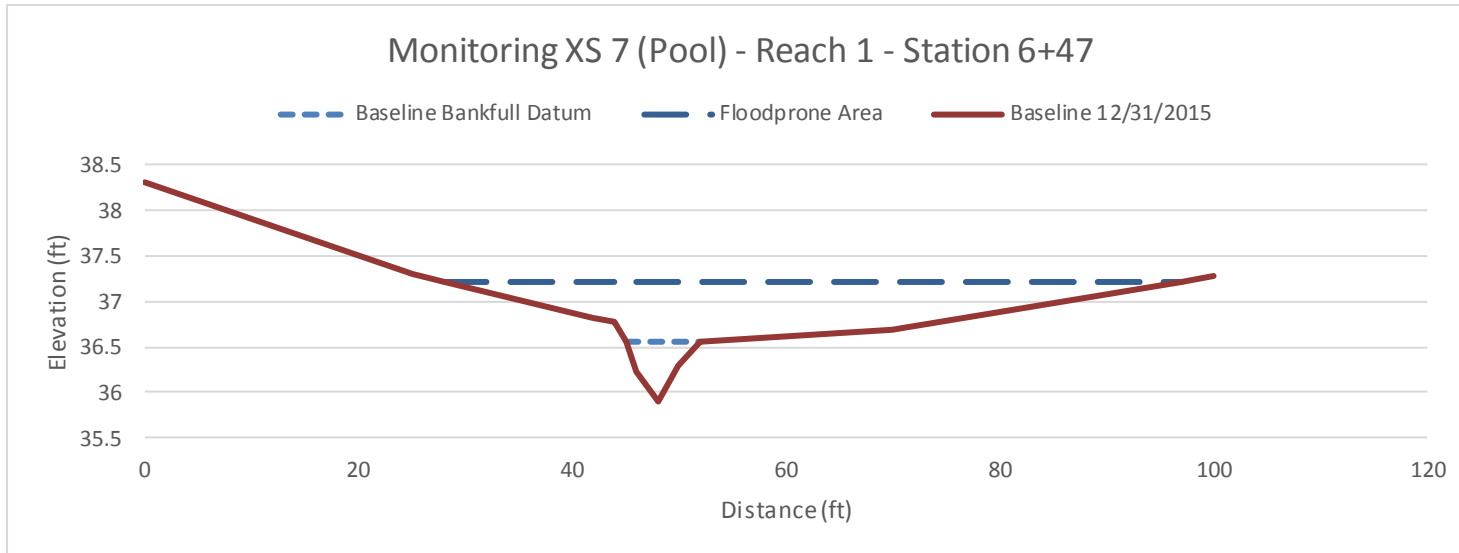
Station	Elevation
0	39.02
25	37.62
37.5	36.36
50	35.46
53	34.6
55	34.56
57	35.42
70	36.36
75	36.78
100	38.92

SUMMARY DATA	
Bankfull Elevation	35.46
Bankfull Cross Sectional Area	4
Bankfull Width	7.55
Floodprone Area Elevation	36.36
Floodprone Width	32.5
Max Depth at Bankfull	0.9
Mean Depth at Bankfull	0.53
W / D Ratio	14.25
Entrenchment Ratio	4.3
Bank Height Ratio	1



