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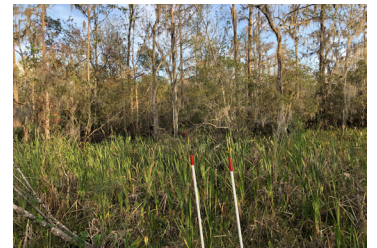
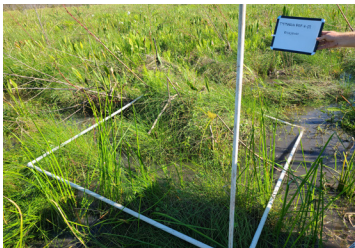
JEAN LAFITTE NATIONAL
HISTORICAL PARK
AND PRESERVE

Canal Backfilling for Hydrological Restoration Environmental and Ecological Monitoring

Field Infrastructure
and Baseline
Monitoring Report

JULY 2022

FINAL



**CDM
Smith**

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Section 1

Introduction

This report documents the monitoring infrastructure installation and baseline environmental and ecological data collection for the Jean Lafitte National Historical Park and Preserve Canal Backfilling for Hydrological Restoration Project.

CDM Smith, Comite Resources, and Fugro (the team) performed the baseline field activities in 2021 and 2022. The baseline field activities were delayed by Hurricane Ida, which made landfall as a category 4 hurricane on August 29, 2021. The start of field activities were delayed until October 2021 due to post-hurricane conditions. The team established a total of 12 monitoring sites (sites) to evaluate the restoration, comprised of six focal canal sites (restoration) and six reference sites (**Figure 1**). In collaboration with National Park Service (NPS), CDM Smith stratified the sites by ecosystem type and apportioned them approximately relative to land cover within the park, with eight sites in marsh and four sites in forested wetlands (**Table 1**).

Table 1 Monitoring Sites

Site Name	Ecosystem (Forested, Herbaceous)	Site Type (Restoration, Reference)	Latitude	Longitude
REF-F-03b	Forested	Reference	29.82746057	-90.12097867
REF-F-05	Forested	Reference	29.80681531	-90.12476295
RES-F-#a	Forested	Restoration	29.84805298	-90.14353985
RES-F-#b	Forested	Restoration	29.86373507	-90.12252208
REF-H-03	Marsh	Reference	29.81608571	-90.12509225
REF-H-05	Marsh	Reference	29.80736184	-90.15868696
REF-H-06	Marsh	Reference	29.8017602	-90.13209593
REF-H-07	Marsh	Reference	29.77170629	-90.10941597
RES-H-#a	Marsh	Restoration	29.83579634	-90.15114104
RES-H-#b	Marsh	Restoration	29.76702409	-90.14176838
RES-H-01	Marsh	Restoration	29.84325525	-90.14795477
RES-H-03	Marsh	Restoration	29.8016781	-90.15863465

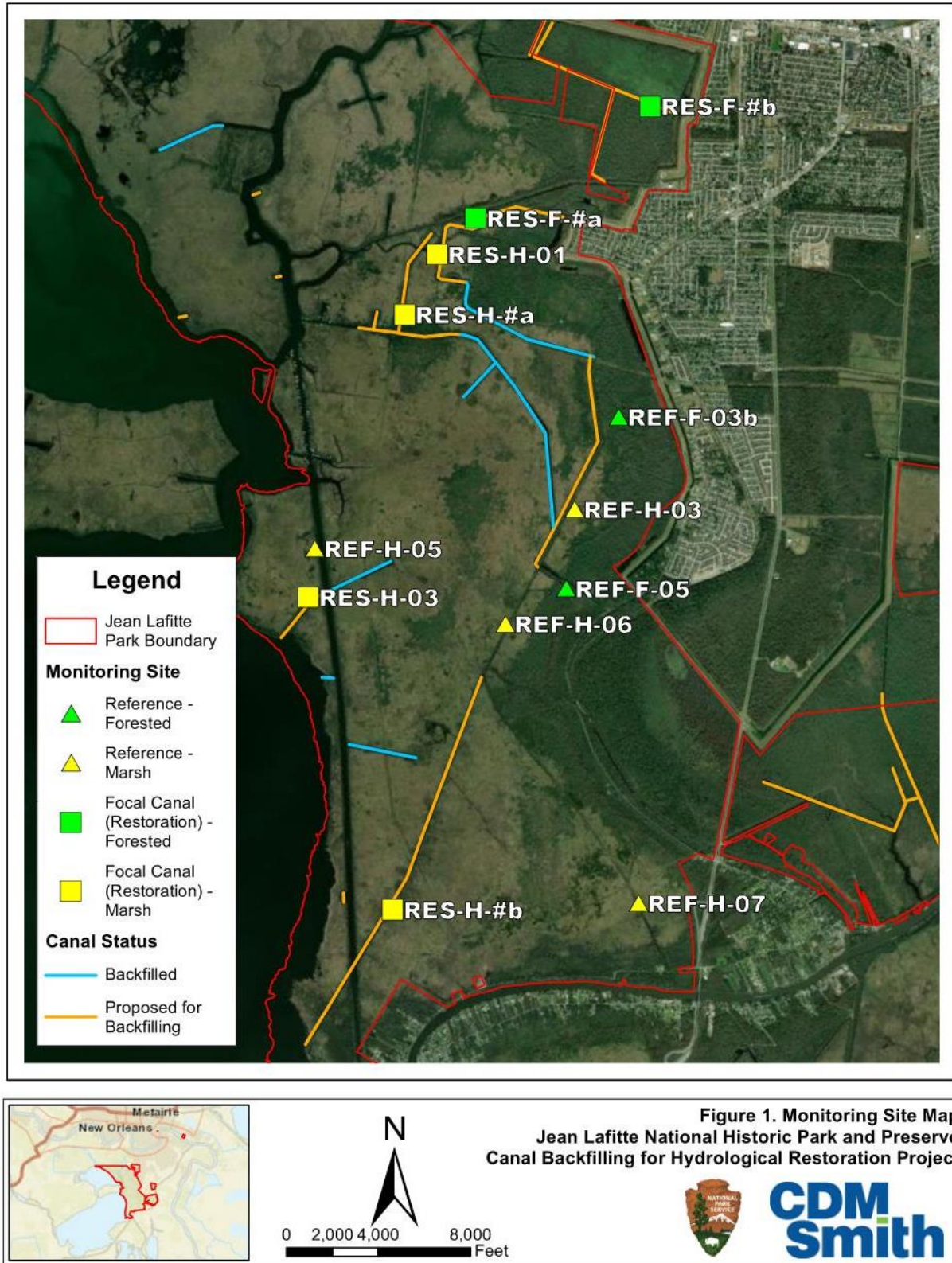


Figure 1
Location Map

Section 2

Field Infrastructure and Survey

At each site, the team installed boardwalks, scientific instruments, and infrastructure as part of the baseline monitoring, which included a rod surface elevation table (rSET), piezometers in wetlands, and stilling wells in canals. At each of the monitoring sites, the boardwalks consisted of two, parallel, 2-inch by 8-inch by 8-foot pressure-treated boards supported by legs made of 2-inch by 4-inch pressure-treated boards and crosspieces. Because of the permanent flooded conditions overlying several feet of unconsolidated mud, the team required longer walkways at the forested wetland sites. For each of the four forested wetland sites, the team constructed a boardwalk of approximately 50 feet running perpendicular from spoil bank edge into the forested wetlands terminating near the rSET installations.

2.1 Water Loggers

From October 11 to 19, 2021, the team installed a total of 24 data loggers to monitor water levels and salinity in piezometers in the wetlands and stilling wells in the nearby canal at the 12 monitoring sites. Each monitoring site has paired loggers: one in the wetland and one in the adjacent canal. The piezometers extend 6 feet below the wetland surface and are made of 10-foot long, 2-inch diameter, 0.01-inch slotted polyvinyl chloride (PVC) pipe. The team used the same housing type for stilling wells in the nearby canal with level set at approximately the same as the wetland sites. NPS requested that Solinst 3001 Levellogger 5 LTCs be deployed because this equipment is already in use by NPS at the park. NPS provided the team with the *Jean Lafitte National Historic Park and Preserve Elevation-Hydrology Dynamics Array Protocol* (Version 2). After installation of the water logger piezometers and stilling wells, the team deployed water recorders according to the NPS-provided protocol to collect hourly salinity and water level readings. The team calibrated the probes with known standards prior to field measurements. On December 13 and 14, 2021, at the request of NPS, the team moved the water loggers located in the canals to locations further away from the canal bank to capture low water conditions in the canals. On January 8, 2022, the team moved the loggers at the restoration monitoring sites to the opposite side of the bayou to avoid potential impacts to the loggers associated with construction and removal of the levees.

