A STANDARD OPERATING PROCEDURES MANUAL FOR THE LOUISIANA DEPARTMENT OF NATURAL RESOURCE'S COASTAL RESTORATION DIVISION:

Methods for Data Collection, Quality Assurance/ Quality Control, Storage, and Products

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March 15, 2004

Suggested reference citation:

Folse, T. M. and J. L. West. 2004. A Standard Operating Procedures Manual for the Louisiana Department of Natural Resource's Coastal Restoration Division: Methods for Data Collection, Quality Assurance / Quality Control, Storage, and Products. Louisiana Department of Natural Resources, Baton Rouge, LA. 158 pp.

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ACKNOWLEDGEMENTS

Brian Perez, Greg Steyer, Erick Swenson, Guerry Holm, and Leigh Ann Phillips made contributions to this document. We are grateful to Richard Raynie, Darin Lee, John Troutman, Dona Weifenbach, Melissa Hymel, Jonathan Barmore, Bill Boshart, Brady Carter, Donald Rodrigue, Mike Miller, Mark Mouledous, Troy Barrilleaux, Justin Price, David Castellanos, Larry Reynolds, and Sydney Dobson for constructive comments, suggestions, and criticisms during the preparation of this document. Glen Curole, Elaine Lear, Todd Hubbell, and Karen Gray provided preliminary drafts for various chapters. Figures were produced in Autocad by Shane Triche.

EXECUTIVE SUMMARY

With the implementation of a Coast-wide Reference Monitoring System-Wetlands throughout southern Louisiana's coastal wetlands, the development of a new document updating and outlining the standard operating procedures for site selection and establishment, data collection, maintenance of data integrity, and data storage of all coastal restoration projects and reference sites was required. This document provides the necessary procedures for the Louisiana Department of Natural Resources' (LDNR) personnel to perform: (1) preliminary site visits; (2) site construction; (3) water level measurements; (4) salinity measurements; (5) vertical marsh mat movement; (6) soil porewater salinity measurements; (7) surface elevation table measurements; (8) accretion measurements; (9) emergent vegetation sampling; (10) sampling of wetland soils for soil characteristics analysis; (11) submerged aquatic vegetation sampling; (11) shoreline position measurement; (12) and land/water analysis. Within each section, we provide an overview and introductory material for each separate analysis. We then outline the steps necessary to establish each station, to carry out each sampling design, and to maintain data quality and integrity from data collection to data uploading into the LDNR databases.

1. INTRODUCTION

Currently, coastal Louisiana is experiencing a loss of approximately 25 - 35 square miles of land per year and since the 1930's over 1,900 square miles of valuable wetland habitat have disappeared (Barras et al. 2003). In response to accelerated wetland loss, a multi-agency task force, including many federal and state sponsors, created the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) of 1990 to conserve, restore, create, or enhance coastal wetlands. Under CWPPRA, the establishment of project-specific monitoring resulted in the formation of various data collection variables within the boundary of each CWPPRA project. In association with the data collected in the project boundary, areas in the immediate vicinity and similar in nature were selected as reference sites. By comparing data collected within the project boundary and the reference sites, the project features were evaluated for their effectiveness with respect to the goals and objectives set forth in each project's monitoring plan. This project-specific approach was very effective for small-scale projects, but was not effective for studying and evaluating larger, cumulative effects, or broad-scale ecosystem effects at the hydrologic basin or coast-wide scale.

In the late 1990's, the LDNR/CRD began investigating the implementation of the Coast-wide Reference Monitoring System-*Wetlands* (CRMS-Wetlands) program. The CRMS-*Wetlands* approach randomly selects stations throughout the coastal zone in accordance with the vegetative community (from Visser and Sasser 1998); consequently, the monitoring will be associated with the entire coastal region of Louisiana. This program will allow the LDNR/CRD to better understand problems associated with the loss of coastal marshes as well as provide a valuable long-term ecological data set for southern Louisiana, make available reference data to determine overall trends, and serve as reference sites to test the effectiveness of different restoration/enhancement measures.

Concurrent with this new approach, the LDNR/CRD decided the Standard Operating Procedures (SOP) needed updating with respect to site selection, station construction, data collection methods, data management, data quality, and data interpretation. With the implementation of CRMS-*Wetlands* in 2004, the SOP was disassembled and re-written to correspond with the procedures recommended by the LDNR/CRD. The new SOP will serve as the document for consultation with respect to all data collection variables as they relate to field establishment, site / station construction, data collection, data processing, Quality Assurance (QA) and Quality Control (QC), and data storage. This SOP will assure that the results of any technical work have adhered to specific standards suitable for their intended use.

Data collection plays a critical role in determining any project's effectiveness at achieving long-term goals. To this end, it is crucial that data collection must be consistent and repeatable by all parties involved with CRMS-*Wetlands*, project-specific monitoring, and throughout all coastal wetlands. Since data collected from each of these sites will be made available to not only the public, but also used to publish the coast-wide trends and status report and evaluation of projects aimed to restore, enhance, or conserve coastal ecosystems, it is imperative that these procedures are followed to achieve precise, accurate, repeatable, acceptable, and accredited data (Bass et al. 2003). This document outlines the updated SOP to be implemented with CRMS-*Wetlands* and to be used for project-specific monitoring by the LDNR/CRD. It provides field-tested, step-by-step methods to establish data collection sites and to collect data for multiple variables used in coastal restoration projects. Additionally, it outlines a sound QA/QC program to be maintained for data quality and integrity.

2. PRELIMINARY SITE VISIT

Once the LDNR/CRD has acquired land-rights and/or access permission to a particular site, a preliminary site visit is necessary to verify that the proposed area will be sufficient for the LDNR/CRD purposes and to ascertain the logistics for the site. The objectives for the preliminary site visit include determining the approximate location and length of the boardwalk, the location of each sampling station, and any potential locations for water level/salinity continuous recorders, staff gauges, and secondary benchmarks.

Prior to the preliminary site visit, travel logistics and proposed site locations shall be determined by reviewing the Land Rights Packet supplied by the Land Rights Section of LDNR/CRD (LDNR/CRD/LRS). This Land Rights Packet will provide who to notify before visiting the site (if necessary), directions to the site, and various maps. The directions to the site include roadway access, the nearest town/city, location of boat ramp (if applicable), and directions to the center of the site (e.g., water vessel path from boat ramp to site). LDNR/CRD/LRS will have only acquired access permission for each of these components and travel should be restricted to the directions and paths outlined in the packet. LDNR/CRD/LRS will also provide maps such as digital orthophoto quarter-quadrangles (DOQQ) or SPOT imagery and Tobin plat maps. These maps will provide the location of the site and highlight areas with land rights.

Using GIS software and the GPS coordinates provided by LDNR/CRD, field personnel shall produce an overall map of the area showing a 1 km x 1 km square (1-km^2) boundary with the proposed site location at the center. Each of the sampling stations shall be located in a 200 m x 200 m square within the 1-km^2 boundary and ideally this 200 m x 200 m square will be located in the center of the 1-km^2 boundary. However, this design may not be feasible in all areas due to land rights or geological features. Thus the GIS map and maps provided in the Land Rights Packet shall be examined to identify possible locations of the 200 m x 200 m square within the 1-km^2 boundary (be sure to consider the date when the DOQQ or SPOT images were acquired when determining potential site locations). The ideal location for the 200 m x 200 m square should include a representative area of marsh for placement of an RSET station and a nearby body of water for placement of a water level/salinity continuous recorder. Field personnel shall then produce a “Site Map” (Figure 1) showing a 200 m x 200 m boundary with each possible site location positioned at the center. The “Site Map” should be produced to a scale (~1:1500) that shows the proper amount of detail with respect to the area needed to collect the data. LDNR/CRD recommends the use of DOQQ or SPOT imagery in producing the “Site Map.” The “Site Map” should contain a scale bar, north arrow, potential site number for record purposes, and the imagery (including the year and date acquired) used to produce the map. The “Site Map” should be produced on 8.5” x 11” paper; however, larger sized paper may be used. If an overall map is needed for traveling purposes, then another map should be generated. During the production of the “Site Map”, field personnel shall examine the surrounding areas to find potential entrance points to the site (if applicable given the land rights for the area). Examining the inside of the 200 m x 200 m square will aid in navigating to the site in turn minimizing damage to the area.

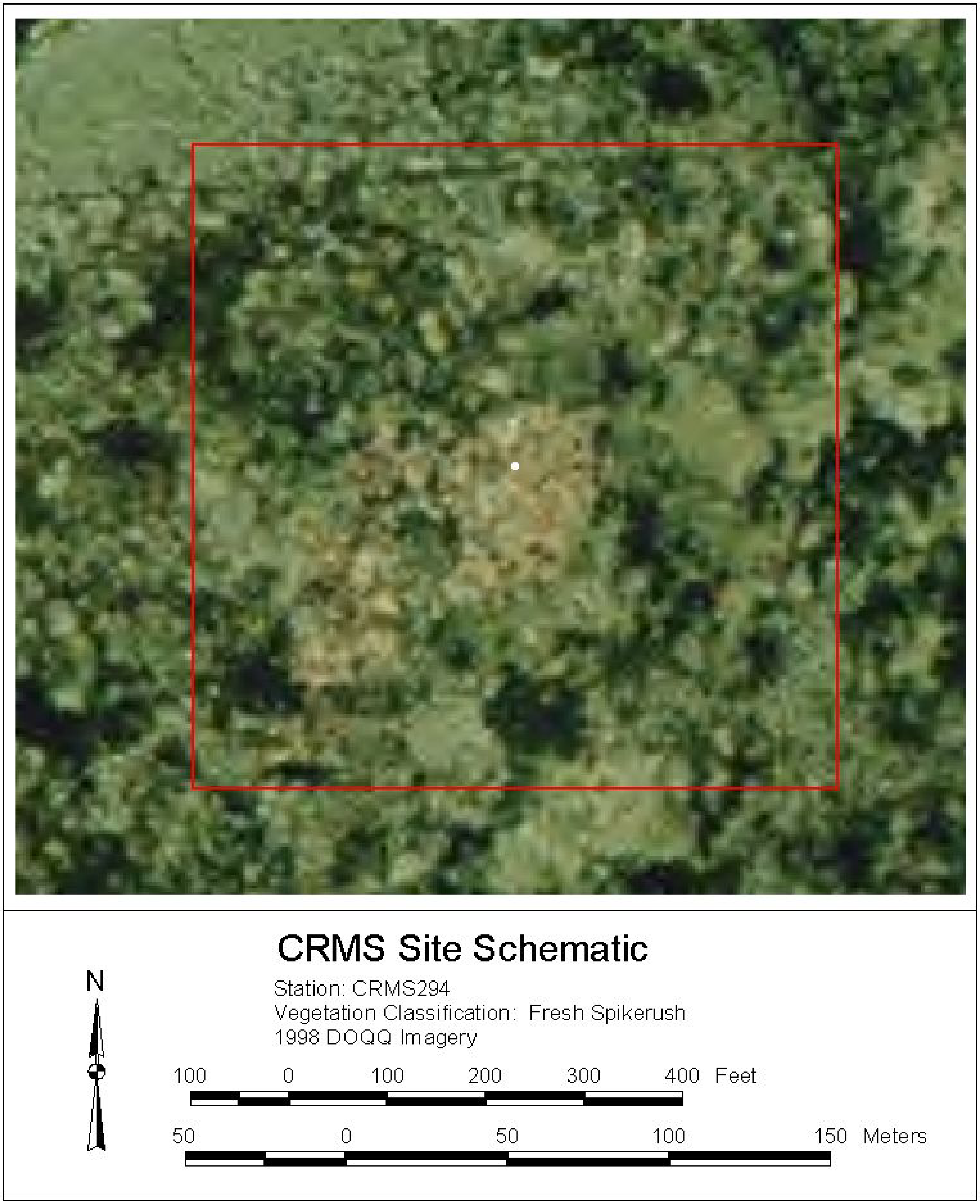

Figure 1: Example of a site map used to identify and document the location of the boardwalks and each potential data collection station. The scale is 1:1500.

Field personnel shall approach the site with great care to maintain site and data collection integrity. In some areas, depending on site location, land-rights, accessibility, or marsh type, a longer boardwalk (known heretofore as Long Boardwalk) may need to be constructed to reach the Sampling Platform (a ten foot boardwalk on either side of the Long Boardwalk; Figure 2). The preliminary site visit will aid in determining the layout, direction, and length of the Long Boardwalk from where the water vessel is parked. This length is very helpful as the correct number of planks, teeth, etc. can be brought along for site construction. The location of the Sampling Platform, the approximate positioning of the sampling stations (e.g., RSET, accretion, water-level instruments), and the coordinates of vegetation starting points and ending points will also be scouted. Any potential problems will also be noted.

During the site visit, the field personnel shall complete the "Site Characterization Sheet" (Form 1). This information/data sheet will characterize the proposed site to determine if the site is suitable for the requirements specified in the projects overall goals and objectives. This information will also provide sufficient documentation for the construction phase of the project. Along with the "Site Map," the construction personnel will be able to construct the necessary platforms and stations without having to decipher the goals and objectives of the project. The "Site Characterization Sheet" will provide enough details that the construction personnel shall deliver the appropriate amount of materials to the site during construction.

The following section provides a list of the minimum materials / equipment necessary to perform an adequate preliminary site visit and evaluation.

2.1. Materials / Equipment (minimum)

1. Compass: 0° to 360° azimuth dial with 2° graduations
2. Digital Camera with Date and Time Stamp capabilities
3. Measuring tape: capable of measuring 100 meters (~328.1 feet)
4. DGPS Unit: capable of real-time surveying
5. "Site Map"
6. "Site Characterization Sheet" (provided by the LDNR/CRD; Form 1)
7. Pencils and pens
8. PVC poles to mark locations for infrastructure installation (e.g., boardwalk(s), continuous recorders)

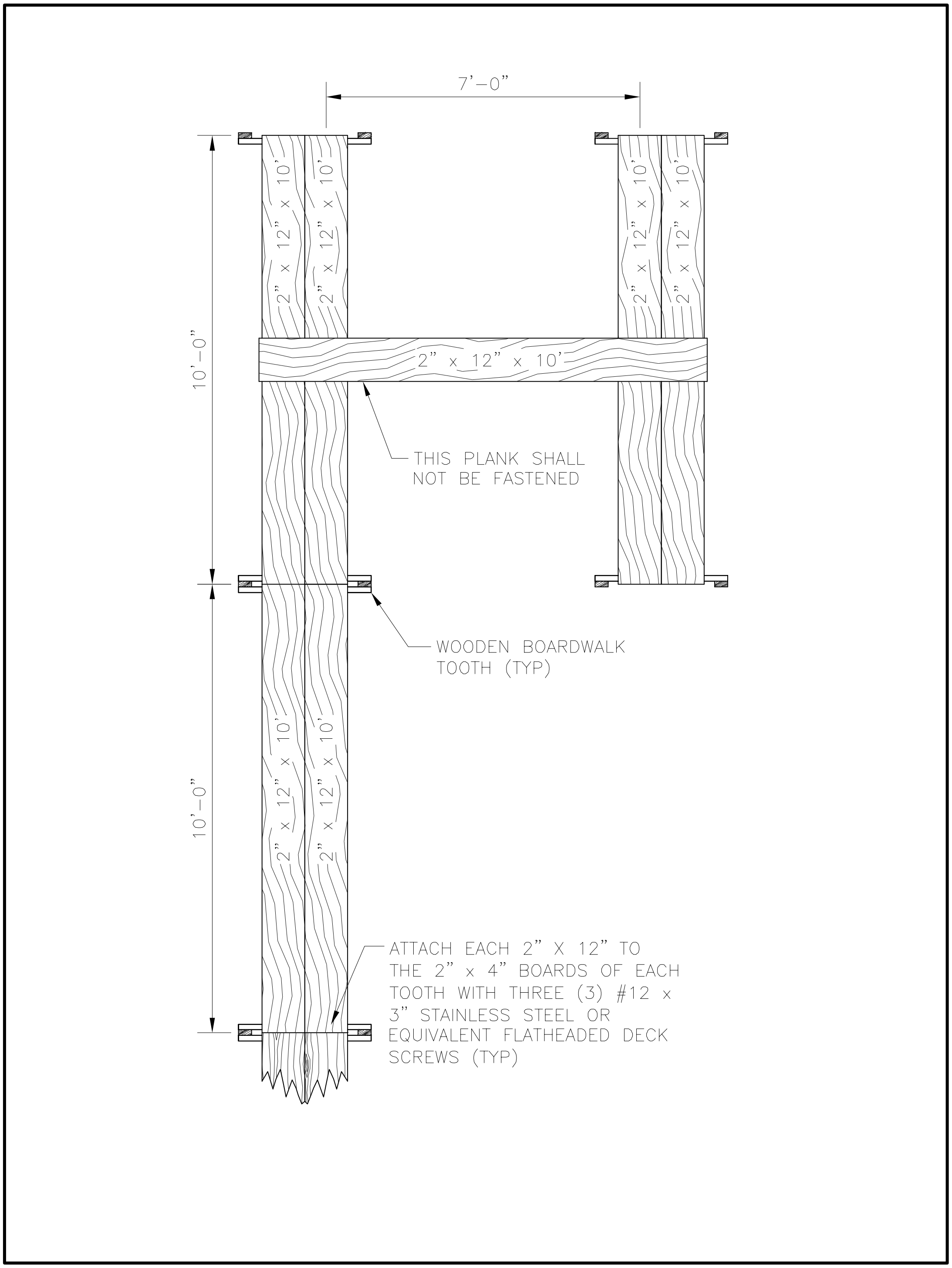

Figure 2: Typical schematic of a boardwalk.

2.2. Site Visit Procedures

The Land Rights Packet should provide water vessel restrictions (e.g., airboats are prohibited in the wildlife management area during duck season) as well as identify any areas to avoid while in transit. The "Site Map" may also be helpful in recognizing these locations.

1. Using the Land Rights Packet, "Site Map", "Site Characterization Sheet", GPS coordinates, and/or other maps, travel towards the data collection site verifying any proposed access routes and making note of marsh characteristics. Upon entering the 200 m x 200 m square, examine the area with respect to the potential placement of the stations. Inspect water bodies in the area for potential continuous recorder and staff gauge installation (i.e., the water body is deep enough for a continuous recorder). Carefully approach the proposed site. Observe the dominant vegetation in area.
2. Once the area has been examined, determine the approximate placement of the boardwalk(s) and the RSET. This location shall be a representative area of marsh and suitable for RSET installation. Be careful not to step in or travel over the potential RSET station.
3. Use a DGPS unit to document the coordinates of the beginning of the Long Boardwalk. Record the GPS coordinates (in UTM, NAD83 Meters) of the beginning point as well as the compass bearing (in degrees) and approximate length (in meters) that the Long Boardwalk will extend from this starting point on the "Site Characterization Sheet".
    a. <u>NOTE</u>: This point represents the position where the construction of the Long Boardwalk will begin and it is the point at which foot or vehicle travel will be prohibited and all traffic to and from the site is limited to the boardwalk only.
    b. <u>NOTE</u>: The Long Boardwalk does not necessarily have to start at the water's edge.
    c. <u>NOTE:</u> PVC markers may be left at the site to mark the exact location; however, enough information should be obtained as not to rely solely on the markers. It is possible that the markers may be removed by others before construction of the site begins.
4. Describe the positioning of the Sampling Platform with respect to the Long Boardwalk. The Sampling Platform is the "H" or focal point for RSET, accretion, and soil porewater data collection stations.
5. Record the dominant vegetation species in the area (at least three (3) species) and describe the quality and/or health of the marsh (e.g., any notable ecological/biological attributes, evidence of nutria herbivory, noticeable causes of degradation such as salt water intrusion, etc.).
6. At the start of the Long Boardwalk, take a few pictures from an elevated position into various directions (preferably N, E, S, and W) to provide a historical reference snapshot prior to site construction. Other pictures, especially along the bearing of the Long Boardwalk, can be taken as needed. Note each picture's number, direction, and time stamp on the "Site Characterization Sheet."
7. Take some time to observe the marsh and describe the marsh characteristics. Note on the data sheet if the marsh is floating or not.
    a. If the marsh is floating, describe the relative mat strength (e.g., very thin marsh, very easy to break through). Recommend a flotant marsh mat recorder

setup (Static for thin marshes and Floating for thick marshes) and record why this setup was recommended.

8. If it is a floating marsh, recommend a floating marsh recorder setup that would best work at this site and describe why. Describe other characteristics of the marsh (e.g., any notable ecological/biological attributes, nutria herbivory in area, noticeable causes of degradation such as salt water intrusion, etc.).
9. When determining an area that will be suitable for the water level and/or salinity continuous recorders, field personnel must consider if the water level will be maintained above sensors the entire sampling year and if not, recommend another water level sensor (e.g., ultrasonic water level sensor). Be sure to consider the season when recommending both placement and type of water level sensor (e.g., dry season vs. wet season). Use a DGPS unit to document the coordinates of this station and record these coordinates on the "Site Characterization Data Sheet". Document the reason a specific water level recorder was recommended.
10. Before leaving the site, briefly describe any potential problems that may arise during initial site construction or during routine sampling of the site and make any recommendations for subsequent site visits. Recommend if this site can be used as a secondary benchmark and describe why or why not. One secondary benchmark can be utilized with more than one site if each site is established within a 3 mile radius of the benchmark.

Complete the "Site Characterization Data Sheet" with as much detail deemed necessary for the construction field crew to establish the stations in the appropriate places. <u>NOTE:</u> The impact to the area must be minimal for all phases for the site usage.

Upon return from the preliminary site visit, use GIS software to upload the DGPS coordinates for the Long Boardwalk and water level continuous recorder (as well as any other notable points taken) to make sure that these sampling stations are located within the 200 m x 200 m square. The "Site Map" shall be reprinted with the locations of these sampling stations incorporated into the map.

2.3. Deliverables

Upon completion of the site visit, a field trip report shall be produced that summarizes the type of water vessels needed to access the site, wetland type, marsh characteristics, potential problems, and any other pertinent information as it concerns the establishment of stations and collection of data. The "Site Map" containing the sampling station layout and a completed "Site Characterization Sheet" shall be included with the field trip. Also, all downloaded pictures (JPEG images) from the field shall be viewed and the file names shall be renamed to describe the site, direction of the picture, and date (e.g. CRMS0395_N_03112004.jpg or there may need to be more descriptive file names).

3. SITE CONSTRUCTION

Each site will require the construction of a boardwalk, the installation of a deep rod similar to a survey monument for the Rod-Surface Elevation Table (RSET) in non-floating marsh, marsh mat recorder and deep rod monument in floating marsh, staff gauge, warning signage, and the establishment of a reference elevation. A general site configuration is shown in Figure 3; however, each site-specific configuration will be determined by the LDNR/CRD prior to construction, during the preliminary site visit. Details concerning this procedure may be obtained in the Preliminary Site Visit chapter.

Upon receipt of the site-specific configuration map ("Site Map" after the preliminary site visit) and site characterization sheets from the LDNR/CRD, the boardwalks shall be constructed first. The construction of the boardwalks enables the installation of the deep rod for the RSET and other data collection stations to be performed from the boardwalk without disturbing the surface of the marsh or swamp. It is very important to maintain the integrity of the study; consequently, any surface alteration that occurs during the construction phase shall result in the LDNR/CRD not accepting the site and requiring the construction of the site at another location.

This section provides a materials list and construction procedure for the minimum amount of boardwalk, the deep rod for the RSET, warning sign placement, water level support pole, staff gauge installation, and elevation surveys that will be constructed, installed, or performed at each site. Some sites may require a longer boardwalk depending on land-rights, accessibility, marsh type, etc., but the construction and material types will remain the same just in a larger quantity.

3.1. Sampling Platform Materials List

All wooden materials used to construct the boardwalk or data collection stations shall consist of pressure treated materials or equivalent. As of December 2003, the lumber industry was forced to change the pressure treatment chemical formulation from chromated copper arsenate (CCA) to alkaline copper quat or copper azole. Because of the change in the chemical formula, commonly used galvanized nails and screws will degrade faster; consequently, the use of stainless steel nails and screws or equivalent treatments shall be used when assembling boardwalks or wooden data collection stations.

The materials list is for a thirty (30) foot boardwalk with a ten foot boardwalk off to the side at the end of the boardwalk.

1. Eighteen (18): 2"x4"x24" treated boards or equivalent.
2. Twelve (12): 2"x4"x8'or 10' treated boards or equivalent.
3. Nine (9): 2"x12"x10' treated boards or equivalent (one will be removed).
4. Twelve (12): 3/8"x4" stainless steel or equivalent carriage bolts with stainless steel or equivalent flat washer, locking washer, and nut.
5. Twelve (12): 3/8"x6" stainless steel or equivalent carriage bolts with stainless steel or equivalent flat washer, locking washer, and nut.
6. Minimum of 48 stainless steel or equivalent exterior 3" screws (6 per 2"x12"x10' board).

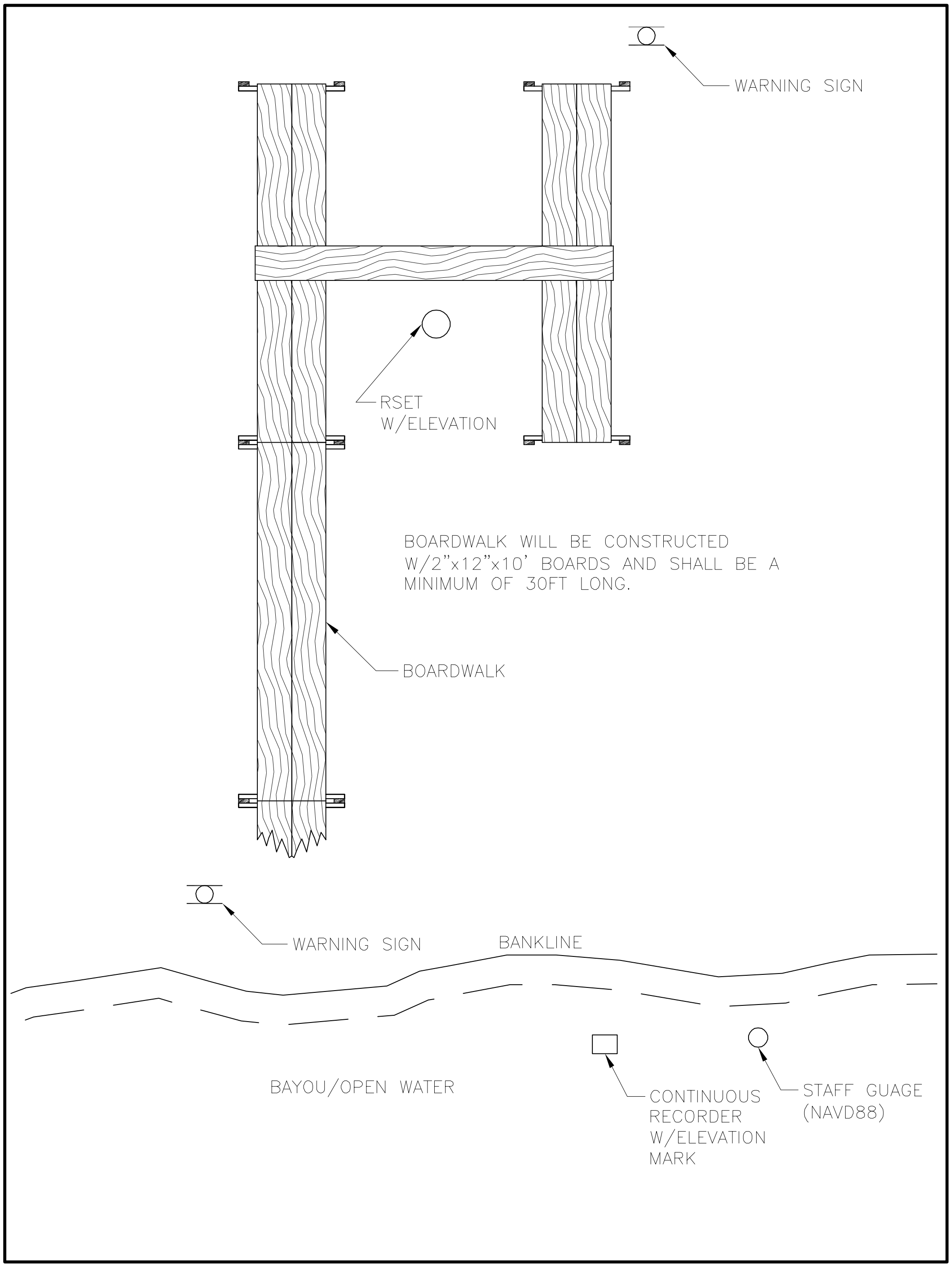

Figure 3: Typical layout schematic of the constructed site features.

7. Recommended tools: hand saw or skill saw to cut boards, cordless drill with various size wooden bits and screwdriver heads, crescent wrenches, socket wrenches, sledge hammer, tape measure, gloves, and hammer. NOTE: Personnel protection equipment (PPE) shall be worn during all phases of material handling.

3.2. Sampling Platform Construction

The main part of the boardwalk platform is called a tooth and is comprised of two (2) legs (2"x4"x8'or 10') attached to three (3) crosspieces with the stainless steel carriage bolts. This part of the boardwalk can be assembled before constructing the boardwalk in the field. If the water vessel is not large enough to safely handle the assembled teeth, it is highly recommend that the teeth be disassembled. A typical tooth construction is found in Figure 4.

Using the pre-approved site-specific configuration provided by the LDNR/CRD, enter the site using the route access. This will ensure that the site will not be compromised by the personnel constructing the site. Other variables will be measured away from the boardwalk; therefore, the route access must be followed at all times. Upon arrival at the beginning of the boardwalk, the construction personnel shall begin the construction of the boardwalk from the water vessel. This will prevent any disturbance of the site.

The following procedures shall be followed to assure proper installation without damaging the marsh or swamp surface.

1. Determine the direction of the boardwalk from the water vessel using the provided information.
2. Place the sharpened end of the tooth onto the marsh / swamp surface.
3. Using the weight of the person installing the tooth, drive the teeth into the surface of the marsh / swamp. NOTE: To facilitate the installation, the four 3/8" carriage bolts should be loosened to allow the legs to penetrate into the marsh surface independently.
4. The bottom support piece shall rest a maximum of eight (8") from the surface. NOTE: The carriage bolts shall be tightened to secure the pieces together and provide a stable platform.
5. Tighten all four carriage bolts once the tooth has been driven to there proper position above the marsh surface. This shall secure the tooth from any horizontal movement.
6. Once the tooth has been installed, lay one end of a 2"x12"x10' board on the tooth with the other end placed on the marsh where the next tooth will be installed.
7. Standing on the end of the board and **NOT** on the surface of the marsh, install the next tooth.
8. Place two 2"x12"x10' boards between the two teeth. Secure the boards to the teeth using the 3" screws. NOTE: Decisions may be made to leave only a portion or none of the boards in place to reduce the risk of vandalism.
9. Repeat steps 2 thru 8 until the boardwalk is to its desired length.
10. Using the site-specific configuration, determine the placement of the shorter boardwalk.
11. At the end of the boardwalk (opposite end of the water vessel), lay a board (2"x12"x10') on the marsh in the direction where the shorter boardwalk will be established. NOTE: This distributes the weight of the person and reduces damage to the marsh surface.

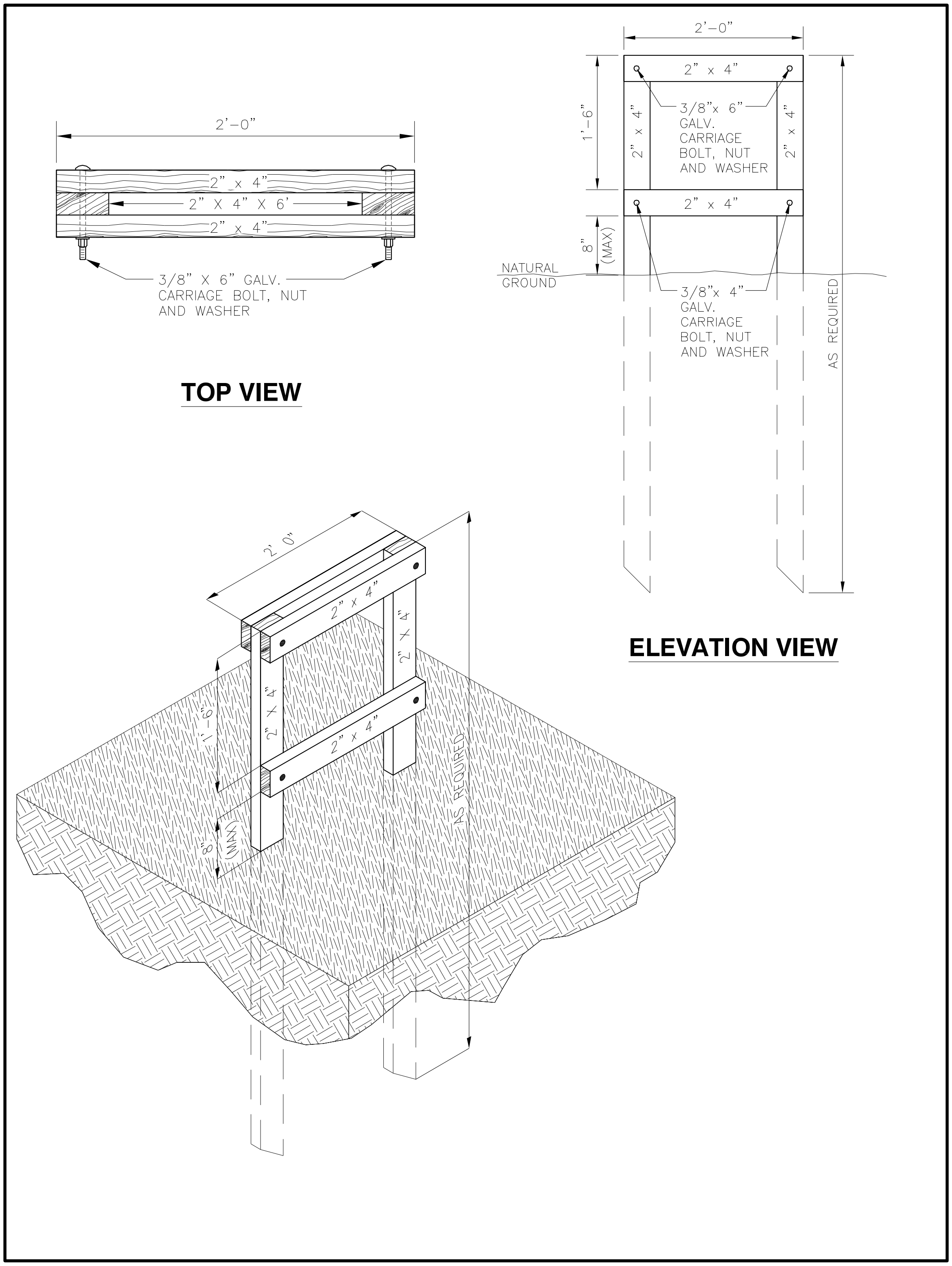

Figure 4: Tooth construction diagram used to support the boardwalk for access to the data collection stations.

12. Using the same procedures, construct a ten (10) foot boardwalk that is parallel to the longer boardwalk and a minimum of 6 feet away.
13. The final product shall closely, if not exactly, resemble Figure 2.

During the construction of the site, no one shall walk on the surface of the marsh / swamp at any time. It is imperative that this be followed since the integrity of the data that will be collected at a later date depends on the natural functions of the wetland in an undisturbed manner. Failure to follow this guideline shall result in the construction of another site at another location at the expense of the contractor. The replacement site would be determined by the LDNR/CRD.

3.3. <u>Rod-Surface Elevation Table</u>

Upon completion of the boardwalks, the deep rod needed for the rod-surface elevation table (SET) will be established from the boardwalks. Once again it is imperative that the installation of the rod for the RSET be performed without disturbing an area with a maximum diameter of six inches. The rod for the RSET will be established using the guidelines set forth in Cahoon et al. (2002). This paper describes the design of the surface elevation table (SET) that will be supplied by the LDNR/CRD and the two types of benchmarks that can be used with the SET. However, the LDNR/CRD will only establish the deep rod benchmark.

Deep Rod Benchmark Materials List

1. Multiple 9/16" diameter by 4 foot stainless steel rods with threads (Berntsen SS91604 or equivalent)
2. 9/16" diameter stainless steel drive point (Berntsen SS12 or equivalent)
3. Locking connector thread (Berntsen M13 or equivalent)
4. Steel drive pin for a 9/16" diameter rod (Berntsen M1DPA or equivalent)
5. Manual driving adapter (Berntsen MDA or equivalent)
6. Power driving adapter (Berntsen PDA or equivalent)
7. Loctite cement for stainless steel
8. PVC, Schedule 40, 6" diameter by 3-4 feet
9. Cement mix
10. Collar and screws (Figure 5, inset; provided by LDNR/CRD)

Installation Materials List

1. Power driving device (Pionjar 120, Cobra 148, or equivalent)
2. Pipe wrenches (two 6" wrenches)
3. Post hole digger (maximum 6" diameter)
4. Hacksaw
5. File
6. 2"x12"x10' treated board (2)
7. Cement mixing equipment: bucket, shovel, water, etc.
8. Personal Protective Equipment: minimum eye protection, gloves, and ear plugs
9. Hammer or small sledge hammer
10. Compass

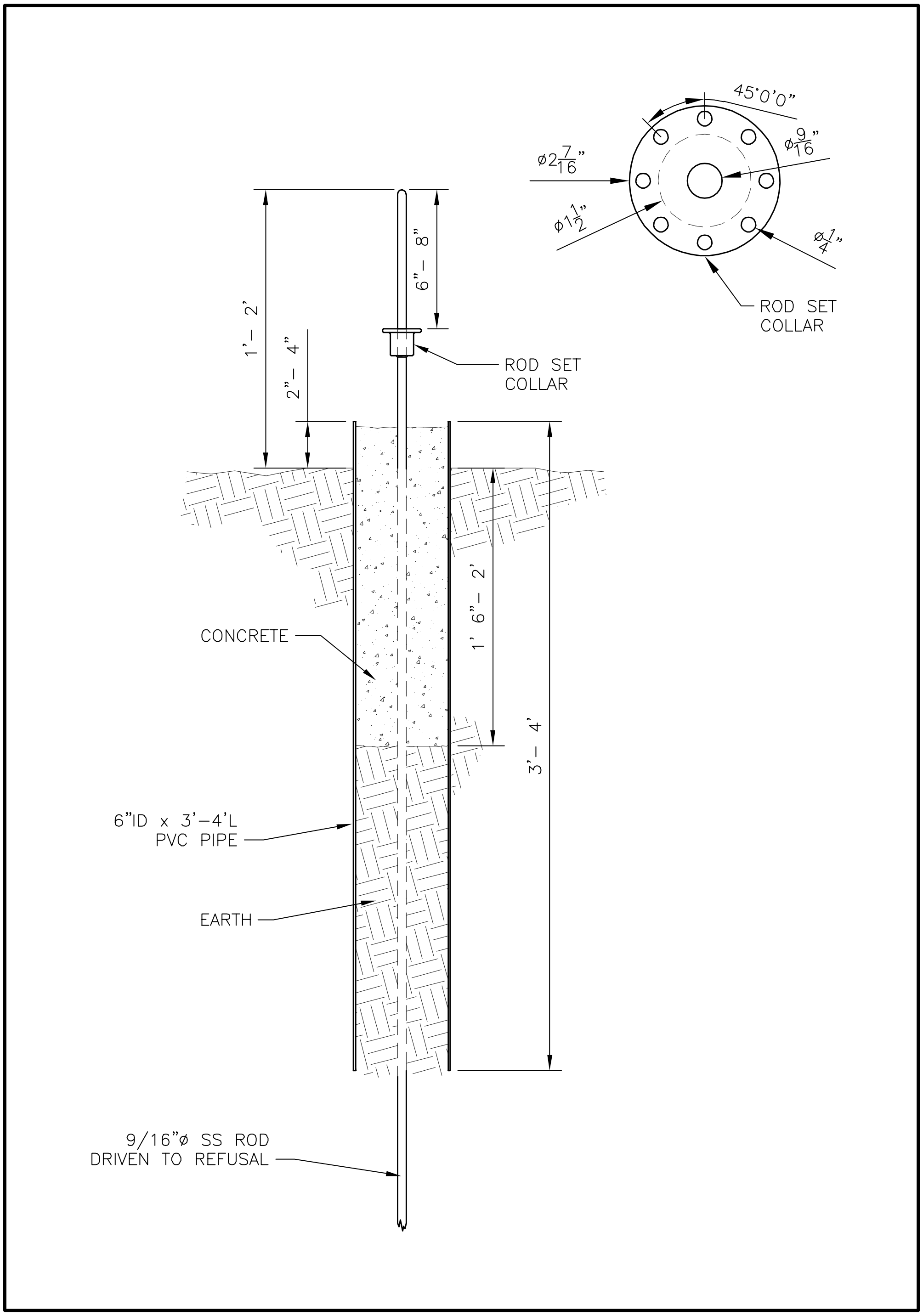

Figure 5: Detail construction drawing of a typical RSET station with collar. Inset: Collar detail.

11. Bucket to remove the soil

Deep Rod Benchmark Installation Procedure

1. Place the board across the two existing boardwalks where the rod for the RSET will be installed. If more than one person will be installing the rod for the RSET, a second board shall be used for safety.
2. Using a post-hole digger, dig a hole 1-1/2 – 2 feet deep with a maximum diameter of 6 inches. <u>NOTE:</u> All soil or surface material extracted from the hole must be discarded away from the site. No soil or extracted material shall remain on the surface.
3. Drive the 9/16" stainless steel rods in the center of the hole to refusal using the manufacture's recommended procedures for the rods. These procedures shall include the use of all the materials listed in the benchmark materials list. <u>NOTE:</u> Refusal is defined as "No more than 1 foot of penetration of the rod in one minute of impacting with a gasoline powered reciprocating driver (i.e., Pionjar 120, Cobra 148, or equivalent)." Also the rod must be plumb at the end of the installation.
4. The rod shall remain 2 feet above the marsh surface after the rod is driven to resistance. Any excess shall be cut with a hacksaw.
5. Position the 6" PVC such that the 9/16" stainless steel rod is at the center. Push the PVC pipe into the soil until 2-4" remain above the surface. A small hammer may be used depending on the soil characteristics.
6. Mix enough concrete to fill the PVC. <u>NOTE:</u> When mixing the concrete and or filling the PVC, no concrete must remain on the sediment surface outside the PVC.
7. Fill the PVC. Be sure not to overflow the PVC.
8. Slide the collar 8" below the top of the stainless steel rod.
9. Position four of the eight holes on the collar in the four cardinal points.
10. Attach the collar in the position using the 4 screws and loctite cement. Be sure not to move the rod when fastening the collar to the rod if the cement is still wet.
11. The final product shall resemble Figure 5.

The RSET will be established at sites approved by the LDNR/CRD. In areas where the marsh is classified as floating, a rod for the RSET will not be established. Instead, a deep rod monument will be established in a close proximity to the site. The establishment of this secondary monument will follow "A Contractor's Guide to Minimum Standards" dated June 2003 unless a more recent version is released.

Documentation shall be made as to the depth of refusal and the distance for the top of the rod to the top of the collar at each site and include the number of rods used during the installation as well as a length in feet. Pictures shall contain a date and time stamp. These pictures will ensure the LDNR/CRD that the surface adjacent to the monument was not disturbed.

When establishing the elevation of the rod for the RSET using real-time kinematic (RTK) surveying methods, all necessary equipment must be elevated from the marsh surface. Since this area is being used for the collection of scientific data, any instrumentation or equipment that is placed on the marsh / swamp surface will affect the efforts of the scientific community. Consequently, all the equipment that is used to determine the elevation of the benchmark must be raised using a technique that meets the requirements of the surveyor and meets approval from the LDNR/CRD.

3.4. Warning Signage

Two warning signs (Figure 6) similar to those used for pipelines will be placed near the boardwalks. One sign will be placed on the outside of the boardwalk near the arrival point and the other sign will be place on the outside of the shorter boardwalk (Figure 3). This configuration indicates that caution needs to be taken when entering the area between the signs. Recommended signage will consist of a single 3-4" pipeline marker with an orange cap, similar to that shown in Figure 6, or other design or color that is highly visible, distinctly different from pipeline or other markers, and approved by LDNR/CRD. Sign shall extend at least 60 inches above the marsh surface and extend at least 36 inches into the soil.

Figure 6: Typical warning sign used at sites to mark research stations.

3.5. Water Level Support Poles

Each site will require the installation of a water level support pole; however, there are three types of support poles that can be used at a site. Two of the poles will be utilized when an instrument can be mounted onto a pole to collect continuous surface water levels. This instrument will be used when there is an open body of water that holds a minimum depth of water that submerges the sensors. The second type of pole will be used to mount an ultrasonic sensor or equivalent that records surface water levels when the marsh / swamp surface becomes inundated. The type of pole that will be established will be determined by the LDNR/CRD.

To ensure proper installation, the following procedures shall be used to achieve acceptance by the LDNR/CRD. Failure to adhere to these procedures may result in an improperly constructed station. The LDNR/CRD reserves the right to accept or reject the final product. If the LDNR/CRD rejects the final product, the person or agency/company installing the station will be required to remove the station and establish it correctly at their expense. These procedures have been used extensively by the LDNR/CRD and are proven to work in all environments.