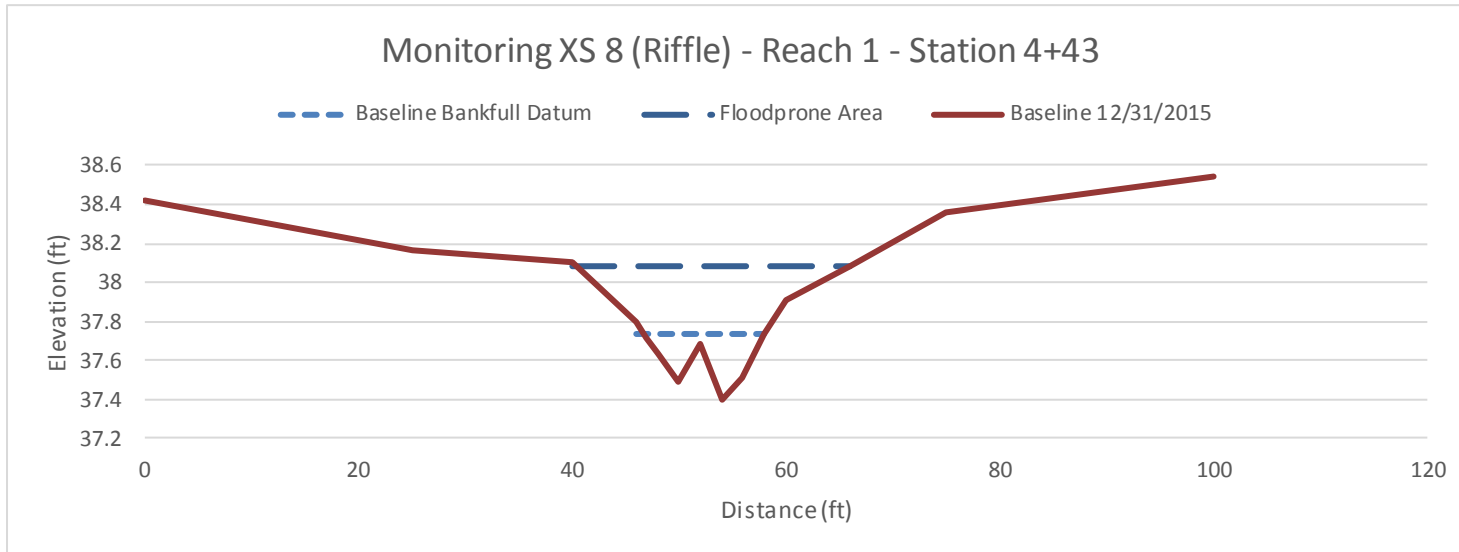
Station	Elevation
0	40.95
25	38.72
35.5	37.625
41.25	37.08
46	36.53
47	36.47
48	36.09
50	35.98
52	35.67
54	35.97
56	36.2
58	36.57
65.5	37.335
75	38.1
100	40.28

SUMMARY DATA	
Bankfull Elevation	36.53
Bankfull Cross Sectional Area	5.28
Bankfull Width	11.78
Floodprone Area Elevation	37.39
Floodprone Width	38.2
Max Depth at Bankfull	0.86
Mean Depth at Bankfull	0.35
W / D Ratio	26.18
Entrenchment Ratio	2.39
Bank Height Ratio	1



Station	Elevation
0	38.31
25	37.31
28	37.21
42	36.82
44	36.78
45	36.56
46	36.24
48	35.91
50	36.29
52	36.56
70	36.69
97	37.21
100	37.29

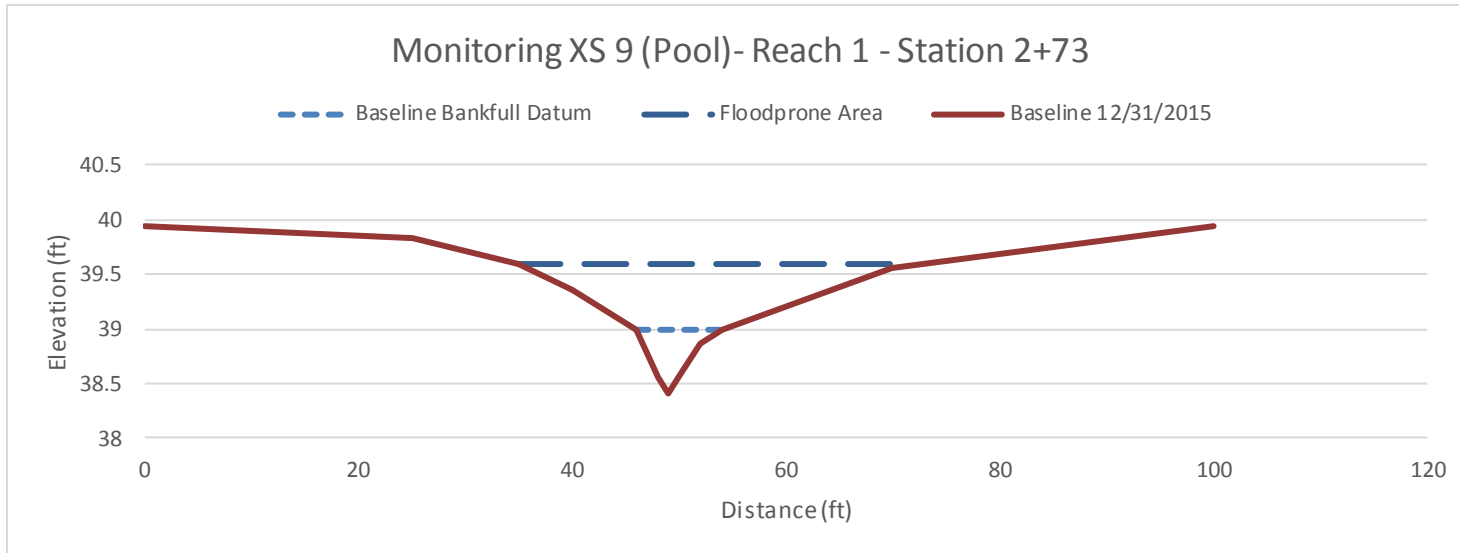
SUMMARY DATA	
Bankfull Elevation	36.56
Bankfull Cross Sectional Area	2.37
Bankfull Width	7
Floodprone Area Elevation	37.21
Floodprone Width	69
Max Depth at Bankfull	0.65
Mean Depth at Bankfull	0.33
W / D Ratio	21.21
Entrenchment Ratio	9.86
Bank Height Ratio	1