2.2 Rod Surface Elevation Tables and Feldspar Markers

The team established rSETs at all 12 monitoring sites on October 5, 6, and 19, 2021, adhering to methods outlined by the NPS SET and marker horizon protocol (Lynch et al. 2015). The team established rSETs in the wetlands adjacent to the spoil bank (**Figure 2**). The team installed permanent rSET marks anchored within the sediment using a demolition hammer. Each rSET consists of a base support pipe made up of 4-foot sections of 9/16-inch-diameter stainless steel rod that are threaded together and driven to substantial resistance or refusal in the sediment using a jack hammer (Lynch et al. 2015). The team sunk 52 to 68 feet of rod at each rSET site. They cut the remaining rod section at the sediment surface and encased the rod in a 6-inch-diameter PVC pipe ranging from 3 to 4 feet long. The team fit the upper end of the base support

pipe with another machined notched pipe designed to receive the upper portable part of the rSET. The team then filled the PVC tube with concrete, sealing the lower and upper ends of the base support pipe. The concrete cured and settled for a few weeks before the first measurements were taken.

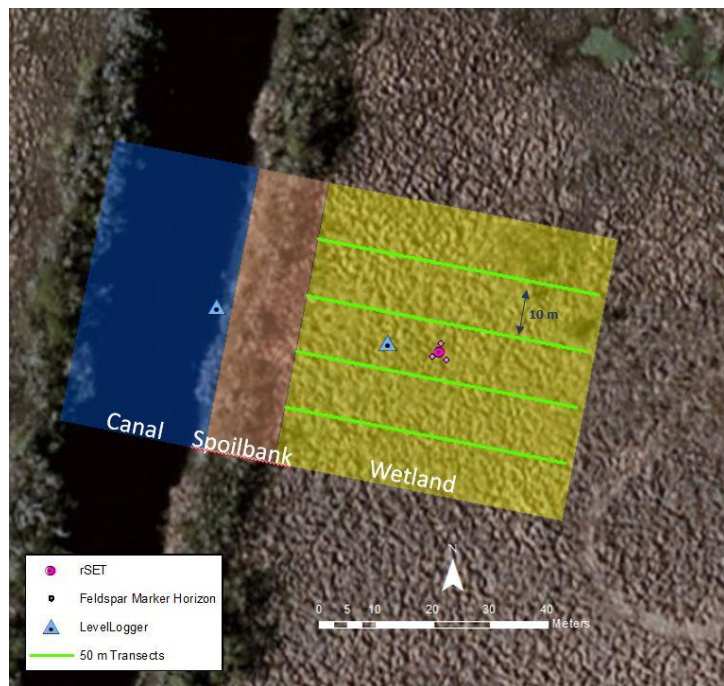


Figure 2
Typical Erosion/Accretion Monitoring Layout

The portable part of the rSET is a precisely machined device that can be leveled in two planes and positioned in four directions around the base support pipe. Once leveled, the plate at the end of the rSET is in the exact same position during every measurement, providing a constant reference plane in space from which the distance to the sediment surface is measured repetitively through time (Boumans and Day 1993; Cahoon et al. 2002a,b). At herbaceous sites, nine 3-millimeter-diameter, 120-centimeter (cm)-long fiber glass rods (i.e., pins) were used to measure the distance to the wetland surface in four quadrants, providing 36 measurements per sampling effort. At the forested sites, 182.8-cm pins were used to reach the wetland surface due to deep water conditions. The mean difference between individual pin measurements divided by the amount of time since the first measurement determines the rate of elevation change. A board was temporarily placed across the parallel boardwalk boards during measurements to minimize disturbance of the surrounding surface (Lane et al. 2006, 2020). The team measured wetland elevation as the distance above the top bar of the rSET to the top of the pin (Boumans and Day 1993; Lane et al. 2006, 2020; Lynch et al. 2015; Osland et al. 2017).

The team laid a layer of powdered feldspar clay 1-cm thick on the wetland surface at three 0.25-square-meter (m^2) plots next to each rSET platform at the same time as the first rSET measurements (**Figure 2**). This feldspar clay will be sampled in the future to measure accretion.

2.3 Survey

On February 8 through 10, 2022, the team installed two, permanent, deep-rod surveying monuments adjacent to two monitoring sites (REF-H-06 and RES-H-01) to provide overall survey control for all survey elevation measurements acquired throughout the project. The team installed deep-rod surveying monuments in accordance with the standards set forth in the solicitation provided by the NPS. Once the site was determined, the team drove a stainless steel rod into the earth using a gas-powered mechanical hammer until refusal was met. The team then installed a floating sleeve set in concrete and covered the monument in a protective enclosure. Once all monuments were installed, the team assembled a static GNSS (global navigation satellite system) antenna on a 2-meter, fixed height tripod over each. The instrument collected static positioning data for a period of 4 to 8 hours, followed by a rotation of the individual GNSS antennae to ensure system bias was mitigated. The team repeated this process over two days. Using Trimble Business Center, the team post-processed the data collected during the static GNSS observations. To complete the final adjustment of monument coordinates using the least-squares method and a GNSS network comprised of three continuously operating reference stations, the statistical report culminated in detailed accuracy of the adjustment. A professional land surveyor (PLS #4715) surveyed elevations at each of the 12 monitoring sites along a transect to record the following data canal channel dimensions (depth profile and breadth), spoil bank dimensions (height profile and breadth), and location of terrestrial/aquatic channel boundaries. The surveyor located all monitoring infrastructure, including water logger well tops (top of casing) and rSETs (**Table 2**). **Appendix A** includes survey data with the monument datasheets for deep-rod surveying monuments.

Table 2 Monitoring Infrastructure Survey

Site Name	Monitoring Infrastructure	Measuring Point Elevation (feet NAVD88)	Latitude (decimal degrees)	Longitude (decimal degrees)
RES-H-01	rSET	2.024	29.84306310	-90.14794689
RES-H-01	Wetland Water Logger	5.868	29.84306117	-90.14793125
RES-H-01	Canal Water Logger	6.18	29.84308922	-90.14732500
RES-F-#a	rSET	2.096	29.84797546	-90.14382084
RES-F-#a	Wetland Water Logger	6.383	29.8479714	-90.14375585
RES-F-#a	Canal Water Logger	6.016	29.84786719	-90.14294784
RES-H-#a	rSET	2.37	29.83583303	-90.15113396
RES-H-#a	Wetland Water Logger	6.234	29.83581314	-90.15114786
RES-H-#a	Canal Water Logger	6.282	29.83574887	-90.15166702
RES-F-#b	rSET	1.729	29.86364679	-90.12231289
RES-F-#b	Wetland Water Logger	5.62	29.86367971	-90.12230858
RES-F-#b	Canal Water Logger	5.702	29.86401923	-90.12204389
REF-H-06	rSET	2.408	29.80182494	-90.13214255
REF-H-06	Wetland Water Logger	6.027	29.80180030	-90.13214879
REF-H-06	Canal Water Logger	6.25	29.80176591	-90.13167731
RES-H-#b	rSET	2.424	29.76698518	-90.14178389
RES-H-#b	Wetland Water Logger	6.311	29.76696937	-90.14181354
RES-H-#b	Canal Water Logger	5.892	29.76703727	-90.14239255
REF-H-07	rSET	2.119	29.77163284	-90.10929789
REF-H-07	Wetland Water Logger	6.165	29.77161222	-90.10930183
REF-H-07	Canal Water Logger	6.305	29.77140120	-90.10950191
RES-H-03	rSET	2.465	29.80168552	-90.15864927
RES-H-03	Wetland Water Logger	5.842	29.80171742	-90.15866002
RES-H-03	Canal Water Logger	5.992	29.80192175	-90.15692613
REF-H-05	rSET	2.194	29.80733560	-90.15883726
REF-H-05	Wetland Water Logger	6.238	29.80731173	-90.15882164
REF-H-05	Canal Water Logger	6.463	29.80730202	-90.15819219
REF-H-03	rSET	2.262	29.81601413	-90.12497892
REF-H-03	Wetland Water Logger	6.234	29.81602045	-90.12500463
REF-H-03	Canal Water Logger	6.288	29.81619772	-90.12510706
REF-F-05	rSET	1.847	29.80684689	-90.12511257
REF-F-05	Wetland Water Logger	6.206	29.80686834	-90.12512385
REF-F-05	Canal Water Logger	6.318	29.80714570	-90.12524222
REF-F-03b	rSET	2.12	29.827475770	-90.12079806
REF-F-03b	Wetland Water Logger	6.094	29.82751360	-90.1208569
REF-F-03b	Canal Water Logger	6.391	29.82749429	-90.1210343

