*Mitigation Report*

# Rockwell Pastures Site

**Stanly County, North Carolina**
**USGS HUC: 03040104010020**
**Project ID# D-000624**

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# Executive Summary

The Rockwell Pastures Stream and Wetland Restoration Site (Site) is located 6 miles southeast of Albemarle in Stanly County. The Site easements are located within parcels owned by Charles R. Dennis and wife, Dennis Farms Inc., Deese Family LP, and Reece Vane Deese and wife. The project Site lies within the USGS hydrologic unit (HUC) **03040104010020** in the Yadkin River Basin.

Prior to restoration, the Site included ten (10) degraded unnamed tributaries (UT1, UT2, UT3, UT4, UT5, UT6, UT7, UT8, UT9, and UT10) and a drained and cultivated non-riparian wetland located in a separate valley between UT6 and UT1. The Site stream system includes several first-order streams and a second-order stream that are tributary to David's Creek and Lake Tillery (**Figure 1**).

The upper part of the watershed (the Dennis properties) currently is in agriculture and silviculture uses. Little to no appropriate riparian vegetation was present along the stream banks because row crops were planted to the existing stream edges of the upper part of UT1, as well as those of UT5, UT6, and UT7. These same streams were directly impacted and straightened in some locations as a result of the surrounding land practices. Silvicultural activities, including direct impacts to the stream bed, had completely destabilized UT4 and had resulted in a removal of native bottomland and headwater forest vegetation. The upper reach of UT4 had been impounded, creating two agricultural ponds. The restored non-riparian wetland between UT1 and UT6 had been drained by ditching and crowning and placed into agricultural use. The ongoing silvicultural and agricultural activities resulted in sedimentation from surrounding runoff as well as stream instability. These activities also allowed for direct inputs of nutrients and other pollutants. Additionally, the lack of forested buffers resulted in elevated temperature and lack of habitat and substrate.

The lower part of the project (the Deese properties) — which includes middle and lower UT1, UT2, UT3, UT7, UT8, UT9, and UT10 — primarily consists of pastureland where cattle had unlimited access to the streams. UT1 also had been historically straightened. As a result, the streams were highly sedimented and contaminated with livestock waste, which created a source of biochemical oxygen demand (BOD), fecal coliform, and nutrients among other pollutants. The buffer was vegetated with fescue or other grasses with few areas of sparsely populated trees resulting in instability, poor habitat, and elevated temperatures.

The altered conditions of the streams and the lack of riparian buffer reduced water quality and impaired habitat. Livestock access resulted in the direct input of nutrients, fecal coliform, and BOD into the streams. Additionally, hoof-shear created bank instability resulting in heavy sedimentation. Agricultural and silvicultural activities also resulted in direct and indirect addition of nutrients and sediment into the streams, degrading habitat and impairing water quality. Overall, these impacts also reduced dissolved oxygen within the water column, increased turbidity from bank erosion, and elevated water temperatures. Habitat potential was reduced by the diminished water quality and loss of physical habitat such as bed features, woody debris, and a well-developed riparian vegetative community. The restored non-riparian wetland area had its natural hydrology removed by ditching and crowning. Natural vegetation and habitat had been replaced by row crops.

# Goals and Objectives

Based on the above site conditions, the Goals and Objectives of the project were the following:

**Project Goals Achieved:**

- Provided ecological uplift by reducing sedimentation, BOD, fecal coliform, and nutrient input and re-establishing a diverse aquatic habitat.
- Provided ecological uplift to an entire watershed degraded by historical agricultural and silvicultural activity and livestock management.
- Provided ecological uplift by re-establishing habitat and diversity as well as improving water quality.
- Provided ecological uplift through the addition of forested riparian buffers planted with native species.
- Provided improved natural stream and riparian area function through the reconnection of the stream with the historic floodplain or new floodplain.
- Provided wetland hydrology and habitat to a drained and altered wetland.
- Provided ecological uplift to almost an entire headwater watershed.

**Project Objectives Achieved:**

- Re-established forested riparian buffers along streams by removing invasive species, planting native forest species, and fencing out livestock.
- Removed direct pollutant sources by providing created vernal pool wetlands in areas where concentrated runoff enters the riparian buffer.
- Stabilized stream banks using natural channel design techniques.
- Established appropriate riffle pool complexes through a variety of in-stream structures.
- Created organic substrate and habitat diversity by introducing wooden structures such as log vanes and deflectors.
- Planted canopy species that will provide shading, substrate, and habitat.
- Reconnected streams to adjacent floodplains and wetlands by establishing a natural channel cross section and profile.
- Raised groundwater levels in wetlands adjacent to the streams by raising adjacent channel bed elevation.
- Removed/plugged ditches and field crowns used to drain a historic non-riparian seep wetland to re-establish hydrology.
- Created microtopography within the wetland to re-establish habitat and hydrology.
- Improved crossings by excluding livestock and contact with farm equipment.

- Preserved stable on-site streams and wetlands.
- Excluded livestock through fencing.
- Re-vegetated the stream banks, wetlands, and riparian area with an appropriate mix of native forest species to improve bio-diversity and habitat.

The streams were restored and enhanced using a combination of Rosgen Priority 1 and 2 Restoration techniques. Some reaches were planted only with native forest species after invasive species were removed. The application of each technique varied as described in the figures and "As-built" Record Drawings.

The non-wetland (or formerly wetland) riparian areas were ripped to remove compaction from the livestock and to create microtopography. The riparian buffer and wetlands were replanted or planted with native forest species to restore ecological function to the buffer and wetlands. Additionally, small vernal wetlands were created to receive and attenuate runoff in areas where concentrated flow entered the riparian buffers. The drainage ditches and field crowns were removed from the non-riparian wetland restoration area. This area also was planted with appropriate native forest species.

With restoration and enhancement, water quality should be improved due to a decrease in nutrients and turbidity as well as moderation in water temperature. Biological and chemical oxygen demand should be reduced through filtering in the riparian buffer and riparian wetlands. Potential habitats have been added through the creation of bed features, woody debris, and re-establishment of riparian vegetative community. The result is the rehabilitation of almost an entire headwater watershed.

The mitigation work at the Site has resulted in the restoration of 10,953 linear feet of stream, the enhancement (Levels I and II) of 6,834 linear feet of stream, and the restoration of 1.7 acres of non-riparian wetland (**Tables 1**, **2, and 3**).

Table 1: Mitigation Summary Table

| Project Stream | Existing Length | Prop. Length | Restoration | Enhance Level I | Enhance Level II | Wetland Restoration |
|---|---|---|---|---|---|---|
| | FT | FT | FT | FT | FT | ACRES |
| **Total Site** | **15,955** | **17,786** | **10,953** | **982** | **5852** | **1.7** |
| **Total SMUs** | **--** | **--** | **10,953** | **654** | **2,341** | **--** |
| **Total WMUs** | **--** | **--** | **--** | **--** | **--** | **1.7** |

Monitoring will be conducted in 2009 through 2014 to assess the Site's stream and wetland areas to determine success. The stream and wetland monitoring plan has been established based on guidance provided by The Stream Mitigation Guidelines disseminated by the United States Corps

of Engineers – Wilmington District (McLendon, Scott, Fox, Becky et al., 2003) and the version of the EEP documents titled "Content, Format, and Data Requirements for EEP Monitoring Reports" current at the time of the RFP. The plan also is described in the Rockwell Pastures Site Restoration Plan (July 2008). Wetlands will be monitored based on gauge data from groundwater monitoring sites and on stem counts from vegetation success as described in the Restoration Plan. Streams will be monitored for stability using cross section and longitudinal profile surveys and photo documentation.

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# Narrative

The Rockwell Pastures Stream and Wetland Restoration Site (Site) is located 6 miles southeast of Albemarle in Stanly County. Rockwell Pastures lies within the Yadkin River Basin, North Carolina Division of Water Quality (DWQ) sub-basin 03-07-08, and local HUC 03040104010020.

Prior to restoration, the Site included ten (10) degraded unnamed tributaries (UT1, UT2, UT3, UT4, UT5, UT6, UT7, UT8, UT9, and UT10). In addition, a drained and crowned non-riparian wetland was located between UT6 and UT1. The Site stream system contains several first-order streams and a second-order stream, and accounts for approximately 16,027 linear feet of tributary to David's Creek and Lake Tillery (**Figure 1**). Lake Tillery is listed as DWQ class Water Supply (WS-IV, CA) waters. As such, these streams are considered to be WS-IV streams. The project area is located in the Carolina Slate Belt sub-ecoregion of the Piedmont ecoregion. The Site is defined by the protective conservation easement surrounding the stream, riparian buffers, and wetlands that encompass approximately 51.5 acres. The Site also makes up almost an entire headwater watershed.

The upper part of the watershed (the Dennis properties) currently is in agriculture and silviculture uses. Little to no appropriate riparian vegetation was present along the stream banks because row crops were planted to the existing stream edges of the upper part of UT1, as well as those of UT5, UT6, and UT7. These same streams were directly impacted and straightened in some locations as a result of the surrounding land practices. Silvicultural activities, including direct impacts to the stream bed, had completely destabilized UT4 and had resulted in a removal of native bottomland and headwater forest vegetation. The upper reach of UT4 had been impounded, creating two agricultural ponds. The restored non-riparian wetland between UT1 and UT6 had been drained by ditching and crowning and placed into agricultural use. The ongoing silvicultural and agricultural activities resulted in sedimentation from surrounding runoff as well as stream instability. These activities also allowed for direct inputs of nutrients and other pollutants. Additionally, the lack of forested buffers resulted in elevated temperature and lack of habitat and substrate.

The lower part of the project (the Deese properties) — which includes middle and lower UT1, UT2, UT3, UT7, UT8, UT9, and UT10 — primarily consists of pastureland where cattle had unlimited access to the streams. The main tributary (UT1) was completely straightened and channelized in the early 1970s, according to the landowner. As a result, the streams were highly sedimented and contaminated with livestock waste, which created a source of biochemical oxygen demand (BOD), fecal coliform, and nutrients among other pollutants. The buffer was vegetated with fescue or other grasses with few areas of sparsely populated trees resulting in instability, poor habitat, and elevated temperatures.

The altered conditions of the streams and the lack of riparian buffer reduced water quality and impaired habitat. Livestock access resulted in the direct input of nutrients, fecal coliform, and BOD into the streams. Additionally, hoof-shear created bank instability resulting in heavy sedimentation. Agricultural and silvicultural activities also resulted in direct and indirect addition of nutrients and sediment into the streams, degrading habitat and impairing water quality. Overall, these impacts also reduced dissolved oxygen within the water column, increased turbidity from bank erosion, and elevated water temperatures. Habitat potential was reduced by the diminished water quality and loss of physical habitat such as bed features, woody debris, and a well-developed riparian

vegetative community. The restored non-riparian wetland area had its natural hydrology removed by ditching and crowning. Natural vegetation and habitat had been replaced by row-crops.

The overall goal of this project was to effectively provide functional uplift to an entire watershed by restoring or enhancing most of the stream, wetland, and riparian areas within the watershed. The result is the rehabilitation of almost an entire headwater watershed. The actions taken to accomplish this goal improved the water quality, ecological function, and habitat as detailed below.

**Project Goals Achieved:**

- Provided ecological uplift by reducing sedimentation, BOD, fecal coliform, and nutrient input and re-establishing a diverse aquatic habitat.
- Provided ecological uplift to an entire watershed degraded by historical agricultural and silvicultural activity and livestock management.
- Provided ecological uplift by re-establishing habitat and diversity as well as improving water quality.
- Provided ecological uplift through the addition of forested riparian buffers planted with native species.
- Provided improved natural stream and riparian area function through the reconnection of the stream with the historic floodplain or new floodplain.
- Provided wetland hydrology and habitat to a drained and altered wetland.
- Provided ecological uplift to almost an entire headwater watershed.

**Project Objectives Achieved:**

- Re-established forested riparian buffers along streams by removing invasive species, planting native forest species, and fencing out livestock.
- Removed direct pollutant sources by providing created vernal pool wetlands in areas where concentrated runoff enters the riparian buffer.
- Stabilized stream banks using natural channel design techniques.
- Established appropriate riffle pool complexes through a variety of in-stream structures.
- Created organic substrate and habitat diversity by introducing wooden structures such as log vanes and deflectors.
- Planted canopy species that will provide shading, substrate, and habitat.
- Reconnected streams to adjacent floodplains and wetlands by establishing a natural channel cross section and profile.
- Raised groundwater levels in wetlands adjacent to the streams by raising adjacent channel bed elevation.

- Removed/plugged ditches and field crowns used to drain a historic non-riparian seep wetland to re-establish hydrology.
- Created microtopography within the wetland to re-establish habitat and hydrology.
- Improved crossings by excluding livestock and contact with farm equipment.
- Preserved stable on-site streams and wetlands.
- Excluded livestock through fencing.
- Re-vegetated the stream banks, wetlands, and riparian area with an appropriate mix of native forest species to improve bio-diversity and habitat.

Rosgen Priority 1 and 2 (Rosgen, David L., 1997), and Enhancement Level I and II (USACE Stream Mitigation Guidelines, 2003) treatments were used to rehabilitate the streams as appropriate to the condition of the existing streams. Priority 1 or enhancement techniques were used adjacent to existing wetlands to maintain the wetlands' hydrology. An innovative restoration approach was used in the middle section of UT4 to re-establish the channel, which had been over-widened and braided as a result of direct impacts from logging. The upper part of UT4 had been impounded with two ponds. The stream channel is being allowed to reform on its own in what had been the pond bottom as shown in the Record Drawings. The amount of potential stream restoration was quantified as the distance between the constructed channel above and below. This was done to show the minimum amount of restoration that will result. The non-riparian wetland was re-established by removing ditches and field crowns and providing microtopography.

The riparian buffer was planted using four zones:

**Zone 1** — The stream bank zone consisting of planted tree and shrub species and seeded native herbaceous species typically found along stream banks in the region.

**Zone 2** — A forested riparian area consisting of tree and shrub species tolerant to the hydrology of a floodplain.

**Zone 3** — The wet zones within the forested riparian zone that included pockets of wetter areas within Zone 2 and the non-riparian wetland restoration. This zone was planted with tree and shrub species tolerant of the hydrology of a wetland environment.

**Zone 4** — The Oxbow wetland areas located on-site that are permanently ponded areas within Zone 2. Woody species were not planted in this zone, and wetland seed mix was applied to the fringes of the oxbow wetland.

Zone 1 was planted with live stakes, and Zones 2 and 3 were planted using bare root seedling plants. Planting spacing was determined according to the planting type. The entire easement was planted as described above. Separate reference wetlands for hydrology and vegetation were located on-site, and plantings were based on natural communities described in Shafale and Weakley (Schafale and Weakley, 1990).

Inspection of the vegetation plots during the baseline monitoring phase showed that the planting density matched the density prescribed in the planting plan. It should be noted that Zone 4

plantings in currently forested areas are supplemental. As a result, the actual densities may reflect the spacing of mature forested areas.

**Table 2: Reach by Reach Mitigation Summary**

| Project Stream | Existing Length | Prop. Length | Restoration | Enhance Level I | Enhance Level II | Wetland Restoration |
|---|---|---|---|---|---|---|
| | FT | FT | FT | FT | FT | ACRES |
| UT1 | 6,580 | 6916 | 5,697 | - | 1,219 | 1.7 |
| UT2 | 635 | 635 | - | - | 635 | - |
| UT3 | 717 | 872 | 872 | - | - | - |
| UT4 | 3,952 | 4,934 | 3,357 | 982 | 596 | - |
| UT5 | 1,075 | 1,086 | - | - | 1,086 | - |
| UT6 | 1,174 | 1,184 | - | - | 1,184 | - |
| UT7 | 1,313 | 1,419 | 689 | - | 730 | - |
| UT8 | 485 | 485 | 83 | - | 402 | - |
| UT9* | - | 152 | 152 | - | - | - |
| UT10 | 24 | 103 | 103 | - | - | - |
| **Total Site** | **15,955** | **17,786** | **10,953** | **982** | **5,852** | **1.7** |
| **Total SMUs** | **--** | **--** | **10,953** | **654** | **2,341** | **--** |
| **Total WMUs** | **--** | **--** | **--** | **--** | **--** | **1.7** |

*UT9 – Existing length lies outside of Project Easement.