Station	Elevation
0	38.42
25	38.16
40	38.1
46	37.8
47	37.71
48	37.63
50	37.49
52	37.68
54	37.4
56	37.51
58	37.74
60	37.91
66	38.08
75	38.36
100	38.54

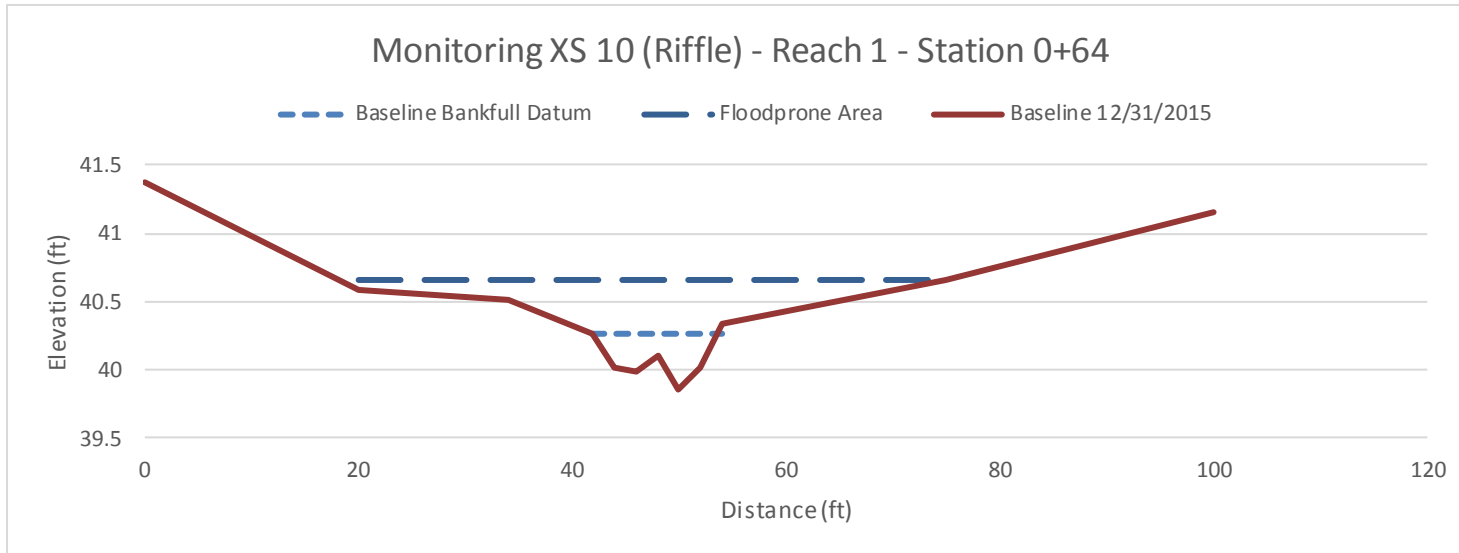
SUMMARY DATA	
Bankfull Elevation	37.91
Bankfull Cross Sectional Area	4.26
Bankfull Width	16.2
Floodprone Area Elevation	38.42
Floodprone Width	83.33
Max Depth at Bankfull	0.51
Mean Depth at Bankfull	0.26
W / D Ratio	62.31
Entrenchment Ratio	5.14
Bank Height Ratio	1





Station	Elevation
0	39.94
25	39.84
35	39.59
40	39.36
46	39
48	38.56
49	38.41
50	38.56
52	38.86
54	39
70	39.56
100	39.94