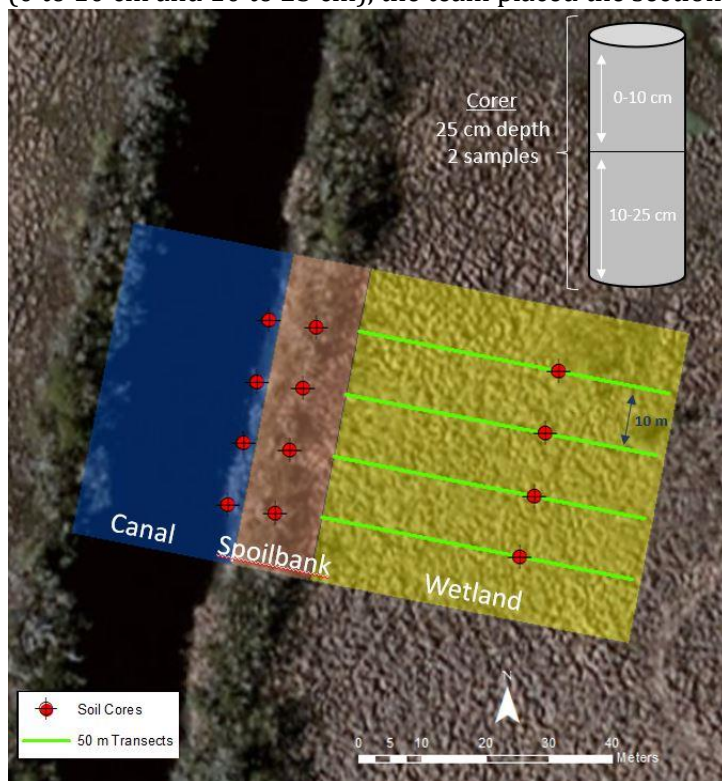
Section 3

Environmental and Ecological Monitoring

At each monitoring site, the team carried four transects perpendicular from the canal. Three zones were sampled along the 50- to 100-meter transect: within the canal, at the spoil bank, and in the wetland vegetation. In each of the three zones, the team collected samples and recorded measurements in accordance with the methods described below. The team entered all data into a Microsoft Access database that will be provided to NPS. Below is a summary of the methods and experimental design. Data analysis, analytical findings, and data trends will be compiled and presented in the final data analysis and findings report (March 2025) which will include data from the baseline, post-construction, and 2-3 years post-construction intensive field monitoring events.

3.1 Soil/Substrate Physical Properties

On September 30 and October 4, 2021, the team collected soil cores from each of the three zones along four transects at each of 12 monitoring sites, for a total of 144 cores (**Figure 3**). The team took soil bulk density samples using a 5.0-cm-diameter McAuley corer to a depth of 25 cm below land surface (bls) (Bricker-Urso et al. 1989). Sectioning the cores in the field into two increments (0 to 10 cm and 10 to 25 cm), the team placed the sections into labeled plastic bags, and put the



bags in a cooler for transport to the laboratory where they were refrigerated until processing. Staff at the laboratory then weighed the soil samples before and after drying at 80 degrees Celsius ($^{\circ}\text{C}$) to a constant weight. The weight difference between wet and dry samples determined water content (percent [%]), and the dry weight and the volume of the sample determined the bulk density (Brady and Weil 2001; NRCS 2011). Laboratory staff then analyzed the samples for the percentage of organic carbon by dry combustion (i.e., loss on ignition) using a Neytech 85M controlled-temperature furnace as detailed by the National Resources Conservation Service (NRCS 2011).

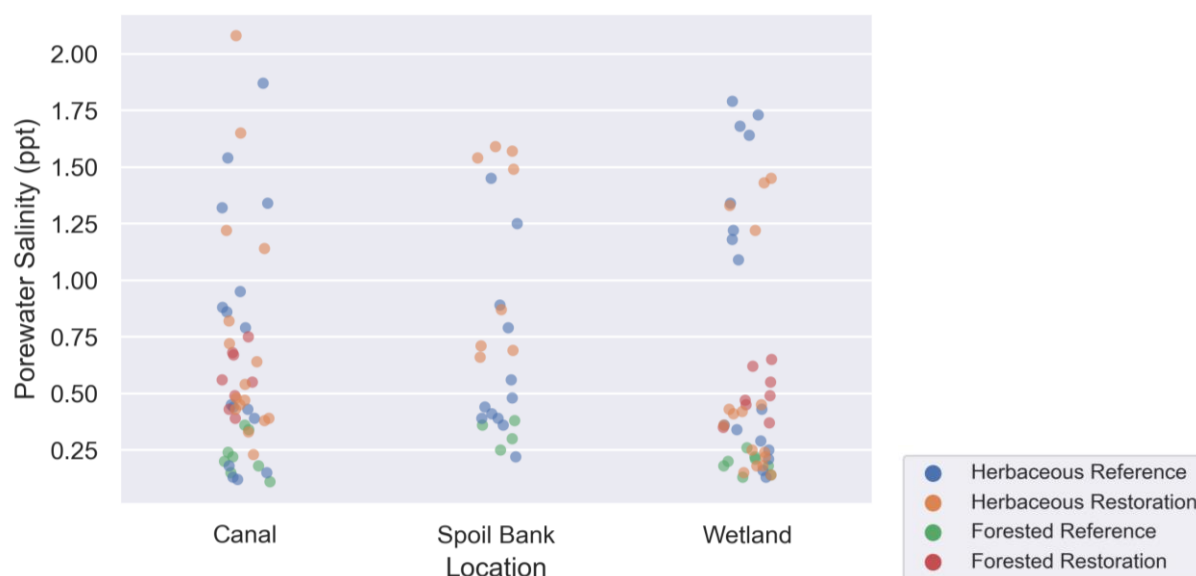
Figure 3
Typical Soil/Substrate Physical Property Sampling Layout

Data showing soil physical properties are plotted by location (canal, spoil bank, wetland) and shown on **Graphic Charts 1 - 6**.

Graphic Charts 1 to 6. Clockwise from top left Bulk Density 0-10 cm bls, Organic Carbon Content 0-10 cm bls, water content 0-10 cm bls, Bulk Density 10-25 cm bls, Organic Carbon Content 10-25 cm bls, water content 10-25 cm bls depth.

In similar wetland systems in Louisiana, bulk density typically ranges from 0.05 to 0.35 g/cm³, organic carbon content ranges from 20 to 55 percent by weight, and water content ranges from 25 to 95 percent by weight (Wang et al. 2017; Sanks et al. 2020).

Data showing soil porewater salinity are plotted by location (canal, spoil bank, wetland) and shown on **Graphic Chart 7**.



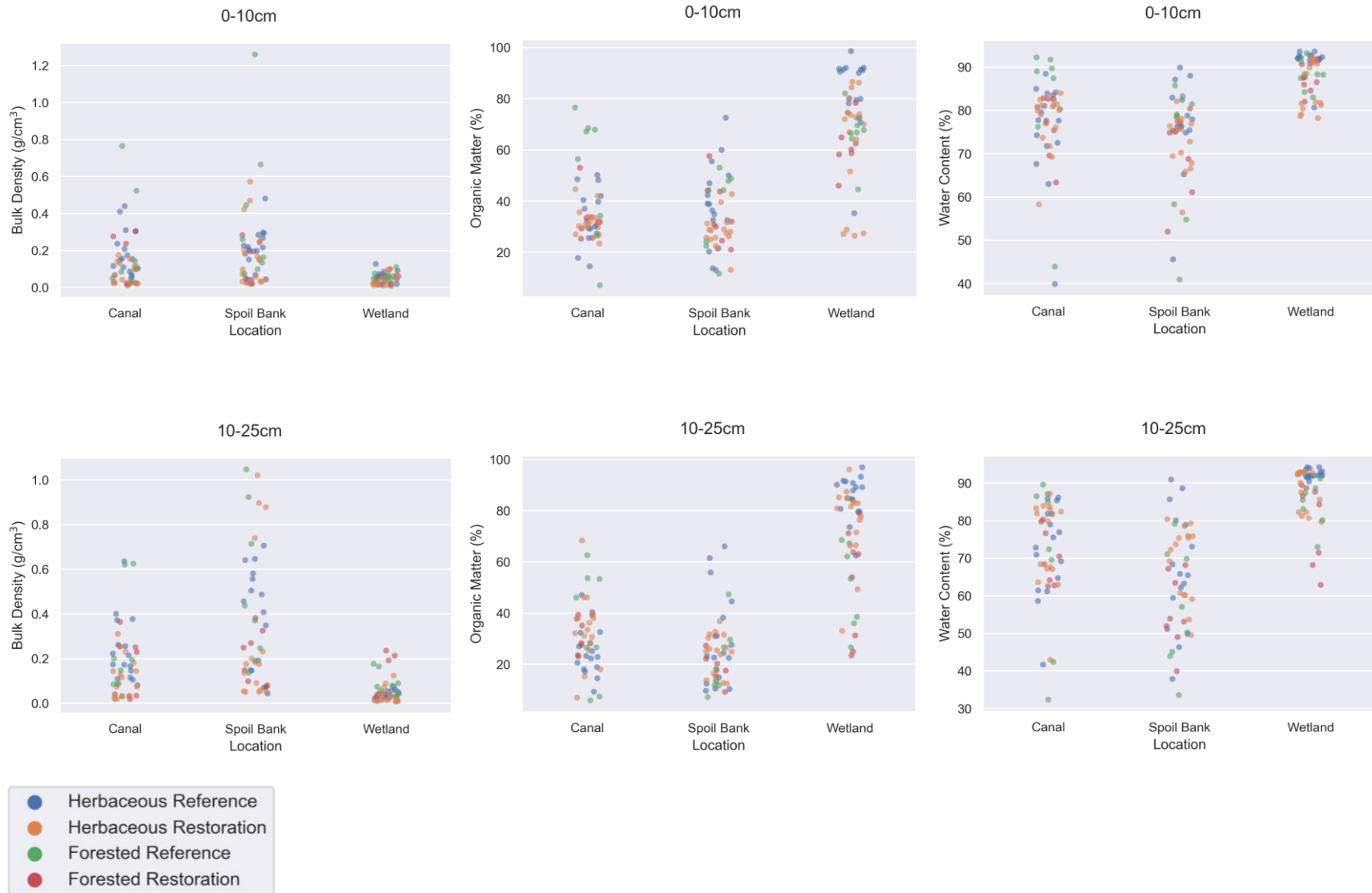
Graphic Chart 7. Porewater salinity plotted by location.