Treated Wooden Post

The minimum materials needed for this installation process include a 4"x4"x16' or 20' treated wooden post, a saw, a widow-maker (a cylindrical steel device that is approximately 36 inches in length, has an outside diameter of 7 inches, and weighs approximately 60 pounds; used for driving post), reflectors, nails/screws (stainless steel or equivalent 6d and 16d or 20d), level, hammer, and screwdrivers.

1. A point shall be cut on one end of the timber post to facilitate the installation process.
2. Transport all the materials and necessary equipment via the water vessel to the site.
3. Position and anchor the boat at the location where the post will be established.
4. Place the timber post in the water with the point down. Slowly lower the post into the water to penetrate the subsurface.
5. Make sure that the post remains plumb in all directions as the post is being installed.
6. Once the post no longer penetrates the substrate by the post's own weight, then the widow-maker must be placed on the top of the post.
7. Using the widow-maker, pound the post into the substrate until resistance is met. <u>NOTE:</u> Refusal occurs when the post no longer penetrates the substrate.
8. Using a level, the post must be checked for plumb in all directions and approximately 4 feet of the post shall remain above the mean high water level or the marsh surface.
9. If the top of the post was damaged, cut the damaged section off. Make sure to cut the post square. This step is critical for elevation surveying.
10. Drive a single 16 or 20 penny stainless steel or equivalent nail 2/3 of the way into the side of the post. This nail must be driven perpendicular to the post. This nail will serve as a reference for measuring the water level while servicing the instrument.
11. The station must be properly marked using reflectors on three sides. The fourth side will be used to attach the continuous recorder. These reflectors shall be secured with 6d penny stainless steel or equivalent nails or exterior screws.

Stainless Steel Mono-pole

The mono-pole was designed for areas of high energy or with large water vessel traffic that required more strength than the wooden post. The use of this mono-pole system requires the fabrication of metal to construct the pole. Figure 7 shows the materials and the design specifications. To install the pole, the use of a vibracore works the best since using a widow-maker destroys the end of the pole. However, a widow-maker may be used, if precautions are taken to prevent damage to the end of the pipe.

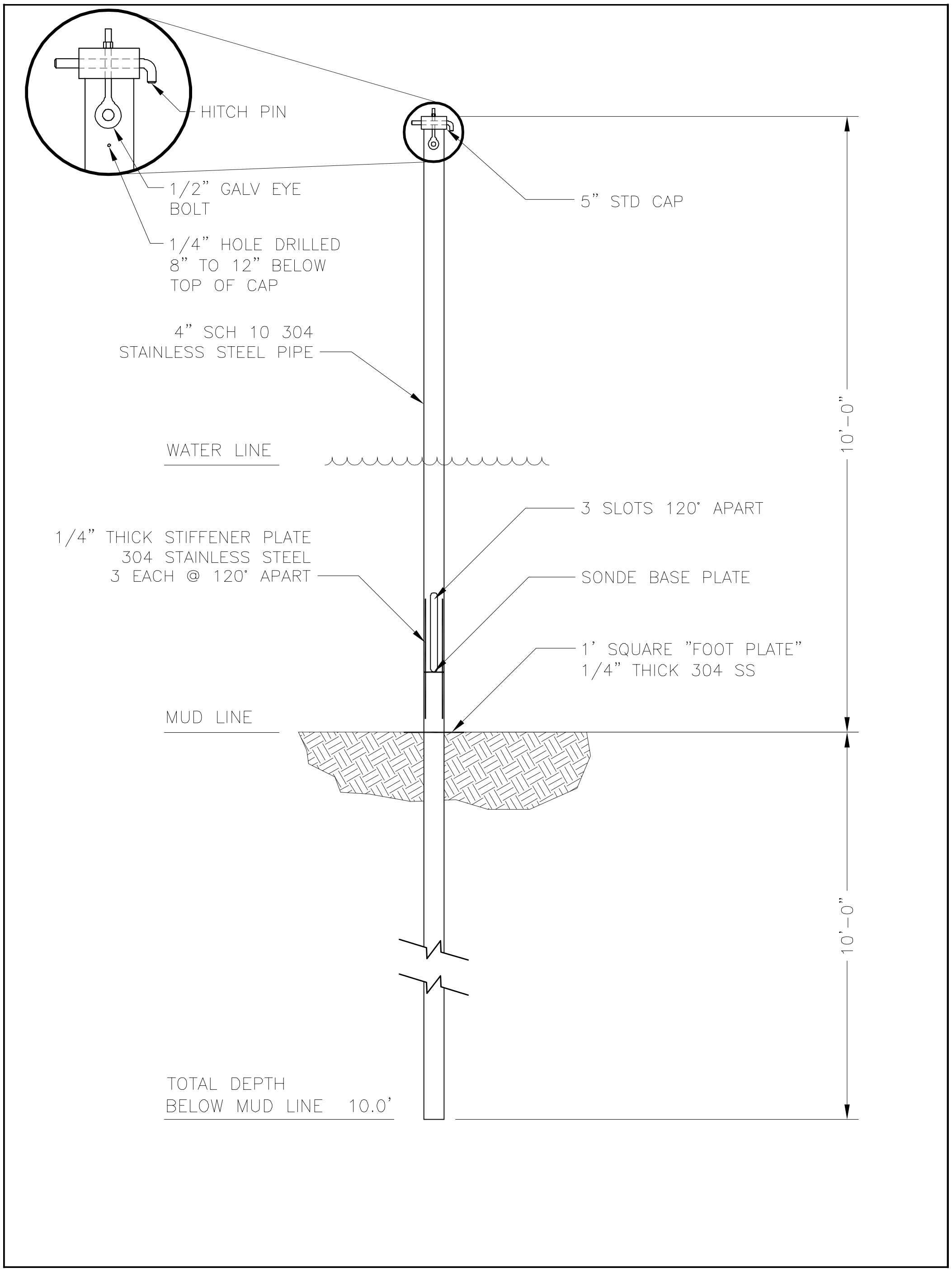

Figure 7: Typical construction diagram of a stainless steel mono-pole.

The mono-pole is constructed in advance of the deployment field trip. The following steps provide a methodology for an acceptable installation process for the mono-pole.

1. Transport the mono-pole and all the necessary equipment needed for the installation process via the water vessel to the site.
2. Position and anchor the water vessel where the mono-pole will be deployed and in a manner that allows for a solid, stable work environment.
3. Obtain the depth of the water at the installation location. (This provides an estimate of how much of the pipe will be above the water and provides an estimate of when the plate will rest on the bottom.)
4. Place the mono-pole over the side of the water vessel in a plumb position.
5. Using the vibracore, vibrate the mono-pole to resistance or until the load plate rests on the bottom of the water body. (If resistance is met before the load plate rests on the bottom, then a widow-maker should be used to try and get the mono-pole deeper into the substrate.)
6. Using a level, verify the mono-pole is plumb.
7. If the top of the pipe was damaged during installation, the pipe shall be cut just below the damaged portion. A ¾" holes for the hitch pin and a ¼" hole for the elevation mark shall be drilled.
8. Take the following measurements and document in the field notebook.
    a. Total pole length
    b. Distance from the bottom of the pole to the load plate
    c. Distance from the load plate to the Top of Casing
    d. Distance from load plate to the continuous recorder stop plate
    e. Water depth
    f. Penetration depth
    g. Mud line to load plate (if not resting on bottom of water body)
    h. Load plate to water surface
    i. Amount of casing removed (if damage was done during installation)
9. Using the brass pin and lock, secure the cap to the pipe.
10. Attach reflective tape to the pipe.

Ultrasonic Sensor

In marshes with variable wet and dry cycles, an ultrasonic water level sensor will be secured to either a wooden post or a metal pole driven to refusal into the marsh via an extension arm to prevent the beam from contacting a surface other than the water. A PVC housing can be used to protect the sensor and shall be fitted with holes or slits to allow water flow inside into the sensor's beam. In some cases, the sensor can be attached to an existing structure without the protective PVC casing. The LDNR/CRD has discussed the use of this setup in such marshes; however, ultrasonic sensors have yet to be used in coastal restoration projects.

3.6. Staff Gauge

A ceramic coated staff gauge (2.5 inches wide ranging from -2 to +3 feet, graduated to hundredths, marked at every foot and every tenth, and 4 grommet holes for fastening with number 8 round headed screws) will be established at sites specified by the LDNR/CRD. The staff gauge will be mounted to a 2”x4”x6’ treated board that has been painted to reduce the reaction between the galvanize and treated board. The board is attached to a 2” galvanized pipe that is driven to resistance. The staff gauge will be set to the vertical datum NAVD 88, Feet during the surveying procedure. A completed drawing is found in Figure 8.

During the construction phase of the site, a 2” galvanized pipe is driven to resistance in a body of water. If a site uses an ultrasonic sensor instead of the continuous recorder, the staff gauge may be established in a small pond, if available, in the vicinity of the ultrasonic sensor.

The minimum materials needed for the installation include several pieces of 4 or 5 foot long 2” galvanized pipe threaded on each end, several couplings, a 2” galvanized cap, two pipe wrenches, and a widow-maker. The procedures for installing the pipe to resistance are as follows:

1. Connect two or more pieces of the pipe using the couplings and tighten with the wrenches.
2. Place the pipe in the water at the desired location; drive the pipe into the substrate using the person’s weight. Making sure the pipe remains plumb by using a level.
3. Continue to add sections of pipe as needed and tightening with the wrenches.
4. Once resistance has been achieved, loosely thread the 2” galvanized cap on the pipe. The cap is used to prevent damage to the threads while using the widow-maker.
5. Using the widow-maker, drive the pipe until refusal is accomplished.
6. Continue to add pieces of pipe by removing the cap and using the couplings. Remember to add the cap before continuing with the widow-maker.
7. The process is complete when the pipe has met refusal and a minimum of 4 feet remains above the marsh surface.
8. Tighten the cap onto the end of the pipe.

3.7. <u>Elevation</u>

Elevations will be collected and established at all the LDNR/CRD sites. All elevations will be surveyed using the vertical datum NAVD 88, Feet. Elevations shall be obtained using real-time kinematic (RTK) surveying technology. This technology utilizes satellites and benchmarks that have known elevations. The LDNR/CRD has developed a secondary benchmark network throughout the coastal zone. These benchmarks have been or will be established according to the methods described in the manual “A Contractor’s Guide to Minimum Standards” dated June 2003. The LDNR/CRD will only accept surveys that utilize accepted benchmarks. Elevations will be established on the continuous recorder, ultrasonic station, the static floating marsh system (if it exists), and the rod for the RSET stations. Staff gauges will be established to the same vertical datum. Marsh elevations will be collected at a minimum of twenty (20) points in the vicinity of the boardwalk. More information concerning the LDNR/CRD protocols and data deliverables for surveying shall be founding chapter 12.

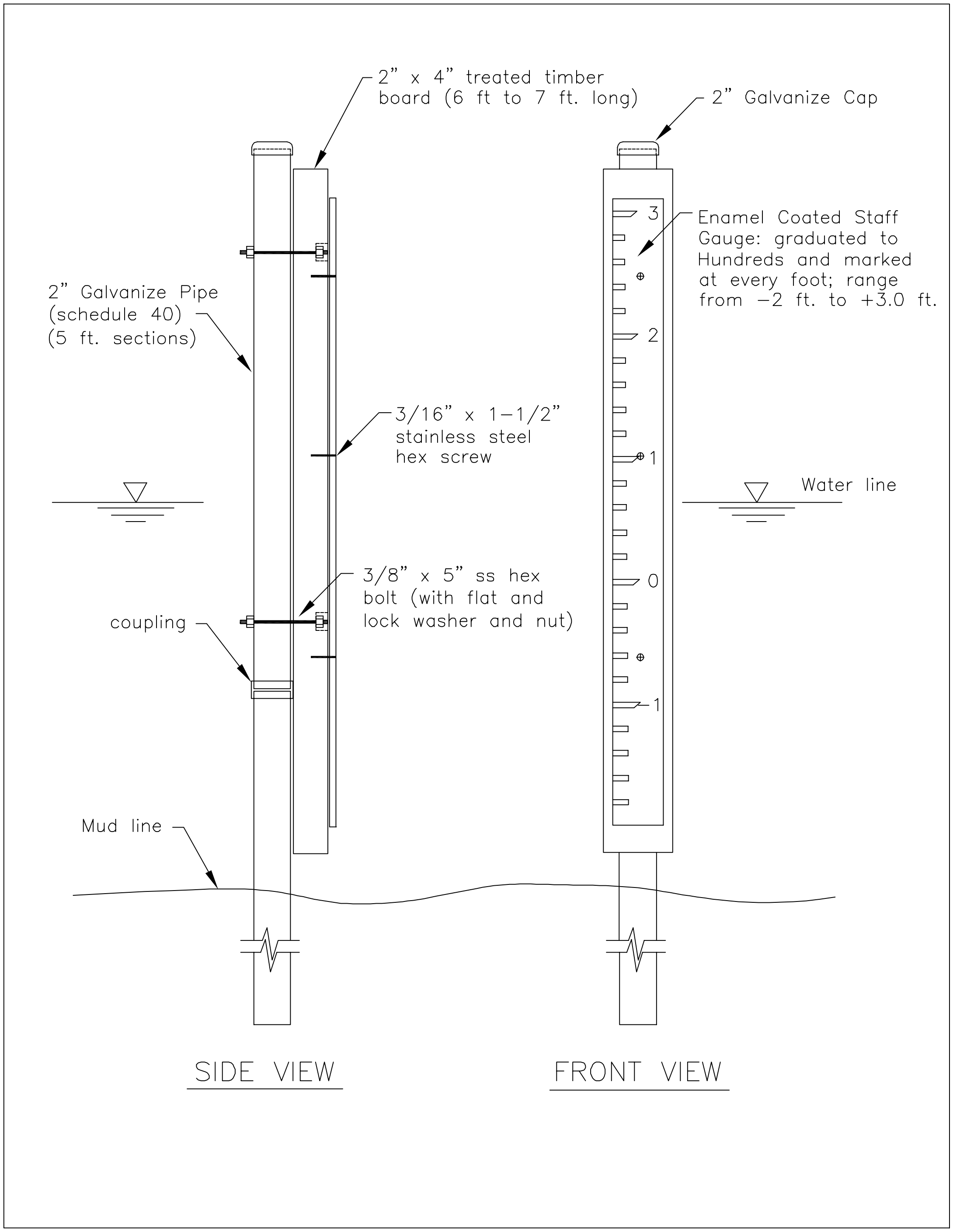

Figure 8: Typical construction diagram for a staff gauge installation.

Continuous Recorder

For both the wooden post and the stainless steel post the following points require an elevation survey. The 4”x4” post has an existing “nail” in the side and this “mark” requires surveying. The stainless steel poles will utilize the top of the ¼” hole (approximately 12 inches from the top of the cap) in the pipe as the “mark” that requires surveying. Once an elevation is achieved at the station, sufficient measurements shall be obtained to complete the spreadsheet *Continuous recorders and staff gauge format for surveyor.xls* (Form 2).

Staff Gauge

Using section J.6 of “A Contractor’s Guide to Minimum Standards,” install the staff gauge onto the galvanized pipe. The manual is written to establish a staff gauge onto a wooden post; however, the LDNR/CRD requires staff gauges to be mounted to a 2” galvanized pipe (Figure 8). Consequently, the technique will be a variation of the manual. Staff gauges shall consist of a 2.5" x 3.3' porcelain enamel coated metal gauge.

Obtain an elevation of the top of the pipe and decide where the top of the staff gauge will be placed. Secure a 2”x4” treated timber to the post using a minimum of two stainless steel or equivalent bolts in a manner that allows approximately 6 inches of the board to remain above the staff gauge. Using the method in section J.6 of the manual, mount a staff gauge to the 2”x4” timber with no less than 3, No.8 round head exterior screws in the existing holes (NO DRILLING THRU THE ENAMEL OF THE STAFF GAGE WILL BE ACCEPTED).

Upon completion of the installation, obtain all the measurements that will complete the spreadsheet *Continuous recorders and staff gauge format for surveyor.xls*. By completing this table, it verifies that the staff gauge and the nail elevation are within the accuracy of the instrument. The difference between the water elevation reading with respect to the nail elevation and the staff gauge shall be within 0.05 feet of each other. If these readings are not within this range, elevations must be obtained and adjustments be made until it is within the acceptable range.

Static Floating Marsh Mat Recorder System

In order to convert the data obtained from this instrument to a vertical datum, a ¼” hole has been drilled within the top twelve inches of the pipe. The elevation of the top of the hole shall be determined by RTK surveying methods.

RSET

All RSET stations will be surveyed to a known elevation (NAVD 88, Feet) at the top of the 9/16” stainless steel rod. The LDNR/CRD will identify which primary or secondary monument to use for the RTK survey. This elevation will be used during the sampling period to determine elevation changes of the marsh / swamp surface.

Marsh Surface

Marsh elevation shall be determined at a minimum of 20 points in attached marshes/swamps. Those areas that are classified as floating marshes shall not be surveyed due the vertical movement of the marsh. Due to each site's uniqueness with respect to the placement of each data collection station, a definitive protocol for surveying the marsh surface will not be attempted. In general, marsh surface with respect to elevation surveys is defined as "when the survey rod is resting among living stems or is supported by soil containing living roots." In order to get a consistent reading, often times it will be necessary to move stems in some marsh vegetation where stem density is extremely high. A minimum of twenty (20) elevations recorded in relation to NAVD 88, Feet (each one separated by 20 ft. to 40 ft.) are needed for this determination. The twenty (20) elevations are averaged to obtain marsh elevation. All 20 readings and the average shall be provided in an Excel spreadsheet that was developed by the LDNR/CRD.

When the dominant species is *Spartina patens* (saltmeadow cordgrass), a minimum of forty (40) elevations will be recorded. Twenty (20) elevations will be recorded on the marsh surface and twenty (20) elevations will be recorded on the crown of the *Spartina patens* that is adjacent to the marsh surface reading. These readings shall be saved and provided to the LDNR/CRD such that a differentiation can be made between the two readings. The average marsh elevation will be obtained by averaging the forty (40) points; however, these readings may need to be separated at a later date.

Prior to obtaining marsh elevation readings, the following information shall be recorded in a field journal: station number, date and time of survey, staff gauge reading or water elevation, and marsh flooding. Marsh flooding is determined by the question, is surface water above the marsh surface? If yes, then document the average water depth over the marsh surface.

Once the survey at each station is completed, the surveyor shall record what type of terrain was encountered during the survey. This should include whether the marsh was firm and easy to traverse, spongy with minimal difficulty, or very soft with extreme difficult and falling through the marsh.

Marsh elevations shall be taken where there is no influence of spoil banks, levees, or any other human induced alterations. Moreover, these elevations shall represent the surrounding marshes.

3.8. <u>Deliverables</u>

Sampling Platform Construction

1. Documentation of the date of construction.
2. Documentation of any problems or concerns with the construction.
3. Diagram of the actual length and layout of the boardwalks with distances.
4. Digital pictures of the site before and after construction. Each picture must have a date and time stamp. Digital pictures must be in a JPEG format and each picture must be named with the site name, description, sequence number, and date (CRMS0397_BoardwalkConstruction_1_March2005.jpg).

RSET

1. Documentation of the date of construction.
2. Documentation of any problems or concerns with the installation.
3. The number of rods used for installation, the total length of the monument, and the distance from the top of the rod to the top of the collar.
4. Digital pictures of the site before and after construction. Each picture must have a date and time stamp. Digital pictures must be in a JPEG format and each picture must be named with the site name, description, sequence number, and date (CRMS0397_RSET_Installation_1_March2005.jpg).
5. Monument datasheet after station is surveyed. Datasheet shall follow the example in the manual "A Contractor's Guide To Minimum Standards" in section I.4.
6. Field notes shall resemble the example in section I.5 of "A Contractor's Guide To Minimum Standards".

Warning Signage

1. Documentation of the date of installation.
2. Documentation of any problems or concerns with the installation.
3. Digital pictures of the site before and after construction. Each picture must have a date and time stamp. Digital pictures must be in a JPEG format and each picture must be named with the site name, description, sequence number, and date (CRMS0397_WarningSign_Installation_1_March2005.jpg).
4. DGPS coordinates in (UTM, NAD83 Meters) of the location.

Water Level Support Poles

1. Documentation of the date of installation.
2. Documentation of any problems or concerns with the installation.
3. Digital pictures of the site before and after construction. Each picture must have a date and time stamp. Digital pictures must be in a JPEG format and each picture must be named with the site name, description, sequence number, and date (CRMS0397_WaterLevelPole_Installation_1_March2005.jpg).
4. DGPS coordinates in (UTM, NAD83 Meters) of the location.

Staff Gauge

1. Documentation of the date of installation.
2. Documentation of any problems or concerns with the installation.
3. Documentation of the number of pipes used for the installation, the total length of the pipe, and the depth of penetration.
4. Digital pictures of the site before and after construction. Each picture must have a date and time stamp. Digital pictures must be in a JPEG format and each picture must be named with the site name, description, sequence number, and date (CRMS0397_StaffGauge_Installation_1_March2005.jpg).
5. DGPS coordinates in (UTM, NAD83 Meters) of the location.

Elevation

1. Marsh Elevations
   a. An Excel spreadsheet with the point number, northing and easting coordinates (UTM, NAD83 Meters), and the elevation (NAVD88, Feet). The LDNR/CRD shall provide a template of the spreadsheet.
   b. Field notes with the required information: date and time of survey, station number, staff gauge reading at time of survey, water level in relation to marsh surface, and description of difficulty doing the survey.
2. Water Level Support Poles
   a. Field notes that contain: a diagram of the pole, the distance from the top of pole to "Mark Elevation", the water elevation, and distance from nail to water surface.
   b. The Excel spreadsheet *Continuous recorders and staff gauge format for surveyor.xls* (Form 2*)* completed.
3. Staff Gauge
   a. Field notes that contain: a diagram of the staff gauge after it has been mounted, the elevation of the top of the pole, the distance from the top of the pole to the water at the time of establishment, and the distance between the top of the pole and the 3' mark on the staff gauge.
   b. The Excel spreadsheet *Continuous recorders and staff gauge format for surveyor.xls* (Form 2) completed.
4. Static Floating Marsh Mat Recorder
   a. Field notes that contain: a diagram of the static floating marsh mat recorder station, the distance from the top of the pole to the top of the ¼" hole, the distance from the top of the pole to the marsh surface, and the elevation of the top of the 1/4" hole.
5. RSET
   a. Field notes that contain: a diagram of the RSET, the distance from the top of the stainless steel rod to the top of the collar, and the elevation of the top of the rod.

4. SURFACE WATER

High variability in water-level and salt-water intrusion have been shown to cause adverse effects on the health of coastal wetland ecosystems (Gagliano et al. 1981). As a corollary, the LDNR/CRD has included these variables into its monitoring program. Both changes in water level and salinity values will be measured on a continuous basis (defined as hourly, unless otherwise stated by the LDNR/CRD) where water depths remain deep enough to continually submerge the sensors. These variables are measured using a pressure transducer and a salinity meter (Steyer et al. 1995). The LDNR/CRD utilizes the YSI 6920, YSI 600XLM, or equivalent continuous recorder with a vented cable as the basic model that can measure water level via a pressure transducer as well as salinity, specific conductance, and water temperature. Likewise, a YSI 30 or equivalent can measure salinity, specific conductance, and water temperature at discrete locations and to assure the data logger is properly calibrated.

Conversely, if the marsh/swamp dries periodically or is only inundated for short periods of time, an ultrasonic water level sensor shall be used to measure water level.

4.1. Instrumentation

Two types of instrumentation shall be used to determine surface water elevation. The preferred type of instrumentation that has been extensively used by the LDNR/CRD is an environmental monitoring instrument that is a multi-parameter, water quality measurement, and data collection system. The instrument is capable of recording and storing water temperature (°C), specific conductance (µS/cm), salinity (ppt), and water level (feet) at specified intervals. The water level sensor shall be a vented level system capable of recording to depths of 9.1 meters (30 feet). The water level sensor must be a vented sensor that has a range of 0 to 9.1 meters (30 feet), a minimum accuracy of ±0.003 meters (0.01 feet) in depths to 3.0 meters (10 feet), and in depths of 3.0 to 9.14 meters (10 to 30 feet) the minimum accuracy must be ±0.018 meters (0.06 feet). Along with the water level sensor specification above, the instrument shall be capable of transferring the raw data through a field display unit or field computer to an Excel spreadsheet for the production of graphs and monthly summary data analysis before the data is imported into the LDNR/CRD's main database. The LDNR/CRD has developed an extensive procedure that shall be followed with respect to the instruments field deployment, servicing, data process, data storage, statistical analysis, and graphic display of analysis.

The second type of instrumentation used to measure surface water elevation uses ultrasonic technology. The ultrasonic water level instrument is not deployed in a matter which submerges its sensor; instead, the sensor is suspended above the surface. Since this sensor is suspended above the surface of the water, it is not a multi-parameter, water quality instrument; therefore, salinity measurements can not be measured. The sole purpose of this instrument is to record the water surface's vertical movement on a continuous basis. To this date, the LDNR/CRD has not utilized this technology, but future projects will require this type of instrumentation; consequently, an extensive procedure regarding the deployment, servicing, data process, data storage, statistical analysis, and graphic display of analysis has yet been developed.

4.1.1. Types of Continuous Recorder Stations

Due to the topographic variability among all sites in coastal Louisiana, several different procedures for station establishment have been developed to collect data with respect to the surface water conditions. For example, a site that has sufficient yearly levels of water (i.e., water would remain above the water sensor throughout the year) would have a YSI 6920, YSI 600XLM or equivalent continuous recorder to measure hourly water level and salinity values. The LDNR/CRD has approved two methods for deploying continuous recorder instruments for the collection of water quality data. The methods differ in the use of materials and environment in which they are suited. One method consists of a four inch by four inch (4"x4") by twenty (20) foot treated wooden post driven into the substrate of an open water body to refusal. A perforated PVC pipe and electrical box are mounted onto a 2"x4"x10' board which is attached onto the wooden post (Figure 9) via two hitch pins. This method works well in meandering bayous and marsh channels, where the mean depth of water is less than 8 feet, and the velocity of water is low to moderate. The other method is a stainless steel pipe henceforth called the mono-pole that has a quarter inch plate welded at a depth such that the plate rests on the bottom for stabilization. The pipe has slits cut out in the water column to facilitate water exchange (Figure 7). This pipe method is suited for all environments; however, it is best used in high velocity or high energy areas such as rivers and large navigational waterways. In determining which method to use, the LDNR/CRD suggests that: 1) In areas with low wave action, wooden post station will be established and 2) In areas with high water velocity, traffic, or wave action, the mono-pole station will be established. Once the wooden post or mono-pole is installed, the same deployment and servicing procedures will be followed.

Wooden Post

Materials List (Minimum)

1. 4"X4"X20' treated timber post or equivalent
2. 2"X4"X10' treated timber board or equivalent
3. 1 – 6" Brass hitch pin
4. 1 – 9" Brass hitch pin
5. 1 – Electrical box (The LDNR/CRD is currently using a Thomas & Betts 125 A Max Type 3R Enclosure; Catalog No. TBL12(4-8)R or Murray Model 21; Catalog No. LW006NR)
6. 3 – ¼"x1¾" stainless steel or equivalent hexagonal screws
7. 1 – ¼"x6" stainless steel or equivalent hexagonal bolt with washer and locking nut
8. 3 – Brass locks (All locks keyed the same and provided by the LDNR/CRD)
9. 1 – 2" or 4" schedule 40 PVC perforated pipe with multiple ¾" holes (28" to 36" in length); size depends on the diameter of the continuous recorder
10. 1 – 1½" schedule 40 PVC pipe (≥2' in length)
11. 1 – 16 penny common stainless steel or equivalent exterior nail (used for a vertical reference point)
12. Reflectors (4 minimum)
13. Stainless steel or equivalent exterior nails or screws for reflectors
14. YSI 6920, YSI 600XLM, or equivalent continuous recorder data logger

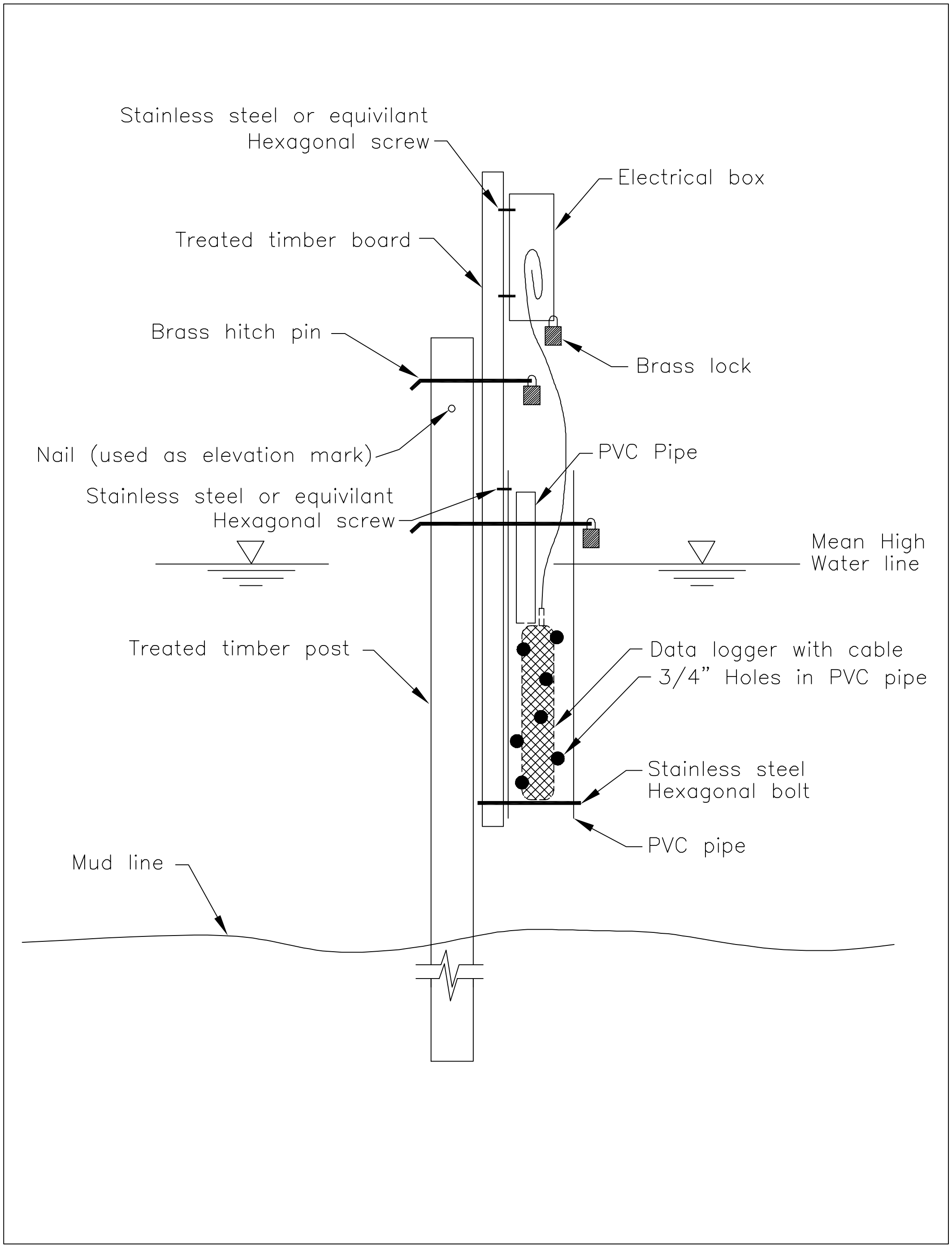

Figure 9: Typical wooden post continuous recorder station.

NOTE: The timber industry has recently changed the process for treating lumber to resist rot due to environmental conditions. With these changes, it may be necessary to use other metal treatments (i.e., stainless steel instead of galvanized).

Additional Materials Needed For the Installation Process

1. Widow-maker: a cylindrical steel device that is approximately 36 inches in length, has an outside diameter of 7 inches, and weighs approximately 60 pounds; used for driving post
2. Wrenches
3. Cordless drill and bits (minimum ¾" wood bit and various size screw driver adaptors)
4. Saw (Wood and PVC)
5. Hammer
6. Socket set and driver
7. Various size screw drivers
8. Level
9. Measuring device (a surveyors rod capable of measuring feet, tenths and hundredths)
10. Personal protective equipment (minimum of gloves and eye protection)

Installation

The following method shall be used for the installation of a continuous recorder station. The method shall be established as follows:

Verification of site selection

1. The site-specific map, site characterization sheet, and a differential Global Positioning System (DGPS) instrument shall be used to locate the pre-determined site. Once the site has been located, the field personnel must verify that the site has not changed and is sufficient for establishment.
2. This verification shall be done by examining the site and answering the following questions: (1) Is the water level / water body deep enough so that the sensors will be submerged during the lowest water levels? (2) Is the site intrusive of a navigational waterway? (3) Is the pre-determined system of deployment sufficient for the site?
3. By answering the questions in step 2, the field personnel shall verify that the pre-determined set-up is sufficient for the site. If it is determined that the set-up is sufficient, the field personnel shall follow the appropriate steps for installation. NOTE: If the field personnel find the site inappropriate, the LDNR/CRD must be notified before the installation.

Procedures for the Wooden Post

To ensure proper installation, the following procedures shall be followed to achieve acceptance by the LDNR/CRD. Failure to adhere to these procedures may result in an improperly constructed station. The LDNR/CRD reserves the right to accept or reject the final product. If the LDNR/CRD rejects the final product, the station will be removed and established correctly at another location selected by the LDNR/CRD. These procedures have been used extensively by the LDNR/CRD and are proven to work in all environments. To facilitate the proper construction of the station, a schematic is provided in Figure 9.

Prior to arriving at the site, a point shall be cut on one end of the timber post to facilitate the installation process.

1. Transport all the materials and necessary equipment via the water vessel to the site.
2. Position and anchor the boat at the location where the post will be established.
3. Place the timber post in the water with the pointed end down. Slowly lower the post into the water to penetrate the subsurface.
4. Make sure that the post remains plumb in all directions as the post is being installed.
5. Once the post no longer penetrates the substrate by the post's own weight, then the widow-maker must be placed on the top of the post.
6. Using the widow-maker, pound the post into the substrate until refusal is met. NOTE: Refusal occurs when the post no longer penetrates the substrate after 3 attempts.
7. At the end of this procedure, the post must be plumb in all directions and approximately 4 feet of the post shall remain above the mean high water level or the marsh surface.
8. If the top of the post was damaged, cut the damaged section off (making sure the cut is square). This step is critical for determining distances and elevation.
9. The assembly of the 2"x4" board can be done prior to the field installation. The 2"x4" board is assembled by mounting the electrical box to one end of the board and mounting the perforated PVC pipe to the other end of the board. (NOTE: The PVC shall be at least twelve inches longer than the instrument or high enough to extend above the water during normal high tide. This assures that the instrument will remain in place.) The electrical box is mounted to the board using two ¼"x1¾" stainless steel or equivalent hexagonal screws. The PVC pipe is mounted to the board using a ¼"x1¾" stainless steel or equivalent hexagonal screw at the end closes to the electrical box and a ¼"x6" stainless steel or equivalent hexagonal bolt with washer and locking nut that will serve as a rest for the instrument.
10. Place the assembled 2"x4" board adjacent to the post to determine its position and mark the location of the two holes for the hitch pins.
    a. The bottom of the PVC pipe shall be a minimum of 6" above the mud line.
    b. The electrical box should be high enough to prevent tidal waters from inundating the box during a hurricane, but low enough to reach during servicing.
    c. Holes should be a minimum of 6" from the top of the post and a minimum of 12" from the top hole. The bottom hole should be out of the mean high water range.
11. Drill the two ¾" holes through the post and board.
12. Fasten the board to the post by using the 6" hitch pin in the top hole and the 9" pin in the bottom hole.
13. Place the continuous recorder instrument in the PVC pipe.
14. Take the 1½" PVC pipe and place it on top of the instrument. Make sure the pipe extends a minimum of 4" above the hole for the 9" pin.
15. Drill a hole such that the 9" pin will pass through the 1½" PVC pipe. This assures that the instrument will not move vertically and prevents theft.
16. The cable will be housed in the electrical box by being threaded through the hole on the underneath side.
17. A single 16 penny stainless steel or equivalent nail shall be driven 2/3 of the way into the side of the post. This nail must be driven perpendicular to the post. This nail will serve as a reference for measuring the water level while servicing the instrument.

NOTE: If the post was previously installed and has a nail, then DO NOT add another nail. The post shall have only one nail.

18. Document the following measurements on the "Continuous Recorder Water Level Sensor Data Sheet" (Form 3) by referring to Figure 10:
    a. Nail to top of post
    b. Nail to bottom of continuous recorder
    c. Nail to water level sensor
    d. Nail to water line
    e. Nail to substrate
    f. Water depth
    g. Penetration depth
    h. Total length of pole

    NOTE: The measurements must be transferred to the Excel "Site History" file provided by LDNR/CRD.

19. The station must be properly marked using reflectors on all four sides. These reflectors shall be secured with stainless steel or equivalent screws or nails.
20. The instrument can now be deployed for continuous readings.
21. Secure the site with the three brass locks on the two hitch pins and the electrical box.

Mono-pole

Materials List (Minimum)

1. 1 – 4"x 20' schedule 10 304 Stainless steel pipe
2. 1 – 5" standard cap
3. 1 – ¼"x1square foot 304 stainless steel plate
4. 1 – 6" Brass hitch pin
5. 1 – Brass lock (to be provided by LDNR/CRD)
6. Reflective tape or reflectors

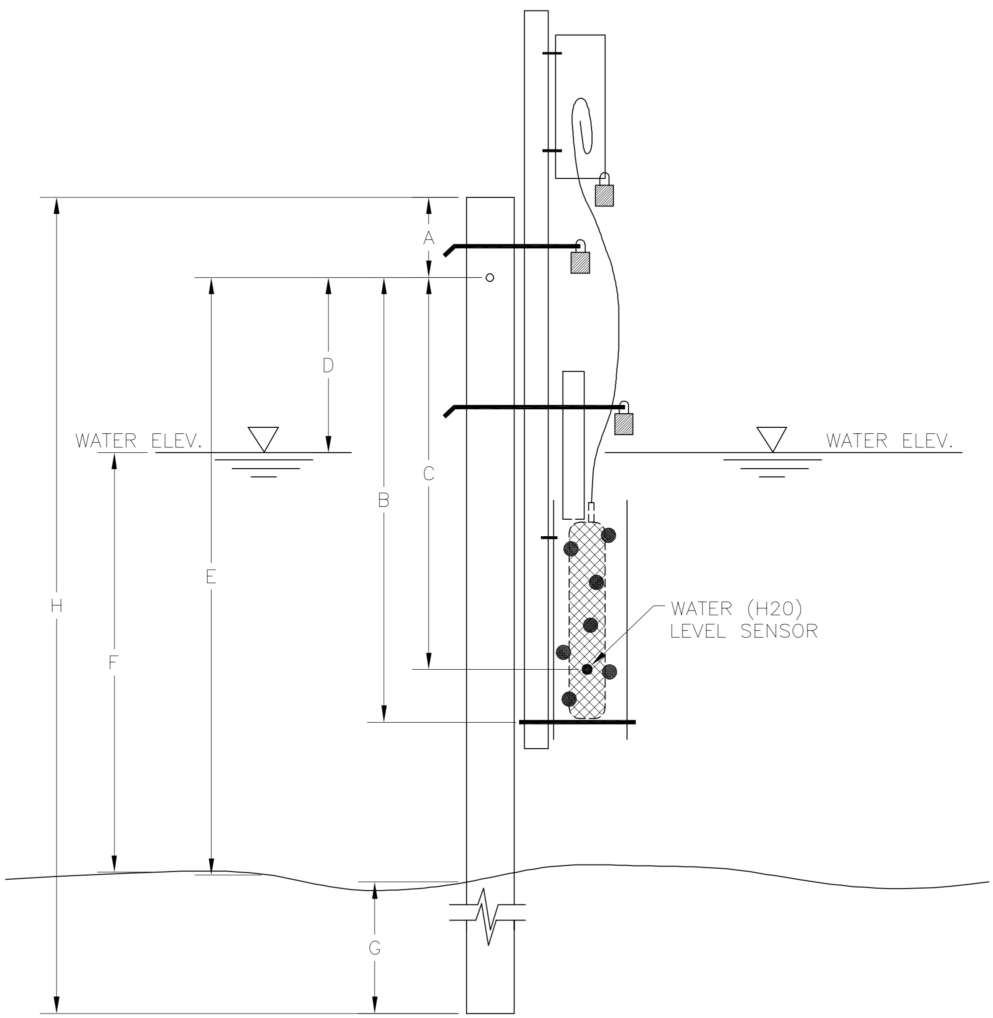

Figure 10: Schematic of distances needed to be measured for the calculations of elevations.

Additional Materials Needed For the Installation Process

1. Vibracore
2. Widow-maker: a cylindrical steel device that is approximately 36 inches in length, has an outside diameter of 7 inches, and weighs approximately 60 pounds; used for driving post
3. Drills and metal bits for stainless steel and driving screws if reflectors are used (minimum of 1/4" and ¾" bits)
4. Hack saw
5. Level

Installation

The field personnel shall install the continuous recorder using the following method. The method shall be established as follows:

Verification of site selection:

1. The site map, site characterization sheet, and a differential Global Positioning System (DGPS) instrument shall be used to locate the pre-determined site. Once the site has been located, the field personnel must verify that the site has not changed and is sufficient for establishment.
2. This verification shall be done by examining the site and answering the following questions: (1) Is the water level / water body deep enough so that the sensors will be submerged during the lowest water levels? (2) Is the site intrusive of a navigational waterway? (3) Is the pre-determined system of deployment sufficient for the site?
3. By answering the questions in step 2, the field personnel shall verify that the pre-determined set-up is sufficient for the site. If it is determined that the set-up is sufficient, the field personnel shall follow the appropriate steps for installation. NOTE: If the field personnel find the site inappropriate, the LDNR/CRD must be notified before the installation.

Procedures for the Mono-pole

The mono-pole is constructed in advance of the deployment field trip (Figure 7). The following steps provide a methodology for an acceptable installation process for the mono-pole

1. Transport the mono-pole and all the necessary equipment needed for the installation process via the water vessel to the site.
2. Position and anchor the water vessel where the mono-pole will be deployed and in a manner that allows for a solid, stable work environment.
3. Obtain the depth of the water at the installation location. (This provides an estimate of how much of the pipe will be above the water and provides an estimate of when the plate will rest on the bottom.)
4. Place the mono-pole over the side of the water vessel in a plumb position.
5. Using the vibracore, vibrate the mono-pole to refusal or until the load plate rests on the bottom of the water body. (If refusal is met before the load plate rests on the bottom, then the widow-maker should be used to try and get the "mono-pole" deeper into the substrate.)
6. At the end of installation, the mono-pole shall be plumb.

7. If the top of the pipe was damaged during installation, the pipe shall be cut just below the damaged portion. A ¾" hole for the hitch pin and a ¼" hole for the elevation mark shall be drilled.
8. Document the following measurements on the "Continuous Recorder Water Level Sensor Data Sheet" (Form 3) by referring to Figure 11).
    a. Top of the ¼" hole to the top of the pipe
    b. Top of the ¼" hole to the bottom of the continuous recorder
    c. Top of the ¼" hole to the water level sensor
    d. Top of the ¼" hole to the water line
    e. Top of the ¼" hole to the substrate
    f. Water depth
    g. Penetration depth
    h. Total pole length
    i. Mud line to the load plate (if not resting on bottom of water body)
    j. Amount of casing removed (if damage was done during installation)

    NOTE: The measurements must be transferred to the Excel "Site History" file provided by LDNR/CRD.

9. Attach reflective tape to the pipe.
10. The continuous recorder can now be deployed.
11. Secure the cap to the pipe using the hitch pin and brass lock.

4.1.2. Deployment and Servicing

Deployment

The instruments described in this section are also capable of collecting temperature, specific conductance, and salinity data; however, this section only describes the information necessary for the water level data. The next chapter of this manual describes the salinity procedures which coincide with the water level procedures. For the purpose of this manual, the two variables were separated. It is essential to review the next chapter to complete the calibration sheet.

Prior to the initial deployment, the continuous recorder shall be programmed to record the date (mm/dd/yyyy), time (hh:mm:ss), water temperature (°C), specific conductance (µS/cm), salinity (ppt), water level (ft), and batter volts (v). The recorder must be programmed to record the time in Central Standard Time and must remain in that time configuration during Daylight Savings Time. The continuous recorder shall have all the previous data collected from another station or testing deleted. The only data that shall remain on the instrument is the data that was collected at the station it is deployed. On a yearly basis, the data must be deleted since the file names will repeat themselves.