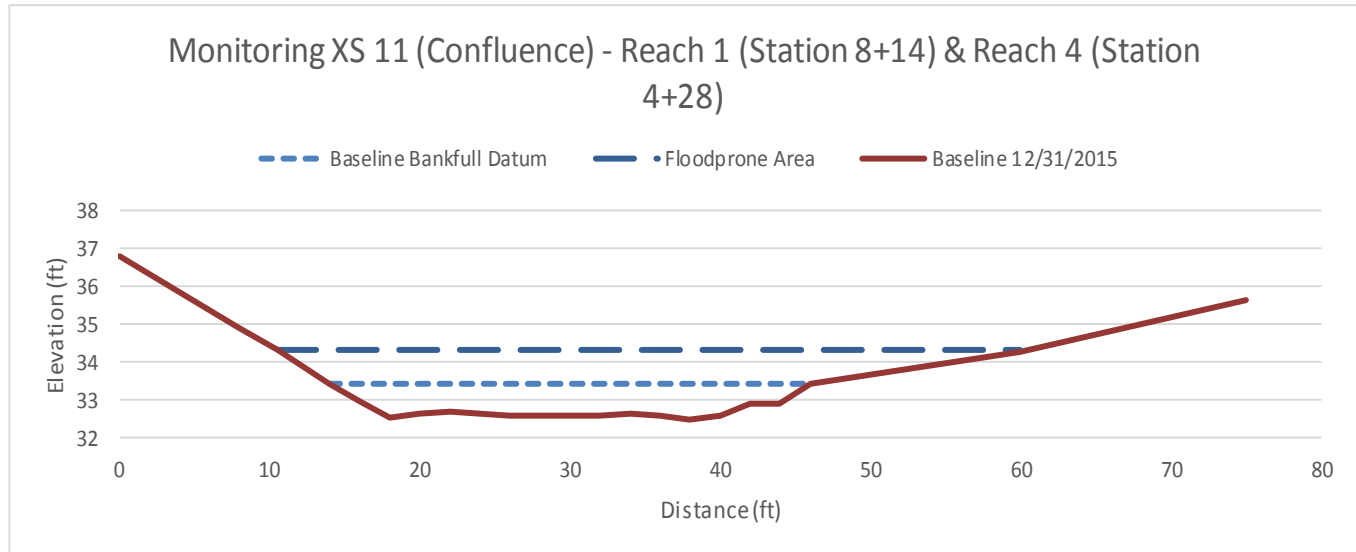
SUMMARY DATA	
Bankfull Elevation	39
Bankfull Cross Sectional Area	2.19
Bankfull Width	8
Floodprone Area Elevation	39.59
Floodprone Width	37.37
Max Depth at Bankfull	0.59
Mean Depth at Bankfull	0.27
W / D Ratio	29.63
Entrenchment Ratio	4.67
Bank Height Ratio	1



Station	Elevation
0	41.38
20	40.58
34	40.52
42	40.26
44	40.02
46	39.98
48	40.1
50	39.86
52	40.02
54	40.34
75	40.66
100	41.16

SUMMARY DATA	
Bankfull Elevation	40.26
Bankfull Cross Sectional Area	2.58
Bankfull Width	11.5
Floodprone Area Elevation	40.66
Floodprone Width	57
Max Depth at Bankfull	0.4
Mean Depth at Bankfull	0.22
W / D Ratio	52.27
Entrenchment Ratio	4.96
Bank Height Ratio	1

Station	Elevation
0	36.81
8	34.895
10.5	34.31
14	33.42
16	32.98
18	32.53
20	32.63
22	32.72
24	32.64
26	32.62
28	32.57
30	32.57
32	32.61
34	32.66
36	32.59
38	32.51
40	32.6
42	32.9
44	32.9
46	33.42
60	34.26
75	35.66



SUMMARY DATA	
Bankfull Elevation	33.42
Bankfull Cross Sectional Area	22.54
Bankfull Width	32
Floodprone Area Elevation	34.33
Floodprone Width	50.34
Max Depth at Bankfull	0.91
Mean Depth at Bankfull	0.7
W / D Ratio	45.71
Entrenchment Ratio	1.57
Bank Height Ratio	1

Table 10a. Baseline Stream Data Summary  
 Project Name/Number (Hudson/ DMS:95361) - Segment/Reach: Reach 1

