ROD-SOF for DA Permit SAJ-1993-01395
Attachment B - Compensatory Mitigation Plan
Attachment A, Part 2 - Stream Work Plan

Stream Work Plan (Attachment A, Part 2)

SOUTH PASTURE EXTENSION
STREAM RESTORATION PLAN

Prepared for:

CF INDUSTRIES, INC.
Wauchula, FL

Prepared by:

AMEC-BCI Engineers & Scientists, Inc.
2000 E. Edgewood Drive, Suite 215
Lakeland, Florida 33803

AMEC-BCI Project No: 03-16268

September 2011
(Revised)

TABLE OF CONTENTS

TABLE OF CONTENTS
(continued)

LIST OF TABLES

LIST OF EXHIBITS

LIST OF FIGURES

LIST OF FIGURES
(continued)

LIST OF APPENDICES

1.0 INTRODUCTION & REPORT FORMAT

The purpose of this document is to describe the restoration approach for the lotic systems of the South Pasture Extension (SPE) property, with particular emphasis on their fluvial geomorphology and associated biological zones. Attention to these aspects of the landscape will help to assure reclamation success in providing viable and sustainable ecological and hydrological functions. For the purposes of this document, "lotic systems" include alluvial stream channels, their meander belt, and the lateral and longitudinal wetland systems to which the stream channels connect. The stream mitigation objectives are;

- Create and preserve a well-buffered, ecologically complex drainage network on the property. Site selection was based primarily on maintaining and improving upon the fluvial functions provided by the onsite systems proposed for impact. After careful consideration for this project, including CF Industries Inc.'s positive 25-year history of stream creation, local stream functions on and immediately downstream of the property will be best restored by onsite mitigation. In this case, restoring streams at offsite locations far downstream or elsewhere in the Peace River basin would not restore functions to the streams on or close to the property, while work on the property will restore these local functions.
- Replace ditched streams with natural channels and create a net increase in natural channels on the property assisting with regional objectives to increase low-order stream channels in the Peace River watershed.
- Rely on application of fluvial geomorphology to develop self-sustaining fluvial systems compatible with on-site hydrology and sediment texture. Particular emphasis is on placing streams in landscape positions with appropriate combinations of valley slope and drainage area to sustain alluvial bed forms.
- Provide longitudinal and lateral wetland-to-stream connections appropriate for the property's position in the Peace River drainage network. This will result in proper large-scale habitat connectivity within the lotic system between streams and their floodplains, their in-line wetlands, and headwater wetlands.
- Create a net functional lift, in part, by using a library of regionally applicable reference sites taken from among the best remaining low-order streams in Florida, to guide restoration details. These details include those related to characteristic discharge, sediment type, channel dimension and bedforms, channel planform, floodplain dimensions and vegetation, and in-stream habitat diversity and abundance. Use of high-quality reference sites to guide design is valuable because most of the streams proposed for impact are altered.
- Use proven techniques pioneered by CF Industries, Inc. (CF) to rapidly create stable and complex channel and floodplain geomorphology at CF's Florida phosphate mine. CF has decades of experience restoring natural streams with healthy biological communities and in recent years has implemented rapid construction techniques to build channels in accordance with the planning and design approaches described in this document.

The stream network on the SPE property drains the upper portions of three sub-basins including Brushy Creek, Lettis Creek, and Troublesome Creek (**Figure SRO-1**). No perennial streams exist on the SPE. The streams are mainly un-named low-order tributaries that provide drainage for local wetland depressions during the wet season. Lettis Creek is a tributary to Brushy Creek and both are part of the 241 square-mile Horse Creek sub-basin. Horse Creek is one of the largest tributaries of the Peace River. The portions of the Brushy Creek and Lettis Creek sub-basins on the SPE include eight square miles within the Horse Creek drainage basin representing only three percent of its total area. Like Horse Creek, Troublesome Creek is a tributary of the Peace River. However, Troublesome Creek is smaller system which drains only 20 square miles of the river's 2,350 square mile watershed. The SPE includes three square miles of the Troublesome Creek sub-basin (15 percent of its total area). The Troublesome Creek drainage network is poorly developed on the SPE, consisting mainly of ditched wetlands. The entire SPE consists of less than one percent of the Peace River watershed (0.5 percent).

The proposed approach to SPE stream restoration is state-of-the-art, in part because it explicitly provides design details concerning not only the stream channel reach, but also fits these channels to the landscape based on a hierarchical association of channel form and function as it relates to valley form and watershed processes. This plan recognizes that Florida stream environments are composed as a series of longitudinal and lateral habitat zones that are inherently self-sustaining based on the aforementioned hierarchy of scale and associated fluvial and ecological processes. This "functional process zone" (FPZ) design approach stems from careful evaluation of the on-site resource and also is based on the results of a three-year study concerning the fluvial forms of Florida streams in settings much closer to pristine than those of the SPE. Furthermore, the FPZ concept has been described for its utility across the globe, and is the primary subject of a recent textbook promoting improved stream characterization, management, and restoration concepts (Thorp et al. 2008). This approach is important because the main emphasis of the plan is to produce a better lotic system after mining than existed before mining wherever practicable. Under the FPZ approach, channel classification (e.g. Rosgen classification) is only one of several interrelated factors evaluated in determining the restoration approach (Thorp et al. 2008). Descriptions of the existing lotic systems may also include artificial drainage features, such as ditches and canals, where they have disrupted or adversely affected the natural fluvial functions of the property. This design document also describes the proposed approach taken to maintain or improve upon the pre-mining functions of these systems through various combinations of lotic system enhancement and restoration (creation), while allowing for practical and beneficial mining use of the property.

The elimination and reduction of impacts to lotic systems was achieved through an iterative process. This process was a phased approach. In making these decisions, CF first considered which streams could practicably be avoided. The next step considered how to minimize system impacts. Finally, a detailed stream creation design to mitigate remaining impacts was developed. The following aspects of each waterbody and lotic system were considered:

- Quality of the stream channel (habitat complexity and abundance, flow regime, and stability).
- Maturity and complexity of adjacent terrestrial habitats, headwater wetlands, and in-line wetlands.
- Regional uniqueness of the waterbody.
- Biological functions of the lotic system.
- Vulnerability of the waterbody to continued and foreseeable functional reductions.
- Restorability of the lotic system functions via mine reclamation.
- Landscape location and scale of the waterbody as it relates to its drainage area size and hydraulic energy regime.
- Landscape location and scale of the lotic system with respect to existing or potential wildlife corridors and habitat nodes, especially gallery forests.
- Landscape location and scale of the lotic system with respect to its effects on practicable mining, mine infrastructure requirements and logistics, and ore recovery.

Total stream avoidance and minimization is particularly difficult at phosphate mines because these systems create rather linear projections in the operations, which limit dragline maneuverability and encumber reserves in a manner disproportionately large for the area avoided. To protect such linear systems, typically a perimeter ditch and berm system is necessary on both sides. Avoidance of narrow stream systems therefore tends to restrict mining from a land area that is at least three times bigger than the stream corridor’s meander belt.

This approach to avoidance decisions does not lend itself to a simple mathematical algorithm and was derived from consensus-building discussions and evaluations balancing all of the foregoing factors by CF staff and consulting experts, and multiple pre-application discussions with agency reviewers.

This document is organized in six chapters. This Chapter 1 presents the introduction. Chapter 2 provides on overview of the existing condition of stream channels found at the SPE and the detailed design criteria CF plans to implement in their restoration. Chapter 3 expands upon the design approach described in Chapter 2 to include broader descriptions of the lotic systems found at the SPE and CF’s plans for restoring stream functions at physical scales greater than the channel itself. Chapter 4 provides some technical background and a glossary to assist readers unfamiliar with some of the key concepts CF is using in this multi-scale design approach and to provide definitions of key terminology used throughout the document. Chapter 5 provides a summary of the design and a description of the project’s functional benefits. Chapter 6 is a bibliography of the references cited.

2.0 STREAM CHANNEL DESIGN

The design approach starts by inventorying, mapping, and classifying each stream channel segment on the property. FLUCCS mapping and classification of streams resulted from a comprehensive field investigation assisted by interpretation of historical and modern aerials from the 1940's and 1970's, and those subsequent to 2000. ENTRIX, Inc. scientists developed a detailed baseline depiction of the stream areas using a combination of high-resolution aerial imagery and Global Positioning System (GPS) equipment for the SPE. For conveyances in areas of primarily native upland or wetland land cover, and for conveyances in agricultural areas exhibiting more-or-less natural stream sinuosity, a Trimble sub-meter GPS unit was used to record a track along center of the channel. The line features collected this way were later traced at a scale of 1:600 using ArcGIS software. This smoothed centerline was created in order to remove the extra "noise" from the GPS antenna movement during data collection.

A total of 87,662 linear feet (LF) of stream channels were mapped on the SPE property (approximately 16.6 miles) (**Figure SRO-2A through E, Table SRO-1**). An inclusive definition was applied to streams for this property, with some sites draining as little as 0.02 square mile watersheds (roughly 13 acres). Streams draining less than 0.1 square miles are likely to provide only ephemeral flow and may often function more as vegetated swales than as alluvial channels. Approximately 5,500 LF (1 mile) of the mapped existing streams drain watersheds less than 0.1 miles representing about 6 percent of the total length delineated.

Of the onsite channels, 32,161 LF (6.1 miles) are in areas proposed for mining and 55,501 LF (10.5 miles) will remain unmined. Of the 32,161 LF of streams proposed for mining, 10,819 LF (2 miles) were previously ditched (**Table SRO-2**). Of the 5,500 LF of ephemeral channels on the property about 5,000 LF are in the proposed mined area. The streams within the proposed avoidance areas are clearly dominated by un-ditched natural channels (98 percent) and less than 1 percent of the un-mined channels provide ephemeral drainage. Thus, the minimization of unavoidable impacts emphasized protection of the largest, most complex and most intact streams on the property. More than 70 percent of the natural streams on the property will be preserved.

In accordance with Rule 62C-16.0051(4), CF will reclaim at least a linear foot equivalency for the total length of natural streams (511 FLUCCS) and ditched natural streams (512 FLUCCS) inventoried and proposed for disturbance at the SPE. In fact, BCI's stream reclamation designers have determined that the post-reclamation landscape can support a net increase in total stream length to improve the lotic system functions of the property. CF proposes to restore 43,838 LF (8.3 miles) of streams via creation. This restoration length includes 10,819 LF of restored channels to replace the existing ditched streams with naturally meandering and complex alluvial channels. Additionally, CF will enhance 4,204 LF (0.8 miles) of existing hydrologically bypassed channel in Lettis Creek by restoring its drainage patterns (see Chapter 3 under the section headings "Lettis Creek East Branch" and "Lettis Creek North Branch"). The proposed stream restoration plan will provide a net increase of 2 miles of stream channels on the property. Given that 2 miles of the streams proposed for impacts are currently ditches; this means that in actuality a net gain of 4 miles of natural channels will be achieved.

In accordance with 62C-16.0051(4), the restored stream segments will be dimensioned to conform to their most appropriate Rosgen Level II stream channel classification. The primary focus of the Rosgen assessments occurs at the reach scale. Reach scale metrics provide sufficient detail for the open channel and floodplain design to facilitate meso-habitat patches that normally assure an appropriate abundance and diversity of fish and wildlife habitat. This design scale provides important details related to the in-stream aquatic habitat and lateral riparian corridor wildlife habitat functions and stream stability to prevent harmful erosion or shoaling.

2.1 Reference Reaches and Rosgen Channel Classification

Property baseline conditions were established on a representative sample of twenty-eight SPE reaches. These were surveyed to determine their channel dimensions, shape, and flood prone width sufficiently to classify each reach in accordance with a Rosgen Level II classification (**Table SRO-3**). This represents about 33 percent of the stream segments inventoried at the SPE, providing an excellent representative sample of on-site Rosgen channel types occurring across the landscape. Surveys were confined to areas within natural channels where bank vegetation appeared to be preventing excessive deformation of the channel morphology at the time of observation. This approach increases the probability that the bankfull dimension is correct as measured. Some streams could not be surveyed as they wholly lacked such stable areas or the natural channel was directly altered (or obliterated) by an artificial ditch.

Each surveyed reach was also observed along a thalweg channel length at least 20 times the bankfull width. Reaches systematically observed on this kind of scale are often referred to as “reference reaches”. This does not mean that they necessarily serve as ideal references for restoration targets as some can be significantly damaged. They are simply references for the rest of the larger natural stream segment to which they belong. Channel widths can vary substantially along a segment and even within a reach in Florida, due to the variable effects of significant vegetative controls on the bank and bed geometry. Therefore, on the SPE property, an attempt was made to find locations that were close to the average condition when assigning a classification to a reach and determining the initial design of the reclaimed system. The design plan will then add channel variability to this “central tendency” dimension along each reclaimed segment as needed to achieve the restoration goals noted above.

Only two types of natural Rosgen channel types, C5 and E5, were observed in the natural stream segments on the SPE (**Figure SRO-5**). Approximately 64 percent of the segments surveyed (18 of 28) were C-type channels, meaning they are comparatively shallow relative to their width. This distribution of Rosgen channel types is typical of peninsular Florida’s flatwoods ecoregions. Some of the streams, however, are artificially entrenched, classifying as E5’s in landscape positions where C5’s would be more normal (at interior links within chains of wetlands).

Observations were made of the in-stream habitat substrates of each reach, as well as the stability of both banks, and the ecological quality of the overbank areas in the riparian corridor in accordance with Florida Department of Environmental Protection’s (FDEP) Habitat Assessment (**Table SRO-4**). Overall segment sinuosity ratios and local bend geometries (radius of curvature) were calculated from ENTRIX’s GPS traces of each stream segment (**Table SRO-3**). Valley slopes, valley bottom widths, and meander beltwidths were determined from these traces and from LiDAR topography. Each system’s sub-basin was assessed for its size, clearing impacts/native cover, and ditching. Each stream segment was observed for barriers to fish passage, such as hanging culverts. Reference reaches were photographed from the ground at the time of survey in the upstream, downstream, right bank, and left bank direction (**Appendix A**).

2.2 Reach Scale Design Metrics

Every stream segment in the reclamation and restoration design was assigned a complete set of specifications to assure appropriate channel habitat complexity and stability, based on the existing and historic on-site conditions (**Table SRO-5**). Stream dimensions are typically described from three perspectives, cross-section, profile, and plan view. Collectively, these perspectives define the stream geometry in 3-dimensions. These dimensions provide the most fundamental basis for the design. **Table SRO-5**, the final specification table, sets the appropriate conditions for construction and also includes the results of design-check calculations. Each parameter included in the master design table at the reach scale is explained below.

Drainage Area and Valley Slope

These are set by the landscape reclamation plan. Drainage area typically plays a key hydrologic role and valley slope can create an important threshold template for stream type (**Exhibit SRO-1**). Both are checked to be within acceptable ranges for the desired FPZ type, Rosgen stream type, and channel cross sectional area. These are not meant to be rigid specifications, as these associations can vary substantially in nature. In the case of drainage area and valley slope, the numbers depicted in the design table represent a design check calculated and used by the fluvial geomorphologist. A broad range of watershed sizes and configurations can be acceptable for each designed reach, but there are limits, and some associations are more likely than others in nature. The design details for each segment comports with regional curves developed by BCI and University of Florida staff for peninsular Florida.

Stream Length

This is the total length of stream channel to be created. It is set by providing at least an overall 1:1 LF replacement for streams cleared for mining purposes and it also must be in accordance the valley length with respect to acceptable ranges for sinuosity (S_r) and bed slope. CF's plan provides a net increase of 2 miles of streams on the property, counting ditches. If the existing ditches are excluded from consideration, CF is providing a net increase of about 4 miles of natural channels on the property. The ratio of natural streams created to natural streams impacted is about 2:1 (8.3 miles created versus 4.0 miles impacted).

Channel Cross Section

A prototypical cross section is defined as a roughly triangular or trapezoidal channel defined by the bankfull width (W_{bkf}), thalweg depth (D_{tw}), and bottom width (W_{bed}) (**Exhibits 2** and **3**). It is important to note that the design depth used is the maximum depth of a typical riffle cross section

(D_{tw}). It is greater than the mean bankfull depth (D_{bkf}) and it is less than the maximum depth in a pool. This prototypical cross section forms an "anchor" from which construction may deviate within limits set by the fluvial geomorphologist. The prototypical section is generally derived from the most typical reference cross section measured from the reference reach or from an "average" configuration for the reference reach. Cross sections at pools and riffles have different dimensions and shape (**Figure SRO-6**).

Cross section dimensions are often cross-checked for consistency of bankfull area (A_{bkf}) with a reference reach or regional curve for streams of similar size watersheds (**Exhibit 4**). Mean bankfull depth (D_{bkf}) is calculated from the prototypical section and then the W_{bkf} / D_{bkf} (W/D) ratio is checked for consistency with the desired Rosgen classification. For example, W/D less than 12 is an E-type. The final design check consists of assessing the tractive forces, using mean shear stress, velocity or stream power at bankfull discharge. Bankfull discharge can be calculated based an association with drainage area (**Exhibit 5**). The prototypical cross-section must provide for tractive forces within the typical ranges encountered for the appropriate stream types in the region (**Exhibit 6**). They must also allow for continuity of sediment transport compatible with the downstream systems.

Inlet and Outlet Inverts

These are the vertical boundary conditions between which the stream is "strung". The upstream or inlet invert is usually set by the outfall conditions desired in the headwater wetland or other connecting conveyance. If from a wetland or lake, this often functions much like a natural broad-crested weir prior to entering the channel. The downstream or outlet invert is either set by a connection point to an existing/preserved stream bed or wetland at the original severance point or to the bed of a reclaimed wetland system. Sometimes the wetland connection points are depositional areas and a small natural berm can form at the outfall near the connection. Inverts can also be located at relatively sharp inflections between two slope regimes along a reclaimed run or at areas where lateral inflows from the watershed increase substantially.

Bed Slope

This is a design-check that is a function of the inlet and outlet inverts and contoured stream length. It must be within the typical ranges established for the reference reaches of similar stream classification types. Typically if the valley slope and sinuosity ratios are within natural norms, the bed slope is not necessary to consider.

Sinuosity Ratio

This is a design guide, with a fair degree of flexibility except in some cases when the sinuosity is an important design factor in assuring proper channel friction and/or slope to slow down velocities to acceptable levels in areas with steep valley slopes.

Meander Beltwidth

This sets the average width of sandtailings or other sandy and organic materials set within the stream valley to provide suitable alluvial material for the channel to meander through as bends migrate over long time frames. This can be viewed as the "wiggle room" for the stream (**Figure SRO-6**).

Belt Thickness

This is simply the average depth below the ground surface that the sandy and riparian organic substrate material is placed within the meander belt. It is typically similar to or greater than the typical thalweg depth of the stream (**Figure SRO-6**).

2.3 In-Stream (Meso-Habitat) Design Metrics

In-stream habitat diversity in low order streams can range from as few as one (1) type of habitat to more than five (5). Generally, at least three (3) habitat types important to macroinvertebrates and fish are present in reasonably intact low-order streams. The most productive habitats include pools, large woody debris, fine woody debris, fine root masses, overhanging vegetation, overcut banks/root overhangs, leaf packs, in-stream macrophytes, and, less frequently, rocks. This plan provides specifications for every reclaimed reach for the following metrics.

Number of Excavated Pools

Pools that deviate by more than 18 inches from the mean bed elevation along the bed slope would be excavated in accordance with their frequency of occurrence in the reference reach or based on recent data from a library of more pristine reference reaches developed from flatwoods channels across peninsular Florida. Pools will also be constructed at every tight bend (radius of curvature less than 10 feet for the streams in this project). This assures that the stream channels have a balance of deep and shallow water.

Number of In-Stream Snags

Large roots, trunks, and snags can play significant roles in directing pool/riffle sequences in small, low-order streams and they provide hard-structure habitat for aquatic fauna. The number of large snags (typically 4-8-inch diameter) to be installed in the stream is specified based on the combined pool and riffle spacing measured in reference reaches, snag inventories of on-site reference reaches, and snag densities reported from other low-order natural streams in peninsular Florida. Large snags will create localized hydraulic conditions that will facilitate the rapid formation of a rough stream bed/bank profile. Snags of less than 6-inch diameter should be anchored/driven at least 2 feet into the banks at or slightly above the contoured bed protruding into the channel at an upstream angle. They can also be placed individually or in a braced “V” arrangement pointing upstream (**Figure SRO-7**). Large stumps (greater than 6-inch diameter) can be loose strewn onto the bed at random angles.

Number of Sharp Bends and Radius of Curvature

Bends provide velocity gradients that create microhabitat opportunities for macroinvertebrates and fish. Bend geometry, particularly radius of curvature (Rc) and the ratio of Rc to bankfull width (Rc/W), was found to be highly variable among streams on the property (**Table SRO-3**). Any individual bend was found to have a Rc less than 3.5 feet to more than 40 feet, with an average Rc of 11.2 ± 6.9 feet (n = 36). The design thus focuses on assuring three to four bends per 20 bankfull widths will have an Rc within 4 to 20 feet. The minimum number of bends is based on the frequency encountered in the reference reach or from research conducted on intact streams. Sharp bends are defined as those with a 10 foot Rc or less for streams in the general width categories of those to be mined and reclaimed at the SPE. Streams will be restored with bend geometries that fall within the normal and natural range of Rc/W ratios for streams in the region. Bends should not curve too severely, and some variability in patterns should be created among bends. Bends and their associated Rc/W ratios and overall segment sinuosity assure appropriately high ratios of bank length to surface area and a variety of bank slopes.

Number of Root Wads

Root wads are intact, flat root masses attached to a stump. Root wads will be added into the bank at low radii bends (sharp bends) as a habitat amendment to allow for the immediate formation of overhanging banks and exposed large root masses.

Root wads will often be left upright (roots down, stump up) and placed in a depression next to the bank with soil packed around all sides except the side exposed to the creek (**Figure SRO-7**). Root masses exposed to the stream will provide habitat and the root wad will form a difficult to move bank feature. This would work with live root stumps as well as dead wood. If available, some species (e.g. sweet bay and dahoon) can coppice from stumps with live root masses. Live root wads may therefore provide a double benefit. Either live or dead root wads will be placed at tight bends in the upright manner described. Trees cleared for mining in the 4 to 10 inch diameter at breast height (dbh) range are expected to work well with the small streams of this plan.

Number of Fine Woody Fascines

For the purposes of this project, fascines are defined as jumbled, interwoven sticks which are crammed into the bed close to and against the bank. Each stick is typically less than 4 inches in diameter and each fascine should be comprised of several sticks. Some of these fascines can be constructed as "brush piles" obstructing as much as 75 percent of the channel at selected cross sections. The number of fascines specified is aimed at providing sufficient friction in the channel to assure the proper balance of hydraulics, channel stability, and sediment transport capacity. Such fine woody debris is also productive fish and macroinvertebrate habitat.

2.4 Temporary Stabilization

In addition to the more permanent channel and bank construction features described in previous sections, the stream restoration work plan calls for several interim measures to be taken to assure channel stability during the time it takes for the native vegetation to create sufficient ground cover and root structure. This typically occurs within one (1) to three (3) years.

Therefore, biodegradable erosion control blankets (ECB) will be used to stabilize the banks. Two to three-year rated ECBs are recommended for use on streams with bank angles steeper than the angle of repose of sand. These are usually made from coir (coconut fiber) and come in a variety of weaves and strengths. Note that encapsulation means that bank sediments are placed over a portion of the blanket and that the blanket is wrapped around the face of the bank to the bankfull elevation. An inner straw blanket is recommended across the portion of the ECB face exposed to the bank to prevent sand from sifting through the outer ECB layer.

Stream segments that have side slopes that are gentler than the angle of repose of fine sand can have their ECBs simply staked down in a single layer across the bank surface without encapsulation. These segments are also in gentler sloped valleys with higher groundwater tables and are likely to reach sufficient root densities quickly. Therefore, a 1-year rated blanket can be utilized. Either a biodegradable weed-free straw or wood fiber blanket should be utilized.

The recommendations for ECBs assume the use of cohesionless sand tailings or fine native sands in the meander belt. In some cases, the meander belt will be fully amended with combinations of wetland and upland topsoil that have moderate cohesion with a viable seedbank and live plant rhizomes, rendering the use of ECBs unnecessary. Also, CF has had success creating a complex stream channel using hydraulic carving rather than mechanical construction techniques. If CF deploys this construction technique at the SPE, ECBs will not be deployed to encapsulate the bank but will be selectively layered across the bank face and/or deployed as log-rolls at the channel toe if the bank material is cohesionless.

Silt fences should be placed parallel to the banks near the top of bank for the full length of the stream, to prevent the channel from silting-in. This could occur where viable topsoil is not used in the floodplain and large flow events occur within the first year of construction. Likewise, silt fences should be placed at the floodplain/upland interface and parallel to the floodplain to prevent siltation of the floodplain from the adjacent uplands (**Figure SRO-6**). Haybails will not used because hay can introduce *Harmathria* grass and other exotic nuisance species that complicate restoration efforts.

Floodplain velocities are generally much lower than those in the channel, because of significantly higher cross sectional area and greater vegetation density (higher friction). Large woody debris will be selectively scattered across the floodplain, perpendicular to the flowpath, especially at tight bends. This will reduce any tendency for the channel to cutoff the meanders while the floodplain vegetation is still young.

Particular attention will be paid to the stream junctions at the preservation boundaries. These will be carefully and accurately surveyed prior to final design and will be edge-matched to their existing condition.

The reclaimed streams will be temporarily stabilized until shoreline vegetation is established and designed to ensure long-term natural channel stability. Natural streams typically have deformable boundaries and beds. "Stabilization" does not mean the stream will not change shape. It just means that it is unlikely to engage in long-term destabilizing trends of aggradations or degradation that could impair biological function of the stream channel or lead to harmful erosion or shoaling downstream.

2.5 Riparian Corridor Zones and Revegetation

The riparian corridor extends laterally from the stream channel and for the purposes of this design is defined by three zones, 1) the riverscape, 2) the floodscape, and 3) a terrestrial buffer.

<u>Zone 1: Riverscape</u>

The riverscape is the open channel, including its bed and banks. Emergent vegetation is limited on the bed within this zone due to hydraulic forces and sediment transport, but does occur in patches. The bed vegetation is comprised mostly of fast-colonizing herbaceous plants (e.g. smartweed (*Polygonum* sp.)) but can sporadically include trees and shrubs such as pop-ash (*Fraxinus caroliniana*) or buttonbush (*Cephalanthus occidentalis*). Plant species on the bed naturally are greatly limited in most low-order Florida streams due to the combined stresses of sediment transport and shade. Most herbaceous plants found on such stream beds will colonize the bed passively, but some rhizomatous species will be planted into slackwater areas of some of the C5 channels, including golden club (*Orontium aquaticum*), grassy arrowhead (*Sagittaria graminea*), and blueflag (*Iris hexagonia*).

A critical sediment-vegetation interface occurs at the channel banks, which are densely lined by combinations of woody and herbaceous plants. Although there is much overlap in the channel bank species among various stream channel types and valley FPZs, some distinctions are necessary between small streams meandering through confined upland valleys versus those streams meandering through unconfined wetland valleys. Furthermore, some species are mainly associates of larger mid-order or high-order streams rather than the streams that occur at the SPE (e.g. bald cypress (*Taxodium distichum*), water-locust (*Gleditsia aquatica*), and water hickory

(*Carya aquatica*)) and are rarely found in small mid-order and low-order systems. Accordingly, these species will not be planted along the restored SPE channel banks.

Common bank species for low-order streams flowing through undisturbed confined upland FPZs that contribute significantly to bank shear strength include saw palmetto (*Serenoa repens*), Fakahatchee grass (*Tripsacum dactyloides*), wax myrtle (*Myrica cerifera*), gallberry (*Ilex glabra*), maleberry (*Lyonia ligustrina*), fetterbush (*Lyonia lucida*), highbush blueberry (*Vaccinium corymbosum*), slash pine (*Pinus elliottii*), live oak (Quercus virgniana), water oak (*Quercus nigra*), laurel oak (*Quercus laurifolia*), and cabbage palm (*Sabal palmetto*). Bank plantings for this FPZ will emphasize these species, all of which are available from commercial native plant nurseries.

In some cases on the SPE, saw palmetto forms very dense cover on the banks. The saw palmettos provide a lot of habitat structure, armoring, and root shear strength. CF will build the embankments to reclaim such systems using palmetto soil masses acquired from areas permitted for mining whenever such materials are available at the time of stream segment construction. The company has had excellent success doing this at the South Pasture. The channel toe will be selectively protected from erosion by use of a coir roll or ECB. If transplantable palmetto masses are not available, CF will plant nursery-grown palmetto containers on 3-foot centers along the portions of banks desired to be lined by palmettos, installed with a 3-year rated ECB. Most natural systems are not fully lined by palmettos, so data sources (e.g. Kiefer and Durbin 2003) will be used to set the amount of reclaimed embankment to be lined with palmettos on a segment-by-segment basis. CF has also had good experience supplementing areas with mature transplanted cabbage palms and will do so along the upland confined stream banks and as part of the gallery forests of these types of sites.

The streams meandering through confined wetland valleys often have a mixture of bank vegetation patches depending on whether the channel bank is bordering the upland edge of the meander belt or is interior to the wetland bottomlands. Upland channel banks within such FPZs will be planted with species listed for the confined upland FPZ. Wetland channel banks will be planted as listed below.

For FPZs with wetland channel borders, a mixture of fast-growing and climax species will be used to supply both rapid and sustainable shade, leaf packs, and fine root masses to the stream. These plantings will be distributed through the ECB at each segment, working in concert with the ECB to add shear strength to the embankment. Common native species that strengthen wetland stream banks in the region include laurel oak, water oak, sweet gum (*Liquidambar styraciflua*), dahoon (*Ilex cassine*), red maple (*Acer rubrum*), sweet bay (*Magnolia virginiana*), blackgum (*Nyssa sylvatica* var. *biflora*), ironwood (*Carpinus caroliniana*), pop ash, cabbage palm, bluestem palmetto (*Sabal minor*), saw palmetto, Virginia willow (*Itea virginica*), possumhaw viburnum (*Viburnum nudum*), small leaf viburnum (*Viburnum obovatum*), swamp dogwood (*Cornus foemina*), maleberry, fetter-bush, smooth bumelia (*Bumelia reclinata*), storax (*Styrax americana*), hackberry (*Celtis laevigata*), winged elm (*Ulmus alata*), and American elm (*Ulmus americana*). All of these species are available from commercial native plant nurseries.

Establishing shade over the channel reduces colonization by aquatic invasive and ruderal herbaceous species that can clog the channel bed. Fast-growing, native, early successional species will be planted to rapidly establish shade over the channel and to provide quick sources of allochthonous carbon and live root masses and will include Virginia willow, Carolina willow (*Salix caroliniana*), elderberry (*Sambucus canadensis*), wax myrtle, and buttonbush. All of these species are commercially available and can be established using small containerized stock or, for some species, stem cuttings on moist soils. Native species with phenology to grow well from bundles of woody cuttings (e.g. buttonbush, and elderberry) are commercially available as live fascine bundles for stream restoration.

Zone 2: Floodscape

The floodscape includes the wetland or upland areas adjacent to the riverscape, above bankfull stage, that are either subject to annual or more frequent overbank flooding or that exist within the meander beltwidth of the riverscape (whichever is wider). These areas will be planted in accordance with wetland restoration or upland reclamation vegetation requirements and their FLUCCS code as depicted in the reclamation plan.

Zone 3: Terrestrial Buffer

Stream channels and their near-bank vegetation are susceptible to physical disturbance and other alterations that occur in the adjacent uplands, such as erosion from intense cattle grazing and eutrophication from over-fertilization. Riparian buffers can effectively mitigate or even eliminate such effects. Some of the FPZs on the SPE provide inherently wide stream buffers (e.g. wetland underfit channels), while others provide a more limited buffer (e.g. upland confined channels). Therefore, CF will create terrestrial riparian buffer zones comprised of different buffer widths and vegetation depending on the FPZ classification of the stream segment.

Upland confined streams lack any kind of significant wetland floodscape buffer and are typically flanked by a pyrogenic upland community that may or may not include an upland gallery forest. These stream systems are highly susceptible to impacts from the adjacent uplands because they lack extensive lateral wetlands that can trap eroded sediments, can be easily traversable by cattle and off-road vehicles leading to soil disturbance and local rill erosion, and lack extensive histosols that can promote denitrification of runoff from over-fertilization. Therefore, CF will establish native cover buffers at least 95 feet wide on both sides of the meander belt of streams in upland confined FPZs. The 95 feet width meets the recommended riparian forest and grass buffer commonly adopted by the USDA to assure proper riparian system nutrient processing in agricultural landscapes (Welsch, 1991) and exceed the absolute minimum threshold to meet a variety of stream conservation objectives (Wenger 1999). The terrestrial buffer will, whenever practical, be topsoiled with native upland soils to promote rapid establishment of desirable functions related to soil biogeochemistry near these streams. This will also assist with establishment of populations of the shrub species desired for Zone 2, several of which are acidophilic.

Wetland confined streams are less susceptible to water quality impacts and are most susceptible to over-trafficking, which occurs where the channel bends migrate close to the wetland/upland ecotone. Most of the channel is inherently well-buffered by its adjacent wetlands. Native vegetation buffer widths will be extended at least 60 feet beyond the meander belt for streams coursing through wetland confined FPZs. This width assures meeting FDEP “optimal” conditions for Biorecon stream habitat buffers (FDEP SOP-001/01, Form FD 9000-5).

Underfit wetland streams are the least susceptible to lateral water quality and trampling impacts because they typically course well within extensive wetland bottomlands. These lotic systems will be buffered with native upland and transitional vegetation along their outer boundaries in accordance with the upland buffer recommended by SWFWMD adjacent to wetlands of 25 feet (BOR 3.2.7(a)). Topsoiling of the buffer for these FPZs is not critical because the wetland belts tend to be wider than a few hundred feet and they will all be topsoiled with a growing medium suitable for forested wetlands, providing ample opportunity for normal wetland soil biogeochemistry to occur.

2.6 Design Verification, Maintenance Plan, Site Management, Adaptive Strategies, and Financial Assurance

Two primary mechanisms are typically employed to verify the empirical aspects of stream creation design dimensions, 1) analogue and 2) regional curves. Analog design involves the use of reference reaches. The essential dimensions and patterns are simply copied from a reasonably intact stream segment and may be scaled via various dimensionless ratios as a function of basin size or bankfull flow. This approach applies best when local reference reaches are quite similar in basin and valley geomorphology and flow characteristics. This approach requires an applicable group of stable reference reaches. (See the discussion of natural stability, above).

To the greatest extent applicable, CF will specify designs based on analogue (e.g. site-specific) conditions. When such conditions do not apply or when an analogue is not available due to severe disturbance, the design will rely on regional data. Kiefer (2010) has developed a library of nearly pristine reference reaches from flatwoods around the peninsula, and Blanton (2008) has produced a set of draft regional curves for streams in peninsular Florida, which are currently being refined by a team from BCI and UF for the FIPR Stream Restoration Design Manual (due for publication in early 2011) (**Exhibits SRO-1** through **SRO-5**). This body of work enables the design team to fit any stream to its watershed and valley, provide an appropriate FPZ, appropriate Rosgen channel type, and attribute it with a appropriate and natural amount of meso-habitat characteristics, even if the original stream has been completely obliterated by a ditch or farm field.

Maintenance will necessarily include promoting conditions necessary to establish the vegetative communities of the riparian corridor and channel banks. These are described in the “Environmental Narrative.” Placements of large woody debris may need to be supplemented as the riparian corridor matures and the materials used in initial construction decay. The condition and abundance of large woody debris will be assessed as part of the 10 year monitoring and establishment phase. Adaptive management will include selected additions of large woody debris, if necessary, at years 5 and 10. Adaptive management will also include provisions to determine the cause and remedial actions necessary to correct any observed chronic or acute stream channel instabilities. If instability occurs, stream restoration strategies consistent with working with existing unstable streams described in published references such as Section 654 of the National Engineering Handbook will be used to repair the site. In some cases, alternative site locations may be available for enhancement or creation rather than working with an unstable or hydrologically deficient site if it proves impractical. In the very unlikely event of this occurring, CF will work closely with the permitting agency(s) to decide on the best method to correct the deficiency using the following prioritization; 1) correct the deficiency at the originally designed location sufficient to achieve permit performance standards; 2) if that is not practical, seek an alternative site to create an equivalent length of stream system onsite in accordance with the issued permit design criteria and performance standards; 3) in the unlikely event that methods 1 and 2 are not available or practical, CF will pursue the potential to enhance or rehabilitate a functionally equivalent length of damaged stream on-site. If none exists on-site CF may pursue offsite stream channel rehabilitation or enhancement. CF will use a mutually agreeable quantitative functional assessment to determine the lift needed and adequacy of the remediation plan should adaptive strategies prove necessary that cannot be covered under the first or second priorities (in-situ remedial action or on-site additional creation).

Stream monitoring will include macroinvertebrate and fish sampling, hydrology measurements (discharge and stage), field water quality, as-built reference reach surveys, and repeat geomorphic cross-sections. Performance standards will be established for in-stream fauna, stream hydraulics, channel dimension and pattern, and channel stability. Details of the monitoring program objectives, methods, locations, and performance standards are provided in **Table SRO-6** and will be further developed in coordination with FDEP and USACE reviewers.

Financial assurance will include consideration of line items specific to stream restoration that are not already either individually or collectively accounted for elsewhere in standard mechanisms normally applied to Florida phosphate mines (e.g. by Hardee County and/or the FDEP).

3.0 LOTIC SYSTEM DESIGN

As mentioned in the Introduction, CF's plan begins with its focus on the traditional reach-scale metrics and also pays careful attention to important fluvial processes occurring at multiple additional scales, including the watershed, valley, and the arrangements of functional process zone (FPZ) segments within each valley. (For more technical background and definitions, please refer to Chapter 4).

In other words, this design provides details related to a hierarchy of scales progressing from catchment functions operating over hundreds of acres and ultimately addresses habitat patches that may be as small as a few linear feet. While the Rosgen classification system provides important characterization of the open channel riverscape, the additional emphasis provided by CF in classifying valley segments into FPZs adds key consideration of the floodscape adjacent to the riverscape, as well as the lateral and longitudinal interactions between the stream channel and wetland waterbody components of the property. The general timing, duration, and frequency of such hydraulically driven interactions will be assessed by integrated surface water/groundwater modeling prior to final design.

3.1 Catchment and Drainage Network

No perennial rivers or high-order streams occur on the property; it is located at or within a couple of miles of the headwaters of three stream drainage networks within the Peace River watershed. The named streams on the property include Brushy Creek, Lettis Creek and Troublesome Creek. CF will reclaim the sub-basins of these three streams close to their historic dimensions as they existed on the SPE prior to initial agricultural disturbance (to the extent this historic condition can be established), even though the applicable rules require only restoration to the pre-mining function of the systems. **Figures SRO-8** and **SRO-9** depict the drainage network flow paths of the existing pre-mining and proposed post-reclamation sub-basins for the SPE.

Brushy Creek is tributary to Horse Creek, joining it about 10 miles southwest of CF's property. The Brushy Creek headwater wetlands exist on CF's active permitted South Pasture Mine north of the SPE and portions of it are permanently preserved where it presently occurs on SP. CF has made a substantial commitment to the restoration and permanent protection of the Brushy Creek headwater wetlands and surrounding uplands as part of the South Pasture Planned Habitat Area. The main trunk of Brushy Creek is a second-order stream where it enters the SPE. Three smaller branches of second-order streams join Brushy Creek before it exits the SPE as a third-order stream. Despite being the longest, widest, and most complex riparian corridor on the property, Brushy Creek does not provide perennial discharge. In fact, it is non-perennial even closer to its confluence with Horse Creek 10 miles downstream, exhibiting about 12% no-flow days during a higher than average rainfall period from October 1992 through February 1995 (Lewelling 1997).

Lettis Creek is a third-order tributary to Brushy Creek, joining it less than a mile south of CF's property. Like Brushy Creek, portions of the headwater areas of the Lettis Creek sub-basin are part of CF's active South Pasture Mine. Perhaps the dominant feature of the Lettis Creek watershed is a large marsh that serves as the receiving waters for several chains of wetlands. This drainage hub wetland historically distributed flow from these lateral chains to the north fork of Lettis Creek. That fork has been bypassed by a drainage ditch that has severely dewatered the Hub Wetland.

Troublesome Creek is a direct tributary to the Peace River, joining the river about 7 miles southeast of CF's property. Very little of Troublesome Creek actually exists or historically existed on CF's property because its sub-basin is largely occupied by two large headwater wetlands onsite. Both of these wetlands and the short segment of Troublesome Creek at the SPE are heavily ditched and artificially drained.

To the greatest extent practicable, the pre-agricultural conditions of the property were considered in the design to create reclaimed conditions closer to those that occurred prior to extensive onsite ditching and riparian zone clearing. The general idea is to create a network of riparian corridors well-buffered by reclaimed native vegetation zones. Portions of these areas will be protected by a conservation easement, providing permanent protection of much of the riparian corridor network, preventing future clearing that can diminish stream functions.

The post-reclamation network of valleys, in-line wetlands, functional process zones, and stream channel segments will maintain the complexity of the existing network and will, in some cases, restore it as it existed prior to agricultural disturbance (**Figure SRO-3, Figure SRO-4A** through **F**). To the greatest extent practical, the historical pre-disturbance sequences of wetlands and stream functional process zones will be restored for each valley complex. This means that many of the disruptive effects of land clearing and ditching will be overcome. Offsite connections for large and complex areas likely to remain un-mined or unaltered by adjacent landowners (Brushy Creek Main, Lettis Creek Main, and Troublesome Creek East Branch) are maintained as connection points post-reclamation. The existing overall ordering of streams will be maintained for each sub-basin, as will the natural connection points to un-mined areas and offsite locations, except where it is not practicable to do so or where a different connection point will result in a better overall lotic system (discussed below).

3.2 Lotic Systems and Their FPZ Reclamation

<u>Brushy Creek Main Trunk</u>

This system is the longest stream valley on the property (about 2.4 miles) (**Figure SRO-10**). It is substantially intact (unditched and non-erosive) on the SPE with a broad native riparian corridor that typically encompasses the meander belt of the stream and beyond. It drains the largest sub-basin of all the valleys on the SPE (about 4.5 square miles on the SPE), and it is the receiving waterbody for several other lateral streams and second-order drainage networks on site. Portions of the Brushy Creek bottomlands have the most complex geomorphology on the property with dual terraces, an interfluve, and some alluvial floodplain features. This channel system provides wet season hydraulic links from two large offsite headwater wetlands upstream of the SPE to

Horse Creek 10 miles downstream of CF's southern property boundary. Brushy Creek Main Trunk is appropriately viewed as the spine of the onsite ecosystem and is proposed to remain unmined.

The system consists of a central valley that alternates between confined and unconfined wetland functional process zones over most of its length. The width of the valley floor varies considerably, from less than 80 feet to more than 3,000 feet wide. The valley consists of a single wetland bottomland terrace flanked by an upland hillslope along the upper half of its length on the SPE. From the 1.4 mile point, the system suddenly widens, and the valley is occupied by a complex two-terraced geomorphology consisting of a hardwood forested wetland terrace about 130 feet wide embedded within a mesic upland hammock terrace typically 1,500 feet wide. The mesic upland terrace is an interfluve, flanked by Brushy Creek on the south and the Brushy Creek North Central branch to the north. The Brushy Creek Main Trunk riparian corridor was historically flanked by flatwoods that have long since been cleared for farming and which are now intensively grazed as part of a cow-calf operation.

The upper part of the valley, due to its generally narrower and confined condition has been sporadically subjected to the effects of lateral land clearing and cattle grazing, but the bottomlands are in very good overall geomorphic and vegetative condition. Four main dirt road crossings occur, two of which are all-weather culverted embankments. The other two are drive-through crossings on the stream bed that are passable during low flow conditions. The northern crossing has an eroded embankment that may have once served as an irrigation water diversion dam. The downstream crossing is on the main private entrance road to the property, and it has a hanging culvert likely to reduce upstream fish passage during low flow conditions. The riparian corridor improves downstream where its bottomlands are widest and densely vegetated, with minimal effects due to upland land clearing and grazing pressure at such locations.

At about 2.5 miles downstream of the South Pasture boundary, the Brushy Creek Main Trunk is joined by another valley complex (Brushy Northeast Branch). Downstream of that junction, the Main Trunk system exhibits some alluvial floodplain features forming a short sequence of Confined Genetic Floodplain and Unconfined Genetic Floodplain FPZs. From there, the stream exits the SPE and flows into a massive shallow herbaceous in-line slough about 3 miles long on Mosaic property. Despite draining the largest catchment on the property, Brushy Creek is not a perennial stream. It flows during the vast majority of wet seasons and likely has a seasonally intermittent hydrology. Flow is more sporadic during the dry season and may be nonexistent for weeks at a time.

The main valley is joined by three small Headwater Wetland Drain FPZs less than a few hundred feet long and one Chain-of-Wetlands FPZ too small and simple to warrant consideration under an independent "valley" hierarchy. In other words, these four stream segments are inventoried as lateral extensions to the Brushy Creek Main Trunk valley. Three other valley networks (Brushy Northeast Fork, Brushy North Central Fork, and Brushy Northwest Fork) drain into the Main Trunk on the SPE. A fourth valley network, the Brushy Southwest Fork, flows south off of CF's property where it joins Brushy Creek Main Trunk on Mosaic Company's property about 0.4 mile south of the property boundary.

CF proposes to avoid most of the Brushy Creek Main Trunk and its associated valley complex. However, CF does propose to mine and reclaim certain lateral inclusions in the valley. The areas proposed for mining disturbance in this valley complex are the three small Headwater Wetland Drain FPZs and one short Chain-of-Wetlands FPZ noted above. These are comparatively simple drainage features lateral to the main trunk proper, which are the most straightforward stream types to reclaim. The wetlands they connect are also readily restorable. Furthermore, while they are small pieces of the ecosystem, they project laterally out from the main drainage system into areas otherwise highly desirable for ore recovery. If these inclusions were avoided, their linear configuration would preclude ore extraction of the surrounding uplands due to dragline maneuverability around these systems and the need to construct a ditch and berm recharge system even larger than the drainage systems themselves. Therefore, these systems are proposed for mining.

They will be reclaimed in such a manner as to improve their functional value and provide a better lotic system by restoring their entire surrounding area to native upland habitats, providing excellent riparian buffering around these small drainage features and their headwater and in-line wetlands post-reclamation, superior to that existing today. All four systems will be connected to their existing entry points at the Main Trunk preserve boundary (**Figure SRO-11**). The Brushy Creek Main Trunk forms an un-mined spine upon which complementary un-mined habitats and habitat reclamation activities will expand to form a large habitat node and corridor system across the western portion of the SPE. This habitat complex will provide broad linkage to CF’s Planned Habitat Area upstream and to native habitat centered on Brushy Creek to the south offsite.

<u>Brushy Northwest Branch</u>

The valley consists of a series of first and second order stream channels chaining together several wetlands (**Figure SRO-12**). It drains a mixed marsh and swamp headwater wetland, part of which was permitted for mining at CF’s South Pasture Mine. The dominant part of the network (main leg) drains to the south for approximately one mile, where it is joined at a depressional swamp by a truncated Upland Confined Channel that was severed from its headwater wetland by an old farm field. The main leg consists of three FPZs,

> 1) a Chain-of-Wetlands FPZ consisting of the headwater wetland and two other marshes joined by two short channel segments flanked by palmetto uplands,
>
> 2) an Upland Confined Channel FPZ that connects the upper chain to a hardwood swamp near the Brushy Creek Main Trunk valley, and
>
> 3) a short second-order stream segment that emerges from this swamp, draining it into Brushy Creek across the main valley’s mesic hammock terrace and forming another Upland Confined Channel FPZ.

The riparian upland buffer of most of the main leg has been diminished, originally converted to farming and currently used as part of the property-wide cow-calf operations. The clearing impacts alternate on the left and right banks, with the opposite bank typically being well-buffered. Clearing was seldom conducted right up to the bank edge, leaving at least some palmettos or other native vegetation in a thin strip along most of the bankline. This patchwork clearing, combined with the narrow channel and narrow meander beltwidth, has resulted in some cattle-related impacts to this channel system with some sporadic areas of excessive erosion. Despite these impacts, the channel still offers some geomorphic complexity with pools, riffles, tight bends, and exposed root masses. Large woody debris appears diminished, probably due to the aforementioned clearing close to the stream edge and also due to the logging history of the property.

The small truncated stream segment that joins the main leg near the Brushy Creek Main Trunk's bottomlands has lost much of its function as it has been severed from its headwaters by previous farming. Most of the remaining channel was also partially excavated prior to 1970 to provide improved drainage from an agricultural road.

The Brushy Northwest Branch System projects far into a proposed mining area with good ore body characteristics, has channel features that are not very deep or wide, does not drain a large basin delivering significant flow volumes, has a riparian zone partially impacted by clearing, and drains wetlands that are among the most straightforward to reclaim (i.e. marsh). Furthermore, avoidance of this system in its entirety would preclude the construction of a necessary clay settling area (CSA) in this location and require location of the CSA further to the east or west, which in turn would necessitate impacts to more desirable mature forested areas instead. Therefore, CF proposes to mine most of the Brushy Northwest Branch system and to relocate the reclaimed portions to the west to more closely align it to Brushy Creek Main Trunk and enable the construction of a CSA in its original location and permanent preservation of the reconfigured stream within the larger contiguous Brushy Creek main stem preservation. The waste disposal plan attached to the ERP application demonstrates the need for the number and size of the CSAs proposed on SPE based on the volume of clay anticipated from mining. See **Appendix E4**, Backfill Plan.

The historic FPZs of the main stem of this valley system will be reclaimed in a sequence similar to what exists today (**Figure SRO-13**). The reclaimed FPZs will connect to the existing stream channels at the Brushy Creek Main Trunk no-mine boundary, and the most downstream wetland depression and final stream segment along the sequence will remain un-mined. Because the portions of this stream complex proposed for mining generally have some intact in-stream and near-bank habitat components that are fairly typical of modestly disturbed streams draining flatwoods environments in southwest Florida, the stream segments will be reclaimed with careful attention to the diversity and abundance of in-stream habitat features through installation of palmetto soil masses along both banks, tightly meandering planform, and the direct construction of pronounced riffle-pool sequences, with grade control and complexity provided by a dense array of large woody debris deployments. These features, plus the creation of a significantly wider upland riparian buffer along both banks than currently exists, will assure that the existing biological functions are maintained. Some habitat enhancement and functional improvement of the system will be provided by adding slash pines sporadically along the banks, since these were clear-cut from the area many years ago and are now a largely diminished component of the channel banks.

Brushy North Central Branch

This valley consists of a series of first and second order stream channels chaining together several wetlands (**Figure SRO-14**). The drainage network is chiefly occupied by three distinct wetland chains. The longest chain (east leg) is along the eastern part of the network. It originally drained a historic headwater wetland on CF's South Pasture Mine, part of which currently remains on the SPE property. Two highly-altered ditched streams link a small former chain-of-wetlands to the main headwater marsh. This headwater system is connected to a marsh more than 1,000 feet downstream by a channel in a narrow Upland Confined Channel FPZ. This segment is flanked by a narrow upland palmetto buffer along much of its length and is crossed by a much-used cattle crossing where the native vegetation has been wholly cleared. A second channel segment emerges from the marsh in the pasture, joining it to a swamp located about 2,500 feet downstream along the valley's axis. This stream segment consists of two FPZs, an Upland Confined Channel lacking any significant native buffer along both banks in the upper half of the segment, and a Wetland Underfit Channel segment downstream that is relatively intact with a decent native plant buffer. This stream segment disappears into a depressional swamp downstream. The swamp is drained by a second order channel in a valley approximately 1,800 feet long to a marsh depression near the edge of the Brushy Creek mesic hammock valley terrace. This valley segment consists of two FPZs, a Wetland Confined Channel and a Wetland Underfit Channel, both well-buffered and intact. The stream emerges from the marsh, traversing a valley through the Brushy Creek mesic hammock terrace consisting of alternating Wetland Confined and Wetland Underfit Channel FPZs before its junction with Brushy Creek Main Trunk. These FPZ segments are also well-buffered by native vegetation and reasonably intact.

The second wetland chain in the Brushy North Central Branch system is west of the primary channel (center leg), and it starts with a small Headwater Drain FPZ that flows south to a larger deep depressional swamp. This segment has been extensively cleared and straightened. The channel that emerges from the large deep swamp, drains south for about 1,700 feet before reaching its junction with the primary drain (east leg) in this complex located at the southwest end of another depressional swamp. The FPZ connecting these two swamps is interrupted by a small wetland, but consists almost entirely of an Upland Confined FPZ narrowly buffered by palmettos on both banks, with most of its upland buffer converted to bahia pasture. It is subject to some grazing pressure and has sporadic excessive erosion areas as a result. Overall, it has reasonably diverse in-stream habitat with tight bends, pools, riffles, exposed root masses, and emergent vegetation, but has reduced large woody debris due to old logging history.

The third and final wetland chain in this valley network (west leg) consists of two FPZs, a short upper Headwater Drain FPZ and a roughly 1,100 foot long valley segment that forms an Upland Confined FPZ. These FPZ segments are separated by a small marsh and swamp depression. Both FPZs have been completely cleared of native vegetation right up to their banks, compromising the ecological functions and geomorphic integrity of these channels. The Upland Confined FPZ was ditched as well.

The two intact, mature forested wetlands in the Brushy North Central valley complex will remain unmined, as will the highly sinuous channel that connects them and some of the remaining native uplands flanking that particular unmined Upland Confined Channel FPZ. That unmined valley segment will be enhanced by reclaiming adjacent upland riparian habitats to create a broader native habitat buffer than exists today. The downstream portions of this riparian network system will also remain unmined where the streams are generally more complex and are flanked by existing native habitats and enter areas close to the Brushy Creek no-mine area.

In contrast, the waterway areas of this system proposed for mining cross large blocks of uplands with recoverable ore; avoiding these areas would disrupt normal and efficient mining patterns and would preclude ore recover over a large area as a result. Therefore, these areas are proposed to be mined. Furthermore, the portions of these systems proposed for mining and reclamation are comparatively simple or degraded stream channels that are among the most straightforward to reclaim and drain predominantly herbaceous wetlands that are readily restorable. These systems consist of the upstream portions of two chains of wetlands and their Upland Confined Channel FPZs. These FPZs have been functionally diminished by extensive clearing of the uplands bordering the channel, and these sites have been subjected to intensive cattle grazing. These FPZs and their wetlands will be reclaimed in a sequence similar to historic pre-agricultural conditions with broader native upland corridors reclaimed to flank the streams and their largest connected wetlands (**Figure SRO-15**). The existing riparian segments in this valley complex are laterally isolated from one another by large expanses of non-native pasture grasses, a factor that is vastly improved by this reclamation plan. Reclamation will expand native upland cover, providing continuous upland habitat connecting all of the main riparian systems as one bigger, more manageable, and sustainable habitat block.

<u>Brushy Northeast Branch</u>

This system begins with two Headwater Drains entering the same deep swamp. Both of these FPZs have been cleared and ditched. A Chain-of-Wetlands FPZ drains the deep swamp (**Figure SRO-16**). This FPZ consists of three stream channels joining together two swamp depressions. This Chain-of-Wetlands segment courses within a fairly extensive hardwood hammock and cabbage palm forest. It connects to the drainage ditch along the north side of the main private access road, which ditch directs flow to the west into the bottomlands of Brushy Creek Main Trunk.

This system consists of small components in the upstream portions of its network that have been substantially altered by ditching and riparian clearing. It also consists of larger downstream components that have broad intact riparian corridors with good maturity and vegetative diversity occupied by unaltered stream channels. The latter areas, which compromise the bulk of this valley system, will remain un-mined. Given their existing condition, streams of the highly disturbed areas are proposed to be mined and reclaimed largely as simple channels within Headwater Drain FPZs, surrounded by extensive upland buffers as part of a huge habitat block that will connect to adjacent habitat nodes in the Brushy North Central Branch, Brushy Creek Main Trunk, and Lettis Creek North Branch valleys (**Figure SRO-17**).

Brushy Southwest Branch

This system starts on CF SPE property and joins Brushy Creek south of the SPE property boundary with Mosaic Company (**Figure SRO-18**). The Southwest Branch drains offsite to a large lateral canal, significantly deeper and wider than most of the drainage ditches in the region, located less than half a mile south of the SPE. This canal intercepts the flow from the Southwest Branch, artificially diverting it to a location on Brushy Creek. It forces much of the discharge from this branch to bypass a 3,000 foot long third-order stream on Mosaic's property. The original drainage pattern of this system has been significantly disrupted.

The part of this drainage network on the SPE consists of portions of three Chain-of-Wetlands FPZs. The longest and central chain consists of four stream channels linking four depressional wetland systems. The channels are variably impacted, ranging from those that are completely devoid of native cover and ditched to those that are reasonably undisturbed by clearing or ditching, although some of these latter systems are somewhat altered due to upstream drainage changes, former logging, and grazing. The streams mapped in this area are diminutive, and one of these channels, located in the middle of the network, has had a large fraction of its runoff captured and diverted by an eroding cattle trail through the flatwoods, which diminishes the natural channel's normal flow pattern.