**Table 3: Mitigation Yield Summary**

| Contract Stream Mitigation Units | Proposed Stream Mitigation Units | Contract Wetland Mitigation Units | Proposed Wetland Mitigation Units |
|---|---|---|---|
| SMUs | SMUs | WMUs | WMUs |
| 13,427 | **13,948** | 1.5 | **1.7** |

## Modifications to the Restoration Plan and Construction Plan Summary

The following is a summary of changes that were made from the Restoration Plan to the Construction Drawings as well as changes implemented during construction. Most of the changes resulted from field conditions, such as bedrock or soil conditions in relocated sections. Typical changes are the addition of some constructed riffles where soils were poor for bed material. Other changes resulted from property owner concerns that caused a section of restoration to be deleted, but other sections of restoration and enhancement were added to maintain the SMU goal.

These and other changes are outlined below.

**UT1:**

- Added Log Cross Vane to Station 102+65.
- Converted Log Cross Vane at Station 102+80 to Log A-Vane.
- Replaced existing culvert at Station 103+02 with 24-inch RCP with flared end sections.
- Added drainage swale to right bank near Station 104+25 to maintain positive drainage from the adjoining property owner's field.
- Rock Vane at Station 106+13 not constructed because of conflict with existing bedrock in bank.
- The reach along the upper portion just above the main farm road (approximately Stations 107+68 to 114+32) was omitted during construction, and previously was planned to be stabilized using Enhancement Level I.
- The section just below the above omitted portion (approximately Stations 114+32 to 115+95) has been included as 163 feet of Enhancement Level II in this report, where enough property was secured to provide the appropriate 50-foot-wide buffer.
- Added Rock A-Vane at Station 115+95. This was required for the replacement of the existing culvert at Station 116+32.
- Added Rock Cross Vane at Station 116+21. This was required for the replacement of the existing culvert at Station 116+32.
- Replaced existing culvert with 48-inch RCP with flared end sections at Station 116+32.
- Added 12-inch RCP to existing drainage ditch to allow for positive drainage of property owner's crossing. Also added swale with matting on banks to tie in the RCP to the stream. (Station 116+85 Right)
- The Constructed Riffle meant for Station 118+69 was moved upstream to Station 118+32 because of wet site conditions caused by the constructed vernal pool and recent rain. Also, the riffle at Station 118+69 appeared to have been constructed closer to 1.5% instead of 1.78%, which caused more drop across the riffle at Station 118+32. The Constructed Riffle at Station 117+50 was omitted since most of the drop had been constructed across the riffle at Station 117+22.

- The outlet ditch for the vernal pool right of Station 118+60 was constructed to tie in at Station 119+25 (Right) as shown on plans.
- The Constructed Riffle at Station 121+41 was not constructed due to the presence of bedrock.
- A swale with matting and riprap was added at Station 131+86 (Right) to drain the adjacent oxbow wetland.
- Constructed Riffles were added at Stations 132+63 and 132+91.
- The vernal pool at Station 136+86 (Right) was not constructed; UT8 was constructed in its place. A Constructed Riffle will be placed at Stations 0+14 and 0+78.
- An outlet ditch for the oxbow wetland at Station 138+64 (Right) was added as shown on plans.
- UT9 was constructed at Station 144+37 (Right).
- An outlet ditch for the oxbow wetland at Station 144+42 (Left) was added as shown on plans.
- The oxbow wetland at Station 153+57 (Right) was not constructed; UT10 was constructed in its place. A Constructed Riffle was placed at Station 0+00 on UT10.
- An outlet ditch for the oxbow wetland at Station 155+33 (Right) was added as shown on plans.
- The Floodplain Culvert Pipes were removed for the Stream Crossing at Station 157+68. The Dual 48-inch RCPs were changed to Dual 54-inch RCPs as shown on plans.
- A vernal pool was added in the existing channel at Station 161+78 (Left).
- The vernal pool at Station 167+72 (Right) had riprap added to the outlet ditch as shown on plans.
- Additional protective conservation easement was added at the lower end of UT1-Lower to extend the Enhancement Level II section of stream approximately 343 feet.

**UT2:**

- The Boulder Sill at Station 200+00 was removed because of existing bedrock grade control in the channel.
- The Log A-Vane at Station 205+91 was changed to a Boulder Sill.

**UT3:**

- No changes were made to the design plans.

**UT4:**

- Added 7 Log Cross Vanes and 1 Rock A-Vane to stabilize the 84-foot (Station 400+00-400+73) section of the stream that had a 4.5-foot drop at the upper tie in.
- Removed Boulder Toe Protection between Rock Cross Vanes at Station 403+31.

- Deleted the Rock Cross Vane from the plans at Station 407+83 to save an existing tree.
- Dual 36-inch RCPs were installed under the crossing at Station 416+34.
- Swale added at Station 417+72.
- Small Channel Side Blocks added at Station 420+30 (Right), Station 422+17 (Left), and Station 423+13 (Right).
- The following changes were made from Station 428+00-431+50: Station 428+02 — delete Double Wing Deflector (DWD) and replace with a Single Wing Deflector (SWD) on the left bank; Station 428+60 — delete DWD and replace with a SWD on right bank; Station 431+30 — delete DWD.
- Added a Constructed Riffle upstream of the structure at Station 433+00, which has been changed from a Rock Cross Vane to an A-Vane.
- An outlet ditch for the oxbow wetland at Station 433+81 (Right) was added as shown on plans.
- The Constructed Riffle at Station 435+16 was not constructed due to the presence of bedrock.
- Bedrock Outcrop exists in the constructed channel as shown on plans at Station 437+28 and 437+47.
- The Log Vane at Station 437+92 was not constructed.
- The Vernal Pool with Outlet Ditch at Station 438+73 (Right) was not constructed.
- Added Constructed Riffle at Station 439+05.
- Added Constructed Riffle at Station 440+14.
- Added Vernal Pool with Outlet Ditch and Inlet Ditch at Station 440+67.
- Added Constructed Riffle at Station 440+90.
- Added Constructed Riffle at Station 442+25.
- Log Vane at Station 447+66 was not constructed.
- Log Vane at Station 448+31 was not constructed.

**UT5:**

- No changes were made to the design plans.

**UT6:**

- No changes were made to the design plans.

**UT7:**

- Added Vernal Pool with Outlet Ditch and Inlet Ditch at Station 708+96.
- Added Constructed Riffle at Station 709+94.
- Added Constructed Riffle at Station 711+75.

**UT8:**

- This stream section was added during construction. The stream was determined to be an intermittent channel with a stream rating score of 29.75 and a drainage area of 0.02 square miles (13.9 acres). Approximately 83 feet of restoration was added to tie the existing tributary into UT1, and additional easement was added above the restoration to add approximately 402 feet of Enhancement Level II treatment.

**UT9:**

- This stream section was added during construction. The stream was determined to be a perennial channel with a stream rating score of 50.5 and a drainage area of 0.06 square miles (38.3 acres). The existing stream does not lie within the protective conservation easement; however, a restoration section of stream approximately 152 feet in length was added within the easement to tie UT9 into the relocated UT1.

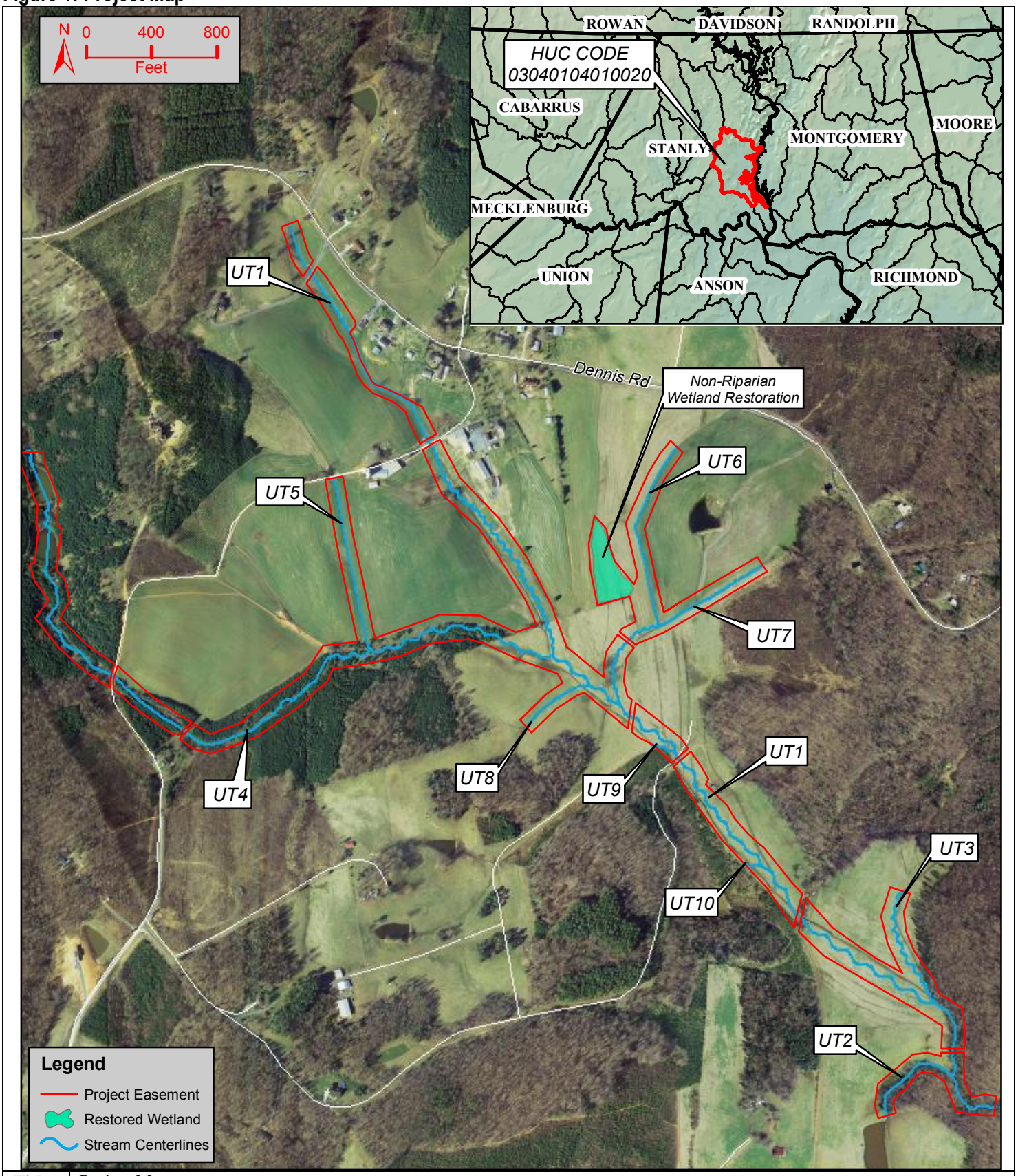
**UT10:**

- This stream section was added during construction. The stream was determined to be a perennial channel with a stream rating score of 48.25 and a drainage area of 0.11 square miles (69.5 acres). This channel discharges directly from an existing farm pond. Approximately 24 feet of existing stream was located within the protective conservation easement, and a total of 103 feet of stream restoration was added within the easement to tie UT10 into the relocated UT1.

**Non-Riparian Wetland:**

- Added flow-breaks to prevent erosion and direct flow-path through system. Locations and elevations are shown the Record Drawings.
- Added a swale as the outlet from the wetland restoration area as shown on plans.

**Figure 1: Project Map**




| | | | |
|---|---|---|---|
| **Title** | Project Map | | |
| Prepared For: Ecosystem Enhancement Program | **Project** | Rockwell Pastures Stream and Wetland Restoration<br>Stanly County, North Carolina | |
| | **Date**<br>5/14/09 | **Project Number**<br>012620017 | Figure 1 |

# Monitoring Plan

The monitoring plan to evaluate the success of the stream restoration project is based on guidance provided by The Stream Mitigation Guidelines (McLendon, Fox, et al., 2003) disseminated by the United States Corps of Engineers – Wilmington District and recommendations from the Ecosystem Enhancement Program. The non-riparian wetland groundwater hydrology will be monitored using shallow continuous monitoring gauges. Monitoring gauges have been placed as shown in the Record Drawings. Data from these gauges will be used to establish that the success criteria have been met. Monitoring data will be collected and summarized in accordance with the version of the EEP documents titled "Content, Format, and Data Requirements for EEP Monitoring Reports" in existence when the RFP was issued.

Monitoring work will occur annually for five years and include reference photographs, materials sampling, site survey, and visual assessment and mapping of significant features. The success criteria and assessment methods for the Site's streams and riparian buffer are provided below.

## Stream Monitoring

### *Success Criteria*

The stream geometry will be considered successful if the cross section geometry, profile, and sinuosity are stable or reach a dynamic equilibrium. It is expected that there will be some changes in the designed cross sections, profile, and/or substrate composition. Changes that may occur during the monitoring period will be evaluated to determine whether they represent a trend toward a less stable condition (e.g., down cutting, erosion, etc.) or are simply an increase in stability (e.g., settling, vegetative changes, coarsening of bed material, etc.).

Deviation from the design ratios will not necessarily denote failure as it is possible to maintain stability and not stay within the design geometry. This is especially true in regard to the upper and middle portions of UT4 and the reaches treated with Enhancement Level II techniques. It is anticipated that the stream geometry will change in these reaches as the streams and vegetation approach a mature state. Additionally, determination of true bankfull will be difficult until the stream has had adequate flooding events to create strong bankfull indicators.

### *Assessment Methods*

The survey of channel dimension consists of 24 permanent cross sections placed at unique stream segments throughout the project extent as shown in the Record Drawings. The cross sections represent 12 riffles and 12 pools. Annual photographs showing both banks will be taken for each cross section. Longitudinal profile will be conducted on 4,000 linear feet of channel.

Field observations performed by the engineer during construction confirmed that the stream was constructed to specification and within the specified elevation tolerances for the project. Any changes performed in the field that varied from the Construction Drawings have been edited and reflected in the Record Drawings. Therefore, the profile and plan view found in the Record Drawings should serve as the longitudinal profile and plan form for the project.

Right and left bank view permanent photos stations have been established to visually monitor stream conditions. These photo stations are mapped on the Record Drawings.

The entire restored length of stream will be investigated for channel stability and in-stream structure functionality. Any evidence of channel instability will be identified, mapped, and photographed. All structures will be inventoried for functionality.

## Riparian Buffer and Wetlands Vegetation

### *Success Criteria*

The success of riparian and vegetation planting will be gauged by stem counts of planted species. Stem counts of more than 320 trees per acres after three years, and 260 trees per acre after five years will be considered successful. Photos taken at established photo points should indicate maturation of riparian vegetation community.

### *Assessment Methods*

The success of vegetation plantings will be measured through stem counts. The permanent vegetation plots will be used to sample the riparian buffer and restoration wetlands. Each quadrant covers 100 square meters. During the counts, the health of the vegetation will be noted. The vegetation survey will occur during the growing season. Permanent photo points have been set up for each plot.

## Wetland Hydrology

### *Success Criteria*

The success of wetland restoration will be measured by comparing the restored wetlands with similar, more functional wetlands with respect to vegetation, soils, and hydrology. Success criteria are summarized in the following sections.

#### Hydrology

Success of the restoration of wetland hydrology will be measured by improvements to the frequency and duration of saturated soils compared to the reference wetland. Successful wetland hydrology is defined as the saturation of soils for a period equal to or greater than 85% of the period measured in the reference wetland. The minimum requirement for the restoration wetland hydrology will be the USACE guidelines (United States Army Corps of Engineers, 1987) including saturation of the upper surface of the soils for 7% of the growing season. The hydroperiod of the reference wetland will be measured using groundwater gauges.

#### Vegetation

The prevalent vegetation should consist of macrophytes that typically are adapted for life in saturated soil conditions. These species should have the ability to grow, compete, reproduce, and persist in anaerobic soil conditions. For the restoration areas, study plots showing that the

composition and density of vegetation in the restoration areas that compare to the reference areas will indicate restoration success for vegetation.

### Soil

A primary measure of the enhancement and restoration of wetland soils will be the establishment of hydric character as defined by USACE guidelines (United States Army Corps of Engineers, 1987). Soil enhancement and restoration also may be inferred based on successful enhancement and restoration of wetland hydrology and vegetation.