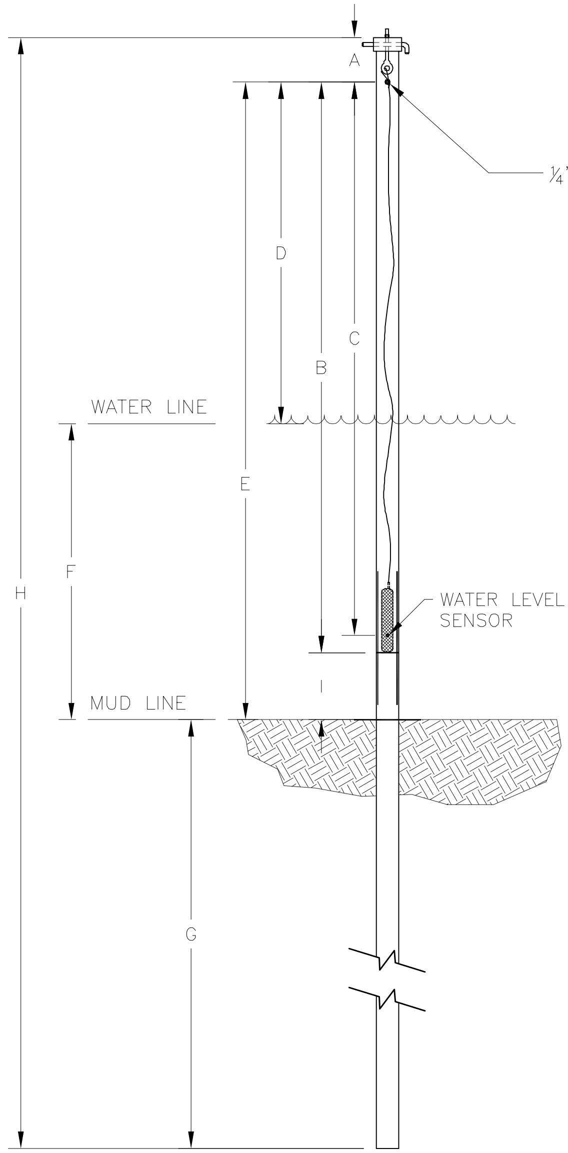

Figure 11: Schematic of distances needed to be measured for elevation calculations.

Several measurements, calibrations, and readings must be obtained, if they were not obtained during the installation process, before the initial deployment. The information obtained from these measurements, calibrations, and readings shall be documented on the "Continuous Recorder Calibration Sheet" (Form 4), which is provided by the LDNR/CRD. These measurements and readings include:

1. Prior to initial deployment, the "Mark to Sensor Distance (ft)" must be measured. This is the distance between the nail which is placed on the wooden post or the top of the ¼" hole on the stainless steel pole to the water level sensor on the continuous recorder (do not confuse the water level sensor with the conductivity/salinity sensor). This measurement will allow the water level readings to be converted to a vertical datum (NAVD 88) when the nail or top of ¼" hole has been surveyed by a professional and licensed individual or company. This measurement may be obtained several ways; therefore, the "Continuous Recorder Water Level Sensor Data Sheet" (Form 3) shall be completed.
2. Calculate the Sensor Elevation (NAVD 88, ft) by using the Mark Elevation (NAVD 88, ft), provided by a professional surveyor, and the Mark to Sensor Distance (ft). Record the Sensor Elevation (NAVD 88, ft) in the appropriate box of the 'Staff Gauge' section of the "Continuous Recorder Calibration Sheet".
3. Calibrate the instrument's water level sensor to zero (0) when it is out of the water prior to deployment. Follow the procedures in the owner's manual for the specific instrument being used. Record the "Depth Out of Water (ft)" reading after calibration in the 'Clean Reading' section.
4. Once the instrument has been placed into position for deployment and has stabilized, record the depth of the water from the instrument onto the calibration sheet in the 'Clean Reading' section.
5. Verify that the water depth reading is correct by using a surveyors measuring rod. Place the "Mark to Sensor Distance" value on the rod at the nail on the timber post or the top of the ¼" hole on the "mono-pole". This places the bottom of the rod (zero reading) at the water level sensor on the continuous recorder. Read the water level on the rod and place that number in the "Water Level on Rod (ft)" box on the calibration sheet under the 'Staff Gauge' section. This number should be within 0.10 of the continuous recorder depth reading. If the difference between the numbers are greater than 0.10, then a problem exists and must be rectified.
6. Add the "Sensor Elevation (NAVD, ft)" to the "Water Level on Rod (ft)" to get the "Water Level (NAVD 88, ft)."
7. Record the staff gauge reading in the "Staff Gauge (NAVD, ft)" box. The staff gauge was established to the vertical datum.
8. Calculate the difference between the "Staff Gauge (NAVD 88, ft)" reading and the "Water Level (NAVD 88, ft)" from the continuous recorder station. Record this value in the appropriate box. <u>NOTE:</u> The value should be less than 0.07. If the value is greater, then measurements need to be taken to rectify the difference.

The LDNR/CRD requires the following when deploying a continuous recorder and requires the documentation in the 'Deployment' section of the calibration sheet:

1. The instrument only allows eight characters for the file name; therefore, the LDNR/CRD requires all file name to follow this order: **project**<u>month</u>*station* (Example: **CR**<u>06</u>*0098*)

2. All times must be in Central Standard Time and written in 24 hours. Even during Daylight Savings Time.
3. The manufacturer, the model number, and serial number of the continuous recorder must be documented.
4. The continuous recorders battery volts at the time of deployment must be documented.
5. The date and time the instrument is deployed must be documented.

After the initial deployment has taken place, the instrument needs to be serviced no earlier than 30 days after deployment and no more than 45 days after deployment unless otherwise stated or agreed upon by the LDNR/CRD.

Servicing

The instruments described in this section are also capable of collecting temperature, specific conductance, and salinity data; however, this section only describes the information necessary for the water level data. The next chapter of this manual describes the salinity procedures which coincide with the water level procedures. For the purpose of this manual, the two variables were separated. It is essential to review the next chapter to complete the calibration sheet.

All data and information concerning the condition of the station shall be documented on the "Continuous Recorder Calibration Sheet" (Form 4).

1. Upon arrival at the station, complete the top section of the calibration sheet by recording the project name, station number, basin/location, agency (company name) and collected by (names of the field personnel), and the marsh elevation for the station in the appropriate boxes.
2. Without disturbing the instrument, connect to the instrument using a laptop computer or a field instrument capable of interfacing with the recorder.
3. Record the date and time from the technician's watch (set to CSTime) and the instrument.
4. Record the instrument's battery volts.
5. Stop the instrument from logging and download the data file. Record the number of samples and the file name.
6. In the 'Dirty Reading' section, record an in situ "dirty" water depth from the display unit attached to the continuous recorder.
7. Remove the continuous recorder from its secured position and place it in the water vessel.
8. Record the "Depth out of Water" reading when the instrument has stabilized.
9. Record the instruments manufacturer, model, and serial number in the top section of the calibration sheet.
10. Following the recommended cleaning procedures in the owner's manual, clean all sensors and the exterior such that the instrument is free of all biofouling agents.
11. Remove barnacles, oysters, and other biofouling agents from the inside and outside of the PVC or mono-pole. In saline waters, biofouling appears to be worse due to barnacles and oysters, thus the inside of the pipe should be cleaned on a regular basis. If these biofouling agents are allowed to build-up overtime, the removal of the instrument will become problematic.

12. Determine if the battery power remaining in the instrument is sufficient to power the instrument until the next servicing. If it is determined that the instrument does not have enough battery power to collect all the data, then the batteries must be changed.
13. Set the water sensor to zero (0.00) while the instrument is out of the water. Follow the procedures described in the owner's manual. Record the value after the instrument has accepted the calibration in the "Depth Out of Water" box of the 'Clean Reading' section of the data sheet. The value should be 0.000. A second calibration may be necessary to achieve 0.000.
14. Once the water level sensor has been calibrated, lower the instrument back into its unattended position.
15. In the 'Clean Reading' section, record the water depth reading once the instrument has stabilized.
16. Calculate the water level difference and percent difference by using the following formulas:

    water level difference (wld) = clean reading depth - dirty reading depth

    Then,

    percent difference = wld / clean reading depth * 100
17. Follow the owner's manual for setting the continuous recorder in an unattended mode. Complete the 'Deployment' section of the calibration sheet. Instructions are presented in the previous section (Deployment).
18. Check the desiccant pack to see if it needs changing. It should be changed a minimum of every 60 days.
19. Complete the information in the 'Staff Gauge' section by obtaining all the necessary measurements and readings.
    a. Record the "Water Level on Rod (ft)" value. This value is obtained by placing the "Mark to Sensor Distance (ft)" number at the nail or top of the ¼" hole on the surveyor's rod. This places the bottom of the rod at the instrument's water level sensor. Read the value where the surface of the water appears on the rod.
    b. Calculate the "Water Level (NAVD)" by adding the "Sensor Elevation (NAVD) and "Water Level on Rod (ft)" readings.
    c. Record the staff gauge reading in the "Staff Gauge (NAVD)" box.
    d. Subtract the values in the "Water Level (NAVD)" and "Staff Gauge" boxes and record the value in the "Staff Gauge – Water Level" box. The absolute value should be less than 0.07. If the value approaches 0.10, measurements shall be taken from the continuous recorder to rectify the problem.
20. Compare the "Water Level on Rod (ft)" measurement with the water depth reading in the 'Clean Reading' section of the calibration sheet. If the difference is more than 0.07 ft, then both values need to be examined for accuracy.
21. Secure the instrument and cable using the brass locks on the two brass hitch pins and the electrical box on the wooden post or secure the cap to the top of the pipe using the brass hitch pin and brass lock.
22. Notes shall be taken and documented in the 'Notes' section of calibration sheet and/or in a field notebook. These notes shall include:
    a. The water level in relation to the marsh surface. Approximate the depth of water above the surface or the distance below the surface.
    b. If the instrument is near a water control structure, document the flow direction of the water and approximate the speed of the water flow.

c. The health of the vegetation around the station shall be noted.
d. The health of submerged aquatic vegetation as well as abundance shall be noted.
e. Any changes in the marsh with respect to erosion, subsidence, movement, etc. shall be noted.

If it is determined that any sensor is resting in the sediment and causing erroneous reading, then the instrument needs to be raised. This will cause all the measurements with respect to the water level sensor to be different; consequently, all the distances associated with the water level sensor need to be re-measured and documented on a "Continuous Recorder Water Level Sensor Data Sheet." The "Site History" Excel file shall be appended during the data processing phase with the new measurements.

Troubleshooting

The continuous recorder will be removed from the field when the instrument malfunctions. Examples of such malfunctions may include, but are not limited to, not being able to establish communication with the instrument, seeing an erroneous reading due to a malfunctioning sensor, or calibration of a sensor is not being accepted. Before removing the instrument from the field, several troubleshooting techniques shall be performed: 1) inspect the old batteries and compartment while changing the batteries and look for exploded batteries and acid, 2) carefully clean all the sensors and attempt to calibrate, 3) check the cable connections between the continuous recorder and field display instrument, and 4) change the cable. If the continuous recorder is still malfunctioning, remove the existing instrument and replace with a new instrument. Make sure that the depth is calibrated on the replacement instrument. Document this replacement in the 'Deployment' section and follow the deployment procedures listed above. If the instrument is a different model or if the set-up has changed, then all measurements shall be re-measured and documented on a "Continuous Recorder Water Level Sensor Data Sheet." If the instrument belongs to the LDNR/CRD, malfunctioning instruments will be returned to LDNR/CRD field office responsible for the station accompanied by a written description of the malfunction.

4.1.3. Data Processing

The LDNR/CRD has implemented a two phase protocol for data processing. These two phases are referred to as data entry (Phase I) and quality assurance / quality control (Phase II). These two phases are conducted by separate individuals to assure that the final product is in 100% agreement with the data collected from the field.

Data Entry (Phase I)

The data entry phase includes entering all water temperature, specific conductance, and salinity data along with the water level data since the instrument collects each of these variables. To properly process the data from its field format to its final quality assurance / quality control (QA/QC) format, several files are needed:

1. Raw data file (.dat) from the field display unit.
2. Raw data file (.csv) from the YSI software (EcoWatch or equivalent) for continuous recorder data.
3. YearHour (.xls) provided by the LDNR/CRD to verify date and times.

4. Sondeqc (.xls) template provided by the LDNR/CRD to import the raw data for shifting and quality assurance.
5. Station history (.xls) template provided by the LDNR/CRD to record any information regarding the station, data, or instrumentation at the site.
6. Field trip report (.doc) template provided by the LDNR/CRD to document what occurred during the installation, deployment and/or servicing of the station.

Complete the procedure below using the electronic files to properly process the data obtained from the field.

1. Copy the "Deployment Date and Time" of the file that was downloaded from the field from the previous calibration sheet's 'Deployment' section.
2. Photocopy the "Continuous Recorder Calibration Sheet" used in the field. The original sheet will be properly stored during the QC process. The photocopy becomes the working copy throughout the QC process and the original will be corrected at the end of the process.
3. Transfer the raw data from the laptop or field display unit to a personal computer that has the electronic files provided by the LDNR/CRD following the procedures specified in the owner's manual for the field instrument.
4. Open the downloaded file (.dat) in the software program (EcoWatch for Windows—YSI or equivalent).
    a. Arrange the data in the appropriate order and format: date (mm/dd/yyyy), time (hh:mm:ss), temperature (°C), specific conductance (µS/cm), salinity (ppt), water depth (ft), and battery volts (v).
    b. Using the statistical function, check the minimum and/or maximum values for any data that may be incorrect (i.e., water level and salinity readings in show a negative value for the minimum reading or maximum values that may seem to high).
    c. Export the .dat file as a comma delimited text (.csv) file using the same name as the .dat file.
5. Open the raw data file (.csv) in Excel to verify that the data are arranged in the correct columns. The order of the columns shall be: date (mm/dd/yyyy), time (hh:mm:ss), water temperature (°C), specific conductance (µS/cm), salinity (ppt), water depth (ft), and battery volts (v).
    a. Insert an empty column next to the date.
    b. Open the "YearHour.xls" file.
    c. Copy the same date and time period found in the .csv file from the "YearHour.xls" and paste in the empty column. Verify that there is no missing dates and times. If data are missing, then a new row shall be inserted into the file to contain the missing date and time. The data fields in the row shall remain blank.
6. Open the "Sondeqc.xls." This file contains three worksheets that serve as a template for the continuous recorder data including water temperature, specific conductance, water level, and battery volts. The three worksheets are:
    a. "Data": Enter the data from the calibration sheet in this worksheet. Formulas determine if the data needs to be shifted because of biofouling on the continuous recorder. This worksheet contains three areas: the top area requires the input of data from the "Continuous Recorder Calibration Sheet" that was completed in the field. All the cells with the red font require a change and the information/data are obtained

from the calibration sheet. On the lower portion of the spreadsheet, the raw data are pasted. The salinity and water level data are shifted for biofouling, and the water level data are converted to NAVD 88, Feet. Statistical summary and percent completeness calculations are located on the right side of the worksheet.

b. "Oracle": This worksheet puts the data from the "Data" worksheet into the appropriate format for the LDNR/CRD main database. Any erroneous data that are deleted from the shifted section of the data worksheet will appear as a zero value in the "Oracle" worksheet. These zero values must be deleted.

c. "Graphs": This worksheet contains two graphs. One graph shows the shifted salinity data and the shifted water elevation data to a vertical datum (NAVD 88, Feet). The other graph shows the depth and duration of flooding by overlaying the shifted water elevation (NAVD 88, Feet) with the marsh elevation (NAVD 88, Feet).

7. Before changing any information or pasting any data into the spreadsheet, save the file under a different name. The name of the file should be the same as the name of the raw data file except that it should be in an Excel file format (.xls).
8. Change all the red font information in the first 13 rows of the "Data" worksheet to match the information on the "Continuous Recorder Calibration Sheet" that corresponds to the data file.
9. Copy and paste the raw data excluding the headers from the .csv file into the first seven columns of the raw data portion of the "Data" worksheet.
10. Formulas have been incorporated into the spreadsheet to shift the salinity and water level data as well as convert the water level data to the vertical datum (NAVD88, Feet). These formulas are located in the four columns directly to the right of the 'Count' column and may need to be filled down to the end of the raw data if necessary. The 'Count' is used in the calculation of the shift and must begin with '0' at the first row of raw data and be filled all the way down to the end of the raw data. If the percent difference is greater than 5% between the dirty continuous recorder readings and the calibration instrument for the salinity or water level data, then a shift is applied in the shifted data columns. Scroll down the spreadsheet to make a visual check of the raw and shifted data. If any erroneous data need to be deleted, always delete the data from the SHIFTED columns. NEVER delete raw data from the file. Some examples of erroneous data include, but are not limited to: 1) In very low salinity environments, a biofouling shift on salinity in the negative direction may cause some shifted values to be negative. These negative values must be deleted and the resulting zeroes in "Oracle" should be removed. 2) Raw depth should not be negative. If negative raw depth values are encountered, there was either an instrument malfunction or the water level may have dropped below the depth sensor during the sampling period resulting in erroneous readings. In the first case, all shifted data may need to be deleted beyond the point where the malfunction occurred. In the second case, you may need to only delete the shifted data taken while the sensor was out of the water.
11. While the spreadsheet is designed to handle 3000 lines of data, most files will not have this much data; consequently, any rows containing information below the last raw data sample must be deleted.
12. Change the heading of the summary statistics and percent completion page to reflect the project, station, and date and time period that the data represents.
13. When the "Data" worksheet is complete, click on the "Oracle" worksheet.
    a. Delete any rows containing information beyond the end of the current sampling period.

b. Delete the zeroes out of the shifted columns where any shifted data were deleted out of the "Data" worksheet. Never delete data from the raw data columns.
c. Delete the zeroes out of the cells that have no data because the instrument was not recording.

14. Open the "Graphs" worksheet and adjust the graphs such that all the data are displayed on the graph for the entire sampling period. NOTE: This can be done by changing the row numbers in the source data of the graph to match the first and last row of data in the "Data" worksheet.
15. Change the headings of each graph to match the project name, station number, and the date range of the presented data.
16. While viewing the graphs, determine if any additional data need to be voided due to erroneous readings or the water level falling below the sensors.
17. If data were voided, this must be noted, dated, and initialed in the 'Comments' section of the "Continuous Recorder Calibration Sheet," as well as in the "Site History" Excel file (explained below).

The procedure above has placed the data into a format that will be accepted by the LDNR/CRD database; however, the transition between the data in the previous month's file and the data in the current file needs to be verified. The technician will compare the last two weeks of data from the previous file (if one exists) to the data in the beginning of the current file to verify that the transition is smooth, the pattern is similar, and there are no missing data. Often an hourly reading is missing while the instrument is being cleaned. If this occurred, insert a row at the beginning of the current data file in both the "Data" worksheet and the "Oracle" worksheet. Insert the missing date and time into the appropriate columns and leave the rest of the data row blank. If the transition between the two files seems to be erroneous, then the technician must resolve the problem by examining the data and the data sheet associated with the files. If it is determined that a data set must be voided, specific documentation must occur in the "Site History" file.

Once the technician has completed the review of the data and believes it to be 100% correct, the technician must print out the graphs from the "Graph" worksheet and the statistics and percent completeness portion of the "Data" worksheet. These graphs and summary statistics become part of a QA/QC packet.

Once the Excel spreadsheet is complete with respect to the data, the "Site History" Excel file (provided by the LDNR/CRD) must be completed and updated with respect to all the pertinent worksheets:

1. Site Visit History: This worksheet gives a history of when the site was visited.
2. Recorder Deployment_Removal: This worksheet tracks the make, model, and serial number of each continuous recorder at each station along with the date and time each recorder was serviced as well as changed because of malfunctions.
3. Data History: This worksheet tracks each station's omission of data whether it is related to a malfunction, deletion because of shift, and/or voided data as well as provides a history of missing and deleted data.
4. Recorder Elevations: Any updates or changes that may have occurred as a result of changing instruments or other problems must be documented.

Once the Excel files have been completed, a field trip report must be generated. The field trip report must include: 1) field personnel and their respective agency, company, or organization on the trip, 2) purpose of the trip 3) general weather conditions, 4) sites that were sampled, 5) type of sampling that took place, 6) an explanation of any logistical problems encountered in the field, especially problems that may affect the data, 7) any notable biological activity or physical activity that may have altered the site, and 8) details of when and where the calibration instrument was calibrated and the solution used.

When the Excel files and field trip report have been completed, the technician must compile a quality assurance (QA) / quality control (QC) packet. This packet shall include:

1. the appropriate QA/QC checklist (Form 5) cover sheet
2. field trip report
3. photocopied "Continuous Recorder Calibration Sheet(s)" (depends on the number of stations in a packet
4. graphs printed from the Excel file "Graphs" worksheet
5. summary statistics and percent completeness calculations printed from the Excel file "Data" worksheet

The QA/QC packet and associated Excel files are sent to another individual for further examination and verification. This individual is referred to as the QA/QC officer.

Quality Assurance / Quality Control (Phase II)

The QA/QC officer immediately dates the packet upon receipt. The QA/QC officer will read the report, provide grammatical corrections, suggest clarifications, and make comments as it pertains to the information on the calibration sheet(s). The QA/QC officer then examines the calibration sheet(s) for completeness and accuracy especially in the sections where calculations were performed in the field. The QA/QC officer must also check on the calibration sheet that the depth reading on the continuous recorder is within 0.07 ft of the 'Water Level on Rod,' and that the 'Staff Gauge – Water Level' difference is within 0.07 ft. The QA/QC officer must then ensure that:

1. All data were transferred correctly from the calibration sheet to the upper portion of the "Data" worksheet.
2. The starting/ending dates and times of the data within the Excel file correspond with the dates and times on the calibration sheets.
3. There is no suspect data in the file, all data have been shifted correctly, and that depth data were converted to NAVD 88, Feet. If there are missing data, it must have been noted and explained in the "Site History" file and on the calibration sheet.
4. There are no erroneous zeros in the "Oracle" worksheet due to deleted shifted data.
5. Graphs are correct, including the source data and heading (project name, station name, and date range).
6. The transition between the previous and current month's data is smooth and that no sample point is missing between the two sample periods due to instrument cleaning.

If mistakes or questions arise, then documentation must occur on the QA/QC checklist. At times it may be beneficial to place removable notes (e.g., Post-it® notes) on the photocopy data sheet.

The QA/QC officer also checks the "Site History" file to verify that the information regarding all aspects of the station are up-to-date and accurate.

Once the packet and files have been reviewed, the QA/QC officer shall initial and date those portions of the QA/QC checklist that have been accepted as complete according to the questions provided on the QA/QC checklist. Those areas that possess errors or have presented questions shall be addressed by the person responsible for Phase I.

Once the data collector has corrected or answered any problems found by the QA/QC officer, the QA/QC packet is returned to the QA/QC officer. The QA/QC officer examines the questions and verifies that all the data and information is 100% correct. This process will continue until all the corrections have been made and all the questions have been answered to the satisfaction of the QA/QC officer. Upon approval of the packet, the QA/QC officer will initial and date the rest of the QA/QC checklist.

After the QA/QC packet has been finalized, the data collector or the QA/QC officer must obtain the original data sheet(s). If problems were found with the data sheet(s) during the QA/QC process, then the original data sheet(s) must be corrected. This process shall be carried out by using a black ball point ink pen. The person shall not erase any data or information on the original data sheet. The proper procedure will be to draw a single line through the error and place the correction as close to the error as possible. The person will also place their initials and the date next to the correction.

Strategic Online Natural Resources Information System (SONRIS) Data Entry

After the QA/QC procedure has been completed on two successive data acquisition periods, the first data set shall be entered into the SONRIS database. Consequently, there will be a one QA/QC packet lag between the SONRIS database and the QA/QC packet. The SONRIS database is a storage and retrieval mechanism with respect to the continuous hydrographic data. The LDNR/CRD Restoration Technology Section (RTS) is responsible for the development and maintenance of the database as it pertains to field data and reports.

The LDNR/CRD/RTS has developed a user’s manual for uploading hydrographic data into SONRIS. The manual is updated periodically as the database changes with technology. The latest version of the manual was released on December 29, 2003 with respect to the hydrographic data. To properly import the data into the SONRIS database, the User’s Manual for Hydrographic and Emergent Vegetation Data Management dated December 29, 2003 shall be followed. The most current version of this manual must always be used.

The person responsible for the collection of data is also responsible for uploading the data into the SONRIS database. Once the person has followed the procedures outlined in the user’s manual, the QA/QC officer is responsible for verifying the procedures have been followed properly and the data are properly stored in the database. Once the data has been accepted into the database, the QA/QC officer shall complete the QA/QC Checklist as it pertains to the database. Upon completion of this section, the QA/QC packet is completed and the data shall be turned over to the LDNR/CRD.

Any statistical analysis, summary graphics, or data that are requested must be downloaded from the SONRIS database and never directly from the Excel file.

4.1.4. Summary Data and Graphics

Twice per year (January and July), the previous 6-months (July) or 12 months (June) of QA/QC'd, stored data shall be downloaded from Oracle. With these data, summary graphics shall be produced to show the entire period of salinity and water level data as well as flood depth and duration data. With the yearly data, summary statistics and percent completeness with respect to the analysis used in the monthly packets shall be performed and printed with the graphs and provided to the LDNR/CRD.

4.1.5. Deliverables

Upon completion of the QA/QC process (after the data are loaded into SONRIS) both hardcopies and electronic copies of the summary data and graphics, the original data sheets, the field trip report, the QA/QC packet, field notes, "Site History" file and any other information collected with respect to the station shall be delivered to the LDNR/CRD. Electronic files containing the data shall be in the appropriate deliverable format (see Appendix) once the data has completed the QA/QC process. This also includes the raw data files (.dat) that were downloaded from the instrument. These shall be delivered electronically and stored in folders by station and year.

4.2. Ultrasonic Water Lever Sensors

Measuring water via a pressure transducer is not possible at sites with seasonal wet and dry cycles, that periodically dry out, or that have ephemeral flooding. In these situations, an ultrasonic water level sensor can be used. Ultrasonic technology provides a non-contact method of detecting flow, presence, and distance measurements that can be readily adapted for use in determining water level changes in coastal restoration studies. These types of sensors are not affected by target surface, color, translucency, specific gravity, or viscosity of liquids. They are reliable, easily adjustable, require little to no maintenance, and function extremely well in harsh environments.

Ultrasonic sensing is similar to radar in that a sound wave is generated by the instrument and if this sound wave meets something reflective or solid, such as a liquid, it bounces back to the instrument. The time delay is measured and distance between the object and the sensor can be calculated. Although the speed of sound is well-known, many variables (e.g., ambient temperature, humidity) can affect the speed. However, advances in technology can account for and factor out these variables to provide highly accurate data.

Advantages of ultrasonic sensing include that no part of the instrument ever touches the water and is therefore not affected by dirty water, debris, or aquatic life in the water column; they require very little maintenance except the occasional clearing of cobwebs, vegetation, or debris from the sensor's path or washing of the distilling tube; they are easy to calibrate; and they have excellent linearity and long-term reliability in data collection (for more information, see chapter 4 at http://www.itrc.org/reports/WaterLevelSensor/WaterLevelSensor.html). However, some disadvantages are that occasional inaccurate readings may occur due to floating debris or foam; alignment must be precise and directly perpendicular to the water surface; and they are currently unable to measure salinity.

Installation

Many companies, including OTT Hydrometry, Campbell Scientific, and Hydrolab, produce data-logging ultrasonic or radar-based sensing equipment. Each of these companies has installation or mounting instructions for their respective sensors. The LDNR/CRD has not yet adapted the use of ultrasonic technology in any restoration project. Installation of an ultrasonic water-level sensor requires several considerations:

1. Sensors must be placed as close as possible to the maximum water level expected. Accuracy of most sensors is reported to be about ±0.4% of distance to target.
2. The sensor beam must be exactly perpendicular to the reflecting surface in order for the sound waves to reflect directly back to the sensor.
3. When mounting, the sensor's beam angle and maximum height of the sensor to it's reflecting surface are used to calculate the sensor beam's conical path and clearance radius:

$$BEAM_{Radius} = \text{Tangent (Beam Angle}° / 2) \times BEAM_{Height}$$

 Where:

 $BEAM_{Height}$ = The maximum height of the sensor to it's reflecting surface
 $BEAM_{Radius}$ = Clearance radius

 The clearance radius provides the area that no object could obstruct the sensor's beam. This area and the conical path should be kept clear of debris or vegetation as to not interfere with the sensor's accuracy.
4. In some cases, a stilling well or a PVC pipe can be used to protect the sensors and prevent obstructions within the clearance radius. A stilling well or PVC pipe is usually fitted with slits or holes to allow water to enter or leave the inside of the well or pipe. They also buffer water levels during heavy wave action. However, the inside diameter of the well or pipe must be wide enough to not interfere with the clearance radius of the beam. For example, if a sensor with a 3° beam angle is mounted 1 meter from the reflecting surface, it would have a 2.62 cm clearance radius. The inside diameter of a PVC pipe would need to be greater than 5.24 cm (~ 2 in) to prevent inaccurate readings (assuming the sensor is mounted perfectly in the center of the pipe). Manufacturers have differing recommendations as to the use and specifications of stilling wells. If either a stilling well or PVC is used, frequent maintenance and cleaning of the inside area will be required. Additionally, steps will need to be taken to prevent vegetation from growing inside the pipes or wells and that the ground elevation in the pipe or well is exactly the same as the ambient ground elevation.
5. There are several potential methods for securing the sensor at a constant elevation:
 a. The sensor (and PVC housing) can be securely attached to an existing structure.
 b. A 4"x 4" wooden post can be driven into the marsh surface to refusal and the sensor can be attached to the wooden post.
 c. A long and extremely strong PVC pipe can be driven into the marsh surface to refusal. At or very near the marsh surface, slits or holes are cut into the PVC to allow water

(during inundated conditions) into and out of the PVC. The sensor is then affixed inside the portion of the PVC above the marsh.

d. The sensor can be mounted onto a tripod or arm attachment that is fixed to an existing structure.

5. SALINITY

High variability in water-level and salt-water intrusion have been shown to cause adverse effects on the health of coastal wetland ecosystems (Gagliano et al. 1981). As a corollary, the LDNR/CRD has specific goals to reduce variability in water level and decrease mean salinity values in many areas. Both changes in water level and salinity values will be measured on a continuous basis (defined as hourly, unless otherwise stated) using a pressure transducer and a salinity meter (Steyer et al. 1995). The LDNR/CRD advocates the use of the YSI 6920, YSI 600XLM, or equivalent continuous recorder as the basic model that can measure water level via a pressure transducer, salinity, specific conductance, and water temperature on a continuous basis. Likewise, a YSI 30 or equivalent can measure salinity, specific conductance, and temperature at discrete locations and to assure the data logger is properly calibrated.

Due to the large diversity of ecosystems found in the coastal zone, differing procedures to measure salinity will need to be adapted to each site or area of investigation. For example, a marsh water body with sufficient yearly levels of water (i.e., does not dry out) will use a YSI 6920, YSI 600XLM, or equivalent continuous recorder to measure hourly salinity concentrations. Since these instruments are used to collect water level and salinity data simultaneously the method for field establishment is thoroughly explained in the previous chapter (Surface Water). This chapter explains the methods for deployment and servicing the instrument with respect to the salinity data.

In some cases, it may not be feasible to establish continuous recorders. In such cases, it is imperative that monthly sampling at discrete areas for water temperature, specific conductance, and salinity occur in adjacent marsh ponds on a monthly basis. These water quality readings are taken with a portable, hand-held instrument (e.g., YSI 30 or equivalent) that provides the user with water temperature, specific conductance, and salinity readings. Discrete readings provide data concerning the spatial and temporal variation in salinity throughout the area. Water level may also be determined by adding a weight near the sensor and graduating the cord. Depth is measured by gently lowering the cord to the subsurface, assuring that the cord is perpendicular, and recording the depth.

Instrumentation

The environmental monitoring instrument that shall be used for the LDNR/CRD must meet the following criteria. The instrument must be a multi-parameter, water quality measurement, and data collection system. The instrument must be capable of recording and storing water temperature (°C), specific conductance (μS/cm), salinity (ppt), and water level (feet) at intervals specified by the LDNR/CRD. Salinity concentrations will vary from fresh (<0.1 ppt) to sea (>30.0 ppt) and at times may be considered polluted.

The water temperature and specific conductivity sensor must meet or exceed the following standards. The temperature sensor must be able to function in a range of -5 to 45°C, have a range of ±0.15°C, a resolution of 0.01°C, and able to work in depths of 200 meters (656 feet). The conductivity sensor must be able to function in a range of 0 to 100 mS/cm, have an accuracy of ± 0.5% of readings, a resolution of 0.001 mS/cm to 0.1 mS/cm, and able to function in 200 meters (656 feet) of water. The salinity values are calculated from the conductivity and water temperature readings and must have a range of 0 to 70 ppt, an accuracy of ± 1.0% of readings or 0.1ppt (whichever is greater), and a resolution of 0.01 ppt.

Along with the sensor specifications above, the instrument shall be capable of transferring the raw data through a field display unit or field computer to an Excel spreadsheet for the production of graphs and monthly summary data analysis before the data is uploaded into the LDNR/CRD's main database. The LDNR/CRD has developed an extensive procedure that shall be followed with respect to the instruments field deployment, servicing, data process, data storage, statistical analysis, and graphic display of analysis.

To verify that the continuous recorder is within calibration at the time of deployment and to calculate the drift of the continuous recorder due to biofouling, a portable, hand-held discrete instrument (YSI 30 or equivalent) is used. This water quality instrument provides the user with water temperature (°C), specific conductance (µS/cm), and salinity (ppt). This instrument is also used to collect readings at discrete stations.

The YSI 30 or equivalent must be capable of taking salinity readings in water depths up to 7.6 meters (25 feet). The YSI 30 or equivalent must be capable of field calibration by using push buttons, have a backlit display, automatically compensate for temperature, and use a four-electrode conductivity cell. Minimum accuracy requirements for the instrument are found in Table 1. Any instrumentation that does not meet these specifications must be approved by the LDNR/CRD.

Table 1: Conductivity, salinity, and temperature range and accuracy minimum standards for the handheld water quality units.

Measurement	Range	Resolution	Accuracy
Conductivity	0 to 499.9 µS/cm	0.1 µS/cm	±0.5% full scale
	0 to 4999 µS/cm	1 µS/cm	±0.5% full scale
	0 to 49.99 mS/cm	0.01 mS/cm	±0.5% full scale
	0 to 200.0 mS/cm	0.1 mS/cm	±0.5% full scale
Salinity	0 to 80 ppt	0.1 ppt	±2% or ±0.1 ppt
Temperature	-5 to +95°C	0.1°C	±0.1°C

5.1. Salinity and Water Level Continuous Recorder

The instrumentation and field deployment used to record salinity is the same as those used to collect the water level data; therefore, the standards used in the previous chapter to determine the type of deployment system applies to this section. Refer to 4.1 and 4.1.1 for information concerning the reasoning for determining the type of station and the method in which it is deployed.

5.1.1. Deployment and Servicing

Deployment

The procedures set forth in this section deal solely with the salinity sensor. Any procedure or information regarding the water level sensor shall refer to the previous chapter (Surface Water). The deployment of this instrument requires both procedures to be conducted simultaneously.

Prior to initial deployment, the instrument must be programmed according to the specifications in the Surface Water chapter; however, more calibrations and readings must be obtained for the salinity sensor. The information obtained from the calibration and readings shall be documented on the "Continuous Recorder Calibration Sheet" (Form 4). These measurements and readings include:

1. Calibrate the continuous recorder and hand-held instrument's salinity probe to a known conductivity standard that is similar to the ambient water salinity concentration at the time of deployment. Document the calibration and calibration standard in the 'Comments' section of the calibration sheet.
2. Verify that the continuous recorder has accepted the calibration by using the calibrated hand-held salinity meter (YSI 30 or equivalent) which is also used for discrete readings.
    a. Place the two salinity probes next to each other and lower them into the water to the deployment depth.
    b. Record the water temperature, specific conductance, and salinity reading from both instruments in the 'Clean Reading' section of the calibration sheet.
    c. Calculate the specific conductance difference by using the formulas:

        Specific conductance difference = calibration instrument - constant recorder

        Record the value in the appropriate box.

        Percent difference = specific conductance difference / specific conductance (of the calibration instrument) *** 100**

        If the percent difference is below 5%, then the instrument is calibrated. If the percent difference is above 5%, then the instrument needs to be re-calibrated or is mal-functioning (see section on calibration, steps 18-20 of servicing below).
3. Once the instrument is calibrated, place the continuous recorder into position for deployment.

The LDNR/CRD has developed specific protocols with respect to the deployment of a continuous recorder. These protocols were developed to provide continuity between all the offices collecting data for the LDNR/CRD. These protocols deal with file names, date and time format, and the tracking of instrumentation. The specific deployment protocols are described in the previous chapter.

After the initial deployment has taken place, the instrument needs to be serviced no earlier than 30 days after deployment and no more than 45 days after deployment unless otherwise stated or agreed upon by the LDNR/CRD.

Servicing

As previously discussed, the collection of water level and salinity data occur simultaneously; therefore, many steps that occur during the servicing of the continuous recorder have been duplicated in this section (due to the organizational style of this document). Those steps that begin with *Water Level, Servicing #:* indicate they are repeated from the water level chapter under the servicing section. These steps have been included for clarification purposes. Steps that do not posses this nomenclature have not been explained previously and relate directly to the salinity data.

All data and information concerning the condition of the station shall be documented on the "Continuous Recorder Calibration Sheet" (Form 4).

1. Calibrate the hand-held instrument before using and document the solution used in the 'Comments' section. NOTE: Discard the calibration solution used to calibrate the instrument.
2. *Water Level, Servicing 1*: Upon arrival at the station, complete the top section of the calibration sheet by recording the project name, station number, basin/location, agency (company name), collected by (names of the field personnel), and marsh elevation for the station in the appropriate boxes.
3. *Water Level, Servicing 2*: Without disturbing the instrument, connect to the instrument using a laptop computer or a field instrument capable of interfacing with the recorder.
4. *Water Level, Servicing 3*: Record the date and time from the technician's watch (set to CSTime) and the instrument.
5. *Water Level, Servicing 4*: Record the instrument's battery volts.
6. *Water Level, Servicing 5*: Stop the instrument from logging and download the data file. Record the number of samples and the file name.
7. Lower the hand-held salinity meter probe to a depth near the sensor of the continuous recorder.
8. In the 'Dirty Reading' section, record an in situ "dirty" water temperature, specific conductivity, and salinity from the display unit attached to the continuous recorder.
9. In the 'Dirty Reading' section, record the readings from the hand-held salinity meter. This includes the water temperature, specific conductance, and salinity.
10. *Water Level, Servicing 7*: Remove the continuous recorder from its secured position and place it in the water vessel.
11. Calculate the specific conductivity difference and the percent difference between the continuous recorder and the calibration instrument. This is accomplished by using the following formulas:

    Specific conductance difference = calibration instrument - constant recorder

    Then,

    Percent difference = specific conductance difference / specific conductance (of the calibration instrument) * 100

12. Following the recommended cleaning procedures in the owner's manual, clean all sensors and the exterior such that the instrument is free of all biofouling agents.
13. *Water Level, Servicing 11*: Remove barnacles, oysters, and other biofouling agents from the inside and outside of the PVC or mono-pole. In saline waters where biofouling appears to be worse due to barnacles and oysters, the inside of the pipe should be cleaned on a regular basis. By not removing these biofouling agents, eventually the removal of the instrument will become problematic.
14. *Water Level, Servicing 12*: Determine if the battery power remaining in the instrument is sufficient to power the instrument until the next servicing. If it is determined that the instrument does not have enough battery power to collect all the data, then the batteries must be changed.
15. Place the sensors from the hand-held salinity meter and continuous recorder side by side and lower them in the water to the deployment depth of the continuous recorder.

16. Record the water temperature, specific conductance, and salinity of both instruments in the appropriate boxes under the ‘Clean Readings’ section.
17. Using the formulas stated in step 11, calculate the specific conductance difference and the percent difference for the ‘Clean Readings.’
18. If the percent difference is <5%, then the instrument does not need calibration (proceed to step 22). If the percent difference is ≥ 5%, then the instrument needs to be calibrated (Perform steps 19-22).
19. Calibration of the salinity probe for the continuous recorder. Use a standard that is closest to the specific conductance reading on the salinity meter. Calibrate the continuous recorder following the procedures in the owner’s manual for the instrument.
20. In the ‘Calibration Required’ section, document that the instrument accepted the calibration and the solution used for calibration.
21. Lower both instruments back into the water to verify that the readings are now within 5% of each other.
    a. Record the temperature, specific conductance, and salinity of both instruments in the ‘Calibration Required’ section.
    b. Perform the specific conductance and percent difference calculations and record the values.
    c. If the continuous recorder is still out of calibration, try to trouble shoot the instrument or change the instrument out with the spare. If a spare is used this instrument needs to be calibrated.
22. Lower the instrument back into its unattended position.
23. Follow the owner’s manual steps for setting the continuous recorder in an unattended mode. Follow the guidelines for files name, etc. in the section *Water Level,* **Deployment** section of the previous chapter.
24. *Water Level, Servicing 20*: Secure the instrument and cable using the brass locks on the two brass hitch pins and the electrical box on the wooden post or secure the cap to the top of the pipe using the brass hitch pin and brass lock.
25. *Water Level, Servicing 21*: Notes shall be taken and documented in the ‘Notes’ section of the calibration sheet or in a field notebook. These notes shall include:
    a. The water level in relation to the marsh surface. Approximate the depth of water above the surface or the distance below the surface.
    b. If the instrument is near a water control structure, document the flow of the water and approximate the speed of the water flow.
    c. The health of the vegetation around the station shall be noted.
    d. The health of submerged aquatic vegetation as well as abundance shall be noted.
    e. Any changes in the marsh with respect to erosion, subsidence, movement, etc. shall be noted.

Troubleshooting

Refer to the troubleshooting section in chapter 4.1.2.

5.1.2. Data Processing

Refer to chapter 4.1.3 (Data Processing).

Strategic Online Natural Resources Information System (SONRIS) Data Entry

Refer to the SONRIS section in chapter 4.1.3.

5.1.3. Summary Data and Graphic

Refer to chapter 4.1.4 (Summary Data and Graphics).

5.1.4. Deliverables

Refer to the chapter 4.1.5 (Deliverables).

5.2. Discrete Sampling

Discrete samples include water quality readings that are collected on a monthly basis from the same location that has been randomly selected by the LDNR/CRD for specific purposes related to specific projects. These water quality readings are taken with a portable, hand-held instrument (YSI 30 or equivalent) that provides the user with water temperature (°C), specific conductance (μS/cm), and salinity (ppt). Estimated water depth (ft) readings are obtained at each location using the graduated cable on the YSI 30 or equivalent. Discrete readings provide data concerning the spatial and temporal variation in salinity throughout the area.

Discrete readings are unique in the aspect that the data collection takes place in the same location; however, there are no station establishment materials associated with this type of sampling. The readings take place in the same location of a water body (lake, bayou, navigational channel, marsh pond), but there is no need to establish any distinctive markings. Repeated measures are obtained by using global positioning systems to ensure the readings are occurring in the same location. Coordinates shall be provided by the LDNR/CRD once the location of each station has been determined.

The discrete sampling locations are selected to indicate a spatial and temporal variation in salinity throughout the area over time. Since it is not cost effective to deploy a continuous recorder in every location possible, discrete readings are taken. Over time the analysis of these readings coupled with the continuous recorder data provide a status and trends with respect to the movement of salinity within an area. In order to achieve quality data, the LDNR/CRD has developed extensive protocols with respect to instrument calibration, field sampling methods, and instrument quality assurance.

Before readings are taken in the field with a hand-held water quality meter, the meter must be calibrated for quality assurance. Since the meter is capable of measuring a wide range of salinity concentrations, the instrument shall be calibrated with a solution that is relatively close to the conditions in the field. To maintain the highest degree of accuracy, the instrument must be calibrated whenever the instrument is turned on or when the field conditions have dramatically changed. Procedures for calibrating the instrument are found in the owner’s manual.

5.2.1. Calibration

Using the YSI 30 or equivalent owner's manual, follow the procedures on how to calibrate the instrument, but also use the LDNR/CRD protocol for calibration for more specific instructions.

1. The conductivity probe must be clean and free from any organic or mineral sediment.
2. Rinse the probe with conductivity-free water, preferably deionized water, between changes of calibration solutions. Conductivity standards must be purchased from an approved manufacturer or supplied by the LDNR/CRD. Once the standard is removed from its original container, it shall be discarded after its use since the standard is considered contaminated.
3. Calibrate the instrument using a conductivity standard that brackets the range of the field samples. The concentration of the standard used for the calibration should be based on the testing needs for the field activity. A single point check standard in the range of the sample concentration to be measured shall be used for field screening and shall be within ±5% range of accuracy of true value for the calibration to be acceptable. NOTE: It is important that the calibration process established by the instrument manufacturer be examined in order to determine suggested concentrations of the conductivity standards for the operating environment encountered at the time of field sampling.
4. Using the manufacturer's recommended container for calibration, transfer the appropriate amount of solution to the container.
5. Suspend the probe in the solution so that the electrode does not rest against the container. Make sure the electrode's vent hole is submerged. Move the probe vigorously from side to side to free the vent hole of air bubbles if necessary.
6. Calibrate the instrument by following the manufacturer's manual for calibration.
7. Document the concentration of the standard used on the "Discrete Hydrographic Data Sheet" (Form 6).