A shorter chain with two channel segments is west of the larger chain just described. Despite the fact that this western chain is surrounded by native vegetation, its stream channels lack a rich abundance of complex in-stream habitat and may have been historically altered by grazing and logging operations. A third chain drains a fairly large headwater marsh, connecting it to a smaller marsh at the property boundary east of the two chains just described. The channel in this eastern Chain-of-Wetlands FPZ has been cleared of native vegetation to both banks and was straightened.

CF proposes to mine and reclaim Brushy Southwest Branch in its entirety. This system occupies an area with good ore characteristic bounded on two sides (west and south) by Mosaic's planned Ona Mine. The system also occupies an area designated by CF for a necessary clay settling area; this area is the preferred location for the CSA by Hardee County staff, given the County's request to keep settling areas as far away from existing highways and planned rural town centers as possible. Therefore it is proposed for mining and cannot be practicably avoided. The need for the CSAs is discussed in the Backfill Plan, **Appendix E4**. Further discussion of the placement of the CSAs is contained in the Environmental Narrative. This location also minimizes impacts to or displacement of better, more intact riparian systems, larger wetlands, and more mature forested habitats on the SPE.

Rebuilding this system on exactly the same sequence and dendricity of the existing FPZs is not feasible, given the location of the required settling area. Thus, the reclaimed system will be reclaimed as a Chain-of-Wetlands FPZ, with the riparian drainage network shifted to the east and with fewer and shorter channel segments. The reclaimed system will link directly to the un-mined Brushy Creek Main Trunk bottomlands near a bend close to the no-mine boundary, which will be permanently protected via a conservation easement (**Figure SRO-19**).

The linear feet of channel reclamation that cannot be functionally fit into this location due to the CSA will be made up with some longer reclaimed channels where the landscape can support them, in other sections of the Brushy Creek, Lettis Creek, and Troublesome Creek sub-basins. All of these additional stream segments will be reclaimed as part of extensive upland habitat reclamation zones surrounding the reclaimed Chain-of-Wetlands FPZs.

Lettis Creek Main Trunk

This roughly 1,700 foot long valley segment on the SPE is downstream of the junction of the East and North Forks of Lettis Creek draining to the southern property boundary with Mosaic Company (**Figure SRO-20**). The valley continues southwest, where it joins Brushy Creek Main Trunk on Mosaic Company property less than a mile south of the SPE. On the SPE, this valley consists entirely of a Wetland Underfit Channel; most of the channel runs tightly along the upland boundary of the wetland bottomlands along their western edge. This FPZ is well-buffered laterally by upland hammocks and flatwoods on both sides. However, large sections of this channel are somewhat entrenched, perhaps due to the increased hydraulic energy delivered over the past few decades by the extensive ditching of many of the wetlands and stream FPZs upstream of this section of the drainage network. Despite the potentially artificial entrenchment, the in-stream habitat is complex, with an abundance of tight bends, exposed roots, large woody debris, fine woody debris, deep pools and pronounced riffles. It is possible that the entrenched condition may have reduced overbank flow events, reducing lateral exchanges of energy, nutrients, and carbon. However, continued degradation of this complex channel could be arrested by improving the hydrology of the sub-basin, making it less flashy by reducing the effects of artificial ditches in the landscape via reclamation and enhancement practices.

The Lettis Creek Main Trunk channel, which is a third-order system, and its surrounding native cover will remain un-mined. A roughly 8-acre inclusion of pasture grasses in this un-mined corridor will also remain un-mined and will be enhanced by replanting with native upland cover, enhancing the ecology of this riparian area by flanking it with a more continuous adjacent habitat.

CF proposes to mine a small lateral drainage area feeds into the Lettis Creek Main Trunk within a mineable area near CF's southern property boundary with Mosaic. These areas forms a relatively simple Chain-of-Wetlands FPZ drained by small channels of a type and dimension that are readily reclaimed, as are the herbaceous wetland community types they drain. These systems will be reclaimed in an almost identical FPZ pattern and position to the pre-mining condition, except that the native cover surrounding them will be wider, improving the habitat adjacent to the riparian system (**Figure SRO-21**). The un-mined, restored, and reclaimed native habitat zones in this part of the property will connect to the large Brushy Creek habitat area to the west and to large habitat blocks in the eastern and northern Lettis Creek sub-basin, resulting in an overall improvement in existing habitat connectivity.

Lettis Creek East Branch

This branch features a chain of wetlands that flows west from a headwater swamp/marsh system near County Road 663 to the aforementioned Lettis Creek Main Trunk FPZ (**Figure SRO-22**). The East Branch valley consists of a Headwater Drain FPZ that has been altered directly by channelization. Aerials from the 1940's suggest that this area included a series of three short confined stream channels joining three depressional marshes. This contrasts with its current configuration which is a 2,000 foot long ditch flowing through two FPZs, an Upland Confined Channel and an Unconfined Wetland Channel. This headword portion of the network joins a large depressional swamp/marsh to the southwest. That depression is drained by a ditched stream flowing mostly through an Upland Confined FPZ with a small downstream Wetland Underfit Channel. That segment flows about 1,700 feet due west to another small paralotic swamp where the open channel rapidly disappears. The channel reforms shortly downstream, continuing west within a 1,200 foot long Wetland Confined FPZ with a beltwidth of about 130 feet wide. That channel disappears into a sizeable forested wetland depression, which is drained by the final leg of this chain to Lettis Creek Main Trunk approximately 1,500 feet to the west. This final leg consists of two FPZs of roughly equal length, an Underfit Wetland Channel upstream, and a Wetland Confined Channel downstream with a meander beltwidth of about 75 feet wide.

Three lateral drainage features join the main stem of the East Branch. One is a short Headwater Drain FPZ that comes in from the south. The second is a ditched Headwater Wetland that comes in from the north. The third is a Chain-of-Wetlands FPZ that drains in from the north. This Chain-of-Wetlands FPZ consists of two short first-order, well-buffered, confined upland streams entering the same swamp depression. That depression is joined to the main stem of the East Branch by an altered confined upland channel.

That unnatural channel segment was likely directly altered as part of a much larger drainage alteration upstream. A large depressional marsh functions as a drainage hub in the northwestern part of the Lettis Creek sub-basin on the SPE property. That hub drained into the North Fork of Lettis Creek prior to agricultural disturbance of the property. The hub was aggressively and effectively ditched, and its flow path was diverted to the East Fork of Lettis Creek by an upland-cut ditch connecting it to the aforementioned altered stream segment. It appears that the original and natural stream segment at that location was enlarged and straightened to accommodate the bypass discharge.

CF analyzed the various factors noted above in Section 1.0, considered the existing condition and functions of these areas as discussed above, and weighed these considerations against the tons of ore lost if these areas were avoided. As a result of this analysis, CF proposes that the main stem of the Lettis East Branch drainage system and its meander belt will remain un-mined, in addition to a large block of native isolated wetland and oak hammock habitat surrounding it. The ditched headwater wetland and ditched streams upstream of the un-mined main drainage alignment will be mined and reclaimed as a Headwater Drain FPZ, with a variably confined and underfit wetland channel system providing the drainage (**Figure SRO-23**).

The existing small Chain-of-Wetlands complex that enters the main stem of East Branch from the north will be mined and reconfigured via reclamation to eliminate the diversion ditch from the North Fork hub wetland. Instead, the waterway pattern will be reclaimed with a small Chain-of-Wetlands FPZ that will drain to the un-mined main stem via a natural meandering channel (instead of the ditch that is there today). This configuration will move the system closer to the FPZs that were present in this general area of the property prior to agricultural disturbances. Furthermore, this area will be reclaimed with broad upland habitats flanking the Chain-of-Wetlands complex that will be part of the Lettis Creek habitat corridor.

Lettis Creek North Branch

This drainage complex represents one of the most directly impacted systems on the property. Historically, four chains of wetlands discharged into the previously mentioned large hub marsh in the North Fork sub-basin (**Figure SRO-24**). The first chain is the furthest west. It is a Chain-of-Wetlands FPZ consisting of four short first-order stream channels linking four marsh depressions to a hardwood strand swamp that joins to the hub marsh. The headwater wetland of this particular chain, on CF's South Pasture property, has already been mined. Moving around the hub marsh clockwise, the second drain comes into the hub marsh almost directly from the north. The headwater wetland of this particular drain has also been mined. This drain forms a Wetland Confined Channel with a beltwidth of about 75 feet wide. Continuing east, the next chain joining the hub is a short Headwater Drain that has been ditched. The final chain entering the hub is mainly a series of strands and wetland depressions that have been extensively ditched. A potentially aberrant short channel was mapped near the South Pasture property boundary at the headword part of this strand-depression complex. Prior to mining at the South Pasture, this channel connected to an upland-cut ditch draining a large isolated wetland. It probably best classifies as a Headwater Drain in terms of its pre-mining function, although it may just be a feature that eroded into the landscape as a result of the previous agricultural ditching. All four of these chains are extensively flanked by adjacent upland native vegetation, but they connect to a heavily altered drainage configuration and to a hub marsh that was not merely ditched, but that had its flow re-routed to another valley.

The bypassed natural stream has its geomorphology largely intact, in large part because it occupies a heavily vegetated riparian corridor that is so dense that it retards (but certainly does not eliminate) cattle entry. Some flow enters laterally into the system, but the bypass ditch takes most of the flow from the hub wetland and its sub-basin.

Prior to agricultural disturbance, the large hub marsh was naturally drained by a slough/strand exiting it from near its southwest corner. This paralotic waterway joined the presently bypassed channel (4,204 LF), which meanders along a 2,900 foot long valley with a 140 foot- wide wetland beltwidth, forming a Wetland Confined Channel FPZ. A narrow upland oak belt, typically only one "row" of trees wide, flanks this wetland FPZ. The former flatwoods on both sides of the valley hillslope have been fully cleared along almost the full length of this FPZ and have been farmed and grazed. The channel generally has less hydraulically-formed habitat than expected, such as fine-root masses, pools and riffles induced by large woody debris, and exposed fresh sand bars. The channel system has unusually high densities of leaf litter. Normal stream discharges in the flatwoods routinely sweep leaves through the channel and aid in the decomposition of those that remain, forming decaying leaf packs in the channel. The seemingly decreased occurrence of hydraulically-induced habitats and the over-abundance of non-sorted leaf litter reflect the lack of a normal flowing water regime for this bypassed system.

CF analyzed the various factors noted above in Section 1.0, considered the existing condition and functions of these areas as discussed above, and weighed these considerations against the tons of ore lost if these areas were avoided. As a result of this analysis, CF proposes that the large and heavily ditched hub marsh will remain un-mined and will be enhanced by ditch plugs and by the elimination of the unnatural drainage that currently diverts flow out of the North Branch drainage system (**Figure SRO-25**). In keeping with the goal of restoring the surface water drainage configuration of the historic system, the original natural riparian system that drained the hub wetland will also remain un-mined, and flow from the hub wetland will be diverted back to its pre-agricultural course. This will enhance the hydraulic and aquatic functions of the longest uninterrupted Wetland Confined FPZ that is physically and vegetatively intact on the property outside of the Brushy Creek Main Trunk corridor.

As in the pre-mining condition, four Chain-of-Wetlands FPZs will be created to drain into the un-mined, enhanced hub wetland. Moving clockwise from the west, the first chain encountered will be reclaimed as a series of short, shallow channel segments joining together three depressional wetlands, much like the existing system. The next system to the east will provide drainage from two headwater swamps to be reclaimed on the South Pasture property, with a small, shallow channel joining to an un-mined natural Upland Confined FPZ and its meandering channel that feeds into the un-mined hub wetland. The next system to the east will essentially consist of a large marsh and swamp linked by a single Headwater Drain FPZ. This configuration is in lieu of the heavily ditched conveyance system that exists in an analogous landscape position today. The fourth and easternmost chain will be reclaimed to provide a Chain-of-Wetlands FPZ with two meandering upland confined channels joining together three wetland depressions. This chain will drain into the hub via a paralotic strand, instead of a wetland-cut ditch, representing an ecosystem improvement of this part of the reclaimed landscape. Wetland Chain 4 will terminate in a ditch at its boundary with the hub marsh preserve. The ditch will be hydraulically ineffective because the Hub's bypass ditch will be eliminated. However, to prevent potential headcutting, the interface between the relict ditch and Wetland Chain 4 will be stabilized by geotextiles and/or rip-rap to prevent headcutting of the ditch into the reclaimed slough.

The ditches in this entire reclaimed valley complex will be eliminated by a mine reclamation design to restore a more natural hydropattern to one of the largest wetlands on the property and one of the longest continuous natural channels as well. All of the riparian FPZs in this area will be surrounded or flanked by native upland reclamation, creating ample habitat nodes connecting to other similar habitat areas, thus creating a broad habitat corridor. This corridor will span much of the western half of CF's South Pasture and SPE property.

Two additional stream channels will be reclaimed in this sub-basin. One will drain a large settling area from the east to the reclaimed headwater marsh-swamp mosaic as an Upland Confined or Wetland Confined FPZ. The second stream will drain a reclaimed lake and slough from the east to the same headwater wetland system. This system will also consist of an Upland Confined or Wetland Confined FPZ.

Troublesome Creek East Branch

This riparian valley consists of a relatively short section of open channel onsite, approximately a quarter-mile long (**Figure SRO-26**). This channel once formed the beginning of a 7.2 mile long stream valley extending offsite to the Peace River, Troublesome Creek. However, the original short section of natural channel on the SPE has been artificially channelized, as has much of the original natural channel offsite. The onsite riparian system was probably a narrow Wetland Confined Channel FPZ prior to substantial agricultural modification. Some of the system may have been an Upland Confined FPZ. The natural channel once drained a large headwater marsh more than a mile long and about 0.3 miles wide. This marsh has been reduced to a series of much smaller wetland pockets surrounded by intensively grazed bahia pasture as a result of extensive ditching.

CF analyzed the various factors noted above in Section 1.0, considered the existing condition and functions of these areas as discussed above, and weighed these considerations against the tons of ore lost if these areas were avoided. As a result of this analysis, CF proposes that this whole area be mined and reclaimed close to its pre-mining topography without the drainage ditches (**Figure SRO-27**). To further restore something akin to the pre-disturbance hydrology and to recover wetland functions lost decades ago, the drainage characteristics of this system will also be improved by reclaiming its outlet (Troublesome Creek), which is currently a ditch, as a natural meandering stream in a Wetland Confined FPZ. The resulting reclamation will restore a substantially better lotic system than existing on the property today. Two additional opportunities exist to create streams in this part of the sub-basin, one upland-confined stream draining a reclaimed settling area and another upland confined stream draining a reclaimed lake. Both of these systems will link to the large eastern reclaimed headwater marsh-swamp mosaic.

Troublesome Creek West Branch

This valley is dominated by large ditched wetlands (**Figure SRO-28**). The headwaters commence on CF property and the broad, flat valley angles southeast toward the Eastern Branch of Troublesome Creek across an irregularly shaped property boundary. An existing ditch, about 1,300 feet long, drains the headwater marsh of this valley. This ditch was once a Wetland Confined FPZ stream channel prior to agricultural modifications. It drains into a very large marsh that dominates the valley across the southern SPE property boundary. From there, the valley connects to the Eastern Branch back on the SPE via the same ditch that drains the big wetland. Prior to agricultural modification, this system connected to the Eastern Fork's formerly immense headwater marsh via a shallow slough north of the existing ditch.

This system is similar to the Eastern Fork, except that it diagonally straddles the SPE property line. Thus the avoidance analysis was similar. This property configuration precludes the full restoration of pre-agricultural hydrology of this system. However, the proposed reclamation can nonetheless achieve two significant overall ecological improvements to this valley complex. First, CF will reclaim a headwater stream located near the existing northernmost ditch on the SPE to restore its previous meander (**Figure SRO-29**). The original meander pattern is very clear on the historical aerials, making it a useful template to guide restoration of this feature as part of the reclamation plan. Second, the ditches connecting this branch to the Troublesome Creek East Branch will be reclaimed as a more meandering, natural channel with hydraulic equivalency to the existing ditches in order to avoid adverse effects on adjacent off-site property.

4.0 TECHNICAL BACKGROUND & GLOSSARY

This chapter includes three sections,

1. Descriptions of three key scientific components of the riparian system characterization and design approach used in this plan. These includes "hierarchical patch dynamics," "functional process zones," and "reference reach."
2. A basic glossary providing the working definitions of fluvial terminology used throughout much of the document.
3. Definitions of the FPZ types found on the SPE.

4.1 Hierarchical Patch Dynamics

The first component adopts a viewpoint that riverine systems operate at a hierarchy of scales. The scales include the physiographic region, watershed, valley, functional process zone, reach, and meso-habitat patches (Ward 1989, Thorpe et al. 2006). Each hierarchy can be viewed in terms of a decreasing scale in lateral, longitudinal, vertical, and temporal dimensions. The conditions of the upper hierarchy set limitations and drive functions at the subsequently lower hierarchy. In other words, the patches are nested under each hierarchy. For example, in-stream meso-habitat patches such as pools, woody debris, aquatic vegetation, and root mats are each less than a few feet in length or width and they can change seasonally or annually. The types and distribution of such meso-habitat patches depend on the channel morphology, bank vegetation, and hydraulic conditions that occur at the reach scale, which is typically a few hundred feet long and at least 50 feet wide and usually takes many years or even decades to adjust to perturbations that occur in its valley's vegetation or watershed's land use. In essence, streams belong to their watersheds and valleys and hierarchical patch dynamics is one way to properly conceive the details of how that is occurring on the property and beyond.

4.2 Functional Process Zones

The second component adopts a viewpoint that stream ecosystems form patchy environments with sudden transitions between patches where the habitat patches form distinct functional process zones which can repeat themselves at various points along the valley length (Thorpe et al. 2006, 2008). This perspective of viewing riparian systems as zonal is in direct contrast to viewing riverine networks as clinal. The latter viewpoint tends to oversimplify natural drainage systems. For example, by incorrectly assuming that lotic communities and geomorphology change in a gradual, non-repetitive fashion along the longitudinal profile, important ecotonal values of these open systems are neglected. Natural or nearly natural Florida stream networks clearly follow patterns that are not inherently clinal, with even relatively short valleys frequently exhibiting multiple and repetitive segments with obvious and abrupt differences in their morphology and vegetation (Kiefer, in press). The historic condition is often homogenized by ditching, clearing, and overgrazing. Such homogenization can certainly reduce riparian functions and, in some cases, virtually eliminate some functions (Thorpe et al. 2008). All of the stream systems of the SPE have had some level of disturbance, with some systems exhibiting rather radical simplification and others with very minor effects.

4.3 Reference Reach

The third component focuses on the geomorphic classification of the natural channel at the reach scale. The reach is typically defined as a longitudinal section of the river 10 to 30 bank full widths long. Usually on the order of a few hundred feet for most wadable streams. Sometimes reference reaches will be set at fixed lengths by government agencies, especially for biological assessments (e.g. 100 meters for FDEP's BioRecon). The reach scale has been the primary focus of applied research governing the conservation and restoration of small freshwater streams for at least the past decade, including biological integrity measurements (e.g. EPA's Rapid Biological Assessments and FDEP's Stream Condition Index) and fluvial geomorphology (e.g. Leopold 1994, Rosgen 1996). The reasons for emphasis on the reach include;

- the habitats and geomorphic features encompassed by this scale are readily observable and measurable from the ground,
- these features can easily change within the course of a human lifetime at this scale due to either natural or unnatural perturbances,
- these scales encompasses predictable and repeatable riffle/pool and bend geometry sequences occurring within its dimensions that are the geomorphic units most important to the physical stability, in-stream aquatic fauna, and water quality processes of natural stream channels.

Rosgen (1996) has developed a popular classification system at this scale, based on channel shape, channel boundary materials, and channel entrenchment into its valley, which is quite useful for descriptive purposes and, if placed in its proper hierarchical context, offers some consideration of normal variations and associations among channel width, depth, cross-sectional area, slope, meander patterns, velocity, and sediment texture.

4.4 Basic Glossary

The three components mentioned above require working knowledge and common understanding of some key terminology which is summarized below for handy reference:

Alluvium: Sediment transported and deposited by fluvial forces. For the purposes of this document, we are referring to modern and ongoing processes operating on a timescale that can be measured in terms of a season, a few years, or perhaps a few decades. This is an important distinction because the upper lithology of much of the Florida peninsula is comprised of ancient sili-clastics that are relicts of past alluvial transport. For the purposes of applied fluvial geomorphology and stream characterization in Florida, when referring to alluvium or alluvial processes, we are typically talking of the modern and on-going re-working of ancient alluvial deposits.

Bankfull: The discharge quantity and channel stage indicated by inflections in channel geomorphology, changes in vegetation, and signs of geomorphic work transporting alluvium that differentiates between comparatively routine in-channel flows versus less common floodplain flow conditions. Bankfull stage delineates the physical and biological thresholds that determine the lateral limits between the open channel waterbody and the adjacent floodplain.

B_, F_, G_ Rosgen Type II Stream Types: Moderately to extremely entrenched stream cross-sections, often resembling gullies. These systems are uncommon natural associates of undisturbed flatwoods ecoregions in Florida, typically confined to mid-order or larger stream channels occupying valley segments crossing ancient marine escarpments. If found in a different valley type, they are likely indicators of excessive erosion and stream degradation in the flatwoods physiographic regions of Florida. They are more common as natural associates of the highlands sand ridge ecoregions of Florida and can also naturally occur in karst regions along some spring runs occupying carbonate paleochannels.

C5 Rosgen Type II Stream Type: A sandy natural meandering stream channel, typically with pronounced pools and point bars, that has a relatively wide and shallow bankfull cross-section and is only slightly entrenched in its floodprone area (Rosgen 1996). The letter designation 'C' defines the channel shape as having a Width to Depth ratio (W/D) greater than 12 and is modified according to the dominant channel boundary material by a numeric designation (in this case, sand = '5'). For example, a shallow-broad channel (W/D > 12) that is slightly entrenched in its valley (ER > 2.2) is a C-type. If it is bounded by sandy materials, then it becomes a C5. A C6 has a similar geomorphology, but is bordered by silt/clay, whereas a C4 channel is bounded by gravel. The vast majority of natural low-order channels in southwest Florida flatwoods are either C5's or E5's (see definition below), with C5's exhibiting tendencies to occupy flatter wetland valleys and E5's occupying more confined and steeply sloped upland valleys. However, both types can be encountered virtually anywhere.

E5 Rosgen Type II Stream Type: A sandy natural meandering stream channel, typically with pronounced pools and riffles, that has a bankfull cross-sectional width to depth ratio of less than 12 and is slightly entrenched in its floodprone area (Rosgen 1996). The vast majority of natural low-order channels in southwest Florida flatwoods are either C5's (see definition above) or E5's. E5's tend to occupy more steeply sloped valleys than C5's and are more likely to occupy headwater positions in the drainage networks of Florida's flatwoods versus higher-order positions. However, both types can be encountered virtually anywhere.

Entrenchment Ratio: Ratio of the "Floodprone width" to the "Bankfull channel width" (Rosgen 1996).

Ephemeral: Streams that are dry for most of the year, have a lot of inter-annual flow variability with long dry spells and rarely, if ever, receive groundwater baseflow.

Floodprone Width: The valley width at twice the elevation of the bankfull thalweg depth (Rosgen 1996).

Floodscape: The aquatic and terrestrial components of the riparian zone that are flooded when the stream discharge is above bankfull conditions (Thorpe et al 2006).

Functional Process Zone: A fluvial geomorphic unit, typically smaller than a valley and larger than a reach, with functions related to dynamic physical processes that occur over time and that native biota are adapted to colonize and utilize to sustain their local populations (Thorpe et al 2006).

Gallery Forests: Gallery forests form as corridors along streams and wetlands and they project into landscapes that are otherwise more sparsely canopied such as open woodlands, savannas, or grasslands. Gallery forests are able to exist where the surrounding landscape will not support dense forests because the riparian zones in which they grow offer greater protection from fire, are often of higher fertility, and have a more reliable water supply at the root zone. As a result, the boundary between the gallery forest and the surrounding woodland or grassland is usually very abrupt, with the ecotone being only a few feet. Gallery forests are adversely affected worldwide by overgrazing, altered fire regimes, logging, and conversion to agriculture.

Hydraulic Residence Time: The volume of a waterbody divided by its net discharge rate.

Hydroperiod: The cumulative inundation or saturation duration of a waterbody, usually expressed as a percentage or as the average number of months per annum.

Interfluve: A terrestrial or floodplain land area located between two stream valleys.

Intermittent: Stream channels that are not perennial and only receive groundwater flow for part of the year. Seasonally intermittent streams that flow predominantly only during the summer and early fall wet-season are very common in Florida flatwoods ecoregions. Seasonally intermittent channels can perform much like perennial channels during the wet season and more like ephemeral channels during the dry season.

Lentic Waterbody: Still waters. The water surface profile is nearly level. Water flow is gradual compared to the volume contained within the waterbody, leading to average hydraulic residence times typically at least several days long. Typical examples include headwater and isolated depressional wetlands, ponds, and lakes. Lentic wetlands are mapped as 600-series FLUCCS.

Lotic System: This is the landscape definition for inter-connected flowing waterbodies. It includes all the lentic and paralotic waterbodies that are connected by stream channels (see “lotic waterbody”). A typical lotic system in the flatwoods of Florida will include headwater wetland depressions, in-line wetlands, alluvial stream channels, and riparian wetlands. Sloughs and strands may also be part of the lotic system. The key distinguishing characteristic of a lotic system is flowing water, with at least some of that flow concentrated and conveyed by alluvial channel linkages.

Lotic Waterbody: Synonymous with "Stream." Characterized by running waters with a dominant unidirectional flow controlled by gravity. The water surface profile is noticeably sloped. Residence time is usually very short, less than a few days and often only a few seconds depending on the scale observed. Typical examples include the open bankfull channels of creeks, branches, and rivers. Lotic waterbodies exhibit continuous alluvial features on the channel bed and are bounded by well-defined banks that are held by dense emergent vegetation. They are mapped as 511 FLUCCS when natural or 512 FLUCCS when ditched at the locations of historically natural streams.

Paralotic Waterbody: Gently flowing waters that have a multi-directional flow pattern that typically is not organized at sufficient stream power to routinely conduct geomorphic work. Water slopes may be nearly level or very gradually sloped. Residence times are intermediate between those of lentic and lotic waterbodies and may vary considerably by season. Typical examples include in-line wetlands and in-line lakes, linear backswamps and oxbows in riverine floodplains, and vegetated swales, sloughs and strands lacking a continuous and open inorganic alluvial channel. Paralotic wetlands are typically mapped as 600-series FLUCCS, not as 511's or 512's.

Perennial: Stream channels that flow virtually year-round for most years. Such streams would typically exhibit long-term flow-duration curves where less than 10% of the total record was at zero flow. Perennial streams receive at least some groundwater baseflow throughout the year during the vast majority of years. The inter-annual variation of flow in perennial streams tends to be less than that of intermittent streams and dry spells are much shorter.

Riverscape: The aquatic habitat located within the bankfull channel (Thorp et al 2006).

4.5 Functional Process Zone Descriptions

The SPE is located entirely within a flatwoods ecoregion, exhibiting many features typical of that physiography including high wet-season groundwater tables, lotic system hydrology dominated by runoff (much of which is in contact with wetland vegetation and soils before, and after, reaching the lotic environment), and somewhat dense drainage networks punctuated by lots of wetlands. The lotic systems of the SPE property have been altered to varying degrees, moderately to severely disrupting their historic functions. The descriptions that follow mainly focus on the intact or pre-disturbance conditions of stream functional process zones that occur in the region. These descriptions provide important background for understanding how certain considerations factor into CF's proposed design approach to create a better overall lotic system on their property post-reclamation versus what exists today after agricultural disturbances.

To understand the functional process zones, it is important to recognize that each stream segment functions as a result of a hierarchy of scale starting with its catchment. Each catchment or sub-basin controls the volume and timing of water delivery and some of the sediment yield to the stream valley. The valley morphology largely influences the overall hydraulic energy and capacity for sediment transport or deposition within the channel and floodplain. The valley can be subdivided into a series of functional process zone (FPZ) segments based on distinct local variations in fluvial geomorphology and the biological communities that are adapted to particular hydrogeomorphic zones (Thorpe et al. 2008). Each FPZ consists of a series of lateral and longitudinal zones or components that often repeat in a predictable manner and can be observed at a reach scale. Within each reach, meso-habitat components can be described and quantified, including physical patches such as pools and riffles, as well as important in-stream biological substrates such as large woody debris (LWD) and submerged aquatic vegetation. Meso-habitat also occurs laterally in the riparian zone, with different zones of plant communities flanking the stream banks, valley flat, alluvial floodplain features (if present), and riparian hillslope.

Although many of the concepts outlined so far focus on the patchiness and punctuated nature of flatwoods fluvial systems (as opposed to gradualistic or clinal perspectives), some gradient effects are evident in Florida flatwoods stream corridors on a large scale basis (Kiefer in press) and are accounted for in this project. For example, alluvial floodplain features such as oxbows, secondary channels, natural levees, hammock islands, and linear backswamps typically occur only in mid-order Florida channels or larger, draining watersheds at least several square miles in size. Where these occur, they are important meso-habitat components of the floodscape bordering the open channel system (aka riverscape). Floodscapes and riverscapes are variably connected by seasonal flow pulses. In most low-order systems, the floodscape is non-alluvial and may even be an upland community (terrestrial floodscape). The design approach proposed here takes into account the variations of the riverscape (channel) and floodscape (floodplain/valley form) present on the property. These variations are key components used to describe FPZs.

Attention to the hierarchy of scale is important because while there are only two types of natural channel (or riverscape) classes present on CF's property based on Rosgen's reach scale classification system (E5 and C5), the floodscape forms are more variable given that flood prone areas flanking the riverscape can be alluvial or non-alluvial in their genesis, can be occupied by upland or wetland communities (or both), can be longitudinally steep or gradual, and can be laterally confining or open. These are template factors that drive the hydraulic energy and sediment flux regimes, floral composition and plant species distribution in the riparian corridor, and carbon/nutrient concentrations and fluxes. The FPZs therefore serve as a convenient design scale related to functions such as riparian food chain support, water quality transformations, a balance of sediment transport and depositional zones preventative of harmful erosion and shoaling, and a balance of surface water conveyance and detention through the drainage network.

Seven FPZs occur on the SPE and each are described below. In general terms, the FPZs are comprised of valley segments with floodscape configurations that differ in their associations among their floodplain genesis, floodplain and valley form, riparian vegetation zones, and hydrogeomorphology. FPZs are readily observed and delineated based on topography, aerial photography, and landuse maps using commonly available GIS resources from FDEP LABINS, SWFWMD LiDAR, and the Florida Geographic Data Library, with groundtruthing. Within each FPZ, one of two types of channel type can occur (Rosgen C5 or E5). The historic and existing onsite FPZs include the following classes:

Unconfined Genetic Floodplains

This is the classic textbook stream and floodplain configuration. The stream channel migrates freely through a broad relatively flat bottomland valley that is partially formed by fluvial forces and that has frequent overbank flooding. The term “genetic” is based on the fact that the floodplain geomorphology is at least partially formed and maintained from the genesis of alluvial transport and deposition. The valley bottom is wider than the meander beltwidth of the open channel, a condition which is called an “underfit” channel or an “unconfining” valley. The riverscape (channels) are typically Rosgen C5’s, but can also be E5’s. The floodplain geomorphology is “flat” meaning it has a minimal overall lateral hillslope relief, but the flat valley cross-section is roughly textured by alluvial features such as natural levees, linear backswamps, secondary channels and chutes, oxbow lakes/swamps, and islands. These are called alluvial features because their form is driven largely by scour and deposition patterns of fine alluvium carried from the stream into the floodplain during powerful and even routine flood events. Each of these features presents different patches of biological communities, floral and faunal, within the floodscape.

Because these valley segments tend to be wide and are typically occupied by extensive wetlands, lateral fluxes of sediment from the adjacent non-riparian hillslopes to the riverscape are minimal, while sediment fluxes in the opposite direction, from the riverscape to the floodscape, are more important. The abundance and diversity of alluvial floodplain features typically increases with the size of the drainage area and these features are rarely present in Florida streams draining catchments less than a few square miles in area. These FPZs are typically occupied by hardwood and/or cypress wetland bottomland vegetation, sometimes with complex mosaics of hydric and mesic oak and palm hammocks as well. This FPZ tends to present abundant and diverse aquatic habitat substrate within its riverscape such as deep bend pools, sand bars, large woody debris and induced scour pools, patches of emergent aquatic vegetation, root mats, fine woody debris, leaf packs, and overhanging root wads. Riverscape and floodscape habitat patches interact and interconnect frequently and sometimes for time periods extending for months during the wet season. The flow regime of these systems typically range from seasonally intermittent to perennial, providing extended and complex habitat benefits to aquatic fauna. Intact stream segments within this FPZ class seem to provide the greatest overall opportunities for biodiversity among Florida’s riparian zones. They also present long regionally-important gallery forests in the flatwoods, serving as natural firebreaks, terrestrial wildlife corridors for a variety of large and small mammals and herpetofauna, and migration pathways for neotropical migratory birds.

Confined Genetic Floodplains

This FPZ is similar to the Unconfined Genetic Floodplain FPZ in that both have floodplain features created and maintained by fluvial forces. The main difference is that the Confined Genetic Floodplain streams have valley sides or hillslopes that are closer together and that exhibit greater lateral relief. This valley geomorphology provides a more U-shaped cross-section which at least partially confines the migration path of the open channel. In other words, the meander beltwidth of the channel is as wide as the valley bottom, with its shoreline frequently abutting the outer portion of the valley toe. This means that the riverscape has direct interaction with upland hillslope as well as its flat wetland bottomlands. These FPZs can be high-energy systems so the alluvial floodpain features tend to based on heavier materials (e.g. sand levees) and scour (e.g. chutes and secondary channels) as opposed to finely textured sediments and depositionally driven features (e.g. oxbow swamps). These FPZs are more sensitive to clearing in the uplands adjacent to the riparian corridor which can allow for direct lateral yields of eroded sediment to enter the riverscape without intervening wetlands to trap the material. This sediment path also can occur, to a lesser degree, naturally. Rosgen E5 channels are typical, but C5's can occur as well. Native vegetation includes mixed hardwood and conifer uplands and hardwood or cypress bottomland wetlands. This FPZ tends to present abundant and diverse aquatic habitat substrate such as deep bend pools, sand bars, large woody debris and induced scour pools, patches of emergent aquatic vegetation, root mats, fine woody debris, leaf packs, and overhanging root wads. The flow regime of these systems typically range from seasonally intermittent to perennial. In addition to providing valuable lotic habitats, they also can present regional gallery forests in the flatwoods, serving as natural firebreaks, terrestrial wildlife corridors for a variety of large and small mammals and herpetofauna, and migration pathways for neotropical migratory birds.

Wetland Underfit Channels

Most lower-order Florida streams draining catchments less a few square miles in size lack alluvial floodplain features because they rarely generate alluvial transport and deposition beyond the channel banks. In many cases, these stream channels are migrating through broad low-lying valley segments occupied by wetland vegetation. In cases where the wetlands are wider than the channel meander beltwidth, the channel is defined as being "underfit" to the valley. The wetland hydrology is largely independent of overbank flow and in some cases may be fed extensively by groundwater seepage or is simply intersecting a high groundwater table. These FPZs are typically occupied by C5 Rosgen channels, less commonly with E5's. The wetland community is usually forested (hardwood swamp, bay swamp, or mixed hardwood coniferous wetland), but can also be freshwater marsh in landscapes with very high fire frequencies. The complexity and the diversity of aquatic habitat types can vary substantially among these systems, but can include any of the in-stream substrates described for the other FPZs. The flow regime of these systems is typically seasonally intermittent or less frequent, although some that drain extensive seepage slopes may approach perennial conditions, at least at a trickle. When intact, these systems provide local corridor functions related to their gallery forests.

Wetland Confined Channels

Like the Wetland Underfit Channels, the Wetland Confined Channel FPZs are typically encountered in landscape positions draining small catchments of less than a few square miles and do not have genetic floodplains. The distinguishing factor is that these stream channels are flowing through valleys with wetland bottomland widths that coincide with the meander beltwidth of the stream channel. Most of the channel shoreline is flanked by wetland vegetation with upland embankments occurring periodically at the outer channel bends. These systems can be either E5 or C5 Rosgen channel types with E5's favoring the more longitudinally steep valley segments. Large woody debris, fine woody debris, leaf packs, root mats and emergent vegetation tend to be the most common aquatic habitat substrates with frequent bend pools or root-induced riffles and scour pools. Some of these systems, particularly those associated with E5 channels, can have very tight bends. These bends tend to create diverse in-stream habitat patches. Most of these systems are seasonally intermittent or less. When intact, these systems provide local corridor functions related to their gallery forests.

Upland Confined Channels

The Upland Confined Channel FPZs are typically encountered in landscape positions draining small catchments of less than a few square miles, most-often less than a square mile. The stream channels flow through upland valleys where the groundwater table is not routinely high enough, nor the land sufficiently depressional, to hold water at threshold durations in the root zone for wetland formation. Wetland vegetation is usually confined to the streambank margins and may be almost completely lacking in some cases, with palmetto dominating the banks. These systems can be either E5 or C5 Rosgen channel types with E5's favoring the more longitudinally steep valley segments. These systems tend to be rather diminutive in width and depth, allowing live woody vegetation and palmettos to exert tremendous vegetative control on their planform, bank slopes, and grade control. Because of this, they are highly susceptible to being ruined by land-clearing activities and are vulnerable to the erosive effects of over-grazing. Fine woody debris, root mats and emergent vegetation tend to be the most common aquatic habitat substrates with occasional bend pools or root-induced riffles and scour pools. Some of these systems, particularly those associated with E5 channels, can have very tight bends that practically wrap around individual trees or palmetto clonal masses. These bends tend to create diverse in-stream habitat patches. Most of these systems are intermittent, while some have rather ephemeral flow. These systems can provide local corridor functions related to their gallery forests, although the density of the gallery forest is highly dependant on fire-frequency with many of these systems naturally and normally exhibiting narrow shrubby corridors with few trees, making them more like palm or pine savannas versus a fully-canopied forest corridor.

In-Line Wetlands/Chains-of-Wetlands

Depressional or very gradually sloped portions of many Florida valleys in the flatwoods do not allow for the sustained formation of well-defined open channels with alluvial bed forms. These in-line wetlands can occupy portions of the continuous flow path of the valley, alternating with segments occupied with an alluvial channel. In Florida, if the scale of the channels between wetlands is small, on the order of several hundred feet or less for each channel segment, the fauna of the channel tends to reflect that of the adjacent wetland (T.L.Crisman personal communication). Longer channel segments begin to pick up fauna that may differ from the closest wetlands. Therefore, if the individual channel segments are all less than a thousand feet long, the chain can be classified as a "Chain-of-Wetlands" FPZ. Chain-of-wetland channel reaches tend to classify as C5's, but E5's are not that uncommon on steeper sloped connections. This FPZ is highly susceptible to ditching and the ditches can destroy its normal hydrogeomorphic ecotones. These systems are also often rather narrow and open, and are therefore easily susceptible to overgrazing.

If the stream segments joining the wetlands are more than several hundred feet long, they may be best viewed as distinct FPZs, falling into one of the aforementioned classes. In such cases, the wetland zone is also then viewed not as an inclusion of another FPZ, but as its own FPZ, "In-Line Wetland." In-Line Wetlands are not streams as defined for the purposes of 62C-16.5001. Instead, they are paralotic waterbodies best classified based on their dominant vegetation communities (FLUCCS).

Headwater Wetland Drains

Almost all natural first-order streams in flatwoods ecoregions drain a headwater wetland. These wetlands can be virtually any type found in the flatwoods; wet prairies, bay swamps, freshwater marshes, shrub marshes, coniferous swamps, hardwood swamps and various mixtures and mosaics of all of the above. The headwater wetland functions as a collection point of surface water runoff and lateral groundwater inflow, which is then slowly released to the stream via a somewhat confined outlet or pop-off during the wet season. Some small streams simply function as the drainage outlet for a single wetland before discharging to a much larger waterbody or the main trunk of a riparian bottomland system. These systems are less complex than chains of wetlands and probably warrant consideration as distinct FPZs. Many such headwater drains are small enough to be considered lateral features of a larger valley's hillslope, while some less commonly achieve stream lengths warranting consideration as a separate valley. These coupled headwater-drain systems typically feature C5 and/or E5 channel reaches. The C5's tend to occupy areas of lower valley slope than the E5's. Particularly steep headwater valleys (e.g. greater than 2% slope) can support Rosgen B, F or G channel types. No such particularly steep valleys occur on CF's property.

This FPZ normally has minor lateral wetland zones flanking the channel, while some are flanked mainly by uplands. Most of these streams are intermittent, although some draining short hydroperiod wetlands such as wet prairies may be more ephemeral and those draining seepage wetlands may be seasonally intermittent (at least at a trickle). The stream channels of this FPZ, when undisturbed, often provide narrow gallery forests across their meander belt which finger out from the larger regional riparian galleries into the flatwoods. These small gallery forests can range from densely canopied systems to open woodlands with sparse canopy, depending largely on the fire frequency of the surrounding flatwoods savanna.

5.0 DESIGN SUMMARY

CF has developed a mining and reclamation plan that carefully considers the quality, complexity, restorability, and landscape location of the streams on the SPE to accomplish the following goals:

- Eliminate and/or reduce mining impacts to the lotic systems to the greatest extent practicable in light of the quality of the systems and mining constraints;
- Maintain or improve the biological functions of the streams impacted by mining operations by state-of-the-art restoration techniques;
- Improve the overall biological function of the agriculturally-impacted lotic systems on the property by restoring and enhancing every system to be disturbed by mining activities to include functional process zones and stream channel types found in more intact flatwoods riparian corridors in peninsular Florida.

To accomplish these goals, the highest quality, largest streams with the most complex riparian corridors will remain un-mined, especially those linking large, mature wetland forests that are also included in no-mine areas. Despite the fact that no perennial streams exist on the property, the stream length in the un-mined areas totals 10.5 miles, representing 63 percent of the total stream channel length on the SPE (**Table SRO-2**).

The 6.1 miles of streams within the proposed mining areas represent low-order, small channels, without alluvial floodplain features that have hydraulic regimes, geomorphology, and in-stream habitats that are comparatively straightforward to restore. Approximately 2.0 miles of the streams proposed for mining currently consist of ditches. Most of the remaining 4.0 miles of streams within the mining areas have been physically or hydrologically altered by various combinations of over-grazing, riparian clearing, watershed clearing, and upland and wetland drainage ditches.

The functions and form of the stream channels proposed for mining will be maintained or improved by using their most intact reaches as on-site templates to guide restoration design, while also relying on information gathered from more pristine streams measured as part of a concentrated study of intact fluvial systems in the flatwoods of peninsular Florida (Kiefer 2010). This library of intact streams with intact riparian corridors and nearly natural watersheds provides a superior set of reference sites versus most of the streams on site. This plan provides that the 2.0 miles of ditched streams and 4.0 miles of small, variably damaged streams will be restored by 8.3 miles of fully functional naturally functioning channels, moving the property closer to its pre-agricultural riparian functions and also providing much-needed increases in headwater stream channel length lost elsewhere in the Peace River watershed. **Table SRO-7** provides an estimated time schedule of stream impacts. Restored channels will be Rosgen C5 and E5 types, consistent with their flatwoods ecosystem setting (**Table SRO-5**).

Furthermore, CF will enhance a 0.8 mile stream valley that is the longest channel of the North Branch of Lettis Creek. Although this channel was hydraulically bypassed by an upland cut ditch, it remains geomorphically intact with an intact wetland riparian gallery forest. CF's reclamation plan proposes to restore the flow path through this channel, which in turn, will restore the hydrology of its headwater marsh as well.

In all, 2.8 miles of ditched or bypassed streams will be transformed to a system with a clearly improved fluvial form and function compared to that which exists today (including the 0.8 mile bypassed stream plus the 2.0 miles of ditched natural streams). The remaining natural and variably damaged 4.0 miles of streams proposed for mining impacts will be restored in accordance with a highly detailed and progressive plan based on conditions studied in relatively pristine low-order streams in peninsular Florida (**Table SRO-5**).

CF's stream restoration plan pays detailed attention to in-stream channel design and improvements, as well as the overall lotic systems on the property, including headwater wetlands, in-line wetlands, and the habitat zones of flanking wetlands and terrestrial communities within and along the riparian valley. This is important because while only two Rosgen channel types occur on the SPE, these stream channels occur as part of seven different valley types referred to as functional process zones (FPZs). FPZs are geomorphic and vegetative associations larger than the stream channel that occur within a valley. FPZs can include more than one channel segment. Just like the stream channels themselves, the FPZs are in various states of alteration on the SPE, and some are adversely impacted by clearing of their native vegetation, drainage ditches, and over-grazing. CF will restore and improve the overall lotic system by creating natural combinations of FPZs found in intact flatwoods with emphasis of restoring pre-agricultural conditions to the SPE wherever practical. CF is a leader in the development of stream restoration techniques in Florida and will apply state-of-the-art approaches to assure the highest possible quality in stream mitigation.

To accomplish these goals, broader gallery forest corridors and native upland riparian zones will typically replace those that were historically cleared for agriculture on the SPE. The reclaimed valleys will form an unditched drainage network with a flow regime that is not artificially flashy like the existing ditched systems. CF's plan pays significant attention to landscape scale associations important to overall stream function by matching drainage area to valley geomorphology, width of the meander belt, and FPZ types and sequences. The design covers a full hierarchy of scales, restoring a series of habitat patches and zones progressing from in-stream meso-habitats, such as individual logs and pools a few feet long, to the geomorphic and hydraulic linkages of entire lentic, paralotic, and lotic waterbodies and their associated ecotones encompassing many acres. These landscape linkages are based largely on the historic conditions of the property, prior to land clearing and ditching, which will provide a better overall lotic system versus that existing immediately prior to mining.

6.0 REFERENCES

Blanton, K.M. 2008. Development of Bankfull Discharge and Channel Geometry Regressions for Peninsular Florida Streams. Masters Thesis. University of Florida. Gainesville, FL.

Crisman, T.L. 2009. personal communication. University of South Florida, Tampa, FL.

Kiefer, J.H. (2010). Hydrobiogeomorphology of Fluvial Systems in Peninsular Florida: Implications to Classification, Conservation, and Restoration. Doctoral Dissertation. University of Florida, Gainesville, FL.

Kiefer, J.H. and Durbin, D. 2004. Stream Restoration Plan for the IMC Phosphates Ona Fort Green Extension Parcel. Mulberry, FL.

Leopold, L.B. 1994. A View of the River. Harvard University Press. Cambridge, MA.

Lewelling, B.R., 1997, Hydrologic and Water-Quality Conditions in the Horse Creek Basin, West-Central Florida, October 1992-February 1995: U.S. Geological Survey Water-Resources Investigations Report 97-4077, 72 p.

Rosgen, D. 1996. Applied River Morphology. Wildland Hydrology. Pagosa Springs, CO.

Thorp, J.H., Thoms, M.C., and M.D. Delong. 2006. The riverine ecosystem synthesis: Biocomplexity in river networks across space and time. River Research and Applications. 22:123-147.

Thorp, J.H., Thoms, M.C., and M.D. Delong. 2008. The Riverine Ecosystem Synthesis: Toward Conceptual Cohesiveness in River Science. Elsevier. New York, NY.

Ward, J.V. 1989. The four-dimensional nature of lotic ecosystems. Journal of the North American Benthological Society. 8:2-8; 37:130-137.

Welsch, D. 1991. Riparian Forest Buffers. USDA Forest Service, Forest Resources Management. Radnor, PA.

Wenger, S. 1999. A Review of the Scientific Literature on Riparian Buffer Width, Extent, and Vegetation. University of Georgia. Athens, GA.

Tables

Table SRO-1
South Pasture Extension Stream Segments

Segment Name	Drainage Area (sq mi)	Stream Length (ft)	Mining	Valley Complex	FLUCCS
BC-MT-01	4.66	7,701	No-Mine Area	Brushy Creek Main Trunk	511
BC-MT-02	4.81	1,024	No-Mine Area	Brushy Creek Main Trunk	511
BC-MT-03	4.95	2,638	No-Mine Area	Brushy Creek Main Trunk	511
BC-MT-04	5.18	2,727	No-Mine Area	Brushy Creek Main Trunk	511
BC-MT-05	5.99	5,325	No-Mine Area	Brushy Creek Main Trunk	511
BC-MT-06	7.98	2,692	No-Mine Area	Brushy Creek Main Trunk	511
BC-MT-07	0.09	306	Mine Area	Brushy Creek Main Trunk	511
BC-MT-08	0.12	724	Mine Area	Brushy Creek Main Trunk	511
BC-MT-09	0.12	61	No-Mine Area	Brushy Creek Main Trunk	511
BC-MT-10	0.02	393	Mine Area	Brushy Creek Main Trunk	511
BC-MT-11	0.03	98	No-Mine Area	Brushy Creek Main Trunk	511
BC-MT-12	0.04	667	Mine Area	Brushy Creek Main Trunk	511
BC-MT-13	0.04	178	No-Mine Area	Brushy Creek Main Trunk	511
BC-MT-14	0.14	812	No-Mine Area	Brushy Creek Main Trunk	511
BC-MT-15	0.13	534	Mine Area	Brushy Creek Main Trunk	511
BC-MT-16	0.13	578	No-Mine Area	Brushy Creek Main Trunk	511
BC-NC-01	0.45	1,425	Mine Area	Brushy Creek NC Branch	511
BC-NC-02	0.56	1,463	Mine Area	Brushy Creek NC Branch	511
BC-NC-03	0.59	2,767	No-Mine Area	Brushy Creek NC Branch	511
BC-NC-04	0.69	310	No-Mine Area	Brushy Creek NC Branch	511
BC-NC-05	1.49	2,248	No-Mine Area	Brushy Creek NC Branch	511
BC-NC-06	1.74	1,995	No-Mine Area	Brushy Creek NC Branch	511
BC-NC-07	0.35	196	Mine Area	Brushy Creek NC Branch	512
BC-NC-08	0.36	144	Mine Area	Brushy Creek NC Branch	512
BC-NC-09	0.38	469	Mine Area	Brushy Creek NC Branch	512
BC-NC-10	0.39	149	Mine Area	Brushy Creek NC Branch	512
BC-NC-11	0.54	388	Mine Area	Brushy Creek NC Branch	511
BC-NC-12	0.74	1,315	No-Mine Area	Brushy Creek NC Branch	511
BC-NC-13	0.77	1,321	No-Mine Area	Brushy Creek NC Branch	511
BC-NC-14	0.02	232	Mine Area	Brushy Creek NC Branch	511
BC-NC-15	0.04	1,060	Mine Area	Brushy Creek NC Branch	512
BC-NC-16	0.06	109	No-Mine Area	Brushy Creek NC Branch	512
BC-NE-01	0.15	145	Mine Area	Brushy Creek NE Branch	512
BC-NE-02	0.15	55	No-Mine Area	Brushy Creek NE Branch	512
BC-NE-03a	0.03	200	Mine Area	Brushy Creek NE Branch	512
BC-NE-03b	0.03	180	Mine Area	Brushy Creek NE Branch	511
BC-NE-04	0.04	80	No-Mine Area	Brushy Creek NE Branch	511
BC-NE-05	0.45	1,339	No-Mine Area	Brushy Creek NE Branch	511
BC-NE-06	0.61	589	No-Mine Area	Brushy Creek NE Branch	511
BC-NE-07	0.65	719	No-Mine Area	Brushy Creek NE Branch	511
BC-NW-01	0.40	678	Mine Area	Brushy Creek NW Branch	511

Table SRO-1
South Pasture Extension Stream Segments (continued)

Segment Name	Drainage Area (sq mi)	Stream Length (ft)	Mining	Valley Complex	FLUCCS
BC-NW-02	0.43	873	Mine Area	Brushy Creek NW Branch	511
BC-NW-03a	0.52	3,302	Mine Area	Brushy Creek NW Branch	511
BC-NW-03b	0.52	1,180	No-Mine Area	Brushy Creek NW Branch	511
BC-NW-04	0.52	468	No-Mine Area	Brushy Creek NW Branch	511
BC-NW-05	0.63	549	No-Mine Area	Brushy Creek NW Branch	511
BC-NW-06	0.06	259	Mine Area	Brushy Creek NW Branch	512
BC-NW-07a	0.60	249	No-Mine Area	Brushy Creek NW Branch	511
BC-NW-07b	0.60	183	Mine Area	Brushy Creek NW Branch	511
BC-SW-01	0.22	1,014	Mine Area	Brushy Creek SW Branch	512
BC-SW-02	0.27	1,373	Mine Area	Brushy Creek SW Branch	511
BC-SW-03	0.31	920	Mine Area	Brushy Creek SW Branch	511
BC-SW-04	0.59	711	Mine Area	Brushy Creek SW Branch	511
BC-SW-05	0.02	173	Mine Area	Brushy Creek SW Branch	511
BC-SW-06	0.08	310	Mine Area	Brushy Creek SW Branch	511
BC-SW-07	0.16	860	Mine Area	Brushy Creek SW Branch	511
BC-SW-08	0.18	601	Mine Area	Brushy Creek SW Branch	512
LC-EB-01	0.15	163	Mine Area	Lettis Creek East Branch	512
LC-EB-02	0.19	137	Mine Area	Lettis Creek East Branch	512
LC-EB-03	0.27	729	Mine Area	Lettis Creek East Branch	512
LC-EB-04a	0.80	368	Mine Area	Lettis Creek East Branch	512
LC-EB-04b	0.80	97	Mine Area	Lettis Creek East Branch	512
LC-EB-05	1.04	106	Mine Area	Lettis Creek East Branch	512
LC-EB-06	1.14	1,267	No-Mine Area	Lettis Creek East Branch	511
LC-EB-07	1.20	980	No-Mine Area	Lettis Creek East Branch	511
LC-EB-08	1.35	519	No-Mine Area	Lettis Creek East Branch	511
LC-EB-09	1.85	1,906	No-Mine Area	Lettis Creek East Branch	511
LC-EB-10	0.13	466	Mine Area	Lettis Creek East Branch	512
LC-EB-11a	0.14	143	No-Mine Area	Lettis Creek East Branch	512
LC-EB-11b	0.14	147	No-Mine Area	Lettis Creek East Branch	511
LC-EB-12	0.12	508	Mine Area	Lettis Creek East Branch	512
LC-EB-13	0.14	644	Mine Area	Lettis Creek East Branch	511
LC-EB-14	0.03	202	Mine Area	Lettis Creek East Branch	511
LC-EB-15	3.62	792	Mine Area	Lettis Creek East Branch	512
LC-EB-16	3.63	351	No-Mine Area	Lettis Creek East Branch	512
LC-MT-01	4.18	4,575	No-Mine Area	Lettis Main Trunk	511
LC-MT-02	0.09	768	Mine Area	Lettis Main Trunk	511
LC-MT-03	0.10	115	Mine Area	Lettis Main Trunk	511
LC-NB-01	0.76	212	Mine Area	Lettis Creek North Branch	511
LC-NB-02	0.87	1,935	No-Mine Area	Lettis Creek North Branch	511
LC-NB-03	0.26	4,204	No-Mine Area	Lettis Creek North Branch	511
LC-NB-04	0.49	456	Mine Area	Lettis Creek North Branch	511
LC-NB-05	0.59	680	Mine Area	Lettis Creek North Branch	511

Table SRO-1
South Pasture Extension Stream Segments (continued)

Segment Name	Drainage Area (sq mi)	Stream Length (ft)	Mining	Valley Complex	FLUCCS
LC-NB-06	0.63	871	Mine Area	Lettis Creek North Branch	511
LC-NB-07	0.07	284	Mine Area	Lettis Creek North Branch	511
LC-NB-08	0.19	193	Mine Area	Lettis Creek North Branch	512
LC-NB-09	0.23	347	No-Mine Area	Lettis Creek North Branch	512
LC-NB-10	0.53	770	Mine Area	Lettis Creek North Branch	511
TC-EB-01	1.17	412	Mine Area	Troublesome Creek East Branch	512
TC-EB-02	3.12	1,133	Mine Area	Troublesome Creek East Branch	512
TC-EB-03	0.16	380	Mine Area	Troublesome Creek East Branch	511
TC-EB-04	0.25	265	Mine Area	Troublesome Creek East Branch	511
TC-EB-05	0.29	207	Mine Area	Troublesome Creek East Branch	512
TC-WB-01	0.85	1,271	Mine Area	Troublesome Creek West Branch	512
Total stream length = 87,662 LF					
Total stream length for streams with drainage area <0.1 square miles = 5,499 LF (6%)					
Total length for mined streams with drainage area <0.1 square miles = 5,034 LF (6%)					

Table SRO-2
Stream Impact, Restoration, and Enhancement Summary

			Natural Streams 511	Ditched Streams 512	Total
Pre-Mining	**Mine**	linear feet	21,342	10,819	**32,161**
		mile	4.0	2.0	**6.1**
	No-Mine	linear feet	54,496*	1,005	**55,501**
		mile	10.3	0.2	**10.5**
	Total	linear feet	**75,838**	**11,824**	**87,662**
		mile	**14.4**	**2.2**	**16.6**
Post-Reclamation	**Reclaimed**	linear feet	43,838	0	**43,838**
		mile	8.3	0	**8.3**
	Enhanced	linear feet	4,204	0	**4,204**
		mile	0.8	0	**0.8**
	No-Mine	linear feet	49,312**	1,005	**50,317**
		mile	9.3	0.2	**9.5**
	Total	linear feet	**97,354**	**1,005**	**98,359**
		mile	**18.4**	**0.2**	**18.6**

*Includes 4,204 LF of currently diverted stream channel that will be enhanced by hydrological re-connection (see Chapter 3, East Branch and North Branch of Lettis Creek).
**Includes 520 LF of stream that will be temporarily disturbed by mining infrastructure corridors and subsequently rebuilt to natural conditions

Table SRO-3
Representative Stream Segments Details

Segment Name	Rosgen Class[1]	Mining	Valley Slope (%)	Drainage Area (sq mi)	Bankfull Discharge (cfs)[2]	Bankfull Area[1] (sq ft)	Bankfull Width[1] (ft)	Bankfull Depth[1] (ft)	Hydraulic Depth[1] (ft)	Meander Belth Width (ft)	Radius of Curvature	Sinuosity	Flood-prone Width[3]	FPZ[4]
BC-MT-01	C5	No-Mine Area	0.32	4.66	9.25	9.70	10.97	1.30	0.88	131.2	6.6	1.71	24.13	UGF
BC-MT-08	C5	Mine Area	1.19	0.12	0.74	8.25	12.86	1.00	0.64	39.5	6.5	1.62	28.29	UC
BC-MT-09	C5	No-Mine Area	1.19	0.12	0.74	8.25	12.86	1.00	0.64	39.5	6.5	1.62	28.29	UC
BC-MT-10	C5	Mine Area	2.34	0.02	0.22	2.54	6.08	0.70	0.42	28.9	10.9	1.05	13.38	HW
BC-MT-11	C5	No-Mine Area	2.34	0.02	0.22	2.54	6.08	0.70	0.42	28.9	10.9	1.05	13.38	HW
BC-MT-12	E5	Mine Area	0.56	0.04	0.35	10.23	10.81	1.50	0.95	49.4	5.2	1.11	23.78	HW
BC-MT-13	E5	No-Mine Area	0.56	0.04	0.35	10.23	10.81	1.50	0.95	49.4	5.2	1.11	23.78	HW
BC-MT-15	E5	Mine Area	2.92	0.13	0.78	5.21	4.23	1.60	1.23	52.5	10.7	1.28	9.31	UC
BC-MT-16	E5	No-Mine Area	2.92	0.13	0.78	5.21	4.23	1.60	1.23	52.5	10.7	1.28	9.31	WU
BC-NC-01	C5	Mine Area	0.16	0.45	1.84	16.66	17.18	1.60	0.97	70.1	15.0	1.19	37.80	WU
BC-NC-02	C5	Mine Area	0.09	0.56	2.14	10.06	21.14	0.80	0.48	74.5	9.6	1.06	46.51	WC
BC-NC-03	E5	No-Mine Area	0.27	0.59	2.22	9.88	10.69	1.30	0.92	75.8	9.0	1.36	23.52	WU
BC-NC-05	E5	No-Mine Area	0.09	1.49	4.21	26.00	15.66	2.20	1.66	74.4	9.2	1.42	34.45	WC/WU
BC-NC-13	C5	No-Mine Area	0.99	0.77	2.67	2.39	5.72	0.70	0.42	69.4	3.4	1.72	12.58	UC/WU
BC-NE-06	B5	No-Mine Area	0.35	0.61	2.28	3.22	8.08	0.60	0.40	52.1	7.4	1.14	17.78	WU
BC-NW-01	C5	Mine Area	0.24	0.40	1.70	5.04	10.27	0.70	0.49	70.2	20.6	1.36	22.59	CW
BC-NW-02	E5	Mine Area	0.21	0.43	1.79	9.34	10.17	1.30	0.92	59.7	15.2	1.17	22.37	CW
BC-NW-03	E5	Mine Area	0.89	0.52	2.04	10.59	8.56	1.70	1.24	93.3	5.6	1.38	18.83	WC
BC-NW-04	E5	No-Mine Area	0.89	0.52	2.04	10.59	8.56	1.70	1.24	93.3	5.6	1.38	18.83	WU
BC-SW-02	E5	Mine Area	0.26	0.27	1.30	4.45	6.75	1.00	0.66	33.4	5.5	1.10	14.85	UC/WU
BC-SW-03	C5	Mine Area	0.07	0.31	1.43	3.07	6.30	0.70	0.49	31.4	11.7	1.03	13.86	UC/WU
BC-SW-04	C5	Mine Area	0.28	0.59	2.22	11.81	12.09	1.40	0.98	73.7	14.6	1.48	26.60	WC
BC-SW-06	E5	Mine Area	1.53	0.08	0.56	5.65	6.66	1.20	0.85	14	8.1	1.02	14.65	WU
BC-SW-07	C5	Mine Area	0.04	0.16	0.90	4.22	9.00	0.80	0.47	41.5	5.5	1.32	19.80	WC
LC-EB-09	E5	No-Mine Area	0.15	1.85	4.89	6.49	8.78	1.10	0.74	91.9	12.3	0.26	19.32	WU
LC-EB-13	E5	Mine Area	0.03	0.14	0.82	5.03	6.05	1.00	0.83	46	9.1	1.16	13.31	UC/WU
LC-MT-02	C5	Mine Area	0.53	0.09	0.61	5.67	9.32	0.90	0.61	17.5	40.7	1.02	20.50	UC/WU
LC-NB-03	C5	No-Mine Area	0.27	0.26	1.26	19.14	18.2	1.7	1.05	164.1	19.8	1.18	40.04	WC/WU
LC-NB-04	C5	Mine Area	0.60	0.53	2.06	6.18	10.99	0.90	0.56	26	12.4	1.18	24.18	WU
LC-NB-05	C5	Mine Area	0.39	0.62	2.30	5.68	9.17	1.10	0.62	63.8	11.5	1.46	20.17	CW
LC-NB-06	C5	Mine Area	0.52	0.66	2.40	6.43	10.83	1.00	0.59	44.9	5.5	1.16	23.83	CW
LC-NB-10	C5	Mine Area	0.27	0.53	2.06	2.26	7.09	0.60	0.32	86.8	10.8	1.46	15.60	WU
TC-EB-03	C5	Mine Area	0.28	0.16	0.90	15.20	26.41	0.90	0.58	17.9	6.8	1.02	58.10	CW

[1] Based on cross-sectional survey; [2] Calculated bankfull discharge based on the following regression: $Q_{bkf} = 3.2A_d^{0.69}$; [3] The flood-prone width was calculated by multiplying the bankfull width 2.2 (Rosgen, 1996). This value represents the minimum flood-prone width. [4] FPZ = Functional Process Zone. There are six functional process zones: unconfined genetic floodplain (UGF), upland confined channel (UC), chain of wetlands (CW), headwater drain (HD), wetland underfit (WU), and wetland confined channel (WC).