## References

McLendon, Scott, Becky Fox, Todd St. John, et al. (2003). Stream Mitigation Guidelines. United States Army Corps of Engineers – Wilmington District, United States Environmental Protection Agency, North Carolina Wildlife Resources Commission and North Carolina Department of Natural Resources – Division of Water Quality.

Rosgen, David L. (1997). A Geomorphic Approach to Restoration of Incised Rivers. Management of Landscapes Disturbed by Channel Incision.

Schafale, Michael P. and Alan D. Weakley (1990). Classification of the Natural Communities of North Carolina, Third Approximation, NC Natural Heritage Program, Division of Parks and Recreation, NC Department of Environment, Health, and Natural Resources.

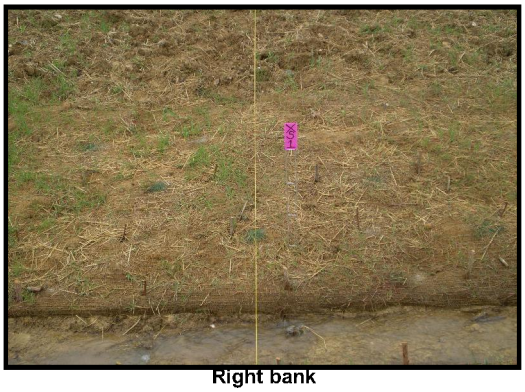
United States Army Corps of Engineers (1987). Corps of Engineers Wetlands Delineation Manual. Waterways Experiment Station, Environmental Laboratory.

# Attachment 1:
# Record Drawings

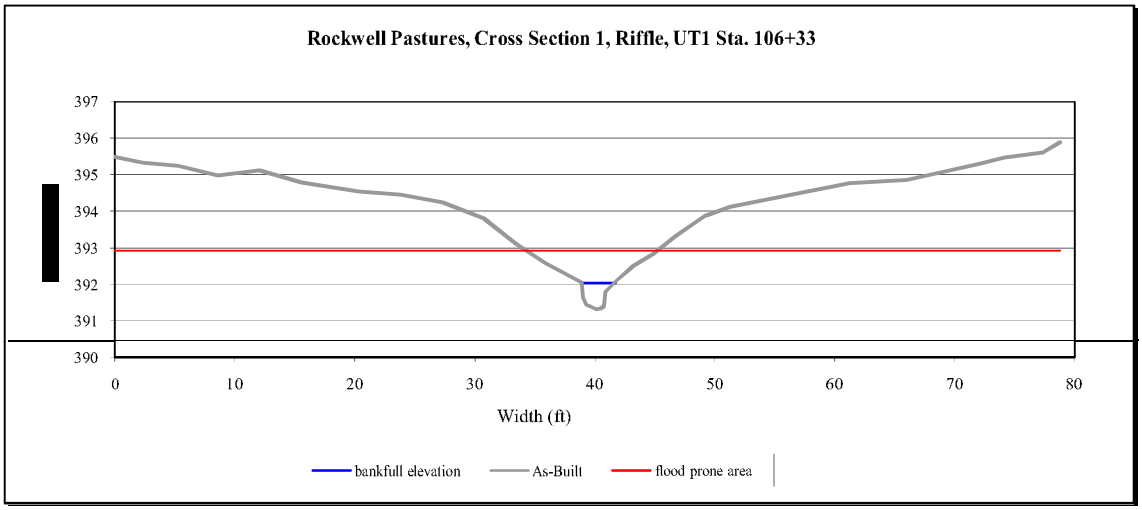
# Attachment 2:
# Baseline Monitoring

# Cross-Section Data

Left bank

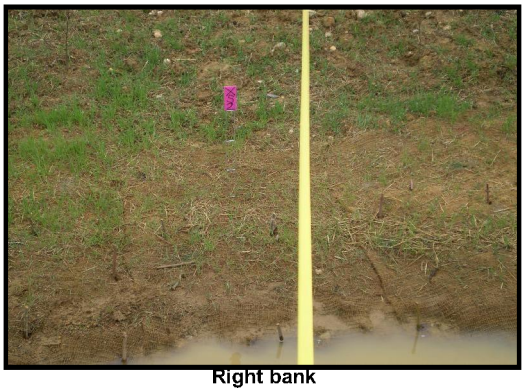


Right bank




| Reach ID | UT 1 |
|---|---|
| Cross Sectional Area | 1.8 |
| Bankfull Width | 4.4 |
| Mean Depth | 0.4 |
| Max Depth | 0.8 |
| Wetted Perimeter | 4.9 |
| Hydraulic Radius | 0.4 |
| Width:Depth Ratio | 10.5 |

Left bank



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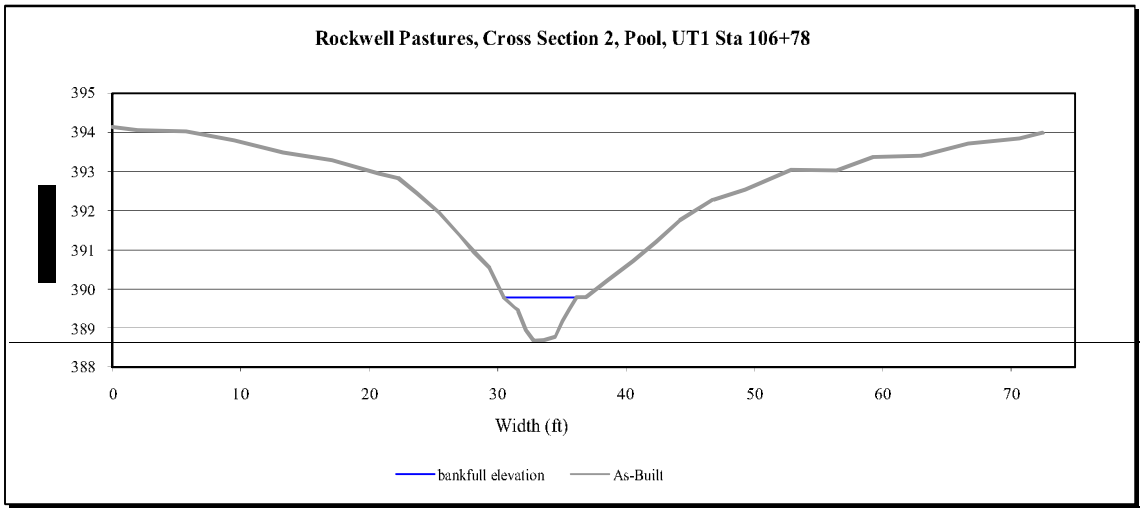
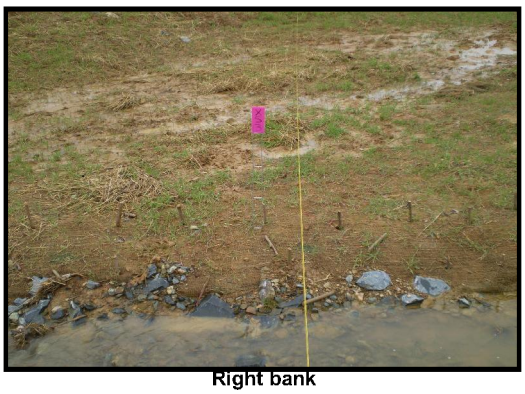
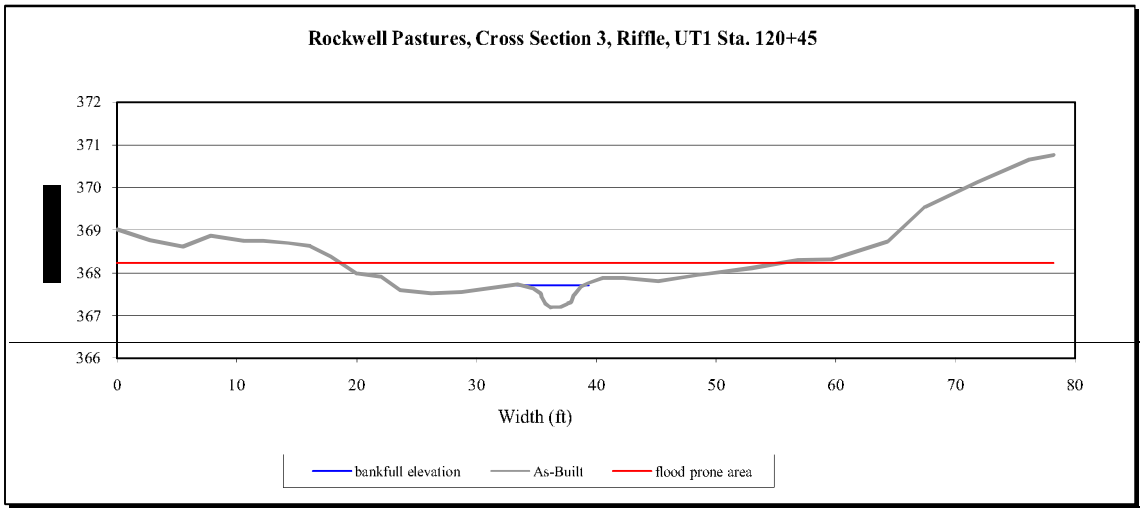



| Reach ID | UT 1 |
|---|---|
| Cross Sectional Area | 7.6 |
| Bankfull Width | 9.1 |
| Mean Depth | 0.8 |
| Max Depth | 1.6 |
| Wetted Perimeter | 9.9 |
| Hydraulic Radius | 0.8 |
| Width:Depth Ratio | 10.9 |

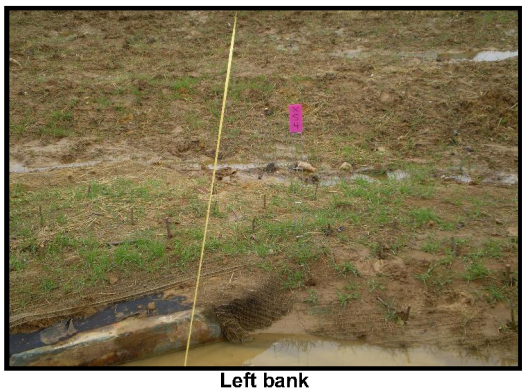
Left bank



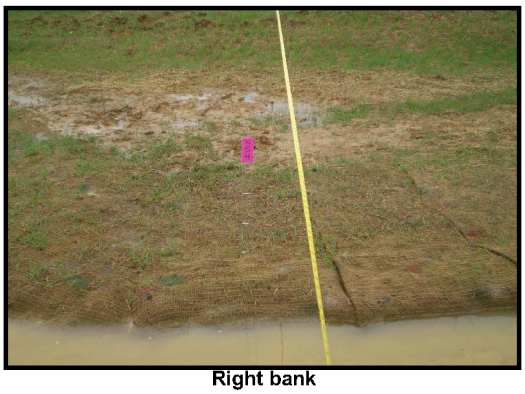
Right bank



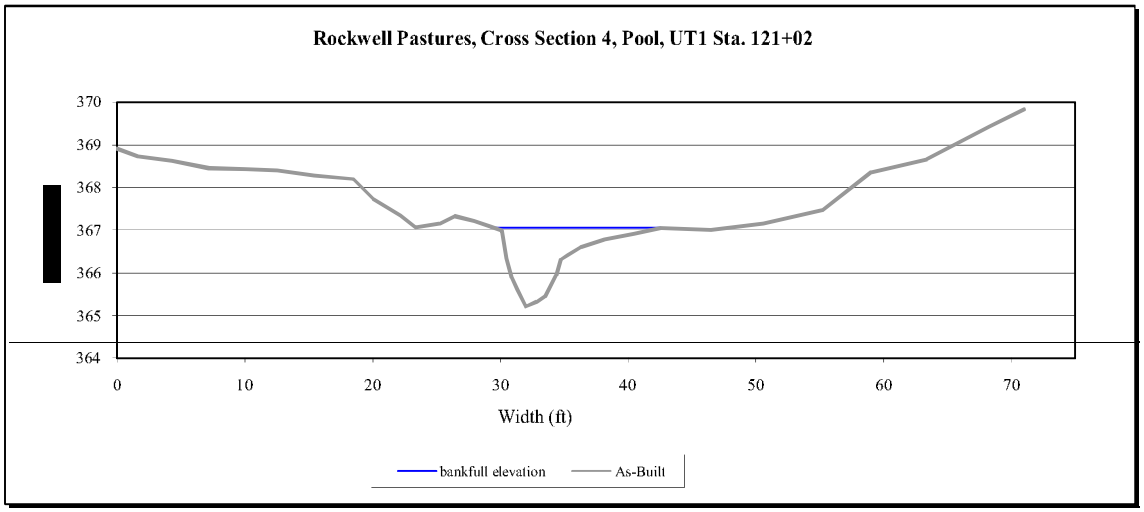

| Reach ID | UT 1 |
|---|---|
| Cross Sectional Area | 1.5 |
| Bankfull Width | 5.4 |
| Mean Depth | 0.3 |
| Max Depth | 0.5 |
| Wetted Perimeter | 5.6 |
| Hydraulic Radius | 0.3 |
| Width:Depth Ratio | 20.3 |



Left bank

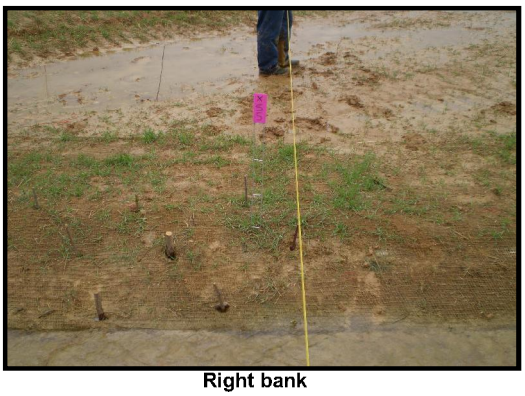


Right bank

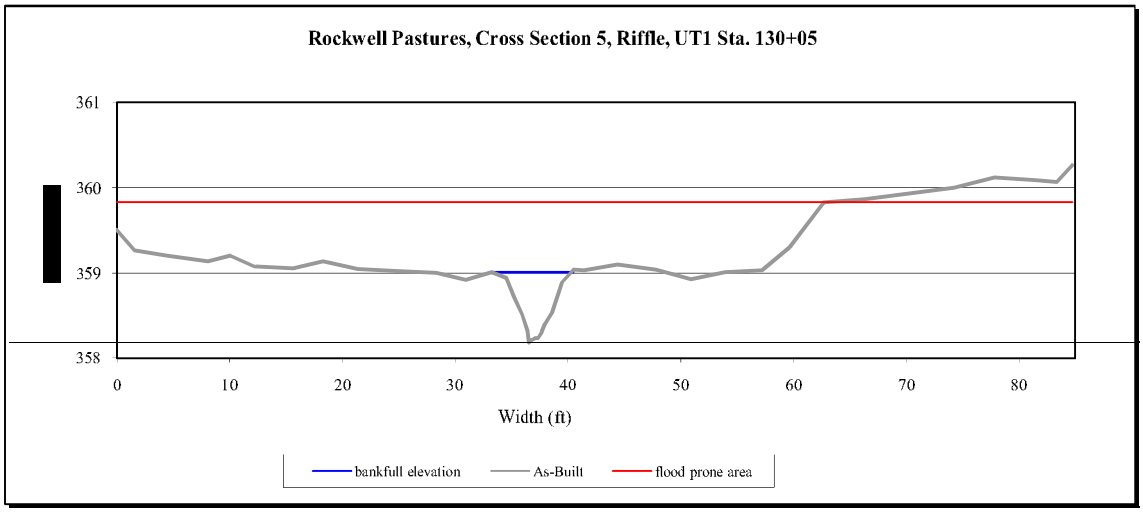



| Reach ID | UT 1 |
|---|---|
| Cross Sectional Area | 8.6 |
| Bankfull Width | 13.0 |
| Mean Depth | 0.7 |
| Max Depth | 1.8 |
| Wetted Perimeter | 14.1 |
| Hydraulic Radius | 0.6 |
| Width:Depth Ratio | 19.8 |