3.2 Accretion/Erosion

3.2.1 Rod Surface Elevation Tables

The team measured initial rSET readings on November 2, 2021, to allow time for rSETs to settle after installation. The team took 36 measurements at each monitoring site and nine at each cardinal direction.

In similar wetland systems in Louisiana, subsidence rates range from 3 to 5 mm/yr (Byrnes et al. 2019).



3.2.2 Feldspar Markers

The team will measure vertical accretion by measuring the thickness of material above the feldspar marker surface of the horizon at 5 to 10 different locations using a narrow shovel, corer, or cryogenic coring device depending on field conditions (Lane et al. 2006, 2020). The team will calculate the rate of vertical accretion by dividing the thickness of material above the feldspar horizon by the amount of time the horizon had been in the sediment. The first results will be reported after measurements are taken in during the next major sampling event, scheduled for the end of the growing season following degradation of canal spoil banks (backfilling).

In similar wetland systems in Louisiana, accretion rates range from 2 to 8 mm/yr (DeLaune et al. 1992, 2013; Nyman et. al. 2006).

3.3 Canal and Spoil Bank Dimensions

The team collected elevation data along a transect-oriented orthogonal to each channel adjacent to each monitoring site. These transects extended across the channel width and extended a minimum of 25 meters, from the waterline into the adjacent wetland, to ensure the full width of each levee was captured. The team collected GNSS data points along the length of each transect at 25-foot intervals or breaks in elevation of 6 inches or greater.

The team post-processed the data using Trimble Business Center and positioned all data collected in the field relative to the established deep-rod monuments using GNSS-derived baselines. To mitigate any potential errant measurements associated with atmospheric noise, cycle slips, or other sources of data noise, the team scrutinized the quality of each GNSS baseline. The team removed GNSS points with excessively noisy baselines and resurveyed them if necessary. Upon the completion of the quality review, the team exported the data in ASCII format for further mapping and analysis. Appendix A provides survey data.

3.4 Discrete Water Quality

On September 30 and October 4, 2021, the team collected wetland soil interstitial porewater at all monitoring sites from each zone at four locations and analyzed the porewater for salinity (**Figure 4**). The team collected porewater sample water using a narrow 3-mm-diameter perforated plastic tube connected to a 50-milliliter (mL) syringe (McKee et al. 1988). The team inserted this tube into the soil to a depth of 15 cm. A three-way valve between the syringe and collection tube allowed the expulsion of air and debris. This apparatus collected relatively clear interstitial water from the wetland substrate within a few seconds, without exposure to the atmosphere. While collecting samples, the team discarded the first 5 to 20 mL of each sample to flush contaminants. The team collected 40 to 50 mL of water and stored the samples in clean 50-mL bottles. At the Comite Resources processing facility, the team filtered the samples through pre-rinsed, 25-mm, 0.7-micrometer (μm) Whatman GF/F glass fiber filters and measured salinity using a salinity meter (APHA 1985).

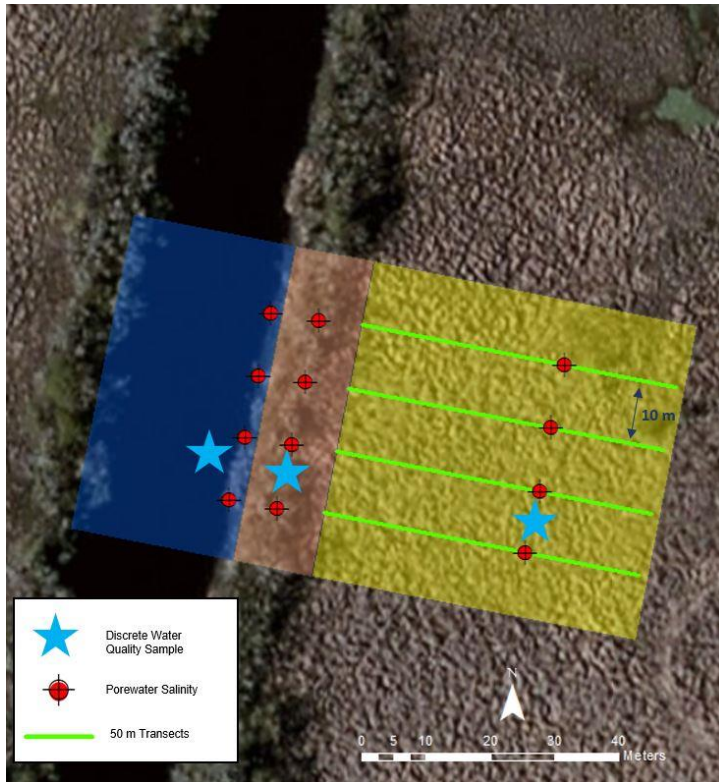


Figure 4
Typical Water Quality and Porewater Salinity Sampling Layout

The team recorded conductivity, salinity, dissolved oxygen, pH and temperature at the three zones of each site during annual September/October monitoring (September 30 to October 19, 2021) using an In-situ smarTROLL Multiparameter Handheld probe. The team calibrated the probe with known standards prior to field measurements.

3.5 Continuous Water Level and Salinity

The team monitored water salinity at 24 sites using Solinst 3001 Levellogger 5 LTCs, which also record water levels. The probes were calibrated with a solution that is close to the conditions in the field. During site visits, the teams serviced the probes to download data and inspect for damage or fouling. The team set the probes to record every hour and the probes have an available memory-storage and battery-life of over a year. The team determined the elevation of the probe relative to North American Vertical Datum of 1988 (NAVD88) during the precision topographic surveying task as described in Section 3.3. On February 8 and 9, 2022, the team downloaded data from the forested monitoring sites and canal water loggers at the marsh sites. During the next major monitoring event, the team will download data from all of the sites and provide water logger data to NPS. The team serviced the probes during site visits to download data and inspect the instrument package for damage or fouling. One of the loggers (RES-F-#a Wetland) did not respond during the attempted download on February 8, 2022. The team left the logger in the piezometer because the data logger may still be functioning. During the next field visit to that monitoring site, the team will attempt to download the data from this water logger.

3.6 Photostations

The team collected photographs during the community vegetation assessments of the herbaceous and forested wetland sites in October 2021 and December 2021, respectively. **Table 3** shows photographs obtained at each site and locations, providing photographic documentation of change over time. The team captured photographs at a uniform height (i.e., approximately 5 feet) in cardinal directions (i.e., north, east, south, and west) at each point. For every site, the team established two photograph points, one located at the canal channel center and the other at a centrally located monitoring plot in the adjacent wetland. The team established the wetland photograph point at the terminus of a temporary boardwalk, extending from the spoil bank to the rSET and water logger infrastructure. The team surveyed the locations of the photograph points to easily allow field personnel to locate photograph points and promote consistency with future monitoring events. Photologs will be provided to NPS and stored in the data repository.