Table SRO-4
2010 Habitat Assessment Scores

Stream ID	Mine/No-Mine	Date HA Performed	HA Score	HA Category	Adjusted HA Score*	Adjusted HA Category*
BC-MT-01	No-Mine	4/20/2010	131	Optimal	139	Optimal
BC-MT-02	No-Mine	4/20/2010	129	Optimal	127	Optimal
BC-MT-03	No-Mine	4/20/2010	129	Optimal	129	Optimal
BC-MT-04	No-Mine	4/20/2010	124	Optimal	131	Optimal
BC-MT-05	No-Mine	4/20/2010	124	Optimal	133	Optimal
BC-MT-06	No-Mine	4/22/2010	109	Suboptimal	123	Optimal
BC-MT-07	Mine	4/20/2010	77	Marginal	77	Marginal
BC-MT-08	Mine	4/20/2010	93	Suboptimal	101	Suboptimal
BC-MT-10	Mine	4/20/2010	113	Suboptimal	119	Suboptimal
BC-MT-12	Mine	4/20/2010	106	Suboptimal	112	Suboptimal
BC-MT-13	No-Mine	5/5/2010	123	Optimal	123	Optimal
BC-MT-14	No-Mine	4/20/2010	127	Optimal	122	Optimal
BC-MT-15	Mine	4/19/2010	88	Suboptimal	99	Suboptimal
BC-MT-16	No-Mine	5/5/2010	121	Optimal	132	Optimal
BC-NC-01	Mine	4/19/2010	123	Optimal	137	Optimal
BC-NC-02	Mine	4/14/2010	112	Suboptimal	111	Suboptimal
BC-NC-03	No-Mine	4/14/2010	121	Optimal	127	Optimal
BC-NC-04	No-Mine	4/14/2010	108	Suboptimal	121	Optimal
BC-NC-05	No-Mine	4/14/2010	127	Optimal	132	Optimal
BC-NC-06	No-Mine	4/14/2010	139	Optimal	149	Optimal
BC-NC-07	Mine	4/19/2010	61	Marginal	78	Marginal
BC-NC-09	Mine	4/19/2010	104	Suboptimal	112	Suboptimal
BC-NC-11	Mine	4/19/2010	79	Marginal	92	Suboptimal
BC-NC-12	No-Mine	4/19/2010	93	Suboptimal	108	Suboptimal
BC-NC-13	No-Mine	4/14/2010	111	Suboptimal	119	Suboptimal
BC-NC-14	Mine	4/19/2010	66	Marginal	67	Marginal
BC-NC-15	Mine	4/19/2010	55	Marginal	66	Marginal
BC-NC-16	No-Mine	4/19/2010	58	Marginal	60	Marginal
BC-NE-01	Mine	4/14/2010	60	Marginal	66	Marginal
BC-NE-03	Mine	5/5/2010	57	Marginal	57	Marginal
BC-NE-04	No-Mine	4/14/2010	102	Suboptimal	102	Suboptimal
BC-NE-05	No-Mine	5/5/2010	122	Optimal	136	Optimal
BC-NE-06	No-Mine	4/14/2010	119	Suboptimal	125	Optimal
BC-NE-07	No-Mine	4/14/2010	130	Optimal	146	Optimal
BC-NW-01	Mine	4/19/2010	129	Optimal	137	Optimal
BC-NW-02	Mine	4/19/2010	129	Optimal	139	Optimal
BC-NW-03	Mine	4/19/2010	112	Suboptimal	115	Suboptimal
BC-NW-04	No-Mine	4/19/2010	126	Optimal	143	Optimal
BC-NW-05	No-Mine	5/5/2010	108	Suboptimal	123	Optimal
BC-NW-06	Mine	4/19/2010	104	Suboptimal	105	Suboptimal
BC-NW-07	No-Mine	4/19/2010	96	Suboptimal	110	Suboptimal
BC-SW-01	Mine	4/20/2010	42	Marginal	50	Marginal
BC-SW-02	Mine	4/22/2010	127	Optimal	138	Optimal

Table SRO-4
2010 Habitat Assessment Scores (continued)

Stream ID	Mine/No-Mine	Date HA Performed	HA Score	HA Category	Adjusted HA Score*	Adjusted HA Category*
BC-SW-04	Mine	4/22/2010	128	Optimal	136	Optimal
BC-SW-06	Mine	4/22/2010	128	Optimal	142	Optimal
BC-SW-07	Mine	4/22/2010	125	Optimal	125	Optimal
BC-SW-08	Mine	4/22/2010	77	Marginal	78	Marginal
LC-EB-01	Mine	4/12/2010	106	Suboptimal	110	Suboptimal
LC-EB-02	Mine	4/12/2010	106	Suboptimal	110	Suboptimal
LC-EB-03	Mine	4/12/2010	107	Suboptimal	112	Suboptimal
LC-EB-04	Mine	4/12/2010	83	Suboptimal	96	Suboptimal
LC-EB-06	No-Mine	4/12/2010	109	Suboptimal	128	Optimal
LC-EB-07	No-Mine	4/12/2010	101	Suboptimal	115	Suboptimal
LC-EB-08	No-Mine	4/12/2010	110	Suboptimal	123	Optimal
LC-EB-09	No-Mine	4/20/2010	116	Suboptimal	131	Optimal
LC-EB-10	Mine	4/12/2010	85	Suboptimal	96	Suboptimal
LC-EB-11	No-Mine	4/12/2010	92	Suboptimal	102	Suboptimal
LC-EB-12	Mine	4/20/2010	51	Marginal	61	Marginal
LC-EB-13	Mine	4/20/2010	127	Optimal	129	Optimal
LC-EB-14	Mine	4/20/2010	100	Suboptimal	100	Suboptimal
LC-EB-15	Mine	4/20/2010	72	Marginal	84	Marginal
LC-EB-16	No-Mine	4/20/2010	102	Suboptimal	118	Suboptimal
LC-MT-01	No-Mine	4/20/2010	121	Optimal	127	Optimal
LC-MT-02	Mine	4/20/2010	97	Suboptimal	97	Suboptimal
LC-MT-03	Mine	4/20/2010	108	Suboptimal	119	Suboptimal
LC-NB-01	Mine	4/12/2010	116	Suboptimal	130	Optimal
LC-NB-02	No-Mine	4/12/2010	118	Suboptimal	134	Optimal
LC-NB-03	No-Mine	4/12/2010	126	Optimal	131	Optimal
LC-NB-04	Mine	4/12/2010	126	Optimal	138	Optimal
LC-NB-05	Mine	4/12/2010	101	Suboptimal	111	Suboptimal
LC-NB-06	Mine	4/12/2010	124	Optimal	136	Optimal
LC-NB-07	Mine	4/12/2010	112	Suboptimal	118	Suboptimal
LC-NB-09	No-Mine	4/12/2010	112	Suboptimal	118	Suboptimal
LC-NB-10	Mine	4/12/2010	125	Optimal	135	Optimal
TC-EB-01	Mine	4/23/2010	87	Suboptimal	87	Suboptimal
TC-EB-02	Mine	4/23/2010	108	Suboptimal	115	Suboptimal
TC-EB-03	Mine	4/23/2010	97	Suboptimal	105	Suboptimal
TC-EB-04	Mine	4/23/2010	110	Suboptimal	125	Optimal
TC-EB-05	Mine	4/23/2010	93	Suboptimal	100	Suboptimal
TC-WB-01	Mine	4/23/2010	58	Marginal	58	Marginal

Notes: * HA Score adjusted to reflect velocity that would occur during the bankfull discharge. HA = Habitat Assessment

SRO-5A
Post-Reclamation Stream Design Channel Specifications

Segment Name	Drainage Area (sq mi)	Channel Specifications														
		Bankfull XS-Area[1] (sq ft)	Bankfull Width[1] (ft)	Bankfull TW Depth[1] (ft)	Hydraulic Depth (ft)	W_{bkf} / Mean D	Pool Depth (ft)	Rosgen Class[2]	Sinuosity[3]	Stream Length[4] (ft)	Bed Slope (%)	Flood-Prone Width[5] (ft)	Bankfull Discharge[1] (cfs)	Bankful Velocity (ft/s)	Bankfull Unit Stream Power (lb/s/ft)	Bankfull Shear Stress (psf)
BC-MT-1-R	0.15	2.2	4.9	0.8	0.5	10.6	1.6	E5	1.55	953	0.31	0.41	0.85	0.38	0.03	0.05
BC-MT-2-R	0.26	3.0	7.7	0.7	0.4	19.6	1.4	C5	1.55	587	0.88	1.28	1.26	0.42	0.09	0.13
BC-MT-4-R	0.02	0.8	4.0	0.4	0.2	20.0	0.8	C5	1.55	508	0.54	0.85	0.22	0.27	0.02	0.04
BC-MT-5-R	0.09	1.7	5.8	0.5	0.3	19.8	1.1	C5	1.55	164	1.29	1.89	0.59	0.35	0.08	0.14
BC-MT-6-R	0.02	0.8	4.0	0.4	0.2	20.0	0.7	C5	1.55	843	0.32	0.50	0.21	0.27	0.01	0.02
BC-NC-1-R	0.02	0.7	3.8	0.4	0.2	20.0	1.0	C5	1.55	335	1.17	1.85	0.19	0.26	0.04	0.08
BC-NC-2-R	0.04	1.1	3.6	0.6	0.3	11.8	1.1	E5	1.55	1535	0.39	0.59	0.32	0.30	0.02	0.04
BC-NC-3-R	0.68	5.0	9.8	0.9	0.5	19.4	1.8	C5	1.20	1409	0.14	0.13	2.45	0.49	0.02	0.03
BC-NC-4-R	0.45	4.0	8.8	0.8	0.5	19.5	1.6	C5	1.20	1236	0.22	0.23	1.83	0.46	0.03	0.04
BC-NE-1-R	0.16	2.3	6.8	0.6	0.3	19.7	1.3	C5	1.55	1851	0.37	0.55	0.90	0.39	0.03	0.05
BC-NE-2-R	0.03	0.9	4.3	0.4	0.2	19.9	0.8	C5	1.55	584	0.37	0.58	0.27	0.28	0.01	0.03
BC-NW-1-R	0.89	5.7	10.5	1.0	0.5	19.4	1.9	C5	1.20	696	0.21	0.17	2.95	0.52	0.04	0.04
BC-NW-2-R	0.92	5.8	10.6	1.0	0.5	19.4	1.9	C5	1.55	1001	0.36	0.46	3.02	0.52	0.06	0.08
BC-NW-3-R	1.00	6.1	7.4	1.3	0.8	9.1	2.6	E5	1.20	3749	0.28	0.31	3.20	0.53	0.07	0.08
BC-SW-1-R	0.12	2.1	6.4	0.6	0.3	19.7	1.2	C5	1.55	733	0.33	0.47	0.76	0.37	0.02	0.04
BC-SW-2-R	0.17	2.4	5.0	0.8	0.5	10.5	1.7	E5	1.55	166	1.31	1.61	0.95	0.39	0.15	0.21
BC-SW-3-R	0.40	3.8	8.6	0.8	0.4	19.5	1.6	C5	1.20	2952	0.15	0.16	1.70	0.45	0.02	0.02
LC-EB-1-R	0.02	0.8	4.1	0.4	0.2	20.0	0.8	C5	1.55	543	0.54	0.86	0.23	0.27	0.02	0.04
LC-EB-3-R	0.08	1.6	5.6	0.5	0.3	19.8	1.1	C5	1.20	977	0.22	0.27	0.55	0.34	0.01	0.02
LC-EB-4-R	0.32	3.3	8.1	0.7	0.4	19.6	1.5	C5	1.20	535	0.25	0.25	1.45	0.43	0.03	0.04
LC-EB-5-R	0.78	5.3	10.2	0.9	0.5	19.4	1.9	C5	1.20	744	0.24	0.22	2.69	0.51	0.04	0.05
LC-EB-6-R	0.20	2.7	7.2	0.7	0.4	19.6	1.3	C5	1.55	415	0.32	0.40	1.07	0.40	0.03	0.04
LC-MT-2-R	0.10	1.8	5.9	0.6	0.3	19.7	1.1	C5	1.55	806	0.51	0.77	0.63	0.35	0.03	0.06
LC-MT-3-R	0.10	1.8	6.0	0.6	0.3	19.7	1.1	C5	1.55	186	0.37	0.46	0.66	0.36	0.03	0.04
LC-NB-1-R	0.59	4.6	9.5	0.9	0.5	19.5	1.7	C5	1.20	4249	0.11	0.12	2.23	0.48	0.02	0.02
LC-NB-3-R	0.04	1.1	4.7	0.4	0.2	19.9	0.9	C5	1.55	981	0.31	0.47	0.34	0.30	0.01	0.03
LC-NB-4-R	0.31	3.3	8.0	0.7	0.4	19.6	1.5	C5	1.20	1135	0.20	0.21	1.42	0.43	0.02	0.03
LC-NB-5-R	0.61	4.7	9.5	0.9	0.5	19.5	1.8	C5	1.55	710	0.42	0.55	2.27	0.49	0.06	0.08
LC-NB-6-R	0.15	2.3	6.7	0.6	0.3	19.7	1.2	C5	1.20	508	0.22	0.23	0.87	0.38	0.02	0.03
LC-NB-7-R	0.09	1.8	5.9	0.5	0.3	19.7	1.1	C5	1.55	236	0.91	1.32	0.62	0.35	0.06	0.10
TB-EB-1-R	2.11	8.9	8.8	1.5	1.0	8.6	3.1	E5	1.20	1082	0.18	0.10	5.36	0.60	0.07	0.06
TB-EB-2-R	0.06	1.4	5.2	0.5	0.3	19.8	1.0	C5	1.55	577	0.44	0.67	0.44	0.32	0.02	0.04
TB-EB-3-R	1.27	6.9	11.5	1.1	0.6	19.4	2.1	C5	1.55	4444	0.13	0.18	3.77	0.55	0.03	0.03
TB-EB-4-R	0.55	4.4	9.3	0.9	0.5	19.5	1.7	C5	1.20	4013	0.17	0.20	2.12	0.48	0.02	0.03
TB-WB-1-R	0.29	3.2	7.9	0.7	0.4	19.6	1.5	C5	1.20	1115	0.18	0.19	1.36	0.43	0.02	0.03
TB-WB-2-R	1.97	8.6	12.9	1.2	0.7	19.3	2.4	C5	1.20	712	0.17	0.08	5.11	0.59	0.04	0.04
TB-WB-3-R	1.16	6.5	11.2	1.0	0.6	19.4	2.1	C5	1.20	569	0.27	0.21	3.53	0.54	0.05	0.06
Total reclaimed stream length: 43,838 LF																

[1] All regression values rounded to the nearest 0.1 units. Calculated channel specifications based on the following regressions for bankfull area, width, and depth: $Q_{bkf} = 3.2A_d^{0.69}$; $A_{bkf} = 6.06A_d^{0.52}$; $W_{bkf\text{-}Ctype} = 10.84A_d^{0.26}$; $W_{bkf\text{-}Etype} = 7.43A_d^{0.22}$; $D_{tw\text{-}bkf\text{-}Ctype} = 0.99A_d^{0.25}$; $D_{tw\text{-}bkf\text{-}Etype} = 1.28A_d^{0.25}$; [2] Rosgen channel type based on valley position, with C5-type channels forming interior links and E5-type channels forming exterior links; [3] Sinuosity of on-site natural streams ranged from 1.02 to 1.72. Used lower half of this range (1.20) for more gradual channels (VS < 0.35) and upper half (1.55) for steeper channels (VS > 0.35).[4] Stream length = Sinuosity * Valley length; [5] Number of bends/pools based on 3.5 bends/pools per 20 bankfull widths; [6] Number of large woody debris snags based on 3 LWD per 100 LF of stream; [5] The flood-prone width was calculated by multiplying the bankfull width by 2.2 (Rosgen, 1996). This value represents the minimum flood-prone width.

SRO-5B
Post-Reclamation Stream Design Valley Specifications

Segment Name	Drainage Area (sq mi)	Valley Specifications						
		Valley Slope (%)	US Sill Elevation (NGVD ft)	DS Invert Elevation (NGVD ft)	Valley Length (ft)	Meander Belt Width (ft)	Belt Thickness (ft)	FPZ[1]
BC-MT-1-R	0.15	0.41	114.0	111.1	615	52	1.6	CW
BC-MT-2-R	0.26	1.28	112.0	106.5	379	49	1.8	HW
BC-MT-4-R	0.02	0.85	104.0	101.1	328	57	1.0	HW
BC-MT-5-R	0.09	1.89	116.0	113.7	106	20	1.4	HW
BC-MT-6-R	0.02	0.50	109.0	106.2	544	72	1.0	HW
BC-NC-1-R	0.02	1.85	106.0	101.9	216	36	1.0	HW
BC-NC-2-R	0.04	0.59	102.0	96.0	990	77	1.1	UC
BC-NC-3-R	0.68	0.13	106.5	104.6	1174	199	1.8	UC
BC-NC-4-R	0.45	0.23	105.0	102.3	1030	144	1.6	UC/WU
BC-NE-1-R	0.16	0.55	106.0	99.0	1194	82	1.6	HW
BC-NE-2-R	0.03	0.58	101.0	98.7	377	75	1.0	HW
BC-NW-1-R	0.89	0.17	115.0	113.5	580	64	1.9	CW
BC-NW-2-R	0.92	0.46	114.0	110.1	646	72	2.5	CW
BC-NW-3-R	1.00	0.31	111.0	100.8	3124	147	2.0	UC
BC-SW-1-R	0.12	0.47	97.2	94.6	473	65	1.5	CW
BC-SW-2-R	0.17	1.61	95.0	92.8	107	41	1.7	CW
BC-SW-3-R	0.40	0.16	100.5	96.2	2460	95	1.6	HW
LC-EB-1-R	0.02	0.86	99.0	95.9	350	83	1.0	HW
LC-EB-3-R	0.08	0.27	97.0	94.8	814	144	1.1	UC
LC-EB-4-R	0.32	0.25	97.5	96.2	446	64	1.5	HW
LC-EB-5-R	0.78	0.22	101.0	99.2	620	57	1.9	WU/WC
LC-EB-6-R	0.20	0.40	101.5	99.9	268	51	1.7	WU/WC
LC-MT-2-R	0.10	0.77	96.0	91.7	520	57	1.4	CW
LC-MT-3-R	0.10	0.46	92.0	91.1	120	40	1.4	CW
LC-NB-1-R	0.59	0.12	105.2	100.5	3541	195	1.7	HW
LC-NB-3-R	0.04	0.47	103.0	99.8	633	81	1.1	HW
LC-NB-4-R	0.31	0.21	105.0	102.8	946	77	1.5	UC
LC-NB-5-R	0.61	0.55	103.0	99.7	458	64	2.3	UC
LC-NB-6-R	0.15	0.23	103.0	101.9	423	76	1.2	CW
LC-NB-7-R	0.09	1.32	105.0	102.7	152	55	1.4	HW
TB-EB-1-R	2.11	0.10	100.0	98.4	902	142	2.4	WC
TB-EB-2-R	0.06	0.67	103.5	100.8	372	55	1.3	WC
TB-EB-3-R	1.27	0.18	107.0	100.7	2867	172	2.7	HW
TB-EB-4-R	0.55	0.20	108.6	101.6	3344	140	1.7	HW
TB-WB-1-R	0.29	0.19	104.3	102.3	929	110	1.5	CW
TB-WB-2-R	1.97	0.08	101.5	100.3	593	39	2.4	WU
TB-WB-3-R	1.16	0.21	101.0	99.5	474	63	2.1	WC
Total reclaimed stream length: 43,838 LF								

[1] FPZ = Functional Process Zone. There are five functional process zones: upland confined channel (UC), chain of wetlands (CW), headwater drain (HD), wetland underfit (WU), and wetland confined channel (WC); US = upstream; DS = downstream

SRO-5C
Post-Reclamation Stream Design Habitat Amendments

Segment Name	Drainage Area (sq mi)	Habitat Amendments				
		No. of Bends / Pools[1]	No. of LWD Snags[2]	No. of Root Wads	No. of Fine Woody Fascines	% Palmetto
BC-MT-1-R	0.15	34	29	34	34	0
BC-MT-2-R	0.26	19	18	19	19	0
BC-MT-4-R	0.02	28	15	28	28	0
BC-MT-5-R	0.09	7	5	7	7	0
BC-MT-6-R	0.02	47	25	47	47	0
BC-NC-1-R	0.02	19	10	19	19	0
BC-NC-2-R	0.04	75	46	75	75	70
BC-NC-3-R	0.68	25	42	25	25	70
BC-NC-4-R	0.45	25	37	25	25	35
BC-NE-1-R	0.16	65	56	65	65	0
BC-NE-2-R	0.03	30	18	30	30	0
BC-NW-1-R	0.89	12	21	12	12	0
BC-NW-2-R	0.92	24	30	24	24	0
BC-NW-3-R	1.00	61	112	61	61	70
BC-SW-1-R	0.12	27	22	27	27	0
BC-SW-2-R	0.17	6	5	6	6	0
BC-SW-3-R	0.40	60	89	60	60	0
LC-EB-1-R	0.02	30	16	30	30	0
LC-EB-3-R	0.08	30	29	30	30	70
LC-EB-4-R	0.32	12	16	12	12	0
LC-EB-5-R	0.78	13	22	13	13	20
LC-EB-6-R	0.20	14	12	14	14	20
LC-MT-2-R	0.10	32	24	32	32	0
LC-MT-3-R	0.10	7	6	7	7	0
LC-NB-1-R	0.59	78	127	78	78	0
LC-NB-3-R	0.04	47	29	47	47	0
LC-NB-4-R	0.31	25	34	25	25	70
LC-NB-5-R	0.61	19	21	19	19	70
LC-NB-6-R	0.15	13	15	13	13	0
LC-NB-7-R	0.09	9	7	9	9	0
TB-EB-1-R	2.11	14	32	14	14	40
TB-EB-2-R	0.06	26	17	26	26	40
TB-EB-3-R	1.27	99	133	99	99	0
TB-EB-4-R	0.55	75	120	75	75	0
TB-WB-1-R	0.29	25	33	25	25	0
TB-WB-2-R	1.97	10	21	10	10	0
TB-WB-3-R	1.16	9	17	9	9	40
Total reclaimed stream length: 43,838 LF						

[1] Number of bends/pools based on 3.5 bends/pools per 20 bankfull widths; [2] Number of large woody debris snags based on 3 LWD per 100 LF of stream.

Table SRO-6
Stream Monitoring Plan

Item	Design Objective	Monitoring Activity	Performance Standard
1	The channel bed and banks should be stable.	Reference reach surveys using Harrelson et al 1994*. Annual inspections of the channel segment and its connections to other waterbodies to identify maintenance items.	Rosgen Level II classification should be consistent with C5 or E5 streams. Bankfull depth and width are in range with natural stable headwater streams in peninsular Florida.
2	The channel should be properly dimensioned to transport water and sediment from its basin in a self-maintaining manner.	Reference reach surveys using Harrelson et al 1994*	The association between valley slope and drainage area must be within range of natural stable headwater streams in peninsular Florida. Bankfull channel cross-section area must be within the range of natural stable headwater streams in peninsular Florida.
3	The channel should exhibit normal and natural complexity in plan and bed forms (have a normal and natural pattern and dimension of bends, riffles, and pools).	Reference reach surveys using Harrelson et al 1994*	The channel sinuosity ratio, number of riffles & number of pools per unit stream length, and radius of curvature of the bends must be within the range of natural stable headwater streams in peninsular Florida.
4	The channel should be topographically compatible with riparian wetlands (lateral, headwater, and receiving waterbodies).	As-built survey of entire riparian system (1-foot contours) and annual visual erosion and stability inspections of the wetland-stream transition areas. With repeat photographs at permanent photo stations.	The slopes and widths across the transition must be stable and in accordance with the design specifications.
5	The channel should provide a normal and natural diversity and abundance of in-stream aquatic habitat features for aquatic fauna.	Perform SVAP and FDEP Stream Habitat Assessments (Year 3, Year 6, and Release Year).	Score “Good” or better on SVAP and “Suboptimal” or better on FDEP Habitat Assessment during release year.
6	The riparian corridor should be sufficiently wide and vegetated with a dominance of native forest canopy, shrub, and groundcover plants normally and naturally associated with headwater riparian corridors in the region.	Standard wetland mitigation vegetation monitoring transects. (Year 3, Year 6, and Release Year).	Meet wetland permit performance criteria by release year.
7	The system should provide adequate water quality for a Florida low-order stream.	Perform grab during flowing conditions of standard field parameters (i.e. temperature, turbidity, pH, specific conductance, dissolved oxygen) (Year 3, Year 6, and Release Year). Perform FDEP SCI (Year 3, Year 6, and Release Year).	Meet existing Class III water standards or otherwise fall within the range of values for reference headwater streams. Score “Healthy” on FDEP SCI during release year or within the range of values for reference headwater streams.

Table SRO-6
Monitoring Plan (continued)

Item	Design Objective	Monitoring Activity	Performance Standard
8	The system should have adequate water supply for a Florida low-order stream.	Measure wet season flow during repeat hydrological monitoring to calculate bankfull flow (Year 3, Year 6, and Release Year). Perform FDEP SCI (Year 3, Year 6, and Release Year).	Wet season flows produce bankfull discharge & velocities within the range of values for reference streams. (see Item 7 regarding SCI).
9	The system should include a diversity and abundance of pools and riffles that support native freshwater fish species.	Collect fish using dipnets and/or electroshock (Year 3, Year 6, and Release Year).	Fish collections support at least 4 native species, with at least one being a piscivore or support at least 8 native species without a piscivore.**

*Harrelson, C.C., C.L. Rawlins, and J.P. Potyondy, J.P., 1994. Stream Channel Reference Sites: an Illustrated Guide to Field Technique. U.S. Department of Agriculture Forest Service General Technical Report RM-245, pp. 61.
**Or otherwise provide a fishery IBI score or diversity index score within the range of such scores exhibited by natural Florida headwater streams.

SRO-7
Time Schedule of Stream Impacts

Segment Name	Valley Complex	Severance	Disturbance	Backfill	Reclaim*	Reconnection
BC-MT-07	Brushy Creek Main Trunk	2025	2026	2028	2030	2032
BC-MT-08	Brushy Creek Main Trunk	2025	2026	2028	2030	2032
BC-MT-10	Brushy Creek Main Trunk	2025	2026-2027	2028	2030	2032
BC-MT-12	Brushy Creek Main Trunk	2026	2027	2028	2030	2032
BC-MT-15	Brushy Creek Main Trunk	2023	2024	2030	2032	2034
BC-NC-01	Brushy Creek NC Branch	2028	2029-2032	2033	2035	2037
BC-NC-02	Brushy Creek NC Branch	2028	2029	2033	2035	2037
BC-NC-07	Brushy Creek NC Branch	2018	2019	2033	2035	2037
BC-NC-08	Brushy Creek NC Branch	2018	2019-2023	2033	2035	2037
BC-NC-09	Brushy Creek NC Branch	2022	2023	2033	2035	2037
BC-NC-10	Brushy Creek NC Branch	2022	2023-2032	2033	2035	2037
BC-NC-11	Brushy Creek NC Branch	2023	2024	2030	2032	2034
BC-NC-14	Brushy Creek NC Branch	2026	2027	2030	2032	2034
BC-NC-15	Brushy Creek NC Branch	2022	2023-2027	2030	2032	2034
BC-NE-01	Brushy Creek NC Branch	2028	2029	2031	2033	2035
BC-NE-03a	Brushy Creek NE Branch	2028	2029	2031	2033	2035
BC-NE-03b	Brushy Creek NE Branch	2028	2029	2031	2033	2035
BC-NW-01	Brushy Creek NW Branch	2027	2028	2030	2032	2034
BC-NW-02	Brushy Creek NW Branch	2025	2026-2028	2030	2032	2034
BC-NW-03a	Brushy Creek NW Branch	2022	2023-2027	2030	2032	2034
BC-NW-06	Brushy Creek NW Branch	2023	2024	2030	2032	2034
BC-NW-07b	Brushy Creek NW Branch	2023	2024	2030	2032	2034
BC-SW-01	Brushy Creek SW Branch	2023	2024-2025	2023	2025	2027
BC-SW-02	Brushy Creek SW Branch	2023	2024	2023	2025	2027
BC-SW-03	Brushy Creek SW Branch	2023	2024	2023	2025	2027
BC-SW-04	Brushy Creek SW Branch	2022	2023-2024	2023	2025	2027
BC-SW-05	Brushy Creek SW Branch	2023	2024	2023	2025	2027
BC-SW-06	Brushy Creek SW Branch	2020	2021	2023	2025	2027
BC-SW-07	Brushy Creek SW Branch	2020	2021	2023	2025	2027
BC-SW-08	Brushy Creek SW Branch	2021	2022	2023	2025	2027
LC-EB-01	Lettis Creek East Branch	2030	2031	2032	2034	2036
LC-EB-02	Lettis Creek East Branch	2030	2031	2032	2034	2036
LC-EB-03	Lettis Creek East Branch	2030	2031	2032	2034	2036
LC-EB-04a	Lettis Creek East Branch	2031	2032	2032	2034	2036
LC-EB-04b	Lettis Creek East Branch	2031	2032	2032	2034	2036
LC-EB-05	Lettis Creek East Branch	2031	2032	2032	2034	2036
LC-EB-10	Lettis Creek East Branch	2029	2030	2031	2033	2035
LC-EB-12	Lettis Creek East Branch	2031	2032	2033	2035	2037
LC-EB-13	Lettis Creek East Branch	2031	2032	2033	2035	2037
LC-EB-14	Lettis Creek East Branch	2031	2032	2033	2035	2037
LC-EB-15	Lettis Creek East Branch	2031	2032	2033	2035	2037
LC-MT-02	Lettis Main Trunk	2029	2030	2031	2033	2035
LC-MT-03	Lettis Main Trunk	2029	2030	2031	2033	2035
LC-NB-01	Lettis Creek North Branch	2029	2030	2033	2035	2037

SRO-7
Time Schedule of Stream Impacts (continued)

Segment Name	Valley Complex	Severance	Disturbance	Backfill	Reclaim*	Reconnection
LC-NB-04	Lettis Creek North Branch	2030	2031	2033	2035	2037
LC-NB-05	Lettis Creek North Branch	2031	2032	2033	2035	2037
LC-NB-06	Lettis Creek North Branch	2028	2029-2030	2033	2035	2037
LC-NB-07	Lettis Creek North Branch	2029	2030	2033	2035	2037
LC-NB-08	Lettis Creek North Branch	2032	2033	2033	2035	2037
LC-NB-10	Lettis Creek North Branch	2028	2029-2033	2033	2035	2037
TC-EB-01	Troublesome Creek East Branch	2026	2027	2028	2030	2032
TC-EB-02	Troublesome Creek East Branch	2026	2027	2028	2030	2032
TC-EB-03	Troublesome Creek East Branch	2026	2027	2028	2030	2032
TC-EB-04	Troublesome Creek East Branch	2026	2027	2028	2030	2032
TC-EB-05	Troublesome Creek East Branch	2026	2027	2028	2030	2032
TC-WB-01	Troublesome Creek West Branch	2028	2029	2029	2031	2033

*Years reflect the completion of initial planting work.
Note that some backfill dates precede the mining date. This is because existing streams being mined at future CSA locations will be relocated to an adjacent reclamation parcel that may be on an earlier backfill schedule.

Exhibits

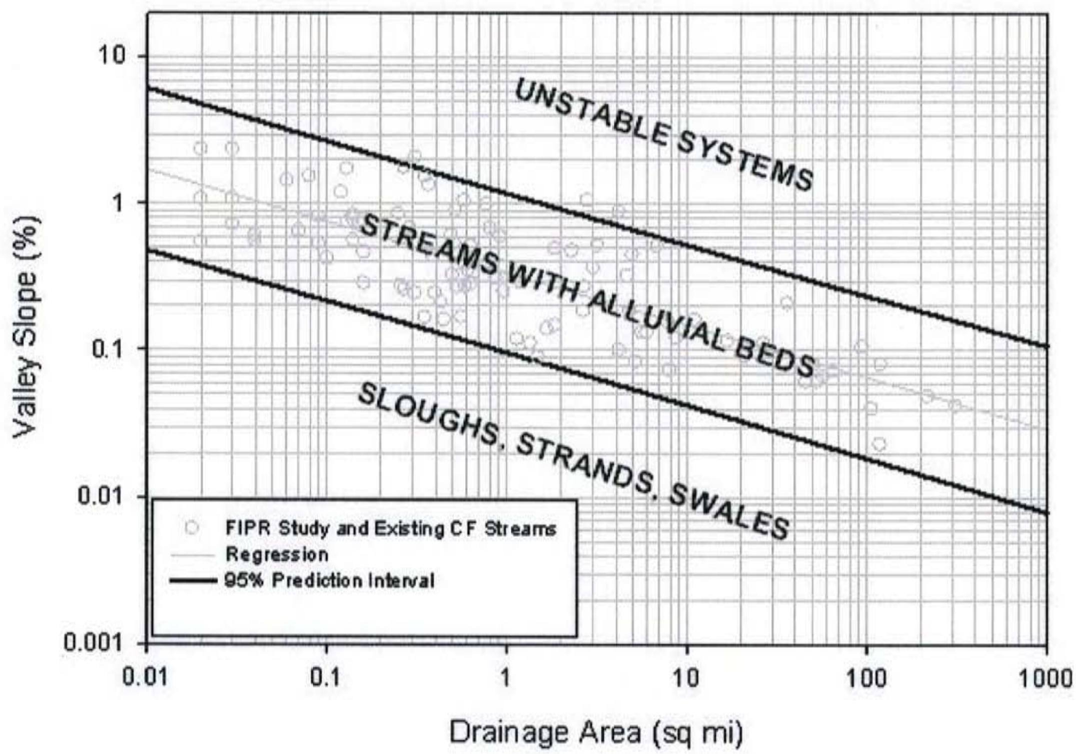


Exhibit SRO-1
Valley Slope versus Drainage Area Regional Curve

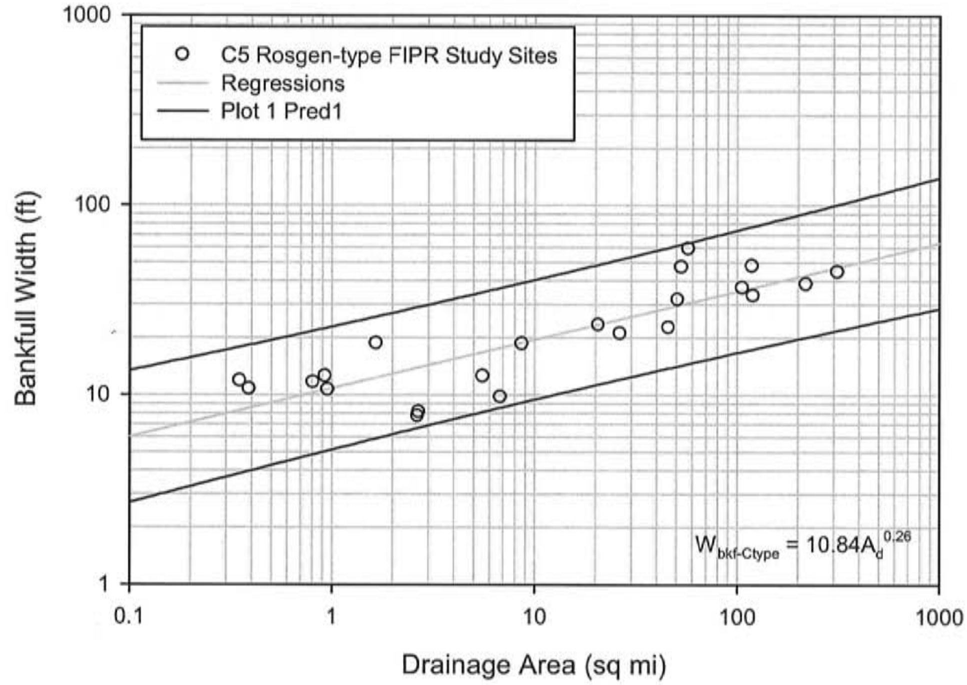


Exhibit SRO-2A
Bankfull Width Regional Curve (C5 Rosgen-type)

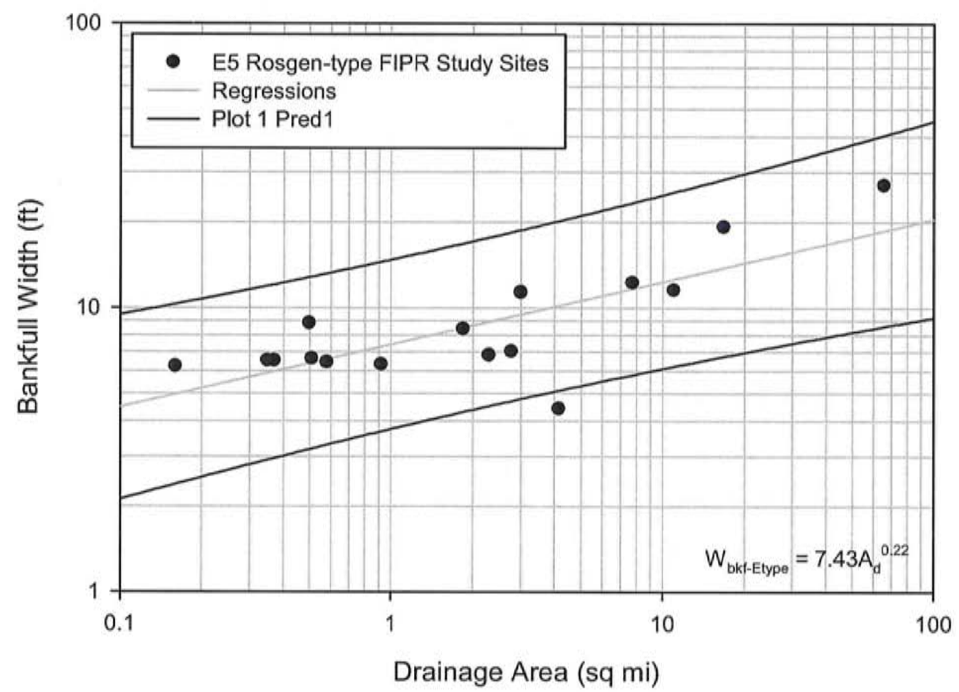


Exhibit SRO-2B
Bankfull Width Regional Curve (E5 Rosgen-type)

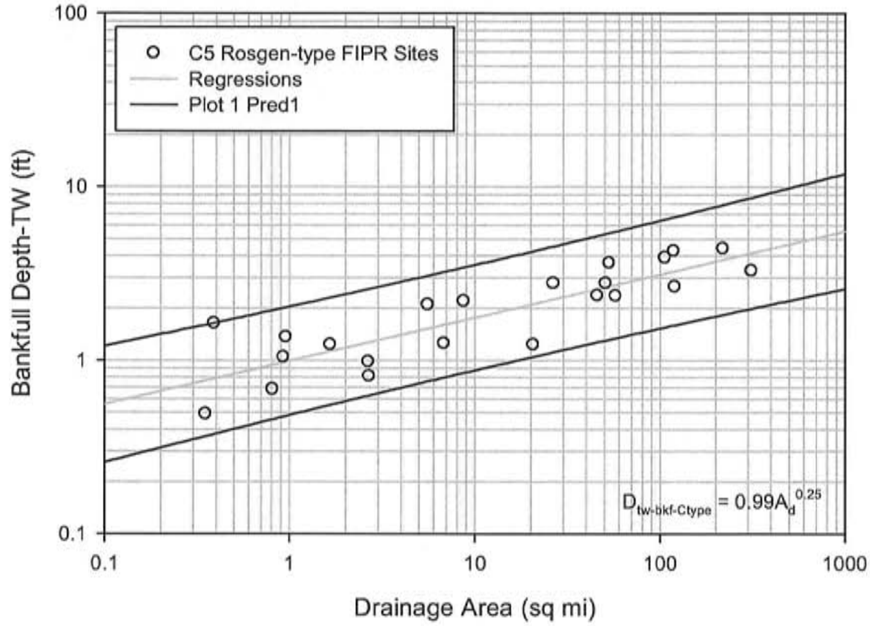


Exhibit SRO-3A
Bankfull Thalweg Depth Regional Curve (C5 Rosgen-type)

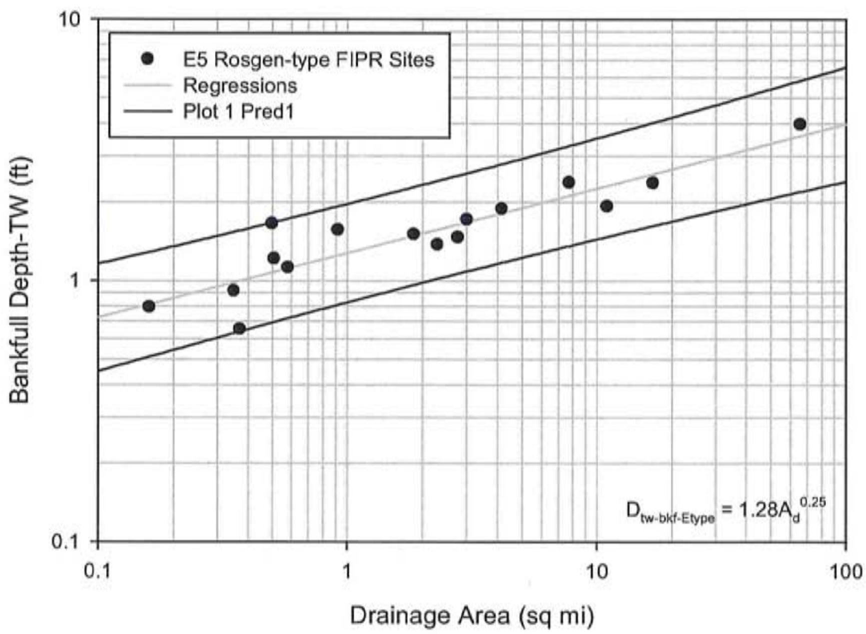


Exhibit SRO-3B
Bankfull Thalweg Depth Regional Curve (E5 Rosgen-type)

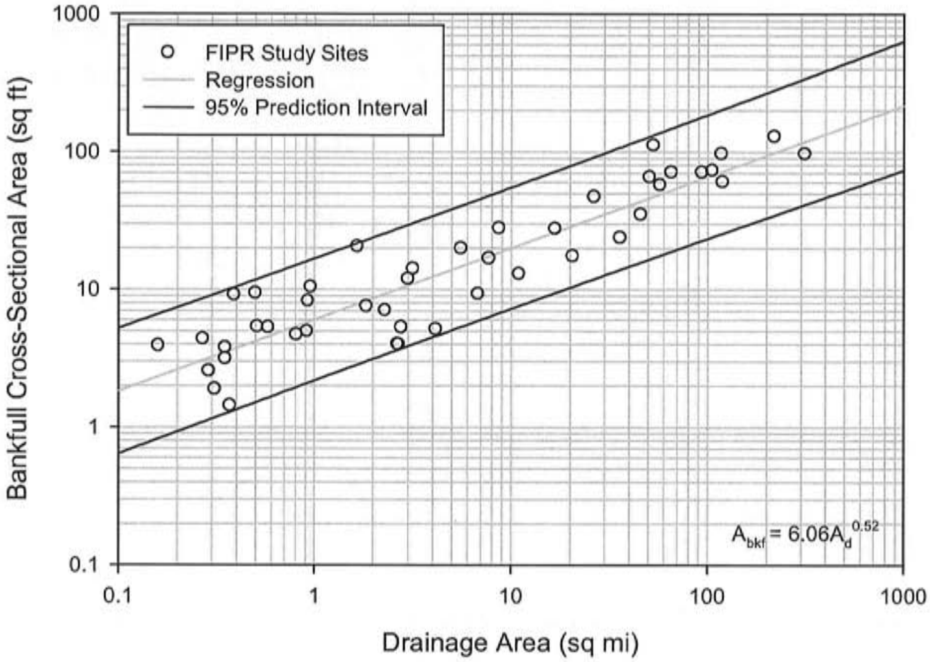


Exhibit SRO-4
Bankfull Cross-Sectional Area Regional Curve

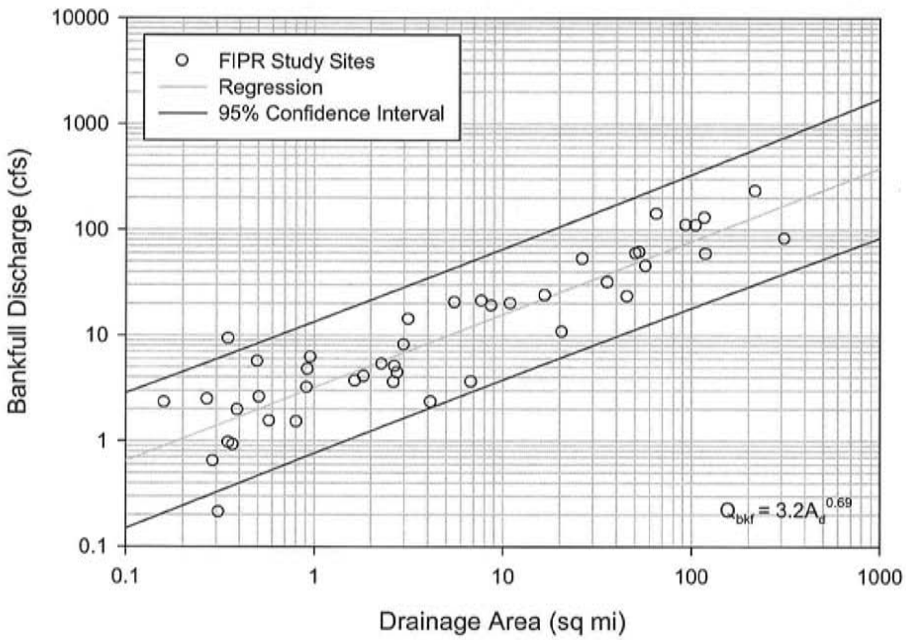


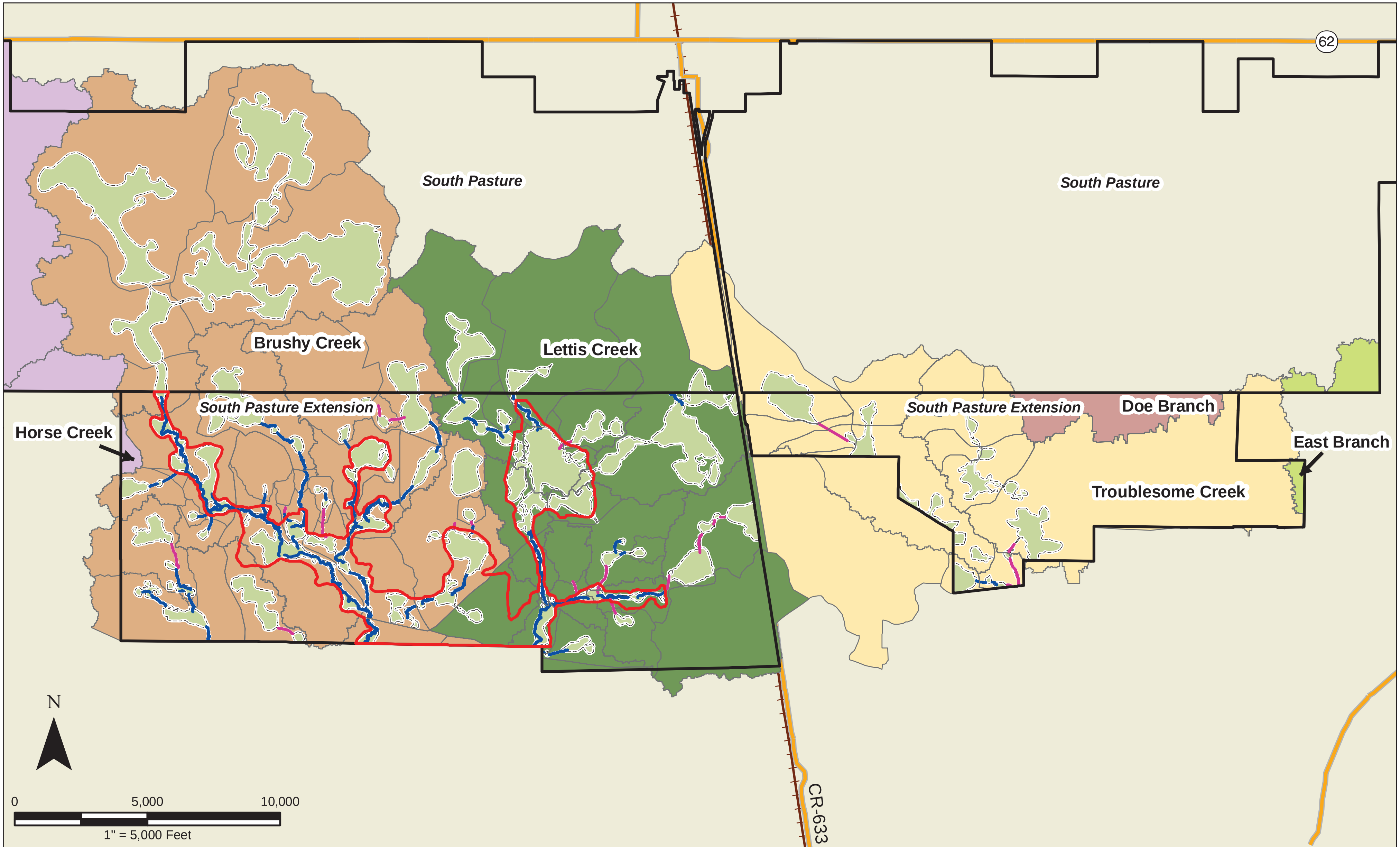
Exhibit SRO-5
Bankfull Discharge Regional Curve

SiteName	Drainage Area (sq mile)	Bankfull Discharge (cfs)	Bankfull Velocity (ft/s)	Bankfull Sheer Stress (psf)	Unit Stream Power (lb/s)
Lower Myakka River UT 3	0.35	0.96	0.365	0.015	0.01
Grassy Creek UT	0.81	1.5	0.34	0.08	0.02
East Fork Manatee UT 2	0.39	1.95	0.12	0.03	0.02
Bell Creek UT	0.16	2.3	0.57	0.21	0.19
Coons Bay Branch	0.51	2.57	0.53	0.17	0.10
East Fork Manatee UT 1	0.92	3.18	0.62	0.11	0.06
Lower Myakka River UT 2	2.66	3.57	0.73	0.04	0.04
Wekiva Forest UT	0.5	5.61	0.53	0.08	0.05
Hillsborough River UT	0.96	6.14	0.7	0.2	0.14
Average	**0.81**	**3.09**	**0.50**	**0.10**	**0.07**
Minimum	**0.16**	**0.96**	**0.12**	**0.02**	**0.01**
Maximum	**2.66**	**6.14**	**0.73**	**0.21**	**0.19**

Exhibit SRO-6

Typical Ranges of Peninsular Florida Headwater Streams Tractive Forces

Figures



amec

CF

Project No.: 03-16268

Notes:

FIGURE SRO-1
PRE-MINING SUB-BASINS & STREAMS
SOUTH PASTURE EXTENSION
HARDEE COUNTY, FLORIDA

Explanation of Features

- No-Mine Boundary
- CF Property
- Lotic Systems

Streams

- 511 - Natural Stream
- 512 - Ditched Stream

Pre-Mining Basins

- Brushy Creek
- Doe Branch
- East Branch
- Horse Creek
- Lettis Creek
- Troublesome Creek

JOHN KIEFER P.E.
FLA. REG. NO. 51991

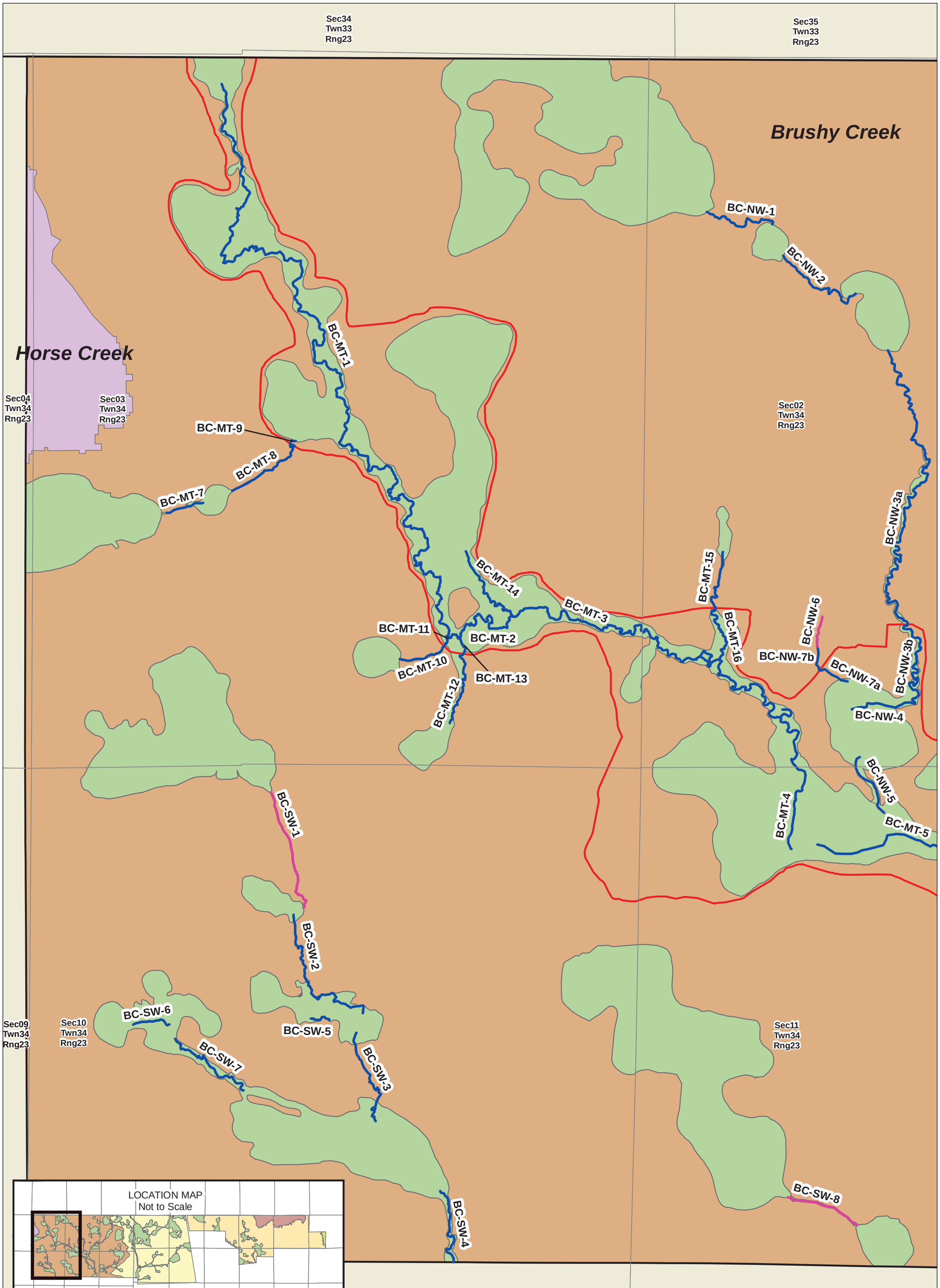
DATE:

Date: August 2011

Checked By: JHK

Map Prepared By: ARK

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\1_ws_bound_20110830.mxd



amec
CF

Project No.: 03-16268

Notes:
1- This map is intended to be used for planning purposes only. It is not a survey.