Left bank

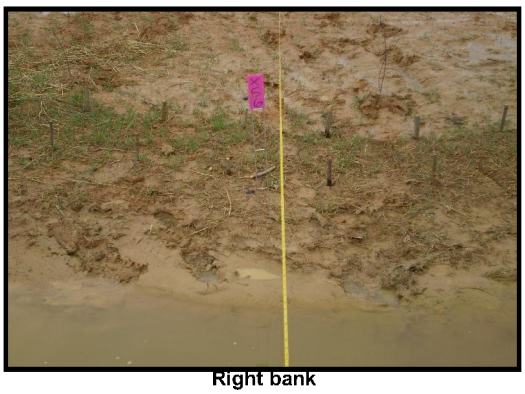


Right bank

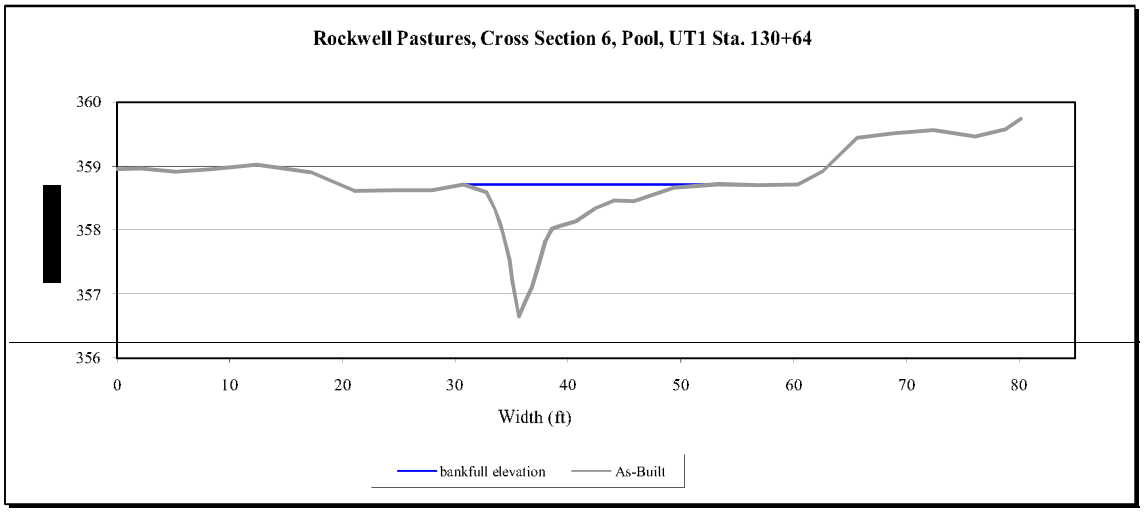



| Reach ID | UT 1 |
|---|---|
| Cross Sectional Area | 2.6 |
| Bankfull Width | 7.0 |
| Mean Depth | 0.4 |
| Max Depth | 0.8 |
| Wetted Perimeter | 7.3 |
| Hydraulic Radius | 0.4 |
| Width:Depth Ratio | 19.2 |

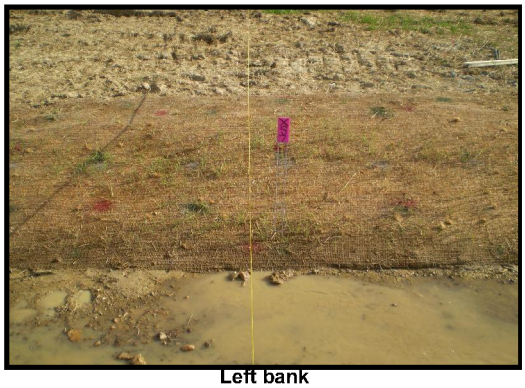
Left bank



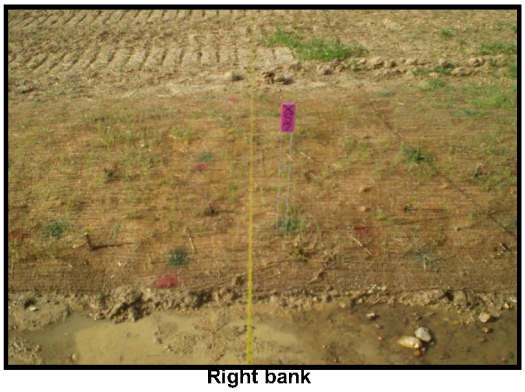
Right bank



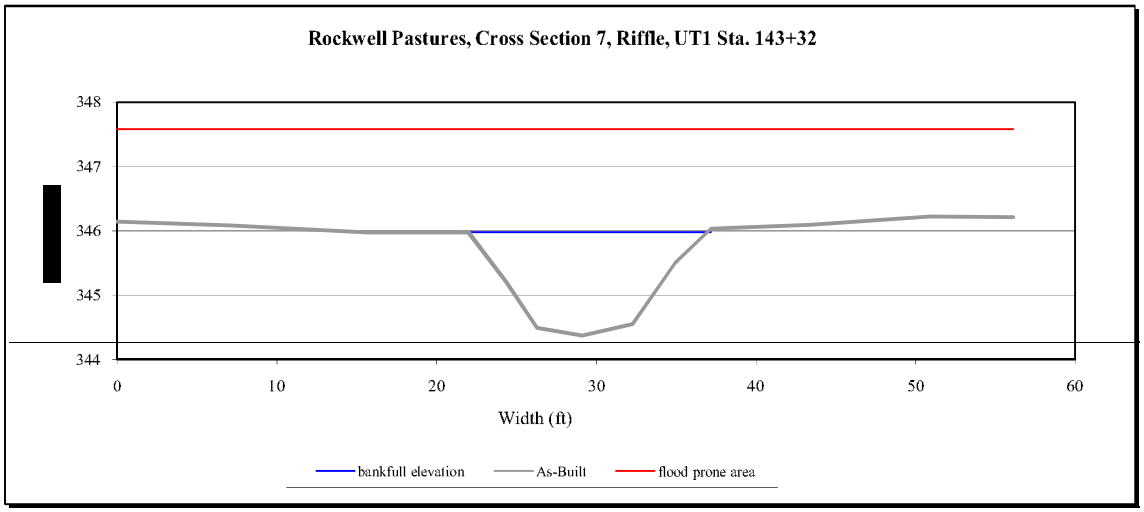

| Reach ID | UT 1 |
|---|---|
| Cross Sectional Area | 10.5 |
| Bankfull Width | 22.0 |
| Mean Depth | 0.5 |
| Max Depth | 2.1 |
| Wetted Perimeter | 23.0 |
| Hydraulic Radius | 0.5 |
| Width:Depth Ratio | 46.3 |



Left bank

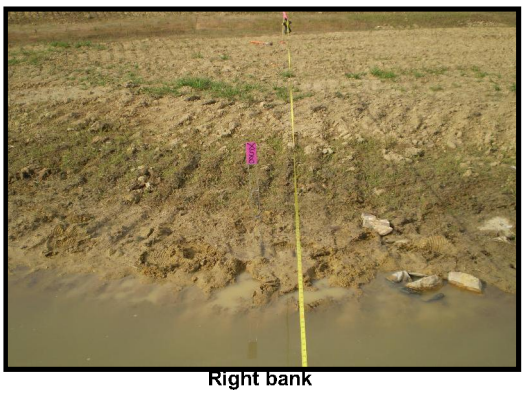


Right bank

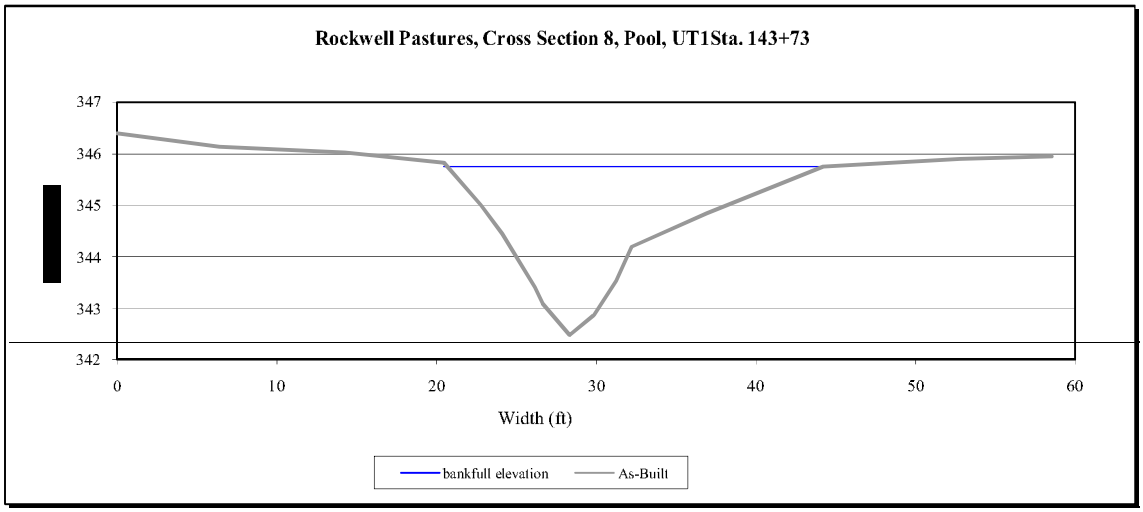



| Reach ID | UT 1 |
|---|---|
| Cross Sectional Area | 15.2 |
| Bankfull Width | 14.9 |
| Mean Depth | 1.0 |
| Max Depth | 1.6 |
| Wetted Perimeter | 15.4 |
| Hydraulic Radius | 1.0 |
| Width:Depth Ratio | 14.7 |

Left bank



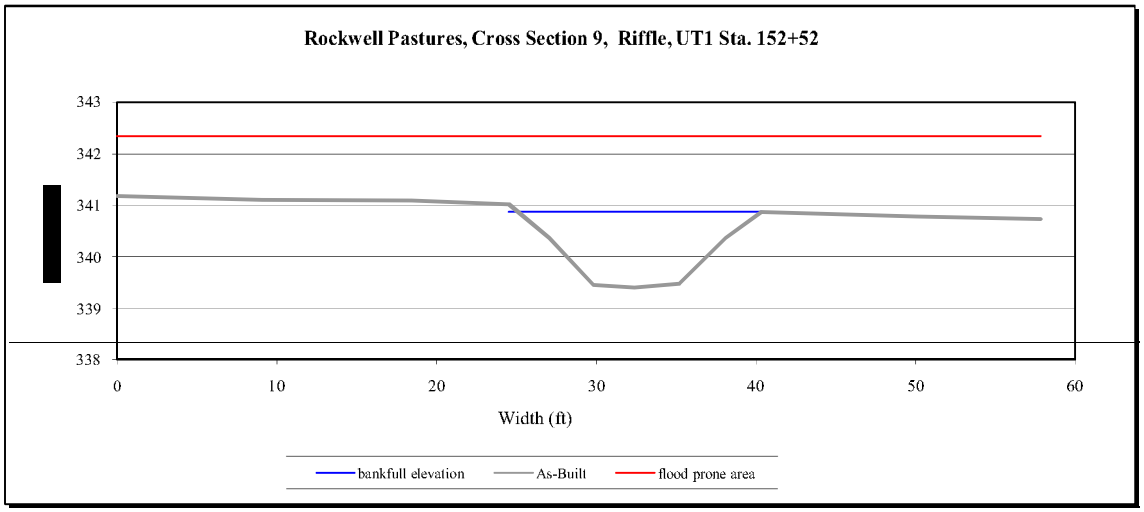
Right bank



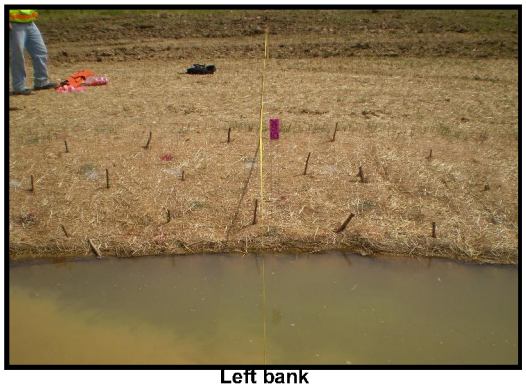

| Reach ID | UT 1 |
|---|---|
| Cross Sectional Area | 31.3 |
| Bankfull Width | 23.5 |
| Mean Depth | 1.3 |
| Max Depth | 3.3 |
| Wetted Perimeter | 24.7 |
| Hydraulic Radius | 1.3 |
| Width:Depth Ratio | 17.7 |

Left bank

Right bank

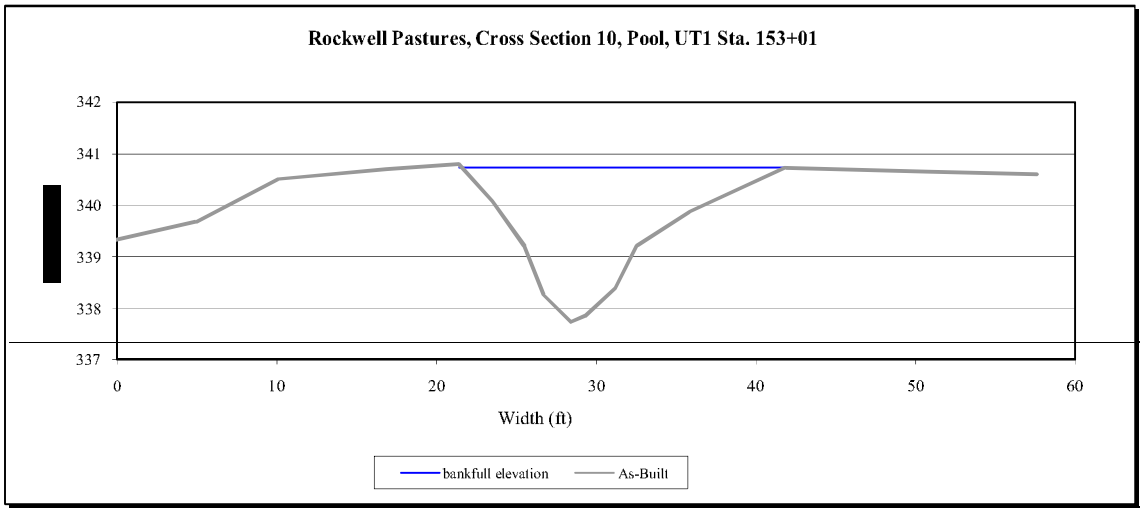



| Reach ID | UT 1 |
|---|---|
| Cross Sectional Area | 14.3 |
| Bankfull Width | 15.3 |
| Mean Depth | 0.9 |
| Max Depth | 1.5 |
| Wetted Perimeter | 15.7 |
| Hydraulic Radius | 0.9 |
| Width:Depth Ratio | 16.4 |



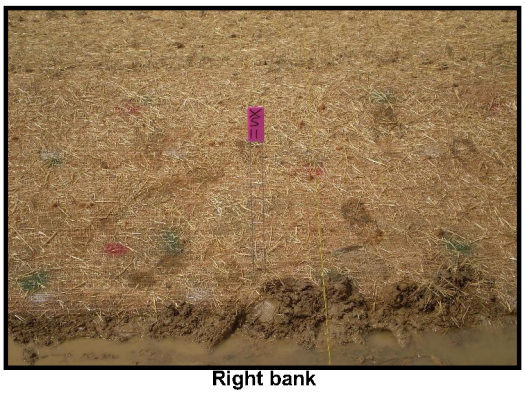
Left bank

Right bank

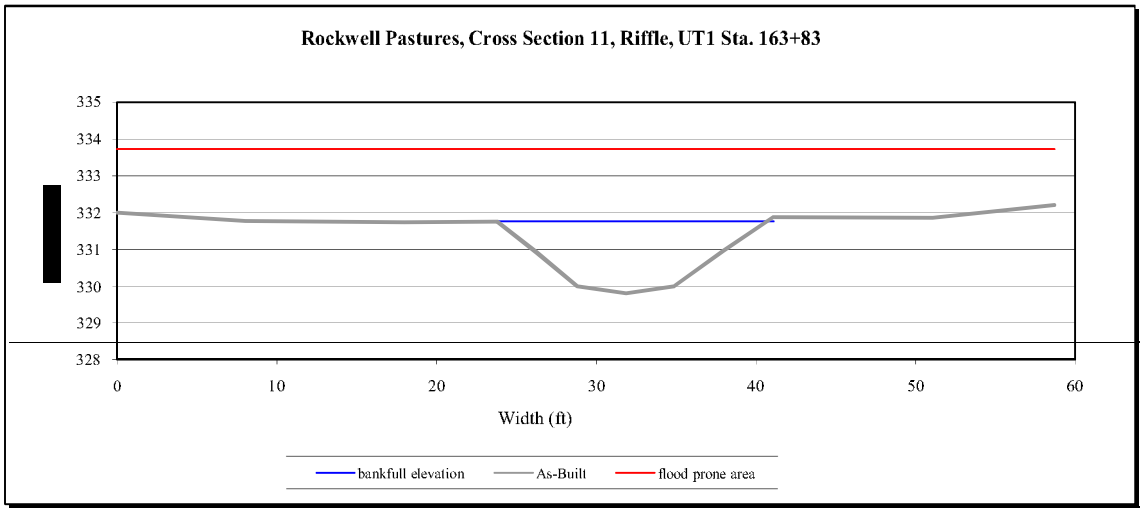



| Reach ID | UT 1 |
|---|---|
| Cross Sectional Area | 26.5 |
| Bankfull Width | 20.2 |
| Mean Depth | 1.3 |
| Max Depth | 3.0 |
| Wetted Perimeter | 21.4 |
| Hydraulic Radius | 1.2 |
| Width:Depth Ratio | 15.4 |