Table 3 Photostation Locations at Each Monitoring Site

Site Name	Ecosystem (forested, marsh)	Location (canal, wetland)	Latitude (decimal degrees)	Longitude (decimal degrees)
REF-F-03B	Forest	Canal	29.82756111	-90.12107194
REF-F-03B	Forest	Wetland	29.82751108	-90.12081108
REF-F-05	Forest	Canal	29.80729167	-90.12533611
REF-F-05	Forest	Wetland	29.80684628	-90.12513053
RES-F-#A	Forest	Canal	29.84780889	-90.14329444
RES-F-#A	Forest	Wetland	29.84807500	-90.14398886
RES-F-#B	Forest	Canal	29.86397500	-90.12203333
RES-F-#B	Forest	Wetland	29.86365831	-90.12230000
REF-H-03	Marsh	Canal	29.81596944	-90.12488778
REF-H-03	Marsh	Wetland	29.81596939	-90.12488790
REF-H-05	Marsh	Canal	29.80742806	-90.15810028
REF-H-05	Marsh	Wetland	29.80727080	-90.15869580
REF-H-06	Marsh	Canal	29.80164167	-90.13165000
REF-H-06	Marsh	Wetland	29.80188990	-90.13201087
REF-H-07	Marsh	Canal	29.77139444	-90.10952944
REF-H-07	Marsh	Wetland	29.77155460	-90.10913470
RES-H-#A	Marsh	Canal	29.83571389	-90.15147389
RES-H-#A	Marsh	Wetland	29.83576510	-90.15095770
RES-H-#B	Marsh	Canal	29.76717889	-90.14224444
RES-H-#B	Marsh	Wetland	29.76702010	-90.14174370
RES-H-01	Marsh	Canal	29.84279500	-90.14745278
RES-H-01	Marsh	Wetland	29.84303820	-90.14815460
RES-H-03	Marsh	Canal	29.80146889	-90.15818806
RES-H-03	Marsh	Wetland	29.80172280	-90.15860240

3.7 Community Vegetation Data

The team recorded multiple parameters documenting community vegetation composition using plot-based sampling, including species presence, total cover, percent cover by species, invasive species presence, dominant height, and average height. These plots were distributed by zone with two in the canal, three in the spoil bank, and three in the wetland. Within each zone, plots included sampling by vegetative strata, including herbaceous, sapling/shrub, and tree (**Figure 5** and **Figure 6**). Plot sizes were as follows:

- Herbaceous plots: 2 by 2 meters
- Sapling/shrub plots: 6 by 6 meters (or equivalent area for spoil bank plots if the width of the spoil bank was less than 6 meters)
- Tree plots: 20 by 20 meters

The team assessed species composition, in order of dominance, first for the general region to establish which species are present at the time of observation, followed by eight visual plots to record species composition and percent cover. The team interpreted cover as the area of ground within a quadrat, or defined area, which was occupied by the aboveground parts of each species when viewed from above. Additionally, the team recorded unvegetated details within each plot (bare ground, dead vegetation, and open water) and identified unique species within 15 feet of the plot. The team conducted assessments of community vegetation at the herbaceous monitoring sites during the week of October 11, 2021, and at the forested monitoring sites during the week of December 13, 2021.

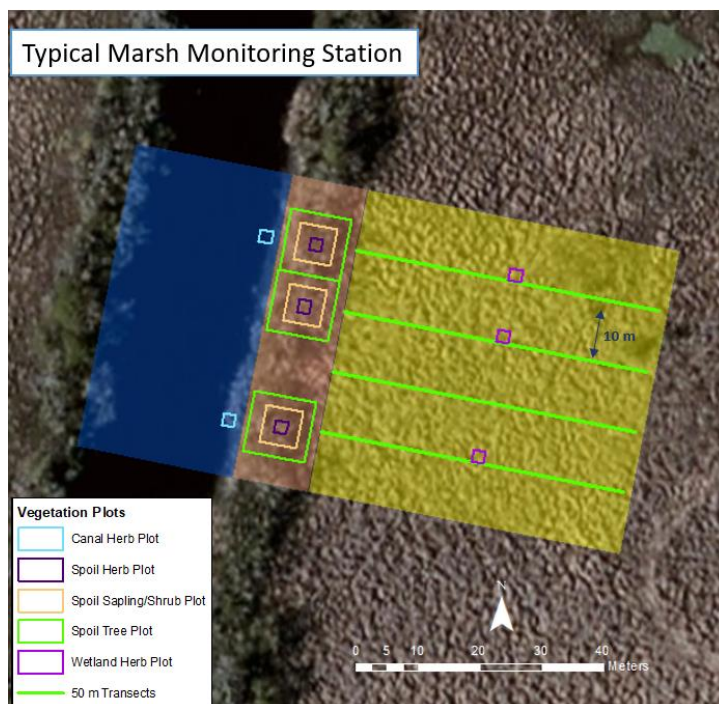


Figure 5
Typical Marsh Monitoring Site Layout

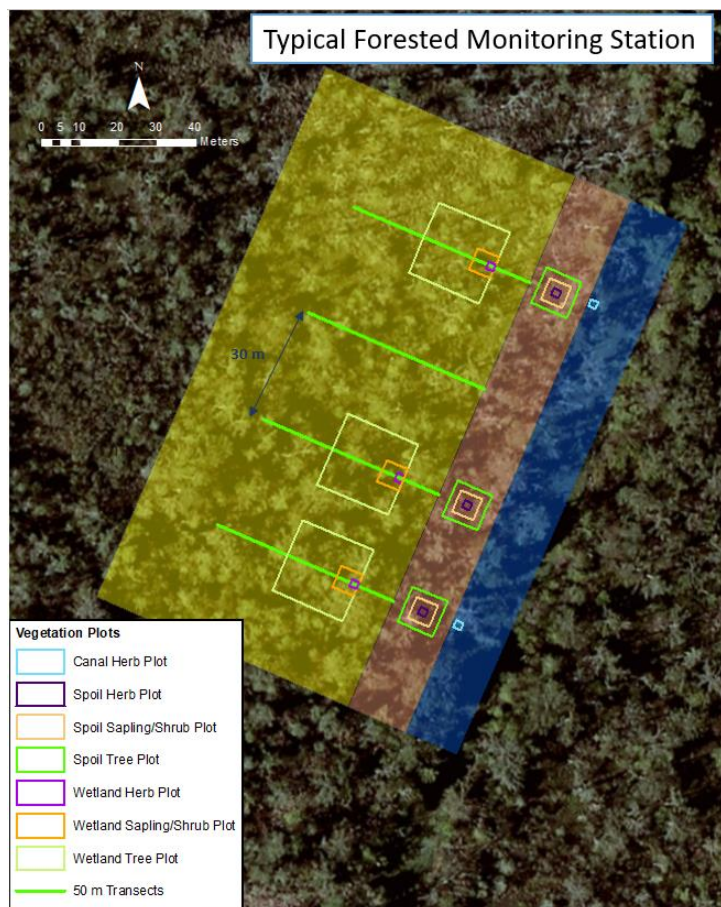


Figure 6
Typical Forested Monitoring Site Layout

3.8 Net Primary Productivity

3.8.1 Herbaceous Monitoring Sites

The team measured end-of-season live biomass on September 30 and October 4, 2021 (White et al. 1978; Burdick et al. 1989) by sampling aboveground biomass in three zones along four transects at each of the 12 monitoring sites (**Figure 7**). For marsh ecosystems, the team sampled 0.5-m² clip plots (Shew et al. 1981) along the four transects across the three zones at each location, resulting in 12 clip plots per site, though not all zones had herbaceous vegetation present. The team cut vegetation within each clip plot as close to the wetland surface as possible, placed the clippings in labeled paper bags, and brought them back to the laboratory where the live vegetation was separated from dead, the live vegetation was dried at 60°C, and each sample was weighed. Dry weight of the live material was extrapolated to live dry weight per square meter (grams dry weight/m²).