FIGURE SRO-2A
PRE-MINING STREAM SEGMENTS
SOUTH PASTURE EXTENSION
HARDEE COUNTY, FLORIDA

Explanation of Features

CF Property
No-Mine Boundary
Lotic Systems

Streams
511 - Natural Stream
512 - Ditched Stream

Pre-Mining Basins
Brushy Creek
Doe Branch
East Branch
Horse Creek
Lettis Creek
Troublesome Creek

0 700
1" =700 Feet

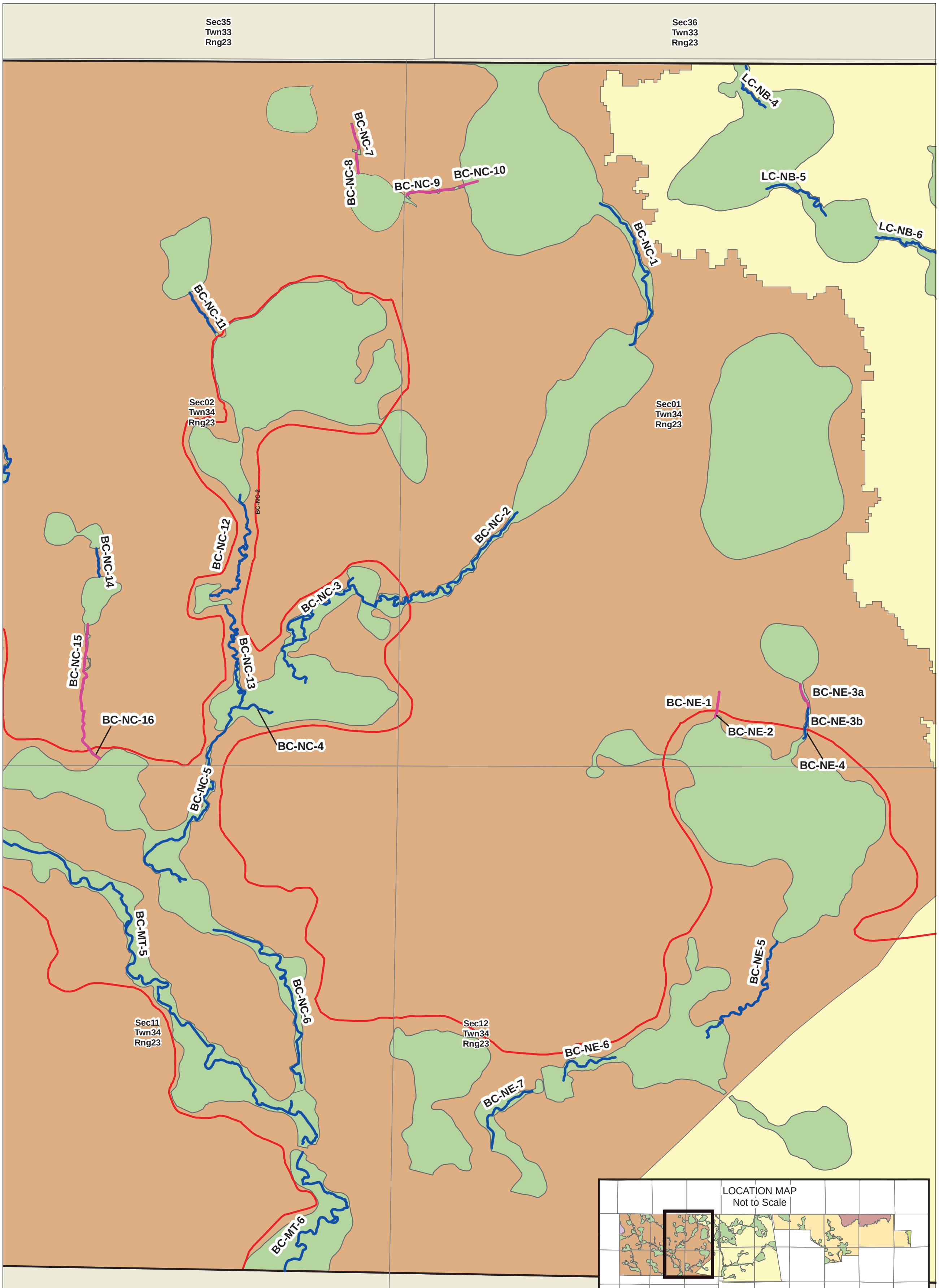
N

JOHN KIEFER P.E.
FLA. REG. NO. 51991

DATE:

Date: Revised Aug. 2011
Checked By: JHK
Map Prepared By: ARK

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\2A_Stream_Segs_updatev2_20110830.mxd



Notes:
1- This map is intended to be used for planning purposes only. It is not a survey.

Project No.: 03-16268

FIGURE SRO-2B
PRE-MINING STREAM SEGMENTS
SOUTH PASTURE EXTENSION
HARDEE COUNTY, FLORIDA

Explanation of Features

- CF Property
- No-Mine Boundary
- Lotic Systems

Streams

- 511 - Natural Stream
- 512 - Ditched Stream

Pre-Mining Basins

- Brushy Creek
- Doe Branch
- East Branch
- Horse Creek
- Lettis Creek
- Troublesome Creek

N

0 700

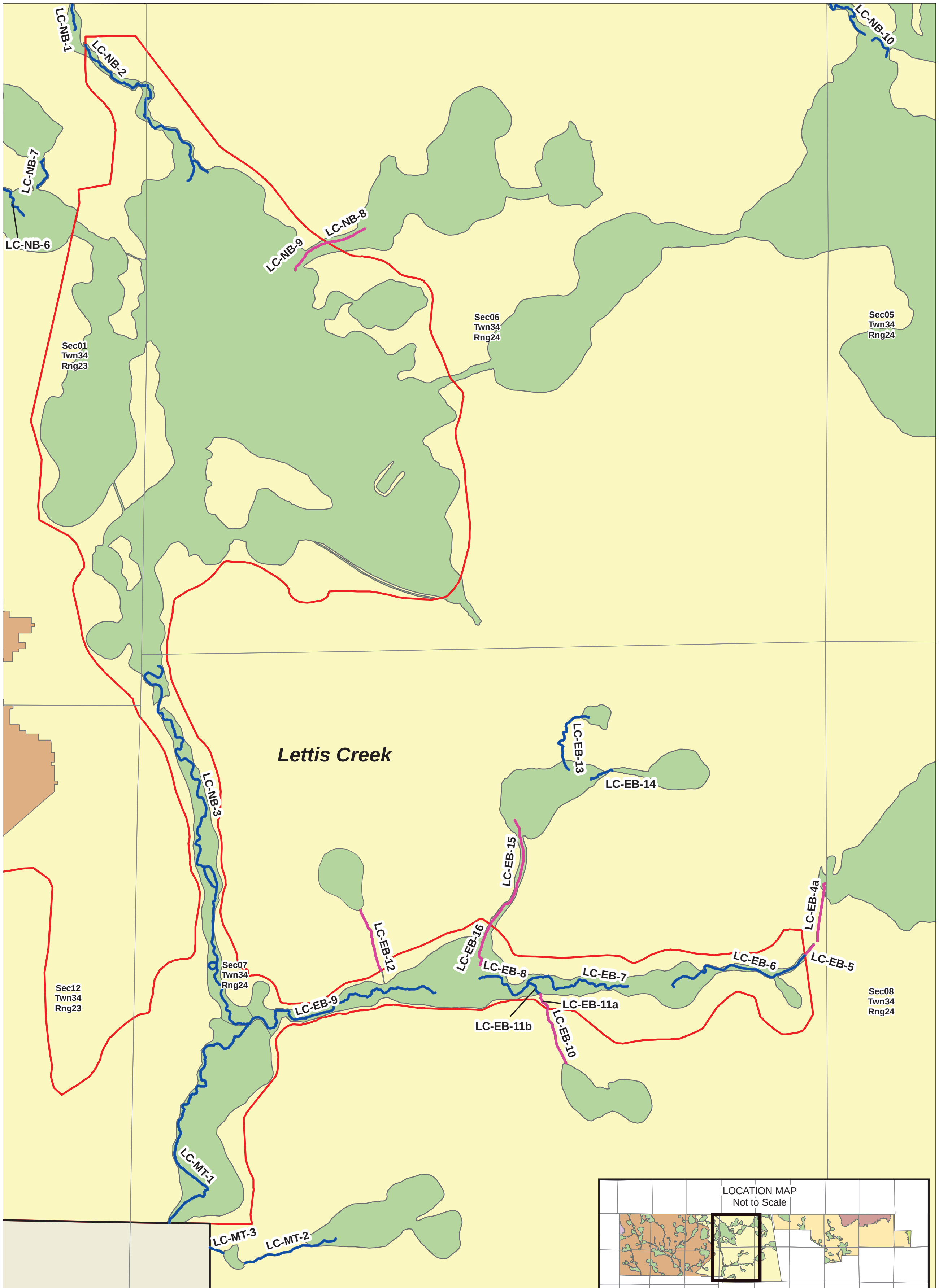
1" =700 Feet

JOHN KIEFER P.E.
FLA. REG. NO. 51991

DATE:

Date: Revised Aug. 2011
Checked By: JHK
Map Prepared By: ARK

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\2B_Stream_Segs_updatev2_20110830.mxd



Project No.: 03-16268

Notes:
1- This map is intended to be used for planning purposes only. It is not a survey.

FIGURE SRO-2C
PRE-MINING STREAM SEGMENTS
SOUTH PASTURE EXTENSION
HARDEE COUNTY, FLORIDA

Explanation of Features

CF Property
No-Mine Boundary
Lotic Systems

Streams
511 - Natural Stream
512 - Ditched Stream

Pre-Mining Basins
Brushy Creek
Doe Branch
East Branch
Horse Creek
Lettis Creek
Troublesome Creek

N

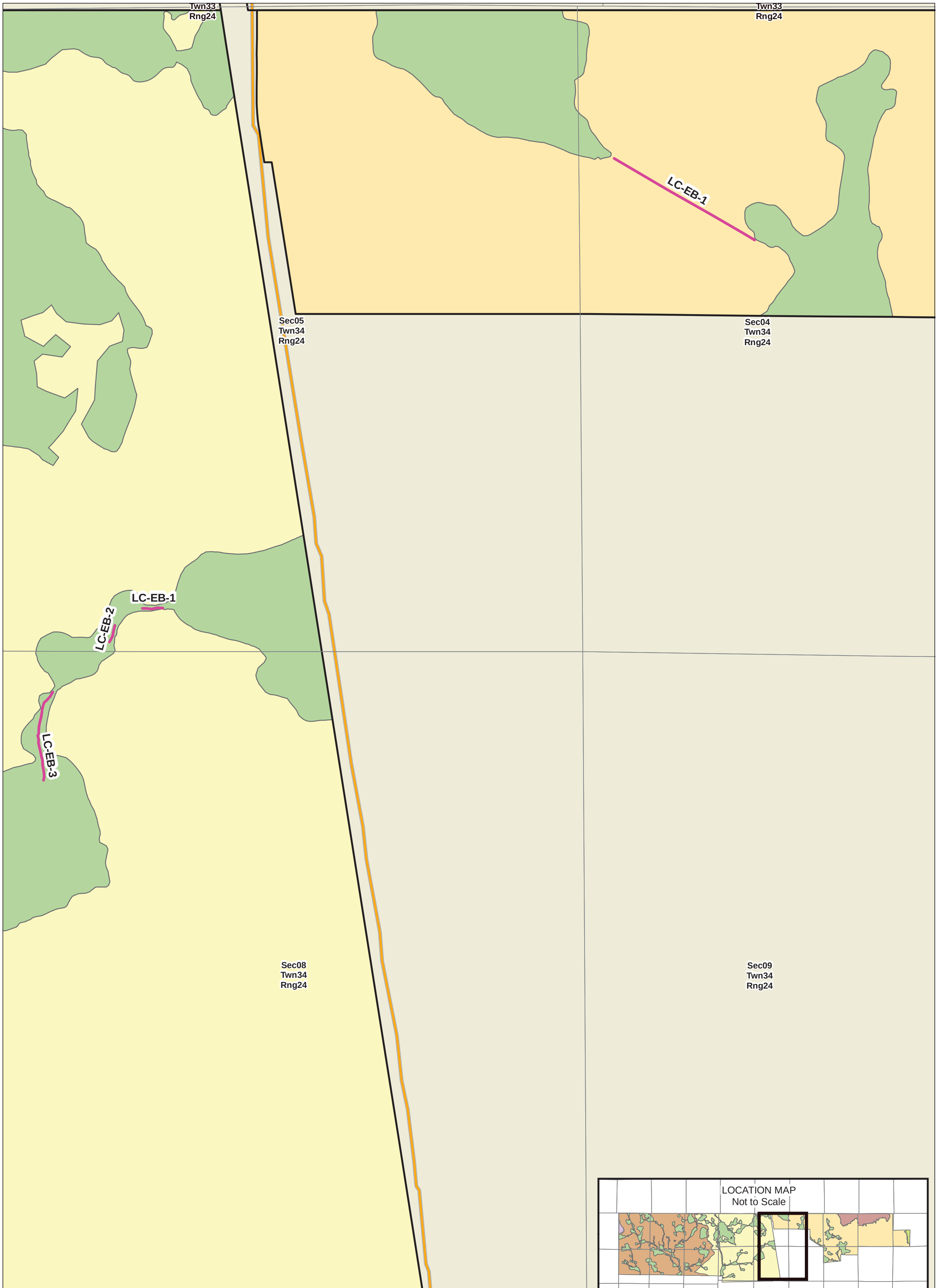
0 700
1" =700 Feet

JOHN KIEFER P.E.
FLA. REG. NO. 51991

DATE:

Date: Revised Aug. 2011
Checked By: JHK
Map Prepared By: ARK

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\2C_Stream_Segs_updatev2_20110830.mxd



amec

CF

Project No.: 03-16268

Notes:
1- This map is intended to be used for planning purposes only. It is not a survey.

FIGURE SRO-2D
PRE-MINING STREAM SEGMENTS
SOUTH PASTURE EXTENSION
HARDEE COUNTY, FLORIDA

Explanation of Features

CF Property
No-Mine Boundary
Lotic Systems

Streams
511 - Natural Stream
512 - Ditched Stream

Pre-Mining Basins
Brushy Creek
Doe Branch
East Branch
Horse Creek
Lettis Creek
Troublesome Creek

N

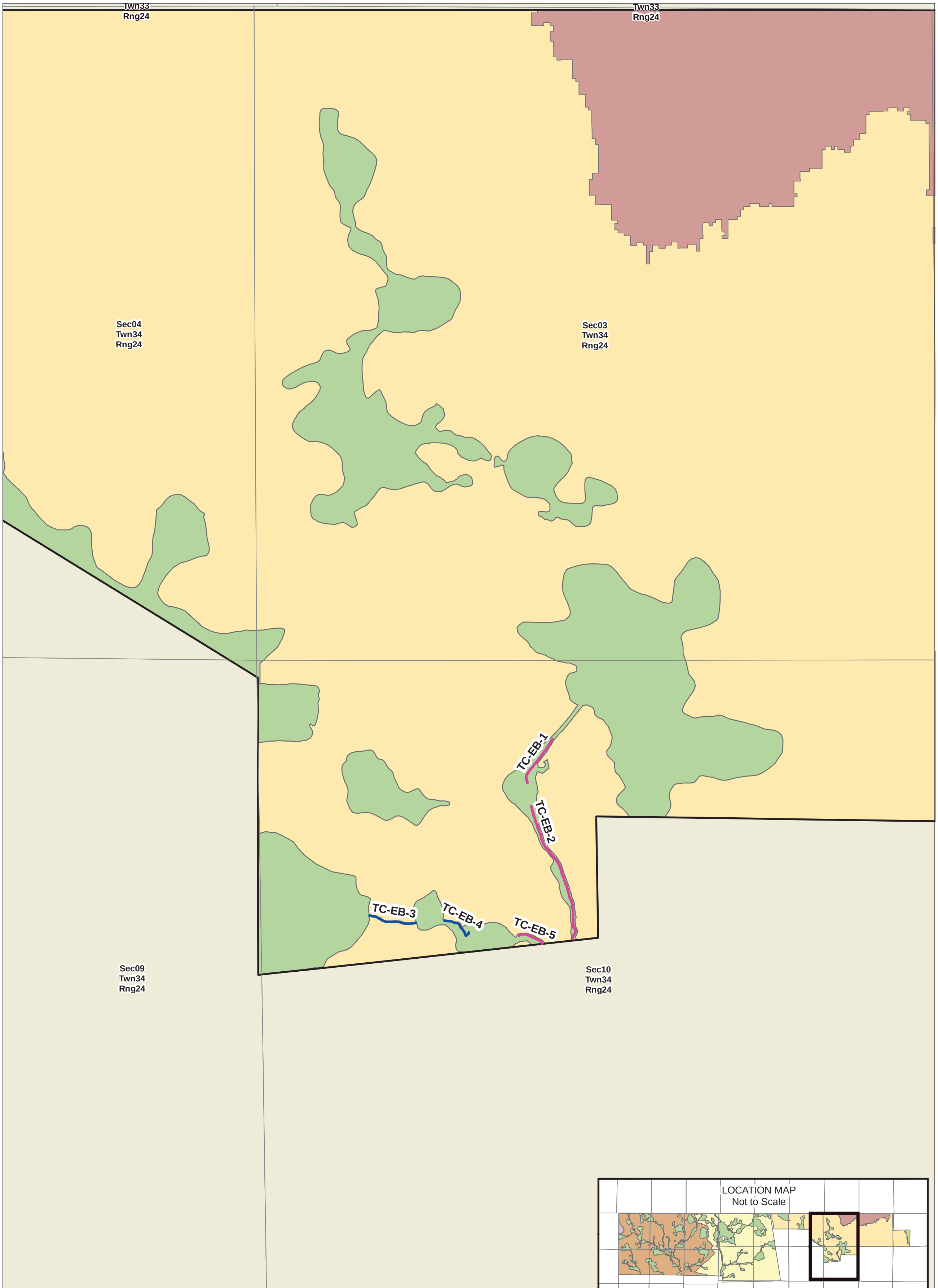
0 700
1" =700 Feet

JOHN KIEFER P.E.
FLA. REG. NO. 51991

DATE:

Date: Revised Aug. 2011
Checked By: JHK
Map Prepared By: ARK

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\2D_Stream_Segs_updatev2_20110830.mxd



Notes:
1- This map is intended to be used for planning purposes only. It is not a survey.

FIGURE SRO-2E
PRE-MINING STREAM SEGMENTS
SOUTH PASTURE EXTENSION
HARDEE COUNTY, FLORIDA

Explanation of Features

- CF Property
- No-Mine Boundary
- Lotic Systems

Streams

- 511 - Natural Stream
- 512 - Ditched Stream

Pre-Mining Basins

- Brushy Creek
- Doe Branch
- East Branch
- Horse Creek
- Lettis Creek
- Troublesome Creek

0 700
1" =700 Feet

N

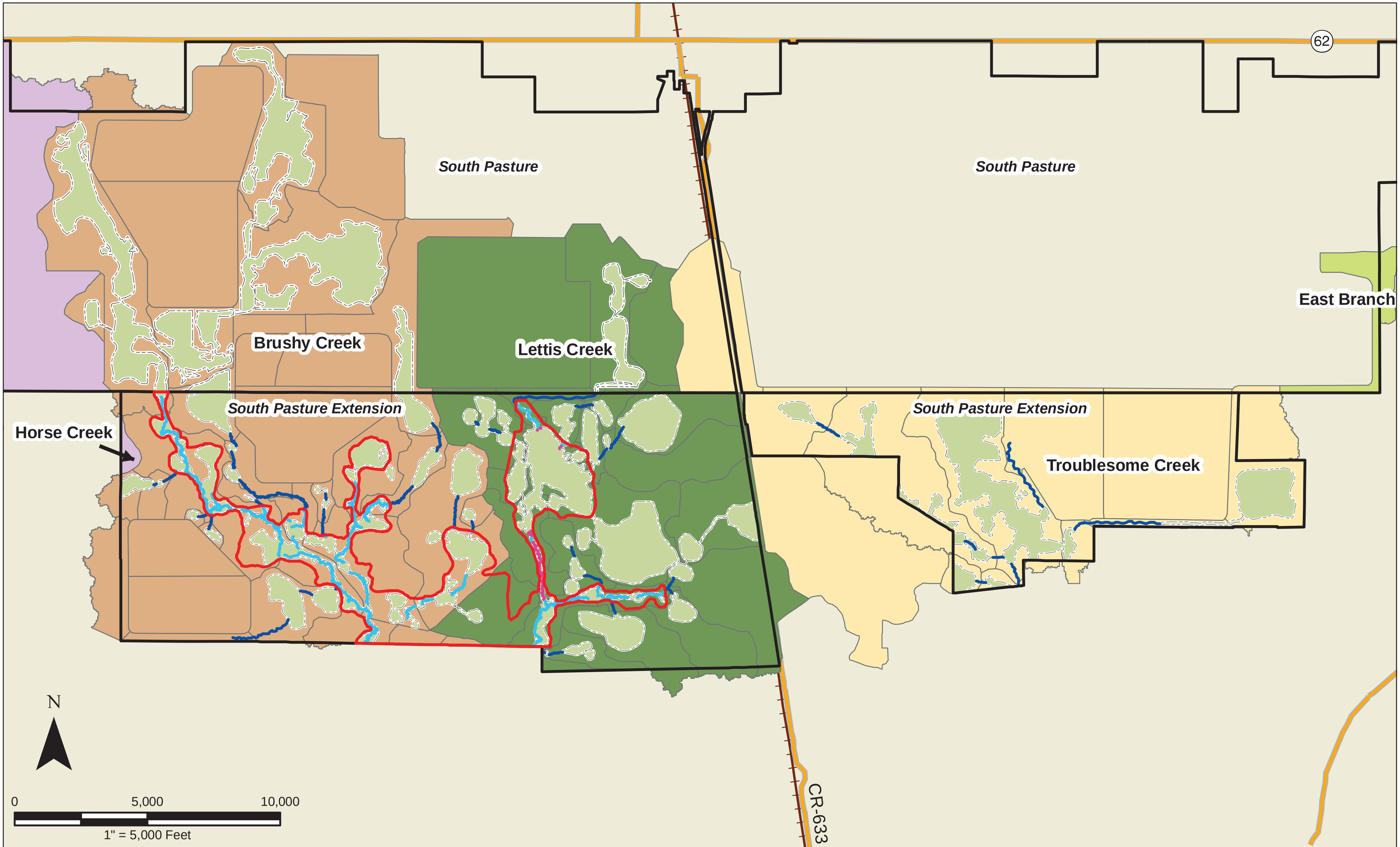
JOHN KIEFER P.E.
FLA. REG. NO. 51991

DATE:

Date: Revised Aug. 2011
Checked By: JHK
Map Prepared By: ARK

Project No.: 03-16268

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\2E_Stream_Segs_updatev2_20110830.mxd



amec

CF

Project No.: 03-16268

Notes:

FIGURE SRO-3
POST-RECLAMATION
SUB-BASINS & STREAMS
SOUTH PASTURE EXTENSION
HARDEE COUNTY, FLORIDA

JOHN KIEFER P.E.
FLA. REG. NO. 51991

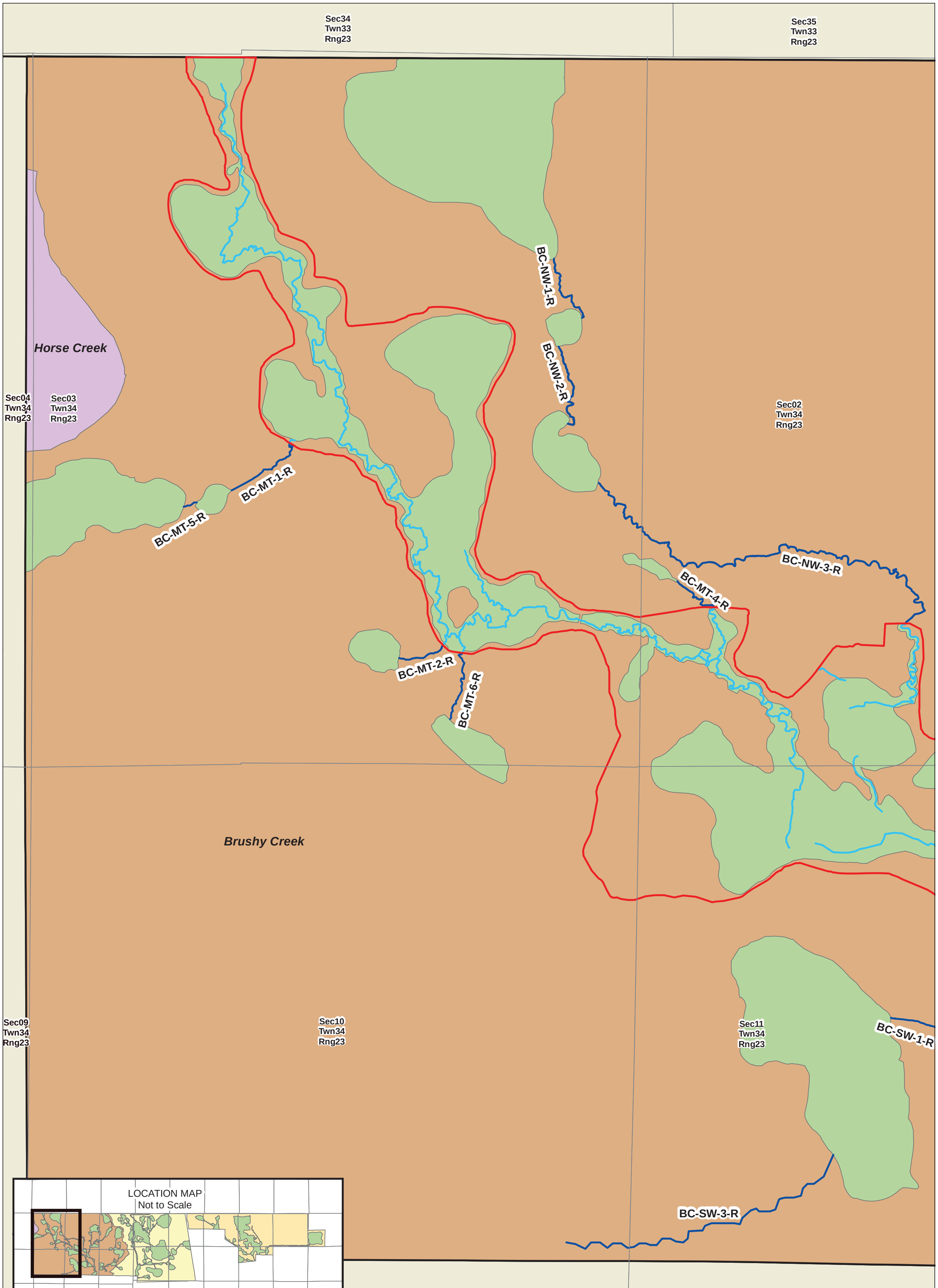
DATE:

Date: Revised Aug. 2011

Checked By: JHK

Map Prepared By: KMB

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\3_ws_bound_20110830.mxd



amec

CF

Project No.: 03-16268

Notes:
1- This map is intended to be used for planning purposes only. It is not a survey.

FIGURE SRO-4A POST-RECLAMATION STREAM SEGMENTS SOUTH PASTURE EXTENSION HARDEE COUNTY, FLORIDA

Explanation of Features

- CF Property
- No-Mine Boundary
- Lotic Systems

Post-Reclamation Streams

- Enhanced Streams
- Non-Mined Streams
- Reclaimed Streams

Post-Reclamation Basins

- Brushy Creek
- Doe Branch
- East Branch
- Horse Creek
- Lettis Creek
- Troublesome Creek

0 700

1" =700 Feet

N

JOHN KIEFER P.E.
FLA. REG. NO. 51991

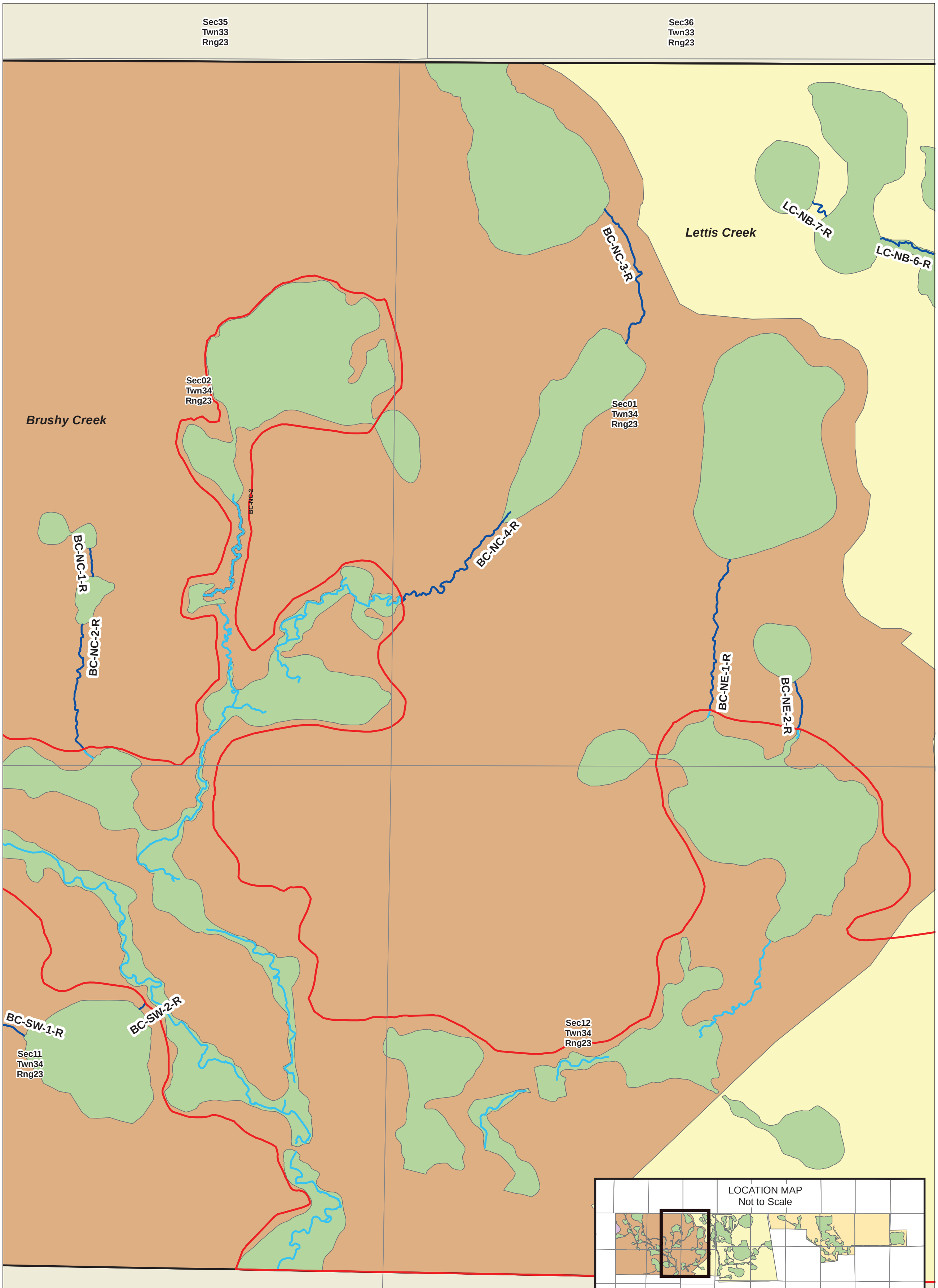
DATE:

Date: Revised Aug. 2011

Checked By: JHK

Map Prepared By: ARK

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\4A_Stream_Segs_update2_20110830.mxd



amec

CF

Project No.: 03-16268

Notes:
1- This map is intended to be used for planning purposes only. It is not a survey.

FIGURE SRO-4B
POST-RECLAMATION STREAM SEGMENTS
SOUTH PASTURE EXTENSION
HARDEE COUNTY, FLORIDA

Explanation of Features

- CF Property
- No-Mine Boundary
- Lotic Systems

Post-Reclamation Streams

- Enhanced Streams
- Non-Mined Streams
- Reclaimed Streams

Post-Reclamation Basins

- Brushy Creek
- Doe Branch
- East Branch
- Horse Creek
- Lettis Creek
- Troublesome Creek

0 700

1" =700 Feet

N

JOHN KIEFER P.E.
FLA. REG. NO. 51991

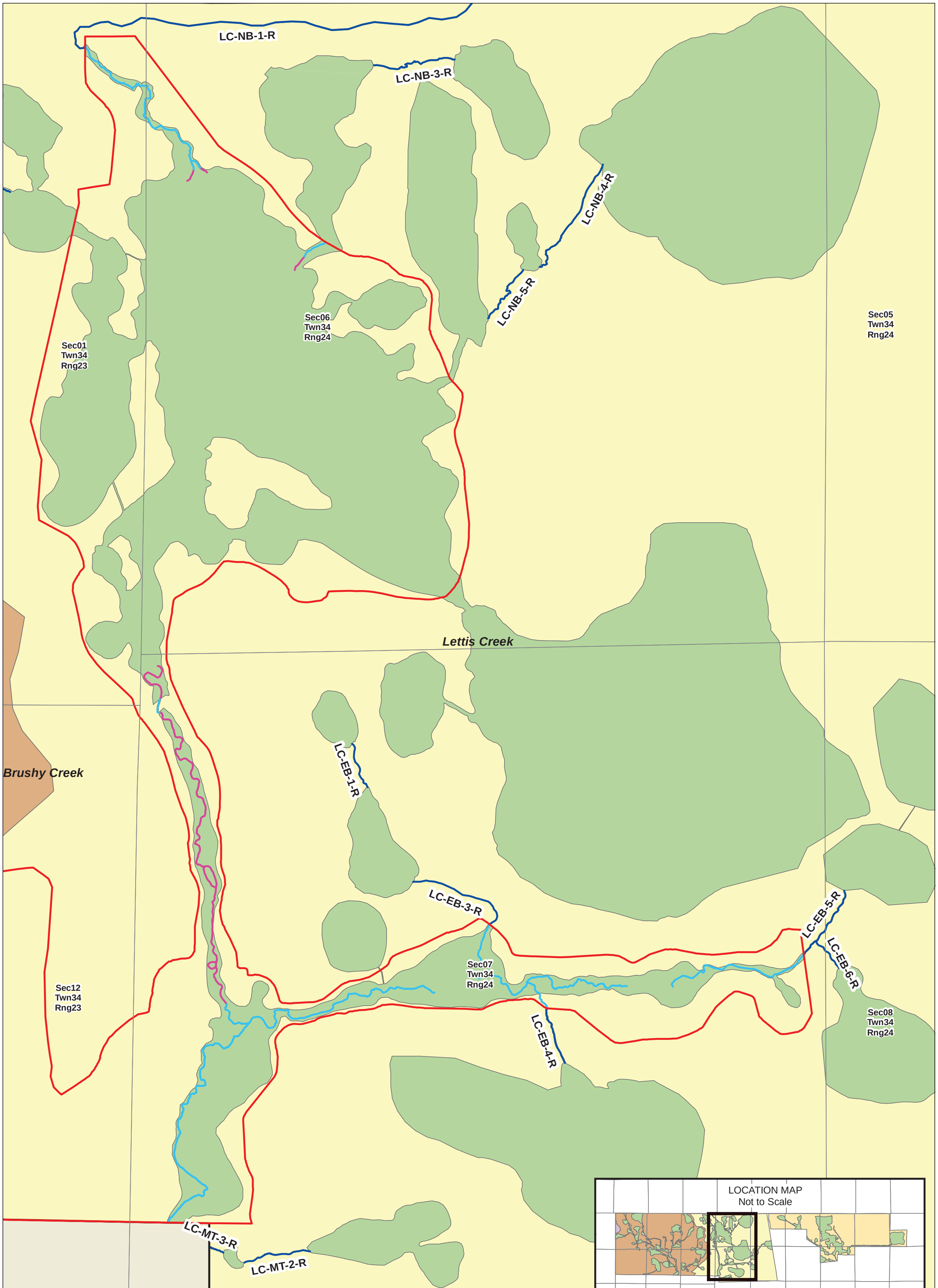
DATE:

Date: Revised Aug. 2011

Checked By: JHK

Map Prepared By: ARK

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_02\2011\2A_Stream_Segs.mxd



Notes:
1- This map is intended to be used for planning purposes only. It is not a survey.

FIGURE SRO-4C
POST-RECLAMATION STREAM SEGMENTS
SOUTH PASTURE EXTENSION
HARDEE COUNTY, FLORIDA

Explanation of Features

- CF Property
- No-Mine Boundary
- Lotic Systems

Post-Reclamation Streams

- Enhanced Streams
- Non-Mined Streams
- Reclaimed Streams

Post-Reclamation Basins

- Brushy Creek
- Doe Branch
- East Branch
- Horse Creek
- Lettis Creek
- Troublesome Creek

0 700
1" =700 Feet

N

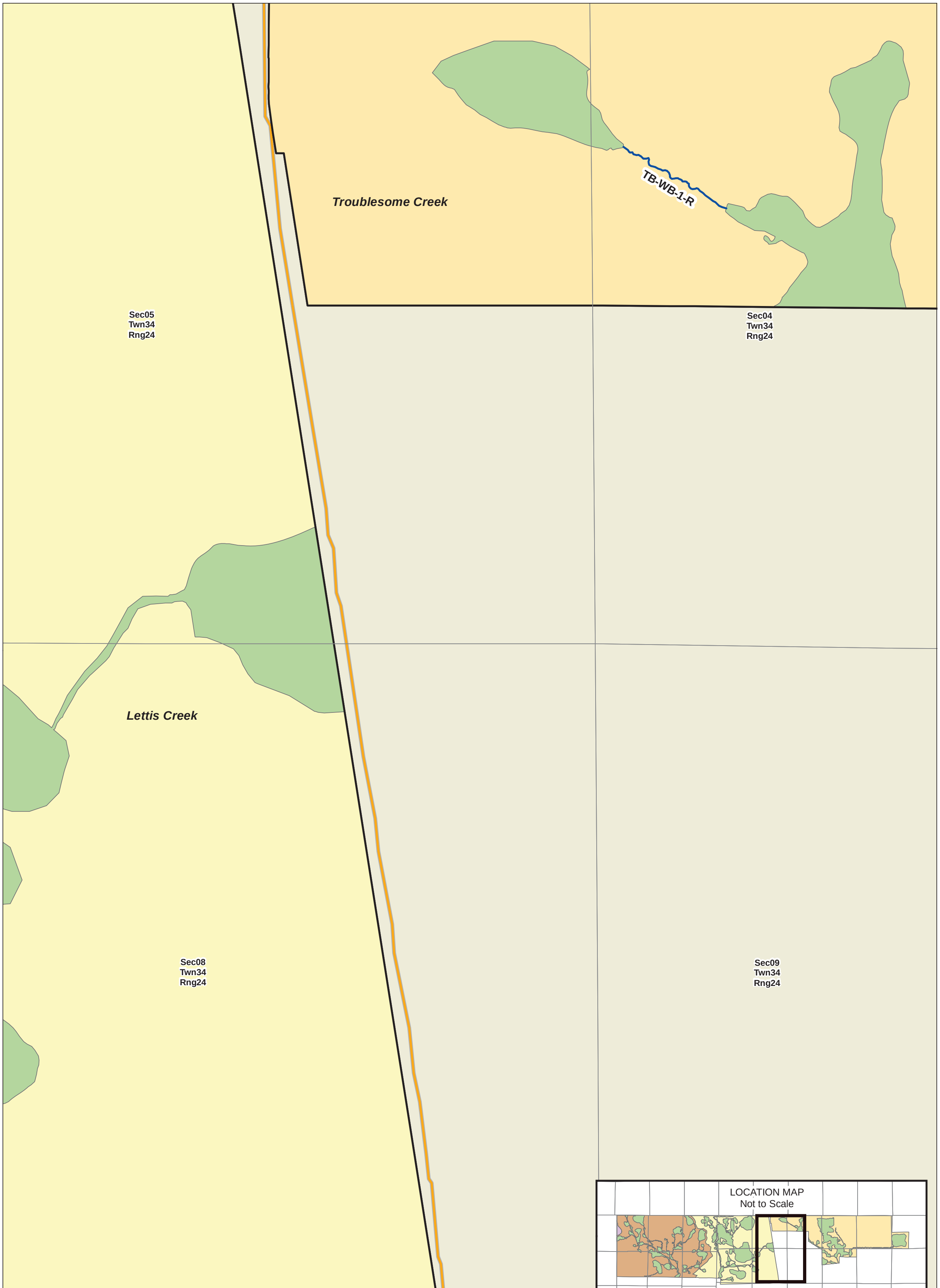
JOHN KIEFER P.E.
FLA. REG. NO. 51991

DATE:

Date: Revised Aug. 2011
Checked By: JHK
Map Prepared By: ARK

Project No.: 03-16268

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\4C_Stream_Segs_updatev2_20110830.mxd



Notes:
1- This map is intended to be used for planning purposes only. It is not a survey.

FIGURE SRO-4D
POST-RECLAMATION
STREAM SEGMENTS
SOUTH PASTURE EXTENSION
HARDEE COUNTY, FLORIDA

Explanation of Features

CF Property
No-Mine Boundary
Lotic Systems

Post-Reclamation Streams
Enhanced Streams
Non-Mined Streams
Reclaimed Streams

Post-Reclamation Basins
Brushy Creek
Doe Branch
East Branch
Horse Creek
Lettis Creek
Troublesome Creek

0 700
1" =700 Feet
N

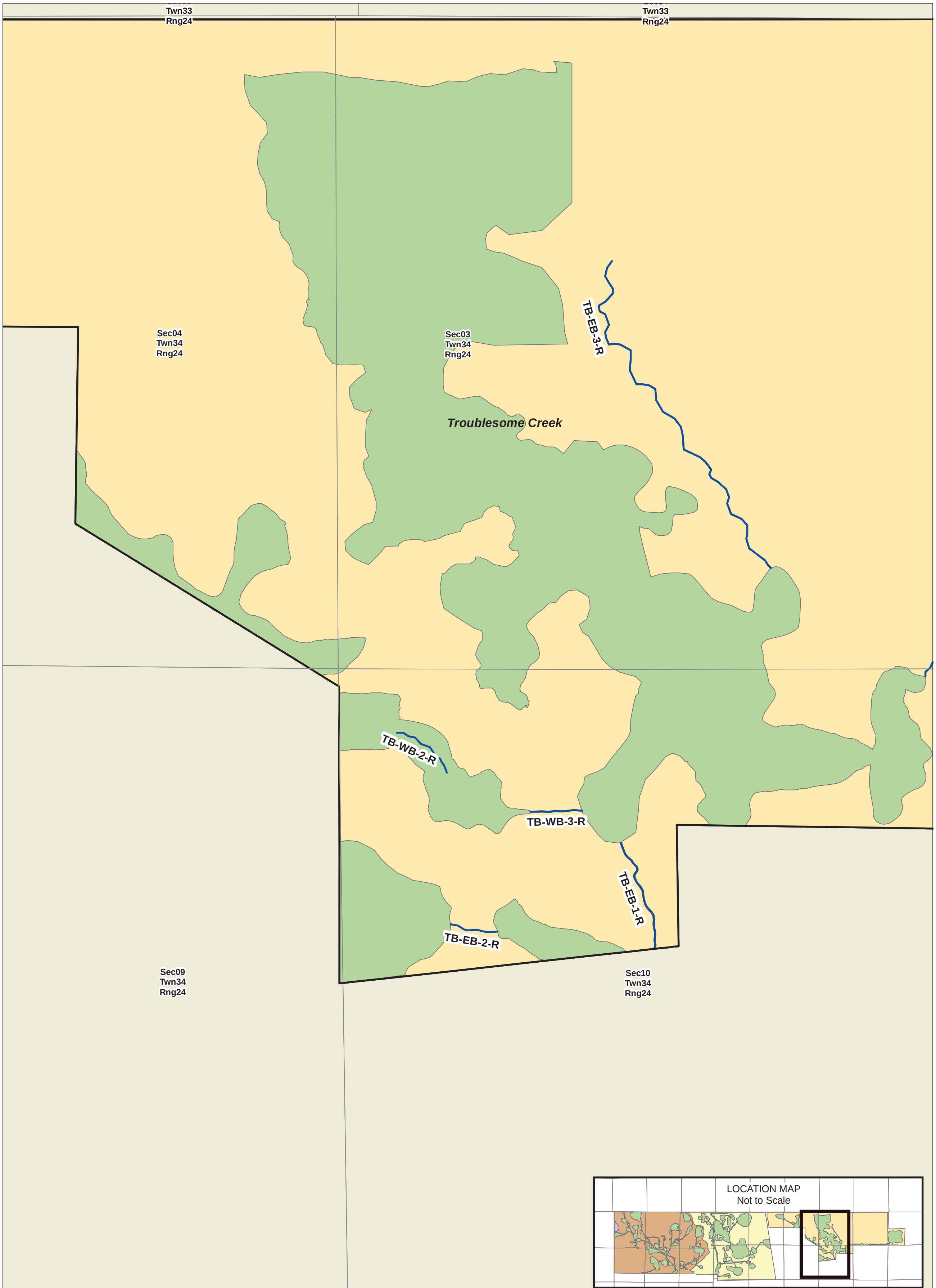
JOHN KIEFER P.E.
FLA. REG. NO. 51991

DATE:

Date: Revised Aug. 2011
Checked By: JHK
Map Prepared By: ARK

Project No.: 03-16268

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\4D_Stream_Segs_updatev2_20110830.mxd



Notes:
1- This map is intended to be used for planning purposes only. It is not a survey.

FIGURE SRO-4E
POST-RECLAMATION STREAM SEGMENTS
SOUTH PASTURE EXTENSION
HARDEE COUNTY, FLORIDA

Explanation of Features

- CF Property
- No-Mine Boundary
- Lotic Systems

Post-Reclamation Streams

- Enhanced Streams
- Non-Mined Streams
- Reclaimed Streams

Post-Reclamation Basins

- Brushy Creek
- Doe Branch
- East Branch
- Horse Creek
- Lettis Creek
- Troublesome Creek

0 700
1" =700 Feet

N

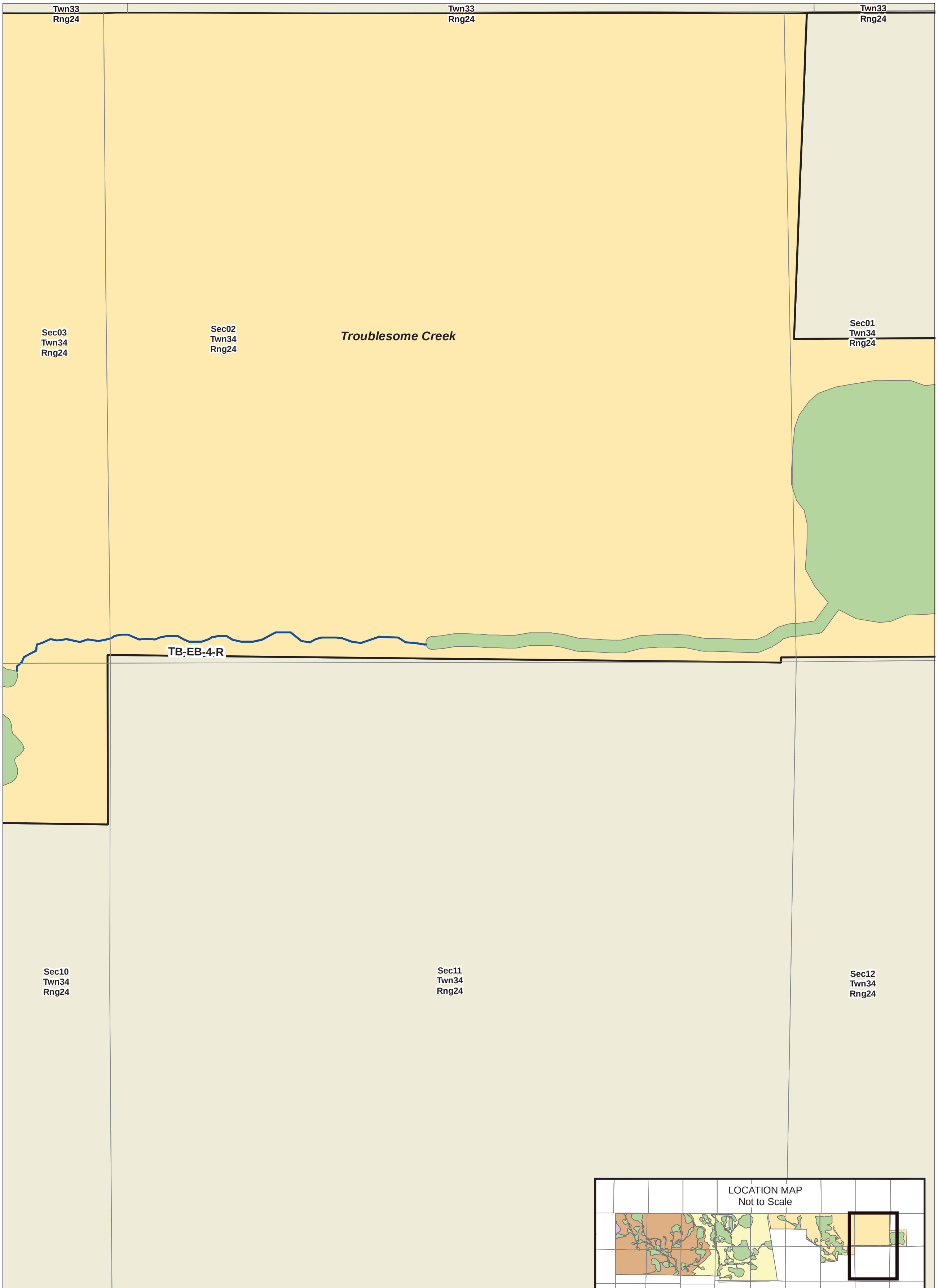
JOHN KIEFER P.E.
FLA. REG. NO. 51991

DATE:

Date: Revised Aug. 2011
Checked By: JHK
Map Prepared By: ARK

Project No.: 03-16268

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\4E_Stream_Segs_updatev2_20110830.mxd



Notes:
1- This map is intended to be used for planning purposes only. It is not a survey.