Calibrations shall be performed monthly in a controlled environment for the assurance of quality data. The instrument must be examined for cleanliness, workmanship, and data quality. With respect to cleanliness, the instrument and sensors must be checked and cleaned of any biofouling that may be contaminating the accuracy of the readings. The examination for workmanship means a thorough examination for cracks, cuts or damage to the housing, cable, and sensors. The most important aspect of the monthly calibration is the accuracy of the instrument. This is accomplished by using a thermometer and quality calibration solution. These readings assure the user that the instrument is accurate. The protocol for monthly inspections of the hand-held meter is found in the Quality Assurance section and a data sheet (Form 7) must be completed. The form is a method of documentation to assure the LDNR/CRD that the instruments being used are of the highest quality.

5.2.2. Data Collection

1. Using the "Discrete Hydrographic Data Sheet" (Form 6), complete the top section.
2. Upon arrival document the station number, the date and time in Central Standard Time (CST) using the 24-hour military code on the field data sheet for this reading.
3. Gently lower the probe into the water until it rests on the subsurface. Record the water depth (ft) on the field data sheet if the instrument has this parameter.

NOTE: If the instrument does not have a water depth sensor, use the following procedure. Before using the instrument in the field, use a calibrated measuring device and place a piece of waterproof tape at 1 foot increments along the cable. Make sure to begin from the tip of the probe and continue the length of the cable. Gently drop the probe into the water until it touches the bottom. Measure the water's depth with the aid of the calibrated tape marks along the cable and record the depth on the data sheet to within approximately 0.3 meters (0.5 feet) accuracy. Pull the probe completely out of the water and rinse it free of organic matter before continuing with data collection.

4. Gently drop the probe until it is suspended in the bottom 20% of the water column. Do not allow the probe to rest on the bottom. Record the bottom readings for temperature (°C), specific conductance (μS/cm), and salinity (ppt). Pull the probe completely out of the water. NOTE: If the water depth is ≤ 1.5 ft., the both readings are the same.
5. Gently drop the probe until it is suspended within the top 20% of the water column. Record the bottom readings for temperature (°C), specific conductance (μS/cm), and salinity (ppt).

Additional Quality Control Readings

1. The discrete reading instrument shall remain powered if data are being collected all day with the instrument.
2. With the conductivity meter, a minimum of three additional readings (multiple readings) shall be collected from the surface and recorded on the field data sheet and noted in the field report. This should only occur when the field team has collected data all day and the instrument was only calibrated at the beginning of the trip.
3. A separate digital thermometer shall be used to collect an additional temperature reading alongside the multiple surface readings and noted in the field report. This thermometer shall be calibrated and shall be able to read ±0.1°C degrees.

5.2.3. Quality Assurance

Every hand-held salinity meter used to collect data shall be tested and calibrated monthly using the following protocol and the completion of the "Monthly Hand-held Salinity Meter Calibration Data Sheet" (Form 7).

1. Obtain a thermometer that has been manufactured to the standards set by the American Society for Testing and Materials. This thermometer should have the following minimum capabilities: range of 0°C to 100°C and divisions of 0.1°C.
2. Pour a generous amount of a known calibration solution into a container that has been cleaned with deionized water and rinsed with the calibration solution. NOTE: Do not pour this solution back into the bottle.
3. Place the thermometer into the solution and set it aside for a few minutes. This allows the solution to obtain room temperature and allows the thermometer to become acclimated to the solution.
4. Take this time to examine the salinity meter. Check for cuts on the wire, sufficient battery life, the instrument is clean, the key pad is working properly, and the LED screen is readable.
5. On the data sheet, record the temperature from the thermometer. Place the probe into the solution and record the temperature, specific conductance, and salinity once it has stabilized.

6. If the specific conductance reading is off, calibrate the instrument to ensure it is working correctly and maintaining the calibration.
7. Complete the data sheet with the required information.
8. If the temperature between the thermometer and the salinity meter is greater than 1 degree, then the instrument should be sent in for inspection unless the instrument has the capability of adjusting the temperature.

5.2.4. <u>Data Processing</u>

The LDNR/CRD has implemented a two phase protocol for data processing. These two phases are referred to as data entry (Phase I) and data quality assurance / quality control (Phase II). These two phases are conducted by separate individuals to assure that the final product is in 100% agreement with the data collected during the field sampling procedure.

Data Entry (Phase I)

Phase I is conducted by the individual responsible for the field data collection. Upon returning from the field, photocopies are produced of the original data sheet(s). The original data sheets shall be filed systematically until both phases are complete and the LDNR/CRD has accepted the final product. As part of the final deliverable product, the LDNR/CRD requires the original data sheet(s) as well as the photocopies.

Using the template Excel spreadsheet (discrete_qc.xls) that has been developed and provided by the LDNR/CRD, the data collector shall save the template using the following naming convention: Discrete_*date*.xls; e.g., Discrete_August2005.xls. This ensures that the template does not get changed accidentally and provides a working copy of the file.

Working from the photocopy, the data are transferred from the field data sheet(s) to the Excel spreadsheet. The person responsible for the field data collection shall transfer 100% of the data into the corresponding cells of the spreadsheet. Once the data and information have been transferred, they must check to verify that the data entry has been completed and all numbers and notes are 100% correct.

Once the Excel files have been completed, a field trip report must be generated. The field trip report must include: 1) field personnel and their respective agency, company, or organization on the trip, 2) purpose of the trip 3) general weather conditions, 4) sites that were sampled, 5) type of sampling that took place, 6) an explanation of any logistical problems encountered in the field, especially problems that may affect the data, 7) any notable biological activity or physical activity that may have altered the site, and 8) details of when and where the calibration instrument was calibrated and the solution used.

When the data have been completely entered and the field trip report has been generated, the appropriate quality assurance / quality control (QA/QC) checklist (Form 8) is attached to the copied data sheet(s) and the field trip report. This compilation is referred to as the QA/QC packet. The QA/QC packet is sent to another individual for further examination and verification. This individual is referred to as the QA/QC officer.

Quality Assurance / Quality Control (Phase II)

The QA/QC officer immediately dates the packet upon receipt. Then the QA/QC officer will read the report and provide grammatical corrections, suggest clarifications, and make comments as well as verifying that all the necessary information is contained in the report. The QA/QC officer then compares the data sheet(s) with the corresponding Excel data file. The QA/QC officer is examining the Excel file for any erroneous data that may have occurred during the transcription phase or that was written incorrectly in the field. If mistakes or questions arise, then documentation must occur on the QA/QC checklist. At times it may be beneficial to place removable notes (e.g. Post-it® notes) on the photocopy data sheet. Once the packet has been reviewed, the QA/QC officer shall initial and date all portions of the QA/QC checklist that are in accordance with the questions provided on the QA/QC checklist. Those areas that possess errors or have presented questions for clarification shall be addressed by the person responsible for Phase I.

Once the data collector has corrected or answered the problems found by the QA/QC officer, the QA/QC packet is again delivered to the QA/QC officer. The QA/QC officer examines the questions and verifies that all the data and information are 100% correct. This process will continue until the Excel data file and the field trip report has been accepted by the QA/QC officer. Upon acceptance of the packet, the QA/QC officer will initial and date the rest of the QA/QC checklist.

After the QA/QC packet has been finalized, the data collector must obtain the original data sheets. If problems were found with the data sheet(s) during the QA/QC process, then the original data sheets must be corrected. This process shall be carried out by using a black ball point ink pen. The person shall not erase any data or information on the original data sheet. The proper procedure will be to draw a single line through the error and place the correction as close to the error as possible. The person will also place their initials and the date next to the correction.

Strategic Online Natural Resources Information System (SONRIS) Data Entry

The SONRIS database is a storage and retrieval mechanism with respect to the discrete hydrographic data. The LDNR/CRD Restoration Technology Section (RTS) is responsible for the development and maintenance of the database as it pertains to field data and reports. Once the discrete hydrographic data has been accepted by the QA/QC officer as 100% correct, the person responsible for phase I shall transfer the data from the Excel data file to the SONRIS database.

The LDNR/CRD/RTS has developed a user's manual for uploading the discrete hydrographic data. The manual is updated periodically as the database changes with expansion and technology. The latest version on the manual was released in December 2003 with respect to the discrete hydrographic data. To properly import the data into the SONRIS database, the "User's Manual for Hydrographic and Emergent Vegetation Data Management" dated December 29, 2003 shall be followed. The most recent version of the document shall be used to input the data into the database.

The person responsible for the collection of data is also responsible for uploading the data into the SONRIS database. Once the person has followed the procedures outlined in the user's manual, the QA/QC officer is responsible for verifying the procedures have been followed properly and the data is properly stored in the database. Once the data has been accepted into the database, the QA/QC officer shall complete the QA/QC Checklist as it pertains to SONRIS. Upon completion of this section, the QA/QC packet is completed and the data shall be delivered to the LDNR/CRD.

Any statistical analysis, summary graphics, or data that are requested must use data downloaded from the SONRIS database.

5.2.5. <u>Summary Data and Graphic</u>

On a yearly basis, each station that has discrete data associated with it must be downloaded for analysis and graphic summary. The data are to be analyzed for the mean salinity values collected at the station for the year. Since several stations may be associated with a particular project, the LDNR/CRD will provide a list of stations that are associated with a project. Once the mean salinity values are obtained, summary graphs shall be produced using a standard format provided by the LDNR/CRD.

5.2.6. <u>Deliverables</u>

Upon completion of the QA/QC process, the original data sheets, the field trip report, the QA/QC packet, the field notebooks, the quality assurance sheets, and all the associated electronic files (see Appendix for data deliverable format) shall be delivered to the LDNR/CRD.

6. Floating Marsh Mat

Due to the varying degrees of thickness among each floating marsh mat site, two measuring systems have been developed and utilized by the LDNR/CRD to measure the vertical movement. The floating system is utilized in areas that have thicker mats in relation to the areas where the static system will be employed. The floating system relies on the mat's ability to carry the weight of the system without influencing its ability to move vertically. In areas where the mat is thin and will not support the floating system, the static system will be utilized. This system relies on the mat's ability to move vertically while a post is embedded through the mat and into the underlying substrate.

The floating system requires a continuous recorder to suspend below the marsh mat in the fluid ooze layer using a YSI 600XLM or equivalent that collects water temperature, specific conductance, salinity, and water level. Knowing the distance that the water level sensor rests below the marsh surface, calculations can be performed to determine the water level in relation to the marsh surface. By having a continuous recorder deployed in an adjacent channel that has an elevation reference, the marsh mat surface and water level can be converted to a vertical datum.

The static system, or counterweight and pulley system, utilizes a cable that is attached to the marsh surface via a spiral auger. As the marsh surface moves vertically, the cable rotates around the pulley system which is attached to the digital shaft encoder. This rotation is converted to a digital signal which is recorded by the data logger (OTT-Thalimedes or equivalent) and can be downloaded during a later field trip. This recorder only measures the movement of the marsh mat.

Both of these techniques have been proven to work in different environments; consequently, the LDNR/CRD will decide which system will be utilized at each site. The LDNR/CRD will provide the continuous recorders (YSI 600XLM, OTT-Thalimedes, or equivalent) for each system while the contractor will supply the other materials.

6.1. <u>Floating System</u>

The LDNR/CRD has developed a method to measure the movement of the marsh surface in a floating marsh environment. This method utilizes a piece of plywood and a series of PVC pipes that are secured to the surface of the marsh by four spiral anchors. Within these PVC pipes, a YSI 600XLM is deployed to record the water temperature, specific conductance, salinity, and water level on a hourly basis, unless otherwise specified by the LDNR/CRD. The following procedures are used to construct the housing for the continuous recorder.

Materials List

1. Schedule 40, 6" PVC pipe
2. Schedule 40, 6" PVC cap
3. Schedule 40, 2" PVC pipe
4. Schedule 40, 2" PVC cap
5. Schedule 40, 1" PVC pipe
6. Treated 5/8" plywood
7. Brass hitch pins, 9" long

8. Brass locks (provided by the LDNR/CRD)
9. Spiral anchors, four
10. L-brackets, 2”
11. Stainless steel or equivalent bolts, ¼”x20x1/2”
12. Stainless steel or equivalent nuts, ¼”x20
13. Marine caulk and adhesive

Tools

1. Drill
2. Drill bits: 7/32”, ¼”, 9/32”, 3/8”, ½”, 5/8”, ¾”, 1”, 2-3/4”
3. Tap, ¼”x20
4. Hacksaw
5. Tape measure

Construction

Mounting Base (Figure 12A)

1. Cut the plywood to measure 2’x2’.
2. Draw lines from corner to corner on the 2’x2’ piece to locate the center and locate the holes for the anchors.
3. Drill a 2-3/4” hole in the center of the board.
4. Drill 1” holes approximately 4” from each corner of the board along the corner lines.

Outside Cover (Figure 12B)

1. Cut the 6” PVC pipe to a length of 30”. Make sure the cut is square.
2. If the PVC pipe is not perforated, then drill a minimum of 20 ¾” holes in the pipe. NOTE: No holes shall be drilled 3” from either side.
3. Place the 6” PVC cap on one end and drill a ¾” hole through the assembly. This will enable a hitch pin to pass through the pipe and cap to lock the instrument.
4. Attach four 2” L-brackets on the opposite end of the 6” PVC pipe from the cap at 90 degrees from one another with the stainless steel or equivalent ¼”x20x1/2” bolts and nuts. NOTE: The holes on the brackets may need to be drilled with a 9/32” bit.

Insert Tube (Figure 12C)

1. Take a 10’ length of 2” PVC pipe and measure 24” from one end.
2. With the bottom of a 2” L-bracket on the mark and the top pointed towards the short end of the PVC, mark the mounting holes at 120 degree angles from one another.
3. Drill the 7/32” mounting holes with a drill press to ensure straightness.
4. Thread the 7/32” mounting holes with a ¼”x20 tap.
5. Drill out the holes on one leg of the L-bracket with a 9/32” drill bit.
6. Fill the tapped holes on the 2” PVC and coat the underside of the L-bracket with marine calking and adhesive.

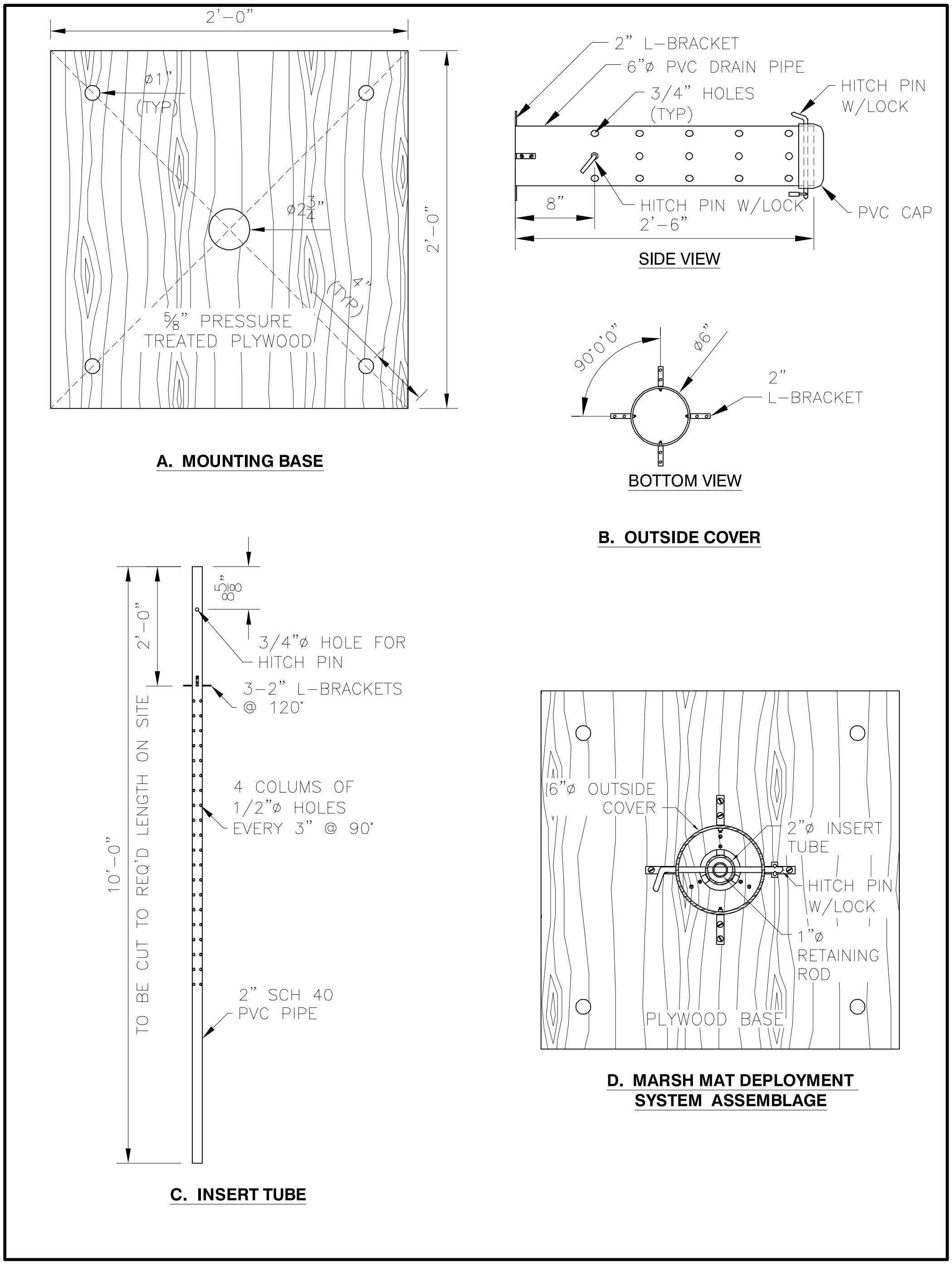

Figure 12: Construction diagram for each individual component of the floating marsh

7. Attach L-brackets (using the drilled out holes) with the stainless steel or equivalent bolts (1/4"x20x1/2").
8. Drill ½" holes in 4 rows 2-3" apart around the entire length of the pipe below the L-bracket.

Mounting the Base, Insert Tube, and Outside Cover (Figure 12D)

1. Align the insert tube so that it is centered in the 2-3/4" hole in the mounting base and attach it to the mounting base using the L-brackets and the 1" stainless steel or equivalent bolts and nuts.
2. Align the outside cover over the insert tube so that it is centered around the insert tube on the mounting base. Attach the cover to the mounting base using the L-brackets and the 1" stainless steel or equivalent bolts and nuts.
3. Drill a ¾" hole through the outside cover and insert tube approximately 8" above the mounting base. <u>NOTE:</u> This facilitates the hitch pin.

Retaining Rod

1. Insert a 10' length of 1" PVC pipe into the insert tube so that approximately 3-4" is above the top of the insert tube.
2. Mark the 1" pipe in the center of the ¾" hole just drilled (step 3 above). Drill a 3/4" hole through the pipe at the mark.
3. Put the pipe back into the insert tube and make certain that the locking hitch pin can be inserted through the outside cover, insert tube, and retaining rod.

Field Station Establishment

Tools (Minimum)

1. Soil corer or auger, 3"
2. Spiral anchors
3. Surveyor rod and/or measuring tape capable of measuring in feet, tenths, and hundredths
4. Hacksaw or PVC cutter
5. 2" PVC cap
6. PVC glue
7. Brass hitch pins, 2 – 9" long
8. Brass locks, 2 (provided by the LDNR/CRD)
9. 2"x10" or 12"x10' treated board

Installation

1. The station location for the instrument will be determined by the LDNR/CRD. A site map and site characterization sheet will be provided for the proper installation location.
2. Using the information provided by the LDNR/CRD, locate the station placement around the boardwalk.

3. Place the board on the marsh surface to displace the weight of the person installing the equipment. If two people are establishing the station, the use of two boards will be needed.mat recorder system.
4. Using the soil corer or auger, cut a hole in the marsh mat. The hole shall continue through the mat.
5. Measure the thickness of the marsh mat and record the measurement in a field notebook with the site name, number, and date.
6. Measure the distance from the bottom of the YSI 600XLM or equivalent to the water sensor. Record the instrument make and model and the measurement in a field notebook.
7. Add the two measurements together.
8. With the measurement obtained in step 7, transfer the measurement to the 2" PVC pipe from the bottom of the 2'x2' board toward the end of the pipe (opposite end of the outside cover).
9. Cut the PVC pipe using the hacksaw or PVC cutter.
10. Glue the 2" PVC cap to the end that was cut.
11. Place the set-up in the hole such that the 2" pipe goes through the marsh mat and the outside cover remains above the marsh surface.
12. Secure the set-up to the marsh surface using the 4 spiral anchors through the 4 holes in the board at the corners.
13. Using the 1" pipe that was pre-drilled (step 3 of the Retaining Rod section), cut the pipe such that the YSI 600XLM remains in place.
14. If the instrument is not being deployed at this time, lock the retaining rod into place using the brass hitch pin and lock. Then lock the 6" cap using the brass hitch pin and lock.
15. If the instrument is being deployed continue with the 'Deployment' section.

Using this method places the water level sensor at the bottom of the marsh mat and the water temperature, specific conductance, and salinity probe slightly below the marsh mat.

The measurement from the marsh surface to the water level sensor is a crucial measurement. It is this measurement that will determine if the water surface is below or above the marsh surface. This information will be used to calculate the depth and duration of the flooding period. Just as important, this measurement will be used to correlate the water level data from this instrument with the water level data from the continuous recorder in the channel to obtain an elevation datum with respect to the water level and marsh surface.

6.1.1. Deployment and Servicing

Deployment

The owner's manual must be read carefully for the use of the YSI 600XLM or equivalent. While reading the manual, the following sections should be read carefully: probe installation, battery installation, cable installation, software set-up, enabling the sensors, setting the features with respect to instrument going to sleep between readings, and calibrations, how to deploy the instrument properly to take unattended readings, how to service the instrument, and troubleshooting.

The LDNR/CRD requires specific documentation and has implemented its own procedures with respect to the field deployment of the instrument. To facilitate these procedures and documentation, the LDNR/CRD has developed a field data sheet (*Floating Marsh Mat Recorder Calibration Sheet;* Form 9) that shall be used for the deployment and servicing of the continuous recorder. This data sheet (electronic and hardcopy) shall be provided in the form of a template.

Before arriving at the site to deploy the instrument, the instrument must be assembled according to the instructions in the owner's manual. Once the instrument has been assembled correctly, the sensors shall be activated to collect water temperature (°C), specific conductance (µS/cm), salinity (ppt), water level (feet), and battery volts (v). The instrument shall be set-up to record the date (mm/dd/yyyy) with a four digit year, the time in Central Standard Time (hh:mm:ss) using the 24 hour system, and the activation of the sleep mode between readings to conserve the battery power. The instrument may be tested before field deployment to verify that the instrument is working correctly.

During the deployment and servicing phases, two other instruments are needed to obtain data: a field display unit (YSI 650MDS or equivalent) that connects to the YSI 600XLM or equivalent and a hand-held discrete instrument (YSI 30 or equivalent) that displays the water temperature (°C), specific conductance (µS/cm), and salinity (ppt). The owner's manual for both instruments shall be read for clarifications with respect to their operations and functions.

The following procedures shall be used for the YSI 600XLM or equivalent.

1. From the boardwalk, remove the brass locks, hitch pins, and the PVC retaining pin.
2. Connect the YSI 650MDS or equivalent to the YSI 600XLM or equivalent.
3. Using the proper menus and functions, calibrate the instrument with a calibration solution that is very close in concentration to the field conditions. This calibration shall be performed using the methods provided in the owner's manual.
4. Calibrate the instrument's water level sensor to zero (0) while it is out of the water. <u>NOTE:</u> Record the water level sensor reading in the "Depth Out of Water" box in the 'Clean Reading' section after it has been calibrated. <u>NOTE:</u> It should be 0.000, if it was correctly calibrated and working properly.
5. Using the proper menus and functions, calibrate the hand-held discrete instrument (YSI 30 or equivalent) using the same solution concentration that was used for the YSI 600XLM or equivalent.
6. Using the *Floating Marsh Mat Recorder Calibration Sheet,* record the calibration solution used in the appropriate box. Indicate if the instrument accepted the calibration or if a second calibration was needed.
7. Fill out the top portion of the calibration sheet as it pertains to the deployment of the instrument.
    a. Project and name boxes
    b. Station box
    c. Location box
    d. Date and time (Time recorded in Central Standard Time)
    e. Calibration Instrument (Manufacturer, Model, Serial Number)
    f. Collected By (Names of personnel on the field trip)
    g. Agency (agency, company or organization name)

8. Place the YSI 600XLM instrument into the insert tube and record the water temperature, specific conductance, and salinity in the appropriate boxes under the 'Clean Reading' section on the Constant Recorder line.
9. Remove the YSI 600XLM.
10. Place the YSI 30 or equivalent probe into the insert tube and record the water temperature, specific conductance, and salinity in the appropriate boxes under the 'Clean Reading' section on the Calibration Instrument line.
11. Calculate the specific conductance difference between the two instruments using the following formula:

    Specific conductance difference = calibration instrument – constant recorder
12. Place the value with the appropriate sign (positive or negative) in the SpCond Difference box under the 'Clean Reading' section on the Constant Recorder line.
13. Calculate the percent (%) difference:

    SpCond Difference (Calculated in step 11) / Calibration Instrument * 100.

    Record the absolute value of the number in the % difference box in the 'Clean Reading' section.
14. If the % difference is 5% or greater, then the instrument needs to be recalibrated. If the % difference is less than 5%, then the instrument is ready for deployment. <u>NOTE:</u> Document the results in the appropriate boxes below the 'Clean Reading' section.
15. Place the instrument inside the insert tube and secure with the retaining pin, hitch pin and lock.
16. Be sure to attach the proper desiccant tube to the cable.
17. Using the appropriate menus, deploy the instrument using the unattended mode function. In this menu, use the following information for deployment:
    a. Interval: 01:00:00 (every hour, unless otherwise directed by the LDNR/CRD)
    b. Start date: the date of field trip
    c. Start time: the top of the next hour
    d. Duration days: 365 days
    e. File: Project*Month***Station** (Example: CR*10***0319**)
18. The rest of the information in this menu does not require any input. Read the information provided in the menu to verify that the battery volts, battery life and free memory are sufficient. <u>NOTE:</u> The instrument must record for a maximum of 60 days.
19. Select the "Start Logging" function and accept.
20. Before disconnecting the field display unit, record the following information on the data sheet:
    a. Water depth (in the clean water section)
    b. Station and location (deployment section)
    c. Date and time (deployment section)
    d. Battery volts (deployment section)
    e. Constant recorder information (Manufacture, Model, Serial Number)
    f. Deployment filename (deployment section)
    g. Duration and interval (deployment section)
21. Disconnect the field display unit and secure the cap once the cable has been coiled inside of the outside cover.
22. Exit the station without stepping on the marsh surface.

Servicing

The instrument shall be serviced between 30 and 45 days after the deployment date unless otherwise agreed upon by the LDNR/CRD. The servicing of the instrument requires the minimum equipment: a field display unit (YSI 650 MDS or equivalent), a hand-held discrete instrument (YSI 30 or equivalent), a Floating Marsh Mat Recorder Calibration Sheet (Form 9), calculator, pencils, calibration solutions, board (2"x10"x10'), and tools necessary to remove and cleanse biofouling from the sensors and the exterior of the instrument according to the manufacture's specifications.

The following procedures were developed by the LDNR/CRD to ensure the collection of data remains acceptable.

1. Using the procedures specified in the owner's manual, calibrate the YSI 30 or equivalent using a solution concentration that is close to the conditions in the field. Record the solution concentration in the comments section of the data sheet. NOTE: Discard the calibration solution after use.
2. Place the board next to the instrument, if it does not exist.
3. From the board, unlock the brass lock and remove the hitch pin and cap.
4. Connect the field display unit to the cable of the YSI 600XLM or equivalent.
5. Stop the YSI 600XLM or equivalent from logging.
6. In the date and time box on the calibration sheet, record the date and time (Central Standard Time, 24-hour) from a watch.
7. In the sonde date and time box on the calibration sheet, record the date and time from the YSI 600XLM. NOTE: If the two times vary by more than 5 minutes, then the time on the YSI 600XLM shall be adjusted using the proper procedures outlined in the owner's manual.
8. Complete the top section of the data sheet as it relates to the project name, station, basin/location, instrumentation, field personnel, and agency.
9. Download the file from the YSI 600XLM to the field display unit.
10. Record the downloaded file name and the number of samples in the file in the appropriate boxes on the top section of the calibration sheet.
11. When the file has finished downloading, document if it was successful by placing a "Y" for yes or "N" for no.
12. Collect a dirty in situ discrete reading using the appropriate menus and functions. The following information shall be recorded on the calibration sheet under the 'Dirty Reading' section on the constant recorder line: temperature (°C), specific conductance (µS/cm), salinity (ppt), and water depth (feet).
13. Record the battery volts in the top section of the calibration sheet in the "dirty battery volts" box.
14. Remove the retaining pin and instrument from the insert tube and place on the side.
15. Read the depth reading while the instrument is out of the water and in a vertical position. Place the depth reading in the "Depth Out of Water" box in the 'Dirty Reading' section.
16. Place the probe of the YSI 30 or equivalent into the insert tube.
17. Record the following readings in the 'Dirty Reading' section on the calibration instrument line: temperature (°C), specific conductance (µS/cm), and salinity (ppt).
18. Calculate the specific conductance difference:
    Specific conductance difference = calibration instrument – constant recorder.

19. Place the value with the appropriate sign (positive or negative) in the "SpCond Difference" box under the 'Dirty Reading' section on the constant recorder line.
20. Calculate the percent (%) difference:

    Specific conductance difference (Step 18) / Calibration Instrument * 100.

    Record the absolute value of the number in the % difference box in the 'Dirty Reading' section.
21. Clean the exterior and sensors of the YSI 600XLM or equivalent using the instructions provided in the owner's manual.
22. Determine if the remaining battery voltage is sufficient to run the instrument until the next servicing date. If the battery voltage is not sufficient, then change the batteries according to the instructions provided in the owner's manual. <u>NOTE:</u> Indicate a "Y" for yes or a "N" for no in the "Battery Changed" box in the 'Deployment section.'
23. Place the YSI 600XLM or equivalent into the insert tube and record the following readings in the 'Clean Reading' section on the constant recorder line: temperature (°C), specific conductance (µS/cm), and salinity (ppt).
24. Remove the YSI 600XLM or equivalent from the insert tube.
25. Place the probe of the YSI 30 or equivalent into the insert tube and record the following readings in the 'Clean Reading' section on the calibration instrument line: temperature (°C), specific conductance (µS/cm), and salinity (ppt).
26. Calculate the specific conductance difference for the clean:

    Specific conductance difference = calibration instrument – constant recorder.
27. Place the value with the appropriate sign (positive or negative) in the "SpCond Difference" box under the 'Clean Reading' section constant recorder line.
28. Calculate the percent (%) difference:

    Specific conductance difference (Step 26) / Calibration Instrument * 100.

    Record the absolute value of the number.
29. If the % difference is 5% or greater, then the YSI 600 XLM or equivalent needs to be calibrated with respect to salinity. If the % difference is less than 5%, then the instrument does not need calibration with respect to salinity. <u>NOTE:</u> Document "Y" for yes or "N" for no in the "Calibration Required" box. If yes, then place the solution concentration value in the "Standard (µS/cm)" box.
30. With the instrument out of the water and in a vertical position, calibrate the depth sensor to zero (0) using the appropriate menus and functions. Record the water level reading in the "Depth Out of Water" box in the 'Clean Reading' section once the instrument has been calibrated. <u>NOTE:</u> It should read 0.000 if the calibration was accepted and the instrument is working properly.
31. Place the instrument inside the insert tube and secure with the retaining pin.
32. Inspect the desiccant tube and change, if necessary. <u>NOTE:</u> Indicate a "Y" for yes or a "N" for no in the "Desiccant Changed" bubble.
33. Using the appropriate menus, deploy the instrument using the unattended mode function. In this menu, use the following information for deployment:
    a. Interval: 01:00:00 (every hour, unless otherwise directed by the LDNR/CRD)
    b. Start date: the date of the field trip
    c. Start time: the top of the next hour
    d. Duration days: 365 days
    e. File: Project*Month***Station** (Example: CR*10***0319**)

34. The rest of the information in this menu does not require any input. Read the information provided in the menu to verify that the battery volts, battery life and free memory are sufficient.
35. Select the "Start Logging" function and accept.
36. Before disconnecting the field display unit, record the following information on the data sheet:
    a. Water depth (in the 'Clean Water' section)
    b. Station and location ('Deployment' section)
    c. Date and time ('Deployment' section)
    d. Battery volts ('Deployment' section)
    e. Constant recorder information (Manufacture, Model, Serial Number)
    f. Deployment filename ('Deployment' section)
    g. Duration and interval ('Deployment' section)
37. Disconnect the field display unit and secure the cap once the cable has been coiled inside of the outside cover using the brass hitch pin and lock.
38. Exit the station without stepping on the marsh surface.

In the 'Notes' section, briefly describe the condition of the area with respect to any noticeable changes that may have occurred since the last trip. Document the water level in relation to the marsh surface and about how many inches above or below the marsh surface the water level is at the time of servicing. Document if there was any vandalism or problems with the boardwalk, accretion stations, vegetation stations, or anything associated with the data collection efforts at the site.

6.1.2. Data Processing

Data processing for the floating marsh mat system is very similar to the process used for the continuous water level and salinity recorders. However, the main difference is that the floating marsh system uses the data from a near-by continuous recorder that is deployed in a deep water channel and possesses an elevation mark. Unlike the continuous recorder station in the deep water, the floating marsh mat system does not possess an elevation mark; consequently, the water elevation data is used to convert the water level data to a datum and to calculate the elevation of the marsh surface by knowing the difference between the marsh surface and the water level sensor.

The LDNR/CRD has implemented a two phase protocol for data processing. These two phases are referred to as data entry (Phase I) and data quality assurance / quality control (Phase II). These two phases are conducted by separate individuals to assure that the final product is in 100% agreement with the data collected during the field sampling procedure. The procedures in this section are very similar to the water level and salinity chapter procedures; however, this procedure utilizes data from another instrument. Consequently, detailed procedures have been described to eliminate confusion.

Data Entry (Phase I)

The data entry phase includes entering all water temperature, specific conductance, salinity and water level data since the instrument collects each of these variables. To properly process the data from its field format to its final quality assurance / quality control (QA/QC) format, several files are needed:
1. Raw data file (.dat) from the field display unit.

2. Raw data file (.csv) from the YSI software (EcoWatch or equivalent) for continuous recorder data.
3. YearHour (.xls) provided by the LDNR/CRD to verify date and times.
4. Mat-qc (.xls) template provided by the LDNR/CRD to import the raw data for shifting and quality assurance.
5. Excel file that contains the data from the near-by water level and salinity continuous recorder.
6. Station history (.xls) template provided by the LDNR/CRD to record any information regarding the station, data, or instrumentation at the site.
7. Field trip report (.doc) template provided by the LDNR/CRD to document what occurred during the installation, deployment and/or servicing of the station.

Complete the procedure below using the electronic files to properly process the data obtained from the field.

1. Copy the "Deployment Date and Time" of the file that was downloaded from the field from the previous calibration sheet's 'Deployment' section.
2. Photocopy the calibration sheet used in the field. The original sheet shall be filed systematically until both phases are complete and the LDNR/CRD has accepted the final product. The photocopy becomes the working copy throughout the QA/QC process.
3. Download the raw data from the field display unit or equivalent to a personal computer (pc) that has the appropriate software (Ecowatch for YSI 600XLM or equivalent package) which formats the data into a graph and table and is capable of exporting the data to a comma delimited text file (.csv). The PC should also have the software Excel.
4. Open the downloaded file for viewing and formatting in Ecowatch or equivalent.
5. Using the appropriate functions of the software, arrange the data in the following order: date (mm/dd/yyyy), time (hh:mm:ss), temperature (°C), specific conductance (µS/cm), salinity (ppt), water depth (ft), and battery volts (v).
6. Use the statistical function of the software package to check for any obvious problems with the data. <u>NOTE</u>: Minimum and maximum values are excellent indicators of outliers in the data.
7. Export the file as a comma delimited text (.csv) using the same name as the data file.
8. Open the Excel spreadsheet "YearHour," provided by the LDNR/CRD and open the comma delimited text file of the data that was exported in step 6.
9. In the comma delimited text file, insert a column next to the date and time column and copy the appropriate time frame from the "YearHour" spreadsheet.
10. Inspect the comma delimited text file for any missing dates and times. If any dates and times are missing, then they shall be added in the appropriate places and the data cells left blank.
11. Open the template Excel file "Mat-Qc", provided by the LDNR/CRD, and save it as an Excel file with the downloaded raw data file name and the .xls extension. This Excel template contains 4 worksheets:
    a. "Marsh Mat Data": Enter the data from the calibration sheet in this worksheet. Formulas determine if the data needs to be shifted because of biofouling on the continuous recorder. This worksheet contains three areas: the top area requires the input of data from the "Continuous Recorder Calibration Sheet" that was completed in the field. All the cells with the red font require a change and the information/data are obtained from the calibration sheet. On the lower portion of the spreadsheet, the raw

data are pasted. They are shifted for biofouling and converted to NAVD 88, Feet. Statistical summary and percent completeness calculations are located on the right side of the worksheet.

b. "Sonde Data": This worksheet is used to paste the values of the continuous recorder data from the instrument that is in the open water or marsh channel near the marsh mat recorder. It is this worksheet that allows the water elevation and marsh surface elevation to be calculated.

c. "Marsh Mat Oracle": This worksheet puts the data from the "Data" worksheet into the appropriate format for the LDNR/CRD main database. Any erroneous data that are deleted from the shifted section of the data worksheet will appear as a zero value in the Oracle worksheet. These zero values must be deleted.

d. "Graphs": This worksheet contains three separate graphs that show different relationships with respect to the data that were collected. These graphs are used to find outliers in the data set as well as to view the trends of the environmental conditions with respect to salinity, water elevations, and marsh surface elevations.

12. Click on the "Marsh Mat Data" worksheet tab at the bottom of the file.
13. Change all the red font information in the upper portion of the worksheet to correspond with the data on the calibration sheet.
14. Copy the data from the comma delimited file. Using the paste special feature, only paste the values in the appropriate cells on the lower section of the worksheet.
15. Click on the "Sonde Data" worksheet.
16. Open the continuous recorder Excel data file that corresponds with the station. This instrument is located in the open water or marsh channel in close proximity to the marsh mat recorder.
17. Copy the data from the "Data" worksheet. Using the paste special feature, paste the data as values into the "Sonde Data" worksheet of the Marsh Mat data file. <u>Remember:</u> The format must remain the same and the date and times must coincide with those in the "Marsh Mat Data" worksheet.
18. Change all the red font information on the "Sonde Data" worksheet to correspond with the information on the corresponding continuous recorder spreadsheet.
19. Close all the files except the working Excel file with all the data.
20. Delete the extra lines at the end of the "Marsh Mat Data" and "Marsh Mat Oracle" worksheets. The template is designed for larger data sets.
21. Change the graphs on the "Graphs" worksheet so that the data extends the entire graph. This is accomplished using the Source Data function for the graphs.
22. Change the title of the graphs to correspond with the project name, station number, and dates of the data presented in the graphs.
23. Examine the graphs for any data that may be outliers and decide if the data needs to be kept or voided. Any data that is voided needs to be documented in the "Site History" spreadsheet provided by the LDNR/CRD.
24. In the Marsh Mat Data worksheet, change the heading of the Summary Statistics page to correspond with the project name, station number, dates and times of the data.
25. Be sure to save the Excel file after this step and through out the other steps.

Technically the data entry is complete; however, the data must be examined for quality assurance. During this process the first data line must be compared to the previous calibration sheet to verify that the data are similar to the data collected by the instrument during the clean readings. Secondly, the last data must be examined to verify that the data collected by the calibration instrument is close to one another. Thirdly, if a shift was applied to the salinity and water level readings, it must be determined if these shifts are accurate with respect to what was collected in the field. Lastly, the transition between the data in the previous month's file and the data in the current file needs to be verified. The technician will compare the last two weeks of data from the previous file (if one exists) to the data in the beginning of the current file to verify that the transition is smooth, the pattern is similar, and there are no missing data.

Once the Excel spreadsheet is complete with respect to the data, the "Site History" Excel file (provided by the LDNR/CRD) must be completed and updated with respect to all the pertinent worksheets:

1. Site Visit History: This worksheet gives a history of when the site was visited.
2. Recorder Deployment_Removal: This worksheet tracks the make, model, and serial number of each continuous recorder at each station along with the date and time each recorder was serviced as well as changed because of malfunctions.
3. Data History: This worksheet tracks each station's omission of data whether it is related to a malfunction, deletion because of shift, and/or voided data as well as provides a history of missing and deleted data.
4. Recorder Elevations: Any updates or changes that may have occurred as a result of changing instruments or other problems must be documented.

Once the Excel files have been completed, a field trip report must be generated. The field trip report must include: 1) field personnel and their respective agency, company, or organization on the trip, 2) purpose of the trip 3) general weather conditions, 4) sites that were sampled, 5) type of sampling that took place, 6) an explanation of any logistical problems encountered in the field, especially problems that may affect the data, 7) any notable biological activity or physical activity that may have altered the site, and 8) details of when and where the calibration instrument was calibrated and the solution used.

When the Excel files and field trip report have been completed, the technician must compile a quality assurance (QA) / quality control (QC) packet. This packet shall include:

1. the appropriate QA/QC checklist (Form 5) cover sheet
2. field trip report
3. photocopied "Continuous Recorder Calibration Sheet(s)" (depends on the number of stations in a packet
4. graphs printed from the Excel file "Graphs" worksheet
5. summary statistics and percent completeness calculations printed from the Excel file 'Data' worksheet

The QA/QC packet and associated Excel files are sent to another individual for further examination and verification. This individual is referred to as the QA/QC officer.

Quality Assurance / Quality Control (Phase II)

The QA/QC officer immediately dates the packet upon receipt. Then the QA/QC officer will read the field trip report and provide grammatical corrections, suggest clarifications, and comment as it pertains to the information on the data sheet. The QA/QC officer then examines the data sheet(s) for completeness and accuracy regarding the sections where calculations were performed in the field. The QA/QC officer must examine the Excel data file for any erroneous data that are questionable. If mistakes or questions arise, then documentation must occur on the QA/QC checklist. At times it may be beneficial to place removable notes (e.g. Post-it® notes) on the photocopy data sheet.

The QA/QC officer also checks several worksheets in the "Site History" file to verify that the information regarding the deployment and removal of instruments is complete as well as the worksheets with respect to the missing or voided data associated with the station.

Once the packet and files have been reviewed, the QA/QC officer shall initial and date all portions of the QA/QC checklist that is in accordance with the questions provided on the QA/QC checklist. Those areas that possess errors or have presented questions shall be addressed by the person responsible for Phase I.

Once the data collector has corrected or answered the problems found by the QA/QC officer, the QA/QC packet is again delivered to the QA/QC officer. The QA/QC officer examines the questions and verifies that all the data and information is 100% correct. This process will continue until all the corrections have been made and all the questions have been answered to the satisfaction of the QA/QC officer. Upon acceptance of the packet, the QA/QC officer will initial and date the rest of the QA/QC checklist.

After the QA/QC packet has been finalized, the data collector must obtain the original data sheets. If problems were found with the data sheet(s) during the QA/QC process, then the original data sheets must be corrected. This process shall be carried out by using a black ball point ink pen. The person shall not erase any data or information on the original data sheet. The proper procedure will be to draw a single line through the error and place the correction as close to the error as possible. The person will also place their initial and the data next to the correction.

6.1.3. Summary Data and Graphic

At this time, the Restoration Technology Section of the LDNR/CRD has not developed a storage database with respect to the marsh mat continuous recorder data. Consequently, the storage media at this time shall be "yearly" Excel files. A template shall be provided by the LDNR/CRD. This template will allow all the monthly file data to be transferred to another file that will contain all the data collected for a year. This data transfer will take place once it has been determined by the QA/QC officer that the data is 100% accurate and no changes will take place to the data.

The "yearly" file shall be assembled on a monthly basis after the second successive data acquisition has occurred and the data has been QA/QC'd; consequently, there will be a one month data lag between the "yearly" file and the QA/Qc packet. The monthly data from the Oracle worksheet will be copied to the "yearly" Oracle worksheet. This will allow all the information to be stored in one file until the database is established. This file will also have a graphs worksheet that will allow the data to be shown with several data acquisition packets. This serves as another QA/QC measure by allowing the data to be presented over a longer period of time.

Upon completion, the summary statistics and percent completeness from the Oracle worksheet along with the three graphs from the graphs worksheet shall be printed. This information will be delivered to the LDNR/CRD upon completion along with the electronic files.

6.1.4. Deliverables

Upon completion of the QA/QC process and the creation of the summary data and graphic, the original data sheet(s), the field trip report, the QA/QC packet, and all the associated electronic files shall be delivered to the LDNR/CRD. Electronic files containing the data shall be in the appropriate deliverable format (see Appendix) once the data has completed the QA/QC process.

Twice per year (January and July), the previous 6-months (July) or 12 months (June) of QA/QC'd, stored data shall be graphed from the "yearly" file. With these data, summary graphics shall be produced to show the entire period of salinity, water level, and depth and duration of marsh flooding data. With the yearly data, summary statistics and percent completeness with respect to the analysis used in the monthly packets shall be performed and printed with the graphs and provided to the LDNR/CRD.