Left bank

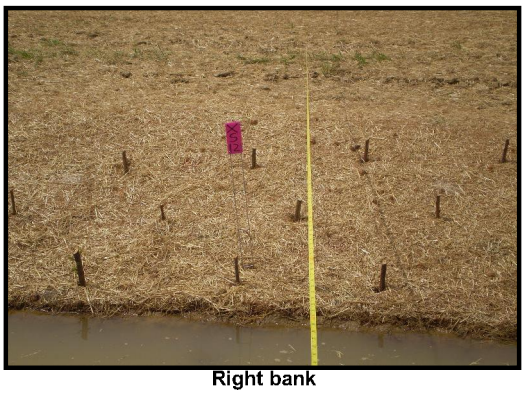



Right bank

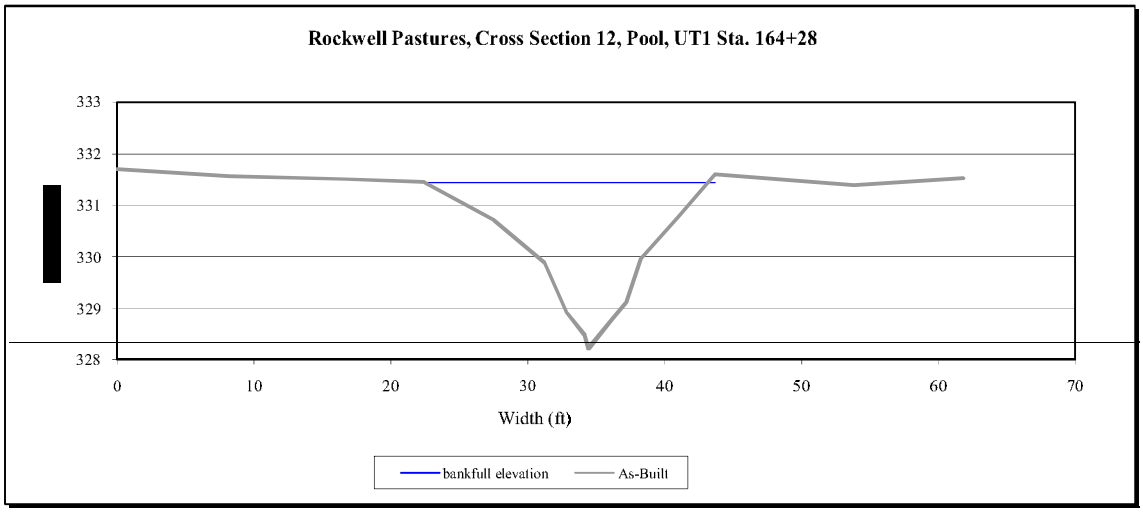



| Reach ID | UT 1 |
|---|---|
| Cross Sectional Area | 20.8 |
| Bankfull Width | 16.9 |
| Mean Depth | 1.2 |
| Max Depth | 2.0 |
| Wetted Perimeter | 17.5 |
| Hydraulic Radius | 1.2 |
| Width:Depth Ratio | 13.8 |

Left bank

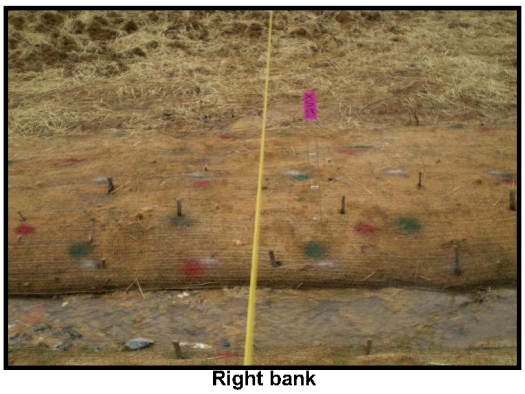


Right bank

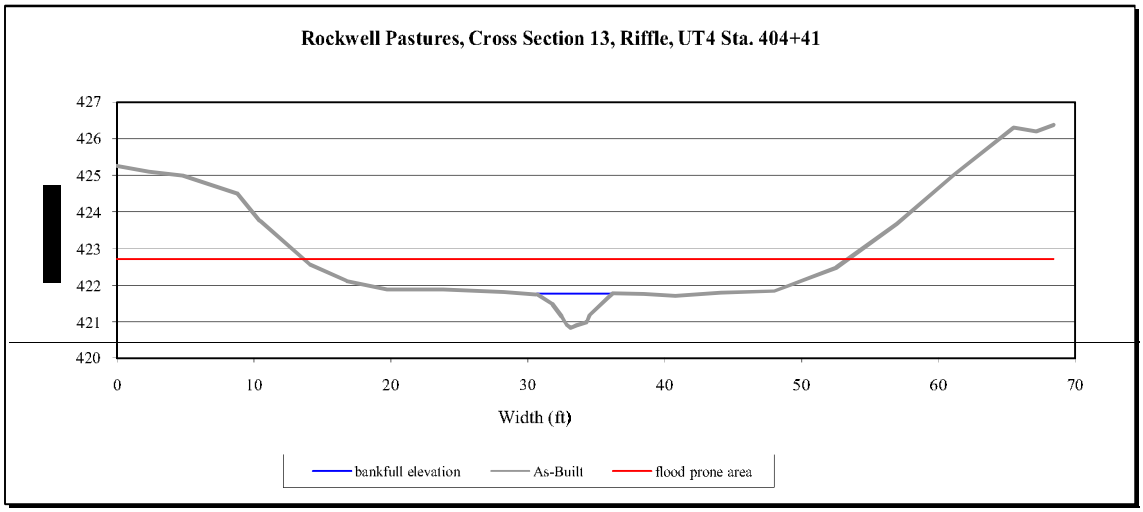



| Reach ID | UT 1 |
|---|---|
| Cross Sectional Area | 27.2 |
| Bankfull Width | 20.7 |
| Mean Depth | 1.3 |
| Max Depth | 3.2 |
| Wetted Perimeter | 21.9 |
| Hydraulic Radius | 1.2 |
| Width:Depth Ratio | 15.7 |

Left bank



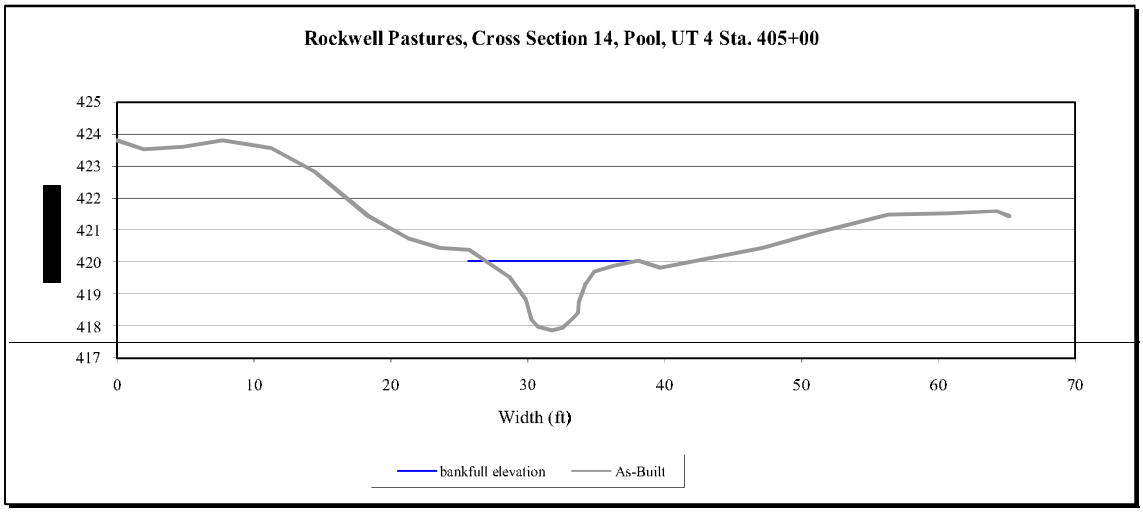
Right bank




| Reach ID | UT 4 |
|---|---|
| Cross Sectional Area | 2.7 |
| Bankfull Width | 7.2 |
| Mean Depth | 0.4 |
| Max Depth | 0.9 |
| Wetted Perimeter | 7.6 |
| Hydraulic Radius | 0.4 |
| Width:Depth Ratio | 19.3 |

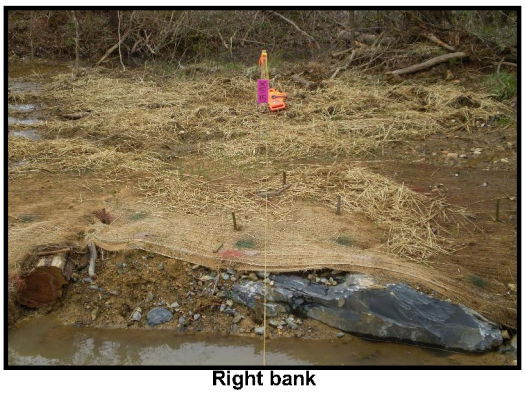
Left bank

Right bank

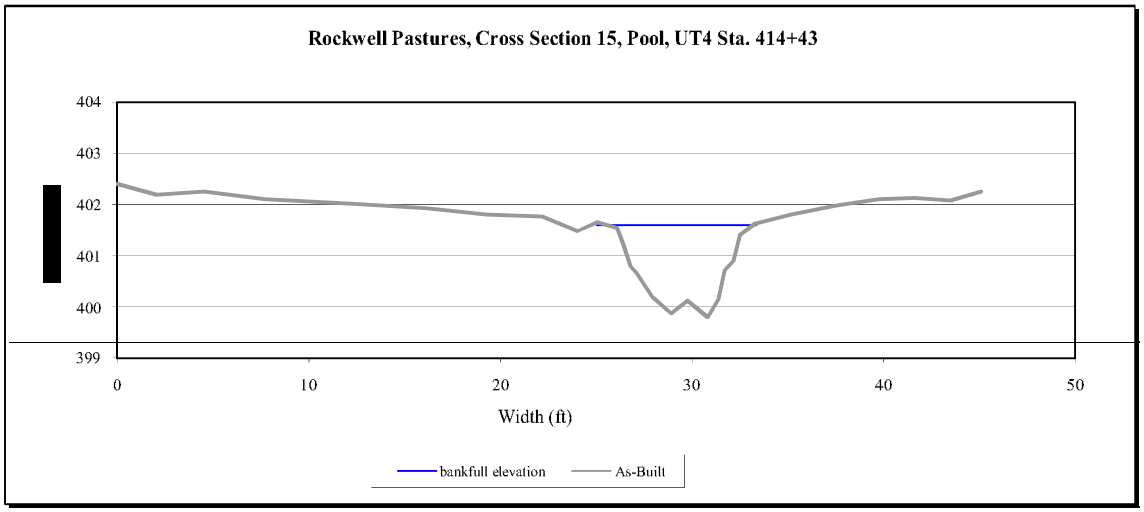



| Reach ID | UT 4 |
|---|---|
| Cross Sectional Area | 10.4 |
| Bankfull Width | 11.2 |
| Mean Depth | 0.9 |
| Max Depth | 2.2 |
| Wetted Perimeter | 12.6 |
| Hydraulic Radius | 0.8 |
| Width:Depth Ratio | 12.0 |

Left bank

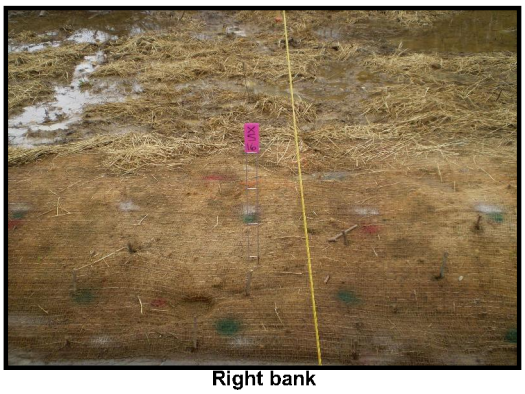


Right bank

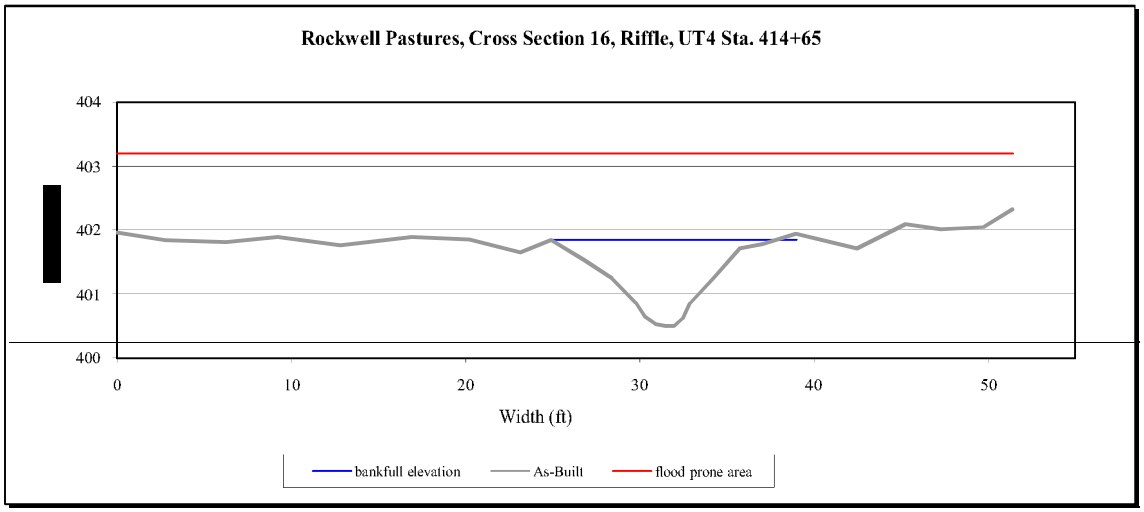



| Reach ID | UT 4 |
|---|---|
| Cross Sectional Area | 8.4 |
| Bankfull Width | 8.3 |
| Mean Depth | 1.0 |
| Max Depth | 1.8 |
| Wetted Perimeter | 9.7 |
| Hydraulic Radius | 0.9 |
| Width:Depth Ratio | 8.1 |