FIGURE SRO-4F
POST-RECLAMATION
STREAM SEGMENTS
SOUTH PASTURE EXTENSION
HARDEE COUNTY, FLORIDA

Explanation of Features

CF Property
No-Mine Boundary
Lotic Systems

Post-Reclamation Streams
Enhanced Streams
Non-Mined Streams
Reclaimed Streams

Post-Reclamation Basins
Brushy Creek
Doe Branch
East Branch
Horse Creek
Lettis Creek
Troublesome Creek

0 700
1" =700 Feet
N

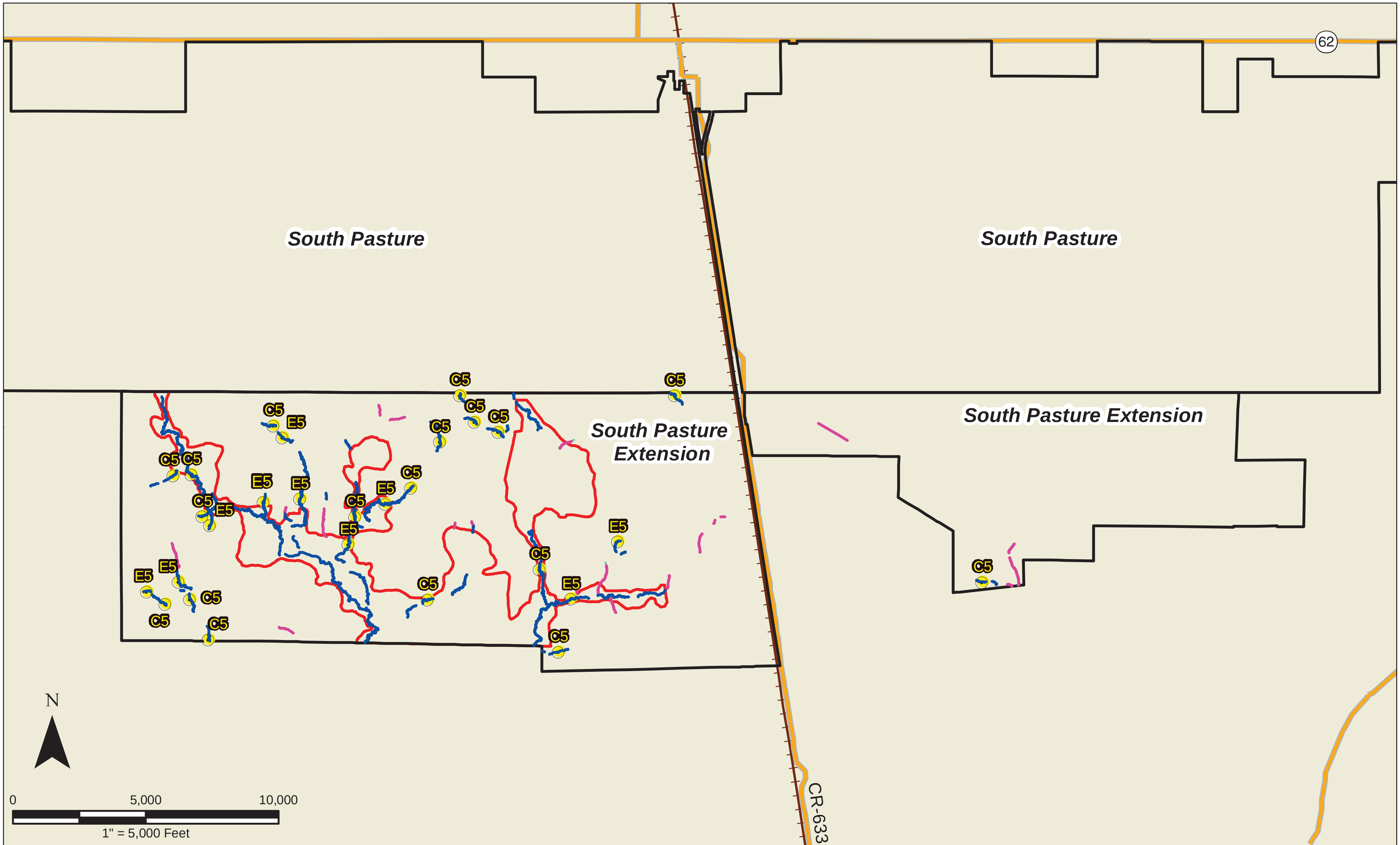
JOHN KIEFER P.E.
FLA. REG. NO. 51991

DATE:

Date: Revised Aug. 2011
Checked By: JHK
Map Prepared By: ARK

Project No.: 03-16268

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\4F_Stream_Segs_updatev2_20110830.mxd



Notes:

Project No.: 03-16268

FIGURE SRO-5
ROSGEN CLASSES
SOUTH PASTURE EXTENSION
HARDEE COUNTY, FLORIDA

Explanation of Features

Streams

- 511 - Natural Stream
- 512 - Ditched Stream
- Cross-Section Locations
- CF Property
- No-Mine Boundary

JOHN KIEFER P.E.
FLA. REG. NO. 51991

DATE:

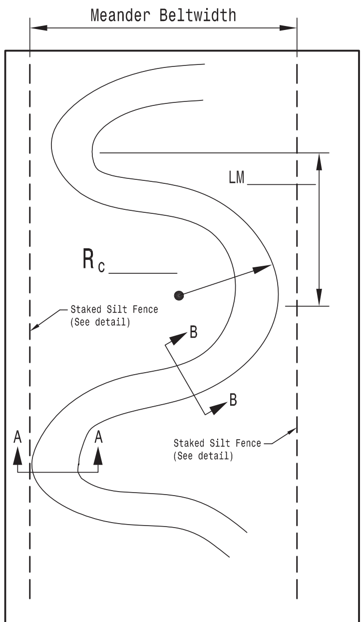
Date: Aug. 2011

Checked By: JHK

Map Prepared By: ARK

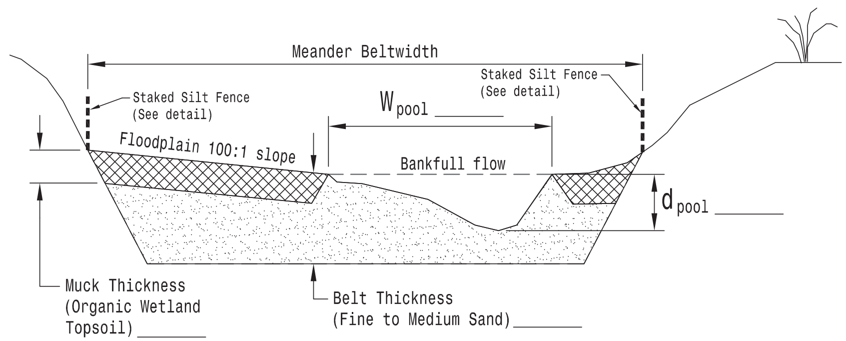
File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\5_Rosgen_20110830.mxd

Figure SRO-6 - Typical Channel Design



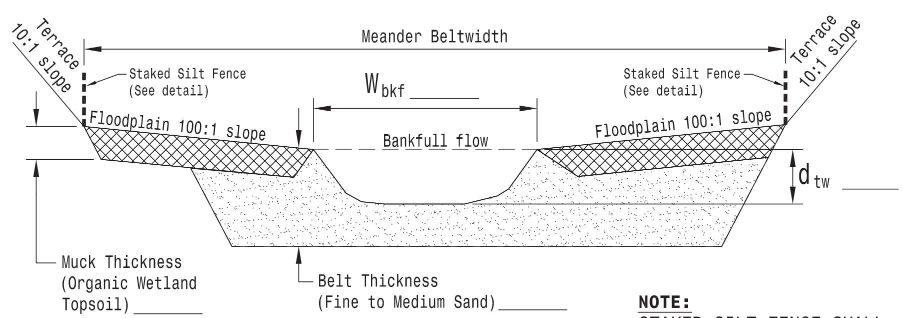
Plan View

Not to scale



Section A-A

Not to scale

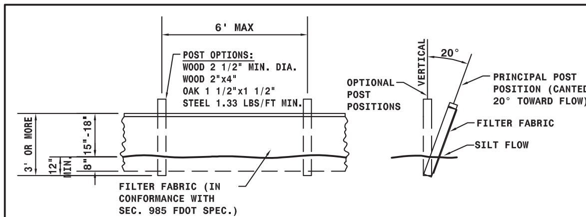


Section B-B

Not to scale

NOTE:
STAKED SILT FENCE SHALL BE ADDED ALONG THE TOE OF TERRACE SLOPE.

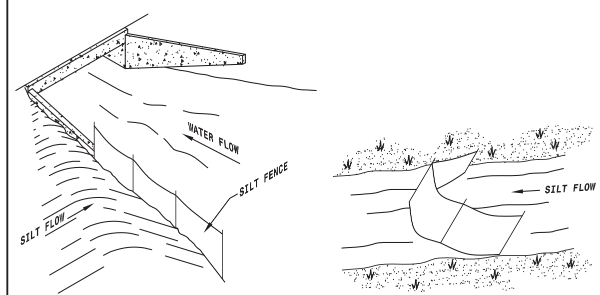
W_{pool} = Width of pool at bankfull flow
d_{pool} = Max. depth of pool at bankfull flow
W_{bkf} = Width of channel riffle at bankfull flow
d_{tw} = Max. depth of channel riffle at bankfull flow
R_c = Radius of curvature
LM = Length of meander



ELEVATION ***SECTION***

NOTE: SILT FENCE TO BE PAID FOR UNDER THE CONTRACT UNIT PRICE FOR STAKED FENCE (L.F.)

TYPE III SILT FENCE



TYPE III SILT FENCE ***TYPE III SILT FENCE***

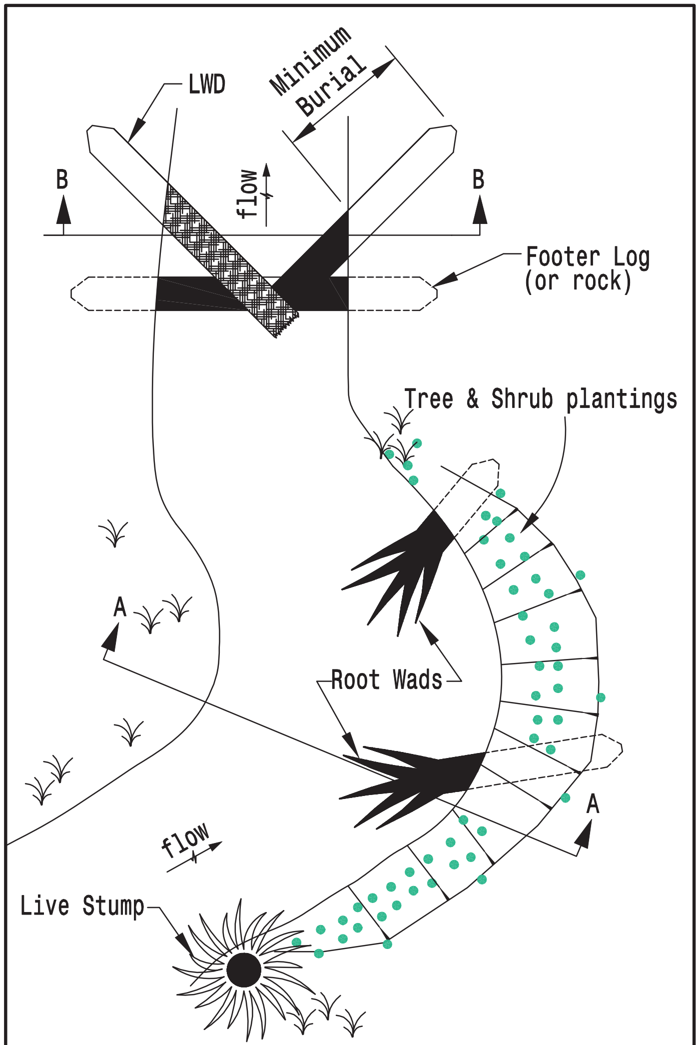
NOTE: DO NOT DEPLOY IN ANY MANNER THAT SILT FENCES WILL ACT AS A DAM ACROSS PERMANENT FLOWING WATERCOURSES. SILT FENCES ARE TO BE USED AT UPLAND LOCATIONS AND TURBIDITY BARRIERS USED AT PERMANENT BODIES OF WATER.

EROSION & SEDIMENT CONTROL

N.T.S.

BCI engineers & scientists
2000 E. Edgewood Dr., Ste #215
Lakeland, FL 33803
863.667.2345 - www.bcieng.com
EB-0007867

Figure SRO-7 - Typical Reach Detail

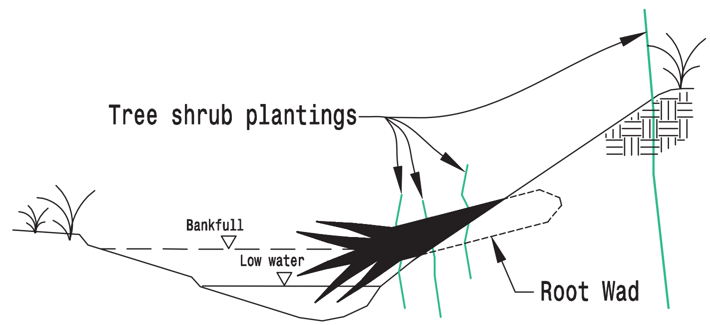


Plan View

Not to scale

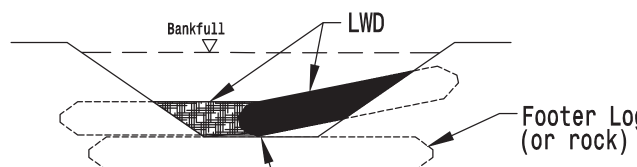
Notes:

1. The entire streambank length shall be protected with temporary erosion control blankets.
2. Live root wads to be installed vertically (roots down, stump pointing straight up).
3. Snag (dead) root wads to be installed horizontally or vertically with majority of root structure between the bed and bankfull elevation.
4. Large logs (LWD) typically arranged as braced V-weirs, with three foot min. penetration into banks.



Section A-A

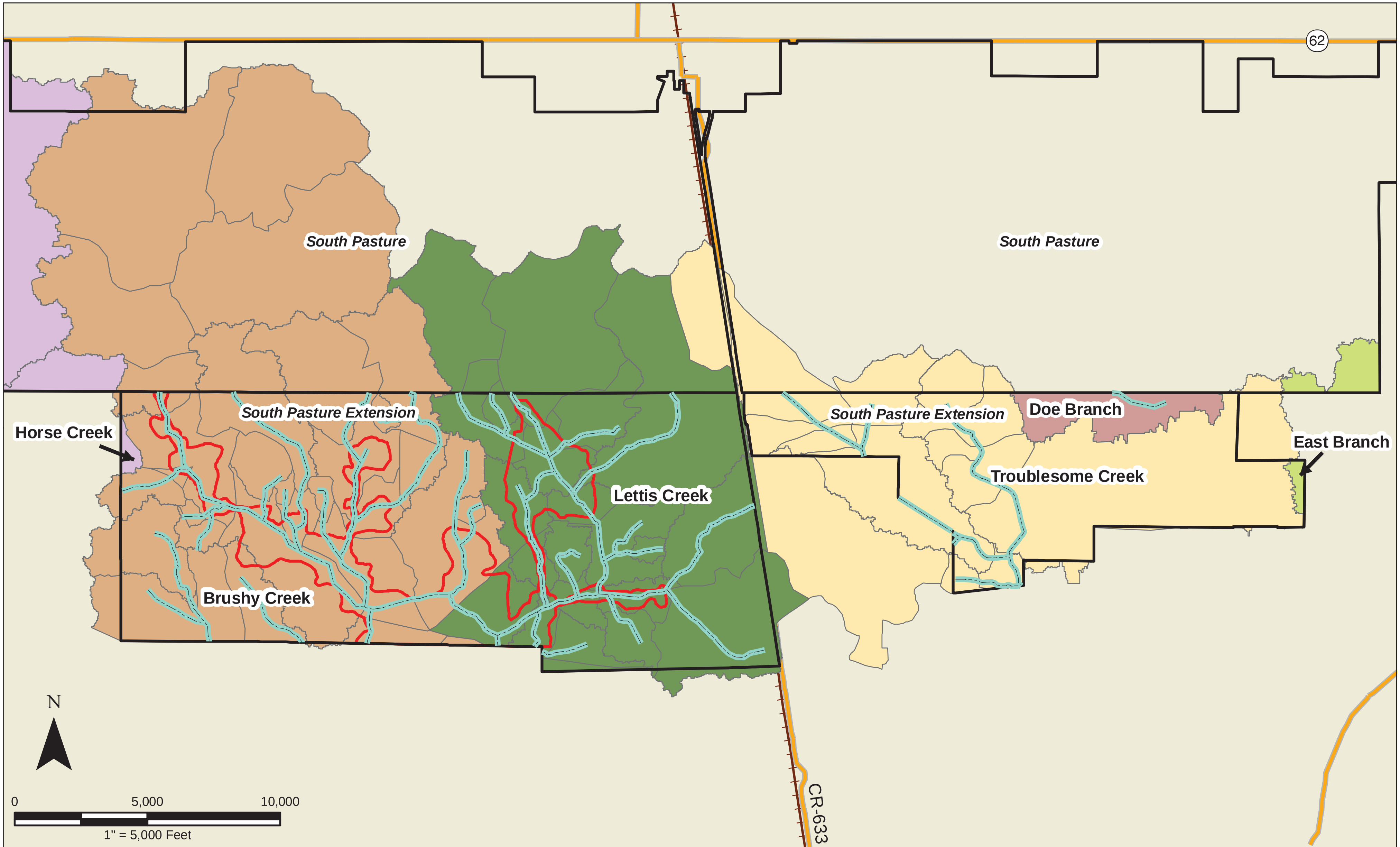
Not to scale



Section B-B

Not to scale

2000 E. Edgewood Dr., Ste #21
Lakeland, FL 33803
863.667.2345 - www.bcieng.cor
EB-0007867



amec

CF

Project No.: 03-16268

Notes:

FIGURE SRO-8
PRE-MINING DRAINAGE PATTERN
SOUTH PASTURE EXTENSION
HARDEE COUNTY, FLORIDA

Explanation of Features

- Pre-Mining Drainage Pattern
- CF Property
- No-Mine Boundary

Pre-Mining Basins

- Brushy Creek
- Doe Branch
- East Branch
- Horse Creek
- Lettis Creek
- Troublesome Creek

JOHN KIEFER P.E.
FLA. REG. NO. 51991

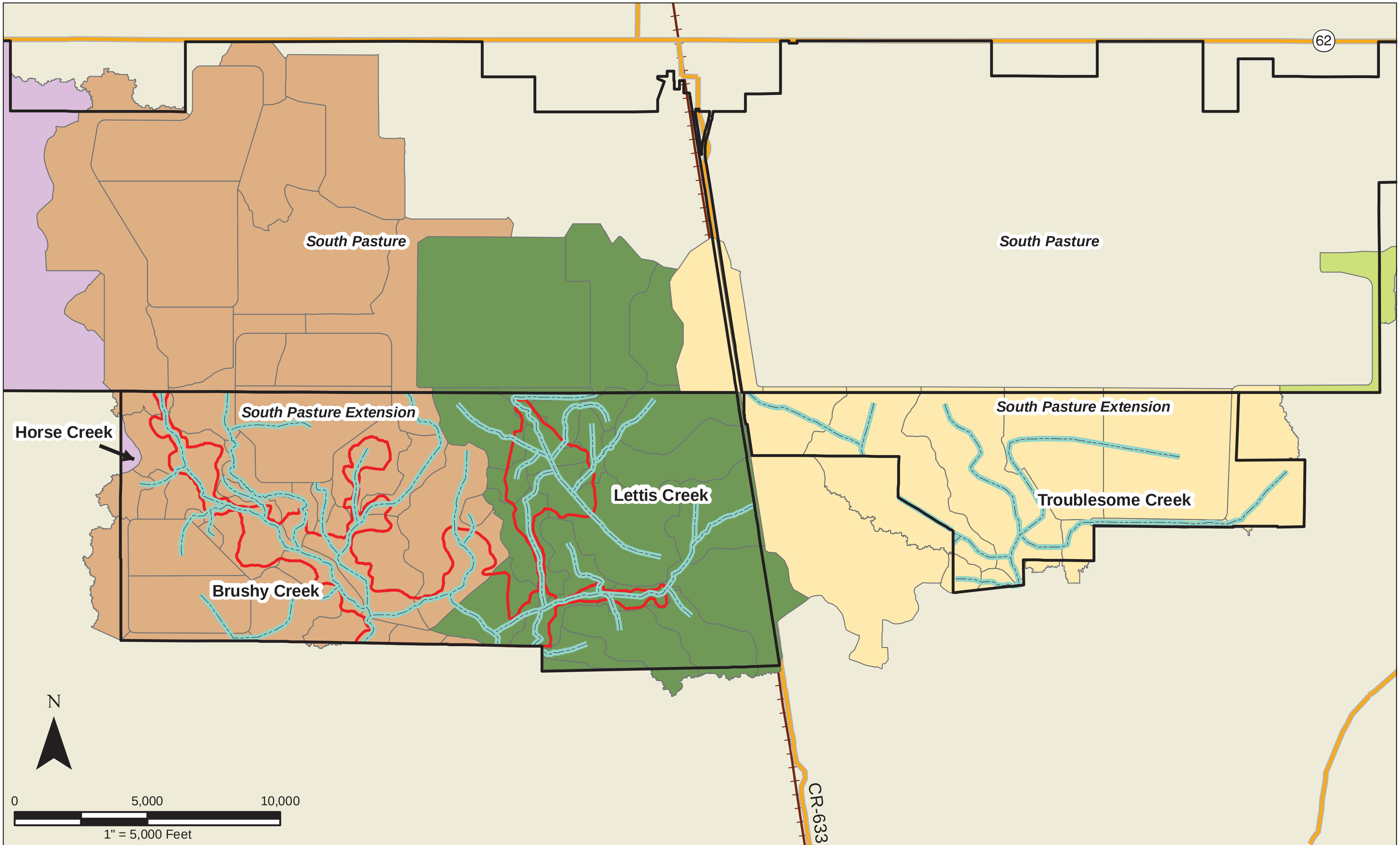
DATE:

Date: Aug. 2011

Checked By: JHK

Map Prepared By: ARK

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\8_Pre_Drainage_20110830.mxd



Notes:

FIGURE SRO-9
POST-RECLAMATION
DRAINAGE PATTERN
SOUTH PASTURE EXTENSION
HARDEE COUNTY, FLORIDA

Explanation of Features

Post-Reclamation Drainage Pattern
CF Property
No-Mine Boundary

Post-Reclamation Basins

Brushy Creek
East Branch
Horse Creek
Lettis Creek
Troublesome Creek

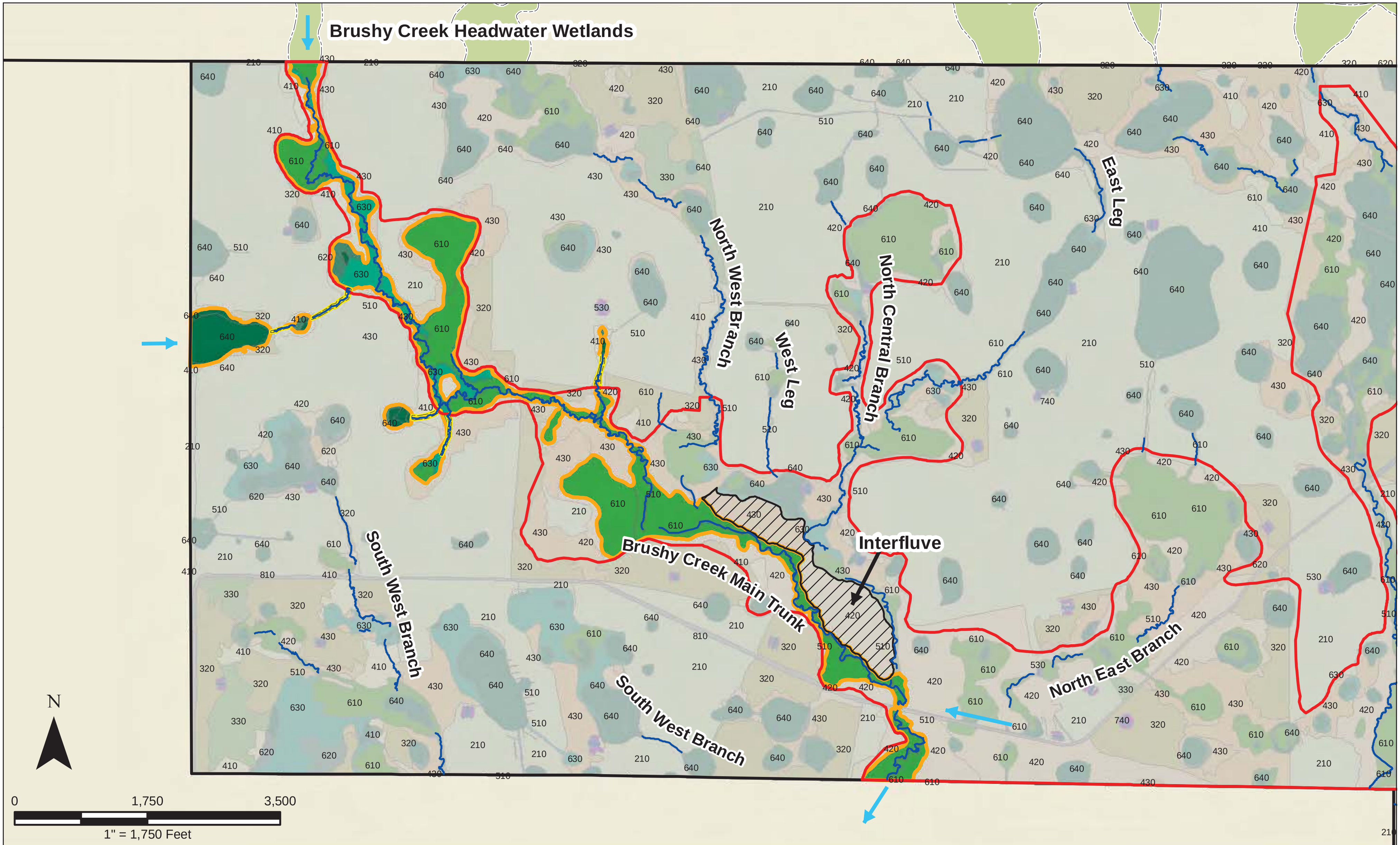
JOHN KIEFER P.E.
FLA. REG. NO. 51991

DATE:

Date: August 2011
Checked By: JHK
Map Prepared By: ARK

Project No.: 03-16268

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\9_Post_Drainage_20110830.mxd



Notes:

FIGURE SRO-10
PRE-MINING BRUSHY CREEK MAIN TRUNK
SOUTH PASTURE EXTENSION
HARDEE COUNTY, FLORIDA

Explanation of Features

- Flow
- Streams
- Interfluve
- Belt Width
- Brushy Creek Main Trunk Lotic System
- South Pasture Lotic Systems
- No-Mine Boundary
- South Pasture Extension Boundary

Pre-Mining Land-Use (FLUCCS 1999)

- 170, Institutional
- 210, Cropland and Pastureland
- 220, Tree Crops
- 260, Other Open Lands <Rural>
- 310, Herbaceous (Dry Prairie)
- 320, Shrub and Brushland
- 330, Mixed Rangeland
- 410, Upland Coniferous Forests
- 420, Upland Hardwood Forests
- 430, Upland Mixed Forests
- 510, Streams and Waterways
- 530, Reservoirs
- 610, Wetland Hardwood Forests
- 620, Wetland Coniferous Forests
- 630, Wetland Forested Mixed
- 640, Vegetated Non-Forested Wetlands
- 740, Disturbed Lands
- 810, Transportation

JOHN KIEFER P.E.
FLA. REG. NO. 51991

DATE:

Date: Aug. 2011

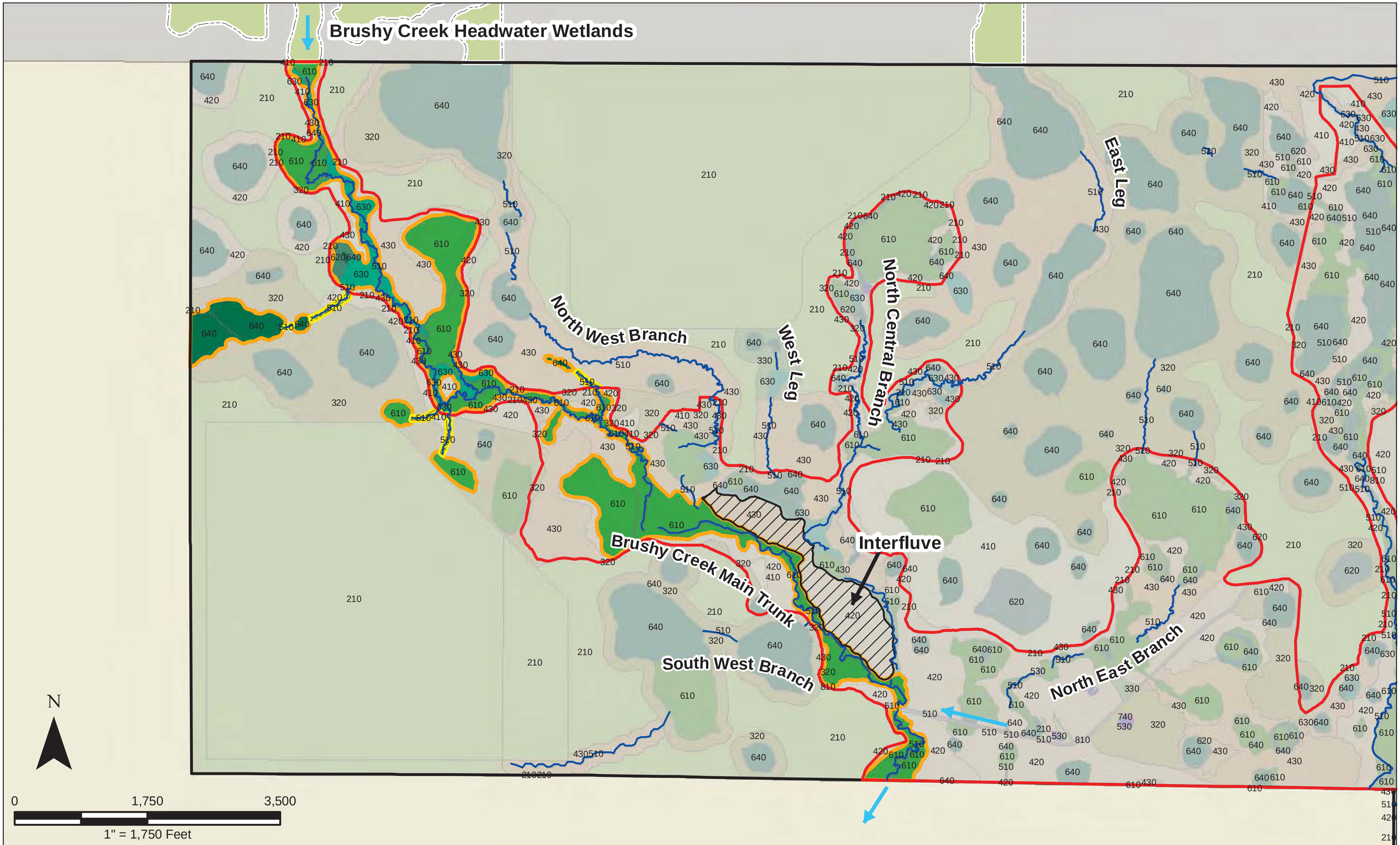
Checked By: JHK

Map Prepared By: ARB

amec
CF

Project No.: 03-16268

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\10_Pre_Brushy_Creek_20110830.mxd



amec

CF

Project No.: 03-16268

Notes:

FIGURE SRO-11
POST-RECLAMATION
BRUSHY CREEK MAIN TRUNK
SOUTH PASTURE EXTENSION
HARDEE COUNTY, FLORIDA

Explanation of Features

- Flow
- Post-Reclamation Streams
- Interfluve
- South Pasture Lotic Systems
- No-Mine Boundary
- South Pasture Extension Boundary
- Brushy Creek Main Trunk Lotic System
- Belt Width

Post Reclamation Land-Use (FLUCCS 1999)

- 150, Industrial
- 170, Institutional
- 210, Cropland and Pastureland
- 220, Tree Crops
- 260, Other Open Lands <Rural>
- 310, Herbaceous (Dry Prairie)
- 320, Shrub and Brushland
- 330, Mixed Rangeland
- 410, Upland Coniferous Forests
- 420, Upland Hardwood Forests
- 430, Upland Mixed Forests
- 510, Streams & Waterways
- 530, Reservoirs
- 610, Wetland Hardwood Forests
- 620, Wetland Coniferous Forests
- 630, Wetland Forested Mixed
- 640, Vegetated Non-Forested Wetlands
- 740, Disturbed Lands
- 810, Transportation

JOHN KIEFER P.E.
FLA. REG. NO. 51991

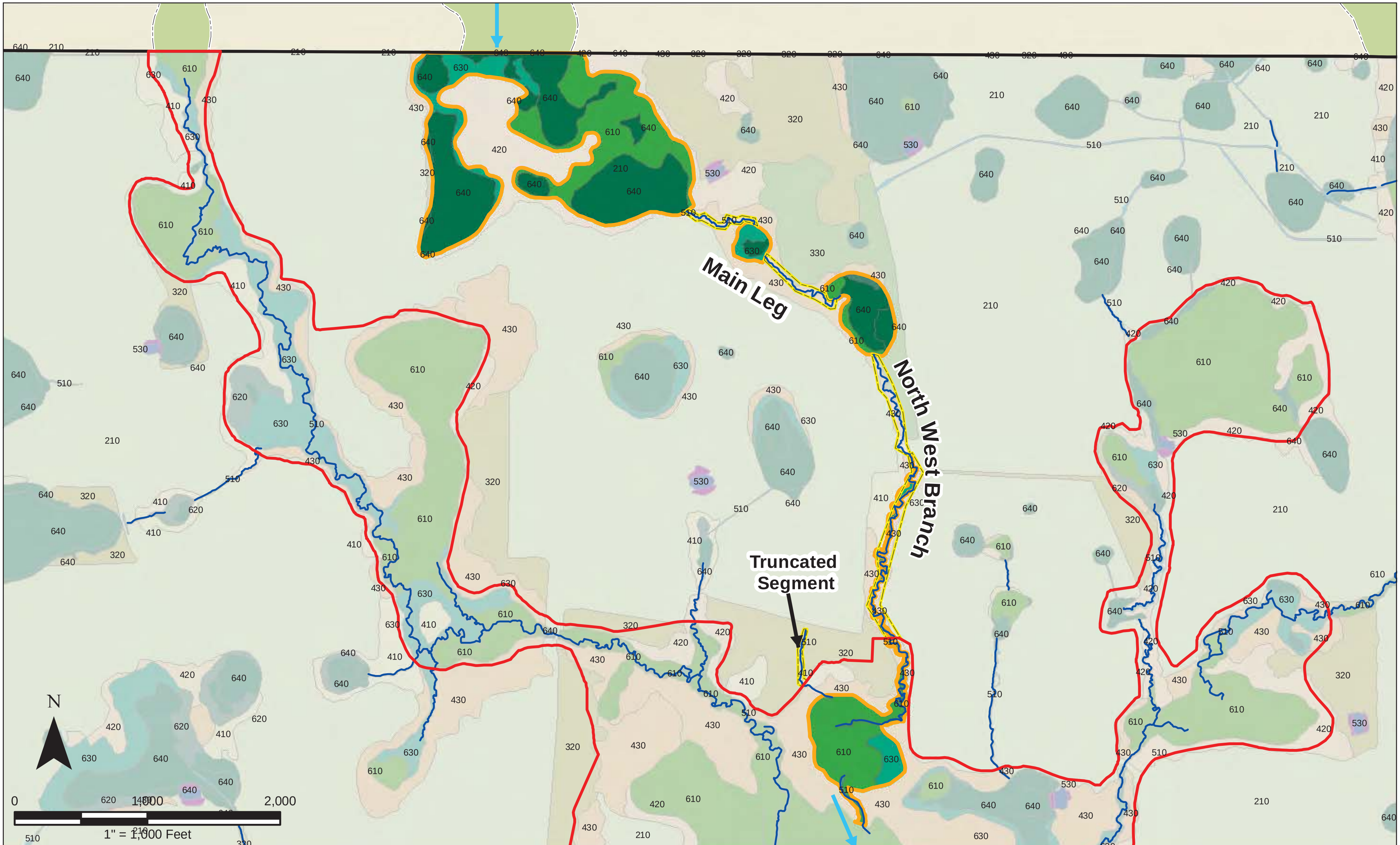
DATE:

Date: Revised Aug. 2011

Checked By: JHK

Map Prepared By: ARB

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\11_Post_Brushy_Creek_20110830.mxd



Notes:

FIGURE SRO-12
PRE-MINING BRUSHY CREEK NORTH WEST BRANCH SOUTH PASTURE EXTENSION HARDEE COUNTY, FLORIDA

Explanation of Features

- Flow
- Streams
- Brushy Creek North West Lotic System
- South Pasture Lotic Systems
- Belt Width
- No-Mine Boundary
- South Pasture Extension Boundary

Pre Mining Land-Use (FLUCCS 1999)

- 170, Institutional
- 210, Cropland and Pastureland
- 220, Tree Crops
- 260, Other Open Lands <Rural>
- 310, Herbaceous (Dry Prairie)
- 320, Shrub and Brushland
- 330, Mixed Rangeland
- 410, Upland Coniferous Forests
- 420, Upland Hardwood Forests
- 430, Upland Mixed Forests
- 510, Streams and Waterways
- 530, Reservoirs
- 610, Wetland Hardwood Forests
- 620, Wetland Coniferous Forests
- 630, Wetland Forested Mixed
- 640, Vegetated Non-Forested Wetlands
- 740, Disturbed Lands
- 810, Transportation

amec
CF™

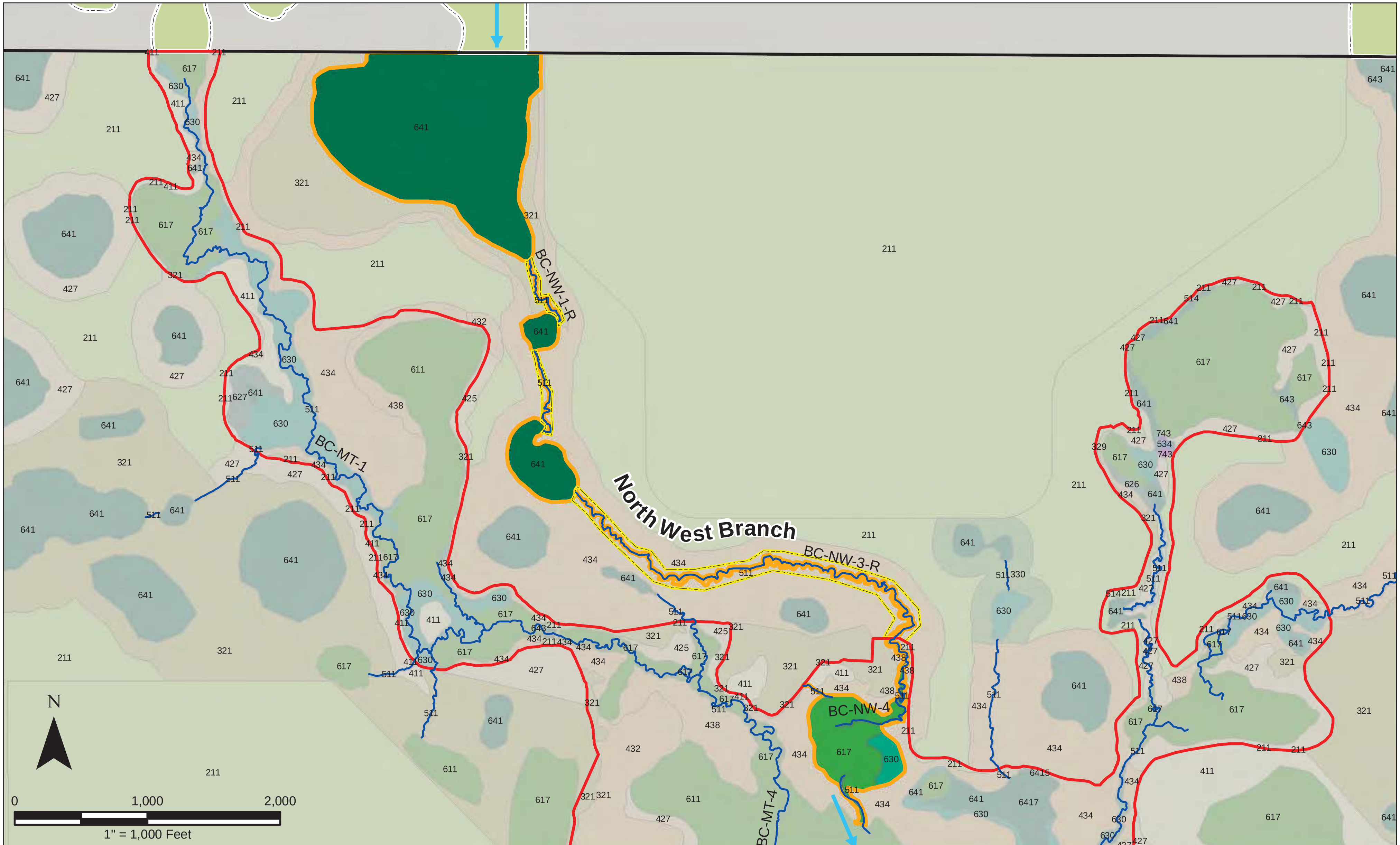
Project No.: 03-16268

JOHN KIEFER P.E.
FLA. REG. NO. 51991

DATE:

Date: August 2010
Checked By: JHK
Map Prepared By: ARB

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\12_Pre_Brushy_NW_20_20110830.mxd



Notes:

FIGURE SRO-13
POST-RECLAMATION BRUSHY CREEK
NORTH WEST BRANCH
SOUTH PASTURE EXTENSION
HARDEE COUNTY, FLORIDA

Explanation of Features

- Flow
- Post-Reclamation Streams
- North West Branch Lotic System
- South Pasture Lotic Systems
- Belt Width
- No-Mine Boundary
- South Pasture Extension Boundary

Post Reclamation Land-Use (FLUCCS 1999)

- 150, Industrial
- 170, Institutional
- 210, Cropland and Pastureland
- 220, Tree Crops
- 260, Other Open Lands <Rural>
- 310, Herbaceous (Dry Prairie)
- 320, Shrub and Brushland
- 330, Mixed Rangeland
- 410, Upland Coniferous Forests
- 420, Upland Hardwood Forests
- 430, Upland Mixed Forests
- 510, Streams & Waterways
- 530, Reservoirs
- 610, Wetland Hardwood Forests
- 620, Wetland Coniferous Forests
- 630, Wetland Forested Mixed
- 640, Vegetated Non-Forested Wetlands
- 740, Disturbed Lands
- 810, Transportation

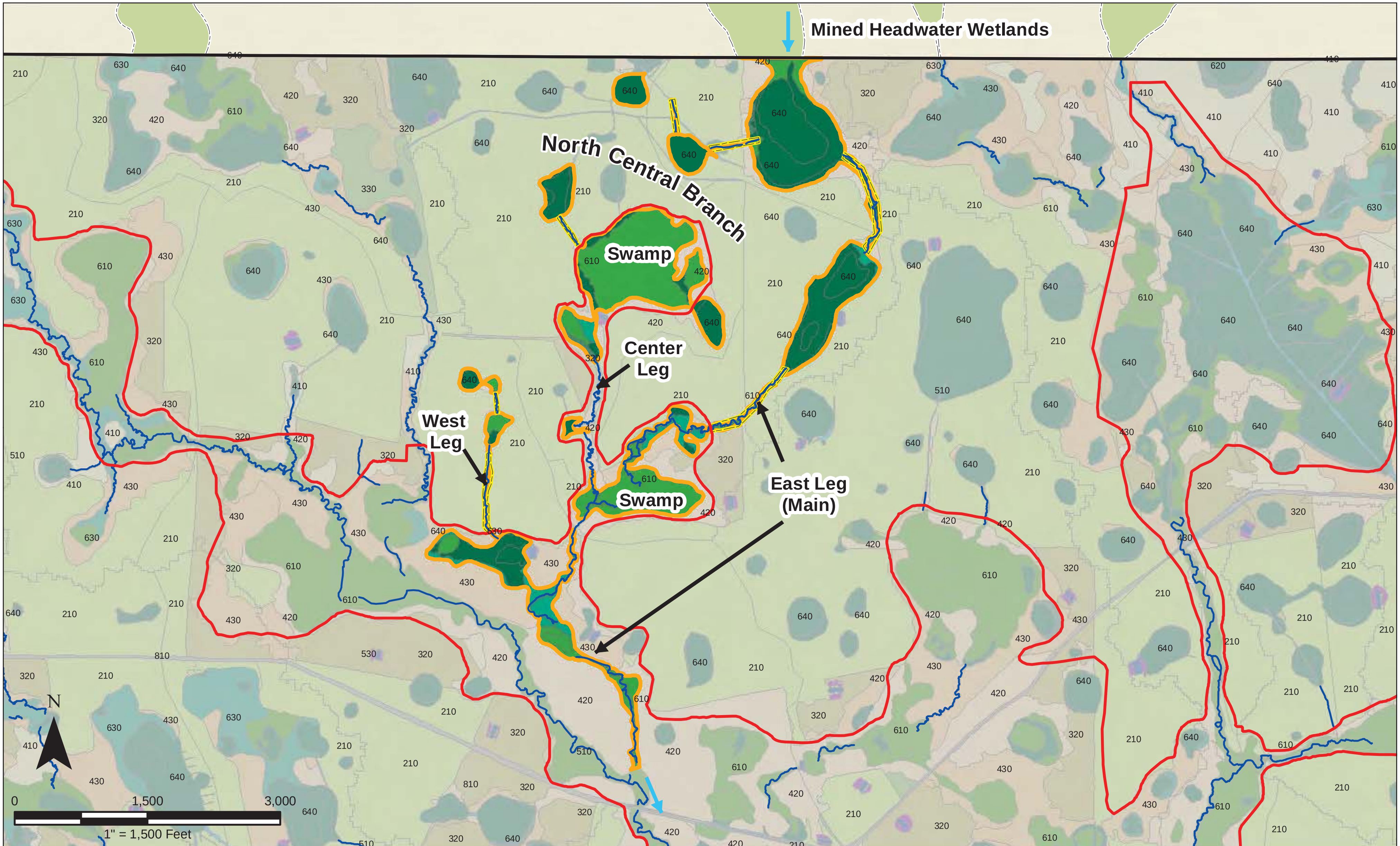
JOHN KIEFER P.E.
FLA. REG. NO. 51991

DATE:

Date: Revised Aug. 2011
Checked By: JHK
Map Prepared By: ARB

Project No.: 03-16268

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\13_Post_Brushy_NW_20110830.mxd



Notes:

FIGURE SRO-14
PRE-MINING BRUSHY CREEK
NORTH CENTRAL BRANCH
SOUTH PASTURE EXTENSION
HARDEE COUNTY, FLORIDA

Explanation of Features

- Flow
- Streams
- North Central Branch Lotic System
- Belt Width
- No-Mine Boundary
- South Pasture Extension Boundary
- South Pasture Lotic Systems

Pre-Mining Land-Use (FLUCCS 1999)

- 170, Institutional
- 210, Cropland and Pastureland
- 220, Tree Crops
- 260, Other Open Lands <Rural>
- 310, Herbaceous (Dry Prairie)
- 320, Shrub and Brushland
- 330, Mixed Rangeland
- 410, Upland Coniferous Forests
- 420, Upland Hardwood Forests
- 430, Upland Mixed Forests
- 510, Streams and Waterways
- 530, Reservoirs
- 610, Wetland Hardwood Forests
- 620, Wetland Coniferous Forests
- 630, Wetland Forested Mixed
- 640, Vegetated Non-Forested Wetlands
- 740, Disturbed Lands
- 810, Transportation

JOHN KIEFER P.E.
FLA. REG. NO. 51991

DATE:

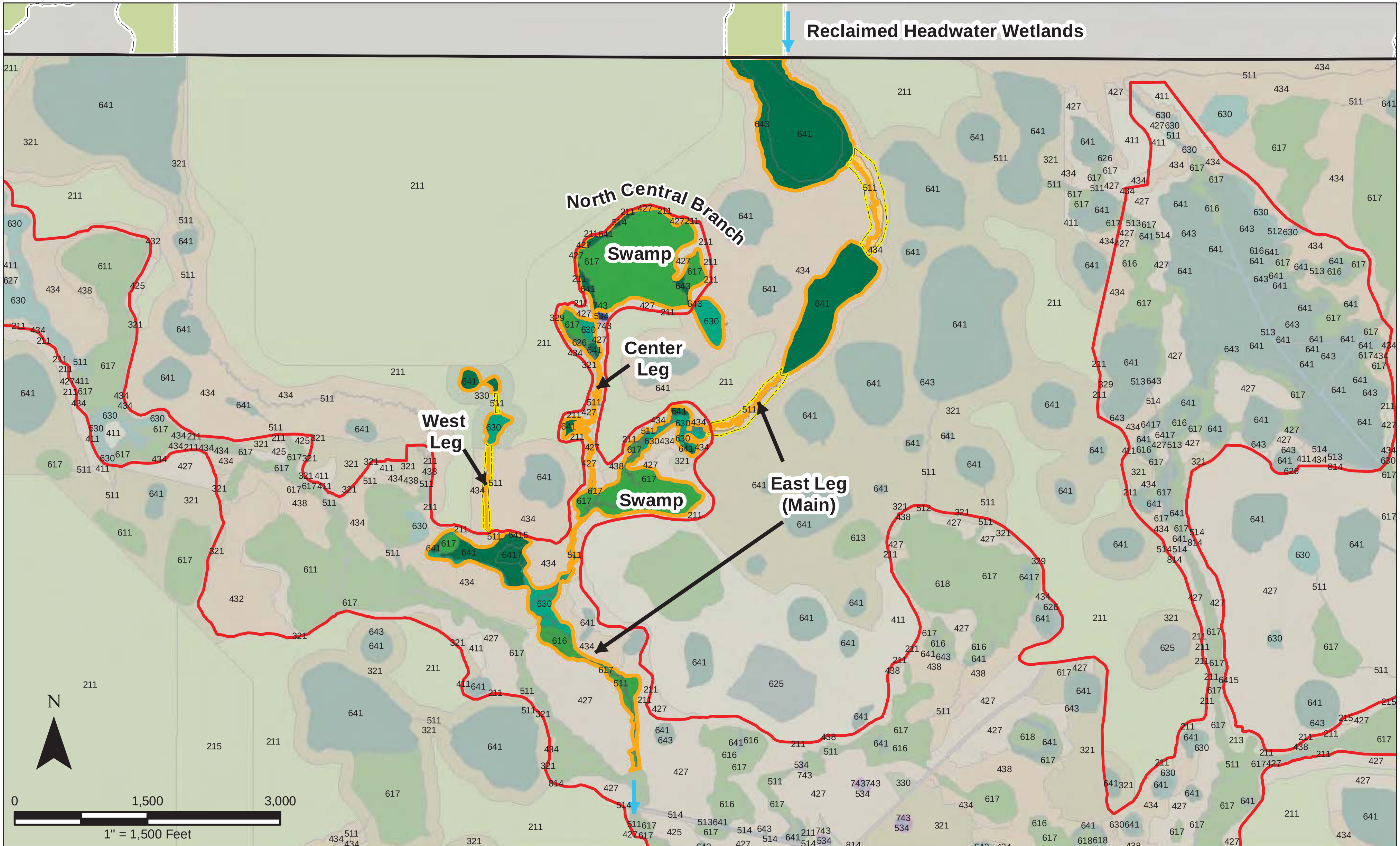
Date: Aug. 2011

Checked By: JHK

Map Prepared By: ARB

Project No.: 03-16268

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\14_Pre_Brushy_NC_20110830.mxd



Notes:

FIGURE SRO-15
POST-RECLAMATION BRUSHY CREEK NORTH CENTRAL BRANCH SOUTH PASTURE EXTENSION HARDEE COUNTY, FLORIDA

amec CF

Project No.: 03-16268

Explanation of Features

- Flow
- South Pasture Lotic Systems
- No-Mine Boundary
- South Pasture Extension Boundary
- Belt Width
- North Central Branch Lotic System

Post Reclamation Land-Use (FLUCCS 1999)

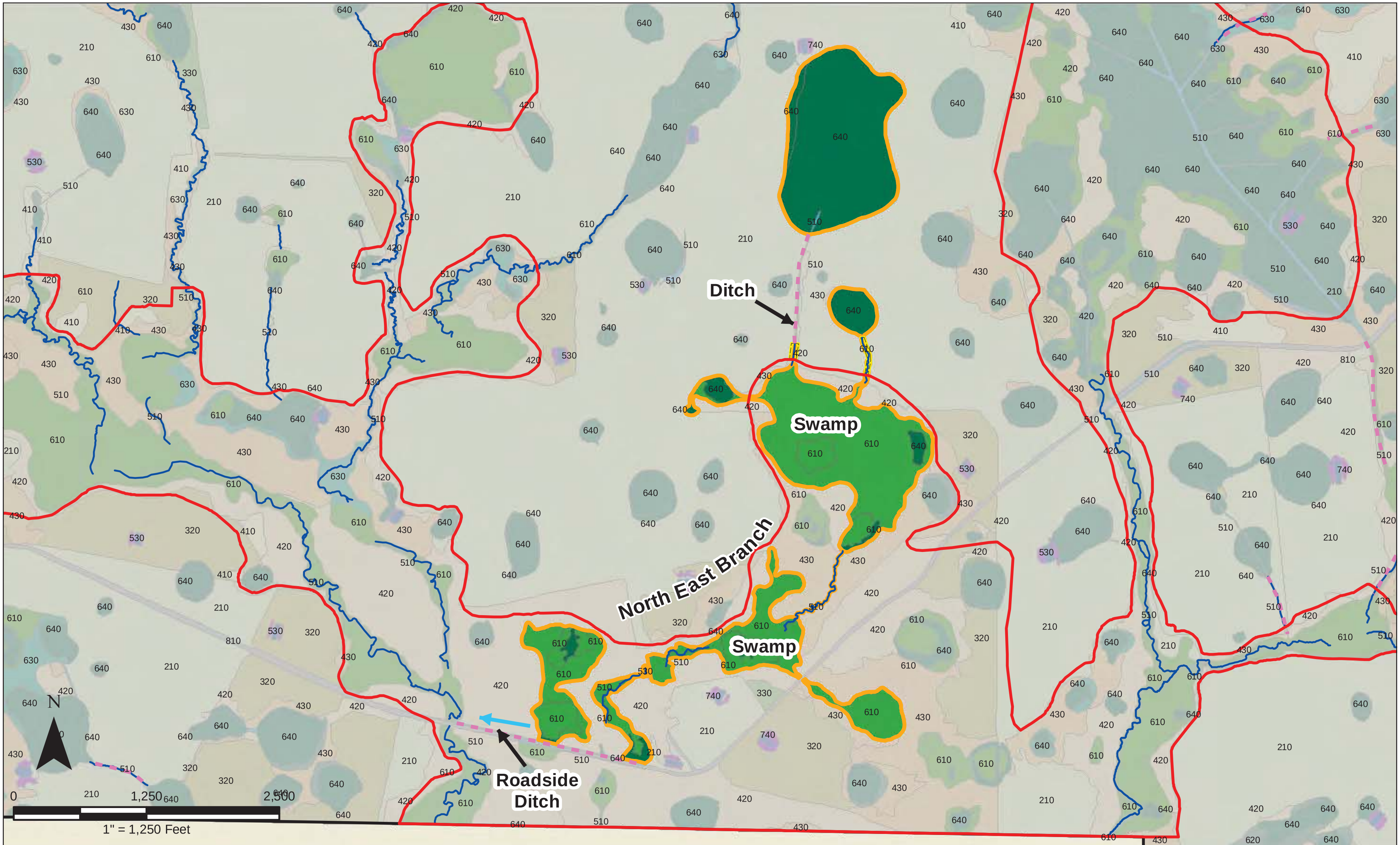
- 150, Industrial
- 170, Institutional
- 210, Cropland and Pastureland
- 220, Tree Crops
- 260, Other Open Lands <Rural>
- 310, Herbaceous (Dry Prairie)
- 320, Shrub and Brushland
- 330, Mixed Rangeland
- 410, Upland Coniferous Forests
- 420, Upland Hardwood Forests
- 430, Upland Mixed Forests
- 510, Streams & Waterways
- 530, Reservoirs
- 610, Wetland Hardwood Forests
- 620, Wetland Coniferous Forests
- 630, Wetland Forested Mixed
- 640, Vegetated Non-Forested Wetlands
- 740, Disturbed Lands
- 810, Transportation

JOHN KIEFER P.E.
FLA. REG. NO. 51991

DATE:

Date: Revised Aug. 2011
Checked By: JHK
Map Prepared By: ARB

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\15_Post_Brushy_NC_20110830.mxd



Notes:

FIGURE SRO-16
PRE-MINING BRUSHY CREEK NORTH EAST BRANCH SOUTH PASTURE EXTENSION HARDEE COUNTY, FLORIDA

Explanation of Features

- Flow
- Streams
- Ditch
- North East Branch Lotic System
- Belt Width
- No-Mine Boundary
- South Pasture Extension Boundary

Pre-Mining Land-Use (FLUCCS 1999)

- 170, Institutional
- 210, Cropland and Pastureland
- 220, Tree Crops
- 260, Other Open Lands <Rural>
- 310, Herbaceous (Dry Prairie)
- 320, Shrub and Brushland
- 330, Mixed Rangeland
- 410, Upland Coniferous Forests
- 420, Upland Hardwood Forests
- 430, Upland Mixed Forests
- 510, Streams and Waterways
- 530, Reservoirs
- 610, Wetland Hardwood Forests
- 620, Wetland Coniferous Forests
- 630, Wetland Forested Mixed
- 640, Vegetated Non-Forested Wetlands
- 740, Disturbed Lands
- 810, Transportation

JOHN KIEFER P.E.
FLA. REG. NO. 51991

DATE:

Date: Aug. 2011

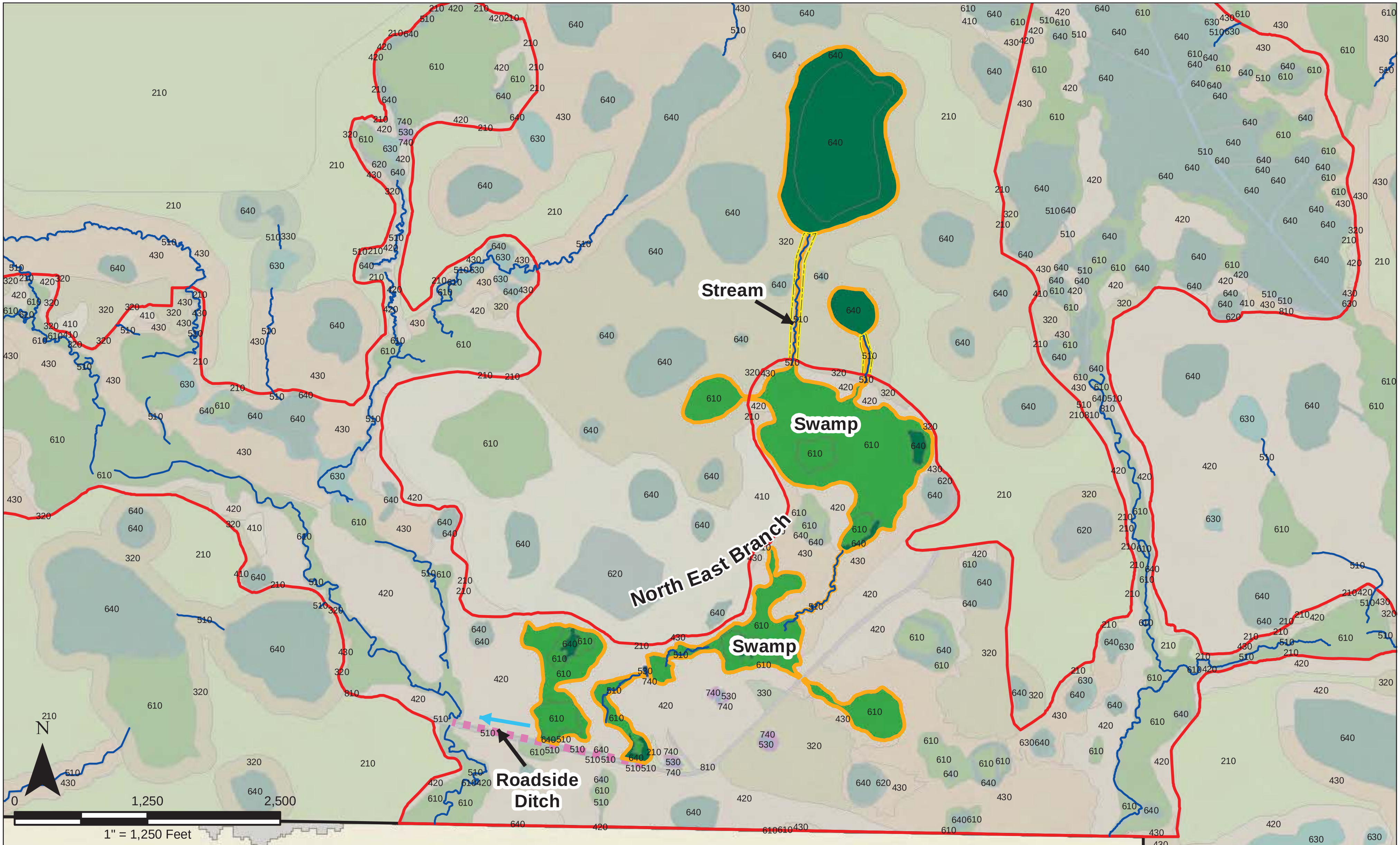
Checked By: JHK

Map Prepared By: ARB

amec
CF

Project No.: 03-16268

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\16_Pre_Brushy_NE_20110830.mxd



Notes:

FIGURE SRO-17
POST-RECLAMATION BRUSHY CREEK NORTH EAST BRANCH SOUTH PASTURE EXTENSION HARDEE COUNTY, FLORIDA

Project No.: 03-16268

Explanation of Features

- Flow
- Post-Reclamation Streams
- Ditch
- No-Mine Boundary
- South Pasture Extension Boundary
- Belt Width
- North East Branch Lotic System

Post Reclamation Land-Use (FLUCCS 1999)

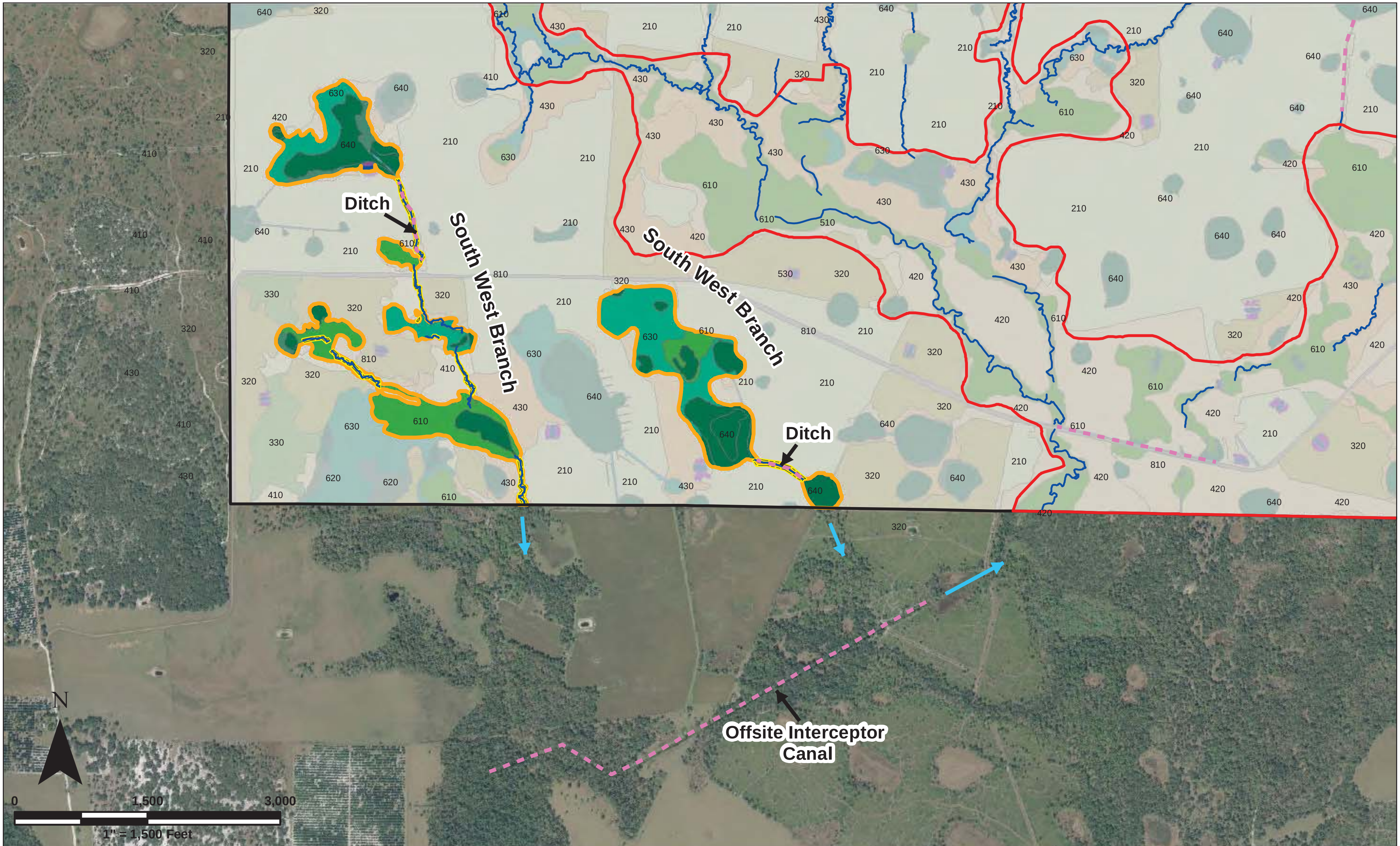
- 150, Industrial
- 170, Institutional
- 210, Cropland and Pastureland
- 220, Tree Crops
- 260, Other Open Lands <Rural>
- 310, Herbaceous (Dry Prairie)
- 320, Shrub and Brushland
- 330, Mixed Rangeland
- 410, Upland Coniferous Forests
- 420, Upland Hardwood Forests
- 430, Upland Mixed Forests
- 510, Streams & Waterways
- 530, Reservoirs
- 610, Wetland Hardwood Forests
- 620, Wetland Coniferous Forests
- 630, Wetland Forested Mixed
- 640, Vegetated Non-Forested Wetlands
- 740, Disturbed Lands
- 810, Transportation

JOHN KIEFER P.E.
FLA. REG. NO. 51991

DATE:

Date: Revised Aug. 2011
Checked By: JHK
Map Prepared By: ARB

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_020911\17_Post_Brushy_NE.mxd



Notes:

1. 2007 Aerial Imagery

FIGURE SRO-18
PRE-MINING BRUSHY CREEK SOUTH WEST BRANCH SOUTH PASTURE EXTENSION HARDEE COUNTY, FLORIDA

Explanation of Features

- Flow
- Streams
- Ditch
- Belt Width
- South West Branch Lotic System
- No-Mine Boundary
- South Pasture Extension Boundary

Pre-Mining Land-Use (FLUCCS 1999)

- 170, Institutional
- 210, Cropland and Pastureland
- 220, Tree Crops
- 260, Other Open Lands <Rural>
- 310, Herbaceous (Dry Prairie)
- 320, Shrub and Brushland
- 330, Mixed Rangeland
- 410, Upland Coniferous Forests
- 420, Upland Hardwood Forests
- 430, Upland Mixed Forests
- 510, Streams and Waterways
- 530, Reservoirs
- 610, Wetland Hardwood Forests
- 620, Wetland Coniferous Forests
- 630, Wetland Forested Mixed
- 640, Vegetated Non-Forested Wetlands
- 740, Disturbed Lands
- 810, Transportation

JOHN KIEFER P.E.
FLA. REG. NO. 51991

DATE:

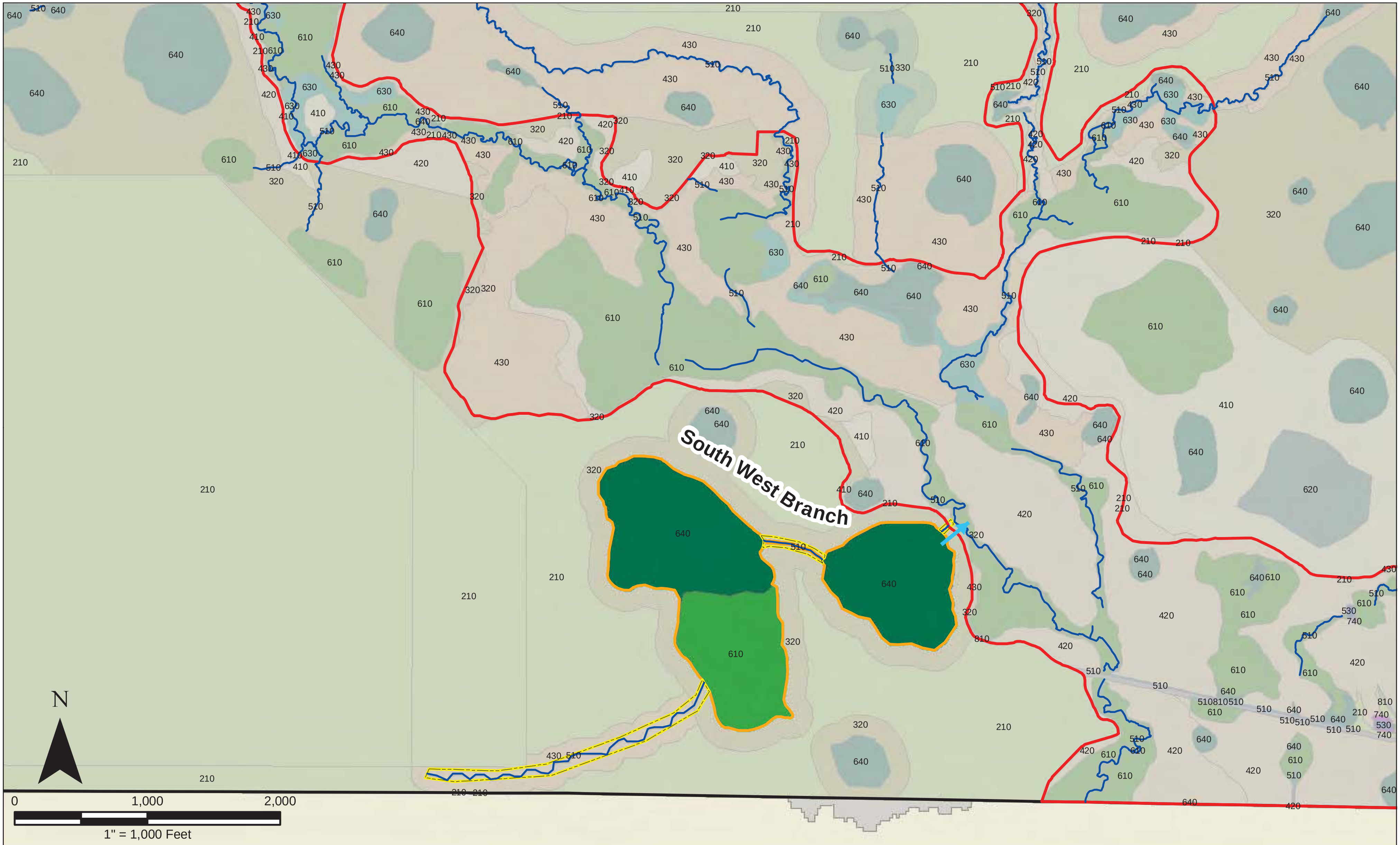
Date: Aug. 2011

Checked By: JHK

Map Prepared By: ARB

Project No.: 03-16268

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_052510\18_Pre_Brushy_SW_20110830



Notes:

FIGURE SRO-19
POST-RECLAMATION BRUSHY CREEK
SOUTH WEST BRANCH
SOUTH PASTURE EXTENSION
HARDEE COUNTY, FLORIDA

Explanation of Features

- Flow
- Post-Reclamation Streams
- No-Mine Boundary
- South Pasture Extension Boundary
- Belt Width
- South West Branch Lotic System

Post Reclamation Land-Use (FLUCCS 1999)

- 150, Industrial
- 170, Institutional
- 210, Cropland and Pastureland
- 220, Tree Crops
- 260, Other Open Lands <Rural>
- 310, Herbaceous (Dry Prairie)
- 320, Shrub and Brushland
- 330, Mixed Rangeland
- 410, Upland Coniferous Forests
- 420, Upland Hardwood Forests
- 430, Upland Mixed Forests
- 510, Streams & Waterways
- 530, Reservoirs
- 610, Wetland Hardwood Forests
- 620, Wetland Coniferous Forests
- 630, Wetland Forested Mixed
- 640, Vegetated Non-Forested Wetlands
- 740, Disturbed Lands
- 810, Transportation

JOHN KIEFER P.E.
FLA. REG. NO. 51991

DATE:

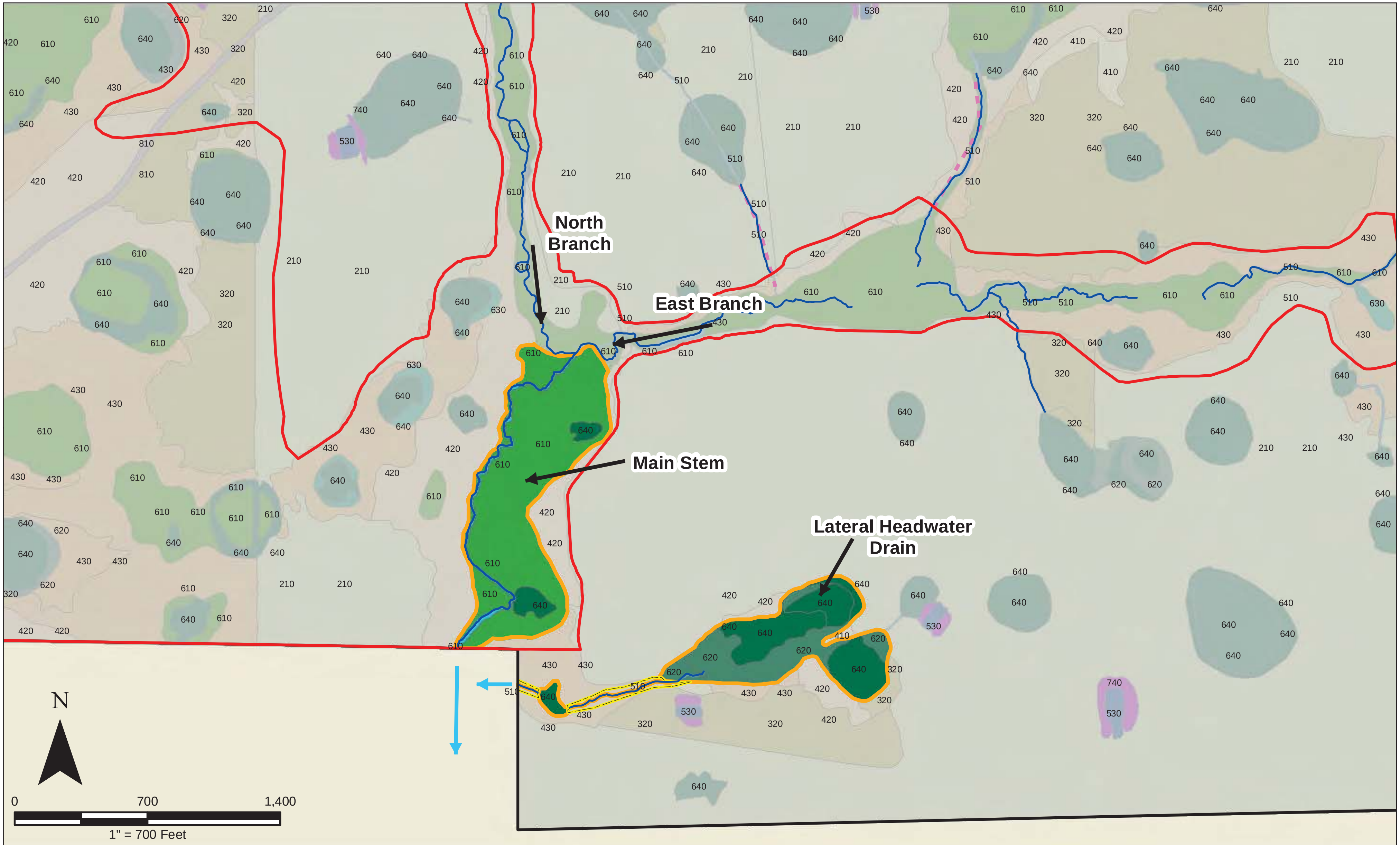
Date: Revised Aug. 2011

Checked By: JHK

Map Prepared By: ARB

Project No.: 03-16268

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\19_Post_Brushy_SW_20110830.mxd



Notes:

FIGURE SRO-20
PRE-MINING LETTIS CREEK
MAIN TRUNK
SOUTH PASTURE EXTENSION
HARDEE COUNTY, FLORIDA

Explanation of Features

- Flow
- Streams
- Main Trunk Lotic System
- Belt Width
- No-Mine Boundary
- South Pasture Extension Boundary

Pre-Mining Land-Use (FLUCCS 1999)

- 170, Institutional
- 210, Cropland and Pastureland
- 220, Tree Crops
- 260, Other Open Lands <Rural>
- 310, Herbaceous (Dry Prairie)
- 320, Shrub and Brushland
- 330, Mixed Rangeland
- 410, Upland Coniferous Forests
- 420, Upland Hardwood Forests
- 430, Upland Mixed Forests
- 510, Streams and Waterways
- 530, Reservoirs
- 610, Wetland Hardwood Forests
- 620, Wetland Coniferous Forests
- 630, Wetland Forested Mixed
- 640, Vegetated Non-Forested Wetlands
- 740, Disturbed Lands
- 810, Transportation

JOHN KIEFER P.E.
FLA. REG. NO. 51991

DATE:

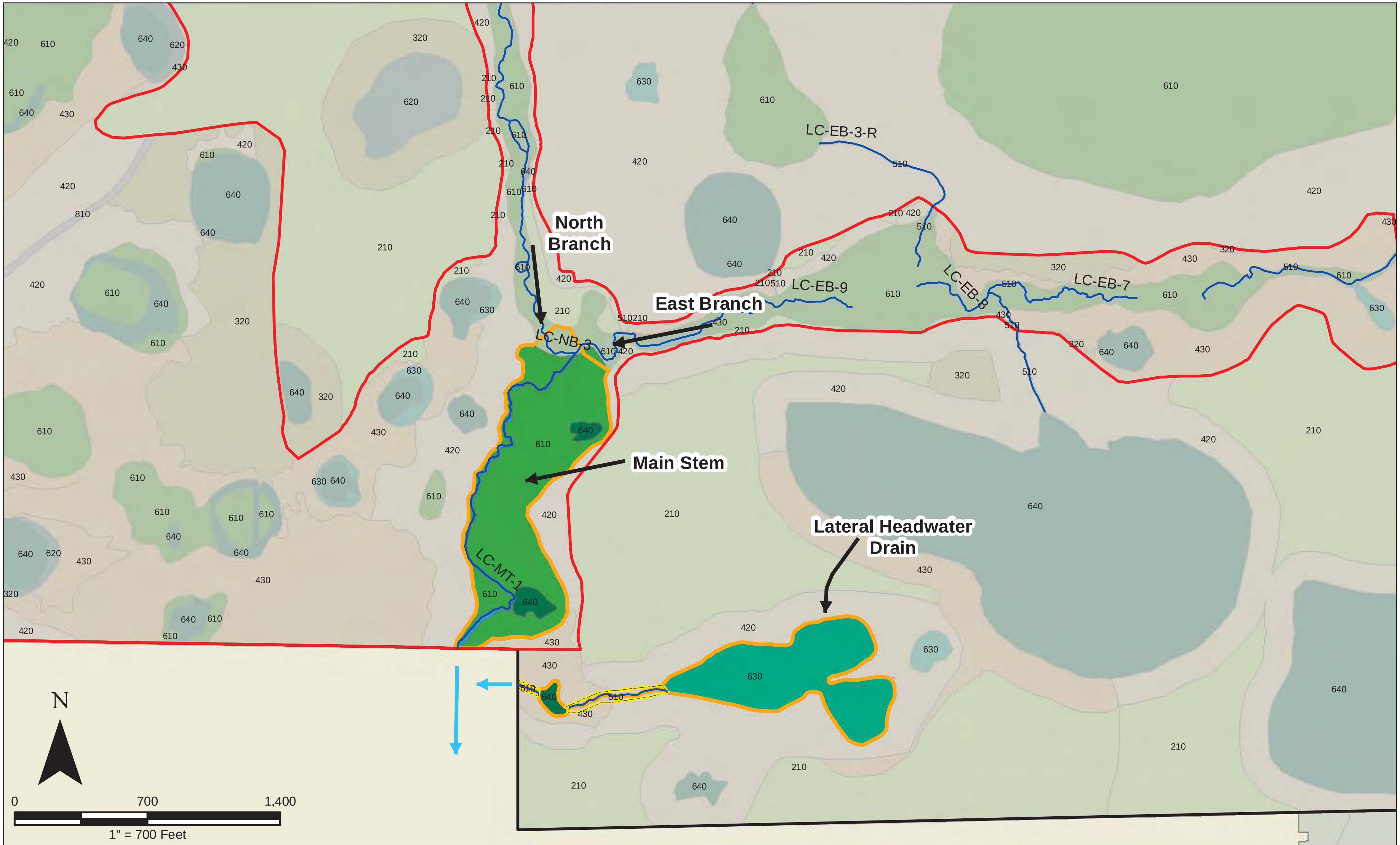
Date: Aug. 2011

Checked By: JHK

Map Prepared By: ARB

Project No.: 03-16268

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\20_Pre_Lettis_Creek_Main1_20110830.mxd



Notes:

FIGURE SRO-21
POST-RECLAMATION LETTIS CREEK
MAIN TRUNK
SOUTH PASTURE EXTENSION
HARDEE COUNTY, FLORIDA

Explanation of Features

- Flow
- Post-Reclamation Streams
- Main Trunk Lotic System
- No-Mine Boundary
- South Pasture Extension Boundary
- Belt Width

Post Reclamation Land-Use (FLUCCS 1999)

- 150, Industrial
- 170, Institutional
- 210, Cropland and Pastureland
- 220, Tree Crops
- 260, Other Open Lands <Rural>
- 310, Herbaceous (Dry Prairie)
- 320, Shrub and Brushland
- 330, Mixed Rangeland
- 410, Upland Coniferous Forests
- 420, Upland Hardwood Forests
- 430, Upland Mixed Forests
- 510, Streams & Waterways
- 530, Reservoirs
- 610, Wetland Hardwood Forests
- 620, Wetland Coniferous Forests
- 630, Wetland Forested Mixed
- 640, Vegetated Non-Forested Wetlands
- 740, Disturbed Lands
- 810, Transportation

JOHN KIEFER P.E.
FLA. REG. NO. 51991

DATE:

Date: Revised Aug. 2011
Checked By: JHK
Map Prepared By: ARB

Project No.: 03-16268

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\21_Post_Lettis_Creek_Main_20110830.mxd

amec

CF

Project No.: 03-16268

Notes:

FIGURE SRO-22
PRE-MINING LETTIS CREEK EAST BRANCH
SOUTH PASTURE EXTENSION
HARDEE COUNTY, FLORIDA

Explanation of Features

- Flow
- Streams
- Ditch
- East Branch Lotic System
- Belt Width
- No-Mine Boundary
- South Pasture Extension Boundary

Pre-Mining Land-Use (FLUCCS 1999)

- 170, Institutional
- 210, Cropland and Pastureland
- 220, Tree Crops
- 260, Other Open Lands <Rural>
- 310, Herbaceous (Dry Prairie)
- 320, Shrub and Brushland
- 330, Mixed Rangeland
- 410, Upland Coniferous Forests
- 420, Upland Hardwood Forests
- 430, Upland Mixed Forests
- 510, Streams and Waterways
- 530, Reservoirs
- 610, Wetland Hardwood Forests
- 620, Wetland Coniferous Forests
- 630, Wetland Forested Mixed
- 640, Vegetated Non-Forested Wetlands
- 740, Disturbed Lands
- 810, Transportation

JOHN KIEFER P.E.
FLA. REG. NO. 51991

DATE:

Date: Aug. 2011

Checked By: JHK

Map Prepared By: ARB

V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\22_Pre_Lettis_Creek_E_20110830.mxd

Notes:

Project No.: 03-16268

FIGURE SRO-23
POST-RECLAMATION LETTIS CREEK
EAST BRANCH
SOUTH PASTURE EXTENSION
HARDEE COUNTY, FLORIDA

Explanation of Features

- Flow
- Post-Reclamation Streams
- East Branch Lotic System
- No-Mine Boundary
- South Pasture Extension Boundary
- Belt Width

Post Reclamation Land-Use (FLUCCS 1999)

- 150, Industrial
- 170, Institutional
- 210, Cropland and Pastureland
- 220, Tree Crops
- 260, Other Open Lands <Rural>
- 310, Herbaceous (Dry Prairie)
- 320, Shrub and Brushland
- 330, Mixed Rangeland
- 410, Upland Coniferous Forests
- 420, Upland Hardwood Forests
- 430, Upland Mixed Forests
- 510, Streams & Waterways
- 530, Reservoirs
- 610, Wetland Hardwood Forests
- 620, Wetland Coniferous Forests
- 630, Wetland Forested Mixed
- 640, Vegetated Non-Forested Wetlands
- 740, Disturbed Lands
- 810, Transportation

JOHN KIEFER P.E.
FLA. REG. NO. 51991

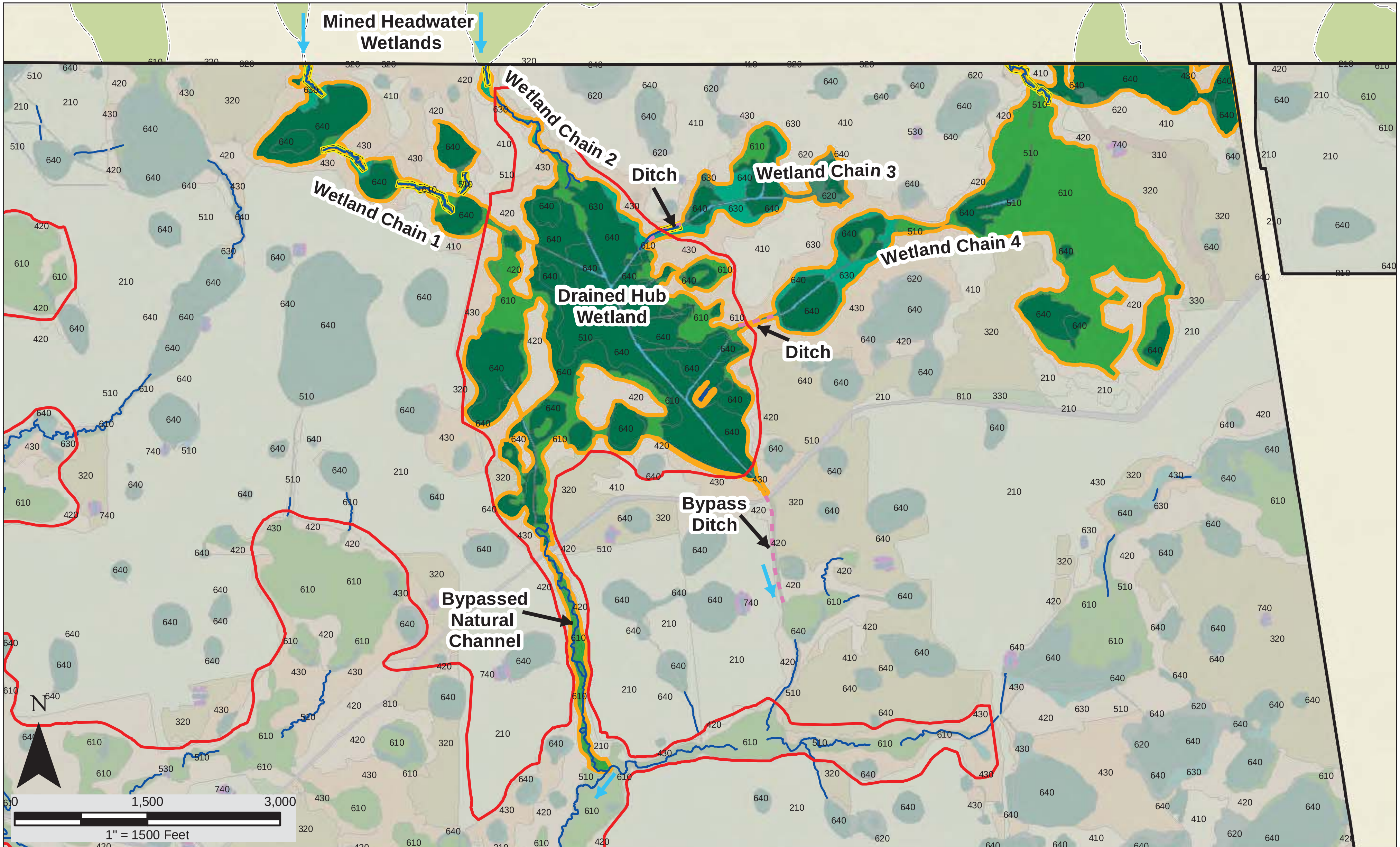
DATE:

Date: Revised Aug. 2011

Checked By: JHK

Map Prepared By: ARB

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\23_Post_Lettis_Creek_E_20110830.mxd



Notes:

FIGURE SRO-24
PRE-MINING LETTIS CREEK NORTH BRANCH SOUTH PASTURE EXTENSION HARDEE COUNTY, FLORIDA

Explanation of Features

- Flow
- Streams
- Ditch
- North Branch Lotic System
- Belt Width
- South Pasture Lotic Systems
- No-Mine Boundary
- South Pasture Extension Boundary

Pre-Mining Land-Use (FLUCCS 1999)

- 170, Institutional
- 210, Cropland and Pastureland
- 220, Tree Crops
- 260, Other Open Lands <Rural>
- 310, Herbaceous (Dry Prairie)
- 320, Shrub and Brushland
- 330, Mixed Rangeland
- 410, Upland Coniferous Forests
- 420, Upland Hardwood Forests
- 430, Upland Mixed Forests
- 510, Streams and Waterways
- 530, Reservoirs
- 610, Wetland Hardwood Forests
- 620, Wetland Coniferous Forests
- 630, Wetland Forested Mixed
- 640, Vegetated Non-Forested Wetlands
- 740, Disturbed Lands
- 810, Transportation

JOHN KIEFER P.E.
FLA. REG. NO. 51991

DATE:

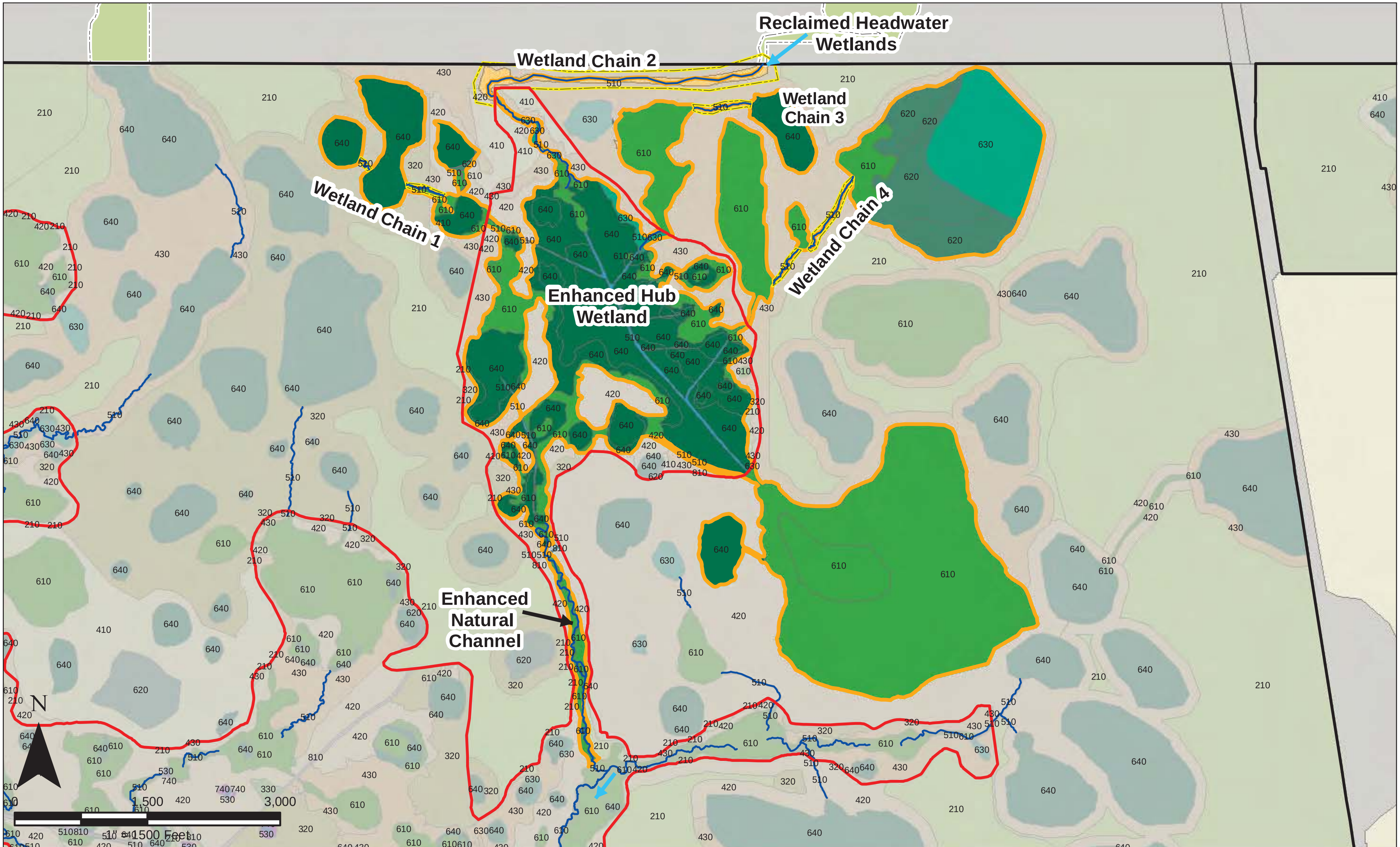
Date: Aug. 2011

Checked By: JHK

Map Prepared By: ARB

Project No.: 03-16268

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\24_Pre_Lettis_Creek_N_20110830.mxd



Notes:

FIGURE SRO-25
POST-RECLAMATION LETTIS CREEK NORTH BRANCH
SOUTH PASTURE EXTENSION
HARDEE COUNTY, FLORIDA

amec

CF

Project No.: 03-16268

Explanation of Features

- Flow
- Post-Reclamation Streams
- South Pasture Lotic Systems
- No-Mine Boundary
- South Pasture Extension Boundary
- Belt Width

Post Reclamation Land-Use (FLUCCS 1999)

- 150, Industrial
- 170, Institutional
- 210, Cropland and Pastureland
- 220, Tree Crops
- 260, Other Open Lands <Rural>
- 310, Herbaceous (Dry Prairie)
- 320, Shrub and Brushland
- 330, Mixed Rangeland
- 410, Upland Coniferous Forests
- 420, Upland Hardwood Forests
- 430, Upland Mixed Forests
- 510, Streams & Waterways
- 530, Reservoirs
- 610, Wetland Hardwood Forests
- 620, Wetland Coniferous Forests
- 630, Wetland Forested Mixed
- 640, Vegetated Non-Forested Wetlands
- 740, Disturbed Lands
- 810, Transportation

JOHN KIEFER P.E.
FLA. REG. NO. 51991

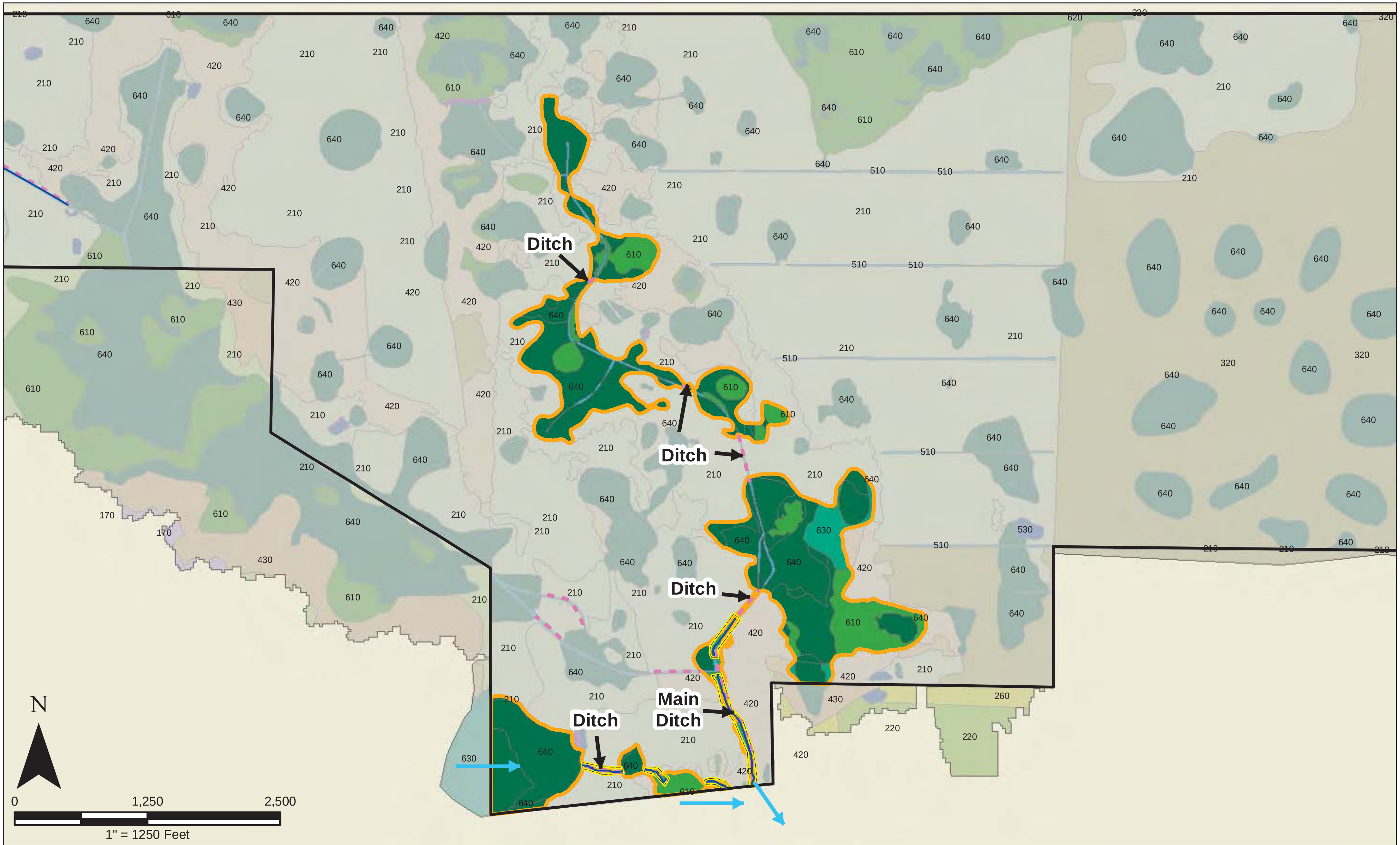
DATE:

Date: Revised Aug. 2011

Checked By: JHK

Map Prepared By: ARB

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\25_Post_Lettis_Creek_N_20110831.mxd



Explanation of Features

- Flow
- Streams
- Ditch
- East Lateral Chain Lotic System
- Belt Width
- No-Mine Boundary
- South Pasture Extension Boundary

Pre-Mining Land-Use (FLUCCS 1999)

- 170, Institutional
- 210, Cropland and Pastureland
- 220, Tree Crops
- 260, Other Open Lands <Rural>
- 310, Herbaceous (Dry Prairie)
- 320, Shrub and Brushland
- 330, Mixed Rangeland
- 410, Upland Coniferous Forests
- 420, Upland Hardwood Forests
- 430, Upland Mixed Forests
- 510, Streams and Waterways
- 530, Reservoirs
- 610, Wetland Hardwood Forests
- 620, Wetland Coniferous Forests
- 630, Wetland Forested Mixed
- 640, Vegetated Non-Forested Wetlands
- 740, Disturbed Lands
- 810, Transportation

amec

CF

Project No.: 03-16268

Notes:

FIGURE SRO-26
PRE-MINING
TROUBLESOME CREEK EAST BRANCH
SOUTH PASTURE EXTENSION
HARDEE COUNTY, FLORIDA

JOHN KIEFER P.E.
FLA. REG. NO. 51991

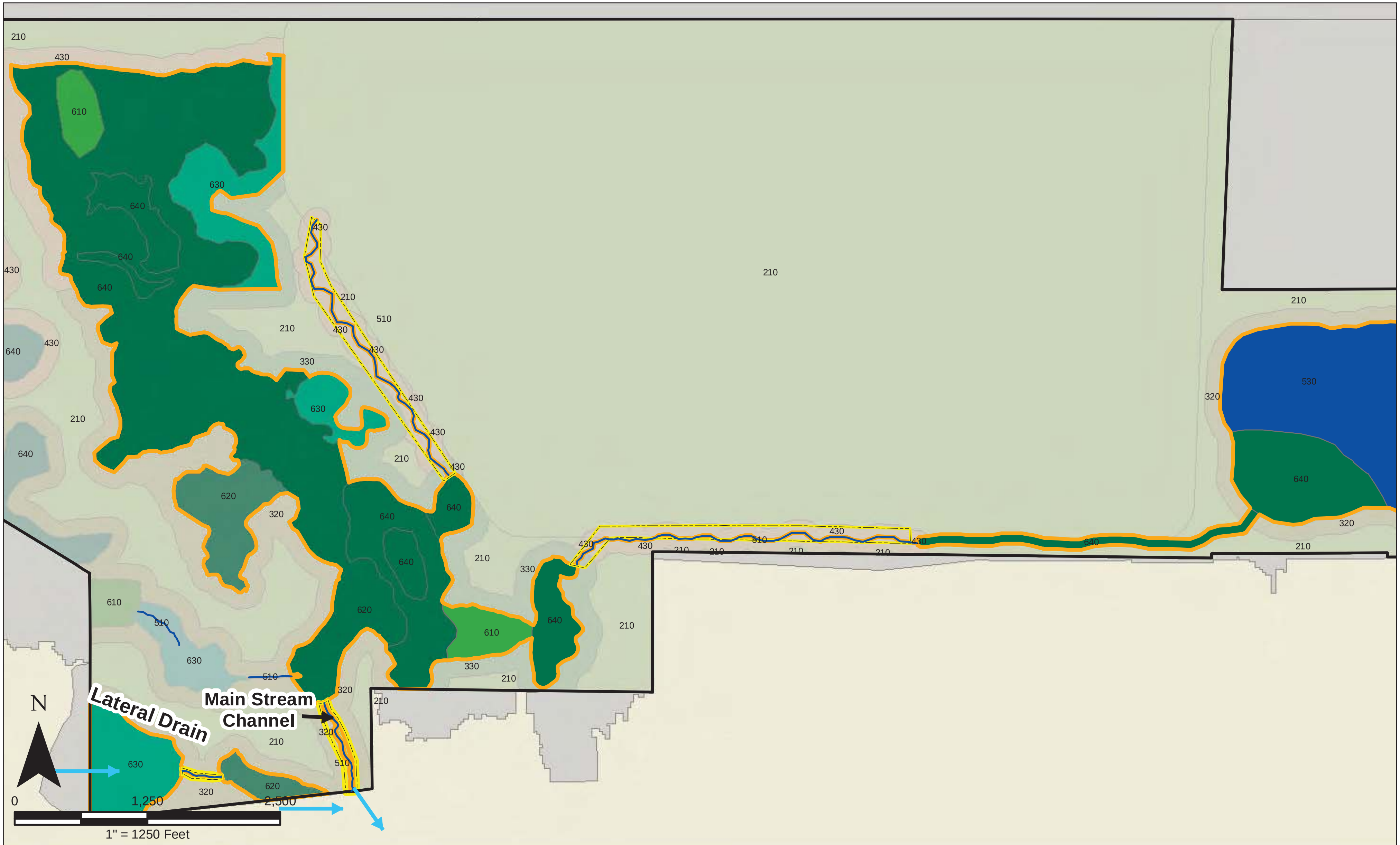
DATE:

Date: Aug. 2011

Checked By: JHK

Map Prepared By: ARB

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\26_Pre_Troub_Creek_E_20110831.mxd



Notes:

FIGURE SRO-27
POST-RECLAMATION TROUBLESOME CREEK EAST BRANCH SOUTH PASTURE EXTENSION HARDEE COUNTY, FLORIDA

Explanation of Features

- Flow
- Post-Reclamation Streams
- East Lateral Chain Lotic System
- No-Mine Boundary
- South Pasture Extension Boundary
- Belt Width

Post Reclamation Land-Use (FLUCCS 1999)

- 150, Industrial
- 170, Institutional
- 210, Cropland and Pastureland
- 220, Tree Crops
- 260, Other Open Lands <Rural>
- 310, Herbaceous (Dry Prairie)
- 320, Shrub and Brushland
- 330, Mixed Rangeland
- 410, Upland Coniferous Forests
- 420, Upland Hardwood Forests
- 430, Upland Mixed Forests
- 510, Streams & Waterways
- 530, Reservoirs
- 610, Wetland Hardwood Forests
- 620, Wetland Coniferous Forests
- 630, Wetland Forested Mixed
- 640, Vegetated Non-Forested Wetlands
- 740, Disturbed Lands
- 810, Transportation

JOHN KIEFER P.E.
FLA. REG. NO. 51991

DATE:

Date: Revised Aug. 2011

Checked By: JHK

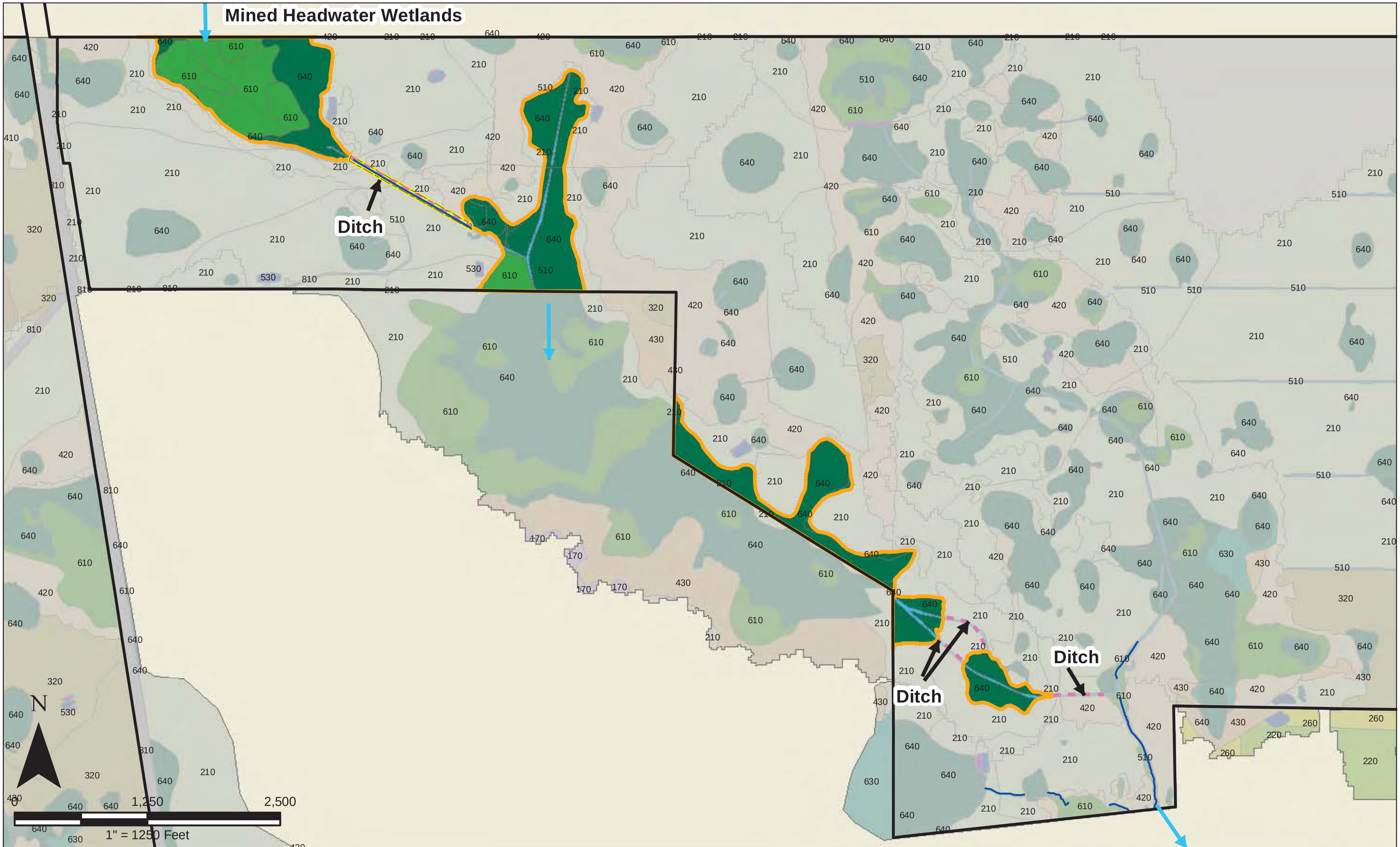
Map Prepared By: ARB

amec

CF

Project No.: 03-16268

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\27_Post_Troub_Creek_E_20110831.mxd



Notes:

FIGURE SRO-28
PRE-MINING
TROUBLESOME CREEK WEST BRANCH
SOUTH PASTURE EXTENSION
HARDEE COUNTY, FLORIDA

Explanation of Features

- Flow
- Streams
- Ditch
- West Lateral Chain Lotic System
- Belt Width
- No-Mine Boundary
- South Pasture Extension Boundary

Pre-Mining Land-Use (FLUCCS 1999)

- 170, Institutional
- 210, Cropland and Pastureland
- 220, Tree Crops
- 260, Other Open Lands <Rural>
- 310, Herbaceous (Dry Prairie)
- 320, Shrub and Brushland
- 330, Mixed Rangeland
- 410, Upland Coniferous Forests
- 420, Upland Hardwood Forests
- 430, Upland Mixed Forests
- 510, Streams and Waterways
- 530, Reservoirs
- 610, Wetland Hardwood Forests
- 620, Wetland Coniferous Forests
- 630, Wetland Forested Mixed
- 640, Vegetated Non-Forested Wetlands
- 740, Disturbed Lands
- 810, Transportation

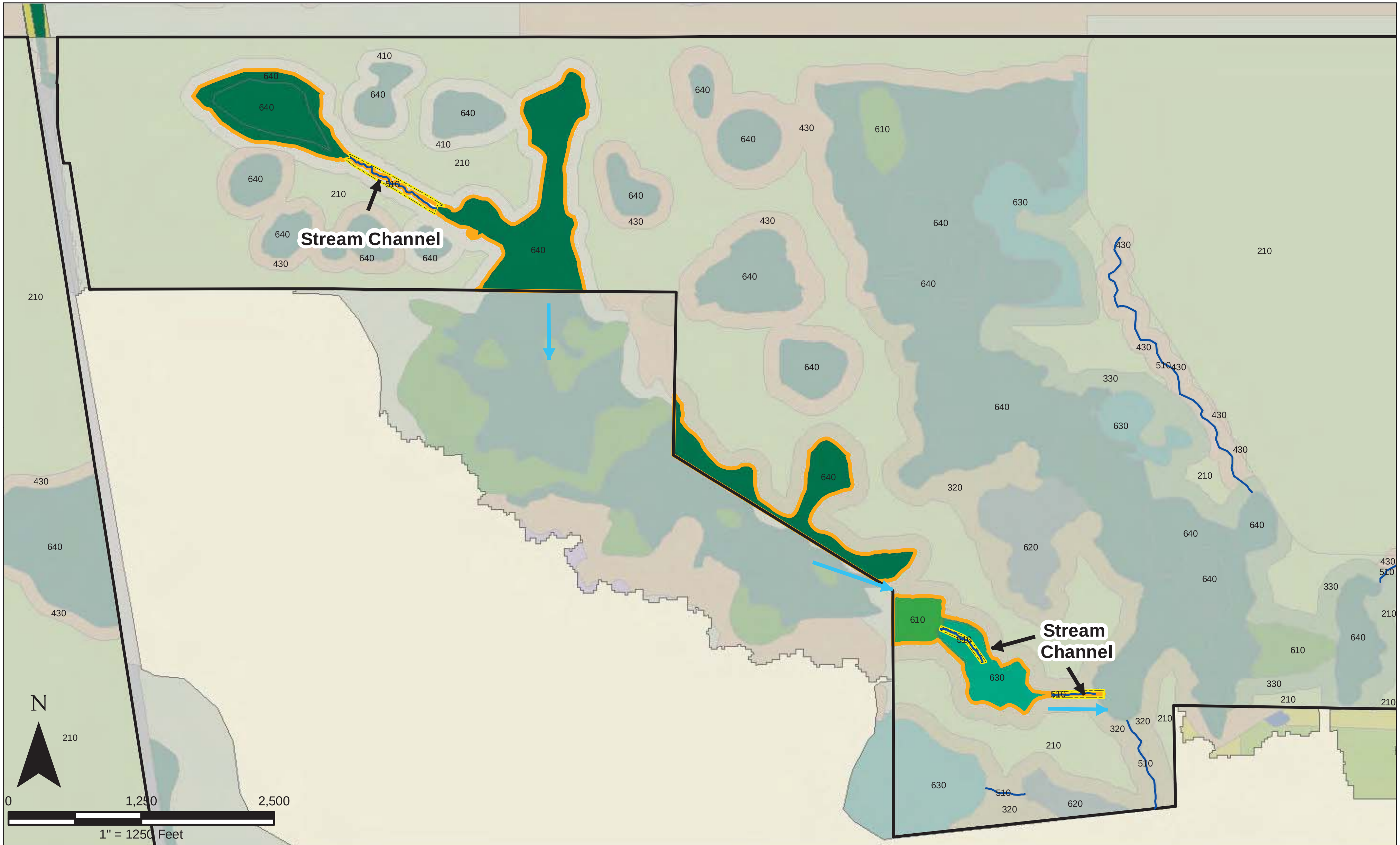
JOHN KIEFER P.E.
FLA. REG. NO. 51991

DATE:

Date: Revised Aug. 2011
Checked By: JHK
Map Prepared By: ARB

Project No.: 03-16268

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\28_Pre_Troub_Creek_W_20110831.mxd



Notes:

FIGURE SRO-29
POST-RECLAMATION
TROUBLESOME CREEK WEST BRANCH
SOUTH PASTURE EXTENSION
HARDEE COUNTY, FLORIDA

Explanation of Features

- Flow
- Post-Reclamation Streams
- West Lateral Chain Lotic System
- Belt Width
- No-Mine Boundary
- South Pasture Extension Boundary

Post Reclamation Land-Use (FLUCCS 1999)

- 150, Industrial
- 170, Institutional
- 210, Cropland and Pastureland
- 220, Tree Crops
- 260, Other Open Lands <Rural>
- 310, Herbaceous (Dry Prairie)
- 320, Shrub and Brushland
- 330, Mixed Rangeland
- 410, Upland Coniferous Forests
- 420, Upland Hardwood Forests
- 430, Upland Mixed Forests
- 510, Streams & Waterways
- 530, Reservoirs
- 610, Wetland Hardwood Forests
- 620, Wetland Coniferous Forests
- 630, Wetland Forested Mixed
- 640, Vegetated Non-Forested Wetlands
- 740, Disturbed Lands
- 810, Transportation

JOHN KIEFER P.E.
FLA. REG. NO. 51991

DATE:

Date: Revised Jan. 2011

Checked By: JHK

Map Prepared By: ARB

amec

CF

Project No.: 03-16268

File Pathway: V:\03-16268_CF_SP_SPX_Permit\Streams_Restoration\MXD\Update_083011\29_Post_Troub_Creek_W_20110831.mxd

Appendix

Photograph #1: 2010 BC-MT-01 Upstream

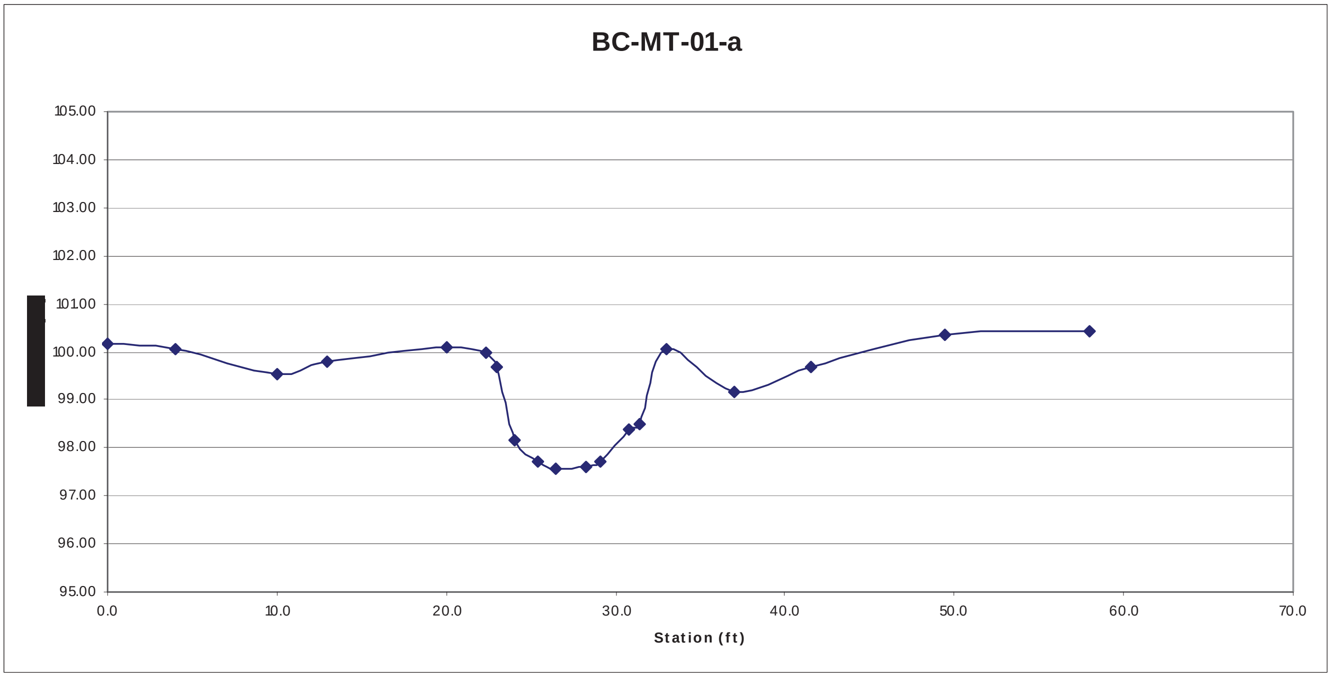
Photograph #2: 2010 BC-MT-01 Downstream

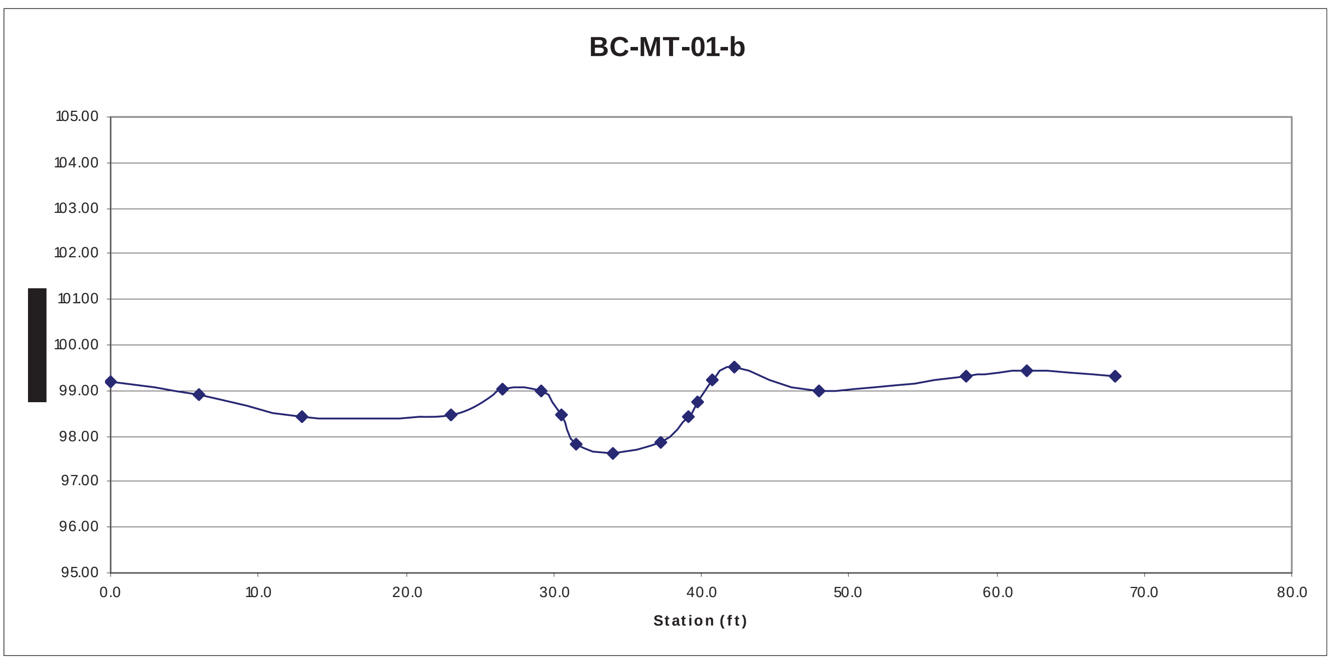
Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2010 BC-MT-01 Right Bank

Photograph #4: 2010 BC-MT-01 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.





Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2007 BC-MT-08 Upstream

Photograph #2: 2007 BC-MT-08 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2007 BC-MT-08 Right Bank

Photograph #4: 2007 BC-MT-08 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2010 BC-MT-08 Upstream

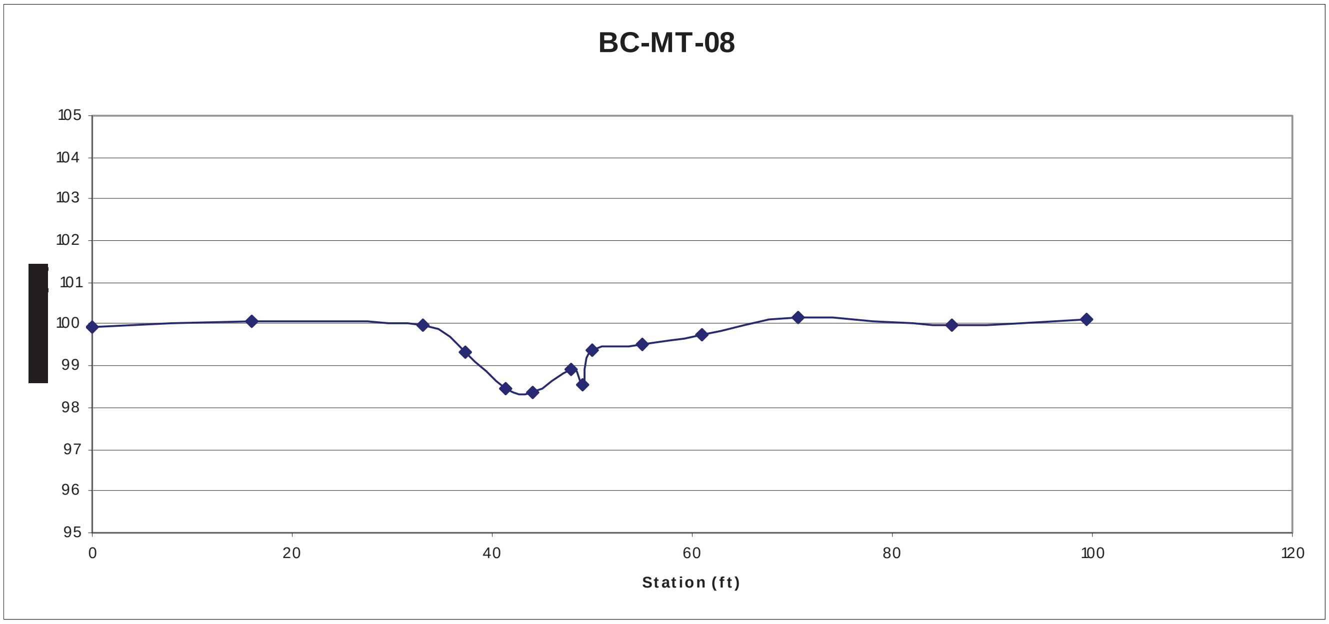
Photograph #2: 2010 BC-MT-08 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2010 BC-MT-08 Right Bank

Photograph #4: 2010 BC-MT-08 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2007 BC-MT-09 Upstream

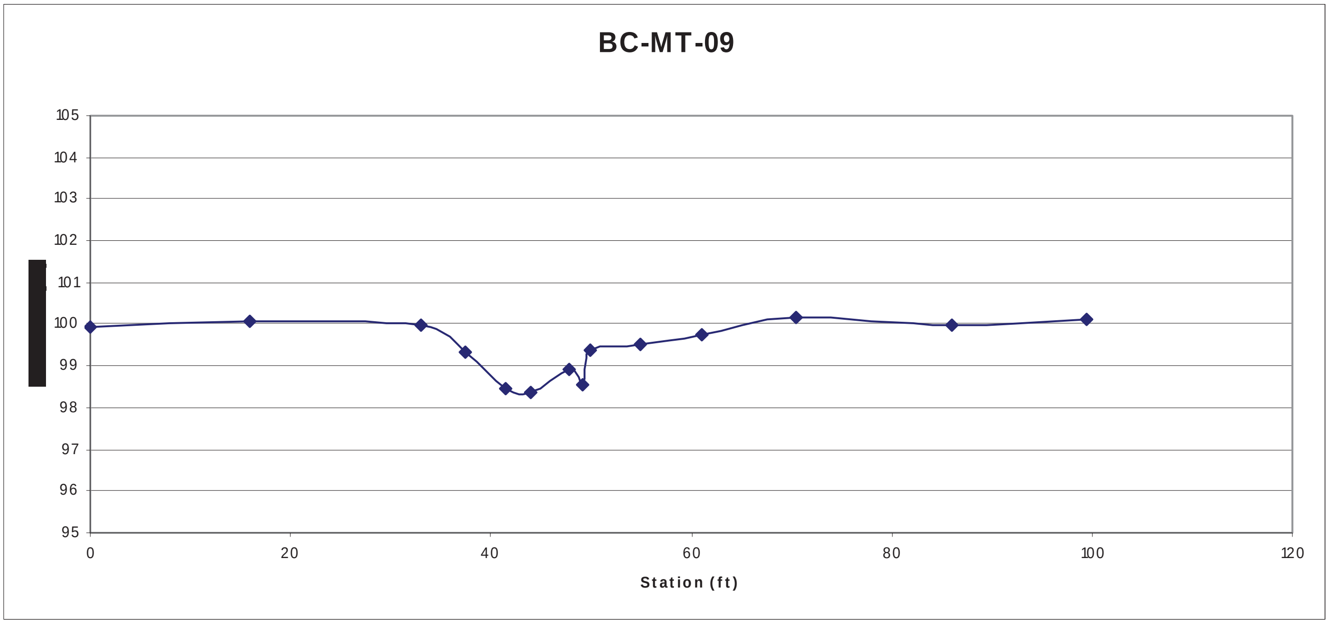
Photograph #2: 2007 BC-MT-09 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2007 BC-MT-09 Right Bank

Photograph #4: 2007 BC-MT-09 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2007 BC-MT-10 Upstream

Photograph #2: 2007 BC-MT-10 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2007 BC-MT-10 Right Bank

Photograph #4: 2007 BC-MT-10 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2010 BC-MT-10 Upstream

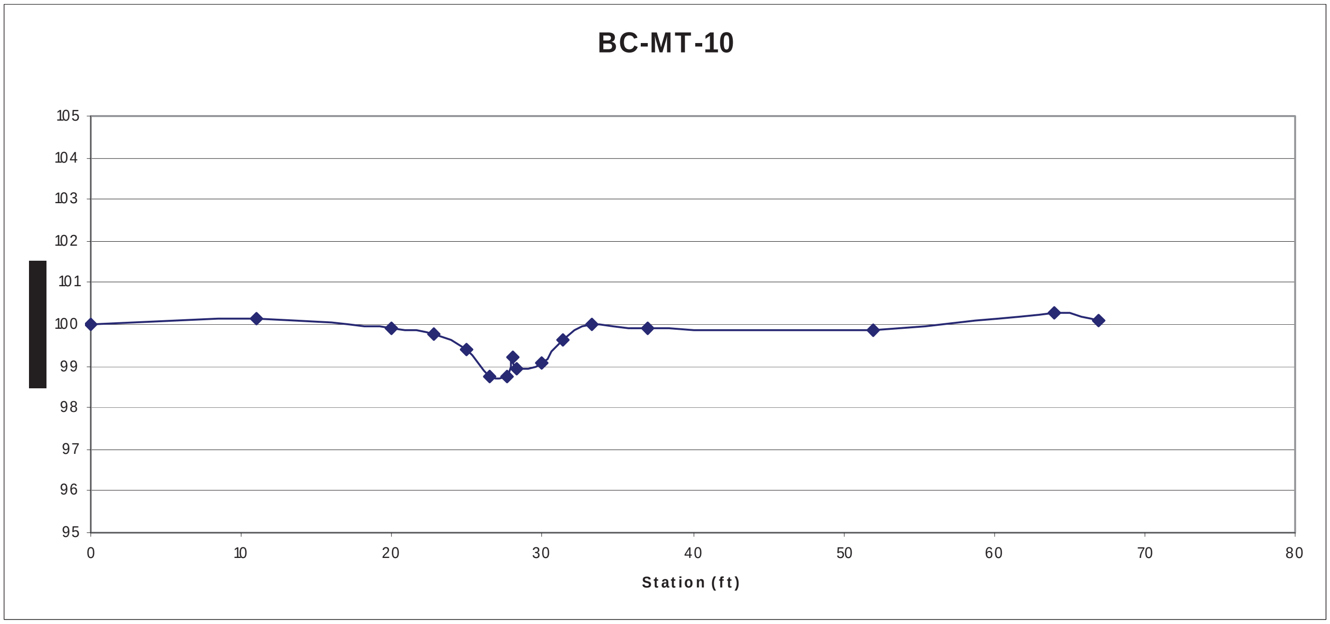
Photograph #2: 2010 BC-MT-10 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2010 BC-MT-10 Right Bank

Photograph #4: 2010 BC-MT-10 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2007 BC-MT-11 Upstream

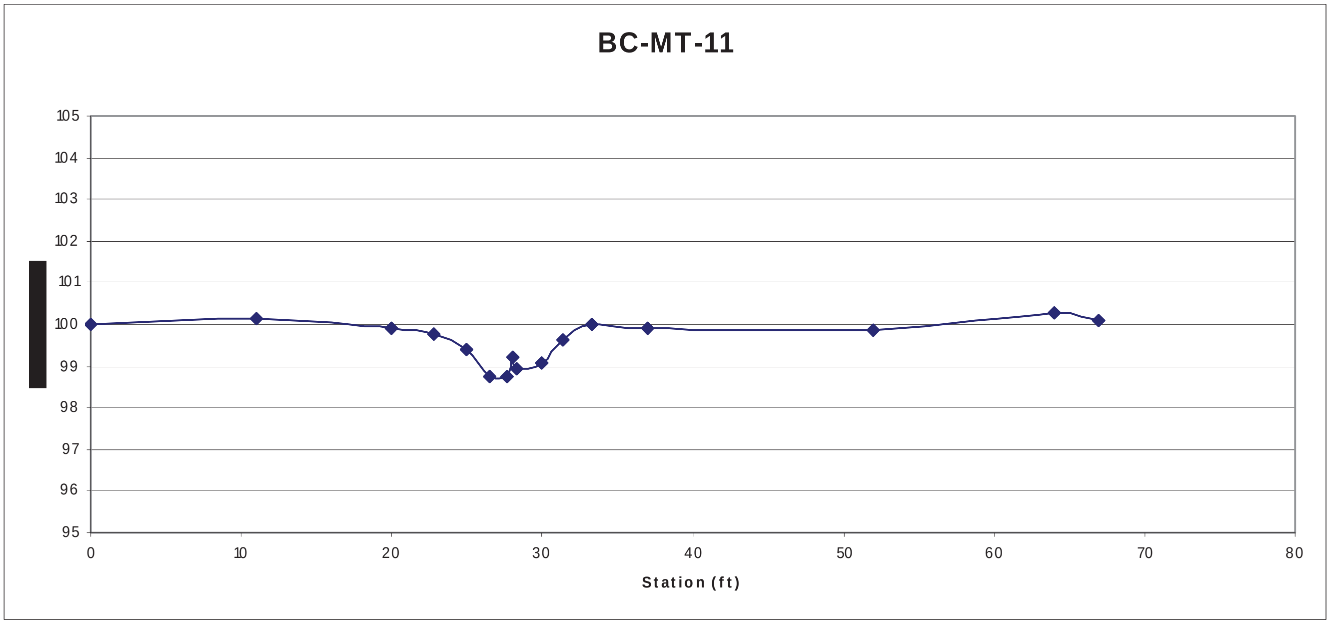
Photograph #2: 2007 BC-MT-11 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2007 BC-MT-11 Right Bank

Photograph #4: 2007 BC-MT-11 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2010 BC-MT-12 Upstream

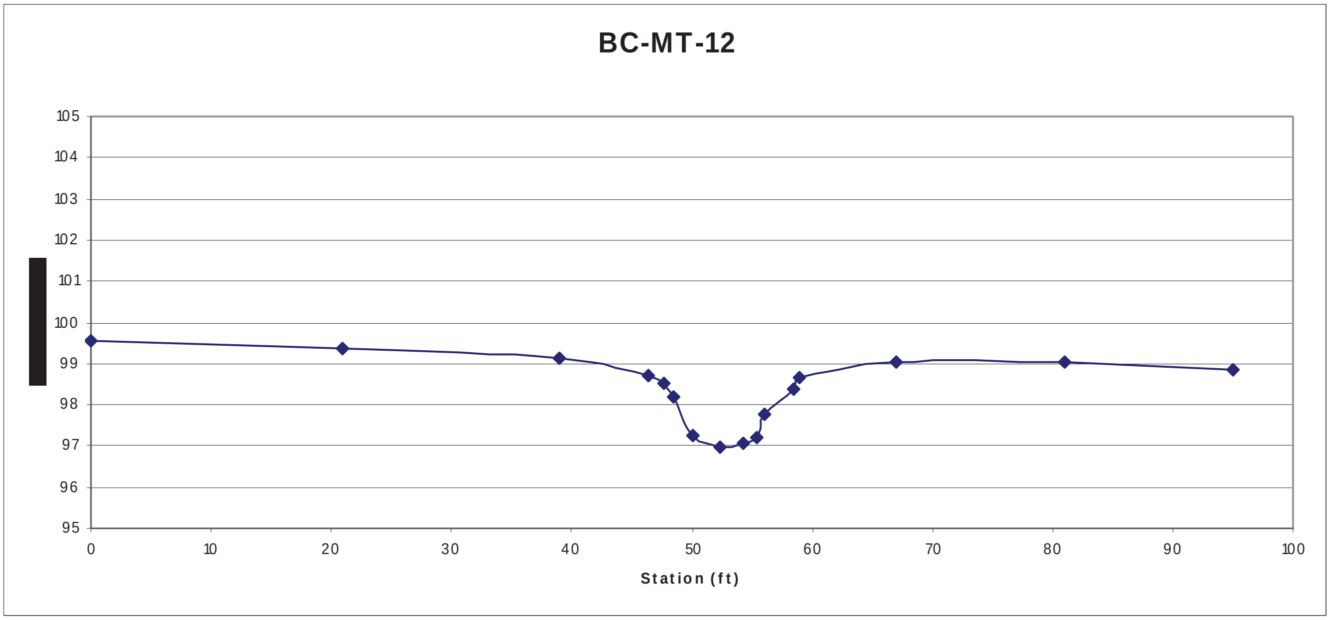
Photograph #2: 2010 BC-MT-12 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2010 BC-MT-12 Right Bank

Photograph #4: 2010 BC-MT-12 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2007 BC-MT-13 Upstream

Photograph #2: 2007 BC-MT-13 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2007 BC-MT-13 Right Bank

Photograph #4: 2007 BC-MT-13 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2010 BC-MT-13 Upstream

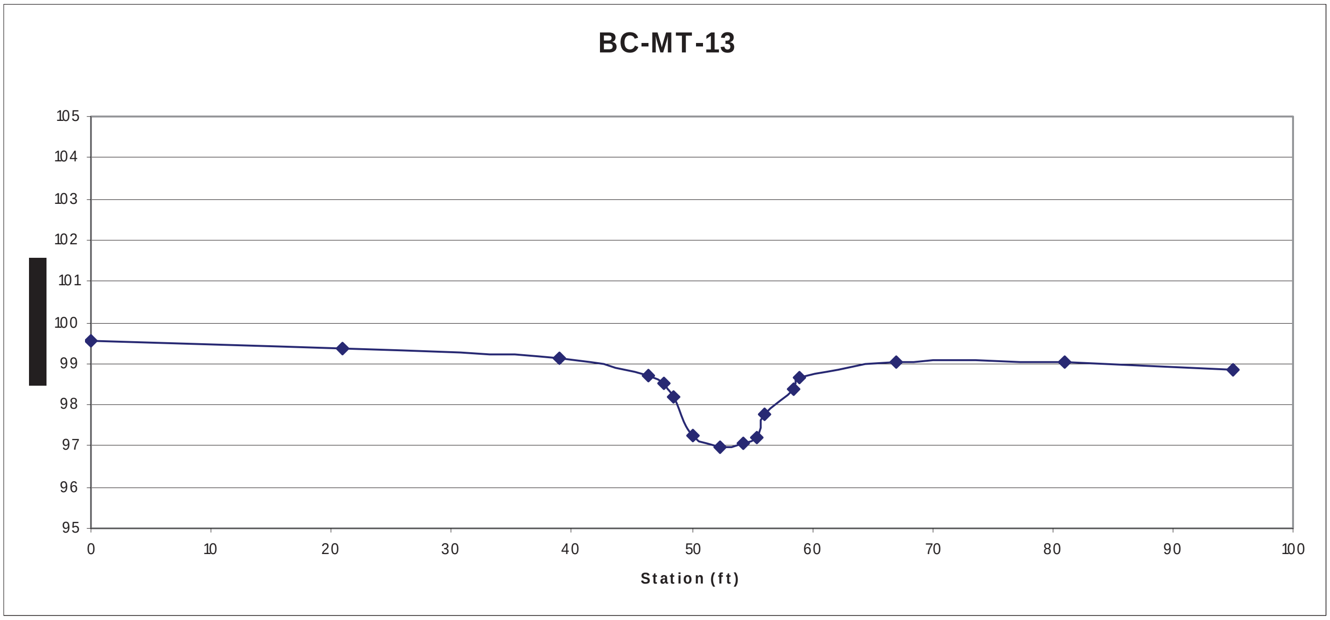
Photograph #2: 2010 BC-MT-13 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2010 BC-MT-13 Right Bank

Photograph #4: 2010 BC-MT-13 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2007 BC-MT-15 Upstream

Photograph #2: 2007 BC-MT-15 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2007 BC-MT-15 Right Bank

Photograph #4: 2007 BC-MT-15 Left Bank

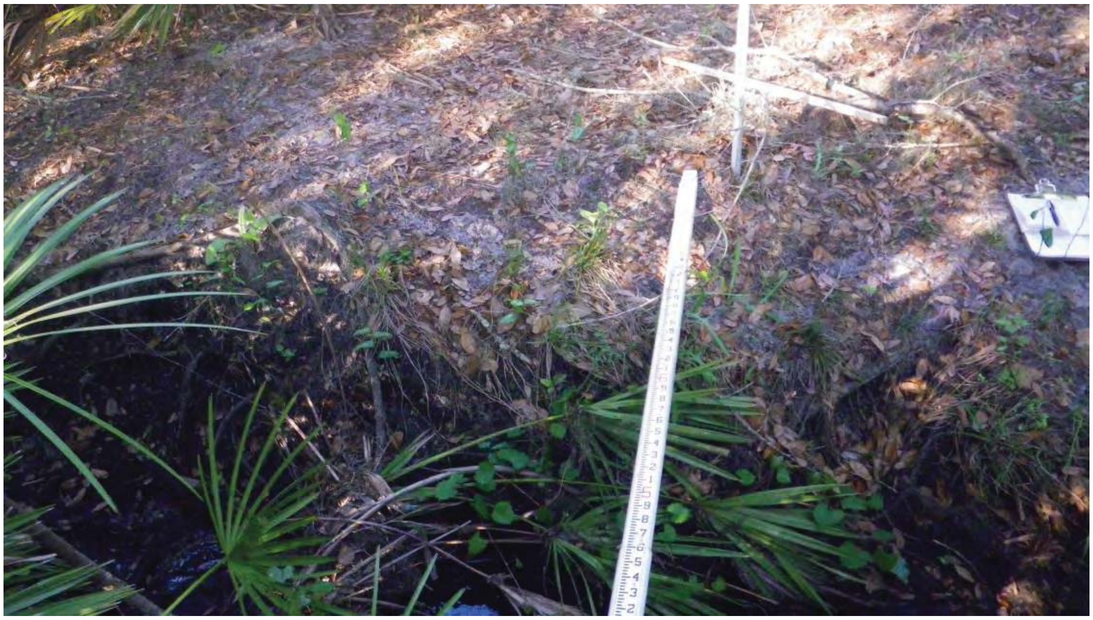
Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2010 BC-MT-15 Upstream

Photograph #2: 2010 BC-MT-15 Downstream

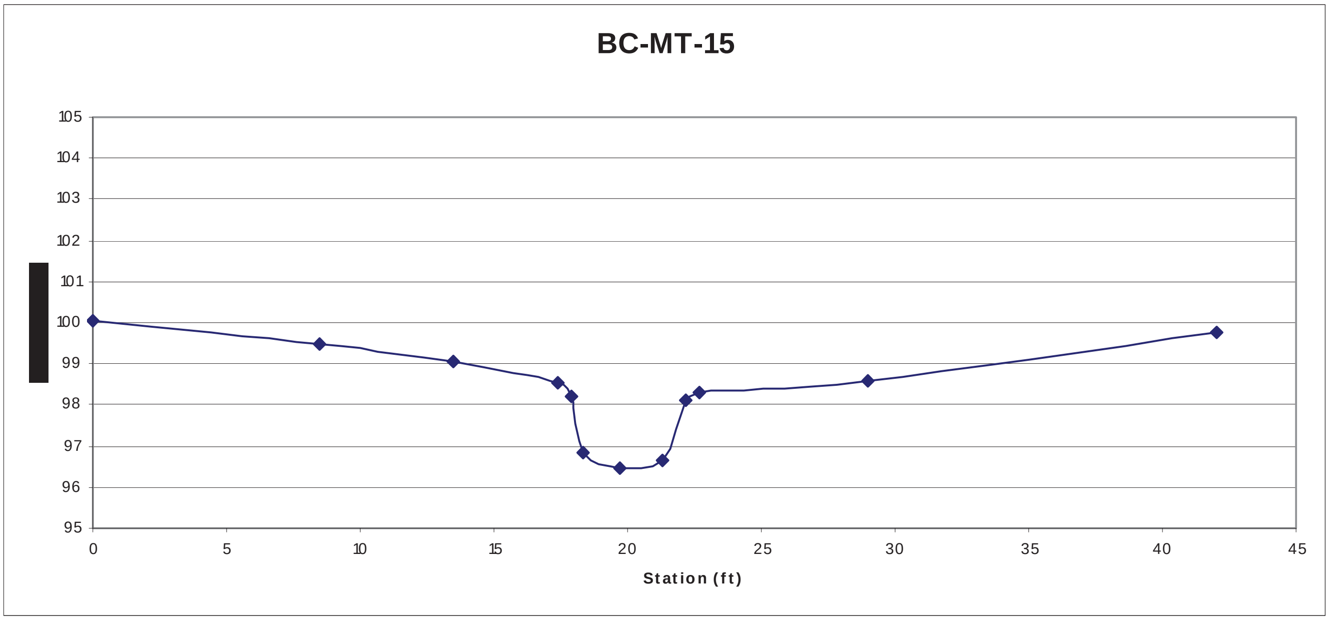
Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2010 BC-MT-15 Right Bank



Photograph #4: 2010 BC-MT-15 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2007 BC-MT-16 Upstream

Photograph #2: 2007 BC-MT-16 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2007 BC-MT-16 Right Bank

Photograph #4: 2007 BC-MT-16 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2010 BC-MT-16 Upstream

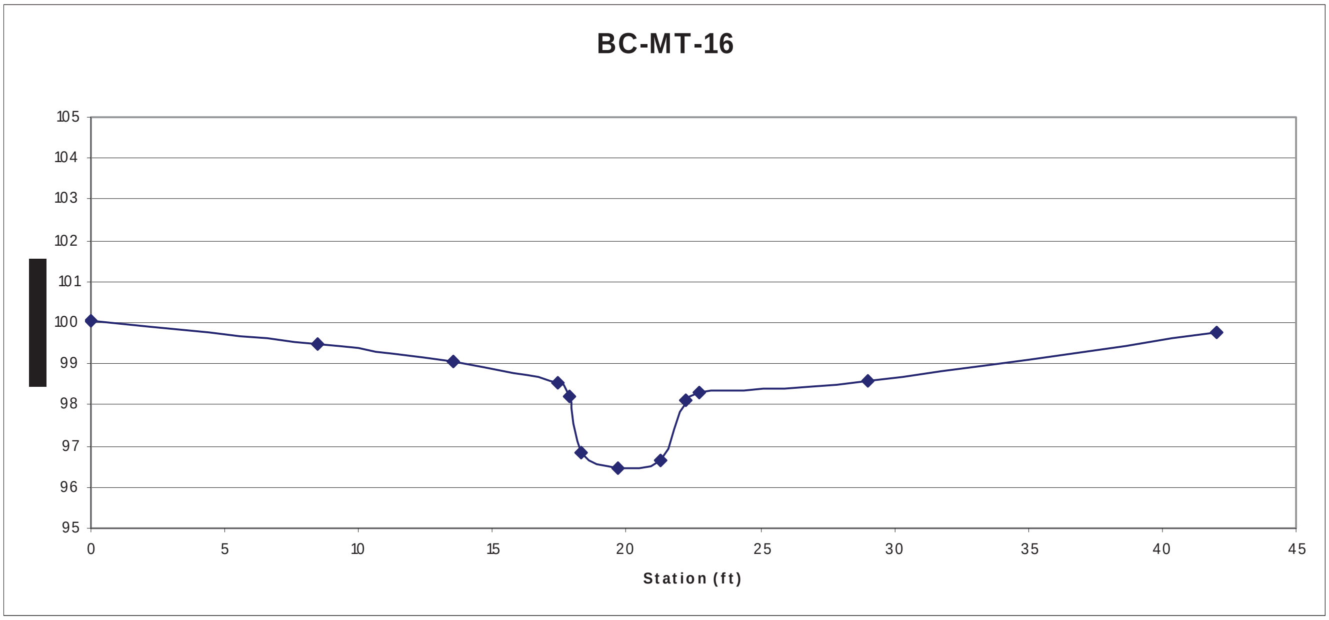
Photograph #2: 2010 BC-MT-16 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2010 BC-MT-16 Right Bank

Photograph #4: 2010 BC-MT-16 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2007 BC-NC-01 Upstream

Photograph #2: 2007 BC-NC-01 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2007 BC-NC-01 Right Bank

Photograph #4: 2007 BC-NC-01 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2010 BC-NC-01 Upstream

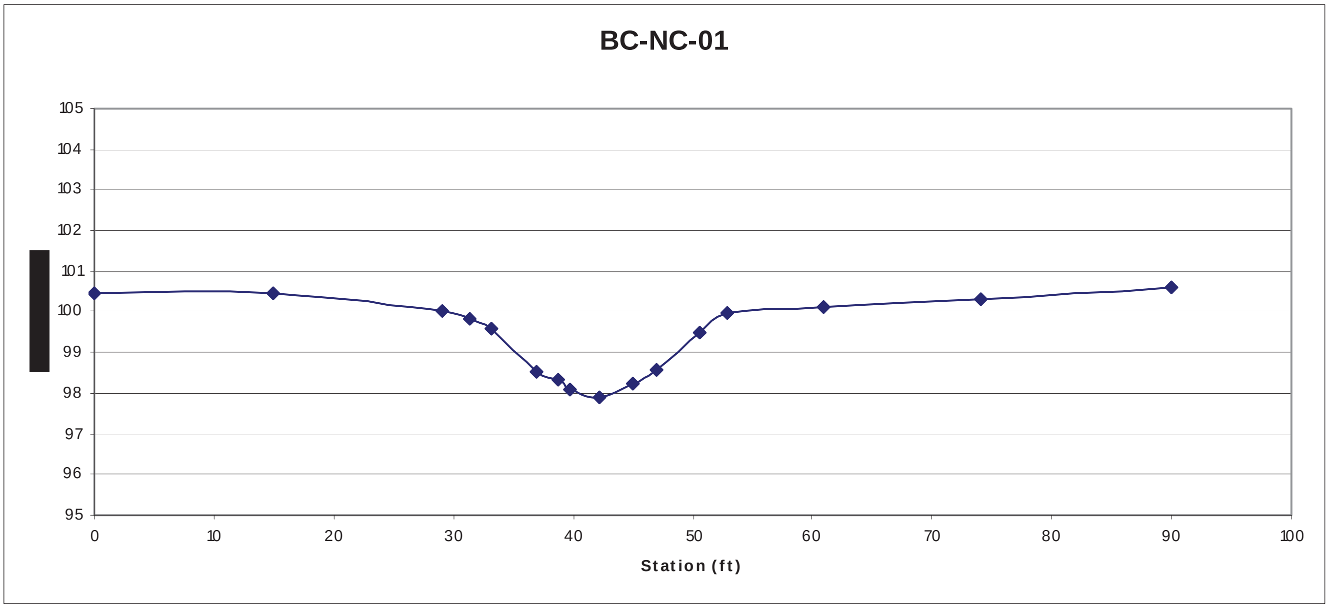
Photograph #2: 2010 BC-NC-01 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2010 BC-NC-01 Right Bank

Photograph #4: 2010 BC-NC-01 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2007 BC-NC-02 Upstream

Photograph #2: 2007 BC-NC-02 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2007 BC-NC-02 Right Bank

Photograph #4: 2007 BC-NC-02 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2010 BC-NC-02 Upstream

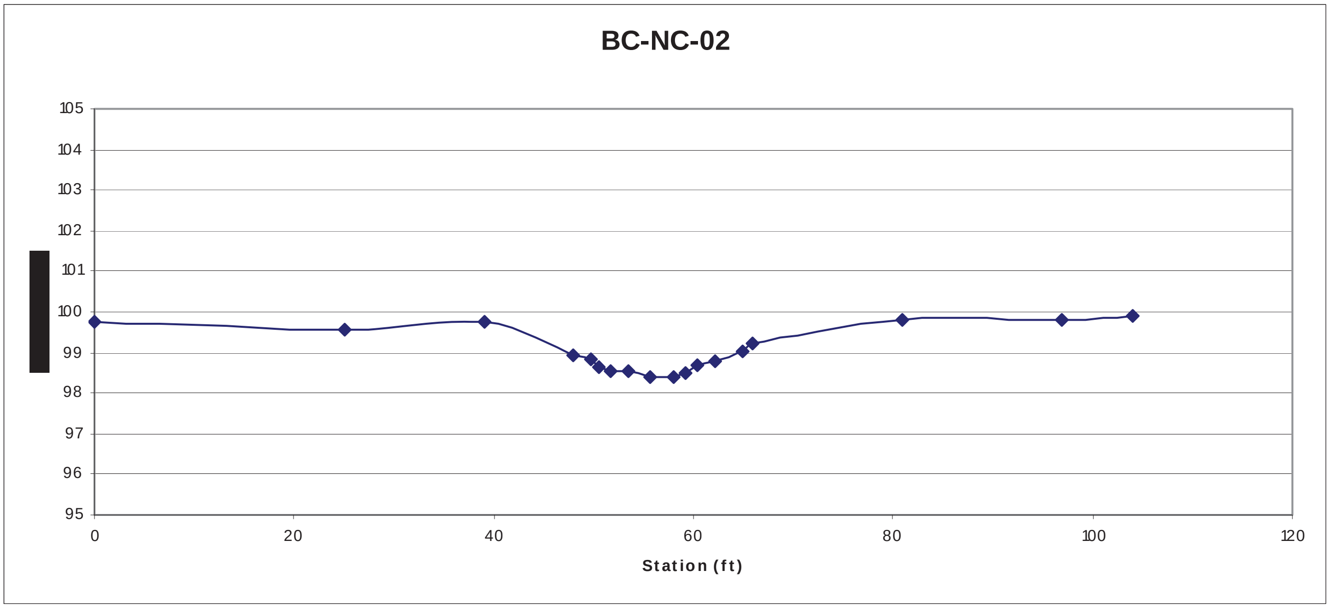
Photograph #2: 2010 BC-NC-02 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

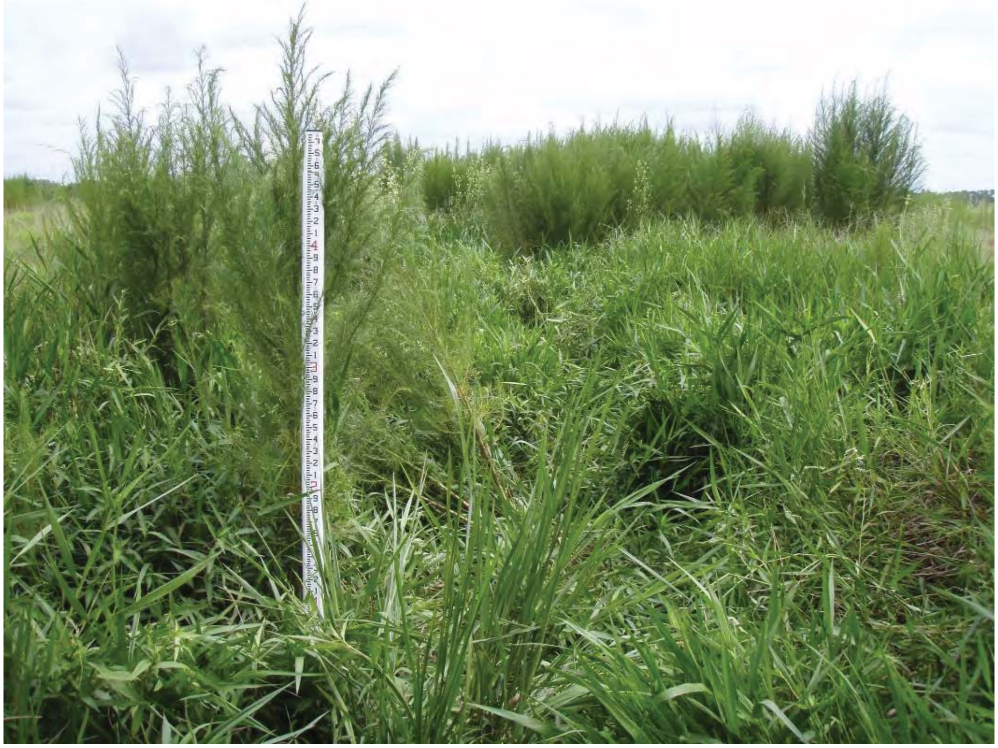
Photograph #3: 2010 BC-NC-02 Right Bank

Photograph #4: 2010 BC-NC-02 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Photograph #1: 2007 BC-NC-03 Upstream

Photograph #2: 2007 BC-NC-03 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2007 BC-NC-03 Right Bank

Photograph #4: 2007 BC-NC-03 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2010 BC-NC-03 Upstream

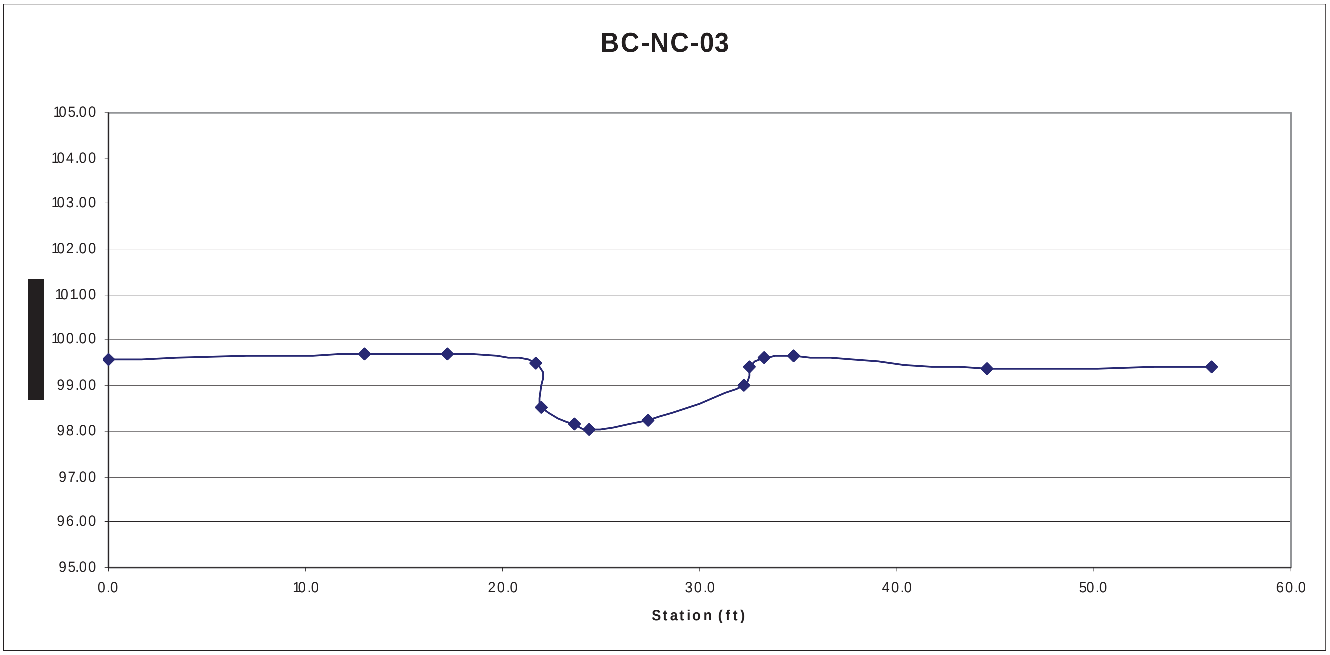
Photograph #2: 2010 BC-NC-03 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2010 BC-NC-03 Right Bank

Photograph #4: 2010 BC-NC-03 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2007 BC-NC-05 Upstream

Photograph #2: 2007 BC-NC-05 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2007 BC-NC-05 Right Bank

Photograph #4: 2007 BC-NC-05 Left Bank

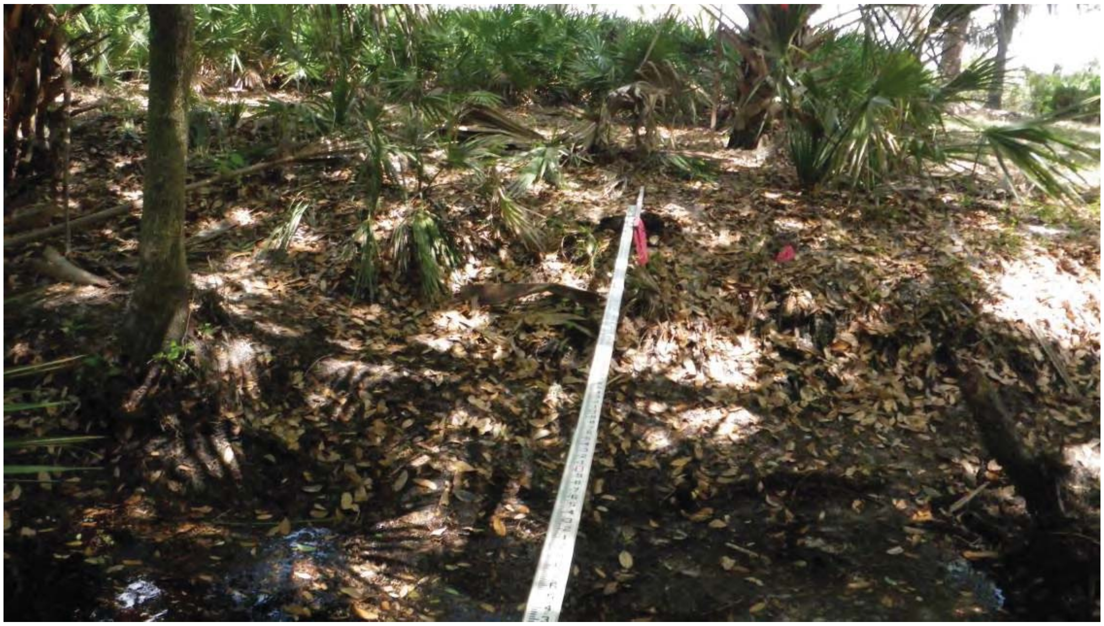
Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2010 BC-NC-05 Upstream

Photograph #2: 2010 BC-NC-05 Downstream

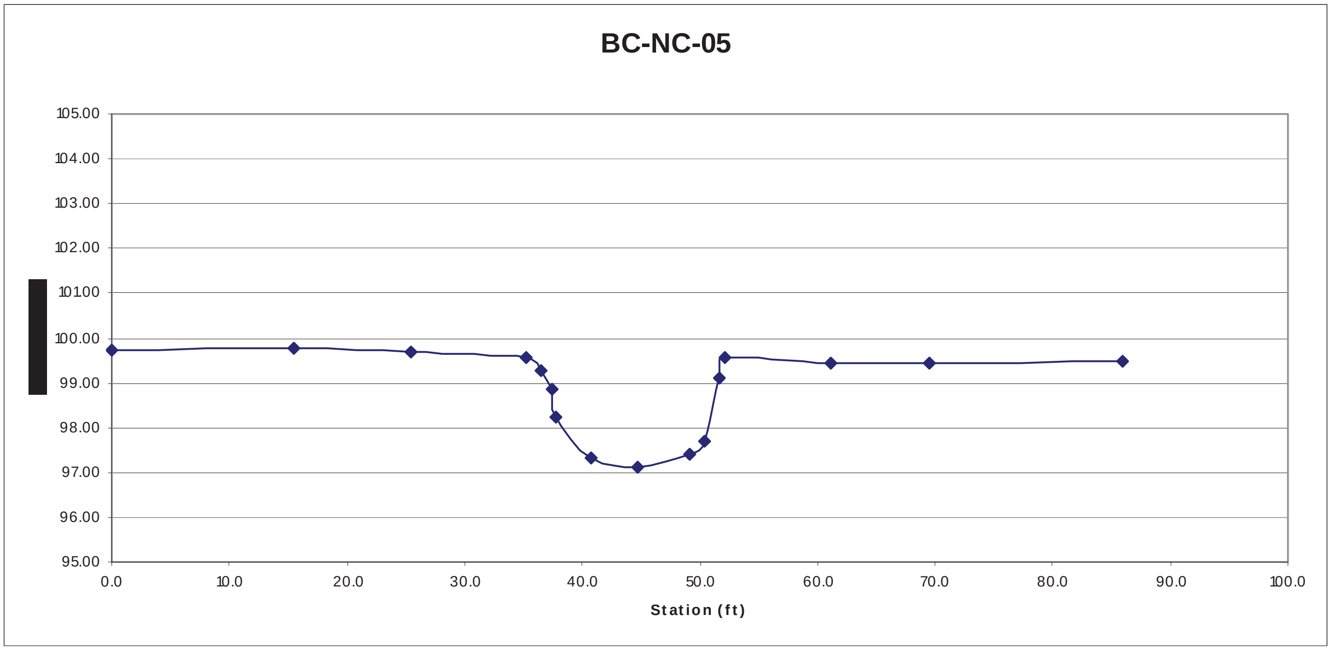
Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2010 BC-NC-05 Right Bank



Photograph #4: 2010 BC-NC-05 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2010 BC-NC-13 Upstream

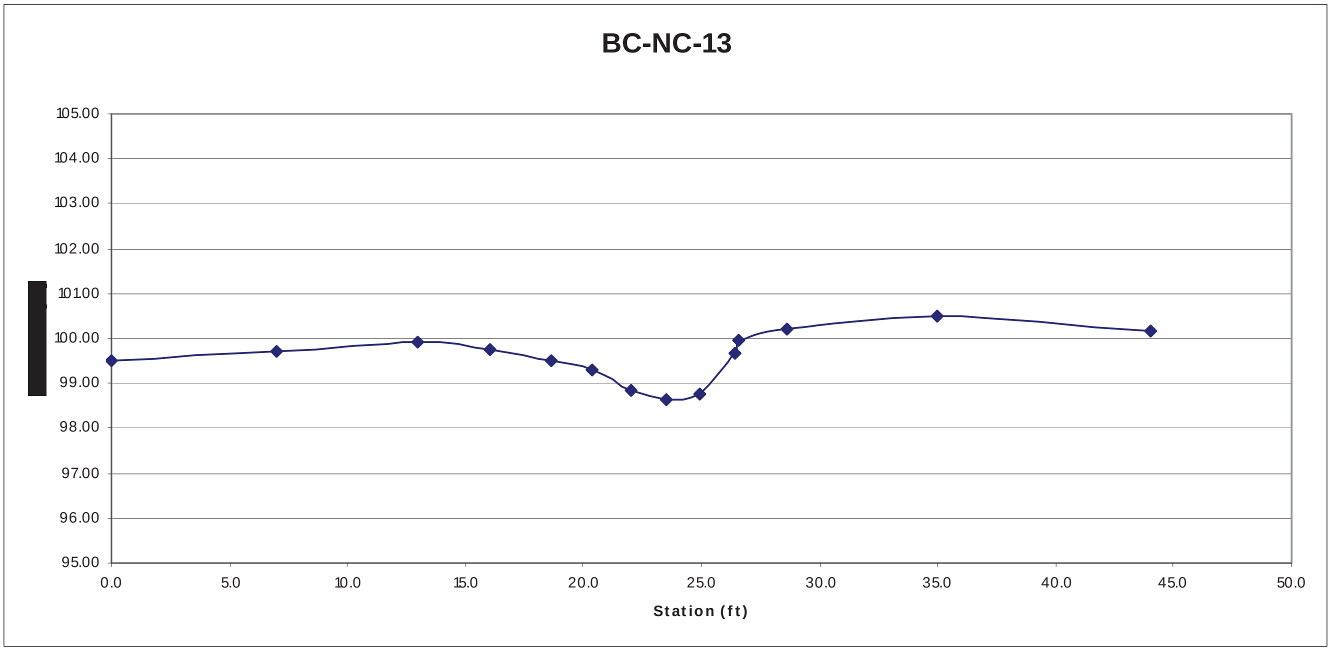
Photograph #2: 2010 BC-NC-13 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2010 BC-NC-13 Right Bank

Photograph #4: 2010 BC-NC-13 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2010 BC-NE-06 Upstream

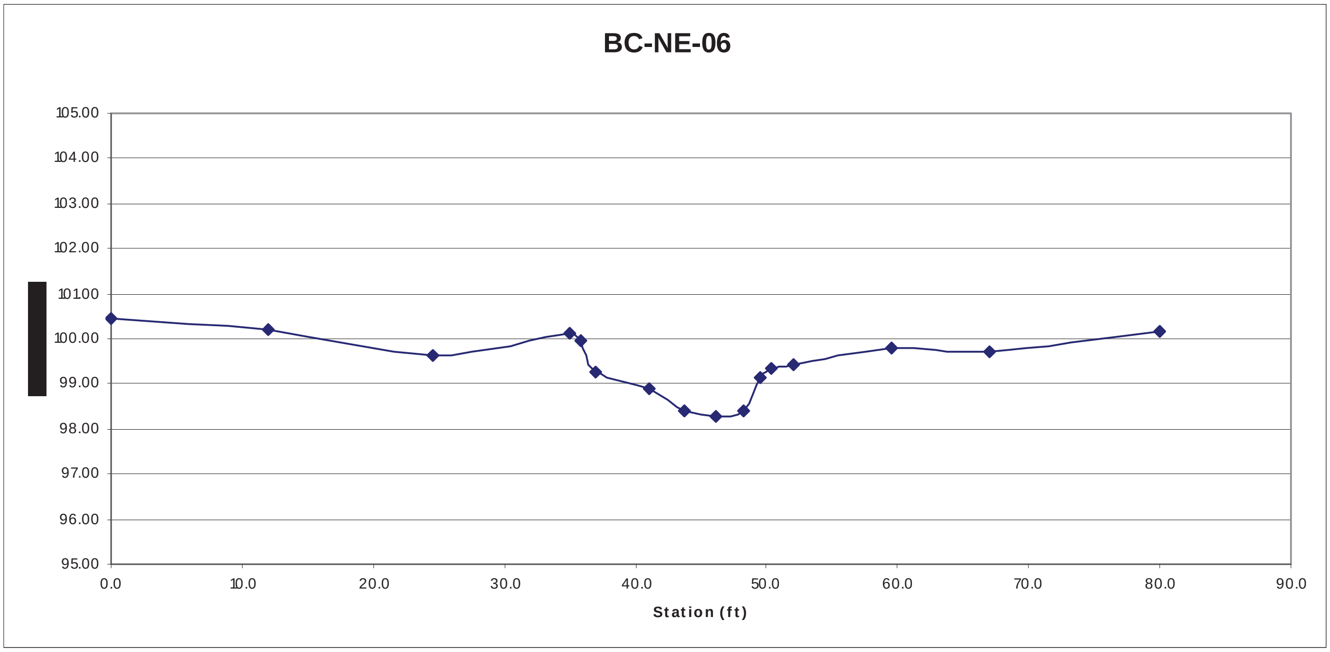
Photograph #2: 2010 BC-NE-06 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2010 BC-NE-06 Right Bank

Photograph #4: 2010 BC-NE-06 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2007 BC-NW-01 Upstream

Photograph #2: 2007 BC-NW-01 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2007 BC- NW-01 Right Bank

Photograph #4: 2007 BC- NW-01 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2010 BC-NW-01 Upstream

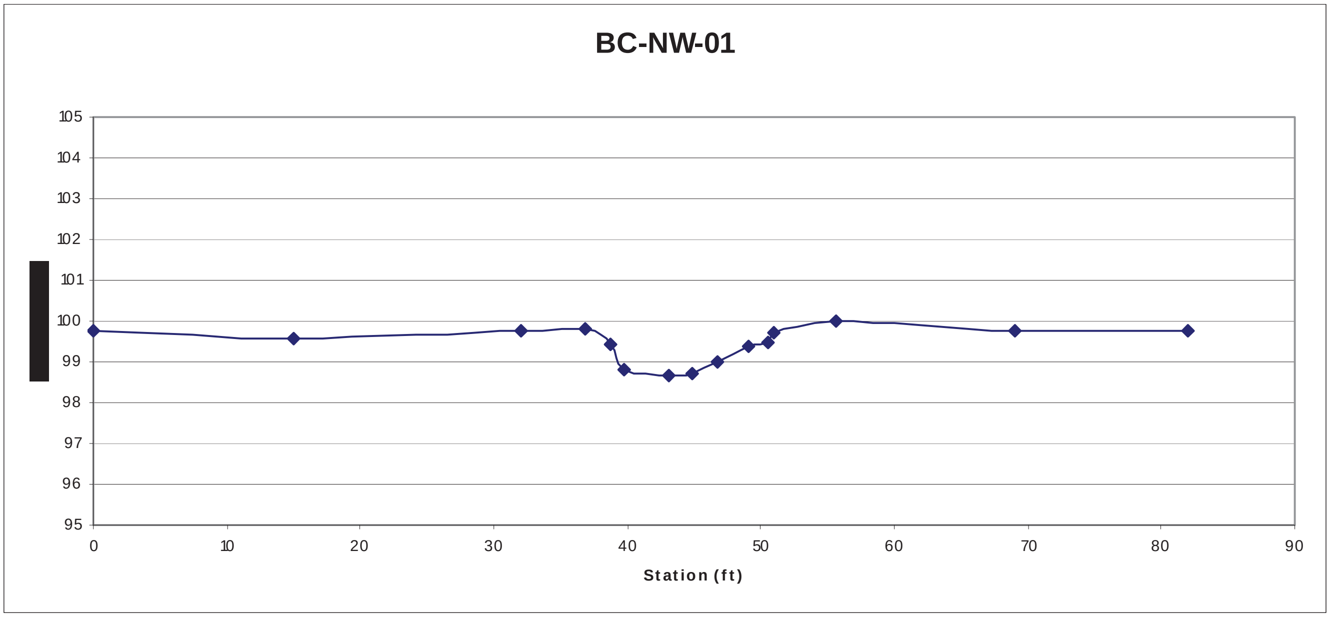
Photograph #2: 2010 BC-NW-01 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2010 BC-NW-01 Right Bank