Parameter	Gauge <sup>2</sup>	Regional Curve			Pre-Existing Condition						Reference Reach(es) Data						Design			Monitoring Baseline					
		LL	UL	Eq.	Min	Mean	Med	Max	SD <sup>5</sup>	n	Min	Mean	Med	Max	SD <sup>5</sup>	n	Min	Med	Max	Min	Mean	Med	Max	SD <sup>5</sup>	n
<b>Dimension and Substrate - Riffle Only</b>																									
Bankfull Width (ft)					3.36		3.83	6.02			19.74		21.97	24.2				9.02	Max	11.5			16.2		2
Floodprone Width (ft)					6.47		6.91	10.5			44		64.5	85			18.06	26.74	34.89	57			83.33		2
Bankfull Mean Depth (ft)					0.45		0.52	0.6			0.7		0.75	0.82				0.42		0.22			0.26		2
<sup>1</sup> Bankfull Max Depth (ft)					0.56		0.87	1.07			0.85		1.02	1.18			0.44	0.53	0.61	0.4			0.51		2
Bankfull Cross Sectional Area (ft <sup>2</sup> )					1.99		2	2.68			16.09		16.49	16.89				3.8		2.58			4.26		2
Width/Depth Ratio					5.64		7.37	13.52			24.22		29.27	34.67				21.4		52.27			62.31		2
Entrenchment Ratio					1.74		1.8	1.93			2		2.94	3.87			2	2.94	3.87	4.96			5.14		2
<sup>1</sup> Bank Height Ratio																				1			1		2
<b>Profile</b>																									
Riffle Length (ft)					N/A*						12		46.5	81			4.93	19.09	33.25						
Riffle Slope (ft/ft)					N/A*						0.004		0.011	0.017			0.006	0.016	0.025						
Pool Length (ft)					N/A*						21		30.5	40			4.72	8.41	14.98						
Pool Max depth (ft)					N/A*						1.4		1.65	1.9			0.72	0.93	1.15						
Pool Spacing (ft)					N/A*						40		59	78			16.42	26.95	35.63						
<b>Pattern</b>																									
Channel Beltwidth (ft)					N/A*						27		49	76			11.08	20.11	31.19						
Radius of Curvature (ft)					N/A*						90		92	95			36.94	37.76	38.99						
Rc:Bankfull width (ft/ft)					N/A*												4.10	4.19	4.32						
Meander Wavelength (ft)					N/A*						12.43		15.07	18.25			112.1	135.9	164.6						
Meander Width Ratio					N/A*												1.23	2.23	3.46						
<b>Transport parameters</b>																									
Reach Shear Stress (competency) lb/ft <sup>2</sup>								0.26										0.18							
Max part size (mm) mobilized at bankfull																									
Stream Power (transport capacity) W/m <sup>2</sup>								0.56										0.14							
<b>Additional Reach Parameters</b>																									
Rosgen Classification								G5-G6					C5-C6				C5-C6						C5/6		
Bankfull Velocity (fps)																									
Bankfull Discharge (cfs)								5.6																	
Valley length (ft)								840					264												
Channel Thalweg length (ft)								846					264					833					850		
Sinuosity (ft)								1.01					1				1.04					1.04			
Water Surface Slope (Channel) (ft/ft)								0.007					0.004				0.007								
BF slope (ft/ft)																							0.006		
<sup>3</sup> Bankfull Floodplain Area (acres)																									
<sup>4</sup> % of Reach with Eroding Banks																									
Channel Stability or Habitat Metric																									
Biological or Other																									



Table 10a. Baseline Stream Data Summary  
 Project Name/Number (Hudson/ DMS:95361) - Segment/Reach: Reach 2