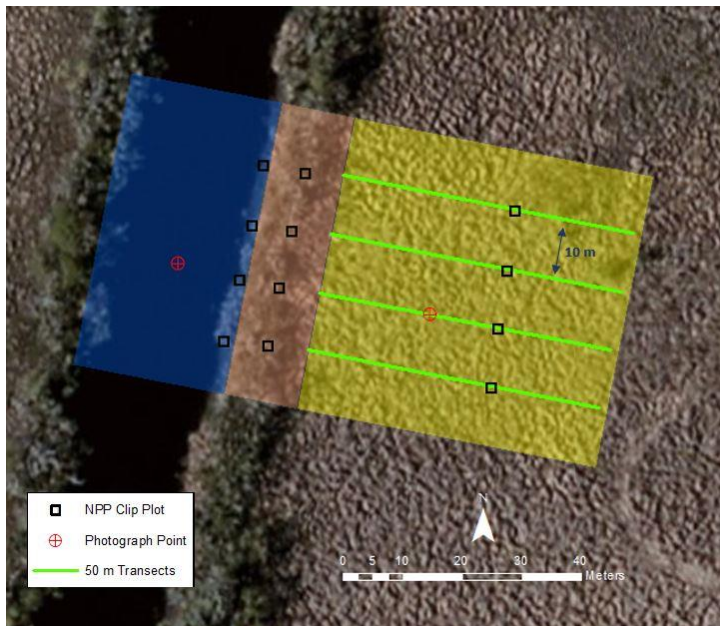
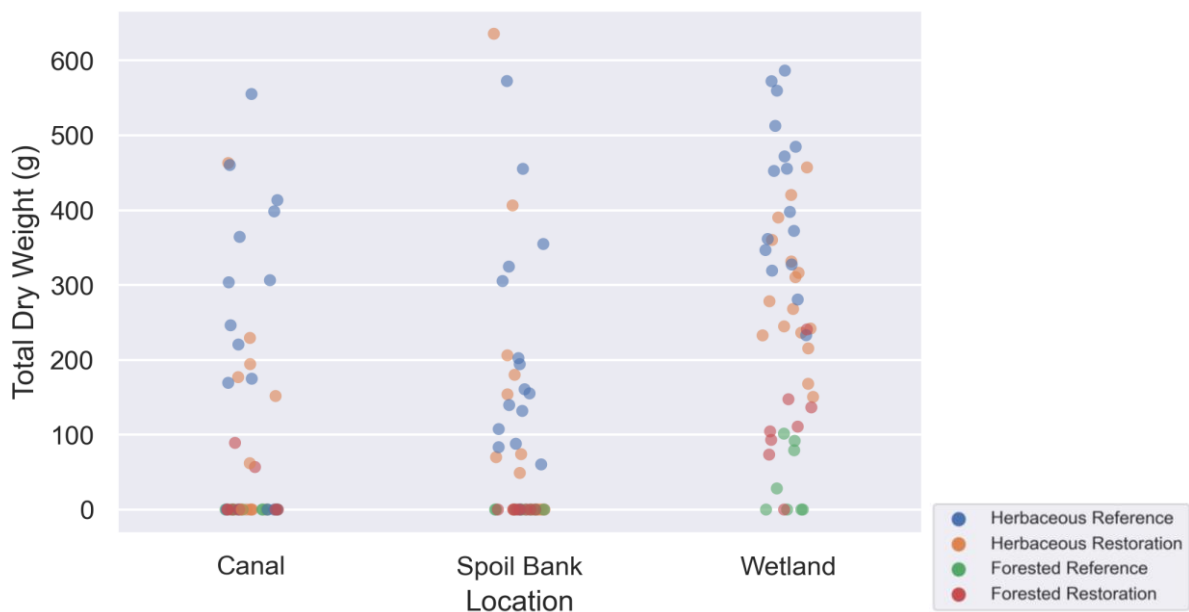


Figure 7
Typical NPP Clip Plot Layout

Data showing end-of-season live biomass are plotted by location (canal, spoil bank, wetland) and shown on **Graphic Chart 8**.



Graphic Chart 8. End-of-season live biomass plotted by location.

In similar wetland systems in Louisiana, end-of-season live biomass range from 65 to 2,000 g/m²/yr (Burdick et al. 1989; Shaffer et al. 2009; Visser & Sasser 2009).

3.8.2 Forested Wetland Monitoring Sites

For forested wetland monitoring sites, the team estimated mean aboveground tree biomass per unit area based on field measurements of all trees within three 20-meter square plots per site collected on February 8 and 9, 2022. The team tagged trees within each plot, recorded the species, and using centimeter diameter tape with 0.1 cm increments, measured diameter at breast height (dbh) of each tree in the plot directly above and below the identification tag, which was located approximately 4.5 feet above the ground. The team followed the procedures as outlined in the *Forest Inventory and Analysis National Core Field Guide* (Version 7.2, USFS 2017). The team tagged trees with buttresses approximately 1.5 feet above the butt swell. **Table 4** shows the species specific allometric equations used to calculate tree biomass (Chojnacky et al. 2014).

Table 4 Allometric Equations Used to Convert Diameter at Breast Height to Woody Biomass

Common Name	Scientific Name	Allometric Biomass Equation (kilograms)	Range (cm)
Bald Cypress	<i>Taxodium distichum</i>	$\text{EXP}(-2.6327 + 2.4757 \cdot \ln[\text{dbh}])$	3–109
Green Ash	<i>Fraxinus pennsylvanica</i>	$\text{EXP}(-2.0314 + 2.3524 \cdot \ln[\text{dbh}])$	3–43
Red Maple	<i>Acer rubrum</i>	$\text{EXP}(-2.0470 + 2.3852 \cdot \ln[\text{dbh}])$	3–109
Sweet Gum	<i>Liquidambar styraciflua</i>	$\text{EXP}(-2.6390 + 2.5466 \cdot \ln[\text{dbh}])$	3–53
Water Elm	<i>Ulmus americana</i>	$\text{EXP}(-2.2118 + 2.4133 \cdot \ln[\text{dbh}])$	3–64
Water Oak	<i>Quercus nigra</i>	$\text{EXP}(-3.0304 + 2.4982 \cdot \ln[\text{dbh}])$	3–74
Water Tupelo	<i>Nyssa aquatica</i>	$\text{EXP}(-2.2118 + 2.4133 \cdot \ln[\text{dbh}])$	3–64

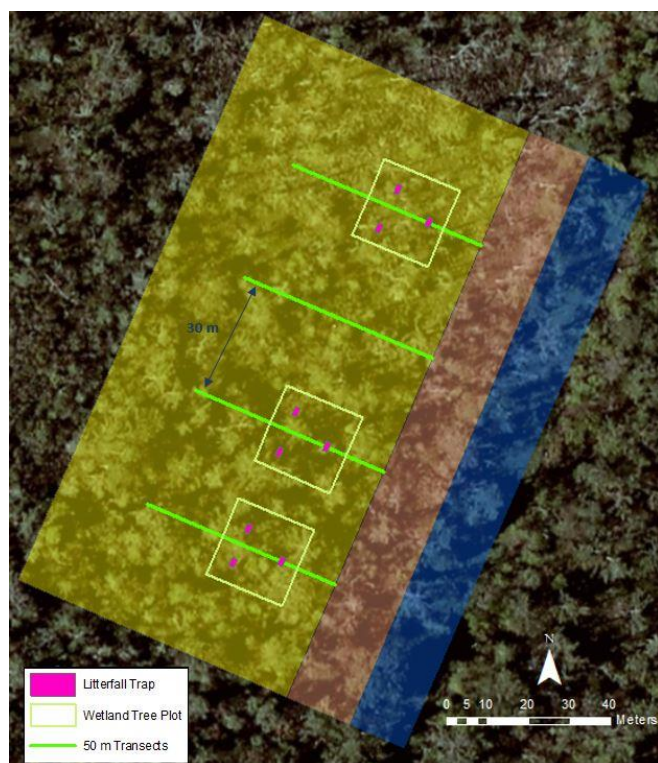


Figure 8
Typical Leaf Litter Box Layout

To capture foliar contribution to net primary productivity in forested sites, during the October 2021 monitoring event the team installed three 0.25-m² leaf litter boxes at each of the three forested biomass plots in the adjacent wetland zone for a total of nine leaf litter boxes per forested site (**Figure 8**). The team collected the litter during the February 2022 field visit. Additionally, the team recorded canopy cover at the center of each forested plot using a spherical crown densiometer during the assessments of community vegetation of forested sites in December 2022.

In similar wetland systems in Louisiana, mean aboveground tree biomass per unit area range from 150 to 1,200 g/m²/yr (Conner et al. 2014; Shaffer et al. 2009).

3.9 Nekton

On October 11 and 12, 2021, the team sampled nekton using a throw net with a round weighted bottom and floating ring top that captured approximately 3 m² of the water column (Kushlan 1981). The team threw the sampling device at random from the boat or shore into undisturbed open water. The team collected three replicate throw nets from each site and removed nekton from the throw net with a dip net, put into plastic bags, stored on ice, and frozen until identification. The team identified all nekton to species level when possible (Cook 1959; Douglas, 1974) and recorded total abundance and fork length.

Common nekton species in similar wetland systems in Louisiana include Least killifish (*Heterandria Formosa*), Mosquitofish (*Gambusia affinis*), Rainwater killifish (*Lucania parva*), Sailfin molly (*Poecilia latipinna*), and Sheepshead minnow (*Cyprinodon variegatus*) (Piazza and La Peyre 2009).