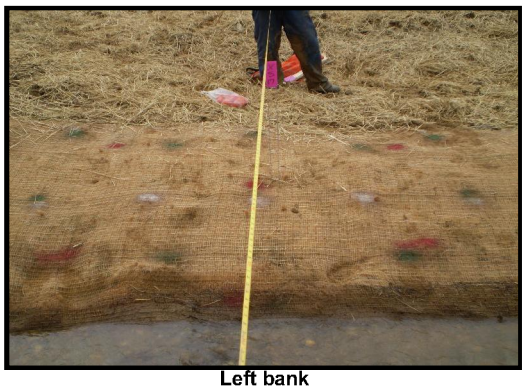
Left bank



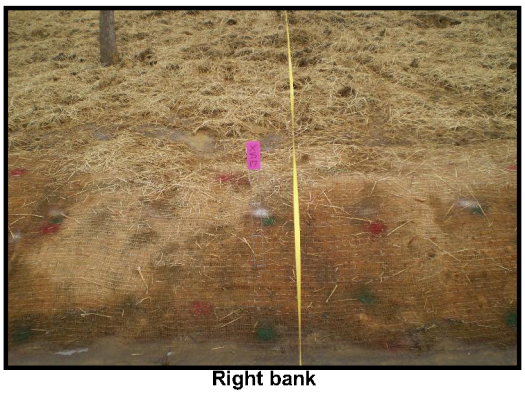
Right bank



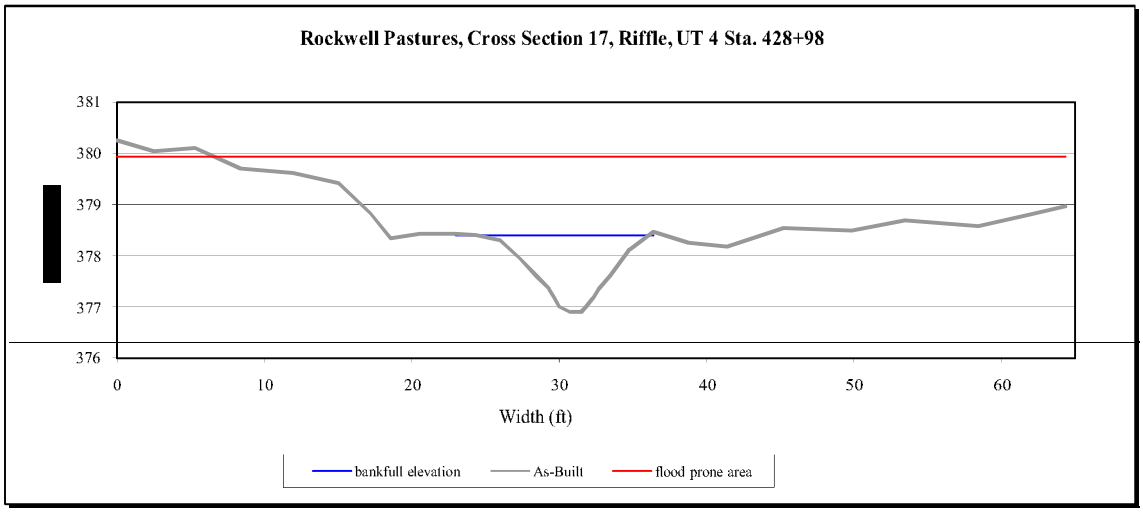

| Reach ID | UT 4 |
|---|---|
| Cross Sectional Area | 7.8 |
| Bankfull Width | 13.0 |
| Mean Depth | 0.6 |
| Max Depth | 1.4 |
| Wetted Perimeter | 13.3 |
| Hydraulic Radius | 0.6 |
| Width:Depth Ratio | 21.6 |



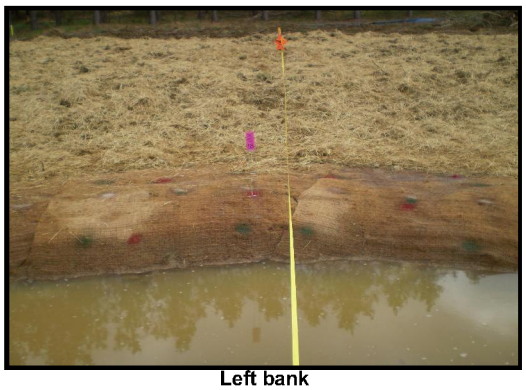
Left bank



Right bank

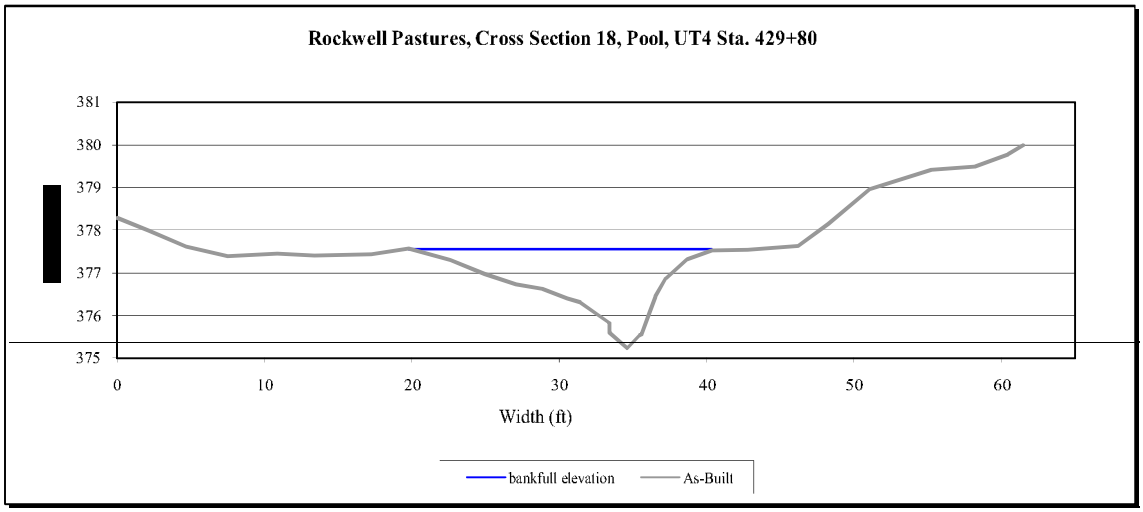



| Reach ID | UT 4 |
|---|---|
| Cross Sectional Area | 8.4 |
| Bankfull Width | 13.2 |
| Mean Depth | 0.6 |
| Max Depth | 1.5 |
| Wetted Perimeter | 13.7 |
| Hydraulic Radius | 0.6 |
| Width:Depth Ratio | 20.7 |



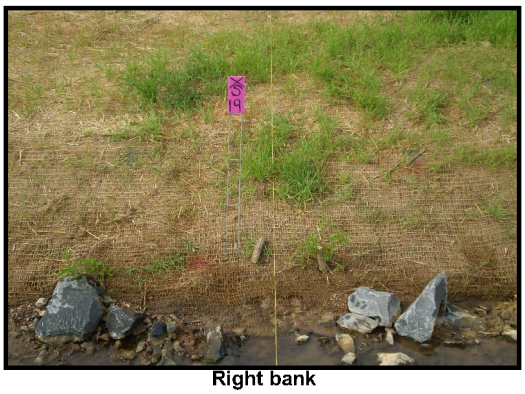
Left bank

Right bank

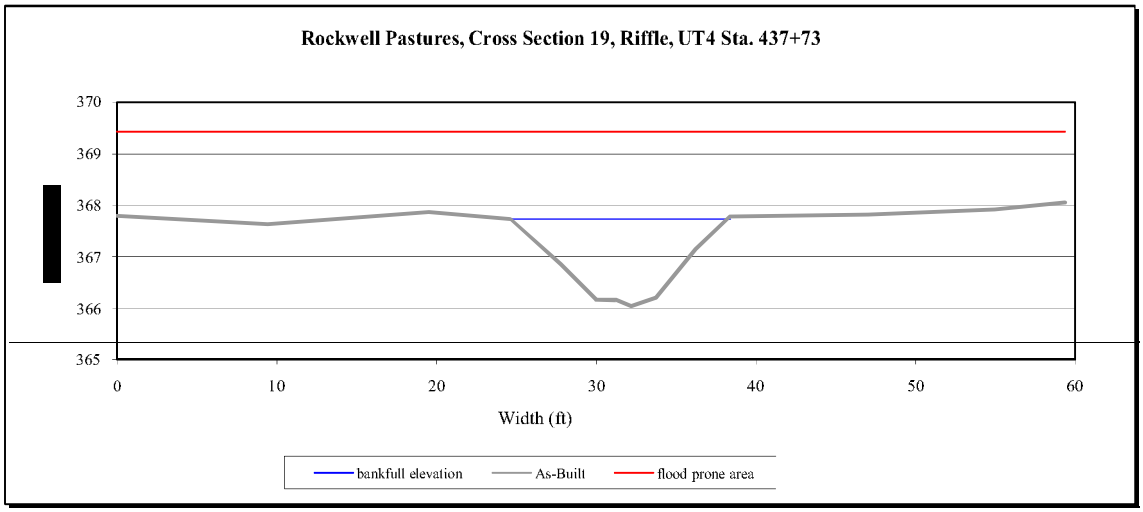



| Reach ID | UT 4 |
|---|---|
| Cross Sectional Area | 17.9 |
| Bankfull Width | 20.4 |
| Mean Depth | 0.9 |
| Max Depth | 2.3 |
| Wetted Perimeter | 21.5 |
| Hydraulic Radius | 0.8 |
| Width:Depth Ratio | 23.3 |


Left bank



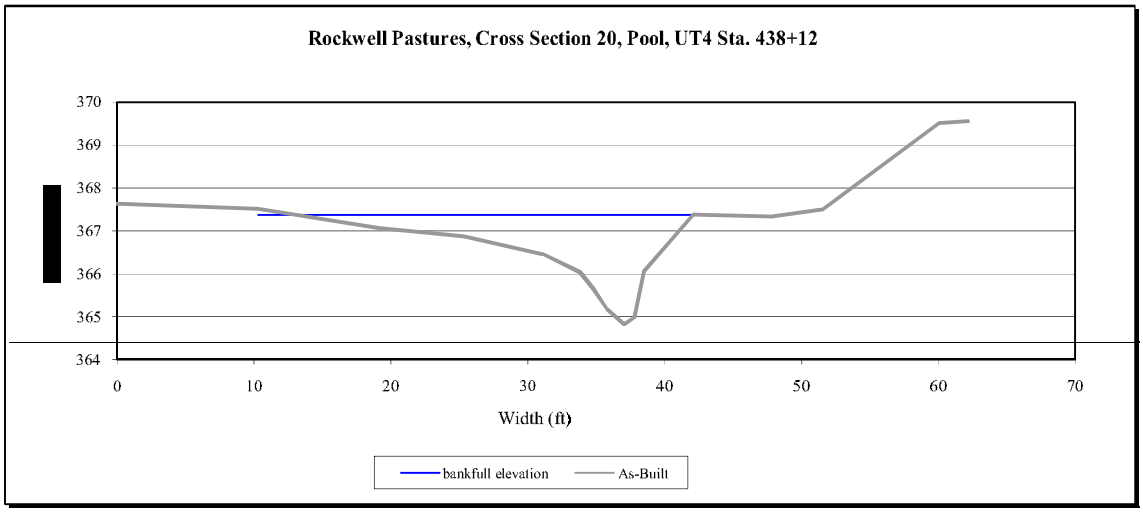

Right bank




| Reach ID | UT 4 |
|---|---|
| Cross Sectional Area | 13.3 |
| Bankfull Width | 13.6 |
| Mean Depth | 1.0 |
| Max Depth | 1.7 |
| Wetted Perimeter | 14.1 |
| Hydraulic Radius | 0.9 |
| Width:Depth Ratio | 13.8 |

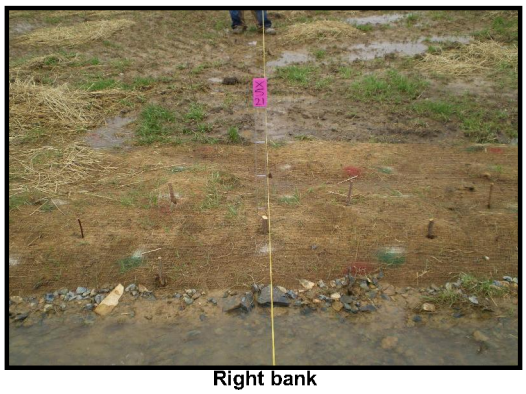

Left bank


Right bank

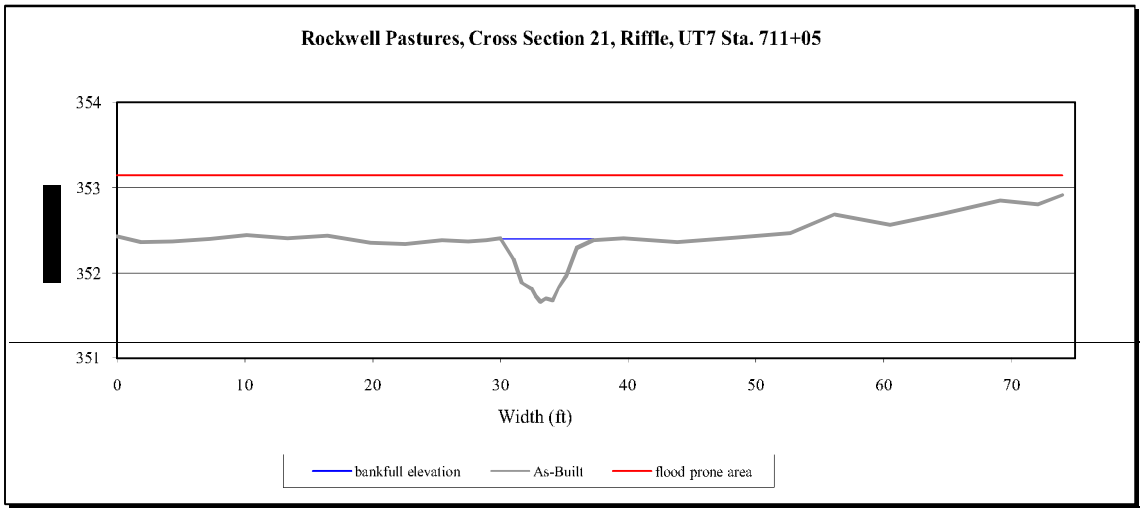



| Reach ID | UT 4 |
|---|---|
| Cross Sectional Area | 22.4 |
| Bankfull Width | 29.0 |
| Mean Depth | 0.8 |
| Max Depth | 2.5 |
| Wetted Perimeter | 30.2 |
| Hydraulic Radius | 0.7 |
| Width:Depth Ratio | 37.7 |

Left bank

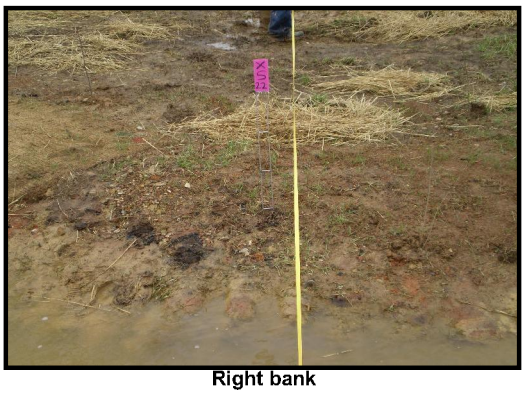


Right bank

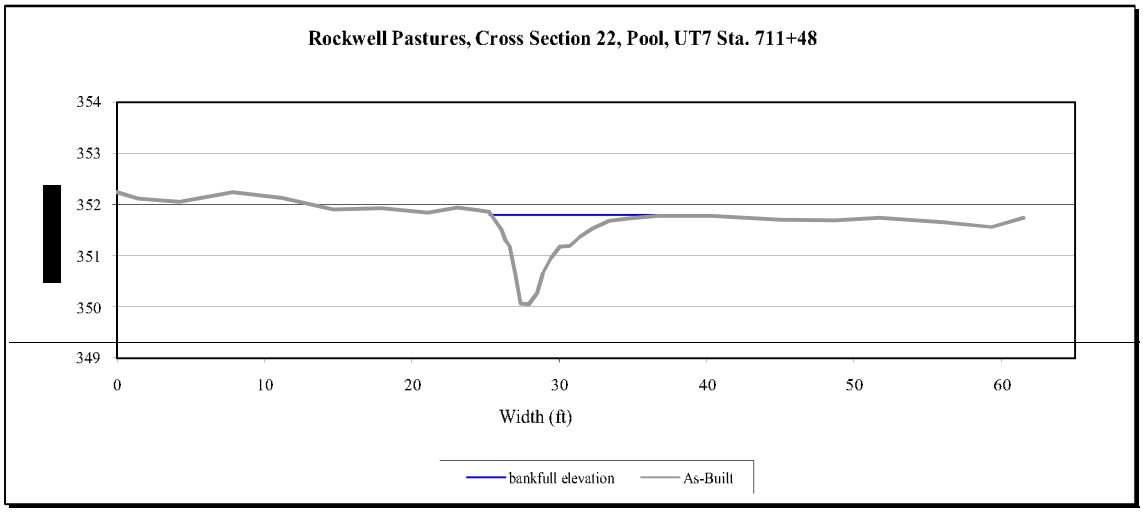



| Reach ID | UT 7 |
|---|---|
| Cross Sectional Area | 2.8 |
| Bankfull Width | 7.2 |
| Mean Depth | 0.4 |
| Max Depth | 0.7 |
| Wetted Perimeter | 7.5 |
| Hydraulic Radius | 0.4 |
| Width:Depth Ratio | 18.5 |