6.2. Static System

The static system of measuring the vertical movement of floating marsh mats is utilized when the marsh mat has been classified as a thin mat and will not support the weight of the floating system. This system uses an Ott-Thalimedes or equivalent instrument which is a data logger, float-counterweight, and pulley operated shaft encoder. This instrument has a measuring range of ±19.99 meters with a maximum measuring error of ±0.002 meters. The instrument can communicate via a contact free IrDA-interface, a notebook or PC, palmtop, an OTT field display unit, or remote data transmissions via a RS232 interface.

Utilizing the Ott-Thalimedes or equivalent instrument only measures the vertical movement of the marsh surface without the collection of water temperature, specific conductance, and salinity. The float is removed and replaced with an auger that is attached to the marsh surface. As the marsh surface moves vertically, the cable rotates around the pulley system and sends a digital signal to the data logger that is recorded and stored until the instrument is serviced. The following sections describe how the instrument is deployed in the field and utilized for measuring vertical marsh movement.

6.2.1. Field Station Establishment

The station is established using an aluminum post or equivalent material that is driven through the marsh mat and into the underlying substrate until resistance is met. This provides a stable environment for the attachment of the housing compartment (Figure 13) and pulley cable extension arm. The housing and extension arm is an aluminum platform and cover or equivalent material that attaches to the top of the post and protects the instrumentation from weather and vandalism. The arm allows for the cable to attach to the marsh away from the pipe. Figure 14 is a schematic of how the post and housing are assembled during installation.

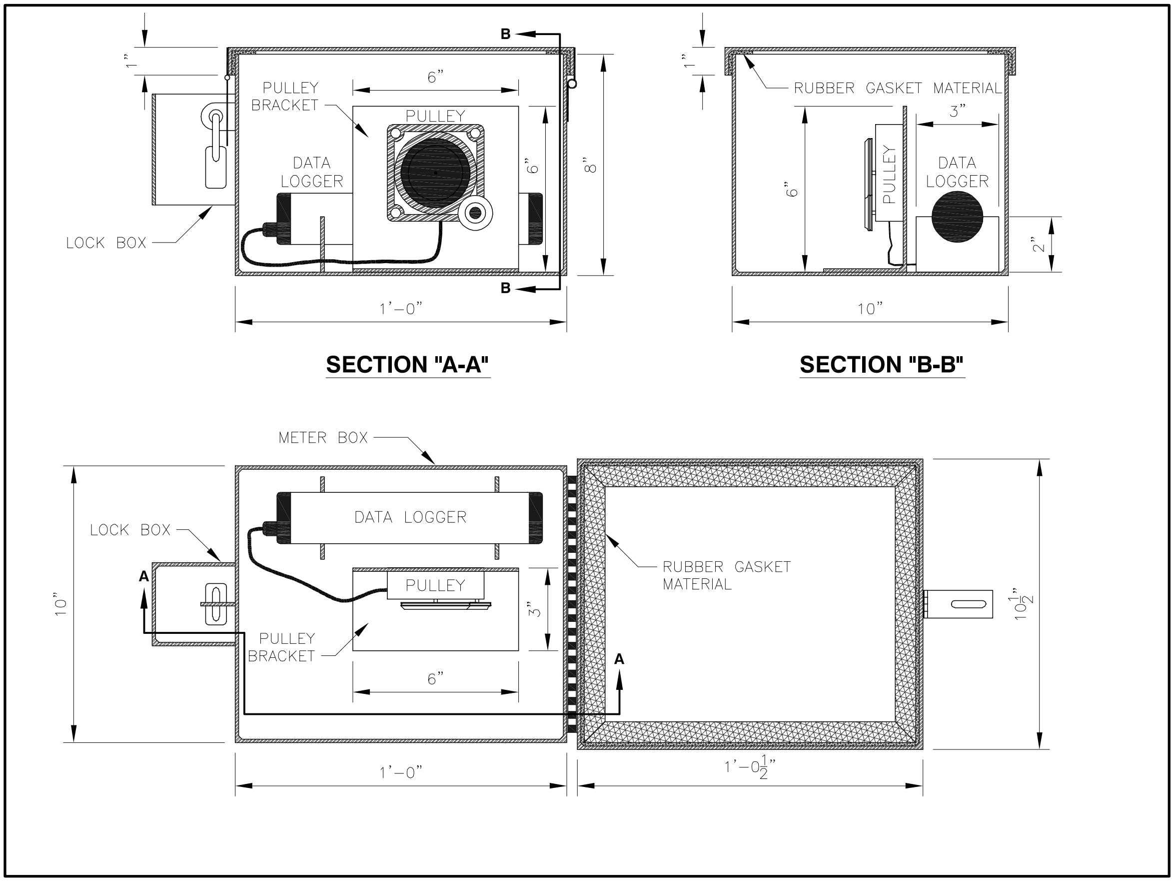

Figure 13: Construction drawing for the instrument housing unit used on the static marsh mat continuous recorder system.

The following are recommended procedures for the establishment of the station.

1. From the boardwalk, cut a hole in the marsh mat the size of the post using a soil auger or coring tube.
2. Place the post in the hole. NOTE: The post shall be with an open end; however, the post shall remain high enough above the marsh surface such that the counter weight does not rest upon anything in the tube during deployment or servicing. If the counter-weight touches anything inside the post it may adversely affect the readings.
3. Using the persons weight drive the post into the underlying substrate as deep as possible while maintaining plumb.
4. Using a widow-maker or similar device, drive the post into the substrate until resistance is met. NOTE: A protective cap or covering shall be used on the post to prevent any damages from the pounding. If any damage has occurred during the installation process, cut the damaged portion off, but it must be cut squarely so that the platform will rest perpendicular on the post.

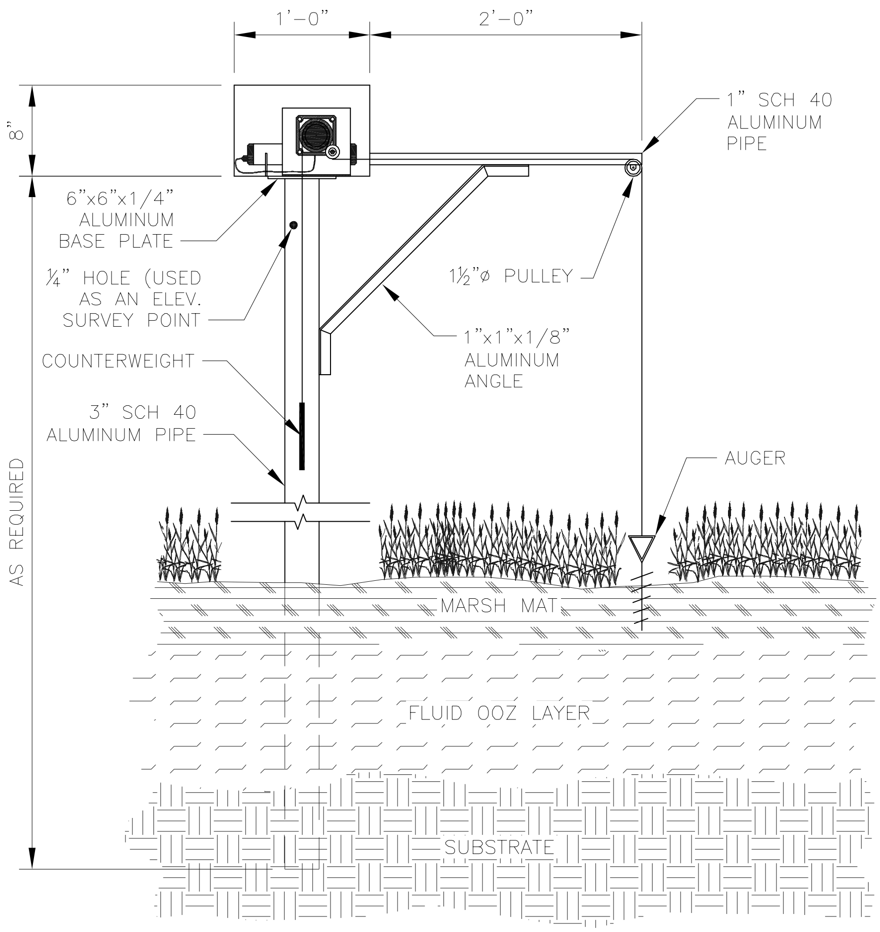

Figure 14: Schematic of a static marsh mat continuous recorder station.

5. Once the post is secured and remains a minimum of four feet above the boardwalk, drill a ¼” hole in the pipe closes to the boardwalk approximately 8-10” from the top. This hole will serve as an elevation mark for the instrument.
6. Attach 4 brackets to the top of the pipe in a manner that allows the housing to mount flush on the top of the pipe.
7. Secure the housing to the pipe using the brackets and bolts according to the schematic. NOTE: The housing shall be secured to facilitate the ease of servicing the instrument while also placing the cable and auger the maximum distance from the pipe.

6.2.2. Deployment and Servicing

Deployment

The following equipment is needed to deploy the instrument: data sheet (Static Marsh Mat Recorder Calibration Sheet; Form 10), pencil, watch, field notebook, surveyor’s measuring rod, tape measure, batteries, field servicing instrument, tools to replace the instrument if a problem occurs, and calculator.

1. From the boardwalk, unlock the housing on the platform to access the brackets and holes for the instrument.
2. Mount the bracket to the housing platform if one does not exist.
3. Mount the pulley system on the bracket in the housing.
4. Assemble the counterweight, cable, and auger according to the instructions provided in the owner’s manual.
5. Secure the spiral auger to the marsh surface, a minimum of 12 inches from the pipe.
6. Insert the battery into the instrument according to the instructions provided in the owner’s manual.
7. Using the procedures stated in the owner’s manual, set the instrument to log the following data: date, time (set up for the Central Standard Time), measured value (feet), and battery voltage. The recorder shall record a reading every hour on the hour.
8. The instrument has two modes for measuring the vertical movement. Each mode has its advantages and disadvantages, but only one shall be selected. Document the mode that has been selected on the calibration sheet.
    a. Depth measurement: As the water level (marsh surface) increases, the measured value decreases and as the water level (marsh surface) decreases, the measured value increases. NOTE: If the platform elevation (NAVD88) is not known at the time of deployment, then this is the setting that shall be used. Measured values will be recorded in reference to the movement of the marsh surface as it relates to the distance from the platform to the marsh surface.
    b. Level measurement: As the water level (marsh surface) increases the measured value increases and as the water level (marsh surface) decreases, the measured value decreases. NOTE: If the platform has a known elevation at the time of deployment, then this mode shall be used. The instrument shall be set to record the actual marsh elevation. Therefore, no correction factor would have to be applied to the data. The data would be recorded with respect to the NAVD 88 elevation datum.

9. Using the surveyor's measuring rod, measure the distance from the top of the platform to the marsh surface and from the top of the platform to the measuring sensor. Record these values on the data sheet in the 'Clean Reading' section.
10. Add the two values in step 9 to provide a distance from the measuring sensor to the marsh surface.
11. Depending on the mode setting used for measuring (step 8), set the instrument to record the marsh surface elevation or the distance from the measuring sensor to the marsh surface.
12. Fill out all the information on the top portion of the data sheet.
13. Fill out all the information in the 'Clean Readings' section.
14. Calculate the marsh elevation if the elevation of the top of the ¼" hole has been surveyed by a professional surveyor.
15. Record the staff gauge reading in the 'Elevation' section.
16. Fill out the 'Deployment' section once the instrument has been completely set-up for the data collection.

Servicing

The minimum amount of equipment that is needed to service the instrument is as follows: data sheet, pencil, watch, field notebook, surveyor's measuring rod, tape measure, field servicing instrument, tools to replace the instrument if a problem occurs, calculator, and boards.

The following procedures are recommended to ensure the accuracy of the data.

1. Visually inspect the site from a distance and document any problems on the data sheet in the 'Comments/Notes' section, i.e. any slack in the cable or the auger is out of the marsh surface.
2. Place a board (2"x10"x10') on the tooth, if a board was not left at the site.
3. Unlock the housing from the platform to expose the instrument and pulley system.
4. Visually inspect the instrument and pulley system to verify that all the working parts are in the proper place and tension remained on the pulley. Record any problems.
5. Record the project name, station number, location, date and Central Standard Time, field personnel, agency, continuous recorder manufacturer and model, and serial number on the top section of the data sheet.
6. Using the procedures stated in the owner's manual, activate the instrument to display the readings. Record the date, time, measured value, and battery volts in the 'Dirty Readings' section for the continuous recorder.
7. Determine the distance between the marsh surface and the measuring sensor. Record the value in the appropriate box on the data sheet.
8. If water is present on the marsh surface, record the depth of water in the appropriate box on the data sheet. If no water is present on the surface, write *No Water* in the appropriate box.
9. Calculate the difference between the continuous recorder's measured level and the value from the surveyor's measuring rod. The formula is:
   continuous recorder (measured level) - manual reading (top of platform to marsh surface)
   Place the value in the "Distance Difference" box of the 'Dirty Reading' section.
10. Calculate the % Difference by using the formula:
    "Distance Difference" (step 9) / manual reading (top of platform to marsh surface) * 100
    Place the value in the "% Difference" box.

11. Download the instrument using the procedures set forth in the owner's manual. Record if the download was completed and successful.
12. Decide whether the battery volts are sufficient to properly power the instrument until the next servicing period. If the battery volts are not sufficient, replace the battery using the procedure set forth in the owner's manual.
13. Perform a precision check by rotating the pulley a known distance and seeing if the value changes by the known distance.
    a. Record the known distance of the pulley rotation in the box in the 'Pulley Precision Check' section.
    b. Record the measured level value before the pulley is rotated in the "Before" box.
    c. Rotate the pulley the known distance.
    d. Record the measured level value after the pulley is rotated in the "After" box.
    e. Calculate the difference between the two readings using the formula:

       "After" – "Before"

       Record the value in the "Difference" box.
    f. Calculate the % difference using the formula:

       Difference (value in step 13e) / "After * 100

       Record the absolute value in the appropriate box.
    g. If the values are within the acceptable range (according to the owner's manual), check the "Yes" box. If the values are not within the acceptable range (according to the owner's manual), check the "No" box. NOTE: If the values is out of the acceptable range, then the instrument needs to be replaced since it has to be sent in for repairs.
14. Clean readings.
    a. Measure the distance from the sensor to the surface of the marsh surface. Record this value.
    b. Record the measured level value from the instrument.
    c. Calculate the difference by using the formula:

       continuous recorder (measured level) - manual reading (top of platform to marsh surface)

       Place the value in the "Distance Difference" box of the 'Clean Reading' section.
    d. Calculate the % Difference by using the formula:

       "Distance Difference" (step 14c) / manual reading (top of platform to marsh surface) * 100.

       Place the value in the "% Difference" box.
    e. If the values are off, adjust the reading such that they are the same.
    f. Record the measured value on the instrument after the adjustment has been made on the data sheet.
    g. Record if the battery was changed.
15. Deploy the instrument according to the instructions provided in the owner's manual.
16. Record the date, time, continuous recorder manufacturer and model, and serial number.
17. Secure the instrument with the housing and lock.
18. Read the nearest staff gauge and record.
19. Calculate the marsh surface by using the formula:

    Top of the ¼" hole (NAVD 88, FT) + Distance from the top of the ¼" hole to the sensor - the "Clean Reading" (from the instrument)

    Record the value in the 'Marsh Surface' (NAVD 88, FT) box.
20. In the 'Comments/Notes' section, document the site number and/or station number, date, time, field personnel, and weather conditions. Describe the site with respect to the water level as it relates to the marsh surface. The condition of the emergent vegetation, and any

changes that has occurred since the last visit, any damages to the boardwalk or other stations with respect to the site.

21. Exit the site.

6.2.3. <u>Data Processing</u>

The LDNR/CRD has implemented a two phase protocol for data processing. These two phases are referred to as data entry (Phase I) and data quality assurance / quality control (Phase II). These two phases are conducted by separate individuals to assure that the final product is in 100% agreement with the data collected during the field sampling procedure.

Data Entry (Phase I)

1. Photocopy the calibration sheet used in the field. The original sheet shall be filed systematically until both phases are complete and the LDNR/CRD has accepted the final product. The photocopy becomes the working copy throughout the QC process.
2. Download the raw data from the field display unit or equivalent to a personal computer (pc) that has the appropriate software (Excel).
3. Open the downloaded file for viewing and formatting in Excel.
4. Using the appropriate functions of Excel, arrange the data in the following order and format: date (mm/dd/yyyy), time (hh:mm:ss), measured level (water level/marsh surface) (ft), and battery volts (v).
5. Open the Excel spreadsheet "YearHour," provided by the LDNR/CRD.
6. In the raw data file, insert a column next to the date and time column and copy the appropriate time frame from the "YearHour" spreadsheet.
7. Inspect the raw data file for any missing dates and times. If any dates and times are missing, then they shall be added in the appropriate places and the data cells left blank.
8. Open the template Excel file "Vertical Mat-Qc", provided by the LDNR/CRD, and save it as an Excel file with the naming convention: project*month***stationnumber** and the .xls extension, i.e. CR*10***0398**. This Excel template contains 4 worksheets:
    a. "Marsh Mat Data": This worksheet contains three sections: (1) the upper section—station information and instrument information is documented and the data that was collected in the field is entered into the corresponding cells which is used to apply the shifts for biofouling, (2) the lower section--is where the data is pasted from the comma delimited file once it has been inspected for missing dates and times; it is where the data is shifted and adjusted for biofouling, and (3) the right section—contains formulas that give a summary statistics of the data that was collected and gives a percent completeness for all the variables collected.
    b. "Sonde Data": This worksheet is used to paste the values of the continuous recorder data from the instrument that is in the open water or marsh channel near the marsh mat recorder. This worksheet provides the water elevation which will be used to calibrate flood depth and duration.
    c. "Marsh Mat Oracle": This worksheet is used to copy the data to a yearly file that is produced to view the data during a specific time period. It will be used later to input the data into the LDNR/CRD main database system.

d. "Graphs": This worksheet contains two separate graphs that show different relationships with respect to the data that was collected. These graphs are used to find outliers in the data set as well as to view the trends of the environmental conditions with respect to water elevations, and marsh surface elevations.

9. Click on the "Marsh Mat Data" worksheet tab at the bottom of the file.
10. Change all the red font information in the upper portion of the worksheet to correspond with the data on the calibration sheet.
11. Copy the data from the comma delimited file. Using the paste special feature, only paste the values in the appropriate cells on the lower section of the worksheet.
12. Click on the "Sonde Data" worksheet.
13. Open the continuous recorder Excel data file that corresponds with the station. This instrument is located in the open water or marsh channel in close proximity to the marsh mat recorder.
14. Copy the data from the "Data" worksheet. Using the paste special feature, paste the data as values into the "Sonde Data" worksheet of the Marsh Mat data file. Remember: The format must remain the same.
15. Change all the red font information on the "Sonde Data" worksheet to correspond with the information on the continuous recorder spreadsheet.
16. Close the continuous recorder, raw data file, and "YearHour" files.
17. Delete the extra lines at the end of the "Marsh Mat Data" and "Marsh Mat Oracle" worksheets. The template is designed for larger data sets.
18. Change the graphs on the "Graphs" worksheet so that the data extends the entire graph. This is accomplished using the Source Data function for the graphs.
19. Change the title of the graphs to correspond with the project name, station number, and dates of the data presented in the graphs.
20. Examine the graphs for any data that may be outliers and decide if the data needs to be kept or voided. Any data that is voided needs to be documented in the "Site History" spreadsheet.
21. In the "Marsh Mat Data" worksheet, change the heading of the Summary Statistics page to correspond with the project name, station number, and dates and times of the data presented in the graphs.
22. Be sure to save the Excel file after this step and through out the other steps.

Technically the data entry is complete; however, the data must be examined for quality assurance. During this process the first data line must be compared to the previous calibration sheet to verify that the data is similar to the data collected by the instruments during the clean readings. Secondly, the last data must be examined to verify that the data collected by the calibration instrument is close to one another. Lastly, the transition between the data in the previous month's file and the data in the current file needs to be verified. The technician will compare the last two weeks of data from the previous file (if one exists) to the data in the beginning of the current file to verify that the transition is smooth, the pattern is similar, and there are no missing data.

Once the Excel spreadsheet is complete with respect to the data, the "Site History" Excel file (provided by the LDNR/CRD) must be completed and updated with respect to all the pertinent worksheets:

1. Site Visit History: This worksheet gives a history of when the site was visited.

2. Recorder Deployment_Removal: This worksheet tracks the make, model, and serial number of each continuous recorder at each station along with the date and time each recorder was serviced as well as changed because of malfunctions.
3. Data History: This worksheet tracks each station's omission of data whether it is related to a malfunction, deletion because of shift, and/or voided data as well as provides a history of missing and deleted data.
4. Recorder Elevations: Any updates or changes that may have occurred as a result of changing instruments or other problems must be documented.

Once the Excel files have been completed, a field trip report must be generated. The field trip report must include: 1) field personnel and their respective agency, company, or organization on the trip, 2) purpose of the trip 3) general weather conditions, 4) sites that were sampled, 5) type of sampling that took place, 6) an explanation of any logistical problems encountered in the field, especially problems that may affect the data, 7) any notable biological activity or physical activity that may have altered the site, and 8) details of when and where the calibration instrument was calibrated and the solution used.

When the Excel files and field trip report have been completed, the technician must compile a quality assurance (QA) / quality control (QC) packet. This packet shall include:

1. the appropriate QA/QC checklist (Form 5) cover sheet
2. field trip report
3. photocopied 'Continuous Recorder Calibration Sheet(s)' (depends on the number of stations in a packet
4. graphs printed from the Excel file 'Graphs' worksheet
5. summary statistics and percent completeness calculations printed from the Excel file 'Data' worksheet

The QA/QC packet and associated Excel files are sent to another individual for further examination and verification. This individual is referred to as the QA/QC officer.

Quality Assurance / Quality Control (Phase II)

The QA/QC officer immediately dates the packet upon receipt. Then the QA/QC officer will read the report and provide grammatical corrections, suggest clarifications, and comment as it pertains to the information on the data sheet. The QA/QC officer then examines the data sheet(s) for completeness and accuracy regarding the sections where calculations were performed in the field. The QA/QC officer must examine the Excel file for any erroneous data that is questionable. If mistakes or questions arise, then documentation must occur on the QA/QC checklist. At times it may be beneficial to place removable notes on the photocopy data sheet.

The QA/QC officer also checks the other Excel files to verify that the information regarding the deployment and removal of instruments is complete as well as the data history file with respect to the missing or voided data associated with the station.

Once the packet and files have been reviewed, the QA/QC officer shall initial and date all portions of the QA/QC checklist that are in accordance with the questions provided on the QA/QC checklist.

Those areas that possess errors or have presented questions shall be addressed by the person responsible for Phase I.

Once the data collector has corrected or answered the problems found by the QA/QC officer, the QA/QC packet is again delivered to the QA/QC officer. The QA/QC officer examines the questions and verifies that all the data and information is 100% correct. This process will continue until all the corrections have been made and all the questions have been answered to the satisfaction of the QA/QC officer. Upon acceptance of the packet, the QA/QC officer will initial and date the rest of the QA/QC checklist.

After the QA/QC packet has been finalized, the data collector or the QA/QC officer must obtain the original data sheets. If problems were found with the data sheet(s) during the QA/QC process, then the original data sheets must be corrected. This process shall be carried out by using black ball point ink pen. The person shall not erase any data or information on the original data sheet. The proper procedure will be to draw a single line through the error and place the correction as close to the error as possible. The person will also place their initial and the data next to the correction.

6.2.4. Summary Data and Graphic

Twice per year (January and July), the previous 6-months (July) or 12 months (June) of QA/QC'd stored data shall be downloaded from Oracle. Summary graphics shall be produced to show the entire period of marsh mat movement in reference to the elevation datum, the depth and duration of flooding, and the salinity concentration below the marsh mat, if applicable. With the yearly data, summary statistics and percent completeness with respect to the analysis used in the monthly packets shall be performed. This summary shall be printed with the graphs and provided to the LDNR/CRD.

6.2.5. Deliverables

Upon completion of the monthly QA/QC process, the original data sheets, field trip report, the QA/QC packet, and all the associated electronic files shall be delivered to the LDNR/CRD. Electronic files containing the data shall be in the appropriate deliverable format (see Appendix) once the data has completed the QA/QC process.

7. Soil Porewater

An important factor in determining vegetative productivity and species distribution in coastal marshes and swamps is the salinity of the soil porewater (Mitsch and Gosselink 1993). The salinity in marsh soil water depends on several factors including inundation, depth to water table, groundwater movement, and freshwater inflow/diversion. As saltwater intrusion is an important concern in Louisiana coastal marshes, field personnel will measure soil porewater salinity at specific stations at 10 cm and 30 cm depth on a monthly basis. Soil porewater constituents are relatively uniform above 20-25 cm (Feijtel et al. 1988) and these depths represent the approximate mean and maximum depth of the root zone (Mitsch and Gosselink 1993). Soil porewater salinities are easily measured in the field with use of a sipper probe to aid in extracting interstitial water from each depth and measuring salinity with a handheld salinity meter of extracted water (McKee et al. 1988).

Materials List

1. Rigid Sipper Probes:
   a. Rigid plastic or stainless steel tubing with a diameter of 3.0 mm (0.12 in) with a maximum length of 95 cm (37.4 in)
   b. Epoxy or sealant
   c. Drill and bits [0.5 mm (0.02 in.)]
2. 60 ml syringe
3. 50 ml plastic centrifuge tube (or similar tube) with an inside diameter of at least 2.54 cm (1.0 in)
4. Hand-held discrete salinity meter (YSI 30 or equivalent)
5. Tygon Tubing: 30-90 cm (1.0-3.0 ft) length of tygon tubing attached to the open end of the rigid sipper probe
6. Two-way valve (if necessary)
7. Cheesecloth

Construction of Sipper Probe and Pore Water Extractor

1. Cut the rigid plastic or stainless steel tubing to length (~50 cm).
2. Seal one end of the tubing with an epoxy or sealant to prevent the passage of any liquid material.
3. Drill six (6) 0.5-mm holes, on opposite sides, 2, 3, and 4 cm from the sealed end. Thus, three (3) of the holes will be on one side while the other three (3) will be on the opposite side. This will allow the liquid to flow through the tubing into the syringe and minimize the effects of clogging.
4. Mark 10 cm and 30 cm on the rigid plastic tube measured from the center of the middle holes. Mark using tape or score the tube so that the depth can be felt on insertion
5. Securely attach a piece of the tygon tubing to the other end of the probe.
6. Then attach a two-way valve to the syringe and to the other end of the tygon tubing. Figure 15 shows the completed pore water extractor and syringe schematic.

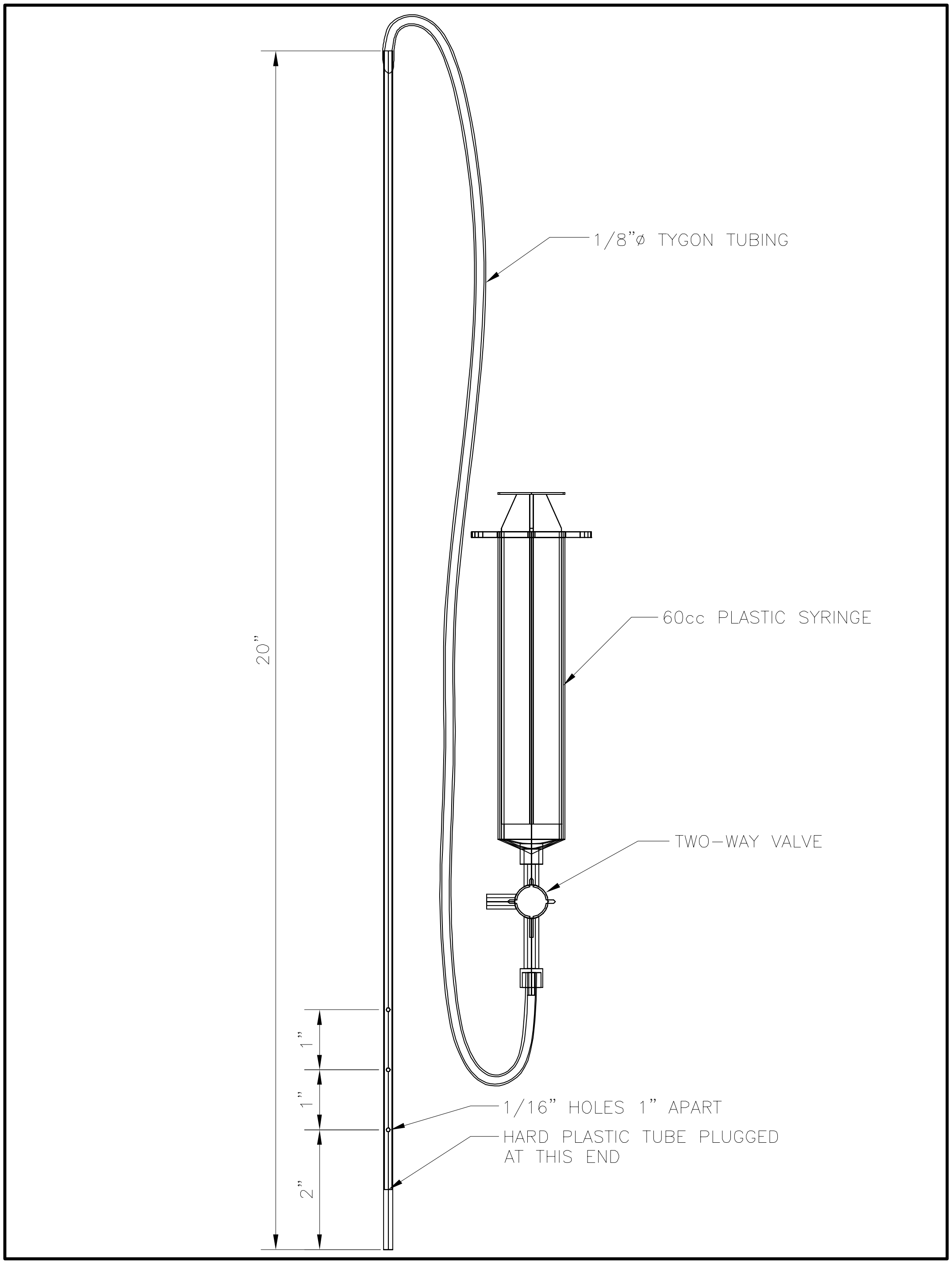

Figure 15: Construction drawing of a soil porewater sipper.

6.1. Data Collection

Soil porewater samples will be extracted from the sediment matrix from the same location each trip. Samples will be taken from the Long Boardwalk on the opposite side of the Sampling Platform. Three (3) replicate samples will be taken from each depth. However, the second and third replicate for each depth will be moved successively five centimeters (2") to the right of the previous sample. Prior to sampling the 30-cm depth, the field personnel will move another five centimeters (2") to the right of the third 10-cm sample and begin sampling at the second depth in the same manner (i.e., moving 2 inches to the right on each subsequent sample).

Note: Before readings are taken in the field with a hand-held discrete salinity meter, the meter must be calibrated for quality assurance. Since the meter is capable of measuring a wide range of salinity concentrations, the instrument shall be calibrated with a solution that is relatively close to the conditions in the field. To maintain the highest degree of quality, the protocol for instrument calibration must be adhered to whenever the instrument is turned on or when the field conditions have dramatically changed. The meter shall also be calibrated monthly (see chapter 5.2).

1. Prior to insertion for each replication, inspect the sipper holes for blockage and unclog as necessary.
2. From the boardwalk, insert the porewater sipper with the two marked graduations (10 and 30 cm) into the soil to the 10 cm (or 30 cm) graduation.
3. Before measuring porewater salinity, the tubing, syringe, and centrifuge tube must be rinsed with porewater from each sampling depth at least once. Fill about one-third to one-half the volume (~20-30 ml) of the syringe with porewater and rinse the interior of the syringe thoroughly. Discard the water. Extract another 30 ml of porewater and use it to rinse the centrifuge tube (it is recommended to use a two-way valve to dispense water from the syringe into the centrifuge tube to prevent losing suction on the sipper or the sipper hose).
4. Dispose of the rinse and pull a third aliquot of porewater—enough to fill the centrifuge tube and cover the probe when it is in the centrifuge tube (~30-45 ml). In highly organic wetland soils pore water extraction may be blocked or severely inhibited by organic or small clay particles. If this condition occurs, securely fasten a piece of cheese cloth around the intake holes of the porewater sipper(s) to filter obstructing particles and extract another sample.
5. Dispense the sample into the centrifuge tube using the two-way valve, insert the salinity probe, and record the date (MM/DD/YYYY), time (CST), depth (cm), temperature (˚C), specific conductance (µS/cm), and salinity (ppt) on the soil porewater field data sheet (Form 11) for each pore water sample. Try to keep the probe from touching the side of the centrifuge tube.
6. Carefully remove the sipper probe and move ~5 cm (~2 in) to the right and reinsert the sipper probe into the soil matrix. Repeat steps 1-5 for each of all replicates and each depth. At each station, 3 replicates will be taken at the 10 and 30-cm depths for a total of 6 samples.
7. Record surface water temperature, specific conductance, and salinity, if there is surface water on the marsh surface.

6.2. Data Processing

The LDNR/CRD has implemented a two phase protocol for data processing. These two phases are referred to as data entry (Phase I) and data quality assurance / quality control (Phase II). These two phases are conducted by separate individuals to assure that the final product is in agreement 100% with the data collected during the field sampling procedure.

Data Entry (Phase I)

Phase I is conducted by the individual responsible for the field data collection. Upon returning from the field, photocopies are produced of the original data sheet(s). The original data sheets shall be filed systematically until both phases are complete and the LDNR/CRD has accepted the final product. As part of the final deliverable product, the LDNR/CRD requires the original data sheet(s) as well as the photocopies.

Using the template Excel spreadsheet that has been developed and supplied by the LDNR/CRD, the data collector shall save the template using the following naming convention: Station_Porewater_*date*.xls, i.e. CRMS391_Porewater_August2005.xls. This ensures that the template does not get changed accidentally and provides a working copy of the file.

Working from the photocopy, the data are transferred from the field data sheet to the Excel spreadsheet. The person responsible for the field data collection shall transfer 100% of the data into the corresponding cells of the spreadsheet. Once the data and information have been transferred, they must check to verify that the data entry has been completed and all numbers and notes are 100% correct.

Once the Excel files have been completed, a field trip report must be generated. The field trip report must include: 1) field personnel and their respective agency, company, or organization on the trip, 2) purpose of the trip 3) general weather conditions, 4) sites that were sampled, 5) type of sampling that took place, 6) an explanation of any logistical problems encountered in the field, especially problems that may affect the data, 7) any notable biological activity or physical activity that may have altered the site, and 8) details of when and where the calibration instrument was calibrated and the solution used.

When the data have been completely entered and the field trip report has been generated, the appropriate quality assurance / quality control (QA/QC) checklist (Form 8) is attached to the copied data sheet(s) and the field trip report. This compilation is referred to as the QA/QC packet. The QA/QC packet is sent to another individual for further examination and verification. This individual is referred to as the QA/QC officer.

Quality Assurance / Quality Control (Phase II)

The QA/QC officer immediately dates the packet upon receipt. Then the QA/QC officer will read the report and provide grammatical corrections, suggest clarifications, and comment as well as verifying that all the necessary information is contained in the report. The QA/QC officer then compares the data sheet with the corresponding Excel data file. The QA/QC officer is examining the Excel file for any erroneous data that are questionable. If mistakes or questions arise, then documentation must occur on the QA/QC checklist. At times it may be beneficial to place removable notes (e.g., Post-it® notes) on the photocopy data sheet. Once the packet has been reviewed, the QA/QC officer shall initial and date all portions of the QA/QC checklist that is in accordance with the questions provided on the QA/QC checklist. Those areas that possess errors or have present questions for clarification shall be address by the person responsible for Phase I.

Once the data collector has corrected or answered the problems found by the QA/QC officer, the QA/QC packet is again delivered to the QA/QC officer. The QA/QC officer examines the questions and verifies that all the data and information are 100% correct. This process will continue until the Excel data file and the field trip has been accepted by the QA/QC officer. Upon acceptance of the packet, the QA/QC officer will initial and date the rest of the QA/QC checklist.

After the QA/QC packet has been finalized, the data collector or the QA/QC officer must obtain the original data sheets. If problems were found with the data sheet(s) during the QA/QC process, then the original data sheets must be corrected. This process shall be carried out by using a black ball point ink pen. The person shall not erase any data or information on the original data sheet. The proper procedure will be to draw a single line through the error and place the correction as close to the error as possible. The person will also place their initial and the data next to the correction.

6.3. Summary Data and Graphics

A soil porewater graph depicting mean monthly porewater salinity will also be required in January of each year, representing the previous 12 months of pore water data collection. The QA/QC'd data shall be analysed for mean variables at each depth and graphs shall be produced. These summary data and graphics (both hardcopy and electronic) shall be provided to the LDNR/CRD. A digital copy of the soil porewater graph template will be provided to the contractor by LDNR/CRD.

6.4. Deliverables

Once the monthly data set has been QA/QC'd completely, the data sheets (original and photocopied), field trip report, electronic files, monthly calibration checklist, and monthly graphs shall be transferred to the LDNR/CRD.

On a yearly basis, the QA/QC'd data will be downloaded and monthly means shall be performed and graphed to show the salinity means for each month of the year. The LDNR/CRD shall provide a template for the data analysis results and the graph.

8. ROD-SURFACE ELEVATION TABLE

The LDNR/CRD has implemented the use of the rod-surface elevation table (RSET) technique that has been developed by Cahoon et al. (2002a) and Cahoon et al. (2002b). The RSET is the preferred version of the SET that will be established at specified locations in attached, herbaceous marsh and swamp/bottomland hardwood forest ecosystems. The RSET method provides a non-destructive process which precisely measures the sediment elevation over a long period of time relative to a fixed subsurface datum. Briefly, a series of four foot stainless steel rods are driven through the root zone, the organic matter, and any soft underlying materials until refusal is encountered from a driving force on the rod. The rod remains approximately 2 feet above the marsh surface and is stabilized by a six inch diameter pipe that is cemented at the surface. A custom made stainless steel collar (Figure 16, part “I”) is permanently attached to the rod to provide a constant horizontal reference plane as well as long-term repeatability as the table remains fixed for each sampling period. Detailed installation procedures are written in chapter 2.3.

Data collection occurs by attaching a custom made RSET table (Figure 16) to the collar and nine (9) fiberglass pins are pushed through the table from above to the marsh surface (Figure 17). The height (measured in millimeters) that each pin extends above the table is used to calculate vertical changes of the marsh surface over time. Using previously collected data, the rate of change can be calculated to provide a status and trends with respect to changes occurring between the surface and the bottom of the stainless steel rod.

The table is custom made and constructed of aluminum and stainless steel. These materials allow the table to withstand all environmental conditions found in Louisiana’s coastal zone but also make it relatively expensive. The LDNR/CRD will supply surface elevation tables and components necessary to acquire repeatable, precise, and accurate measurements. The table is repositioned to measure the marsh surface in the four cardinal points from the benchmark rod.

Marsh surface change measured by the RSET is influenced by both subsurface processes occurring in the soil profile and surface accretion whereas the feldspar marker horizon (Chapter 9) measures only surface accretion. When these two techniques are used in conjunction, they can provide information on below ground processes that influence surface change. Differences between the rates of vertical accretion and surface change can be attributed to processes occurring below the feldspar layer and above the bottom of the RSET benchmark pipe. Consequently, it is imperative that the first RSET measurements occur on the same day as the establishment of the accretion plots. The accretion plots are established using the feldspar marker horizon method described in chapter 9. The information that is concluded from these two methods do not account for any process that occurs beneath the rod.

Materials List

The materials list for establishing a RSET station is found in chapter 2.3. The LDNR/CRD will provide the collar during the installation phase since it is permanently attached to the stainless steel rod. The LDNR/CRD will also provide the SET and the necessary components needed to collect the measurements. Figure 5 shows a schematic of the benchmark with the collar.

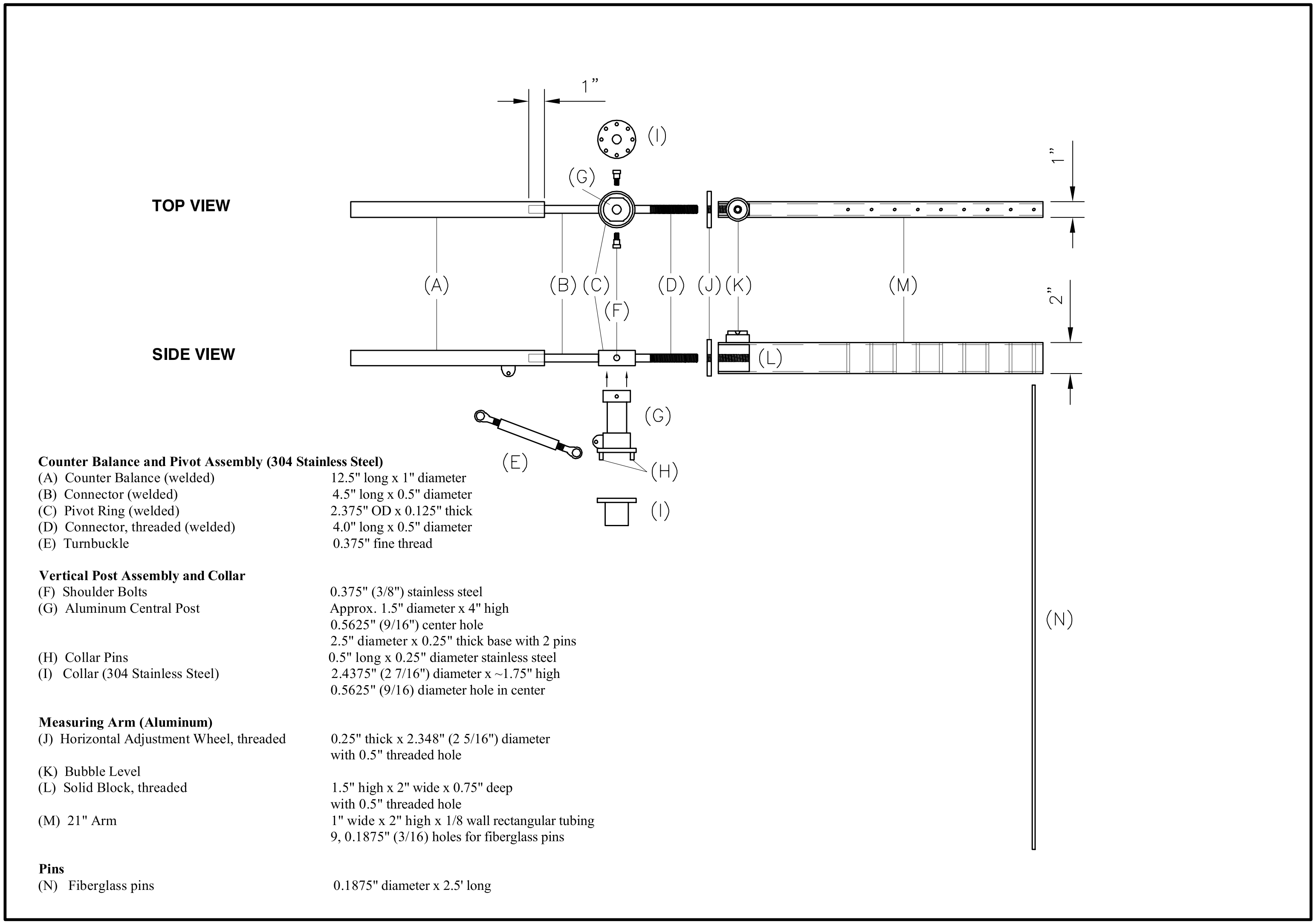

Figure 16: Construction drawing of a surface elevation table used on a 9/16” benchmark rod.