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Appendix A

Survey Data

JELA Baseline Survey 2022				
Point	Northing	Easting	Elevation (ft NAVD88)	Description
401910	475398.589	3662022.205	1.895	MON1
401911	490415.588	3656857.879	1.227	MON2
401912	490404.045	3656844.598	0.256	WATER EDGE
401913	490404.187	3656845.748	1.118	Natural Ground
401914	490405.659	3656870.81	0.98	Natural Ground
401915	490407.077	3656896.802	0.854	Natural Ground
401916	490408.581	3656920.721	0.755	Natural Ground
401917	490410.466	3656952.754	0.648	Natural Ground
401918	490404.451	3656836.783	-0.087	Water Bottom
401919	490405.907	3656819.899	-2.525	Water Bottom
401920	490401.065	3656767.972	-3.841	Water Bottom
401921	490402.978	3656803.717	-4.015	Water Bottom
401922	490400.383	3656789.357	-4.592	Water Bottom
401923	490400.703	3656755.131	-2.894	Water Bottom
401924	490398.334	3656739.741	-1.155	Water Bottom
401925	490397.444	3656730.813	-0.529	Water Bottom
401926	490396.469	3656724.263	0.222	WATER EDGE
401927	490396.313	3656722.122	0.718	Natural Ground
401928	490396.033	3656700.709	1.611	Natural Ground/Toe
401929	490394.655	3656678.402	4.171	Natural Ground
401930	490393.075	3656660.078	1.227	Natural Ground/Toe
401931	490391.591	3656637.013	1.155	Natural Ground
401932	490391.135	3656614.996	1.148	Natural Ground
401933	490362.935	3656631.444	2.024	RES-H-01 rSET
401934	490362.286	3656636.407	5.868	RES-H-01 WATER RECORDER
401935	490361.894	3656636.235	0.946	Natural Ground
401936	490374.473	3656828.49	6.18	WATER RECORDER
401937	490374.928	3656829.355	0.257	Water Surface
401938	490374.73	3656829.269	-1.753	Water Bottom
401939	492162.794	3657920.911	2.096	RES-F-#a rSET
401940	492161.532	3657941.526	6.383	RES-F-#a WATER RECORDER
401941	492161.254	3657941.433	0.815	Natural Ground
401942	492122.591	3658041.659	0.282	WATER EDGE
401943	492122.675	3658029.89	1.177	Natural Ground
401944	492122.546	3658014.925	1.633	Natural Ground/Toe
401945	492122.821	3657997.431	5.571	Natural Ground
401946	492122.884	3657976.376	1.682	Natural Ground/Toe
401947	492123.922	3657963.251	0.145	Natural Ground
401948	492123.323	3657936.118	1.485	Natural Ground
401949	492122.3	3658048.479	-0.393	Water Bottom
401950	492119.966	3658060.66	-2.949	Water Bottom
401951	492120.323	3658072.069	-2.915	Water Bottom
401952	492120.266	3658086.388	-5.283	Water Bottom
401953	492119.789	3658134.636	-5.935	Water Bottom
401954	492121.563	3658173.594	-4.795	Water Bottom
401955	492121.692	3658202.835	-1.659	Water Bottom
401956	492121.729	3658230.939	-0.019	Water Bottom
401957	492121.176	3658247.899	0.202	WATER EDGE
401958	492121.182	3658266.248	0.581	Natural Ground
401959	492121.049	3658290.171	0.841	Natural Ground
401960	492120.844	3658316.883	0.965	Natural Ground
401961	492120.622	3658342.097	1.007	Natural Ground
401962	492126.296	3658198.058	6.016	WATER RECORDER
401963	492126.087	3658197.692	0.294	Water Surface
401964	492125.937	3658197.667	-2.376	Water Bottom

JELA Baseline Survey 2022				
Point	Northing	Easting	Elevation (ft NAVD88)	Description
401965	492119.403	3658117.504	-8.06	Water Bottom
401966	487723.395	3655648.224	2.37	RES-H-#a rSET
401967	487716.118	3655643.892	6.234	RES-H-#a WATER RECORDER
401968	487715.976	3655644	1.441	Natural Ground
401969	487672.947	3655570.243	0.401	WATER EDGE
401970	487672.183	3655575.461	1.573	Natural Ground/Toe
401971	487669.28	3655595.029	2.999	Natural Ground
401972	487666.175	3655616.526	1.443	Natural Ground/Toe
401973	487662.847	3655639.786	1.437	Natural Ground
401974	487659.467	3655664.499	1.325	Natural Ground
401975	487677.531	3655548.325	-1.296	Water Bottom
401976	487679.348	3655511.432	-5.125	Water Bottom
401977	487676.856	3655475.728	-1.111	Water Bottom
401978	487686.143	3655478.637	-1.068	Water Bottom
401979	487687.86	3655467.773	-0.365	Water Bottom
401980	487690.833	3655446.513	1.33	Natural Ground/Toe
401981	487693.433	3655424.661	2.179	Natural Ground
401982	487697.675	3655401.144	1.298	Natural Ground/Toe
401983	487699.794	3655385.431	1.265	Natural Ground
401984	487690.257	3655464.801	0.126	WATER EDGE
401985	487691.049	3655479.54	6.282	WATER RECORDER
401986	487691.283	3655479.338	0.22	Water Surface
401987	487691.278	3655479.359	-1.123	Water Bottom
401988	497932.843	3664678.634	1.729	RES-F-#b rSET
401989	497944.83	3664679.874	5.62	RES-F-#b WATER RECORDER
401990	497945.071	3664679.916	0.932	Water Surface
401991	497945.204	3664679.829	-0.979	Water Bottom
401992	498022.46	3664690.251	0.165	WATER EDGE/TOE
401993	497987.118	3664684.241	1.01	Natural Ground
401994	497962.264	3664680.179	-0.237	Natural Ground/Toe
401995	497937.496	3664675.696	-0.717	Natural Ground
401996	497927.364	3664674.369	-0.571	Natural Ground
401997	498045.12	3664694.572	-5.153	Water Bottom
401998	498069.675	3664701.802	-4.679	Water Bottom
401999	498103.446	3664703.626	-1.646	Water Bottom
402000	498116.895	3664705.893	-1.374	Water Bottom
402001	498139.09	3664711.81	-1.521	Water Bottom
402002	498069.176	3664762.461	5.702	WATER RECORDER
402003	498069.037	3664762.726	0.233	Water Surface
402004	498068.994	3664762.917	-3.212	Water Bottom
402005	475390.878	3662009.862	0.381	WATER EDGE
402006	475390.02	3662013.056	1.773	Natural Ground
402007	475383.967	3662036.309	1.243	Natural Ground
402008	475377.673	3662061.315	1.264	Natural Ground
402009	475371.349	3662085.142	1.16	Natural Ground
402010	475364.904	3662109.049	1.09	Natural Ground
402011	475396.339	3661982.749	-3.907	Water Bottom
402012	475400.269	3661972.5	-3.178	Water Bottom
402013	475403.461	3661964.498	-3	Water Bottom
402014	475408.242	3661942.953	-0.074	Water Bottom
402015	475408.581	3661942.209	0.965	WATER EDGE
402016	475409.694	3661939.919	1.485	Natural Ground/Toe
402017	475415.491	3661915.299	1.776	Natural Ground
402018	475421.09	3661891.105	1.181	Natural Ground/Toe

JELA Baseline Survey 2022				
Point	Northing	Easting	Elevation (ft NAVD88)	Description
402019	475429.115	3661864.862	1.185	Natural Ground
402020	475435.408	3661838.571	1.274	Natural Ground
402021	475419.543	3661798.818	2.408	REF-H-06 rSET
402022	475410.564	3661796.933	6.027	REF-H-06 WATER RECORDER
402023	475410.897	3661796.824	1.186	Natural Ground
402024	475399.625	3661946.592	6.25	WATER RECORDER
402025	475399.65	3661946.917	0.353	Water Surface
402026	475399.644	3661947.077	-0.918	Water Bottom
402027	462718.757	3658872.872	2.424	RES-H-#b rSET
402028	462712.907	3658863.526	6.311	RES-H-#b WATER RECORDER
402029	462712.845	3658863.251	1.476	Natural Ground
402030	462683.023	3658747.228	0.368	WATER EDGE
402031	462681.305	3658752.652	1.975	Natural Ground
402032	462673.093	3658777.645	1.428	Natural Ground
402033	462665.218	3658803.056	1.528	Natural Ground
402034	462658.164	3658827.419	1.508	Natural Ground
402035	462651.515	3658848.057	1.559	Natural Ground
402036	462685.064	3658741.823	-0.797	Water Bottom
402037	462687.859	3658731.148	-3.432	Water Bottom
402038	462692.724	3658717.563	-3.162	Water Bottom
402039	462704.042	3658687.016	-7.422	Water Bottom
402040	462710.748	3658667.265	-2.39	Water Bottom
402041	462714.654	3658654.5	-0.797	Water Bottom
402042	462715.55	3658646.615	0.108	WATER EDGE
402043	462716.898	3658643.404	1.108	Natural Ground
402044	462722.837	3658621.39	1.028	Natural Ground
402045	462730.43	3658597.879	1.125	Natural Ground
402046	462736.569	3658576.099	0.959	Natural Ground
402047	462744.874	3658551.598	0.929	Natural Ground
402048	462752.555	3658529.425	0.674	Natural Ground
402049	462735.69	3658679.574	5.892	WATER RECORDER
402050	462735.672	3658679.971	0.304	Water Surface
402051	462735.586	3658680.199	-2.731	Water Bottom
402052	464517.423	3669161.122	2.119	REF-H-07 rSET
402053	464509.912	3669159.951	6.165	REF-H-07 WATER RECORDER
402054	464509.788	3669160.353	1.333	Natural Ground
402055	464440.438	3669104.599	0.379	WATER EDGE/TOE
402056	464443.12	3669108.164	1.734	Natural Ground
402057	464457.257	3669127.227	1.582	Natural Ground
402058	464471.114	3669146.261	1.199	Natural Ground/Toe
402059	464485.088	3669166.699	1.287	Natural Ground
402060	464500.274	3669182.982	1.209	Natural Ground
402061	464437.305	3669100.867	-0.63	Water Bottom
402062	464431.09	3669092.102	-1.744	Water Bottom
402063	464421.149	3669080.005	-0.87	Water Bottom
402064	464411.446	3669066.198	0.598	WATER EDGE
402065	464407.939	3669061.982	1.61	Natural Ground
402066	464392.284	3669040.231	1.099	Natural Ground
402067	464374.91	3669017.921	1.006	Natural Ground
402068	464356.445	3668992.363	1.063	Natural Ground
402069	464432.5	3669097.3	6.305	WATER RECORDER
402070	464431.865	3669097.766	0.229	Water Surface
402071	464431.733	3669097.744	-1.466	Water Bottom
402072	475281.693	3653392.897	2.465	RES-H-03 rSET
402073	475293.258	3653389.37	5.842	RES-H-03 WATER RECORDER
402074	475292.95	3653389.501	1.113	Natural Ground
402075	475303.695	3653396.984	1.08	Natural Ground
402076	475286.933	3653414.029	1.116	Natural Ground
402077	475269.443	3653431.85	1.131	Natural Ground