Left bank

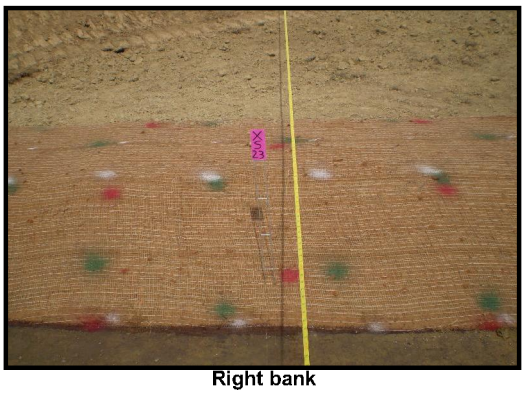


Right bank

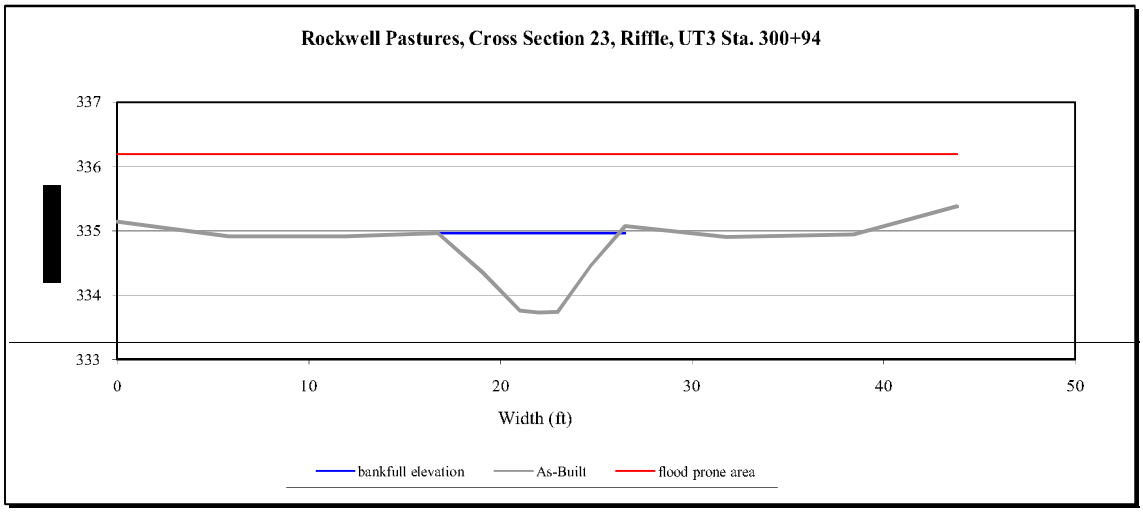



| Reach ID | UT 7 |
|---|---|
| Cross Sectional Area | 5.8 |
| Bankfull Width | 10.9 |
| Mean Depth | 0.5 |
| Max Depth | 1.7 |
| Wetted Perimeter | 12.0 |
| Hydraulic Radius | 0.5 |
| Width:Depth Ratio | 20.6 |

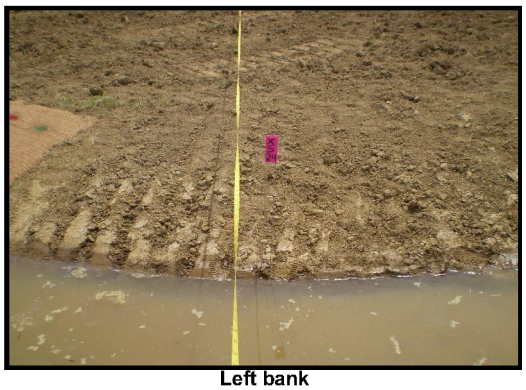
Left bank



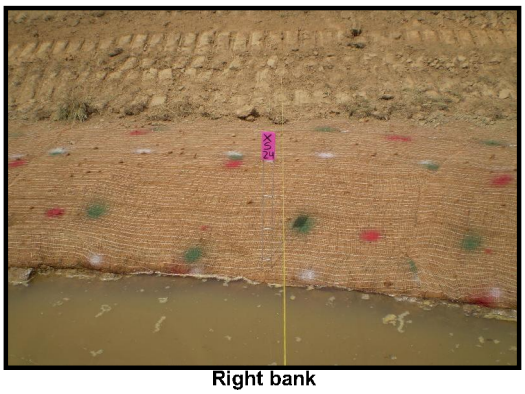
Right bank



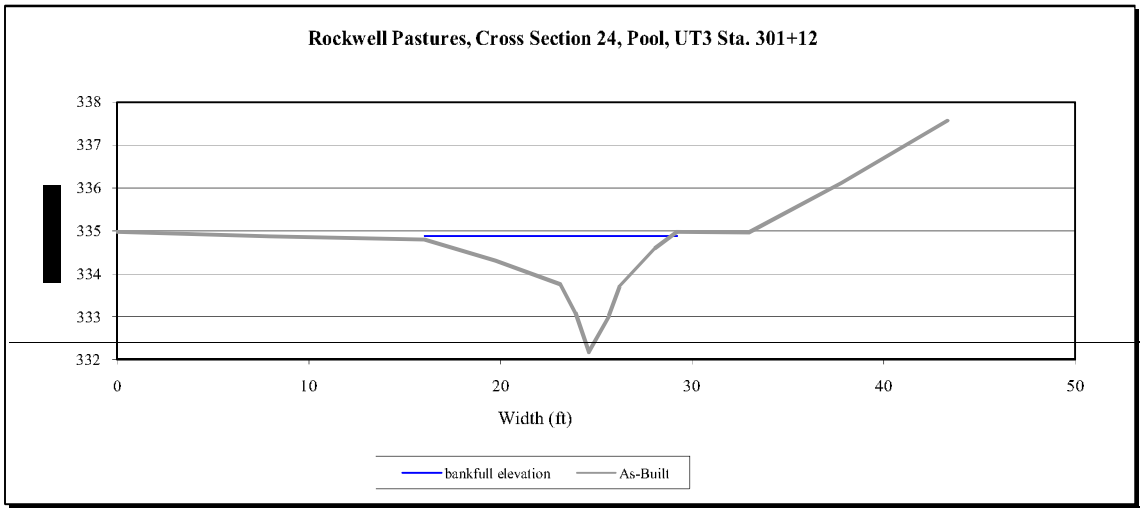

| Reach ID | UT 3 |
|---|---|
| Cross Sectional Area | 6.7 |
| Bankfull Width | 9.4 |
| Mean Depth | 0.7 |
| Max Depth | 1.2 |
| Wetted Perimeter | 9.8 |
| Hydraulic Radius | 0.7 |
| Width:Depth Ratio | 13.2 |



Left bank

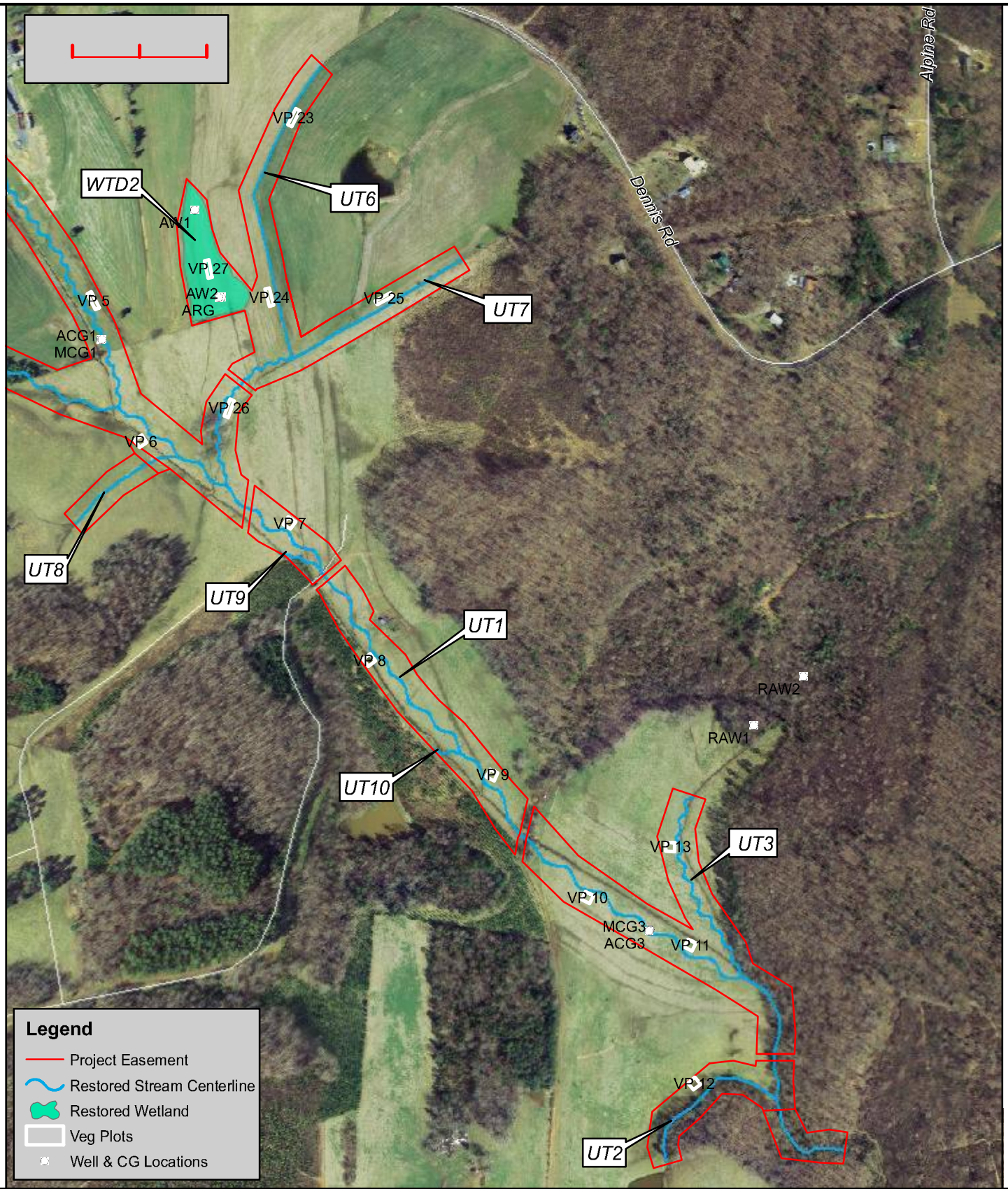


Right bank

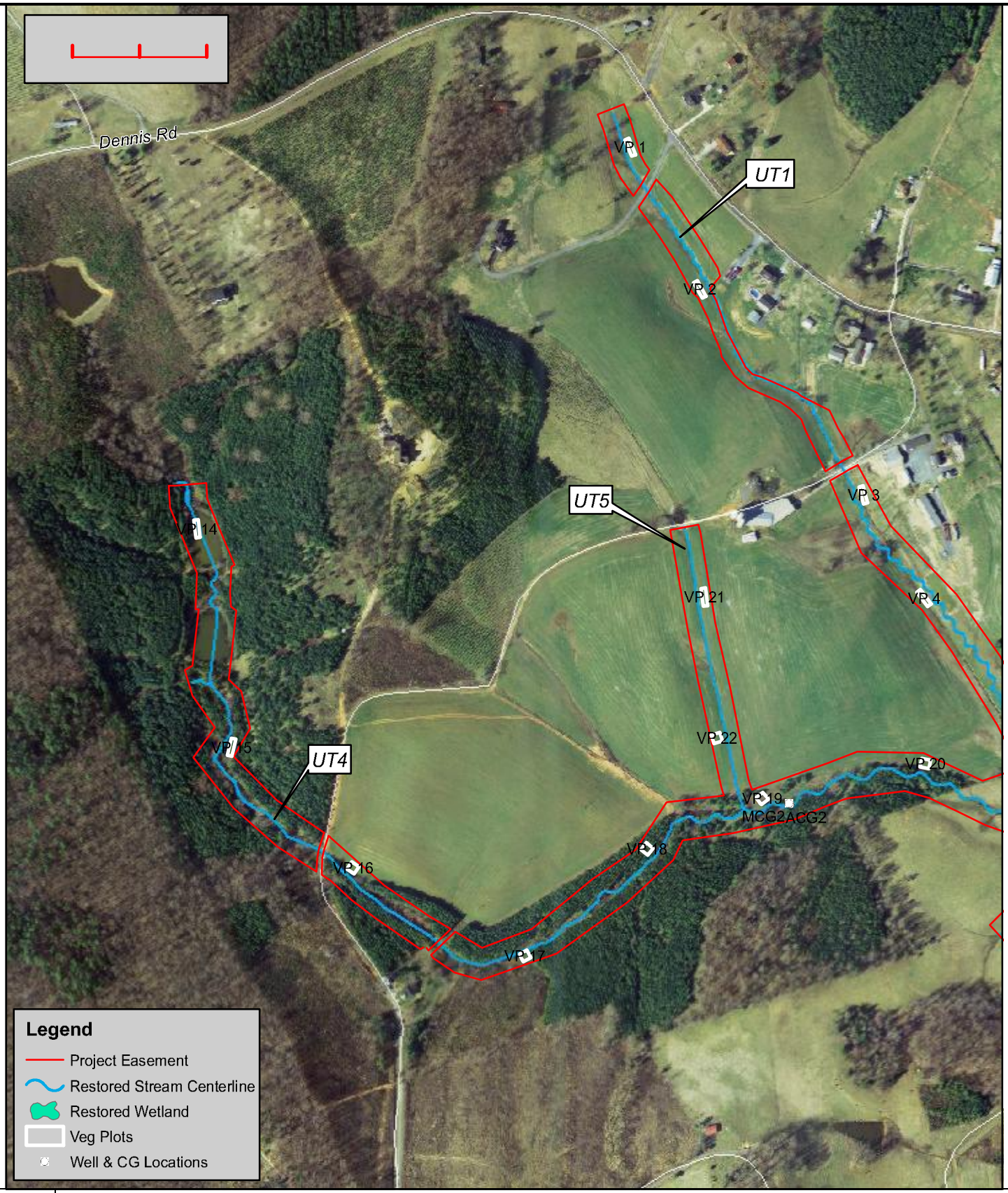



| Reach ID | UT 3 |
|---|---|
| Cross Sectional Area | 11.5 |
| Bankfull Width | 12.8 |
| Mean Depth | 0.9 |
| Max Depth | 2.7 |
| Wetted Perimeter | 14.5 |
| Hydraulic Radius | 0.8 |
| Width:Depth Ratio | 14.4 |

# Monitoring Figures




| | | | |
|---|---|---|---|
| **Title** | Vegetation Plot and Monitoring Well Locations | | |
| Prepared For: Ecosystem Enhancement Program | **Project** | Rockwell Pastures Stream and Wetland Restoration<br>Stanly County, North Carolina | |
| | **Date**<br>5/4/09 | **Project Number**<br>012620017 | **1** |




| | |
|---|---|
| **Title** | Vegetation Plot and Monitoring Well Locations |
| Prepared For: Ecosystem Enhancement Program | **Project** Rockwell Pastures Stream and Wetland Restoration<br>Stanly County, North Carolina |
| **Date**<br>5/4/09 | **Project Number**<br>012620017 |
| **2** | |