Photograph #4: 2010 BC-NW-01 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2007 BC-NW-02 Upstream

Photograph #2: 2007 BC-NW-02 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2007 BC- NW-02 Right Bank

Photograph #4: 2007 BC- NW-02 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2010 BC- NW-02 Upstream

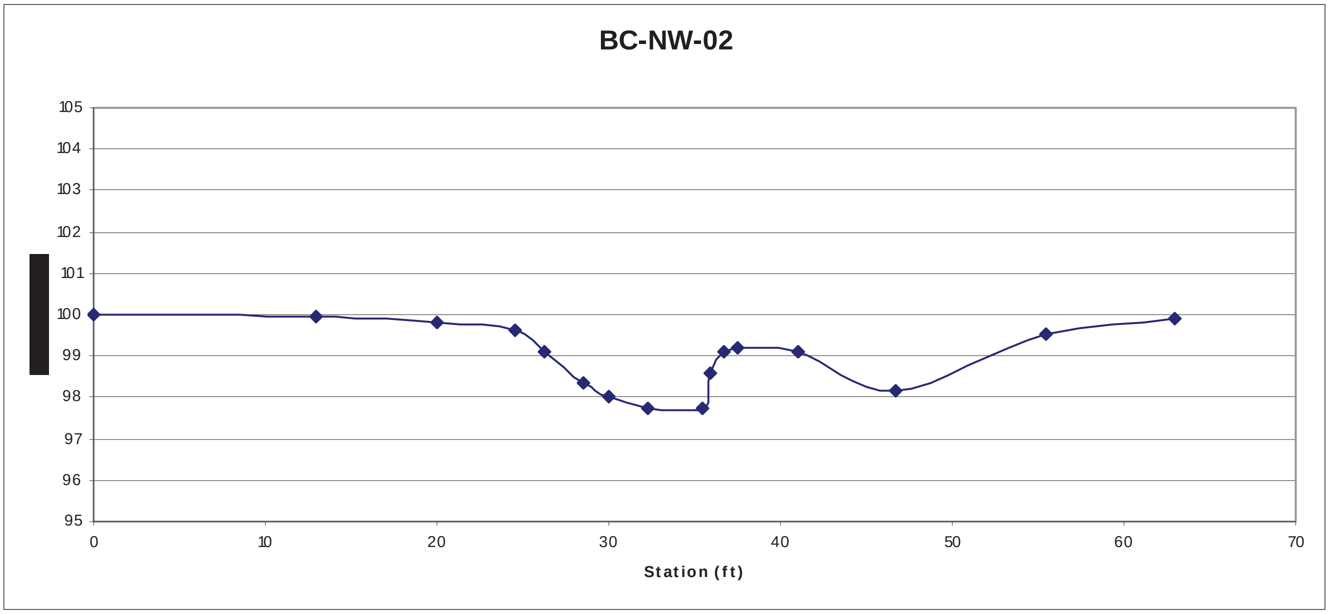
Photograph #2: 2010 BC- NW-02 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2010 BC-NW-02 Right Bank

Photograph #4: 2010 BC-NW-02 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2010 BC-NW-03 Upstream

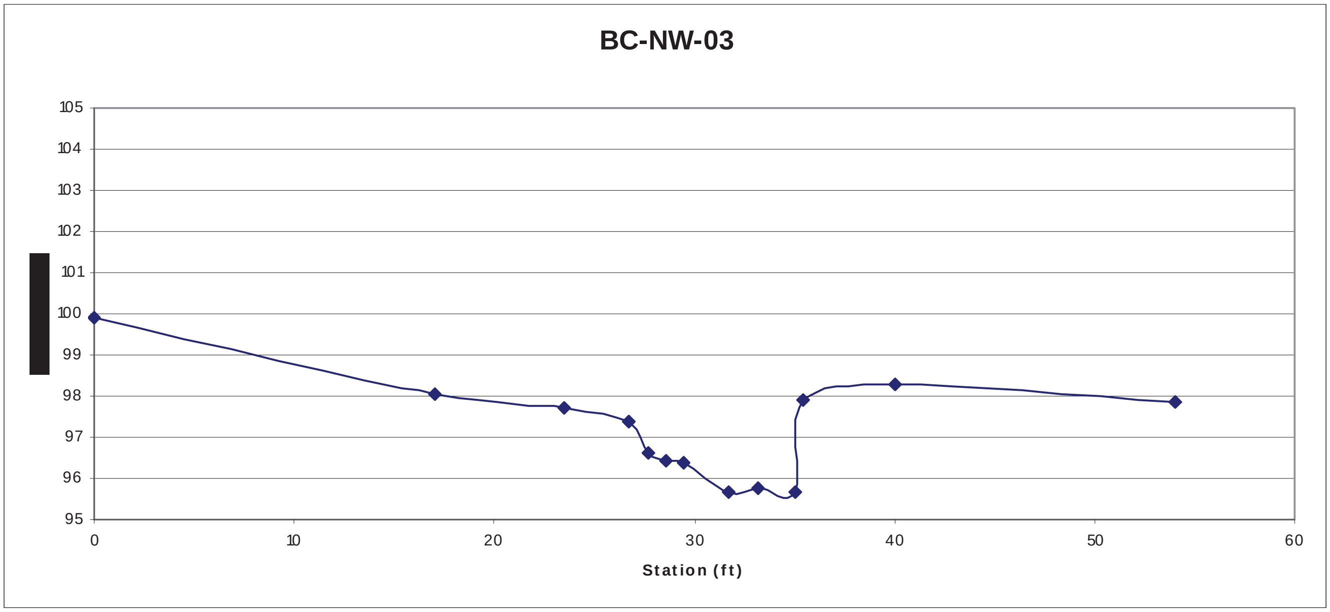
Photograph #2: 2010 BC-NW-03 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2010 BC-NW-03 Right Bank

Photograph #4: 2010 BC-NW-03 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2010 BC-NW-04 Upstream

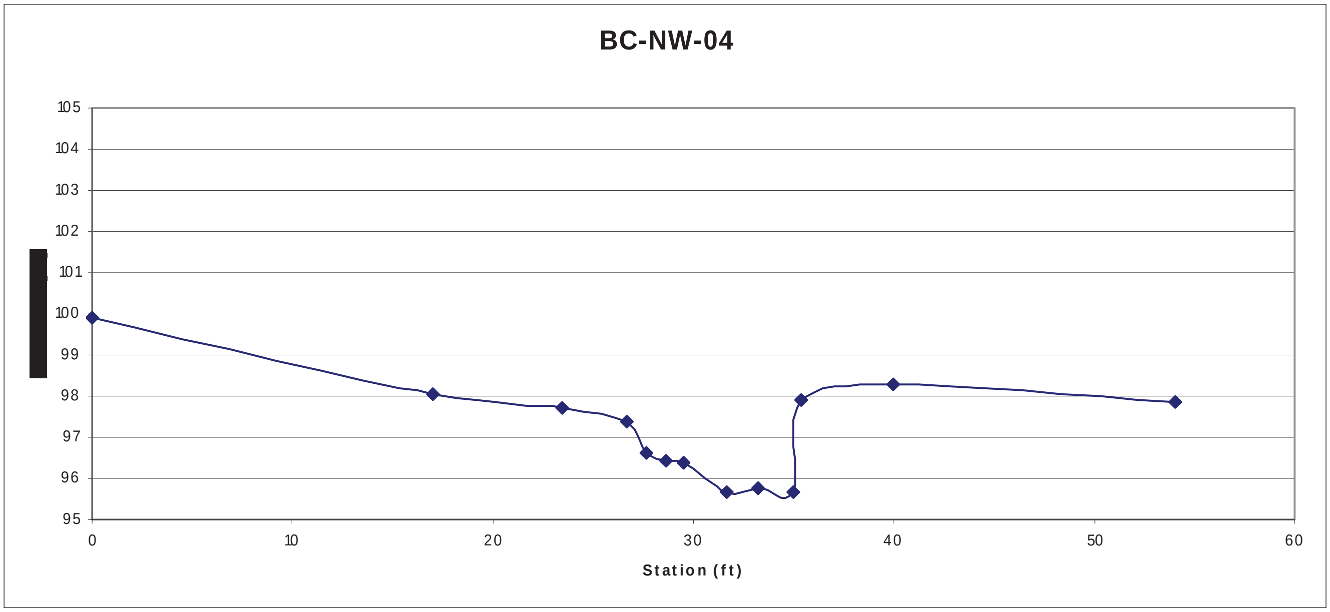
Photograph #2: 2010 BC-NW-04 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2010 BC-NW-04 Right Bank

Photograph #4: 2010 BC-NW-04 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2007 BC-SW-02 Upstream

Photograph #2: 2007 BC- SW-02 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2007 BC- SW-02 Right Bank

Photograph #4: 2007 BC- SW-02 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2010 BC- SW-02 Upstream

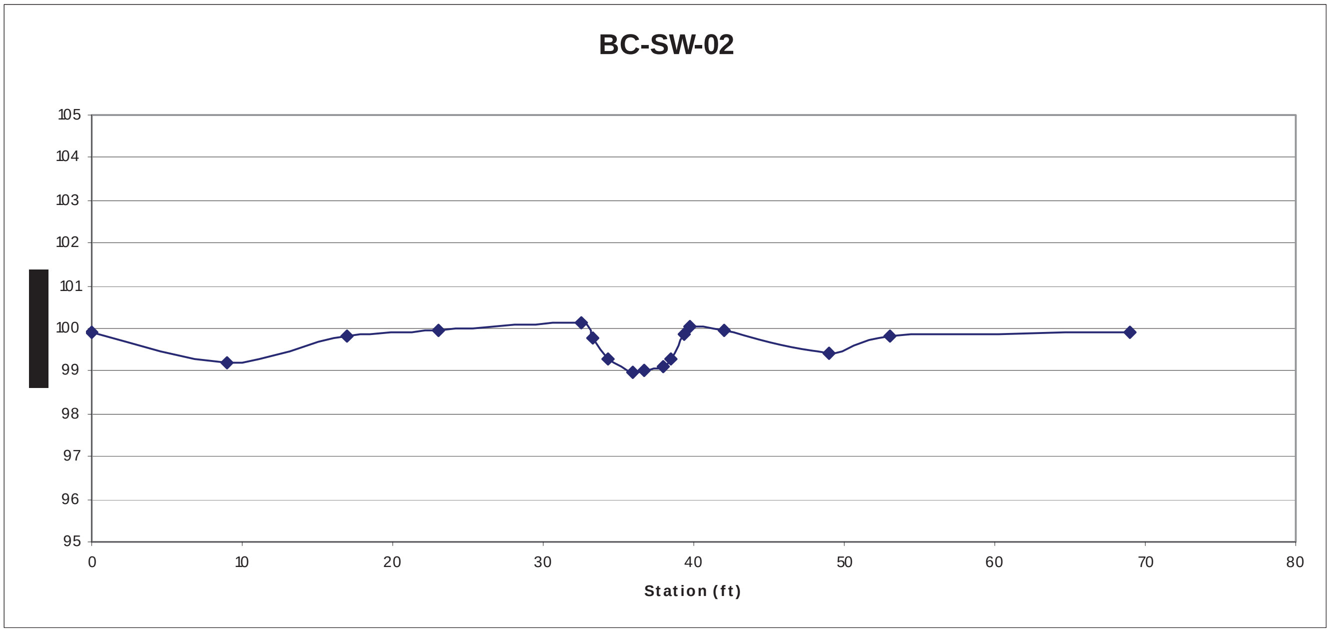
Photograph #2: 2010 BC- SW-02 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2010 BC- SW-02 Right Bank

Photograph #4: 2010 BC- SW-02 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2007 BC-SW-03 Upstream

Photograph #2: 2007 BC-SW-03 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2007 BC-SW-03 Right Bank

Photograph #4: 2007 BC-SW-03 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2010 BC-SW-03 Upstream

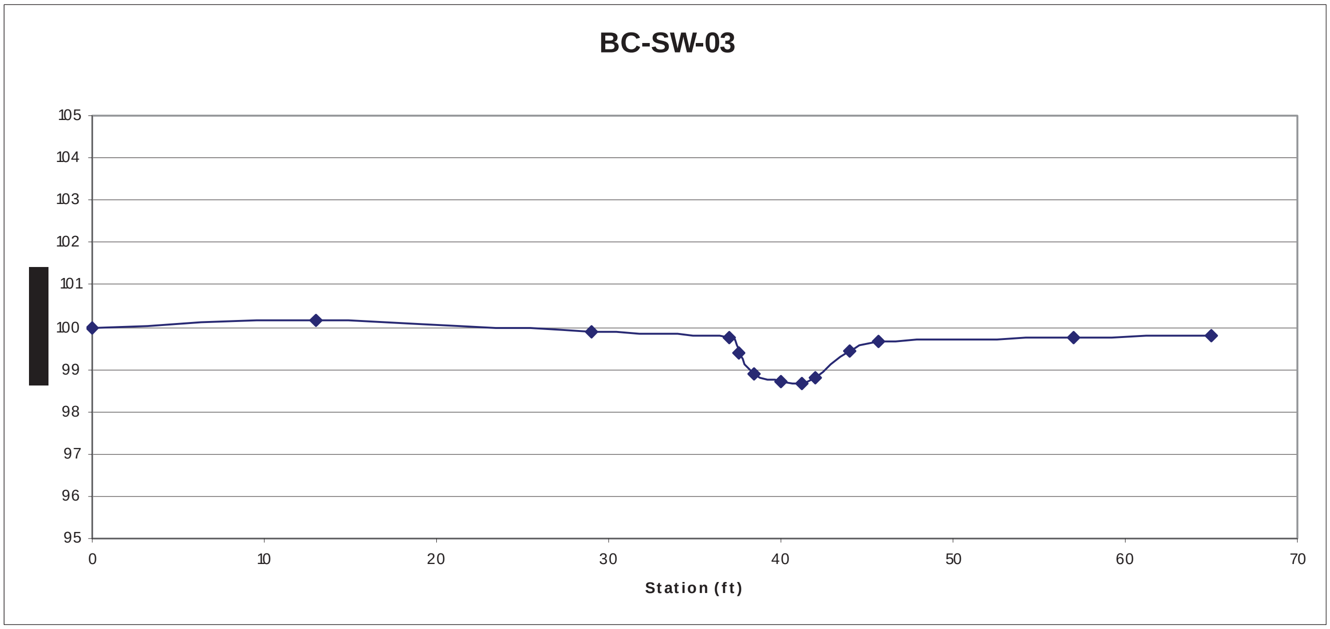
Photograph #2: 2010 BC-SW-03 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2010 BC-SW-03 Right Bank

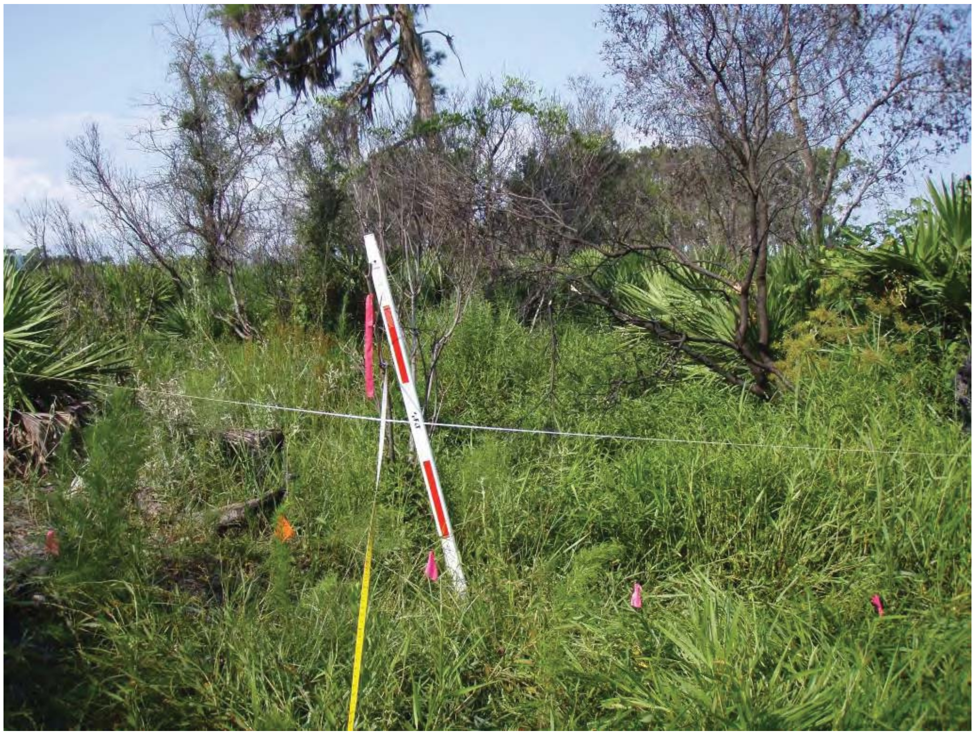
Photograph #4: 2010 BC-SW-03 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2007 BC-SW-04 Upstream



Photograph #2: 2007 BC-SW-04 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2007 BC-SW-04 Right Bank

Photograph #4: 2007 BC-SW-04 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2010 BC-SW-04 Upstream

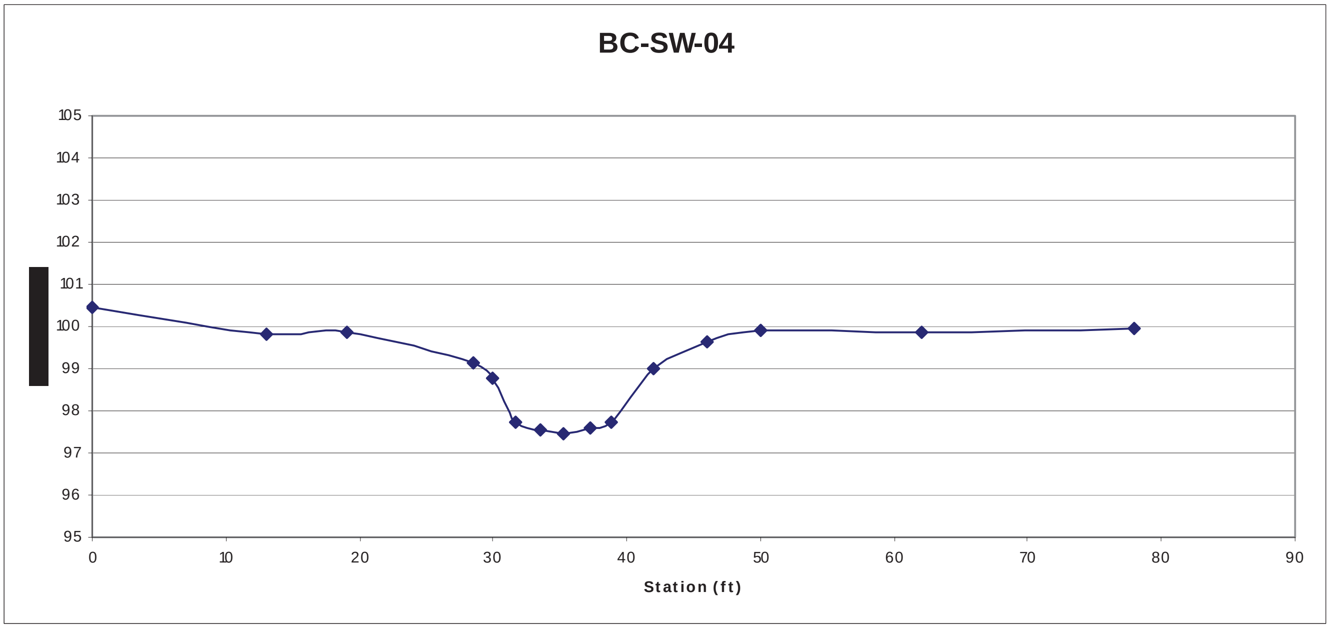
Photograph #2: 2010 BC-SW-04 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2010 BC-SW-04 Right Bank

Photograph #4: 2010 BC-SW-04 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

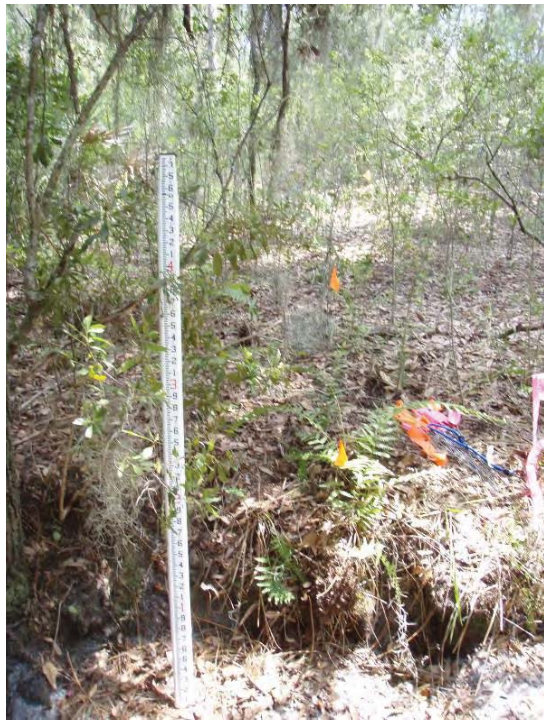


Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2007 BC-SW-06 Upstream

Photograph #2: 2007 BC-SW-06 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Photograph #3: 2007 BC-SW-06 Right Bank

Photograph #4: 2007 BC-SW-06 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2010 BC-SW-06 Upstream

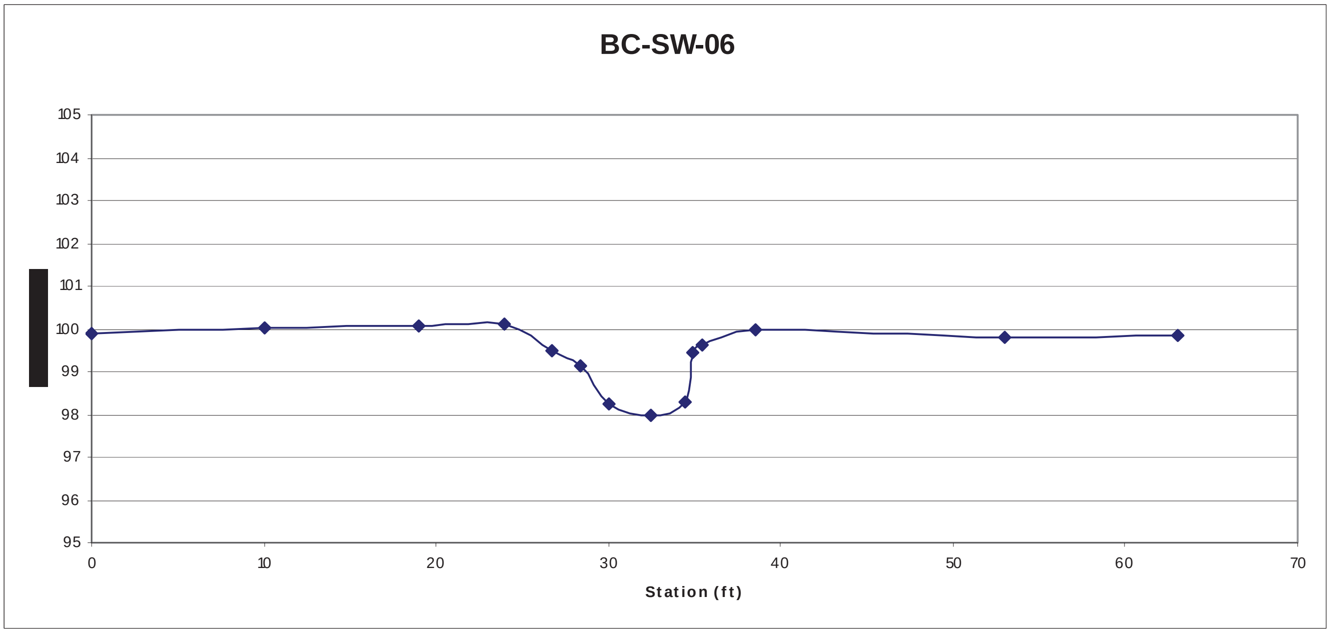
Photograph #2: 2010 BC-SW-06 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2010 BC-SW-06 Right Bank

Photograph #4: 2010 BC-SW-06 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2007 BC-SW-07 Upstream

Photograph #2: 2007 BC-SW-07 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2007 BC-SW-07 Right Bank

Photograph #4: 2007 BC-SW-07 Left Bank

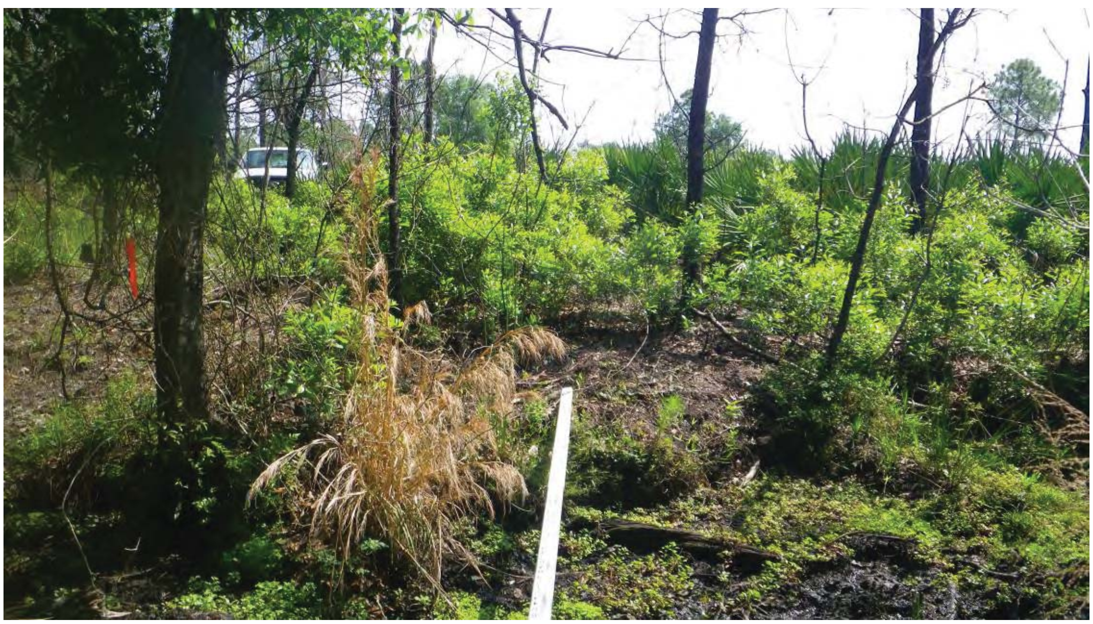
Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2010 BC-SW-07 Upstream

Photograph #2: 2010 BC-SW-07 Downstream

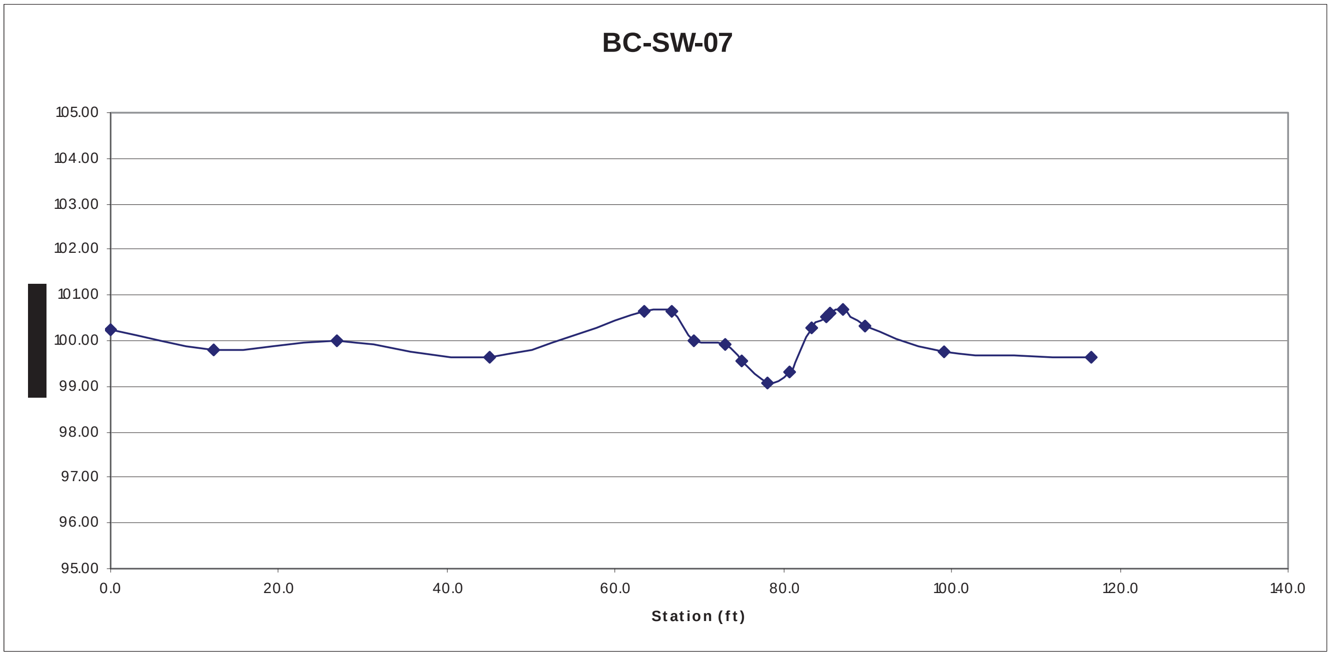
Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2010 BC-SW-07 Right Bank



Photograph #4: 2010 BC-SW-07 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2007 LC-EB-09 Upstream

Photograph #2: 2007 LC-EB-09 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2007 LC-EB-09 Right Bank

Photograph #4: 2007 LC-EB-09 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2010 LC-EB-09 Upstream

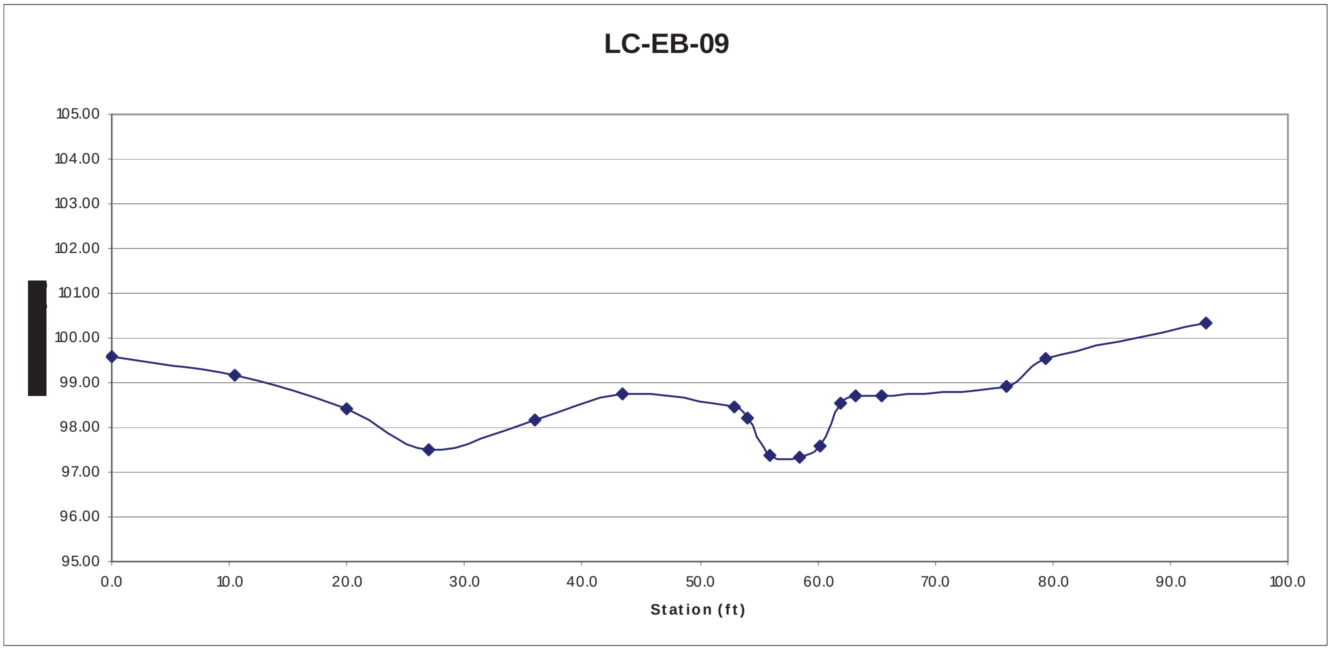
Photograph #2: 2010 LC-EB-09 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2010 LC-EB-09 Right Bank

Photograph #4: 2010 LC-EB-09 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2007 LC-EB-13 Upstream

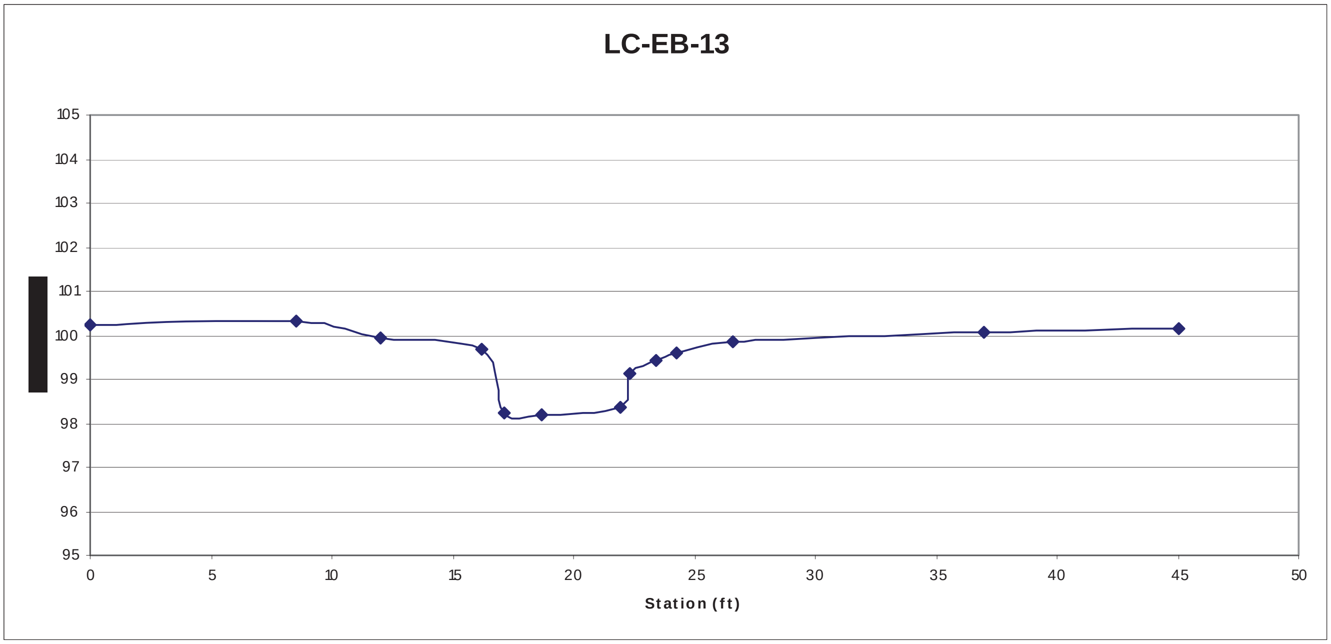
Photograph #2: 2007 LC-EB-13 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2007 LC-EB-13 Right Bank

Photograph #4: 2007 LC-EB-13 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2007 LC-MT-02 Upstream

Photograph #2: 2007 LC-MT-02 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2007 LC-MT-02 Right Bank

Photograph #4: 2007 LC-MT-02 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2010 LC-MT-02 Upstream

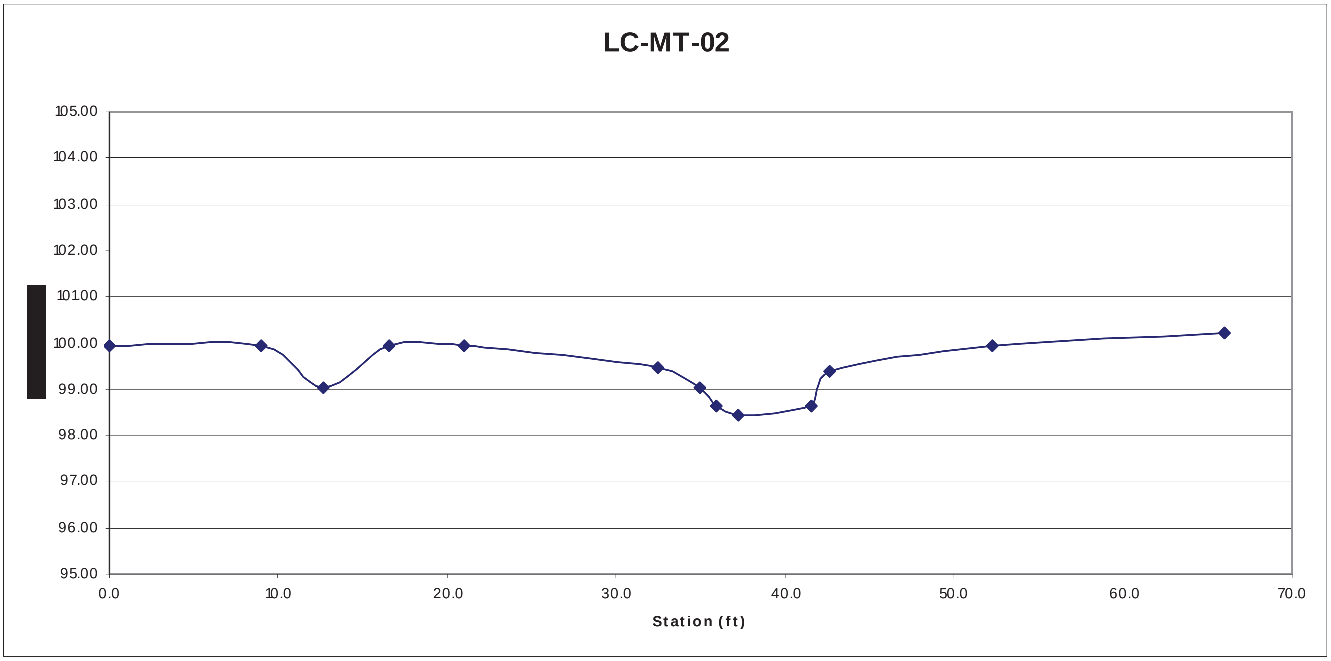
Photograph #2: 2010 LC-MT-02 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2010 LC-MT-02 Right Bank

Photograph #4: 2010 LC-MT-02 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2007 LC-NB-03 Upstream

Photograph #2: 2007 LC-NB-03 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2007 LC-NB-03 Right Bank

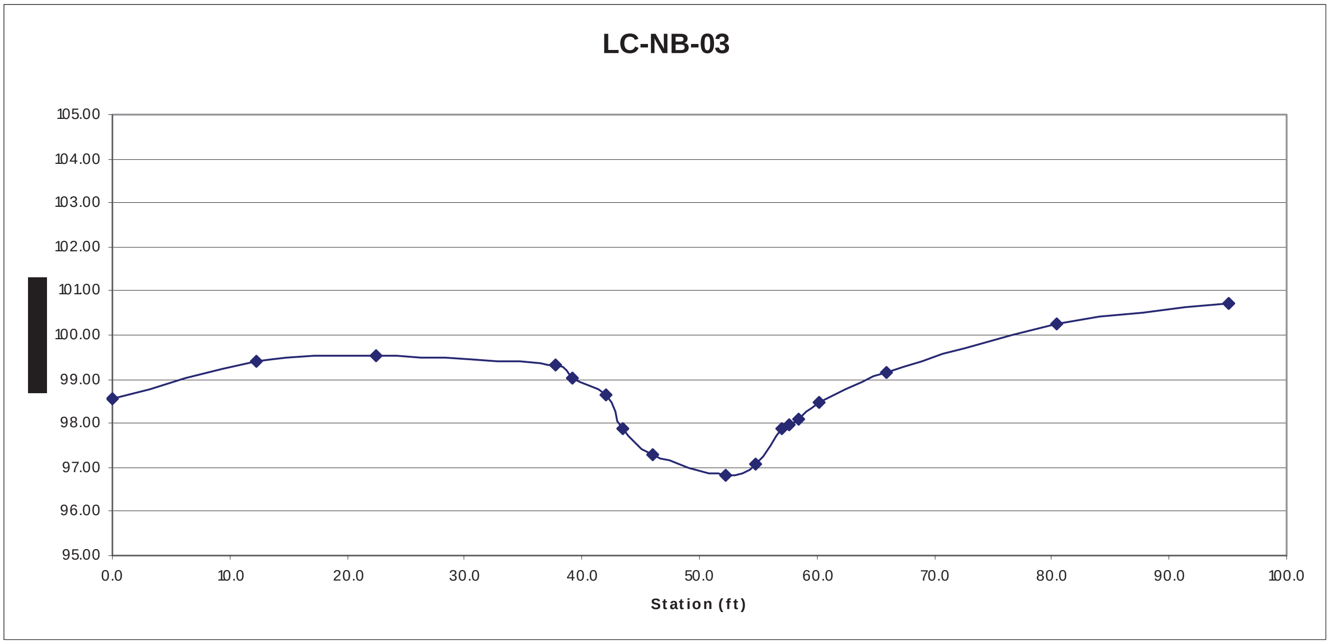
Photograph #4: 2007 LC-NB-03 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2010 LC-NB-03 Upstream

Photograph #2: 2010 LC-NB-03 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2007 LC-NB-04 Upstream

Photograph #2: 2007 LC-NB-04 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2007 LC-NB-04 Right Bank

Photograph #4: 2007 LC-NB-04 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2010 LC-NB-04 Upstream

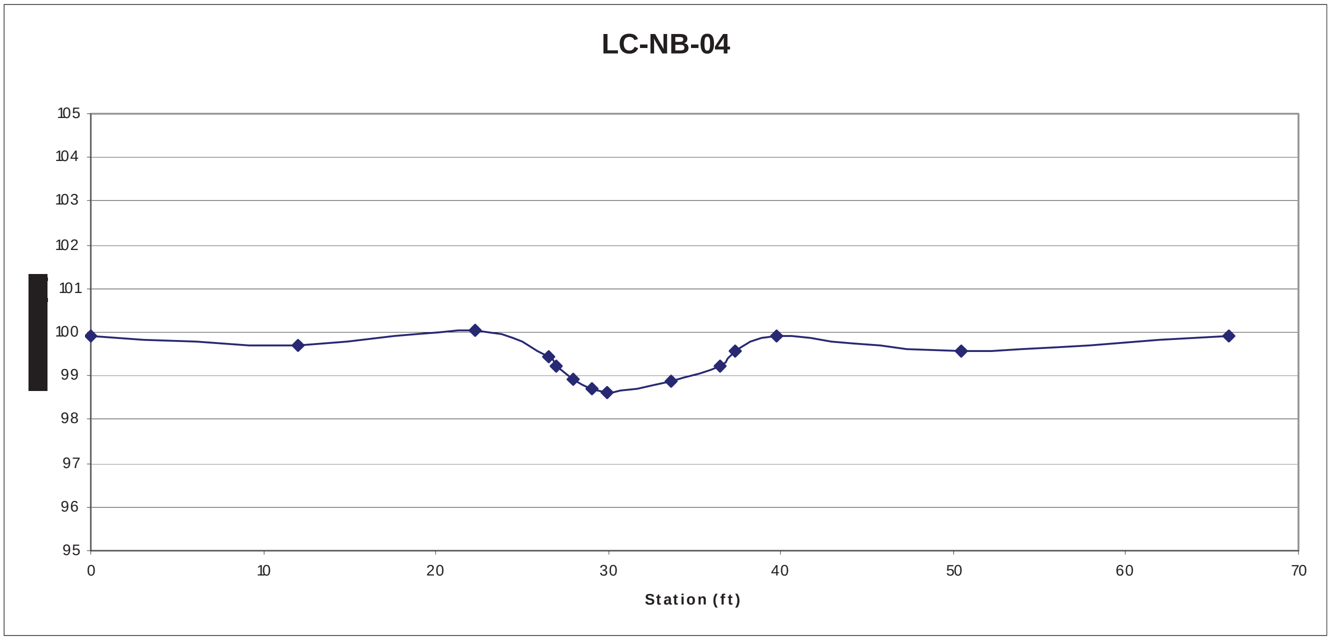
Photograph #2: 2010 LC-NB-04 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2010 LC-NB-04 Right Bank

Photograph #4: 2010 LC-NB-04 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2007 LC-NB-05 Upstream

Photograph #2: 2007 LC-NB-05 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2007 LC-NB-05 Right Bank

Photograph #4: 2007 LC-NB-05 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2010 LC-NB-05 Upstream

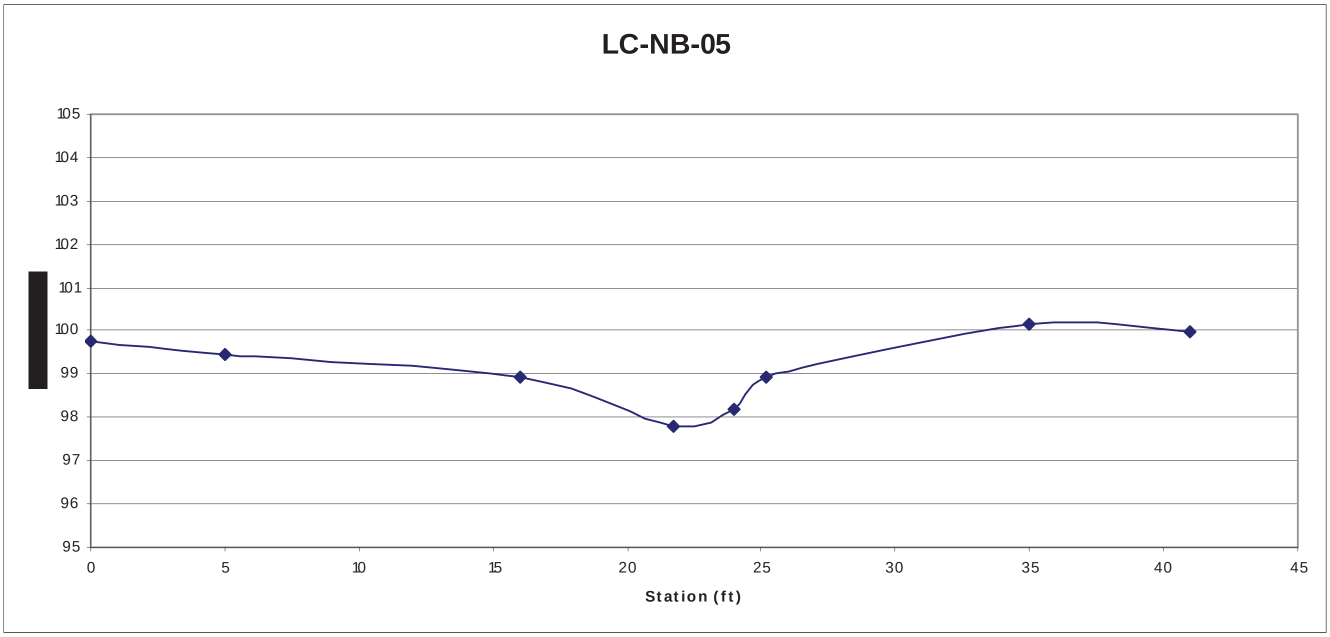
Photograph #2: 2010 LC-NB-05 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2010 LC-NB-05 Right Bank

Photograph #4: 2010 LC-NB-05 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2007 LC-NB-06 Upstream

Photograph #2: 2007 LC-NB-06 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2007 LC-NB-06 Right Bank

Photograph #4: 2007 LC-NB-06 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2010 LC-NB-06 Upstream

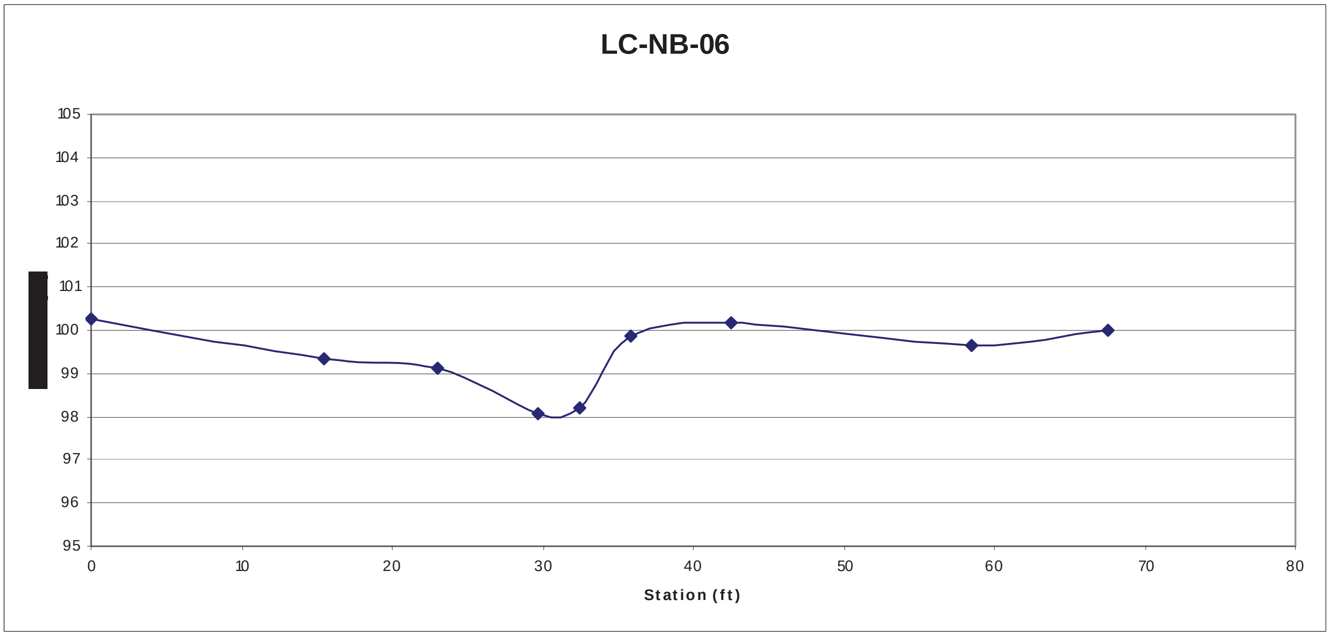
Photograph #2: 2010 LC-NB-06 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2010 LC-NB-06 Right Bank

Photograph #4: 2010 LC-NB-06 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2007 LC-NB-10 Upstream

Photograph #2: 2007 LC-NB-10 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2007 LC-NB-10 Right Bank

Photograph #4: 2007 LC-NB-10 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2010 LC-NB-10 Upstream

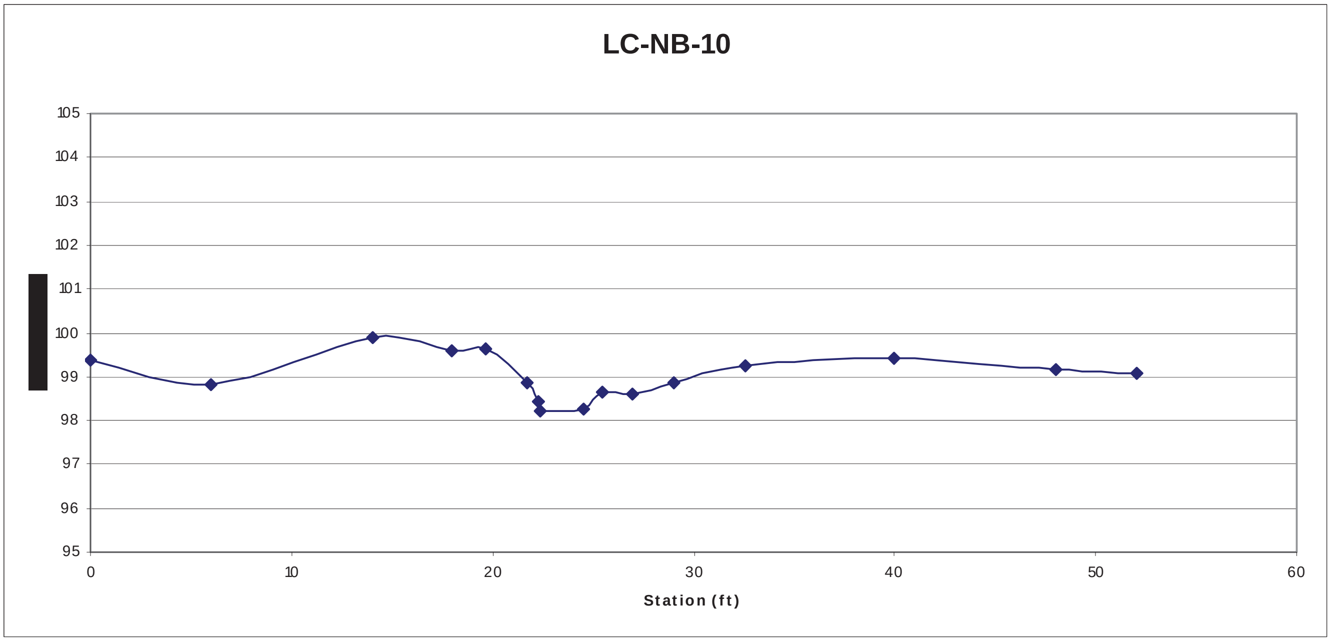
Photograph #2: 2010 LC-NB-10 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2010 LC-NB-10 Right Bank

Photograph #4: 2010 LC-NB-10 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2007 TC-EB-03 Upstream

Photograph #2: 2007 TC-EB-03 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2007 TC-EB-03 Right Bank

Photograph #4: 2007 TC-EB-03 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #1: 2010 TC-EB-03 Upstream

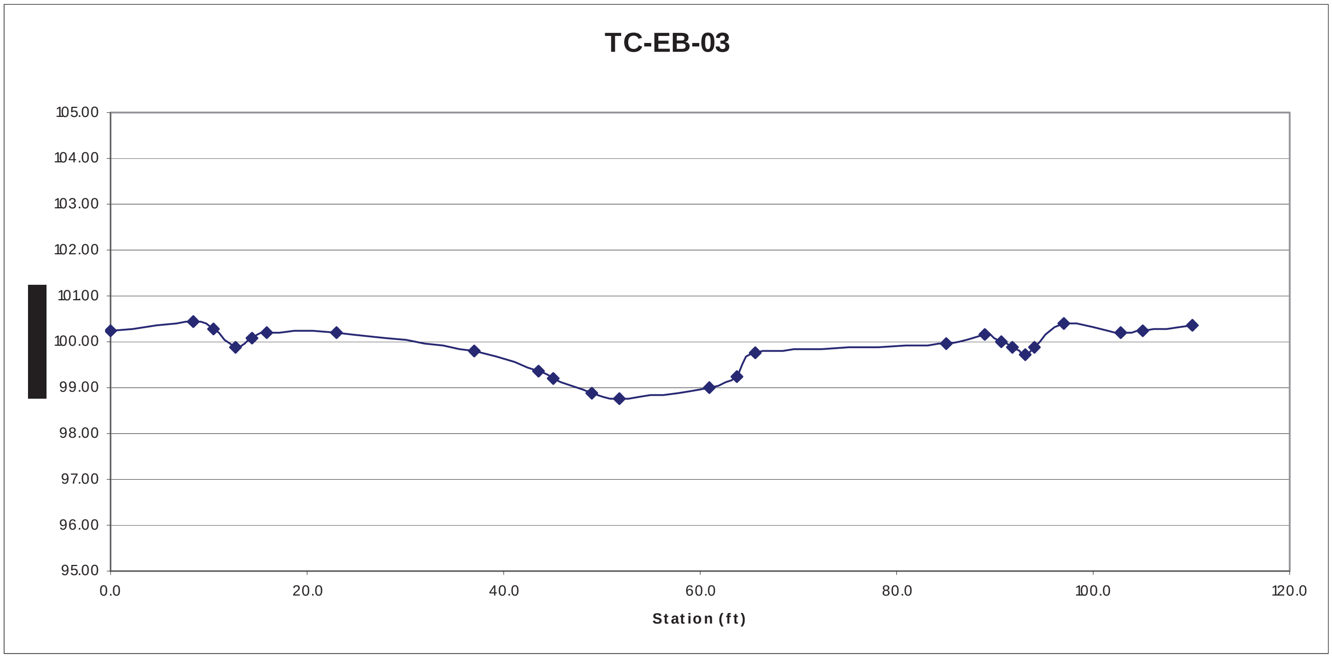
Photograph #2: 2010 TC-EB-03 Downstream

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.

Photograph #3: 2010 TC-EB-03 Right Bank

Photograph #4: 2010 TC-EB-03 Left Bank

Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.



Note: Photographs taken in 2007 and 2010 were taken on the same reach; however, they were not always taken at the exact same cross-section location. 2007 cross-section locations are provided in Figure SRO-5.