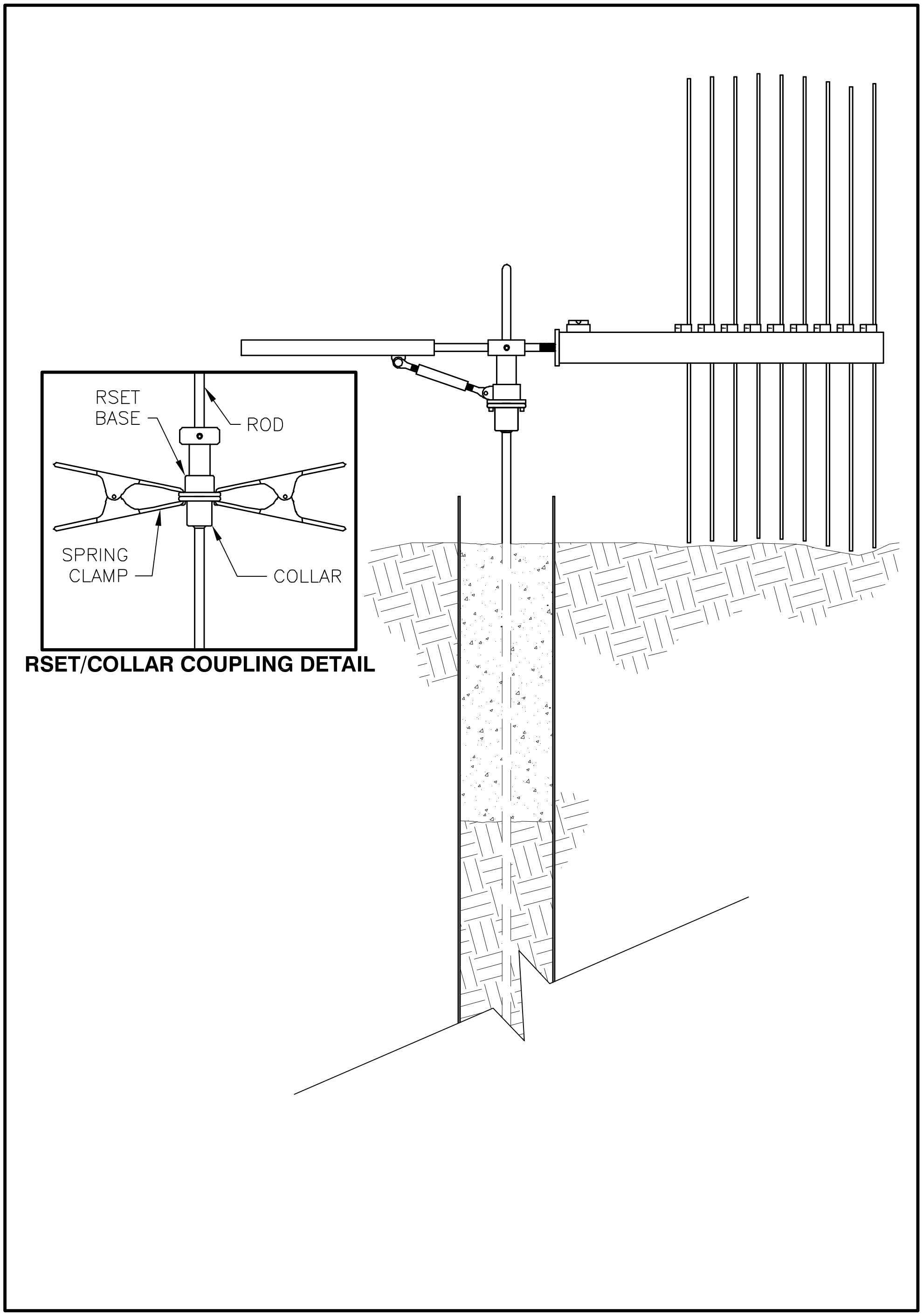

Figure 17: A typical RSET data collection schematic showing nine pins used to measure

8.1. Field Station Establishment

The detailed method for establishing a RSET station is found in Chapter 2: Site Construction, section 2.3 of this manual.

8.2. Data Collection

The LDNR/CRD shall provide all the necessary data collection components needed for the collection of data associated with this technique. To assure that the highest degree of accuracy is achieved, it is imperative that all the components of an individual unit remain together. Since the LDNR/CRD will produce multiple units, each one possesses its own unique serial number. Therefore, when a piece breaks or problems arise with the equipment, the LDNR/CRD must be informed so replacements can be obtained. This equipment is manufactured through the specifications developed by this agency; therefore, any replacement pieces need to be coordinated with the LDNR/CRD.

Each RSET unit shall contain the following components (minimum):

1. The surface elevation table.
2. Minimum of nine (9) fiberglass rods (numbered to correspond with respectively numbered holes on table).
3. Minimum of nine (9) badge clips.
4. Minimum of two (2) spring clamps.
5. Aluminum metric measuring device capable of measuring in millimeters with the end being zero millimeters.

Due to some variability between crucial pieces, it is imperative that the RSET unit used to take the initial reading at a station be used for all subsequent measurements with that station. Therefore, the unit used for the initial reading shall be documented on the "RSET Data Sheet" (Form 12) to verify that the same unit was used at all subsequent data collections.

The following protocol has been adopted from the sampling method developed by Cahoon et al. (2002a, b). The sampling protocol is also thoroughly explained on Cahoon's USGS web site http://www.pwrc.usgs.gov/resshow/cahoon/. These references give an excellent overview of how the sampling occurs, but it must be noted that the following protocol is written for the collection of data according to the LDNR/CRD standards.

Field Materials List

1. RSET unit (contains the RSET and components listed above)
2. Data sheet(s) (Form 12)
3. Field notebook
4. Pencils
5. One or two 2"x12"x10' boards

Procedures

REMEMBER: Accretion stations are to be established during the first RSET sampling period and will be sampled when the RSET measurements are taken and should be noted on the data sheet.

REMEMBER: All work is performed from the boardwalk; consequently, no walking on the marsh surface is permitted.

1. Place one or two boards between the boardwalks.
2. Slide the SET (Figure 16) onto the rod by aligning the collar pins (Figure 16, part "H") with the holes in the collar such that the table points in one of the four cardinal points. NOTE: Sampling will occur at four (4) 90° angles. The directions will be north, south, east, and west, if feasible.
3. Clamp the SET to the collar once it is in place by using two spring clamps.
4. Once the SET is secured to the collar, level the table by using the turnbuckle and level bubble. This table must be perfectly level in order to get precise measurements.
5. Using a compass, determine the direction (bearing) of the table. If the table is not a cardinal point, then record the bearing next to the corresponding direction on the "Surface Elevation Table Data Sheet."
6. Record the unique code and serial number for the SET equipment.
7. Using the aluminum measuring stick, measure the distance between the top of the stainless steel rod and the top of the SET using millimeters. Record the distance in the appropriate place on the data sheet. NOTE: This measurement shall be obtained at the four cardinal points.
8. Record the elevation of the stainless steel rod (provided by a professional surveyor in English units) on the data sheet and the converted metric (millimeters).
9. One at a time, take the nine (9) fiberglass rods (3/16") and pass them through the respectively numbered holes on the arm of the SET. Gently lower the rods onto the surface of the marsh making sure not to penetrate the surface of the marsh. In dense vegetation, leaves and non-attached debris may have to be carefully pushed aside in order for the rod to rest on the marsh surface. In this case, notes shall be written explaining what took place.
10. Once the fiberglass rod is touching the marsh surface, use a badge clip to secure the rod from moving downward.
11. Continue this process until all nine rods are touching the marsh surface and are secured from moving. All nine (9) measurements will be taken by measuring the distance from the top of the aluminum arm (Figure 16, part "M") to the top of the rod in millimeters and recorded on the data sheet to the corresponding pin being measured. The measurer should make sure his/her eyes are level with the ruler to avoid parallax
12. As measurements are being taken, the measurer must observe what the fiberglass rod is resting upon and make notes.
13. Once the measurements have been recorded, raise the fiberglass rods and clamp them with the badge clips so that the pins do not interfere with rotating the SET arm.
14. Unclamp and lift the table so that the pins have cleared the collar.

15. Rotate the table 90°, re-clamp the SET to the collar, and follow procedures 3 through 14.
16. Continue these steps until 4 sets of 90° measurements have been obtained.
17. Upon completion of the forth rotation of the SET, review the data sheet to verify that all the measurements have been obtained.

If measurements have been altered by some type of obstruction, then documentation regarding the quality of the measurement shall be documented on the data sheet. Also, if an unusual occurrence takes place that would alter a majority of the readings in a particular direction, the table shall be rotated 45 degrees to obtain the readings. Specific documentation shall occur for this particular disposition such that the subsequent readings are taken from this position.

8.3. <u>Data Processing</u>

The LDNR/CRD has implemented a two phase protocol for data processing. These two phases are referred to as data entry (Phase I) and data quality assurance / quality control (Phase II). These two phases are conducted by separate individuals to assure that the final product is in 100% agreement with the data collected during the field sampling procedure.

Data Entry (Phase I)

Phase I is conducted by the individual responsible for the field data collection. Upon returning from the field, photocopies are produced of the original data sheet(s). The original data sheets shall be filed systematically until both phases are complete and the LDNR/CRD has accepted the final product. As part of the final deliverable product, the LDNR/CRD requires the original data sheet(s) as well as the photocopies.

Currently, the LDNR/CRD's Restoration Technology Section is in the process of developing the Strategic Online Natural Resources Information System (SONRIS) database for the storage of the RSET data. Upon completion, the data will be entered directly into the database. This data will be stored in a buffer zone of the database while the data is QA/QC'd. Once the data has been entered, the data will be retrieved from the database. The data will then be imported into an Excel spreadsheet that contains formulas and graphs that will assist in the assurance that the data has been entered into the database correctly. Once the data has been checked for erroneous data and approved during the second phase of the QA/QC process, the data will be committed to the database.

Using the template Excel spreadsheet (SETqc.xls) provided by the LDNR/CRD, the data collector shall save the template using the following naming convention: Station_RSET_*date*.xls, i.e., CRMS0398_RSET_August2005.xls. This ensures that the template does not get changed accidentally and provides a working copy of the file.

The RSET Excel spreadsheet (SETqc.xls) shall be used during the QA/QC process and contains three (3) worksheets within the file. The worksheets include "Data_Oracle," "QA_QC analysis," and "Graphs." Some worksheets shall contain instructions on how the data is arranged, how the data is calculated, and how data presented to ensure the highest quality of data management.

1. “Data_Oracle”: This worksheet follows the exact format that SET data is stored and/or retrieved from the LDNR/CRD database. All data collected from the filed shall be placed in this format according to the data headings.
2. “QA_QC analysis”: This worksheet contains formulas and references the “Data_Oracle” worksheet to calculate several pertinent values which are used to verify the entry and/or field measurements are correct. If the difference among pins or measurements appears awkward, then farther investigations need to be performed to explain the differences.
3. “Graphs”: This worksheet aids in the visual inspection of the data for quality assurance and presents the results of the calculations in the “QA-QC analysis” worksheet. These graphs enable a person to visually inspect the data for any outliers or questionable data points.

Working from the photocopy, the information and data are transferred from the field data sheet(s) to the appropriate cells in the “Data_Oracle” worksheet. This worksheet was developed to facilitate the upload of data into the database and importation of data from the database. Neither the arrangement nor format of the columns shall be altered unless it is approved by the LDNR/CRD. The person responsible for the field data collection shall transfer the data into the corresponding cells of the worksheet. Once the data and information have been transferred, they must check to verify that the data entry has been completed and all numbers and notes are 100% correct. This verification includes the examination of the “QA_QC analysis” worksheet and the “Graphs” worksheet. On the graphs, the headings shall be changed to reflect the correct project name, station number, date, and appropriate scale for all four graphs. The scale on all four graphs shall be identical. This facilitates the comparison of data between the four cardinal points.

During the review of data once it has been entered into the spreadsheet, if it is determined that the number coincides with the datasheet, but seems to be wrong, then the data is left alone and documentation of concerns are explained in the comments field of both the data sheet and the Excel data file. No data is deleted from the spreadsheet, only comments are written to alert those using the information. Notes shall be copied to the “Station History” file to explain the reasoning behind any data points that are questionable.

Once the Excel files have been completed, a field trip report must be generated. The field trip report must include: 1) field personnel and their respective agency, company, or organization on the trip, 2) purpose of the trip 3) general weather conditions, 4) sites that were sampled, 5) type of sampling that took place, 6) an explanation of any logistical problems encountered in the field, especially problems that may affect the data, 7) any notable biological activity or physical activity that may have altered the site, and 8) details of when and where the calibration instrument was calibrated and the solution used.

When the data have been completely entered and the field trip report has been generated, the appropriate QA/QC checklist (Form 8) is attached to the copied data sheet and the field trip report. This compilation is referred to as the QA/QC packet. The QA/QC packet is sent to another individual for further examination and verification. This individual is referred to as the QA/QC officer.

Quality Assurance/Quality Control (Phase II)

Phase II begins when the QA/QC officer receives the packet. The QA/QC officer immediately dates the packet upon receipt. Then the QA/QC officer will read the report and provide grammatical corrections, suggest clarifications, and comment on each part of the packet as well as verify that all the necessary information is contained in the report.

The QA/QC officer then compares the data sheet with the corresponding Excel file for any erroneous or questionable data. If mistakes with data transfer have occurred or questions arise, then documentation must occur on the QA/QC checklist. At times it may be beneficial to place removable notes (e.g., Post-it® notes) on the photocopy data sheet. Once the packet has been reviewed, the QA/QC officer initials and dates all portions of the QA/QC checklist that are in accordance with the questions provided on the QA/QC checklist. Those areas that possess errors or have presented questions for clarification shall be addressed by the person responsible for Phase I.

Once the data collector has corrected or answered the problems found by the QA/QC officer, the QA/QC packet is returned to the QA/QC officer. The QA/QC officer examines the questions and verifies that all the data and information are 100% correct. This process will continue until the Excel file and the field trip report have been accepted by the QA/QC officer. Upon acceptance of the packet, the QA/QC officer will initial and date the rest of the QA/QC checklist.

After the QA/QC packet has been finalized, the data collector or the QA/QC officer must obtain the original data sheets. If problems were found with the data sheet(s) during the QA/QC process, then the original data sheets must be corrected. This process shall be carried out by using a black ball point ink pen. The person shall not erase any data or information on the original data sheet. The proper procedure will be to draw a single line through the error and place the correction as close to the error as possible. The person will also place their initials and date next to the correction.

8.4. Summary Data and Graphic

Upon completion of the QA/QC process, the data graphs and summary statistics associated with spreadsheet shall be printed.

Summary statistics and graphs shall be produced twelve months after the initial reading. This data shall be downloaded from the SONRIS database to ensure the data being analyzed has completed the QA/QC process. The data shall be analyzed according to methods provided by the LDNR/CRD. Once the data have been analyzed, summary graphs will be generated using the format provided by the LDNR/CRD. The summary data and graphics shall be transferred to the LDNR/CRD in a hardcopy and electronic format.

8.5. Deliverables

Upon completion of the QA/QC process, the original data sheets, the field trip report, the QA/QC packet, and all the associated electronic files shall be delivered to the LDNR/CRD. Electronic files containing the data shall be in the appropriate deliverable format (see Appendix) once the data has completed the QA/QC process.

Within one month after the third data collection effort for the twelve month period, the summary statistics and graphs shall be delivered to LDNR/CRD in both the hardcopy and electronic format.

9. ACCRETION

Accretion / erosion will be measured by the establishment of three half meter by half meter marker horizon stations systematically placed around a boardwalk. The marker horizon is white feldspar clay that is evenly sprinkled on the surface of the wetland. At six and twelve months after establishment, the stations will be sampled using a cryogenic method developed by Cahoon et al. (1996). After the data have been collected, a two phase approach has been implemented by the LDNR/CRD for the insurance that the field data will be 100% correct when using for analysis and report writing.

Three systematically placed half meter by half meter stations will be established at each site during a two month period (February and March). A materials list and procedures for station establishment are as follows:

Materials List (minimum):

1. Feldspar
   G-200 white feldspar clay from the Feldspar Corporation, Minspar 200 or equivalent (Minimum 80 ounces or 5 mm thickness per station; 5-6 stations per 50 lb bag).
2. 50 cm x 50 cm PVC square
3. Markers
   PVC pipes 5 feet long or other material that will mark the location of the station. Minimum of 2 per station.
4. Spreader / Sieve
   A small cup-like device that will evenly spread the feldspar within the station.
5. Respirator
   A high quality respirator that will prevent the inhalation of the feldspar clay.
6. Watering Can or Garden Sprayer
   Used to moisten the feldspar on a dry marsh; must be able to moisten feldspar without disrupting an even feldspar layer.
7. Trashcan
   Used when the marsh is flooded to prevent the feldspar from settling outside the station area.
8. Miscellaneous
   Gloves and eye protection.
9. Digital Camera
   Capable of a date and time stamp to document the establishment of the stations.
10. Differential Global Positioning System
    To take coordinates of corner station for verification and identification.

9.1. Field Station Establishment

Accretion stations are to be established on the same day that the initial RSET readings are recorded. This gives the best-known baseline for both the accretion and RSET data sets to be interpreted when analysis occurs. Stations shall be established from the second week in February through the last week of March as vegetative growth is minimal during this time. Three stations will be established along the boardwalk in a manner that will be easily sampled at a later date from the boardwalk. The

LDNR/CRD will determine the orientation of stations around the boardwalk prior to the establishment of the stations.

All station establishment procedures must be performed from the boardwalk.

These procedures are as follows:

1. When applying the feldspar, all necessary health precautions should be taken since the material is a fine powder and can be easily inhaled. NOTE: An appropriate respirator and eye protection are required.
2. Document water lever with respect to marsh surface in the "Notes" section of the data sheet (Form 13).
3. Place the 50 cm x 50 cm square on the marsh surface as close to the predetermined location (provided by LDNR/CRD) as possible.
4. Mark the stations using no less than two pieces of PVC. The PVC poles should be placed just inside the corner of the station closest to the boardwalk and closest to the beginning of the boardwalk. The other corner PVC shall be placed at the opposite corner. The PVC poles should be pushed into the marsh surface perfectly plumb until resistance is met or 2.5 feet of PVC is above the surface. NOTE: By using this method it will assure that the sampling will occur inside of the station at a later date.
5. Using a small cup, evenly sprinkle the feldspar on the marsh surface making sure not to leave any on the vegetation (vegetation can be gently shaken to knock any feldspar from the plant to the marsh surface). Each station is evenly coated until a minimum thickness of 5 millimeters (mm) is achieved or no less than 80 ounces (2.27 kg) of feldspar is used.
    a. If the marsh is dry on the day of the station establishment, the feldspar needs to be compacted with water after it is applied. This compaction is accomplished by carefully sprinkling the water through a watering can in a manner that moistens the feldspar to consolidate the material. Special attention needs to be taken such that the water does not produce any voids (exposed marsh surface) in the feldspar.
    b. If the marsh is flooded on the day of the station establishment, some type of barrier needs to be used to allow the feldspar to settle to the marsh surface without drifting out of the boundary of the station. NOTE: The LDNR/CRD recommends a trashcan with the bottom cut out be used or a similar device. The can or device is place on the marsh and slightly penetrates the surface so there is no space between the marsh and can. It may take 15 minutes or longer for all the feldspar to settle. The feldspar has a tendency to float when it is applied until it becomes completely saturated. Remove the barrier when all the feldspar has settled.
6. Using a digital camera with the date and time stamp function enabled, pictures at each site will be taken to show the establishment and orientation of the three stations. NOTE: Pictures will include one taken directly above each station with the PVC pipes in place and another picture of the entire site will be taken. Pictures will be downloaded in a JPEG format and labeled with the appropriate station number and date taken prior to delivery to the LDNR/CRD. File names will be labeled using the following convention: *Station*_Accretion_*date.jpg* (CRMS0395_Accretion_March2005.jpg).
7. Differential Global Positioning System (DGPS) coordinates shall be obtained from one corner of each of the three stations at the site. These coordinates must be obtained by holding

the antenna on the PVC pole closest to the boardwalk for no less than 10 seconds. The coordinates will be provided to the LDNR/CRD with the station number and the northing and easting coordinates of each station in UTM, NAD83 Meters using the "Station Coordinates" Excel files.

9.2. Data Collection

Sampling shall occur six and twelve months after the station has been established unless otherwise agreed upon by the LDNR/CRD. Consequently, the first sampling will occur in August and September and the second sampling will occur in February and March. Because of its white color, feldspar is distinguishable from the surrounding constituents and by knowing the date of establishment and the date of sampling, a rate of accretion/erosion can be determined for the site by measuring the amount of deposition above the horizon marker.

The rate of accretion/erosion is determined by a cryogenic technique (Cahoon et al. 1996) that utilizes a 15 – 20 liter self-pressurized liquid nitrogen Dewar tank (Figure 18) attached to a copper tube fitted with a tapered end (usually a .30 caliber / .308 diameter bullet) for easy insertion into the marsh. The tube is inserted into the marsh to a depth deeper than the feldspar and enough liquid nitrogen is injected into the tube to freeze a small sediment core. Once frozen, a sediment sample can easily be extracted from the marsh and 4 measurements positioned 90^{o} from each other are made from the feldspar layer to the surface.

Data are collected and recorded on data sheets developed and provided by the LDNR/CRD. Notes pertaining to each individual sample must be recorded with respect to the condition of the sample, the coordinates in the station that were sampled, and other problems or concerns that may arise during sampling.

All data collection activities must be performed from the boardwalk.

The following is a materials list that contains the minimum equipment necessary to collect quality data and the procedures that shall be followed for the cryogenic technique for sampling. (see also http://www.pwrc.usgs.gov/resshow/cahoon/).

Materials List (minimum)

1. Self Pressurized Liquid Nitrogen Tank and Assembly
2. Stainless Steel Flexible Hose and fittings
3. Copper Bullets
4. 50 cm x 50 cm PVC square (used during the station establishment)
5. Calipers: High quality stainless steel that measures up to 150 millimeters (mm) in increments of 0.02 mm.
6. Random Number Table
   Table of random numbers used for the sampling location within the station area. The table is arranged in an x,y format and the numbers are between 1 and 5.
7. Data Sheets (Form 13)
8. Field Notebook

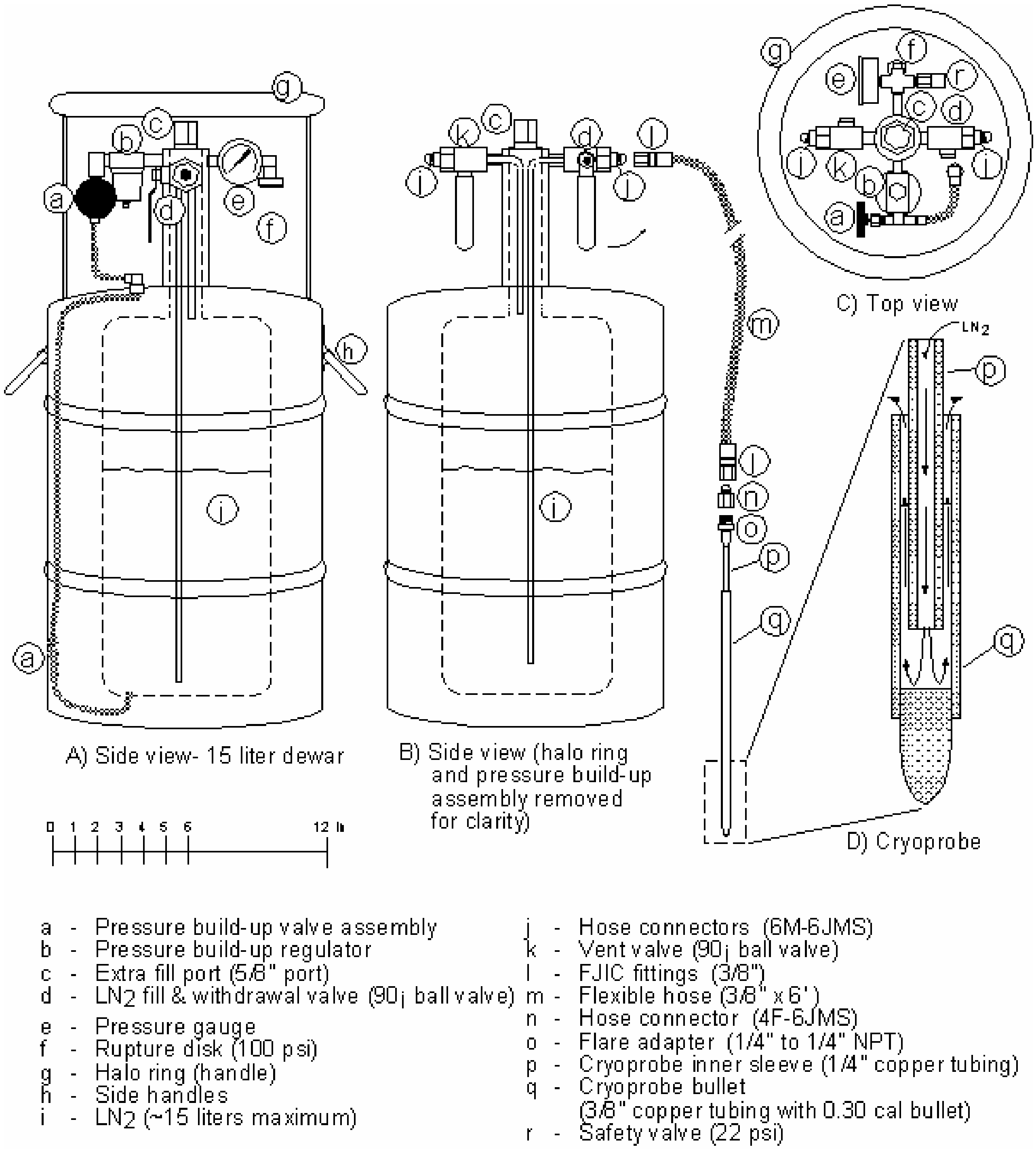

Figure 18: Schematic for the cryogenic coring device developed by Cahoon et al. 1996. A) A side view of a 15-L low pressure nitrogen tank (dewar); B) The side view rotated 90° with a halo ring removed for clarity; C) A top view; D) An enlarged view of the cryoprobe used to collect the sample.

9. Personal Protection Equipment
   Gloves and eye protection
10. Miscellaneous
    Small scraping device, wrenches, pencils, knife

Procedures

In the office, prepare a random number table with X,Y coordinates. This table will contain coordinates of 1,1 to 5,5. To produce this table the numbers 1 through 5 will be randomly generated for each X and Y coordinate. Enough coordinates will be produced to use at each station plus a few extra coordinates. NOTE: The extras will be used when there are problems with the first core. Secondly, if this is not the initial sampling period, make sure that these coordinates were not used previously. Therefore, field personnel must have the coordinates for the previous sampling periods.

The 50cm x 50 cm square used to locate the position of the sample coordinates within the plot shall be divided into 4 evenly spaced sections on all sides. When determining the position of the random coordinate, the side closest to the end of the boardwalk and the left side of the square while the person's back is to the water vessel is consider the position 1,1. Follow the procedure below to properly sample the accretion plots.

1. After arriving at the site, connect the appropriate hose and fittings to the dewar tank.
2. Use the necessary personal protective equipment to prevent any injuries from occurring. A minimum of gloves and eye glasses are required.
3. Place the 50cm x 50cm square over the PVC poles that mark the station location. NOTE: The square shall have 4 evenly spaced markings on all sides. These markings will be used to determine where the sampling will occur in the station.
4. From the randomly generated table (step 1), select the position in the grid that will be sampled. Samples will be taken from the center of the coordinate. NOTE: Make sure these coordinates have not been used previously. Always have the coordinates used from the previous data collection trip(s) on hand.
5. Put the bullet that will be used for sampling over the inner core. This practice prevents any disturbance once the bullet penetrates the marsh surface.
6. Push the bullet with the inner core into the marsh in the location that corresponds to the randomly generated location. The bullet should be deep enough to freeze the feldspar and sediment to the bullet and have enough above the marsh surface to facilitate removal for measuring. This depth varies depending on previous feldspar depth and current field conditions.
7. Do not rock or move the bullet once it penetrates the surface. The marsh must remain in contact with the bullet for this process to be effective.
8. Open the valve on the dewar and start the flow of the liquid nitrogen into the bullet.
9. Allow the marsh to freeze around the bullet. Normally the core is frozen when you start to see a white cloud of gas coming out of the top of the bullet. (It may be best to let the liquid nitrogen run a bit longer until the person has experience with this procedure.)
10. Turn off the dewar when the core is frozen.

11. Remove the inner sleeve from the bullet. Be very careful with the hose as it becomes very brittle once it is frozen.
12. Grab the top of the bullet with your gloves and pull the core out of the marsh. Roots may need to be cut with a knife. NOTE: Make sure not to disturb too much marsh around the sample as it may affect the next sample.
13. When the frozen marsh core is removed, it is affectionately termed a "Cryo-core" or "Marshsicle". Measurements and notes will be taken on the marshsicle.
14. The first thing is to inspect the marshsicle.
15. On the accretion data sheet, complete the upper portion before recording the station information.
16. On the accretion data sheet, record the station number and the associated coordinates for the area being sampled. Record the condition of the feldspar found on the marshsicle as well as the condition of the marshsicle itself. For example, is the feldspar highly visible around the entire sample (record on the data sheet as excellent), is the feldspar only visible a quarter of the way around the sample (record as good to poor depending on how much feldspar is visible), or is no feldspar visible?
17. If the "marshsicle" is in good condition and a minimum of three readings can be acquired then continue onto 18. If the "marshsicle" is in bad condition or the feldspar can not be found then another sample shall be taken. Be sure to document the core's condition on the data sheet. The process then repeats itself with the next set of random coordinates, a new marshsicle is extracted, and the marshsicle is examined. If this is the second or later sampling period, one must ensure that this coordinate has not been used during a previous sampling period.
18. When possible, take four measurements at right angles to each other. Measure the distance from the feldspar layer to the surface of the marsh using the calipers. If four measurements cannot be taken, then no less than three (3) readings shall be recorded.
19. Document the distance (in mm) from the marsh surface to the feldspar on the accretion data sheet with respect to the station number and the randomly chosen coordinates. NOTE: Do not use a zero if the feldspar layer is not visible. Zeroes mean either the feldspar is visible on the surface or once a marshsicle is removed the feldspar is visible but there is no measurable sediment on top.
20. Place the marshsicle back in the hole to thaw. If this process is done properly, a hole or other disturbance will not be left in the marsh where the sample was taken.
21. The station has been sampled when one of the following conditions is met: a marshsicle is extracted and three or four measurements can be collected or when two attempts are made and no feldspar is seen on the marshsicle.
22. Before leaving each site, field data sheets are to be examined for clarification and completion. Any information that was not completed on the boardwalk should be completed prior to leaving the area.

NOTES:

In a perfect world, the feldspar will be visible at all times in a perfect circle around the core; however, this does not always occur. At times the feldspar may still be visible on the surface. If this occurs, select the coordinates and verify that the feldspar is still on the surface and note this for the station.

In a highly organic environment, once the marshicle is removed there may be sediment and decomposing plant matter on top of the feldspar and then a void layer or water layer above the sediment and plant biomass. Only measure what is consolidated on top of the feldspar. Do not include the void area.

The length of the bullet depends on the amount of sediment that has accumulated on top of the feldspar and the depth of water on the marsh surface. Normally, two lengths of bullets are made and brought into the field (12 inches and 18 inches).

Measuring marshsicles can be subjective at times. It is highly recommended that the same person measure at all times when possible.

9.3. Data Processing

The LDNR/CRD has implemented a two phase protocol for data processing. These two phases are referred to as data entry (Phase I) and data quality assurance / quality control (Phase II). These two phases are conducted by separate individuals to assure that the final product is in agreement 100% with the data collected during the field sampling procedure.

Data Entry (Phase I)

Phase I is conducted by the individual responsible for the field data collection. Upon returning from the field, photocopies are produced of the original data sheet(s). The original data sheets shall be filed systematically until both phases are complete and the LDNR/CRD has accepted the final product. As part of the final deliverable product, the LDNR/CRD requires the original data sheet(s) as well as the photocopies.

Using the template Excel spreadsheet that has been developed and supplied by the LDNR/CRD, the data collector shall save the template using the following naming convention: Station_Accretion_*date*.xls, i.e.CRMS0391_ Accretion_August2005.xls. This ensures that the template does not get changed accidentally and provides a working copy of the file.

Working from the photocopy, the data are transferred from the field data sheet(s) to the Excel spreadsheet. The person responsible for the field data collection shall transfer 100% of the data into the corresponding cells of the spreadsheet. Once the data and information has been transferred, they must check to verify that the data entry has been completed and all numbers and notes are 100% correct.

Once the Excel files have been completed, a field trip report must be generated. The field trip report must include: 1) field personnel and their respective agency, company, or organization on the trip, 2) purpose of the trip 3) general weather conditions, 4) sites that were sampled, 5) type of sampling that took place, 6) an explanation of any logistical problems encountered in the field, especially problems that may affect the data, 7) any notable biological activity or physical activity that may have altered the site, and 8) details of when and where the calibration instrument was calibrated and the solution used.

When the data have been completely entered and the field trip report has been generated, the appropriate QA/QC checklist (Form 8) is attached to the copied data sheet and the field trip report. This compilation is referred to as the QA/QC packet. The QA/QC packet is sent to another individual for further examination and verification. This individual is referred to as the QA/QC officer.

Quality Assurance / Quality Control (Phase II)

Phase II begins when the QA/QC officer receives the packet. The QA/QC officer immediately dates the packet upon receipt. Then the QA/QC officer will read the report and provide grammatical corrections, suggest clarifications, and make comments as well as verifying that all the necessary information is contained in the report. The QA/QC officer then compares the data sheet with the corresponding Excel file. The QA/QC officer examins the Excel file for any erroneous data that is questionable. If mistakes with data transfer have occurred or questions arise, then documentation must occur on the QA/QC checklist. At times it may be beneficial to place removable notes (e.g., post-it notes) on the photocopy data sheet. Once the packet has been reviewed, the QA/QC officer shall initial and date all portions of the QA/QC checklist that are in accordance with the questions provided on the QA/QC checklist. Those areas that possess errors or have present questions for clarification shall be address by the person responsible for Phase I.

Once the data collector has corrected or answered the problems found by the QA/QC officer, the QA/QC packet is again delivered to the QA/QC officer. The QA/QC officer examines the questions and verifies that all the data and information are 100% correct. This process will continue until the Excel file and the field trip report have been accepted by the QA/QC officer. Upon acceptance of the packet, the QA/QC officer will initial and date the rest of the QA/QC checklist.

After the QA/QC packet has been finalized, the data collector or the QA/QC officer must obtain the original data sheets. If problems were found with the data sheet(s) during the QA/QC process, then the original data sheets must be corrected. This process shall be carried out by using a black ball point ink pen. The person shall not erase any data or information on the original data sheet. The proper procedure will be to draw a single line through the error and place the correction as close to the error as possible. The person will also place their initials and the data next to the correction.

9.4. Summary Data and Graphic

Upon completion of the QA/QC process, the data summary and graphs associated with spreadsheet shall be printed. The statistical summary and graphs will be provided to the LDNR/CRD in two formats: 1) electronically and 2) a hard copy. The hard copy shall have the appropriate heading and content. An example shall be provided by the LDNR/CRD.

Yearly summary graphs shall be produced after the third data acquisition trip, these graphs shall be produced from the QA/QC'd data and show the mean cumulative rate of accretion and the average rate of accretion for the data collection period. The LDNR/CRD shall provide examples of the graphs that are required for this deliverable.

9.5. <u>Deliverables</u>

Upon completion of the QA/QC process and the creation of the summary data and graphic, the original data sheets, field trip report, the QA/QC packet, the field notebooks, and all the associated electronic files shall be delivered to the LDNR/CRD. Electronic files containing the data shall be in the appropriate deliverable format (see Appendix) once the data has completed the QA/QC process.

Yearly summary graphs and summary statistics shall be provided to the LDNR/CRD one month after the collection of the third data acquisition.

10. EMERGENT VEGETATION

Vegetation sampling has two objectives related to the evaluations of individual project and cumulative project effects. The first objective is to determine the vegetation type that dominates the sampling location. The second objective is to assess the relative vigor of the vegetation. Vegetation sampling is designed to reach these two objectives in both herbaceous marshes and forested swamps, and to be able to document any changes that occur during the life of the project.

Whether the vegetation community is an herbaceous marsh or a forested swamp, stations shall be established away from spoil banks or any type of surface alterations that may have occurred from human intervention. The purpose of these stations is to monitor the plant / tree community over time in its natural state. Any vegetation stations established in an altered community shall be re-established at the request of the LDNR/CRD unless otherwise instructed.

10.1. Herbaceous marsh sampling

Vegetation sampling in herbaceous marshes will consist of ten replicate 2 m x 2 m stations located within a 200 m x 200 m square that also encompasses water level continuous recorders. Vegetation stations will be located randomly on a 282.8-m transect that cuts diagonally through the square from one corner to the opposite corner. Each 2 m x 2 m vegetation station shall be spaced a minimum of 3 m apart giving a possible 94 establishment points along the diagonal transect. Each of the establishment points along the transect marks the southeastern corner of a vegetation station. Stations have north-south and east-west oriented sides.

The orientation of the vegetation transect (i.e., either NE to SW or NW to SE) within the 200 m x 200 m site will be chosen randomly. A set of 94 random, non-duplicated numbers between 1 and 94 shall be selected, recorded to a table, and maintained with the site file. Each random number is then multiplied by 3 which represents the distance in meters that the vegetation station is located from NE or NW corner of the transect towards the opposite corner. The first 10 random numbers are primary locations for each vegetation station. If one of the primary stations is located in an area that is <55% marsh (i.e., the plot cannot be located in an area that is >45% continuous standing water), on a spoil bank, or within 10 meters of the RSET, marsh mat recorder, or any part of the boardwalk, the station will be dropped and a station from the secondary set will be used. This practice will assure that none of the data collection for other variables is compromised and that stations located in unvegetated marsh ponds or channels are excluded at the outset of monitoring. Station establishment is completed when 10 appropriate vegetation stations are positioned that neither interfere with other sampling stations nor are <55% marsh. Each station will be marked with a metal short stake (permanent marker) and a ¾" diameter PVC stake that extends 6 feet above the marsh surface (for ease of locating the station).

Species composition and cover for each station will be determined using visual estimates of cover following either the Braun-Blanquet cover scale (Mueller-Dombois and Ellenburg 1974). The 2 m x 2 m quadrat will be carefully placed on the vegetation and all vegetation within the quadrat, whether rooted within the station or hanging over the station, will be included in the sample. The scale values and the corresponding Braun-Blanquet scale currently used by the LDNR/CRD for monitoring are provided in Table 2.

The relative vigor of the vegetation will be assessed using the total vegetative cover and the average height of the dominant plant species. A total vegetative cover value for the station will be determined to the nearest 5%. The precision of cover estimates may be affected by the potential of introducing bias from one individual to the next. Therefore, the same individual(s) shall conduct the visual estimates every sampling trip, if at all possible. Cover estimates for each individual will be calibrated using a landscape density chart (Kent and Coker 1995). Since overlapping canopies may be present, total vegetative cover may exceed 100%. Plant height will also be documented for each station. Five randomly located stems from the dominant plant species (species with the highest coverage of the station) will be measured to the nearest cm. On the natural vegetation sampling data sheet (Form 14), the average measurement and dominant plant name will be documented. Even if the station contains co-dominants, only one species' height will be measured and recorded.

Table 2. Vegetative cover values associate with the Braun-Blanquet method.

Cover Range	Braun-Blanquet
Solitary	R
Few	+
<1%	1
1.1-2%	1
2.1-5%	1
5.1-10%	2
10.1-25%	2
25.1-50%	3
50.1-75%	4
75.1-95%	5
95.1-100%	5

Qualitative observations are also important in evaluating changes in species composition and abundance over time. During each sampling trip, observations will be recorded regarding the presence or absence of chlorosis (vegetation is discolored or pale green/yellow), rack or debris on the marsh, herbivory damage is evident, and any evidence exists of recent marsh burning.

Every now and then a plant is not recognized by the identifier. The plant shall be listed as unknown followed by a number on the data sheet and described in the description section. The percent cover is assigned to the unknown plant species, if it is inside the station. The plant (or a representative part if only one plant is available) is then collected (preferably from outside the plot if one is nearby) and stored in a zip-lock bag or plant press. The bag or plant press is labeled with the plant number and the description such that when it is identified, the data sheet can be corrected.

Installation

The LDNR/CRD will provide DGPS coordinates in UTM, NAD83 Meters for the start and end of the diagonal vegetation transect as well as orientation/bearing. Prior to site establishment, a unique set of 94 random numbers between 1 and 94 will be selected for each site and maintained with the site file. The first 10 numbers will be arranged numerically from lowest to highest to expedite station establishment, minimize backtracking, and reduce unnecessary travel between sites. Each random number is multiplied by 3 to determine the distance in meters from the north end of the diagonal vegetation transect (either NW or NE corner of the 200 m x 200 m square) to the SE corner of the vegetation plot. Vegetation sampling can be carried out simultaneously with station establishment.

Materials List (minimum)

This list of equipment and supplies is needed to establish and to sample vegetation stations in the herbaceous marshes of south Louisiana. Other equipment and/or supplies may be necessary depending on the site.

1. Metal pipes / rods: ½" diameter by 3' galvanized coated or stainless steel rods used as permanent station markers in case of fires
2. PVC pipes: ½" diameter by 10' pipes used as station locators in the thick, tall herbaceous vegetation (NOTE: Ends may be painted with a fluorescent paint to aid in locating vegetation stations)
3. 2 m x 2 m PVC square: four (4) 2-meter ¾" PVC tubes attached with L-joints or 90° fittings to form a square
4. Measuring tape/device: ½" fiberglass measuring tape capable of measuring 100 meters
5. Compass: 0° to 360° azimuth dial with 2° graduations
6. Random number table: Ninety-four (94) randomly chosen numbers between 1 and 94 with no duplicates. Each random number is then multiplied by 3. The first ten (10) numbers are arranged numerically from lowest to highest. NOTE: Each site must have a different set of random numbers.
7. Differential global positioning system (DGPS)

Herbaceous marsh community:

1. Using a DGPS, carefully approach the northerly end of the diagonal vegetation transect. This location will be the beginning point for the establishment of all the vegetation stations. Remember: Be very careful not to disturb the vegetation along the transect so that the data collection efforts are not compromised.
2. Using the random number table for that site, the diagonal transect bearing provided by LDNR/CRD (usually 135° or 225°), and a measuring tape, carefully move from the beginning point of the transect to the first vegetation station.
3. Using a compass, determine the orientation of the plot. The point on the diagonal transect is the southeast corner of the vegetation station.
4. Measure 2 m North and 2 m West from this point to determine where the plot will fall (or place the 2 m x 2 m PVC square on the marsh). Inspect the potential station to be sure that the station is more than 55% marsh and that it is not within 10 meters of any of the other data collection stations (e.g., RSET, accretion, water level and/or salinity continuous recorder) or either of the boardwalks.
    a. If Step 4 is true, then the station is established and the PVC pole and metal pipe can be placed in the SE corner to mark the station. Before leaving the station, record the actual coordinates using the DGPS. Collect no less than 10 readings with the antenna directly on top of the station marker on the southeastern corner. Label the coordinate with the appropriate station number.

   b. If Step 4 is false, proceed to the next potential vegetation station using the next number from the random number set.
5. Continue step 2 until all 10 random numbers in the primary set have been used. Ten (10) stations shall be established at each site. Depending on the number of stations established from the first set, additional stations will be chosen from the secondary set to supplement the first set until a total of 10 vegetation stations have been established.

Alternative GIS Method for Station Establishment

Using ArcView or ArcGIS, the 200 m x 200 m square can be positioned over a DOQQ for each site. From the Graphics menu, the position (in UTM, NAD83 Meters) of each side of the 200 m x 200 m square is provided. Therefore coordinates (UTM, NAD83 Meters) for the NW and NE corner of the 200 m x 200 m square are easily determined by simply recording the two width values (Easting) and the greater of the two height values (Northing). The NE corner's coordinates are the greater of the two width values and the height value while the NW corner's coordinates are the lesser of the two width values and the height value. After the starting coordinates are determined and orientation of the diagonal transect (i.e., from NE to SW or from NW to SE) is randomly chosen, the coordinates for each vegetation plot can be calculated using the trigonometric function that sin θ = opposite side length / hypotenuse length or:

$$d = 0.7071r$$

Where: r is a random number between 1 and 94 multiplied by 3
d is the distance in meters on both the x and y plane from one end of the diagonal vegetation transect

For each station, a value d is calculated which represents both the change in Easting and Northing. For example, in a site in which the orientation of the diagonal transect is NW to SE, each vegetation station will be located at Easting of the NW corner + d, Northing of the NW corner – d (each vegetation station will have a unique r and d value). Conversely, a site in which the orientation of the diagonal transect is NE to SW, the vegetation station will be located at Easting of the NE corner – d, Northing of the NE corner – d. Ninety-four (94) coordinates shall be calculated using this method as each station will need to be ground-truthed to assure >55% marsh and proper distance from other sampling stations or may need to re-established during future sampling trips. A spreadsheet to calculate random numbers and subsequent vegetation coordinates will be provided by LDNR/CRD.

Data Collection

Vegetation sampling shall occur during the 6 week period on or around September 15 to October 31. If 6 weeks is an insufficient period of time, sampling can began as early as September 1.

The data collection schemes between the herbaceous marsh community and the forested swamp community are different; therefore, the following procedures are to be used for the appropriate community. Two different data sheets will be utilized: herbaceous marsh community data sheet (Vegetation Sampling Data Sheet / Modified Braun-Blanquet Technique; Form 14) and "Forest Community Data Sheet" (Form 15).

The materials list above is also used during data collection. The random number table will be taken to the field during both the initial site establishment trip and all subsequent sampling trips. If a new station needs to be established, the next random number on the list will be used. The metal and PVC pipes will be needed if a station must be re-established. Reasons for station re-establishment include:

1. If both the metal and PVC pipes are removed or lost.
2. If a significant, unnatural anthropomorphic change to the study site has occurred (e.g., digging or dumping of soil at the site).
3. If the station becomes open water.

In the case of station re-establishment, LDNR/CRD shall be notified of the new GPS coordinates and reasons for re-establishment.