Parameter	Gauge <sup>2</sup>	Regional Curve			Pre-Existing Condition						Reference Reach(es) Data						Design			Monitoring Baseline							
		LL	UL	Eq.	Min	Mean	Med	Max	SD <sup>5</sup>	n	Min	Mean	Med	Max	SD <sup>5</sup>	n	Min	Med	Max	Min	Mean	Med	Max	SD <sup>5</sup>	n		
<b>Dimension and Substrate - Riffle Only</b>																											
Bankfull Width (ft)					5.97		6.87	7.2			19.74		21.97	24.2				14.83						11.78		1	
Floodprone Width (ft)					10.03		12.03	13.47			44		64.5	85			29.71	43.55	57.39						28.2		1
Bankfull Mean Depth (ft)					0.91		0.92	0.94			0.7		0.75	0.82				0.67							0.45		1
<sup>1</sup> Bankfull Max Depth (ft)					1.38		1.42	1.54			0.85		1.02	1.18			0.7	0.84	0.98						0.86		1
Bankfull Cross Sectional Area (ft <sup>2</sup> )					5.59		6.32	6.58			16.09		16.49	16.89				10							5.28		1
Width/Depth Ratio					6.38		7.47	7.88			24.22		29.27	34.67				22							26.18		1
Entrenchment Ratio					1.67		1.68	1.96			2		2.94	3.87				2.94							2.39		1
<sup>1</sup> Bank Height Ratio																								1		1	
<b>Profile</b>																											
Riffle Length (ft)					N/A*						12		46.5	81			8.1	31.39	54.68								
Riffle Slope (ft/ft)					N/A*						0.004		0.011	0.017			0.003	0.008	0.012								
Pool Length (ft)					N/A*						21		30.5	40			14.18	20.59	27								
Pool Max depth (ft)					N/A*						1.4		1.65	1.9			1.16	1.48	1.84								
Pool Spacing (ft)					N/A*						40		59	78			27	44.33	58.61								
<b>Pattern</b>																											
Channel Beltwidth (ft)					N/A*						27		49	76			18.23	33.08	51.31								
Radius of Curvature (ft)					N/A*						90		92	95			60.76	62.11	64.14								
Rc:Bankfull width (ft/ft)					N/A*												4.10	4.19	4.32								
Meander Wavelength (ft)					N/A*						12.43		15.07	18.25			184.3	223.5	270.7								
Meander Width Ratio					N/A*												1.23	2.23	3.46								
<b>Transport parameters</b>																											
Reach Shear Stress (competency) lb/ft <sup>2</sup>							0.42											0.11									
Max part size (mm) mobilized at bankfull																											
Stream Power (transport capacity) W/m <sup>2</sup>							1.25											0.18									
<b>Additional Reach Parameters</b>																											
Rosgen Classification							G5-G6						C5-C6				C5-C6									C 5/6	
Bankfull Velocity (fps)																											
Bankfull Discharge (cfs)							17.2																				
Valley length (ft)							486						264														
Channel Thalweg length (ft)							516						264					532								541	
Sinuosity (ft)							1.06						1					1.05								1.05	
Water Surface Slope (Channel) (ft/ft)							0.003						0.004					0.003									
BF slope (ft/ft)																										0.0035	
<sup>3</sup> Bankfull Floodplain Area (acres)																											
<sup>4</sup> % of Reach with Eroding Banks																											
Channel Stability or Habitat Metric																											
Biological or Other																											



Table 10a. Baseline Stream Data Summary  
 Project Name/Number (Hudson/ DMS:95361) - Segment/Reach: Reach 3

Parameter	Gauge <sup>2</sup>	Regional Curve			Pre-Existing Condition						Reference Reach(es) Data						Design			Monitoring Baseline						
		LL	UL	Eq.	Min	Mean	Med	Max	SD <sup>5</sup>	n	Min	Mean	Med	Max	SD <sup>5</sup>	n	Min	Med	Max	Min	Mean	Med	Max	SD <sup>5</sup>	n	
<b>Dimension and Substrate - Riffle Only</b>																										
Bankfull Width (ft)					3.55		4.03	5.05			19.74		21.97	24.2				10						12.5		1
Floodprone Width (ft)					5.97		6.44	9.13			44		64.5	85			20.03	29.36	38.69					32.9		1
Bankfull Mean Depth (ft)					0.55		0.79	0.84			0.7		0.75	0.82				0.5						0.57		1
<sup>1</sup> Bankfull Max Depth (ft)					0.88		1.15	1.44			0.85		1.02	1.18			0.52	0.63	0.72					0.85		1
Bankfull Cross Sectional Area (ft <sup>2</sup> )					1.94		3.17	4.26			16.09		16.49	16.89				5						7.07		1
Width/Depth Ratio					5.12		5.99	6.5			24.22		29.27	34.67				20						21.95		1
Entrenchment Ratio					1.6		1.68	1.8			2		2.94	3.87			2	2.94	3.87					2.63		1
<sup>1</sup> Bank Height Ratio																							1			1
<b>Profile</b>																										
Riffle Length (ft)					N/A*						12		46.5	81			5.46	21.17	36.87							
Riffle Slope (ft/ft)					N/A*						0.004		0.011	0.017			0.005	0.014	0.021							
Pool Length (ft)					N/A*						21		30.5	40			9.56	13.88	18.21							
Pool Max depth (ft)					N/A*						1.4		1.65	1.9			0.86	1.1	1.36							
Pool Spacing (ft)					N/A*						40		59	78			18.21	29.89	39.51							
<b>Pattern</b>																										
Channel Beltwidth (ft)					N/A*						27		49	76			12.29	22.3	24.59							
Radius of Curvature (ft)					N/A*						90		92	95			40.96	41.88	43.24							
Rc:Bankfull width (ft/ft)					N/A*												4.10	4.19	4.32							
Meander Wavelength (ft)					N/A*						12.43		15.07	18.25			124.3	150.7	182.5							
Meander Width Ratio					N/A*												1.23	2.23	3.46							
<b>Transport parameters</b>																										
Reach Shear Stress (competency) lb/ft <sup>2</sup>								0.37										0.14								
Max part size (mm) mobilized at bankfull																										
Stream Power (transport capacity) W/m <sup>2</sup>								1.02										0.18								
<b>Additional Reach Parameters</b>																										
Rosgen Classification							G5-G6						C5-C6				C5-C6								C 5/6	
Bankfull Velocity (fps)																										
Bankfull Discharge (cfs)							8																			
Valley length (ft)							442						264													
Channel Thalweg length (ft)							460						264					445							446	
Sinuosity (ft)							1.04						1					1.01							1.08	
Water Surface Slope (Channel) (ft/ft)							0.007						0.004					0.007								
BF slope (ft/ft)																									0.005	
<sup>3</sup> Bankfull Floodplain Area (acres)																										
<sup>4</sup> % of Reach with Eroding Banks																										
Channel Stability or Habitat Metric																										
Biological or Other																										