# Vegetation Plot Data

**Rockwell Pastures - Vegetation Plot Summary**

| Plot No. | Nearest Stream | Plot Size (Acres) | No. Stems | Stems per Acre |
|---|---|---|---|---|
| VP 1 | UT1 | 0.0247 | 16 | 648 |
| VP 2 | UT1 | 0.0247 | 19 | 769 |
| VP 3 | UT1 | 0.0247 | 21 | 850 |
| VP 4 | UT1 | 0.0247 | 19 | 769 |
| VP 5 | UT1 | 0.0247 | 16 | 648 |
| VP 6 | UT1 | 0.0247 | 17 | 688 |
| VP 7 | UT1 | 0.0247 | 16 | 648 |
| VP 8 | UT1 | 0.0247 | 11 | 445 |
| VP 9 | UT1 | 0.0247 | 16 | 648 |
| VP 10 | UT1 | 0.0247 | 16 | 648 |
| VP 11 | UT1 | 0.0247 | 19 | 769 |
| VP 12 | UT2 | 0.0247 | 18 | 729 |
| VP 13 | UT3 | 0.0247 | 18 | 729 |
| VP 14 | UT4 | 0.0247 | 18 | 729 |
| VP 15 | UT4 | 0.0247 | 18 | 729 |
| VP 16 | UT4 | 0.0247 | 13 | 526 |
| VP 17 | UT4 | 0.0247 | 17 | 688 |
| VP 18 | UT4 | 0.0247 | 20 | 810 |
| VP 19 | UT4 | 0.0247 | 13 | 526 |
| VP 20 | UT4 | 0.0247 | 16 | 648 |
| VP 21 | UT5 | 0.0247 | 17 | 688 |
| VP 22 | UT5 | 0.0247 | 15 | 607 |
| VP 23 | UT6 | 0.0247 | 16 | 648 |
| VP 24 | UT6 | 0.0247 | 16 | 648 |
| VP 25 | UT7 | 0.0247 | 17 | 688 |
| VP 26 | UT7 | 0.0247 | 20 | 810 |
| VP 27 | WTD2 | 0.0247 | 19 | 769 |
| | | **Average:** | **17** | **685** |

Vegetation Plot 1

Vegetation Plot 2

Vegetation Plot 3

Vegetation Plot 4

Vegetation Plot 5


Vegetation Plot 6


Vegetation Plot 7

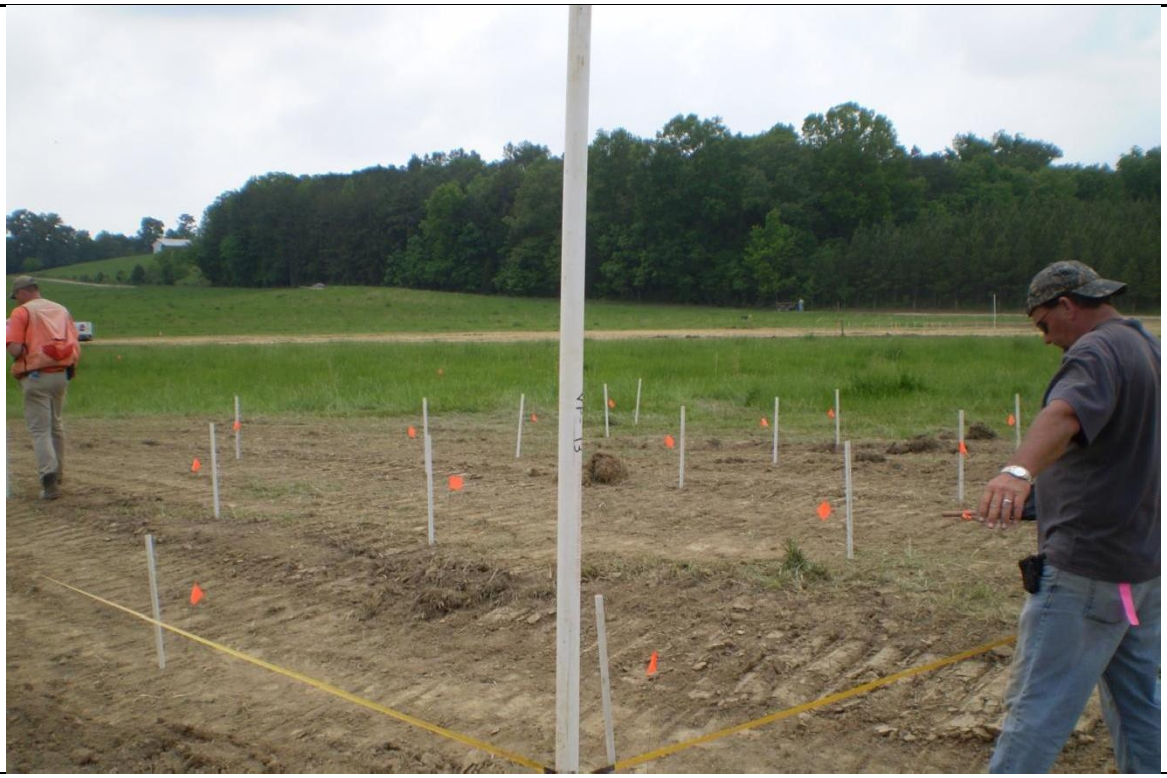

Vegetation Plot 8


Vegetation Plot 9


Vegetation Plot 10


Vegetation Plot 11

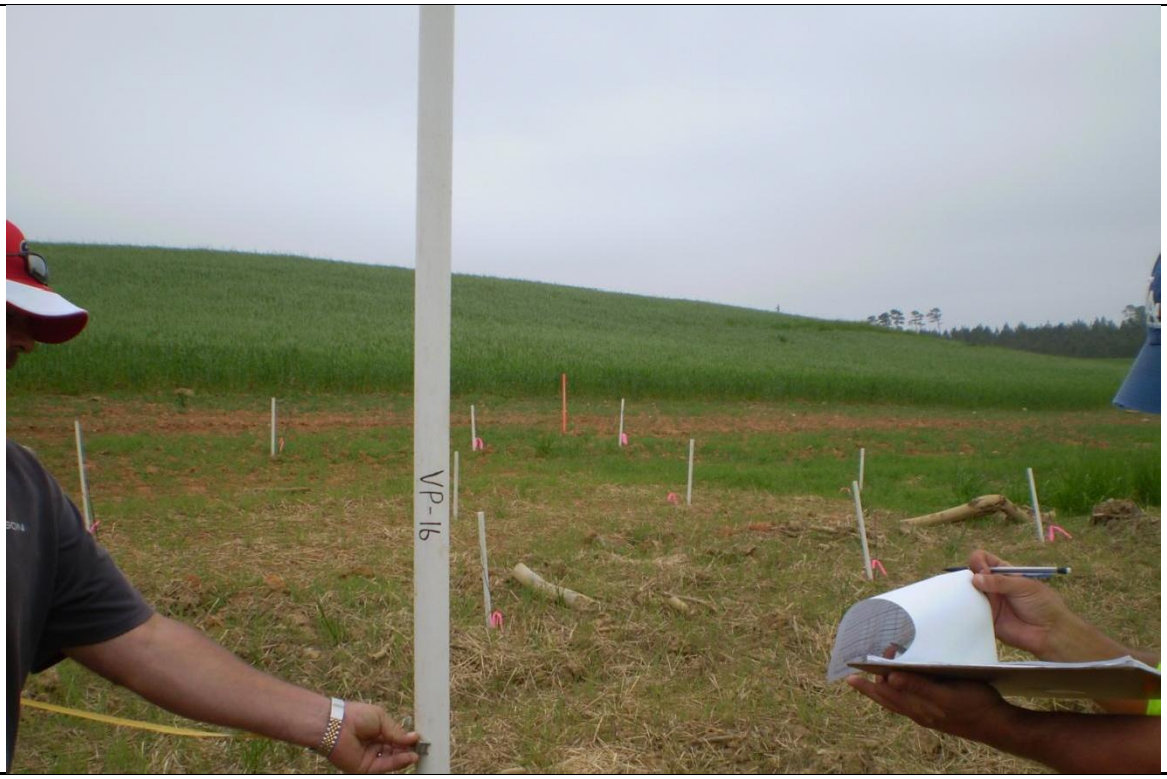

Vegetation Plot 12



Vegetation Plot 13

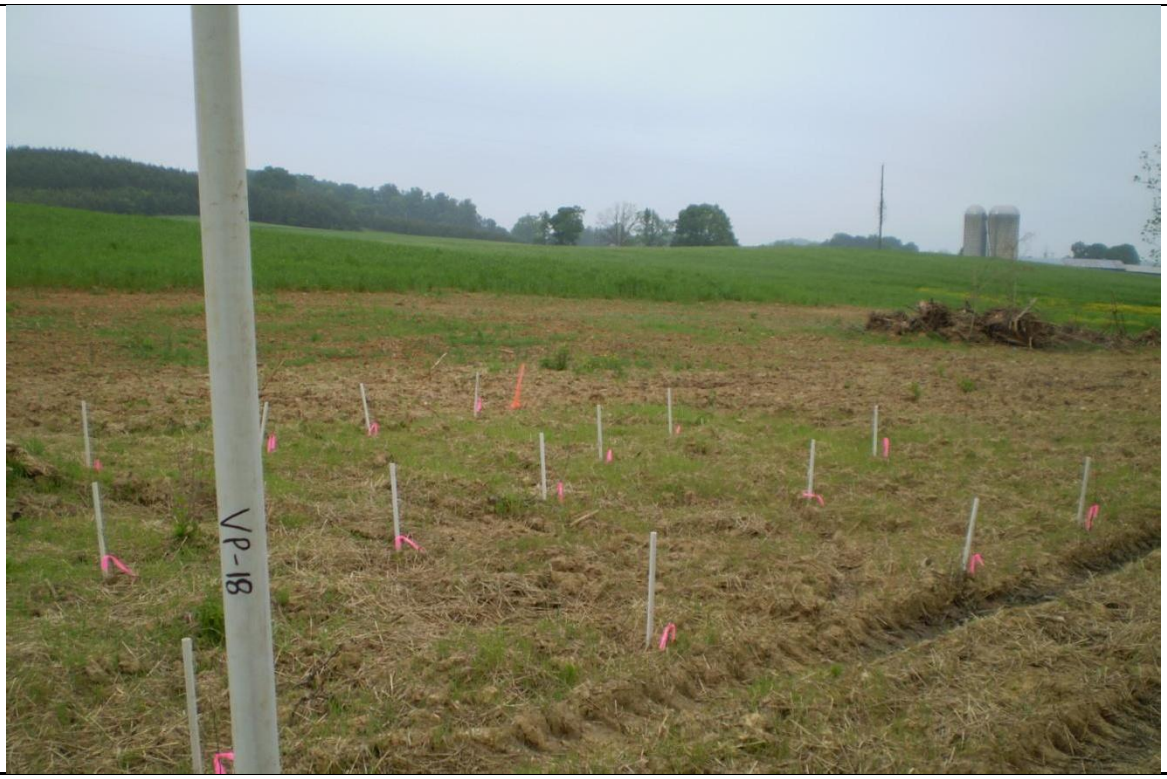
Vegetation Plot 14

Vegetation Plot 15




Vegetation Plot 16


Vegetation Plot 17




Vegetation Plot 18

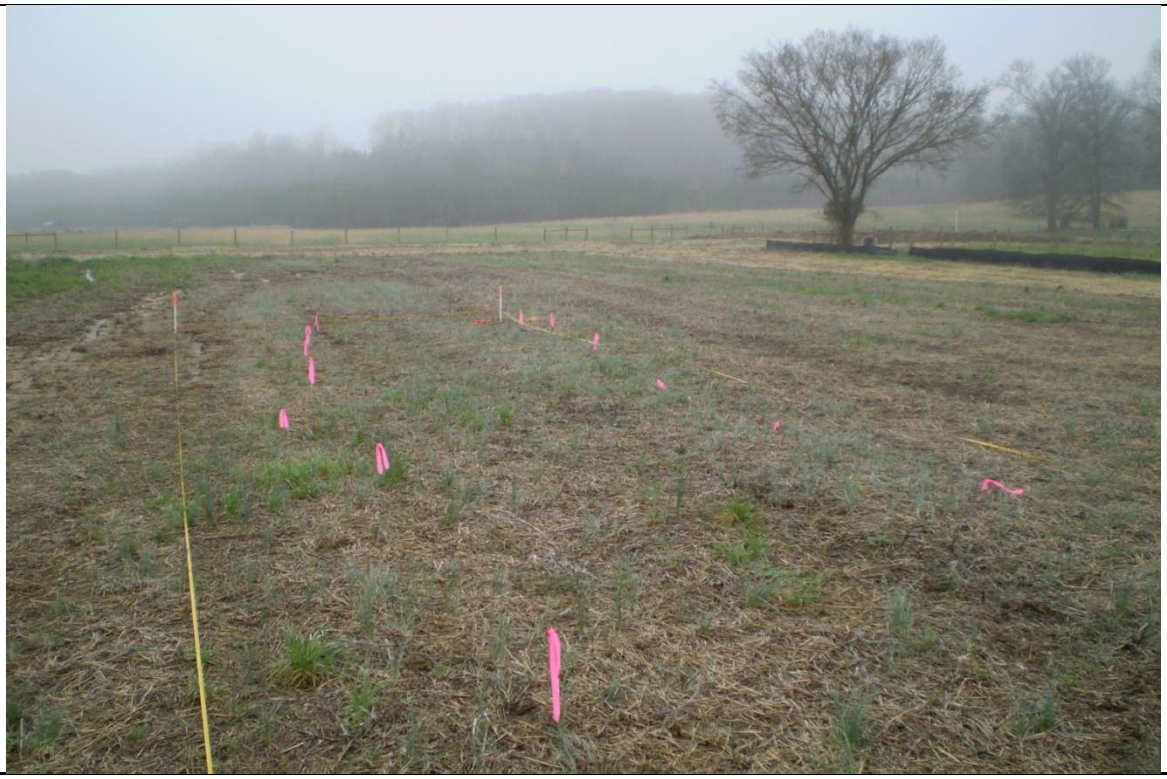

Vegetation Plot 19


Vegetation Plot 20

Vegetation Plot 21


Vegetation Plot 22

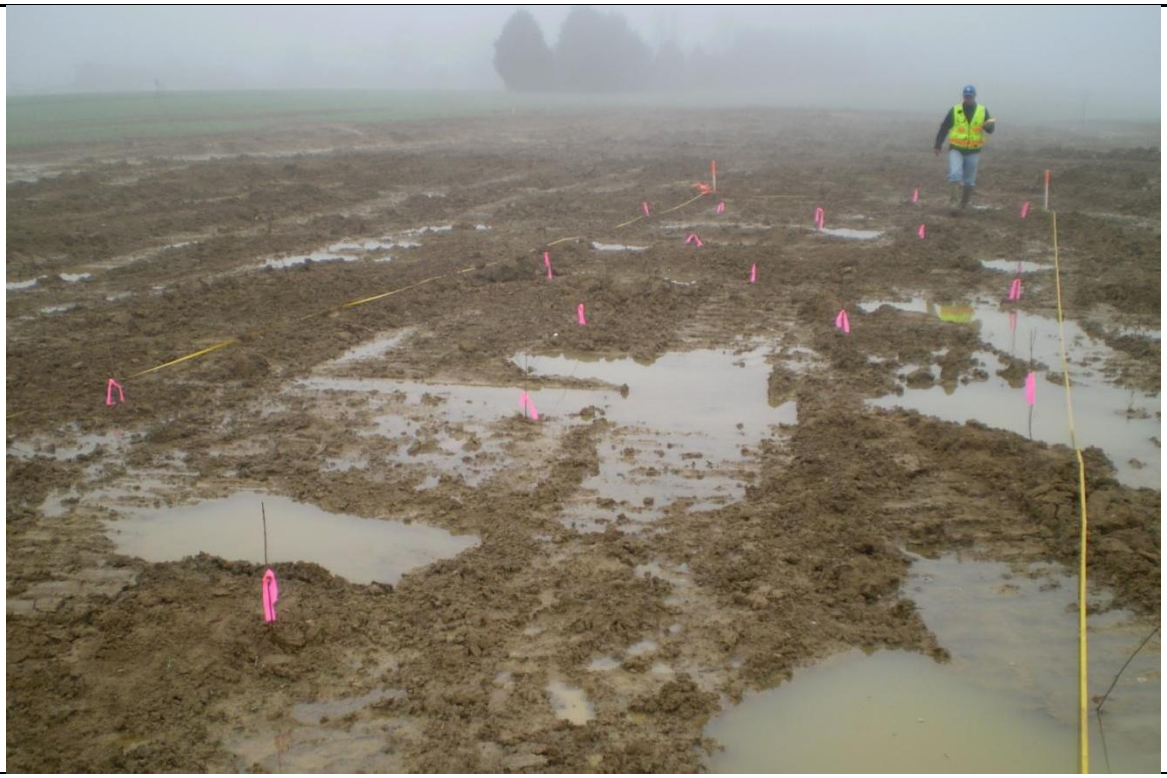
Vegetation Plot 23



Vegetation Plot 24

Vegetation Plot 25

Vegetation Plot 26



Vegetation Plot 27