Herbaceous marsh community:

1. Using the poles established in the installation process, place the 2 m x 2 m PVC square such that the pole is the southeast corner of the station. The orientation of the station is north-south and east-west.
2. Using the "Natural Vegetation Sampling Data Sheet," completely fill out all the sample type, project, station, group, personnel, plot size, date, and plant community type before beginning the collection of data within the station.
3. Examine the entire vegetative community within the boundary of the station.
4. Fill out the cover percentages as they relate to the total cover (all plant types within the boundary of the station) and bare ground. Then begin to separate the plant types (tree, shrub, herbaceous, and carpet) and estimate the percentages.
5. In the species list section of the data sheet, record the scientific name of every plant species present in the station and place an "I" in the In/Out column of the data sheet.
6. Examine the entire station and give a cover percentage for each individual plant species present.
7. Examine the list of plants and their percent cover. Using the plant species with the most cover (dominant species), measure 5 stems of the plant and record an average height on the top section of the data sheet.
8. Repeat step 6 for the tree, shrub, herbaceous, and carpet layer, if they are present.
9. Examine the 10 meters (~33 feet) in all directions outside of the station and list the plant species found by their scientific name. Indicate if there outside presence by placing an "O" in the In/Out column of the data sheet. Note: some plants may be inside and outside the station and can be documented by recording a "I/O" in the In/Out column of the data sheet in that species' row.
10. Proceed to the next vegetation station.

10.2. <u>Forested swamp sampling</u>

Vegetation sampling in swamps will consist of five replicate 20 m x 20 m stations located within a 200 m x 200 m square that also encompasses water level continuous recorders. Vegetation stations will be located randomly on a 282.8-m transect that cuts diagonally through the square from one corner to the opposite corner. Each 20 m x 20 m vegetation station shall be spaced a minimum of 30 m apart giving a possible 9 establishment points along the diagonal transect. Each of the establishment points along the transect marks the southeastern corner of a vegetation station. Stations have north-south and east-west oriented sides.

The orientation of the vegetation transect (i.e., either NE to SW or NW to SE) within the 200 m x 200 m site will be chosen randomly. A set of 9 random, non-duplicated numbers between 1 and 9 shall be selected, recorded to a table, and maintained with the site file. Each random number is then multiplied by 30 which represents the distance in meters that the vegetation station is located from the NE or NW corner of the transect towards the opposite corner. The first 5 random numbers are primary locations for each vegetation station. If one of the primary stations is located in an area that is <55% swamp or within 10 meters of the RSET, marsh mat recorder, or any part of the boardwalk, a station from the secondary set will be used. This practice will assure that none of the data collection for other variables is compromised and that stations located in unvegetated swamp ponds or channels are excluded at the outset of monitoring. Station establishment is completed when 5 appropriate vegetation stations are positioned that neither interfere with other sampling stations nor are <55% swamp. Each station will be marked with a metal short stake (permanent marker) and a ½ inch diameter PVC stake that extends 6 feet above the marsh surface (for ease of locating the station).

Composition and vigor of tree species will be determined using diameter at breast height (DBH) measurements of trees > 5 cm DBH. Trees < 5 cm DBH will be counted by species. The DBH will be measured at a height of 137 cm above the forest floor (Avery and Burkhart 1994). Measuring an irregular tree trunk shall follow the methods prescribed in Avery and Burkhart 1994 (see descriptions below). Trees may be temporarily marked with chalk or paint to assure that each tree has been accounted for and measured as well as to prevent a tree from being measured twice. Measurements at understory stations will follow the measurements taken at marsh stations (see herbaceous marsh sampling).

Installation

The LDNR/CRD will provide DGPS coordinates in UTM, NAD83 Meters or for the start and end of the diagonal vegetation transect as well as orientation/bearing. Prior to site establishment, a unique set of 9 random numbers between 1 and 9 will be selected for each site and maintained with the site file. The first 5 numbers will be arranged numerically from lowest to highest to expedite station establishment and to reduce backtracking. Each random number is multiplied by 30 to determine the distance in meters from the north end of the diagonal vegetation transect (either NW or NE) to the SE corner of the vegetation plot. Vegetation sampling can occur simultaneously with vegetation station establishment.

Materials List (minimum)

This list of equipment and supplies is needed to establish and to sample vegetation stations in the forested swamps of south Louisiana. Other equipment and/or supplies may be needed depending on the site.

1. Metal pipes / rods: ½” diameter by 3’ galvanized coated or stainless steel rods used as permanent station markers in case of fires

2. PVC pipes: ½" diameter by 10' pipes used as station locators in the thick, tall herbaceous vegetation (NOTE: Ends may be painted with a fluorescent paint to aid in locating vegetation stations)
3. 2 m x 2 m PVC square: four (4) 2-meter ¾" PVC tubes attached via L-joints or 90° fittings to form a square
4. Measuring tape/device: ½" fiberglass measuring tape capable of measuring 100 meters
5. Compass: 0° to 360° azimuth dial with 2° graduations
6. Random number table: Nine (9) randomly chosen numbers between 1 and 9 with no duplicates. Each random number is then multiplied by 30 to provide distance in meters from the start of the diagonal transect to the SE corner of the vegetation station. The first five (5) numbers are arranged numerically from lowest to highest. NOTE: Each site must have a different set of random numbers.
7. Differential global positioning system (DGPS)
8. Diameter tape: fabric tape used to measure the diameter of trees in metric (centimeters)
9. Tree marking paint/chalk: used to mark trees that have been measured
10. Hammer and aluminum nails and/or tags: used to mark DBH measurements

Forested (Swamp) community:

1. Using a DGPS, carefully approach the northerly end of the diagonal vegetation transect. This location will be the beginning point for the establishment of all the vegetation stations. Remember: Be very careful not to disturb the vegetation along the transect so that the data collection efforts are not compromised.
2. Using the random number table for that site, the diagonal transect bearing provided by LDNR/CRD (usually 135° or 225°) and a measuring tape, carefully move from the beginning point of the transect to the first vegetation station.
3. Using a compass, determine the orientation of the plot. The point on the diagonal transect is the southeast corner of the vegetation station.
4. Measure 20 m North and 20 m West from this point to determine where the plot will fall. Inspect the potential station to be sure that the station has more than 55% swamp and that it is not within 10 meters of any of the other data collection stations (e.g., RSET, accretion, water level and/or salinity continuous recorder) or either of the boardwalks.
    a. If Step 4 is true, then the station is established and the PVC pole and metal pipe can be placed in the SE corner to mark the station. Before leaving the station, record the actual coordinates using the DGPS. Collect no less than 10 readings with the antenna directly on top of the station marker on the southeastern corner. Label the coordinate with the appropriate station number.
        i. Due to the size and vegetative composition a forested community, all four corners of the plot may need to be to indicate the boundary of the station. Different color paints may be used for each corner.
        ii. The northwest corner of the plot also needs to be established since a 2 m x 2 m station will be established in this area for herbaceous marsh community analysis
    b. If Step 4 is false, proceed to the next potential vegetation station using the next number from the random number set.
5. Continue step 2 until all 5 random numbers in the primary set have been used. Five (5) stations shall be established at each site. Depending on the number of stations established from the first

set, additional stations will be chosen from the secondary set to supplement the first set until a total of 5 vegetation stations have been established.

Note: GIS station establishment can be used in the forest community but each random number is multiplied by 30 instead of 3 in determining distance in meters that vegetation station is located from the northerly end of the diagonal transect.

Data Collection

Vegetation sampling shall occur during the 6 week period on or around September 15 to October 31. If 6 weeks is an insufficient period of time, sampling can began as early as September 1.

The data collection schemes between the herbaceous marsh community and the forested swamp community are different; therefore, the following procedures are to be used for the appropriate community. Two different data sheets will be utilized: herbaceous marsh community data sheet (Vegetation Sampling Data Sheet / Modified Braun-Blanquet Technique; Form 14) and "Forest Community Data Sheet" (Form 15).

The materials list above is also used during data collection. The random number table will be taken to the field during both the initial site establishment trip and all subsequent sampling trips. If a new station needs to be established, the next random number on the list will be used. The metal and PVC pipes will be needed if a station must be re-established. Reasons for station re-establishment include:

1. If both the metal and PVC pipes are removed or lost.
2. If a significant, unnatural anthropomorphic change to the study site has occurred (e.g., digging or dumping of soil at the site, logging activity).
3. If the station becomes open water.

In the case of station re-establishment, LDNR/CRD shall be notified of the new GPS coordinates and reasons for re-establishment.

Forested community:

Each 20 m by 20 m station will have a minimum of three completed datasheets when the sampling for the station is completed. One data sheet will be for the forested community that measures the tree community in the 20 m x 20 m station. The other two sheets will be for the herbaceous community that will be collected in 2 m by 2 m substations in the southeast and northwest corners of the overall station.

1. Determine the southeastern corner of the 20 m x 20 m station.
2. Orient with respect to the 20 m x 20 m station by finding the other pipes associated with the station during establishment.
3. In a systematic procedure, begin on one side of the station and work towards the other side. Each tree greater than 5 cm in diameter at breast height (DBH) must be identified, measured, and recorded on the data sheet.
    a. NOTE: DBH is approximately 137 cm (~4.5 ft) above the forest floor (Avery and Burkhart 1994).

i. If the tree trunk is split below the 137 cm height then the diameter of the each fork is measured at 107 cm (~3.5 ft) above the split and this change is noted on the vegetation data sheet.
ii. If the tree has a fluted bole (e.g., tupelo or cypress), DBH shall be measured 50 cm (~1.5 ft) above the point where the boles stops noticeably tapering and this change is noted on the vegetation data sheet.
iii. If the tree is forked at or above 137 cm height, DBH is taken and 122 cm (~4 ft) and this changed is noted on the data sheet.
iv. If other scenarios occur, refer to LDNR/CRD.

b. It is important to mark the DBH point permanently for future replicated measurements, especially when the DBH point has been shifted up or down. The use of an aluminum tag or an aluminum nail is recommended by most foresters as aluminum will not harm trees or saws.
c. Trees may be marked with tree marking paint/chalk to keep track of which ones have been measured.

4. The herbaceous stations are recorded using the same technique and same data sheet as the herbaceous marsh community (See procedure above). There are two substations per 20 m by 20 m stations. These substations are located at the southeast and northwest corner of the 20 m x 20 m station.

10.3. Data Processing

The samples collected in the field that were not positively identified must be examined by a qualified individual, a botanist or plant taxonomist. The plants shall be provided to the person as soon as possible before the integrity of the sample diminishes.

The data sheets must be examined for the proper spelling of each plant species. If the spelling in the field was done incorrectly then the spelling needs to be corrected. This procedure is accomplished by drawing a single line through the name of the plant written in the field and the correct spelling placed adjacent to the misspelled name. The "authors" name shall be written in the correct form behind the name. The standard botanical name shall follow the USDA Plants Database on the web (available at http://plants.usda.gov/). Since the cover percentage was recorded in the field for each species, the corresponding rank may not have been written in the following column. If the percent cover rank was not recorded in the field, use Table 2 to complete the column.

Once the data sheets have been corrected with respect to the unidentified plants and the author's names have been added to the data sheets, then the person responsible for the data collection can begin the two phase approach established by the LDNR/CRD to ensure the accuracy of the data with respect to the database.

The LDNR/CRD has implemented a two phase protocol for data processing. These two phases are referred to as data entry (Phase I) and data quality assurance / quality control (Phase II). These two phases are conducted by separate individuals to assure that the final product is in agreement 100% with the data collected during the field sampling procedure.

Data Entry (Phase I)

Phase I is conducted by the individual responsible for the field data collection. After completing the additions to the data sheets, photocopies are produced of the original data sheet(s). The original data sheets shall be filed systematically until both phases are complete and the LDNR/CRD has accepted the final product. The photocopied data sheets are used for data entry and throughout the QA/QC process. As part of the final deliverable product, the LDNR/CRD requires the original data sheet(s) as well as the photocopies.

The LDNR/CRD's Restoration Technology Section (RTS) has developed the Strategic Online Natural Resources Information System (SONRIS) database for the input and storage of vegetation data with respect to the herbaceous plant community. The individual responsible for phase I must follow the "User's Manual For Hydrographic and Emergent Vegetation Data Management" dated December 29 2003. This manual ensures the proper transcription of data from the data sheet to the database. The individual must transcribe all the data requested by the database in the appropriate format as stated in the manual. Periodically this manual is updated; therefore, the most recent version of this manual must be used as it pertains to emergent vegetation

Since the LDNR/CRD/RTS has not developed a database with respect to the forested community for the measurements of each individual species, the LDNR/CRD has developed an Excel spreadsheet for this data. The Excel spreadsheet is a standardized spreadsheet that will be used to transfer the data from the spreadsheet to the database once the database has been established. It is important that the individual responsible for the data entry enter the data as requested with respect to the spreadsheet. The Excel spreadsheet provided by the LDNR/CRD is a template and shall be saved using the naming convention, station_forestcommunity_date.xls (CRMS0395_forestcommunity_September2005.xls).

Once the data have been transferred, a field trip report must be generated. The field trip report must include: 1) an explanation of any logistical problems encountered in the field, especially problems that may affect the data, 2) general weather conditions, 3) field personnel and their respective agency, company, or organization on the trip, 4) sites that were sampled, 5) type of sampling that took place, and 6) any notable biological activity or physical activity that may have altered the site.

When the data have been completely entered and the field trip report has been generated, the appropriate quality assurance / quality control (QA/QC) checklist (Form 8) is attached to the copied data sheet(s) and the field trip report. This compilation is referred to as the QA/QC packet. The QA/QC packet is sent to another individual for further examination and verification. This individual is referred to as the QA/QC officer.

Quality Assurance / Quality Control (Phase II)

Phase II begins with the transfer of the QA/QC packet to the QA/QC officer. The QA/QC officer immediately dates the packet upon receipt. Then the QA/QC officer will read the report and provide grammatical corrections, suggest clarifications, and comment as well as verifying that all the necessary information is contained in the report. The QA/QC officer then compares the data sheet(s) with the SONRIS database and the Excel file. The QA/QC officer examines the SONRIS database according to the protocol set forth in the "User's Manual For Hydrographic and Emergent Vegetation Data

Management" dated December 29, 2003 for any erroneous data or data that are questionable. The QA/QC officer also inspects the Excel spreadsheet with respect to the forest community data for any erroneous data or questionable data. If mistakes or questions arise, then documentation must occur on the QA/QC checklist. At times it may be beneficial to place removable (e.g., Post-it) notes on the photocopy data sheet. Once the packet has been review, the QA/QC officer shall initial and date all portions of the QA/QC checklist that are in accordance with the questions provided on the QA/QC checklist. Those areas that possess errors or present questions for clarification shall be address by the person responsible for Phase I.

Once the data collector has corrected or answered the problems found by the QA/QC officer, the QA/QC packet is again delivered to the QA/QC officer. The QA/QC officer examines the questions and verifies that all the data and information are 100% correct. This process will continue until the SONRIS database, the Excel file and the field trip have been accepted by the QA/QC officer. Upon acceptance of the packet, the QA/QC officer will initial and date the rest of the QA/QC checklist.

After the QA/QC packet has been finalized, the data collector or the QA/QC officer must obtain the original data sheets. If problems were found with the data sheet(s) during the QA/QC process, then the original data sheets must be corrected. This process shall be carried out by using black ball point ink pen. The person shall not erase any data or information on the original data sheet. The proper procedure will be to draw a single line through the error and place the correction as close to the error as possible. The person will also place their initial and the data next to the correction.

10.4. <u>Summary Data and Graphic</u>

Upon completion of the QA/QC process, the data summary and graphs associated with data shall be produced. The LDNR/CRD has developed statistical programs and graphs to display the data. These programs and graph templates shall be provided to ensure standardization among the analyses and graphic display for easy comparisons.

10.5. <u>Deliverables</u>

Upon completion of the QA/QC process, the original data sheets, field trip report, QA/QC packet, field notebooks, summary data and graphs, and all associated electronic files shall be delivered to the LDNR/CRD. Electronic files containing the data shall be in the appropriate deliverable format (see Appendix) once the data has completed the QA/QC process.

11. SOIL PROPERTIES

Many of the soil characteristics of concern to the LDNR/CRD include but are not limited to bulk density, percent water, percent organic matter, grain size, and/or soil salinity. Bulk density is defined as the total weight of material, both organic and inorganic fractions, in a known volume of sample and is given in units of grams per cubic centimeter (g/cm^3). Soil density in wetland soils is controlled by the amount of mineral material that infiltrates the organic material framework in highly organic marsh soils. Bulk density will be measured as dry bulk density as the current scientific literature predominately uses this unit. Percent water is determined from the weight change after the core is dried at 60°C and percent organic matter is determined by the amount of weight loss upon ignition at 550°C (Steyer et al. 1995). Grain size is determined via a combination of sieving and gravimetric analysis in the laboratory setting to categorize the inorganic component into percent sand, silt, and clay. Soil salinity is determined by laboratory measurements of a saturated sample's electrical conductivity (Brady and Weil 2002). In some cases, nutrient analyses of the core or soil substrate will be carried out and thus samples shall be transported and stored inside inert containers at 4°C.

Soil samples shall be collected from specified field locations in both attached and flotant marshes during the initial feldspar station establishment during the first, ninth or tenth, and final year of sampling. Soil cores shall be collected carefully to obtain a known volume with little to no compaction of the soil matrix. Care must also be taken to prevent the loss of water or other matter from the core during extraction. Field personnel will collect soil cores with a diameter of 10.2 – 15.2 cm (4.0 – 6.0 in) to a depth of 30.0 – 50.0 cm (11.8 – 19.6 in). This diameter provides sufficient uniformity of the soil profile. Small piston coring devices, such as those developed by Swenson (1982) and Hargis and Twilley (1994), or hydraulic coring samplers (*sensu* Meriwether et al. 1996 and Phillips 2002) have been specifically designed for taking marsh soil samples. Each of these corers consist of a sharpened tube or cutting head to facilitate insertion into the soil and to easily cut through below ground vegetative growth (a sharp serrated knife could also be used to make a vertical cut through the root mat around the circumference of the core tube). Internal pistons in the Swenson and Hargis corers create suction at the top of the core to virtually eliminate compaction while inserting the corer into the marsh. These pistons, or the water-filled headspace in the hydraulic coring sampler, prevent the loss of any liquid or material upon extraction of the core from the marsh. Intact cores, or other pre-specified sample preparations, shall be delivered to a LDNR/CRD-contracted laboratory within 24 hours of collection. Soil sampling, storage/transportation, and sample preparations shall follow methods prescribed by the LDNR/CRD-contracted soils laboratory.

A torvane strength tester shall be used to determine the shear strength in flotant marsh soils (or similar saturated cohesive soils) either in the laboratory or the field (McGinnis, 1997). These instruments measure the torque (kg/cm^2) required to shear through, or deform, the soil (known as failure). A torvane is composed of a toothed plate (a vane) and a spring-loaded torque meter (driver). The torvane is inserted into a flat-surfaced soil in the field or into a soil sample to the depth of the teeth on the vane (~0.5 cm). The torque, or shear strength, is obtained by rotating the driver with constant pressure (torque) until failure occurs. The torque required to shear the sediment along the vertical and horizontal edges of the vane is a relatively direct measure of the shear strength of the mat. With some torvanes, shear strength must be normalized to the vane constant, which is a function of the vane size and geometry. However, most manufacturers (e.g., ELE International, Humboldt Manufacturing, Durham Geo) produce a hand-held torvane that directly returns a measure of shear strength from calibrated springs.

12. ELEVATIONS

The Louisiana Coastal Zone (LCZ) Primary GPS Network was developed to provide consistency between all horizontal and vertical reference data collected. By utilizing this network, water elevation (continuous and monthly) and marsh elevations can be compared among stations throughout the coastal zone. In order to achieve consistency between data collection stations with respect to elevation, "A Guide to Minimum Standards Required by Louisiana Department of Natural Resources, Coastal Restoration Division For Contractors Performing GPS Surveys and Establishing GPS Derived Orthometric Heights Within the Louisiana Coastal Zone Primary GPS Network" dated June 2003 was developed as a minimum standard to be utilized by all surveyors installing deep rod secondary monuments and tying in the monument to the network for the LDNR/CRD.

From the deep rod secondary monuments that have been surveyed into the network, real-time kinematic (RTK) survey technology has facilitated accurate surveying in remote locations through the use of satellites. RTK shall be utilized to establish elevations on the various pieces of equipment used to collect data and to establish marsh elevations. Using RTK technology limits the distance from the secondary monument to a maximum distance of three miles unless the surveying crew advises differently or technological advances increase the range while maintaining the accuracy.

RTK is performed by setting up a RTK base station on an accepted LCZ secondary monument and the rover unit receives differential corrections from the base station. Because these two units communicate using radio waves, as the rover extends beyond the three mile radius and/or obstacles emerge between the units, the signal weakens and the degree of accuracy becomes no longer acceptable. Quality assurance checks shall be performed to confirm the instruments are working correctly near the base station before surveying begins and during the actual elevation determinations. When establishing an elevation point on the continuous recorder, static floating marsh system, and RSET monument or establishing the staff gauge to the vertical datum, two measurements are obtained to verify that the readings are within the acceptable range of 1.22 cm (0.04 feet). One measurement is obtained by collecting the average elevation for all readings during a three minute observation. The second measurement is a check that averages the elevation during a 3-5 second observation. If the two elevations differ by more than 1.22 cm (0.04 feet), measurements shall be performed again until the readings are within the acceptable tolerance of the instrumentation being used to perform the elevation determinations. All observations must be stored in the unit to verify that the readings are correct and the unit was working properly. With respect to marsh elevation determinations, each observation shall last a minimum of 30 seconds.

In an effort to reduce complications associated with the collection of elevation data between two instruments in close proximity to each other and to guarantee previously collected data can be adjusted to the latest survey, the LDNR/CRD has developed an Excel spreadsheet and data sheet. Since RTK enables the elevation of the surveyed object to be displayed in the field, the data sheet shall be completed in the field and all values shall be calculated to verify all the gauges and readings are within the acceptable 1.22 cm (0.04 ft) range. The data sheet Continuous Recorder and Staff Gauge Survey Data Sheet (Form 2) precisely labels each column as well as provides a description of each column. Upon completion of the data sheet, a correction factor shall be generated to apply to previously collected data if a staff gauge existed at the site prior to the survey. The water elevation at the continuous recorder and the staff gauge reading after adjustment or establishment shall be verified to assure the two gauges are within the acceptable range. This is accomplished by reviewing the last column "water elevation" for the continuous recorder and the "staff gauge" (after establishment or adjustment) for the staff gauge.

12.1. Continuous Water Level Recorders

Upon arrival at the continuous recorder station, a nail on the wooden post approximately twelve inches from the top or a ¼" hole on the stainless steel mono-pole approximately eight inches from the top shall be located. If the nail or hole does not exist, it shall be established. The elevation of the nail or the top of the hole shall be determined as well as the elevation of the water at the time of the survey.

Documentation of all the necessary elevations and measurements shall be written on the "Continuous Recorder Water Level Sensor Data Sheet" (Form 4). With respect to the continuous water level recorder, the top portion of the data sheet shall be completed. Completion of this section provides the LDNR/CRD sufficient information to convert the data from the recorders to a vertical datum. Moreover, it provides sufficient information for quality assurance and quality control. Beneath the table, each individual column is explained with respect to where the elevation or measurement between two points shall be acquired.

12.2. Staff Gauge

Often times a staff gauge has been established prior to the LCZ Primary GPS Network or the LDNR/CRD decides to adjust the staff gauge as a result of advances in technology; therefore, it is essential that sufficient information is collected to adjust previously collected data to the latest survey. To ensure that previously collected data can be adjusted to the latest survey, a staff gauge reading prior to the adjustment shall be obtained. On the lower section of the continuous recorder and staff gauge survey data sheet, all the information necessary to adjust the previously collected data shall be documented.

For those sites that will establish a staff gauge for the first time, current protocol requires that staff gauges are established using the method set forth in section 2.6 with a final establishment that resembles Figure 8. Staff gauges shall be established to the vertical datum, NAVD 88, Feet.

Documentation of all the necessary elevations and measurements shall be written on the "Continuous Recorder Water Level Sensor Data Sheet" (Form 4). With respect to the staff gauge, the lower portion of the data sheet shall be completed. Completion of this section provides the LDNR/CRD sufficient information to convert the previously collected data to the current survey. Moreover, it provides sufficient information for quality assurance and quality control with respect to the water elevations between the two gauges, if both exist. Beneath the table, each individual column is explained with respect to where the elevation or measurement between two points shall be acquired.

12.3. RSET

The elevation for the top of the rod (Figure 5) shall be determined in NAVD 88, Feet and a measurement to the top of the collar shall be documented. No data sheet exists for this variable;

however, a drawing of the station, the elevation of each point, and the elevation determination points shall be recorded with clarity in the surveyor's field notebook.

12.4. Static Floating Marsh Elevation

An elevation shall be established on the static floating marsh recorder at the top of the ¼" hole that was established during installation. No data sheet exists for this variable; however, a drawing of the station and the elevation of the hole shall be recorded with clarity in the surveyor's field notebook.

12.5. Marsh Elevations

Marsh elevations used to determine the depth and duration of flooding with respect to the continuous water level data shall be determined at a minimum of 20 points that are separated by 20 to 40 feet. Marsh elevations shall be taken where there is no influence of spoil banks, levees, or any other human induced alterations unless otherwise stated by the LDNR/CRD. Patterns for the elevation determinations shall be determined by the needs of each individual project.

Marsh surface with respect to elevation surveys is defined as when the survey rod is resting among living stems or is supported by soil containing living roots. In order to get consistent readings, it may be necessary to move stems of the vegetation where stem density is extremely high. In areas where *Spartina patens* (Saltmeadow cordgrass) are the dominant species, a minimum of forty (40) elevations will be obtained and recorded. Twenty (20) elevations will be recorded on the marsh surface and twenty (20) elevations will be recorded on the crown (top part of the tuft) of the *Spartina patens* that is adjacent to the marsh surface reading. These readings shall be recorded such that the marsh elevation and the crown readings can be separated. The average marsh elevation will be obtained by averaging the forty (40) points; however, these readings may need to be separated at a later date.

Prior to obtaining marsh elevation readings, the following information shall be recorded in a field journal: station number, date and time of the survey, staff gauge reading (if present), and presence or absence of water above the marsh surface.

Once the survey at each station is completed, the surveyor shall record the type of terrain encountered during the survey. The description should include firmness of the marsh surface and ease of movement which will facilitate how the area may be surveyed at a later date.

12.6. Deliverables

Upon completion of a project, a GPS Survey Report shall be provided to the LDNR/CRD as outlined in Section G – Deliverables of the Contractor's Guide to Minimum Standards. These deliverables have been established for the installation of deep rod secondary monuments; however, the contents shall be applied to the surveys required for the collection of water level and marsh elevations. The packet shall consist of a completed copy of the "Continuous Recorder and Staff Gauge Surveying Data Sheet" (Form 2).

13. SUBMERGED AQUATIC VEGETATION (SAV)

Three techniques are commonly used by researchers to estimate submerged aquatic vegetation (SAV) cover and relative composition. In many fresh and intermediate areas, water is extremely clear and SAV abundance is high and thus SAV cover and relative abundance of SAV can be visually estimated. However in more saline areas, turbidity is extremely high and SAV abundance is low. In such areas, frequency of SAV can be estimated from grab samples that are obtained at regularly spaced intervals on transects by dragging a garden rake as an airboat idles across the pond (Chabreck and Hoffpauir 1962, Nyman and Chabreck 1995). A third technique uses a 1 m^2 aluminum throw trap, which is commonly used to sample aquatic organisms (Kushlan 1981, Rozas and Odum 1987). After the trap is pushed into the sediment, the SAV is harvested (Castellanos 1997) or the water can be pumped out and SAV cover and abundance visually estimated.

Comparing SAV on a coastwide basis is problematic because of extreme variability in water clarity, salinity, and SAV abundance. There are approximately 722,000 ha of lake and pond habitat in coastal Louisiana, of which 68% is likely turbid waters (Chabreck 1971). Visual estimation is the method of choice because it is extremely quick, accurate, and reproducible. However, the technique cannot be used in turbid waters. The use of aluminum throw traps would be too time-consuming and too costly to employ on a coastwide basis. Therefore, in order to standardize methodology to compare SAV across the range of conditions encountered in coastal Louisiana, a modified rake technique will be adapted. This technique is a modification of the regularly spaced grab samples used to estimate frequency in Louisiana brackish and saline ponds as described by Chabreck and Hoffpauir (1962) as well as Nyman and Chabreck (1995). Frequency is a more readily established quantitative measure than either the counting of individuals or the measurement of cover and is often considered a measure of abundance (Mueller-Dombois and Ellenberg 1974:69-80). However, frequency confounds abundance and dispersion because abundant species can have low frequencies if they are restricted to a few dense patches. For this reason and others, the ideal area of a sample is a point (Mueller-Dombois and Ellenberg 1974). The modified method differs from the previous garden rake method in that the garden rake is dragged on the pond bottom for one-second rather than three-seconds.

To assure repeatability across all sites, airboat speed should be as uniform as possible. This requires that the airboat idle into the wind and travel at approximately one boat-length every 10 seconds (~1.7 ft/sec); during strong winds power can be increased as needed. Leaf, bud, or root presence are generally required for a plant to be considered present in terrestrial sampling, but SAV is considered present if whole or part of an identifiable plant is returned to the surface by the rake. The number of points on a given transect should never fall below 25 (Mueller-Dombois and Ellenberg 1974); therefore ponds less than 0.25 ha (roughly 0.5 acres) should be excluded from sampling. Accuracy increases with plot number to an unknown limit; therefore, as many points as reasonable will be sampled as the airboat idles across the pond on three transects that roughly divide the pond into fourths. There is likely no benefit of exceeding 100 points per pond. Transects will not be permanent so that their direction and starting point can vary among sample dates and differing wind directions.

Field Station Establishment Materials and Equipment List

Equipment/Apparatus

1. PVC poles approximately 8-10 ft in length
2. Metal tine rake with depth graduations along the shaft
3. Documentation supplies - logbook, field data sheets, sample labels, no. 2 pencils, black permanent marker
4. Differential GPS
5. Regional field guides to native aquatic plants
6. Compass
7. YSI 30 conductivity/salinity meter or equivalent

13.1. Field Station Establishment

SAV sampling will occur in the pond in which a continuous recorder or discrete water quality station is located.

13.2. Data Collection

Data collection often occurs during the fall months before the water temperature begins to fall and before numerous waterfowl migrate into the coastal areas of Louisiana. The LDNR/CRD may collect SAV data during the spring months but this is highly unusual.

This method requires at least three (3) field personnel: a vessel operator, a data recorder, and a sampler. The data recorder will be responsible for recording SAV species present, water temperature, specific conductance, and salinity at the beginning and ending of each transect (Form 16). Water depth shall be measured every 5 samples. Each station should have at least 3 transects with at least 25 rake-samples taken on each transect. Transects shall be parallel to the wind. Differential GPS coordinates are to be taken at approximately the center of the pond.

(1) While idling an airboat into the wind, one rake sample will be taken every 10 seconds. The sampler will touch the tine-side of the rake into the direction the boat is traveling and to the pond bottom for one second, remove the sample from the bottom, and identify the vegetation from the rake sample.

(2) The sampler will announce the SAV species to the data recorder who will record the species present in the appropriate sample row. To expedite sampling/recording, abbreviations for each species are provided on the data sheet. If a plant species is not known, a sample of the plant is collected and stored in a zip-lock bag. Both the data sheet and the bag are labeled with the plant number and the description such that when it is identified then the data sheet can be corrected. The plant must be placed in a cool environment to help preserve the identity of the plant.

(3) Every five (5) samples, the pond depth shall be measured.

13.3. <u>Data Processing</u>

The LDNR/CRD has implemented a two phase protocol for data processing. These two phases are referred to as data entry (Phase I) and data quality assurance / quality control (Phase II). These two phases are conducted by separate individuals to assure that the final product is in complete agreement with the data collected during the field sampling procedure.

Data Entry (Phase I)

Phase I is conducted by the individual responsible for the field data collection. Upon returning from the field, photocopies are produced of the original data sheet(s). The original data sheets shall be filed systematically until both phases are complete and the LDNR/CRD has accepted the final product. As part of the final deliverable product, the LDNR/CRD requires the original data sheet(s) as well as the photocopies.

Using the template Excel spreadsheet provided by the LDNR/CRD, the data collector shall save the template using the following naming convention: Station_SAV_*date*.xls, i.e. CRMS0395_SAV_August2005.xls. This ensures that the template does not get changed accidentally and provides a working copy of the file.

The data are transferred from the photocopied field data sheet(s) to the Excel spreadsheet. The person responsible for the field data collection shall transfer the data into the corresponding cells of the spreadsheet. Once the data and information have been transferred, they must check to verify that the data entry has been completed and all numbers and notes are correct.

Once the data have been transferred, a field trip report must be generated. The field trip report must include: 1) an explanation of any logistical problems encountered in the field, especially problems that may affect data quality 2) general weather conditions 3) field personnel and their respective agency, company, or organization on the trip 4) sites that were sampled 5) type of sampling that took place 6) any notable biological activity or physical activity that may have altered or characterized the site.

When the data have been entered and the field trip report has been generated, the QA/QC checklist (Form 8) is attached to the copied data sheet and the field trip report. This QA/QC packet is sent to another individual for verification. This individual is referred to as the QA/QC officer.

Quality Assurance / Quality Control (Phase II)

The QA/QC officer immediately dates the packet upon receipt. Then the QA/QC officer will read the report and provide grammatical corrections, suggestive clarifications, and comments as well as verifying that all the necessary information is contained in the report. The QA/QC officer then compares the data sheet(s) with the corresponding Excel file. The QA/QC officer is examining the Excel file for any erroneous or questionable data. If mistakes or questions arise, then documentation must occur on the QA/QC checklist. At times it may be beneficial to place removable notes on the photocopy data sheet. Once the packet has been review, the QA/QC officer shall initial and date all portions of the QA/QC checklist that are in accordance with the questions provided on the QA/QC checklist. Those areas that possess errors or present questions for clarification shall be addressed by the person responsible for Phase I.

Once the data collector has corrected or answered the problems found by the QA/QC officer, the QA/QC packet is again delivered to the QA/QC officer. The QA/QC officer examines the questions and verifies that all the data and information is correct. This process will continue until the Excel file and the field trip have been accepted by the QA/QC officer. Upon acceptance of the packet, the QA/QC officer will initial and date the rest of the QA/QC checklist.

After the QA/QC packet has been finalized, the data collector or the QA/QC officer must obtain the original data sheets. If problems were found with the data sheet(s) during the QA/QC process, then the original data sheets must be corrected. This process shall be carried out by using black ball point ink pen. The person shall not erase any data or information on the original data sheet. The proper procedure will be to draw a single line through the error and place the correction as close to the error as possible. The person will also place their initial and the date next to the correction.

After all the data sheets have been removed from the field, then the data should be converted from the field format to a suitable format conducive to import into the database. To accomplish this, the field technician responsible for the data collection must transfer the raw data (actual data collected from the field) to a spreadsheet designed by DNR and into the DNR database for QA/QC.

13.4. Summary Data and Graphic

Upon completion of the QA/QC process, data shall be analyzed to determine changes between sampling periods. The data analysis programs and the templates of all the summary graphics shall be provided by the LDNR/CRD.

13.5. Deliverables

Upon completion of the QA/QC process, data analysis, and the creation of the summary graphics, the original data sheets, field trip report, the QA/QC packet, the field notebooks, data analysis results and graphic shall be delivered to the LDNR/CRD. Electronic files containing the data shall be in the appropriate deliverable format (see Appendix) once the data has completed the QA/QC process.

14. SHORELINE POSITION

Shoreline position can be monitored using a simple method that involves the use of the Global Positioning System (GPS) and mapping with Geographic Information System (GIS) software. GPS is a world-wide radio-navigation system formed from a constellation of 24 satellites and their ground stations (Ferguson 1997). One's position is determined by triangulation of the distances that a GPS unit receives from 4 or more satellites.

Field personnel traverse the shoreline of project and reference area recording real-time coordinates with a differential GPS (DGPS) unit at various points along vegetated edge of the shoreline. DGPS involves the use of two-ground-based receivers. One monitors variations in the GPS signal and communicates those variations to the other receiver. The second receiver can then correct these calculations for better accuracy and thus yield measurements to as high as sub-meter accuracy.

The recorded coordinates are used in GIS software to map project and reference area potential shoreline movement among different sampling periods. Areal coverages are calculated from different years and changes in area are used to determine if changes in shoreline position have occurred (i.e., if shoreline erosion has occurred). This method assumes that the spatial and temporal variability in the project area due to variable wind and wave orientations is negligible among sampling trips.

GPS Requirements

The following requirements are minimum standards needed to collect DGPS coordinates for the use in determining shoreline positions.

1. GPS Unit: The LDNR/CRD collects GPS data using Trimble AgGPS 122 Integrated DGPS Beacon Receiver. It is a 12-channel GPS receiver (at least 4 channels are required for accurate measurements) with an integrated MSK receiver to provide an all-in-one DGPS unit with real-time processing. It receives both the GPS satellite signals and the differential correction broadcasts from established navigation beacon reference stations to provide real-time correction information making it capable of measuring GPS coordinates to sub-meter accuracy as well as providing repeatable output of position information.
2. Software: The LDNR/CRD uses PenMap (from Condor Earth Technologies, Inc.) which provides real-time surveying, mapping, and GIS data collection. It provides the ability to create GIS themes for analysis using ESRI's ArcGIS or ArcView software. New themes can also be created and existing shapefiles can be uploaded to PenMap and taken to the field for updating.

Field Personnel Requirements

1. The skills necessary for a field team member to conduct sampling trips, collect field data, and differentially correct GPS data shall include having extended knowledge of the applications and theories for the settings, software, and data collecting options for the particular GPS unit being used.
2. At least one week of formal training (including a field and laboratory component) is a minimum requirement for at least one member of the team.

3. The technology related to GPS data collection is rapidly advancing and to that end, annual training to refresh or update knowledge is highly recommended.
4. Prior to coming to the field, approximate locations of the two distal ends of the shoreline are located and GPS coordinates are recorded.
    a. Using ArcInfo, bring in the appropriate DOQQ.
    b. Draw a polygon or rectangle in which two of the sides are parallel and are at approximate right angles to the shoreline in question.
    c. Record the two points where the lines intersect the shoreline; they represent the starting and stopping points for the shoreline position measurement.
    d. Load these values into the GPS unit as waypoints or stations.

Data Collection

Field method: Each site presents a different situation in which field personnel must adapt different strategies to collect data. Note: The GPS reads coordinates in WGS 84 but PenMap can convert these values to other coordinate systems.

1. Proceed to the first waypoint or shoreline intersection point (referred to as shoreline navigation reference point).
2. On the GPS unit, choose polyline and select static mean
3. Walk along the shoreline (defined as edge of the live emergent vegetation by Steyer et al. 1995) from one of the shoreline navigation reference points to the other.
4. Approximately every 5 feet, take a GPS reading in Louisiana State Plane, South Zone Coordinate System, in the North American Datum of 1983 (NAD83) UTM meters. This involves pushing reset on the GPS unit, waiting approximately 10 seconds at each stopping point, and pushing accept. A best fit line is used to extrapolate the shoreline edge of the polygon and each point will be tallied in the GPS unit. In some cases, the position dilution of precision (PDOP) will be less than four (4). Therefore, it will be necessary to wait longer than 10 seconds at each stop. At least 10 stops/readings must be made for accurate results.
5. In some cases, especially areas with long straight shorelines, the interval of GPS coordinates taken may be extended at the discretion of field personnel.

Office method: Use a GIS program such as ArcInfo to plot each point and create a polygon from these points.

1. Within each polygon, the area (m^2) is determined by adding the polyline and measuring the land bisection of the original polygon. This value is compared to the polygon formed by the shoreline position data for other sampling periods.
2. Calculate the difference between the area from one sampling period to other areas from other time periods to determined the total area change over the sampling period.
3. The change is divided by the total length of the polygon to calculate average shoreline change.
4. The total shoreline change was divided by the number of days between the samples and multiplied by 365 days to get an annual shoreline change rate.
5. Shoreline change rate can also be calculated for the entire project area among all sampling years.

The LDNR/CRD does not process the data to determine the accretion / erosion rate of the shoreline. The LDNR/CRD has contracted the Spatial Analysis Branch at the USGS—National Wetlands Research Center (NWRC)to perform its data processing since it does not have the capability to accurately analyze the data.

The USGS-NWRC follows the guidelines set forth in the LDNR/CRD's Quality Management Program (April 2003 and September 1995).

15. AERIAL PHOTOGRAPHY

Color-infrared photography will be acquired at each 1 km^2 CRMS-*Wetland* site to provide a site-specific assessment of land and water coverage trends. An unsupervised classification based on a 50-class assignment, 0.950 convergence threshold, and a maximum of 10 iterations will be performed on the appropriate aerial photography for each site. The new image will be analyzed and interpreted and the original 50 classes will ultimately be combined into two classes: land and water. Unless otherwise noted as a specific preliminary condition, all vegetation such as scrub-shrub, emergent vegetation, and forested areas will fall under the land classification, while open water, nonvegetated mud flats, and aquatic beds will be characterized as water. After classification is complete, an accuracy assessment will be performed to determine a percent accuracy level of the land/water classification. Using the image processing software, no less than 100 points are randomly generated and distributed throughout the image, which is then identified, labeled, and compared to the original classification. After all points are identified and compared to the original classification, an accuracy percentage is calculated. The final image will be submitted to the NWRC photointerpreter, LDNR monitoring manager(s), as well as other members of the CWPPRA team for review to ensure proper classification. All edits and suggestions will be considered and amended where appropriate.

After accuracy has been determined, maps depicting the analysis with acreage amounts overlaid onto base photography will be created in report compatible (8.5 x 11 in.) and presentation (display size) formats. Each will follow standard cartographic procedures. When two or more land/water analyses are to be compared for change in land acreage, the GIS analyst will create a composite file that congregates the different years of data. Four categories of data will be displayed on a composite image: land and water areas that remained unchanged between the two images, as well as classes depicting the areas where land loss and land gain occurred.

The detailed protocol for color-infrared photography acquisition, interpretation, digitization, and statistics can be found in the "Quality Management Plan for Coastal Wetlands Planning, Protection, and Restoration Act Monitoring Plan" revised in June of 2000.

16. SATELLITE IMAGERY

Coastwide satellite imagery will be acquired every three years at a spatial resolution suitable for regional assessment of land and water trends. Landsat Thematic Mapper (TM) multi-spectral imagery will be used for the initial assessments, although other imagery may be incorporated as newer satellites are deployed. Imagery will be acquired during clear weather conditions after frontal passages during the fall, although some later winter imagery may be needed to minimize the presence of aquatic vegetation in fresh marshes. Landsat imagery will be acquired in FASTL-7A format, geocoded, with full terrain correction. All imagery will be radiometrically corrected to normalize digital numbers for between image comparisons over time. Landsat Imagery will be classified with the same classification methodology used to develop the Louisiana Coastal Area Study classified Landsat land and water data sets. Each image will be classified individually to identify land and water. A classification accuracy assessment, using at least 150 randomly generated and distributed points, will be conducted on each classified scene, resulting in an overall accuracy estimate for the classified image. The separate classified land and water images will be mosaiced to produce a seamless coastal classified land and water data set. The coastwide data set will be compared to the most recent land and water data set to identify changes in land and water distribution during the collection interval. Tables summarizing land and water area changes by basin and province, and spatial change data sets and maps highlighting land and water changes will be produced for LDNR and CWPPRA review and distribution.

Improvements in satellite technologies will continually be assessed over time for potential application in land and water trend analysis. Reductions in cost and improvements in accuracy may allow one high-resolution satellite image to meet the site-specific and regional assessment requirements of the CRMS-*Wetland* program.

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17. FORMS

Form 1: Site characterization sheet used during the preliminary site visit.

Site Characterization Sheet

Station: ____________ Basin: ____________ Agency: ____________

Date and Time (CST): ____________ Field Personnel: ____________

Boardwalk Layout:

Coordinates for the beginning of Long Boardwalk (UTM, NAD83 Meters):

Easting	Northing

Direction/Bearing of Long Boardwalk (degrees): ____________

Approximate length of Long Boardwalk (meters): ____________

Placement of Sampling Platform off Long Boardwalk: left / right

Notes on Boardwalk establishment: ____________

____

Vegetation:

Dominant Species: ____________

Quality of Marsh/Health of Marsh: ____________

____

Photos:

Number	Direction	Time Stamp
	N	
	E	
	S	
	W	

Other photos:

Number	Direction	Time Stamp

Marsh Characteristics: ____________

____

____

Floating Marsh? yes / no Recommended Setup: Static ? Floating ?

Why? ____________

Recommended water level recorder: Wooden post ? Mono-pole ? Ultrasonic ?

Coordinates for the continuous recording device (UTM, NAD83 Meters):

Easting	Northing

Notes: ____________

____

Potential Problems of Site: ____________

____

____

Form 2: Example of a surveying spreadsheet used to calculate correction factors for historic monitoring hydrologic data.

Continuous Recorder and Staff Gauge Survey Data Sheet

Station	Date	Continuous Recorder Gauge				
		Top of Recorder Support Pole (4x4 Post, Cap of Pipe, etc.)	Top of Support Pole to Nail or Top of 1/4" Hole	Nail or Hole Elevation	Top of Recorder Support Pole to Top of Water Distance	Water Elevation
		(NAVD 88, Ft.)	(Ft.)	(NAVD 88, Ft.)	(Ft.)	(NAVD 88, Ft.)