Table 10a. Baseline Stream Data Summary  
 Project Name/Number (Hudson/ DMS:95361) - Segment/Reach: Reach 4

Parameter	Gauge <sup>2</sup>	Regional Curve			Pre-Existing Condition					Reference Reach(es) Data					Design			Monitoring Baseline									
		LL	UL	Eq.	Min	Mean	Med	Max	SD <sup>5</sup>	n	Min	Mean	Med	Max	SD <sup>5</sup>	n	Min	Med	Max	Min	Mean	Med	Max	SD <sup>5</sup>	n		
<b>Dimension and Substrate - Riffle Only</b>																											
Bankfull Width (ft)					7.34		7.48	8.84			19.74		21.97	24.2				21.82						9.9		1	
Floodprone Width (ft)					12.21		13.83	16.28			44		64.5	85			43.69	64.05	84.41					31.36		1	
Bankfull Mean Depth (ft)					0.97		1	1.05			0.7		0.75	0.82				0.78						0.32		1	
<sup>1</sup> Bankfull Max Depth (ft)					1.47		1.51	1.82			0.85		1.02	1.18			0.81	0.98	1.13					0.74		1	
Bankfull Cross Sectional Area (ft <sup>2</sup> )					7.49		7.69	8.58			16.09		16.49	16.89				17						3.17		1	
Width/Depth Ratio					7.01		7.47	9.11			24.22		29.27	34.67				28						30.9		1	
Entrenchment Ratio					1.63		1.84	1.88			2		2.94	3.87			2	2.94	3.87					3.17		1	
<sup>1</sup> Bank Height Ratio																								1		1	
<b>Profile</b>																											
Riffle Length (ft)							N/A*				12		46.5	81			11.92	46.18	80.44								
Riffle Slope (ft/ft)							N/A*				0.004		0.011	0.017			0.006	0.016	0.025								
Pool Length (ft)							N/A*				21		30.5	40			20.85	30.29	39.72								
Pool Max depth (ft)							N/A*				1.4		1.65	1.9			1.34	1.71	2.12								
Pool Spacing (ft)							N/A*				40		59	78			39.72	65.21	86.21								
<b>Pattern</b>																											
Channel Beltwidth (ft)							N/A*				27		49	76			26.8	48.66	75.47								
Radius of Curvature (ft)							N/A*				90		92	95			89.37	91.36	94.34								
Rc:Bankfull width (ft/ft)							N/A*										4.096	4.188	4.324								
Meander Wavelength (ft)							N/A*				12.43		15.07	18.25			271.1	328.7	398.2								
Meander Width Ratio							N/A*										1.23	2.23	3.46								
<b>Transport parameters</b>																											
Reach Shear Stress (competency) lb/ft <sup>2</sup>								0.48										0.16									
Max part size (mm) mobilized at bankfull																											
Stream Power (transport capacity) W/m <sup>2</sup>								1.01										0.22									
<b>Additional Reach Parameters</b>																											
Rosgen Classification								G5-G6						C5-C6				C5-C6									C 5/6
Bankfull Velocity (fps)																											
Bankfull Discharge (cfs)								26.2																			
Valley length (ft)								434					264														
Channel Thalweg length (ft)								503					264					437									447
Sinuosity (ft)								1.16					1					1.01									1.01
Water Surface Slope (Channel) (ft/ft)								0.003					0.004					0.003									
BF slope (ft/ft)																											0.0035
<sup>3</sup> Bankfull Floodplain Area (acres)																											
<sup>4</sup> % of Reach with Eroding Banks																											
Channel Stability or Habitat Metric																											
Biological or Other																											

Table 11a. Monitoring Data - Dimensional Morphology Summary (Dimensional Parameters – Cross Sections)  
 Project Name/Number (Hudson/ DMS:95361) Segment/Reach: Reach 1-4 (2200 feet)