JELA Baseline Survey 2022				
Point	Northing	Easting	Elevation (ft NAVD88)	Description
402078	475252.718	3653449.763	1.066	Natural Ground
402079	475236.591	3653468.642	1.418	Natural Ground/Toe
402080	475221.948	3653488.646	1.761	Natural Ground
402081	475211.096	3653500.873	1.313	Natural Ground/Toe
402082	475206.546	3653505.807	0.274	WATER EDGE
402083	475201.82	3653511.511	-1.514	Water Bottom
402084	475194.5	3653523.679	-4.556	Water Bottom
402085	475176.954	3653542.234	-8.817	Water Bottom
402086	475161.014	3653559.927	-7.297	Water Bottom
402087	475143.895	3653576.07	-6.205	Water Bottom
402088	475125.907	3653596.271	-3.538	Water Bottom
402089	475124.963	3653598.109	0.274	WATER EDGE
402090	475113.844	3653610.801	0.768	Natural Ground
402091	475095.795	3653630.079	1.511	Natural Ground
402092	475081.817	3653646.545	1.707	Natural Ground
402093	475064.074	3653666.915	1.472	Natural Ground
402094	475053.744	3653676.545	1.722	Natural Ground
402095	475373.2	3653938.501	5.992	WATER RECORDER
402096	475373.545	3653938.141	0.229	Water Surface
402097	475373.56	3653938.199	-1.193	Water Bottom
402098	477325.526	3653516.913	6.463	WATER RECORDER
402099	477325.308	3653517.38	0.207	Water Surface
402100	477326.333	3653517.191	-1.403	Water Bottom
402101	477335.641	3653312.22	2.194	REF-H-05 rSET
402102	477327.013	3653317.262	6.238	REF-H-05 WATER RECORDER
402103	477327.305	3653317.302	1.188	Natural Ground
402104	477304.721	3653321.628	1.152	Natural Ground
402105	477310.8	3653346.537	1.177	Natural Ground
402106	477317.643	3653374.839	1.2	Natural Ground
402107	477323.961	3653401.765	1.334	Natural Ground
402108	477330.565	3653425.075	1.403	Natural Ground
402109	477337.234	3653450.134	1.702	Natural Ground/Toe
402110	477343.957	3653474.604	1.653	Natural Ground
402111	477348.206	3653490.86	0.915	Natural Ground/Toe
402112	477350.251	3653498.128	0.289	WATER EDGE
402113	477366.463	3653544.743	-1.766	Water Bottom
402114	477367.017	3653565.825	-3.031	Water Bottom
402115	477374.476	3653589.462	-6.498	Water Bottom
402116	477385.661	3653610.231	-8.876	Water Bottom
402117	477389.914	3653648.589	-9.161	Water Bottom
402118	477396.644	3653676.063	-6.836	Water Bottom
402119	477405.285	3653690.963	-3.437	Water Bottom
402120	477409.713	3653725.434	-1.689	Water Bottom
402121	477405.05	3653715.443	-1.852	Water Bottom
402122	477417.153	3653759.048	-0.163	WATER EDGE
402123	477421.028	3653774.588	1.838	Natural Ground
402124	477426.901	3653799.192	1.696	Natural Ground
402125	477434.654	3653827.988	1.479	Natural Ground
402126	477441.687	3653855.009	1.523	Natural Ground
402127	477448.576	3653882.732	1.383	Natural Ground
402128	480603.083	3664016.302	2.262	REF-H-03 rSET
402129	480605.294	3664008.127	6.234	REF-H-03 WATER RECORDER
402130	480605.386	3664008.549	1.282	Natural Ground
402131	480568.582	3664004.068	1.222	Natural Ground
402132	480593.725	3664003.209	1.224	Natural Ground
402133	480615.088	3664001.974	1.215	Natural Ground
402134	480637.06	3664001.749	1.356	Natural Ground/Toe
402135	480661.569	3664004.103	1.718	Natural Ground
402136	480674.484	3664003.511	0.327	WATER EDGE/TOE

JELA Baseline Survey 2022				
Point	Northing	Easting	Elevation (ft NAVD88)	Description
402137	480669.414	3663974.966	6.288	WATER RECORDER
402138	480669.437	3663975.479	0.397	Water Surface
402139	480669.747	3663975.523	-1.848	Water Bottom
402140	480680.88	3664003.332	-2.705	Water Bottom
402141	480694.39	3664004.741	-2.358	Water Bottom
402142	480707.855	3664004.328	-2.628	Water Bottom
402143	480717.174	3664003.948	0.277	WATER EDGE
402144	480729.05	3664003.98	0.966	Natural Ground/Toe
402145	480756.123	3664004.817	1.12	Natural Ground
402146	480784.638	3664004.851	0.922	Natural Ground/Toe
402147	480813.881	3664004.605	0.795	Natural Ground
402148	477269.127	3664009.073	1.847	REF-F-05 rSET
402149	477276.89	3664005.412	6.206	REF-F-05 WATER RECORDER
402150	477277.167	3664005.436	1.006	Water Surface
402151	477277.125	3664005.329	-0.904	Water Bottom
402152	477269.928	3664003.934	-0.673	Water Bottom
402153	477285.376	3664008.08	-0.699	Water Bottom
402154	477301.791	3664012.803	-0.472	Water Bottom
402155	477322.914	3664018.477	1.582	Natural Ground/Toe
402156	477330.72	3664019.816	2.672	Natural Ground
402157	477340.661	3664023.849	0.33	WATER EDGE/TOE
402158	477377.352	3663966.813	6.318	WATER RECORDER
402159	477378.24	3663967.165	0.215	Water Surface
402160	477378.516	3663967.423	-2.516	Water Bottom
402161	477358.155	3664028.797	-4.072	Water Bottom
402162	477375.102	3664033.781	-4.66	Water Bottom
402163	477398.222	3664039.485	-4.22	Water Bottom
402164	477413.587	3664044.191	0.296	WATER EDGE
402165	477425.673	3664046.359	3.457	Natural Ground/Toe
402166	477443.818	3664052.111	6.24	Natural Ground
402167	477460.891	3664056.338	6.194	Natural Ground
402168	477479.954	3664062.285	3.942	Natural Ground/Toe
402169	477495.596	3664066.286	0.293	WATER EDGE
402170	484784.918	3665297.943	2.12	REF-F-03b rSET
402171	484798.477	3665279.14	6.094	REF-F-03b WATER RECORDER
402172	484798.764	3665278.645	1.021	FLOATON Natural Ground
402173	484787.498	3665306.115	-0.537	Natural Ground
402174	484797.618	3665282.348	-1.315	Natural Ground
402175	484798.758	3665278.656	0.979	FLOATON TOP
402176	484808.248	3665259.356	1.337	Natural Ground
402177	484811.391	3665251.085	2.469	Natural Ground
402178	484815.621	3665243.104	0.466	WATER EDGE
402179	484790.859	3665222.969	6.391	WATER RECORDER
402180	484790.515	3665223.244	0.27	Water Surface
402181	484790.601	3665222.838	-2.681	Water Bottom
402182	484817.892	3665237.751	-0.856	Water Bottom
402183	484825.616	3665221.189	-0.55	Water Bottom
402184	484830.413	3665207.811	-0.329	Water Bottom
402185	484836.281	3665198.084	0.4	WATER EDGE
402186	484838.215	3665194.6	2.108	Natural Ground/Toe
402187	484840.257	3665189.749	2.135	Natural Ground
402188	484842.989	3665183.009	1.281	Natural Ground/Toe
402189	484850.004	3665164.267	1.233	Natural Ground
402190	484853.85	3665154.045	-0.424	Natural Ground

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Appendix B

Photostation Log

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