How to Obtain Readings for Each Continuous Recorder Gauge Column

Top of Recorder Support Pole: Obtained by using department approved surveying methods.
Top of Support Pole to Nail or 1/4" Hole: Obtained by physically measuring the distance beween the two points.
Nail or Hole Elevation: Obtained by using the formula subtracting the two previous columns.
Top of Recorder Support Pole to Top of Water Distance: Obtained by measuring the distance between the two points.
Water Elevation: Obtained by using the formula: Top of Recorder Support Pole - Top of Recorder Support Pole to Top of Water Distance.

Station	Date	Staff Gauge						
		Existing Staff Gauge Reading (Upon Arrival)	Top of Staff Gauge Support Pole	Top of Staff Gauge Support Pole to Top of Water Distance	Water Elevation	Staff Gauge Reading (After Establishment or Adjustment)	Computed Difference (Water Elevation vs. Staff Gauge)	Correction Factor
			(NAVD 88, Ft.)	(Ft.)	(NAVD 88, Ft.)	(NAVD 88, Ft.)		

How to Obtain Readings for Each Staff Gauge Column

Existing Staff Gauge Reading: If a staff gauge is present at this location, obtain a reading before any adjustments are made.
Top of Staff Gauge Support Pole: Obtained by using department approved surveying methods.
Top of Staff Gauge Pole to Top of Water Distance: Obtained by physically measuring the distance between the two points.
Water Elevation: Obtained by subtracting the two previous readings (Top of Staff Gauge Support Pole and Top of Staff Gauge Support Pole to Top of Water Distance.
Staff Gauge Reading: Obtained by reading the staff gauge after it has been set to the datum.
Computed Difference: Obtained by subtracting the two previous readings (water elevation and Staff Gage Reading)
Correction Factor: Obtained by subtracting the Existing Staff Gauge Reading and the Staff Gauge Reading. The correction factor is used to correct all previously data collected.

Form 3: Example of a continuous recorder water level sensor data sheet.

CONTINUOUS RECORDER WATER LEVEL SENSOR DATA SHEET

Project: ____________ Station: ____________ Basin: ____________

Date of Installation: ____________ Time (CST): ____________ Agency: ____________

Field Personnel: ____________

Continuous Recorder: ________ (Manufacturer) ________ (Model) ________ (Serial Number)

________ (Overall length) ________ (Top to water level sensor)

☐ Wooden Post

________ (ft) A. Nail to top of post

________ (ft) B. Nail to bottom of continuous recorder

________ (ft) C. Nail to water level sensor

________ (ft) D. Nail to water line

________ (ft) E. Nail to subsurface

________ (ft) F. Water depth

________ (ft) G. Penetration depth

________ (ft) H. Total pole length

☐ Mono-Pole

________ (ft) A. Top of 1/4" hole to top of pipe

________ (ft) B. Top of 1/4" hole to bottom of continuous recorder

________ (ft) C. Top of 1/4" hole to water level sensor

________ (ft) D. Top of 1/4" hole to water line

________ (ft) E. Top of 1/4" hole to subsurface

________ (ft) F. Water depth

________ (ft) G. Penetration depth

________ (ft) H. Total pole length

________ (ft) I. Mud line to load plate (if not resting on subsurface)

________ (ft) J. Amount of casing removed (if damage was done during installation)

Form 4: Example of a continuous recorder calibration data sheet.

Continuous Recorder Calibration Sheet

Project & Name | Station | Basin / Location | Date & CSTime

Constant Recorder | Serial Number | Dirty Battery Volts | Sonde Date &Time

Calibration Instrument | Serial Number | Collected By | Deployed Date &Time

Download Filename | No. of samples | Log Successful | Marsh Elevation (NAVD) | Agency

Dirty Reading	Temp (°C)	SpCond (µS/cm)	Salinity (ppt)	Depth (ft)	Depth Out of Water (ft)	SpCond Difference
Constant Recorder						
Calibration Instrument				% Difference		

Clean Reading	Temp (°C)	SpCond (µS/cm)	Salinity (ppt)	Depth (ft)	Depth Out of Water (ft)	SpCond Difference
Constant Recorder						
Calibration Instrument				% Difference		

Calibration Required? Y ☐ N ☐	Temp (°C)	SpCond (µS/cm)	Salinity (ppt)	Depth (ft)	Depth Out of Water (ft)	SpCond Difference
Constant Recorder						
Calibration Instrument				% Difference		

Standard (µS/cm) ☐ Calibration Accepted

Comments…

Staff Gauge (ft)

Water Level

Sensor Elevation (NAVD)

Water Level on Rod (ft)

Water Level (NAVD)

Staff Gauge (NAVD)

Staff Gauge - Water Level

Water Level Difference

% Difference

Mark to Sensor Distance (ft)

Mark Elevation (NAVD) (ft)

Deployment

Station | Location | Date & CSTime (*MM-DD-YY HH:MM*)

Constant Recorder | Serial Number | Battery Volts | ☐ Battery Changed | ☐ Desiccant Changed

Deploy Filename | Duration days | Interval minutes

Notes .....

Form 5: Example of a QA/QC Hydrologic data checklist.

HYDROLOGIC QA/QC CHECKLIST

Project / Site Number:____________________________ Date discrete data collected:________________ QA officer:________________________

Data Collector:_______________________ Time period for continuous data:______________________ Date approved:____________________

			QA Officer's Initials and Date
1	Y / N COMMENTS:	Was a field trip report generated ?	
2	Y / N COMMENTS:	Were all data entered in datasheets correctly (i.e., data entered in correct columns, all data in correct units)?	
3	Y / N COMMENTS:	Were discrete data entered correctly into Excel? Were any data missing?	
4	Y / N COMMENTS:	Were continuous recorder calibration sheets entered correctly into Excel?	
5	Y / N COMMENTS:	Were continuous data entered correctly into Excel (e.g., time, date, hydrographic data)?	
6	Y / N COMMENTS:	Were specific conductance data shifted for biofouling? If not, list station # and recorder id #.	
7	Y / N COMMENTS:	Were water level data shifted for biofouling? If not, list station # and recorder id #.	
8	Y / N COMMENTS:	Were all water level data converted to a known elevational datum (outside of Oracle)?	
9	Y / N COMMENTS:	Were data graphed?	
10	Y / N COMMENTS:	Was there a normal transition between the last datum record and the present datum record?	
11	Y / N COMMENTS:	Were different recorders deployed than retrieved? If so, was the Excel Recorder Deployment file updated?	
12	Y / N COMMENTS:	Were discrete data entered correctly into SONRIS? Were any data missing?	
13	Y / N COMMENTS:	Were continuous data entered correctly into SONRIS? Were any data missing?	
		Final QA Officer's Initials and Date	

Form 6: Example of a discrete hydrographic data sheet.

Discrete Hydrographic Data Sheet

Date ____________ Project ____________ Sheet ______ of ______

Instrument ____________ Serial No. ____________ Calibration Solution ____________

Personnel ____________ Agency/Company ____________

Station	CST Time (24 hr)	Staff Gauge (ft)	Depth (ft)		Temp (C)	Sp. Cond. (□S/cm)	Salinity (ppt)	NOTES
				Bottom				
				Surface				
				Bottom				
				Surface				
				Bottom				
				Surface				
				Bottom				
				Surface				
				Bottom				
				Surface				
				Bottom				
				Surface				
				Bottom				
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				Bottom				
				Surface				
				Bottom				
				Surface				
				Bottom				
				Surface				
				Bottom				
				Surface				
				Bottom				
				Surface				
				Bottom				
				Surface				

Form 7: Example of a monthly hand-held salinity meter calibration sheet.

Monthly Hand-held Salinity Meter Calibration Data Sheet

Date	Manufacturer / Model	Serial Number	Instrument Appearance	Probe Appearance	Cable Appearance	Calibration Thermometer Temperature	Instrument Temperature	Temperature Difference	Battery level	Initials
			Clean or Dirty*	Clean or Dirty*	Clean / Dirty / Cuts#	°C	°C	°C	Ok or Low	

* If the instrument is dirty, it should be indicated and then it should be cleaned to prevent any damages.
# If cuts are found on the cable, then the instrument needs to be sent in for repairs unless the cuts do not penetrate the exterior coating.

Form 8: Example of a generic QA/QC checklist.

QA/QC CHECKLIST

DATA TYPE: ___RSET ___Accretion ___Discrete ___Soil Porewater
___Herb. (Natural) Vegetation ___Herb. (Planted) Vegetation ___Forest ___SAV

PROJECT:________________________________ Data Collection Date(s):________________
SITE / STATION(S):_________________________ Date Received:______________________
_______________________________________ Date QA/QC Completed:________________

Data Collection Personnel:____
Data Entry Personnel:____

							QA/QC Initials
1	Was a field trip report generated? YES / NO						
2	Did the field trip report have the required information, the correct information, and the proper format?			YES (DATE)	NO (DATE)	Comments	
	A	Project					
	B	Basin					
	C	Purpose					
	D	Field Personnel					
	E	Date(s) of Trip					
	F	Weather Conditions					
	G	Logistical Information					
	H	Biological Information					
	F	Format					
3	Were the data sheets filled to completion? YES / NO If no, then add comments or indicate on the copied data sheets.						
4	Were the data entered into the Excel spreadsheet correctly? YES / NO Applicable YES / NO If no, then add comments or indicate on the copied data sheets.						
5	Were the data entered into SONRIS correctly? YES / NO Applicable YES / NO If no, then add comments or indicate on the copied data sheets.						

Form 9: Example of a floating marsh mat recorder calibration data sheet.

Floating Marsh Mat Recorder Calibration Sheet

Project & Name

Station

Basin / Location

Date & CSTime

Constant Recorder

Serial Number

Dirty Battery Volts

Sonde Date &Time

Calibration Instrument

Serial Number

Collected By

Deployed Date &Time

Download Filename

No. of Samples

Log Successful

Agency

Dirty Reading	Temp (C)	SpCond (uS/cm)	Salinity (ppt)	Depth (ft)	Depth Out of Water	SpCond Difference
Constant Recorder						
Calibration Instrument						% Difference

Clean Reading	Temp (C)	SpCond (uS/cm)	Salinity (ppt)	Depth (ft)	Depth Out of Water	SpCond Difference
Constant Recorder						
Calibration Instrument						% Difference

Staff Gauge (ft)

Staff Gauge (NAVD)

Marsh Elevation (NAVD)

Water Level Difference

% Difference

Mat to Sensor Distance (ft)

Water Level

SHIFT

Calibration Required

Standard (uS/cm)

Calibration Accepted

Dessicant changed

Comments .....

Deployment

Station

Location

Date & CSTime (*MM-DD-YY HH:MM*)

Constant Recorder

Serial Number

Battery Volts

Battery Changed

Deploy Filename

Duration days

Interval minutes

Notes .....

Form 10: Example of a static marsh mat recorder calibration sheet.

Static Marsh Mat Recorder Calibration Sheet

Project Name ________ Station Number ________ Location ________

Date & CSTime ________ Field Personnel ________ Agency ________

Continuous Recorder Manufacturer and Model ________ Serial Number ________

Dirty Readings

Continuous Recorder

Date	CSTime	Measured Level (ft)	Battery Volts	Distance Difference

Manual Reading

Top of platform to marsh surface (ft)	Marsh surface to top of water	% Difference

Download

Start Date & CSTime ________ Complete ☐ YES ☐ NO

End Date & CSTime ________ Successful ☐ YES ☐ NO

Pulley Precision Check

Known distance of pulley rotation ________

Measured Level (ft)

Before ________ Difference ________

After ________ % Difference ________

Acceptable ☐ YES ☐ NO Instrument Replaced ☐ YES ☐ NO

Clean Readings

Continuous Recorder

Date	CSTime	Measured Level (ft)	Battery Volts	Distance Difference

Manual Reading

Top of platform to marsh surface (ft)	Marsh surface to top of water	% Difference

Continuous Recorder Adjustment ☐ YES ☐ NO

Distance Adjustment Made ________ Measured Level (ft) ________

Battery Changed ☐ YES ☐ NO

Elevation

Top of Platform (NAVD, FT) ________

Marsh Surface (NAVD, FT) ________

Staff Gauge (NAVD, FT) ________

Deployment

Date & CSTime	Continuous Recorder Manufacturer and Model	Serial Number

Comment/Notes

Form 11: Example of a soil porewater salinity data sheet.

Soil Porewater Salinity Data Sheet

Project Name ______ Station Number ______ Basin ______

Date and CSTime ______ Field Personnel ______ Agency ______

Salinity Meter Manufacturer and Model Number ______ Serial Number ______

Salinity Meter Calibrated? Y ☐ N ☐

Calibration Standard ______

Replicate	Depth (cm)	Temperature (°C)	SpCond. (µS/cm)	Salinity (ppt)
1	10			
2	10			
3	10			
1	30			
2	30			
3	30			

Is water present on the marsh/swamp surface? ______

If yes, record the following for the surface water:

Temperature (°C) ☐

Salinity (ppt) ☐

SpCond (µS/cm) ☐

Notes:

Form 12: Example of a surface elevation table data sheet

Surface Elevation Table (SET) Data Sheet

Distance from top of rod to top of table (mm): ________________

Project: ________________ Basin: ________________

Station: ________________ Group: ________________

Sample Date: __________ Time: __________ Establishment Date: __________ Time: __________

SET ID: ________________ Organization: ________________

Measured by: ________________ Field personnel: ________________

Pin	Direction (Degrees)	Pin Height (mm)	Comments (description that pertain to problems with reading)
1			
2			
3			
4			
5			
6			
7			
8			
9			
1			
2			
3			
4			
5			
6			
7			
8			
9			
1			
2			
3			
4			
5			
6			
7			
8			
9			
1			
2			
3			
4			
5			
6			
7			
8			
9			

Site Conditions (weather, water level related to marsh surface, dominant plant species, etc.):

Form 13: Example of an accretion measurement data sheet

Accretion Measurement Data Sheet

Feldspar Cryogenic Coring Technique

Project: ______________________________ Date: ______________________

Personnel: ____________________________ Measurer of Cores: ______________

Plot Establishment Date: ______________________

			Cryo-Core		Accretion Measurements (mm)				Core Condition (Excellent, Good, Fair, Poor)
Station	Group	Time	X-Coor.	Y-Coor.					

Notes:

Form 14: Example of a natural vegetation sampling data sheet

Natural Vegetation Sampling Data Sheet

Modified Braun-Blanquet Technique

Sample Type: Stratified_____ Random_____ Transect_____

Project: ____________________________________ Station: ________________________ Group: _______________

Personnel: _________________________________ Plot Size (m^2): ___________________ Date: _______________

Station Coordinates: ____________________________ Organization: ____

Plant Community Type: _____Freshwater _____Intermediate _____Brackish _____Saline _____Cypress-Tupelo Swamp
_____Other (describe) ____

Percent Cover: Total Cover _____% Bare Ground_____% Tree _____% Shrub _____% Herbaceous _____% Carpet _____%

Average Height: Dominant Height _____(cm) Tree _____(cm) Shrub _____(cm) Herbaceous _____(cm) Carpet _____(cm)

Species List

Scientific Name Common Name	% Cover	B-B Rank	IN / OUT	Additional Species Description

B-B Rank: (5) 76-100%, (4) 51-75%, (3) 26-50%, (2) 6-25%, (1) 1-5%, (+) <1%, (r) Solitary

Comments:

Form 15: Example of a forest community data sheet

Forest Community Data Sheet

Sample Type: Stratified_____ Random_____ Transect_____

Project: ______________________________________ Station: _________________________ Group: _______________

Personnel: ___________________________________ Plot Size (m^2): ____________________ Date: _______________

Station Coordinates: _____________________________ Organization: ____

Plant Community Type: _____Cypress-Tupelo Swamp _____Bottomland Hardwood Forest
_____Other (describe) ____

Species List with Diameter at Breast Height (DBH)

Scientific Name	Common Name	Diameter (cm)	Shifted DBH (Y/N)	Distance aboveground (cm)	Additional Species Description

Notes/Comments:

Form 16: Example of a submerged aquatic vegetation transect data sheet

Submerged Aquatic Vegetation (SAV) Transect Data Sheet

Modified Rake Technique

Project:________________________________ Basin:____ Sheet: ____of____

Station:________________________________ Emergent Vegetation Community:_______________________

No. of Samples:_________________________ Personnel:____ Agency:_____________

Species Abbreviations

A = Alga (A1=alga1, etc)
Ca = Cabomba caroliniana
Ch = Chara (Ch1 = sp.1, etc.)
Ce = Ceratophyllum demersum
E = Eleocharis (E1 = sp.1, etc.)
M = Myriophyllum spicatum
Na = Najas guadalupensis
Ne = Nelumbo lutea
O = Ottelia alismatoides
P = Potamogeton (P1= sp.1, etc)
R = Ruppia maritima
V = Vallisneria americana
Z = Zannichellia palustris
____= ________________
____= ________________

Transect No.	Sample No.	Species Present	Depth (cm)	Water Temp (C)	Sp.Cond. (µS/cm)	Salinty (ppt)	Transect No.	Sample No.	Species Present	Depth (cm)	Water Temp(C)	Sp.Cond. (µS/cm)	Salinty (ppt)
	1							21					
	2							22					
	3							23					
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	5							25					
	6							26					
	7							27					
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	11							31					
	12							32					
	13							33					
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	15							35					
	16							36					
	17							37					
	18							38					
	19							39					
	20							40					

Notes:

APPENDIX A

DATA DELIVERABLE FORMATS

The data deliverable formats contained in this appendix provides the column headings and order in which the LDNR/CRD requires the final deliverable product. Static marsh mat recorder data, forest vegetation data, and soil properties data formats are still under development.

Continuous salinity and water level data format.

Station	Date	Time	Raw Water Temp.	Adjusted Water Temp.	Raw Specific Conductance	Adjusted Specific Conductance	Raw Salinity	Adjusted Salinity	Raw Water Level	Adjusted Water Level	Raw Water Elev. To Marsh	Adjusted Water Elev. To Marsh	Raw Water Elev. To Datum	Adjusted Water Elev. To Datum	Raw Battery	Adjusted Battery	Marsh Elevation To Datum
	(MM/DD/YYYY)	(HH:MM:SS)	(^{0}C)	(^{0}C)	(uS/cm)	(uS/cm)	(ppt)	(ppt)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(V)	(V)	(ft)
TE28-07R	01/01/2003	00:00:08	14.75	14.75	351.10	351.10	0.17	0.17	1.95	1.95				1.47	12.00	12.00	
TE28-07R	01/01/2003	01:00:08	14.65	14.65	356.40	356.40	0.17	0.18	1.95	1.95				1.47	12.00	12.00	
TE28-07R	01/01/2003	02:00:08	14.53	14.53	359.80	359.80	0.17	0.18	1.95	1.95				1.47	12.00	12.00	
TE28-07R	01/01/2003	03:00:08	14.39	14.39	358.20	358.20	0.17	0.18	1.95	1.95				1.47	12.00	12.00	
TE28-07R	01/01/2003	04:00:08	14.22	14.22	352.40	352.40	0.17	0.17	1.94	1.94				1.46	12.00	12.00	
TE28-07R	01/01/2003	05:00:08	14.03	14.03	345.00	345.00	0.17	0.17	1.94	1.94				1.46	12.00	12.00	
TE28-07R	01/01/2003	06:00:08	13.87	13.87	335.50	335.50	0.16	0.16	1.93	1.93				1.45	12.00	12.00	
TE28-07R	01/01/2003	07:00:08	13.73	13.73	322.90	322.90	0.16	0.16	1.91	1.91				1.43	12.00	12.00	
TE28-07R	01/01/2003	08:00:08	13.58	13.58	315.10	315.10	0.15	0.15	1.90	1.90				1.42	12.00	12.00	
TE28-07R	01/01/2003	09:00:08	13.51	13.51	308.50	308.50	0.15	0.15	1.89	1.89				1.41	12.00	12.00	
TE28-07R	01/01/2003	10:00:08	13.54	13.54	304.30	304.30	0.15	0.15	1.88	1.88				1.40	12.00	12.00	
TE28-07R	01/01/2003	11:00:08	13.63	13.63	300.00	300.00	0.14	0.15	1.85	1.85				1.37	12.00	12.00	
TE28-07R	01/01/2003	12:00:08	13.67	13.67	297.60	297.60	0.14	0.14	1.84	1.84				1.36	12.00	12.00	
TE28-07R	01/01/2003	13:00:08	13.80	13.80	295.10	295.10	0.14	0.14	1.82	1.82				1.34	12.00	12.00	
TE28-07R	01/01/2003	14:00:08	13.98	13.98	295.10	295.10	0.14	0.14	1.80	1.80				1.32	12.00	12.00	
TE28-07R	01/01/2003	15:00:08	14.08	14.08	295.60	295.60	0.14	0.14	1.79	1.79				1.31	12.00	12.00	
TE28-07R	01/01/2003	16:00:08	14.12	14.12	296.70	296.70	0.14	0.14	1.79	1.79				1.31	12.00	12.00	
TE28-07R	01/01/2003	17:00:08	14.08	14.08	296.60	296.60	0.14	0.14	1.79	1.79				1.31	12.00	12.00	
TE28-07R	01/01/2003	18:00:08	14.00	14.00	296.80	296.80	0.14	0.14	1.79	1.79				1.31	12.00	12.00	
TE28-07R	01/01/2003	19:00:08	13.91	13.91	296.00	296.00	0.14	0.14	1.79	1.79				1.31	12.00	12.00	
TE28-07R	01/01/2003	20:00:08	13.78	13.78	295.70	295.70	0.14	0.14	1.80	1.80				1.32	12.00	12.00	
TE28-07R	01/01/2003	21:00:08	13.66	13.66	295.30	295.30	0.14	0.14	1.81	1.81				1.33	12.00	12.00	
TE28-07R	01/01/2003	22:00:08	13.55	13.55	294.90	294.90	0.14	0.14	1.82	1.82				1.34	12.00	12.00	
TE28-07R	01/01/2003	23:00:08	13.45	13.45	294.60	294.60	0.14	0.14	1.84	1.84				1.36	12.00	12.00	
TE28-07R	01/02/2003	00:00:08	13.37	13.37	294.70	294.70	0.14	0.14	1.86	1.86				1.38	12.00	12.00	

Discrete water quality data format.

Station	Date	Time	Staff Gauge	Depth	Bottom Temp	Surface Temp	Bottom Sp.Cond.	Surface Sp.Cond	Bottom Salinity	Surface Salinity	Bottom DO	Surface DO	Bottom pH	Surface pH	Bottom Velocity	Surface Velocity	Secchi	Fecal Coliform
	mm/dd/yyyy	CST(24hr)	FT	FT	C	C	□S/cm	□S/cm	PPT	PPT	mg/L	mg/L			FT/s	FT/s	FT	MPN/100ml
TE28-169	02/04/2002	13:41		0.5	14.4	14.4	1701	1701	0.9	0.9								
TE28-168	02/04/2002	13:42		1	14.2	14.2	1715	1715	0.9	0.9								
TE28-170	02/04/2002	13:40		1	14.5	14.5	1469	1469	0.7	0.7								
TE28-171	02/04/2002	13:38		1.5	14.2	14.2	666	666	0.3	0.3								
TE28-172	02/04/2002	13:48		1.5	14.2	14.2	952	952	0.5	0.5								
TE28-177R	02/04/2002	11:16		1	13.1	13.1	1923	1923	1	1								
TE28-176R	02/04/2002	11:14		0.5	13.8	13.8	1946	1946	1	1								
TE28-174R	02/04/2002	11:04		1	12.9	12.9	2055	2055	1.1	1.1								
TE28-173R	02/04/2002	11:07		0.6	12.4	12.4	1643	1643	0.8	0.8								
TE28-05R	02/04/2002	11:12	0.63	1.5	13.3	13.3	1920	1920	1	1								
TE28-02	02/04/2002	13:45	0.84	1.5	14.4	14.4	761	761	0.4	0.4								
TE28-07R	02/04/2002	14:18	1.15	5	14.1	14.2	253	253	0.1	0.1								
TE28-178	02/07/2002	10:45		1	8.4	8.4	959	959	0.5	0.5								
TE28-182	02/07/2002	12:06		1	11.3	11.3	539	539	0.2	0.2								
TE28-187R	02/07/2002	10:27		2.5	8.5	8.5	3430	3431	1.8	1.8								
TE28-185R	02/07/2002	10:29		2.5	8.6	8.7	3309	3302	1.7	1.7								
TE28-183R	02/07/2002	10:32		2	8.3	8	3494	3768	1.9	2								
TE28-184R	02/07/2002	10:35		1	8.7	8.7	3484	3484	1.8	1.8								
TE28-186R	02/07/2002	10:37		1	8.2	8.2	3260	3260	1.7	1.7								
TE28-159	02/07/2002	13:08		2	10.2	10.2	520	523	0.3	0.3								
TE28-161	02/07/2002	13:12		1	11.7	11.7	508	508	0.2	0.2								
TE28-162	02/07/2002	13:45		2	10.5	10.5	304	300	0.1	0.1								

Continuous marsh mat water level and salinity data format.

Station	Date	Time	Raw Water Temp.	Adjusted Water Temp.	Raw Specific Conductance	Adjusted Specific Conductance	Raw Salinity	Adjusted Salinity	Raw Water Level	Adjusted Water Level	Raw Water Elev. To Marsh	Adjusted Water Elev. To Marsh	Raw Water Elev. To Datum	Adjusted Water Elev. To Datum	Raw Battery	Adjusted Battery	Raw Marsh Mat Elevation	Adjusted Marsh Mat Elevation
	(MM/DD/YY)	(HH:MM:SS)	(0C)	(0C)	(uS/cm)	(uS/cm)	(ppt)	(ppt)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(V)	(V)	(ft)	(ft)
TE28-218	01/01/2002	00:00:08	16.81	16.81	2350.50	2205.78	1.22	1.18	2.84	2.84		0.06		1.15	5.90	5.90	-0.06	1.09
TE28-218	01/01/2002	01:00:08	16.86	16.86	2400.10	2255.16	1.24	1.21	2.84	2.84		0.06		1.15	5.90	5.90	-0.06	1.08
TE28-218	01/01/2002	02:00:08	16.88	16.88	2451.40	2306.24	1.27	1.24	2.84	2.84		0.06		1.14	5.90	5.90	-0.06	1.09
TE28-218	01/01/2002	03:00:08	16.90	16.90	2489.30	2343.92	1.29	1.26	2.84	2.84		0.06		1.14	5.90	5.90	-0.06	1.08
TE28-218	01/01/2002	04:00:08	16.89	16.89	2516.90	2371.31	1.31	1.27	2.84	2.84		0.06		1.15	5.90	5.90	-0.06	1.09
TE28-218	01/01/2002	05:00:08	16.84	16.84	2532.10	2386.29	1.31	1.28	2.84	2.84		0.06		1.15	5.90	5.90	-0.06	1.09
TE28-218	01/01/2002	06:00:08	16.79	16.79	2527.80	2381.77	1.31	1.28	2.84	2.84		0.06		1.15	5.90	5.90	-0.06	1.09
TE28-218	01/01/2002	07:00:08	16.74	16.74	2518.90	2372.65	1.31	1.27	2.84	2.84		0.06		1.15	5.90	5.90	-0.06	1.10
TE28-218	01/01/2002	08:00:08	16.68	16.68	2509.40	2362.93	1.30	1.27	2.84	2.84		0.06		1.16	5.90	5.90	-0.06	1.09
TE28-218	01/01/2002	09:00:08	16.60	16.60	2503.20	2356.51	1.30	1.26	2.84	2.84		0.06		1.16	5.90	5.90	-0.06	1.10
TE28-218	01/01/2002	10:00:08	16.57	16.57	2499.40	2352.49	1.30	1.26	2.85	2.85		0.07		1.16	5.90	5.90	-0.07	1.10
TE28-218	01/01/2002	11:00:08	16.57	16.57	2493.80	2346.67	1.29	1.26	2.84	2.84		0.06		1.16	5.90	5.90	-0.06	1.09
TE28-218	01/01/2002	12:00:08	16.57	16.57	2483.50	2336.15	1.29	1.25	2.84	2.84		0.06		1.16	5.90	5.90	-0.06	1.10
TE28-218	01/01/2002	13:00:08	16.54	16.54	2463.10	2315.54	1.28	1.24	2.85	2.85		0.07		1.16	5.90	5.90	-0.07	1.10
TE28-218	01/01/2002	14:00:08	16.52	16.52	2452.40	2304.62	1.27	1.24	2.85	2.85		0.07		1.16	5.90	5.90	-0.07	1.09
TE28-218	01/01/2002	15:00:08	16.54	16.54	2452.50	2304.50	1.27	1.24	2.85	2.85		0.07		1.17	5.90	5.90	-0.07	1.09
TE28-218	01/01/2002	16:00:08	16.58	16.58	2455.20	2306.98	1.27	1.24	2.85	2.85		0.07		1.17	5.90	5.90	-0.07	1.09
TE28-218	01/01/2002	17:00:08	16.54	16.54	2452.80	2304.36	1.27	1.24	2.86	2.86		0.08		1.18	5.90	5.90	-0.08	1.10
TE28-218	01/01/2002	18:00:08	16.49	16.49	2447.80	2299.14	1.27	1.23	2.87	2.87		0.09		1.19	5.90	5.90	-0.09	1.10
TE28-218	01/01/2002	19:00:08	16.43	16.43	2437.70	2288.82	1.26	1.23	2.87	2.87		0.09		1.20	5.90	5.90	-0.09	1.11
TE28-218	01/01/2002	20:00:08	16.40	16.40	2434.30	2285.20	1.26	1.23	2.88	2.88		0.10		1.20	5.90	5.90	-0.10	1.10
TE28-218	01/01/2002	21:00:08	16.42	16.42	2442.50	2293.18	1.27	1.23	2.88	2.88		0.10		1.20	5.90	5.90	-0.10	1.10
TE28-218	01/01/2002	22:00:08	16.44	16.44	2447.10	2297.56	1.27	1.23	2.88	2.88		0.10		1.20	5.90	5.90	-0.10	1.10
TE28-218	01/01/2002	23:00:08	16.41	16.41	2450.80	2301.05	1.27	1.23	2.87	2.87		0.09		1.20	5.90	5.90	-0.09	1.10
TE28-218	01/02/2002	00:00:08	16.46	16.46	2464.30	2314.33	1.28	1.24	2.87	2.87		0.09		1.20	5.90	5.90	-0.09	1.10
TE28-218	01/02/2002	01:00:08	16.56	16.56	2509.60	2359.41	1.30	1.27	2.87	2.87		0.09		1.19	5.90	5.90	-0.09	1.10
TE28-218	01/02/2002	02:00:08	16.64	16.64	2585.60	2435.19	1.34	1.31	2.86	2.86		0.08		1.18	5.90	5.90	-0.08	1.09

Soil porewater data format.

Station	Date	Time	Group	Depth	Water Temperature	Specific Conductance	Salinity
	(MM/DD/YYYY)	(HH:MM)		(cm)	(°C)	(µS/cm)	(ppt)
CRMS0395	3/15/2004	10:06	A	10	17.2	295	0.14
CRMS0395	3/15/2004	10:07	B	10	17.1	296	0.14
CRMS0395	3/15/2004	10:08	C	10	17.3	298	0.14
CRMS0395	3/15/2004	10:09	A	30	17	292	0.14
CRMS0395	3/15/2004	10:10	B	30	17.4	292	0.14
CRMS0395	3/15/2004	10:11	C	30	17.2	294	0.14

Surface elevation table (SET) data format.

Station ID	Group	Date (mm/dd/yyyy)	Time (hh:mm)	Establishment Date (mm/dd/yyyy)	Establishment Time (hh:mm)	Direction	Pin Number	Pin Height (mm)	SET ID	Organization	Personnel	Comments
CRMS-0395	REF	1/1/1997	13:32	12/1/1995	15:20	N	1	223	LDNR 1	LA DEPT OF NAT RES (CRDT)	D. Lee; T. Hubbell	
CRMS-0395	REF	1/1/1997	13:32	12/1/1995	15:20	N	2	223	LDNR 1	LA DEPT OF NAT RES (CRDT)	D. Lee; T. Hubbell	
CRMS-0395	REF	1/1/1997	13:32	12/1/1995	15:20	N	3	237	LDNR 1	LA DEPT OF NAT RES (CRDT)	D. Lee; T. Hubbell	
CRMS-0395	REF	1/1/1997	13:32	12/1/1995	15:20	N	4	231	LDNR 1	LA DEPT OF NAT RES (CRDT)	D. Lee; T. Hubbell	
CRMS-0395	REF	1/1/1997	13:33	12/1/1995	15:20	N	5	231	LDNR 1	LA DEPT OF NAT RES (CRDT)	D. Lee; T. Hubbell	
CRMS-0395	REF	1/1/1997	13:33	12/1/1995	15:20	N	6	231	LDNR 1	LA DEPT OF NAT RES (CRDT)	D. Lee; T. Hubbell	
CRMS-0395	REF	1/1/1997	13:33	12/1/1995	15:20	N	7	235	LDNR 1	LA DEPT OF NAT RES (CRDT)	D. Lee; T. Hubbell	
CRMS-0395	REF	1/1/1997	13:33	12/1/1995	15:20	N	8	234	LDNR 1	LA DEPT OF NAT RES (CRDT)	D. Lee; T. Hubbell	
CRMS-0395	REF	1/1/1997	13:34	12/1/1995	15:20	N	9	229	LDNR 1	LA DEPT OF NAT RES (CRDT)	D. Lee; T. Hubbell	
CRMS-0395	REF	1/1/1997	13:34	12/1/1995	15:20	E	1	251	LDNR 1	LA DEPT OF NAT RES (CRDT)	D. Lee; T. Hubbell	
CRMS-0395	REF	1/1/1997	13:34	12/1/1995	15:20	E	2	251	LDNR 1	LA DEPT OF NAT RES (CRDT)	D. Lee; T. Hubbell	
CRMS-0395	REF	1/1/1997	13:34	12/1/1995	15:20	E	3	257	LDNR 1	LA DEPT OF NAT RES (CRDT)	D. Lee; T. Hubbell	
CRMS-0395	REF	1/1/1997	13:35	12/1/1995	15:20	E	4	233	LDNR 1	LA DEPT OF NAT RES (CRDT)	D. Lee; T. Hubbell	
CRMS-0395	REF	1/1/1997	13:35	12/1/1995	15:20	E	5	260	LDNR 1	LA DEPT OF NAT RES (CRDT)	D. Lee; T. Hubbell	
CRMS-0395	REF	1/1/1997	13:35	12/1/1995	15:20	E	6	270	LDNR 1	LA DEPT OF NAT RES (CRDT)	D. Lee; T. Hubbell	
CRMS-0395	REF	1/1/1997	13:35	12/1/1995	15:20	E	7	250	LDNR 1	LA DEPT OF NAT RES (CRDT)	D. Lee; T. Hubbell	
CRMS-0395	REF	1/1/1997	13:36	12/1/1995	15:20	E	8	230	LDNR 1	LA DEPT OF NAT RES (CRDT)	D. Lee; T. Hubbell	
CRMS-0395	REF	1/1/1997	13:36	12/1/1995	15:20	E	9	210	LDNR 1	LA DEPT OF NAT RES (CRDT)	D. Lee; T. Hubbell	
CRMS-0395	REF	1/1/1997	13:36	12/1/1995	15:20	S	1	281	LDNR 1	LA DEPT OF NAT RES (CRDT)	D. Lee; T. Hubbell	
CRMS-0395	REF	1/1/1997	13:36	12/1/1995	15:20	S	2	295	LDNR 1	LA DEPT OF NAT RES (CRDT)	D. Lee; T. Hubbell	
CRMS-0395	REF	1/1/1997	13:37	12/1/1995	15:20	S	3	243	LDNR 1	LA DEPT OF NAT RES (CRDT)	D. Lee; T. Hubbell	
CRMS-0395	REF	1/1/1997	13:37	12/1/1995	15:20	S	4	122	LDNR 1	LA DEPT OF NAT RES (CRDT)	D. Lee; T. Hubbell	
CRMS-0395	REF	1/1/1997	13:37	12/1/1995	15:20	S	5	185	LDNR 1	LA DEPT OF NAT RES (CRDT)	D. Lee; T. Hubbell	
CRMS-0395	REF	1/1/1997	13:37	12/1/1995	15:20	S	6	282	LDNR 1	LA DEPT OF NAT RES (CRDT)	D. Lee; T. Hubbell	
CRMS-0395	REF	1/1/1997	13:38	12/1/1995	15:20	S	7	266	LDNR 1	LA DEPT OF NAT RES (CRDT)	D. Lee; T. Hubbell	
CRMS-0395	REF	1/1/1997	13:38	12/1/1995	15:20	S	8	254	LDNR 1	LA DEPT OF NAT RES (CRDT)	D. Lee; T. Hubbell	
CRMS-0395	REF	1/1/1997	13:38	12/1/1995	15:20	S	9	241	LDNR 1	LA DEPT OF NAT RES (CRDT)	D. Lee; T. Hubbell	

Accretion data format.

Project Number	Station #	Group	Date	Time	Coordinates X	Coordinates Y	Accretion Measurements (mm) Meas. #1	Meas. #2	Meas. #3	Meas. #4
			(MM/DD/YYYY)	(HH:MM:SS)			(mm)	(mm)	(mm)	(mm)
TE-28	TE28-308	CTU1	09/05/2001	15:10:00	1	3				
TE-28	TE28-308	CTU1	09/05/2001	15:11:00	2	1	2	2	2	2
TE-28	TE28-309	CTU1	09/05/2001	15:13:00	0	3				
TE-28	TE28-309	CTU1	09/05/2001	15:14:00	3	3	18	25	27	25
TE-28	TE28-310	CTU1	09/05/2001	15:17:00	0	4	13	2	2	2
TE-28	TE28-311	CTU1	09/05/2001	14:52:00	1	2	2	2	2	2
TE-28	TE28-312	CTU1	09/05/2001	14:53:00	1	3	2	2	2	2
TE-28	TE28-313	CTU1	09/05/2001	14:55:00	2	3	22	21	15	22
TE-28	TE28-314	CTU1	09/05/2001	15:29:00	3	0	2	2	2	2
TE-28	TE28-315	CTU1	09/05/2001	15:32:00	3	1	2	2	2	2
TE-28	TE28-316	CTU1	09/05/2001	15:34:00	2	3	2	2	2	2
TE-28	TE28-317	CTU1	09/05/2001	14:18:00	4	1				
TE-28	TE28-318	CTU1	09/05/2001	14:19:00	4	4				
TE-28	TE28-318	CTU1	09/05/2001	14:21:00	3	0				
TE-28	TE28-319	CTU1	09/05/2001	14:23:00	0	4	2	2	2	2
TE-28	TE28-320	CTU1	09/05/2001	14:04:00	2	0	15	18	21	23
TE-28	TE28-321	CTU1	09/05/2001	14:06:00	0	1	2	2	2	2
TE-28	TE28-322	CTU1	09/05/2001	14:09:00	4	2	23	24	27	23
TE-28	TE28-338	CTU2	09/06/2001	08:52:00	1	2	30	25	26	27
TE-28	TE28-339	CTU2	09/06/2001	08:57:00	1	2				
TE-28	TE28-339	CTU2	09/06/2001	08:59:00	0	3	31	33	27	28
TE-28	TE28-340	CTU2	09/06/2001	09:01:00	1	1				
TE-28	TE28-340	CTU2	09/06/2001	09:03:00	1	4				

Emergent vegetation data format (1 of 3).

Station	Group	Plot Size (sq m)	Collection Date	Community	SampleType	VegetationType	% Cover Total	% Cover Tree	% Cover Shrub	% Cover Herb	% Cover Carpet	Avg Height Dominant (cm)
TE24-75	Bay	4	8/26/1999	Barrier Island	Random	Planted	20					100
TE24-75	Bay	4	8/26/1999	Barrier Island	Random	Planted	20					100
TE24-75	Bay	4	8/26/1999	Barrier Island	Random	Planted	20					
TE24-76	Bay	4	8/26/1999	Barrier Island	Random	Planted	30					100
TE24-76	Bay	4	8/26/1999	Barrier Island	Random	Planted	30					100
TE24-76	Bay	4	8/26/1999	Barrier Island	Random	Planted	30					100
TE24-76	Bay	4	8/26/1999	Barrier Island	Random	Planted	30					

Emergent vegetation format continued (2 of 3).

Avg Height Tree (cm)	Avg Height Shrub (cm)	Avg Height Herb (cm)	Avg Height Carpet (cm)	ScientificName	CommonName	%Cover	Braun-Blanquet Rank
				Spartina patens (Ait.) Muhl.	MARSHHAY CORDGRASS	15	2
				Cynodon dactylon (L.) Pers.	COMMON BERMUDAGRASS	5	1
				Bare Ground	Bare Ground	80	
				Sesbania herbacea (P. Mill.) McVaugh	bigpod sesbania		
				Spartina patens (Ait.) Muhl.	MARSHHAY CORDGRASS	16	2
				Cynodon dactylon (L.) Pers.	COMMON BERMUDAGRASS	14	2
				Bare Ground	Bare Ground	70	

Emergent vegetation format continued (3 of 3).

In/Out	Number Planted	Number Alive	Additional Species Description	Organization	Personnel
Both	16	16		LA DEPT OF NAT RES (CRDT)	L. Aucoin;J. Young;C. Thibodeaux
Both				LA DEPT OF NAT RES (CRDT)	L. Aucoin;J. Young;C. Thibodeaux
Both				LA DEPT OF NAT RES (CRDT)	L. Aucoin;J. Young;C. Thibodeaux
Out				LA DEPT OF NAT RES (CRDT)	L. Aucoin;J. Young;C. Thibodeaux
Both	16	13		LA DEPT OF NAT RES (CRDT)	L. Aucoin;J. Young;C. Thibodeaux
Both				LA DEPT OF NAT RES (CRDT)	L. Aucoin;J. Young;C. Thibodeaux
Both				LA DEPT OF NAT RES (CRDT)	L. Aucoin;J. Young;C. Thibodeaux

Submerged aquatic vegetation data format.

PROJECT	STATION	GROUP	DATE	COMMUNITY	SAMPLE NUMBER	SPECIES	DEPTH
			(MM/DD/YYYY)				(cm)
TE-28	TE28-158	CTU1	10/31/2002	FRESHWATER	1	Ceratophyllum demersum	100
TE-28	TE28-158	CTU1	10/31/2002	FRESHWATER	2	Ceratophyllum demersum	
TE-28	TE28-158	CTU1	10/31/2002	FRESHWATER	3	Ceratophyllum demersum	
TE-28	TE28-158	CTU1	10/31/2002	FRESHWATER	4	Ceratophyllum demersum	
TE-28	TE28-158	CTU1	10/31/2002	FRESHWATER	5	Ceratophyllum demersum	100
TE-28	TE28-158	CTU1	10/31/2002	FRESHWATER	6	Ceratophyllum demersum	
TE-28	TE28-158	CTU1	10/31/2002	FRESHWATER	7	Ceratophyllum demersum	
TE-28	TE28-158	CTU1	10/31/2002	FRESHWATER	8		
TE-28	TE28-158	CTU1	10/31/2002	FRESHWATER	9	Ceratophyllum demersum	
TE-28	TE28-158	CTU1	10/31/2002	FRESHWATER	10		
TE-28	TE28-158	CTU1	10/31/2002	FRESHWATER	11		70
TE-28	TE28-158	CTU1	10/31/2002	FRESHWATER	12	Ceratophyllum demersum	
TE-28	TE28-158	CTU1	10/31/2002	FRESHWATER	13		
TE-28	TE28-158	CTU1	10/31/2002	FRESHWATER	14		120

Marsh elevation survey data format.

LA DNR Survey -- PROJECT NAME

Station: BA02-55
Date and Time: APRIL 23, 2003 & 10:30
Staff Gauge Reading: 1.58 FT.
Marsh Flooded: YES

Point Number	Easting (UTM_NAD83_METERS)	Northing (UTM_NAD83_METERS)	Elevation (NAVD88_FEET)
1	766,129.90	3,271,789.89	1.456
2	766,115.57	3,271,789.89	1.402
3	766,101.61	3,271,789.89	1.429
4	766,087.41	3,271,789.89	1.384
5	766,071.05	3,271,789.89	1.353
6	766,070.96	3,271,775.12	1.484
7	766,086.52	3,271,775.12	1.337
8	766,101.32	3,271,775.12	1.497
9	766,116.98	3,271,775.12	1.502
10	766,132.05	3,271,775.12	1.466
11	766,070.96	3,271,752.77	1.511
12	766,086.52	3,271,752.77	1.347
13	766,101.32	3,271,752.77	1.281
14	766,116.98	3,271,752.77	1.312
15	766,132.05	3,271,752.77	1.423
16	766,070.96	3,271,718.46	1.444
17	766,086.52	3,271,718.46	1.602
18	766,101.32	3,271,718.46	1.399
19	766,116.98	3,271,718.46	1.455
20	766,132.05	3,271,718.46	1.389
AVERAGE MARSH ELEVATION			**1.42365**
MARSH ELEVATION			**1.42**

NOTES / INSTRUCTIONS:

1. Marsh elevation is the average of all the marsh shots.
2. Coordinate system must be properly labeled under the Northing and Easting headings.
3. Vertical datum must be properly labeled under the Elevation heading.
4. A new sheet must be generated for each station.