Based on fixed baseline bankfull elevation <sup>1</sup> Record elevation (datum) used	Cross Section 1 (Pool)				Cross Section 2 (Riffle)				Cross Section 3 (Riffle)				Cross Section 4 (Pool)				Cross Section 5 (Pool)																												
	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+										
	Bankfull Width (ft)	39							39							39							39						39																
Floodproof Width (ft)	6.3							9.9							7.5							7.5						N/A																	
Bankfull Mean Depth (ft)	0.9							0.3							0.6							0.6						0.6																	
Bankfull Max Depth (ft)	1.2							0.2							0.9							0.9						0.4																	
Bankfull Cross Sectional Area (ft <sup>2</sup> )	27.1							3.2							3.2							3.2					4.4																		
Bankfull Width/Depth Ratio	N/A							39.9							N/A							N/A					N/A																		
Bankfull Entrenchment Ratio	N/A							1.7							N/A							N/A					N/A																		
Bankfull Bank Height Ratio	1							1							1							1					1																		
Cross Sectional Area between and pins (ft <sup>2</sup> )	d50 (mm)																																												
Based on fixed baseline bankfull elevation <sup>1</sup> Record elevation (datum) used	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+	Base	MY1	MY2	MY3	MY4	MY5	MY+			
Bankfull Width (ft)	39							39							39							39						39																	
Floodproof Width (ft)	11.6							7.2							11.3							9.6						11.5																	
Bankfull Mean Depth (ft)	30							N/A							25							N/A					57																		
Bankfull Max Depth (ft)	0.4							0.3							0.2							0.2					0.2																		
Bankfull Cross Sectional Area (ft <sup>2</sup> )	5.3							0.6							0.3						0.6						0.4																		
Bankfull Width/Depth Ratio	26.3							2.3							2.3						2.3						2.6																		
Bankfull Entrenchment Ratio	2.5							1.7							N/A						N/A						N/A																		
Bankfull Bank Height Ratio	1							1							1							1					1																		
Cross Sectional Area between and pins (ft <sup>2</sup> )	d50 (mm)																																												

**Exhibit Table 11b. Monitoring Data - Stream Reach Data Summary**  
**Project Name/Number (Hudson/ DMS-95361) Segment/Reach: Reach 1-4 (2200 feet)**

Parameter	Baseline					MY-1					MY-2					MY-3					MY-4					MY-5				
	Min	Mean	Med	Max	n	Min	Mean	Med	Max	n	Min	Mean	Med	Max	n	Min	Mean	Med	Max	n	Min	Mean	Med	Max	n	Min	Mean	Med	Max	n
<b>Dimension and Substrate - Riffle only</b>																														
Bankfull Width (ft)	8.8	10.66	11.3	11.8	1.27	5																								
Floodplain Width (ft)	15	31.8	30	57	15.5	5																								
Bankfull Mean Depth (ft)	0.2	0.28	0.3	0.4	10.084	5																								
Bankfull Max Depth (ft)	0.3	0.56	0.5	0.9	0.24	5																								
Bankfull Cross Sectional Area (ft <sup>2</sup> )	1.9	3.18	2.9	5.3	1.28	5																								
Width/Depth Ratio	26.3	40.32	30.9	51.3	17.6	5																								
Entrenchment Ratio	2.2	2.92	2.5	5	1.3	5																								
<sup>1</sup> Bank Height Ratio	1	1	1	1	0	5																								
<b>Profile</b>																														
Riffle Length (ft)																														
Riffle Slope (ft/ft)																														
Pool Length (ft)																														
Pool Max depth (ft)																														
Pool Spacing (ft)																														
<b>Pattern</b>																														
Channel Beltwidth (ft)																														
Radius of Curvature (ft)																														
Rc-Bankfull width (ft/ft)																														
Meander Wavelength (ft)																														
Meander Width Ratio																														
<b>Additional Reach Parameters</b>																														
Rosgen Classification																														
Channel Thweg length (ft)																														
Sinuosity (ft)																														
Water Surface Slope (Channel) (ft/ft)																														
BF slope (ft/ft)																														
<sup>1</sup> B% / Rc% / P% / G% / S%																														
<sup>1</sup> SC% / Ssk% / G% / C% / B% / Bsk%																														
<sup>2</sup> d16 / d57 / d90 / d84 / d95 /																														
<sup>2</sup> % of Reach with Eroding Banks																														
Channel Stability or Habitat Metric																														
Biological or Other																														

-Pattern data will not typically be collected unless visual data, dimensional data or profile data indicate significant shifts from baseline

## **Appendix E: As-built Plan Sheets**