A Contractor's Guide to Minimum Standards

Required by

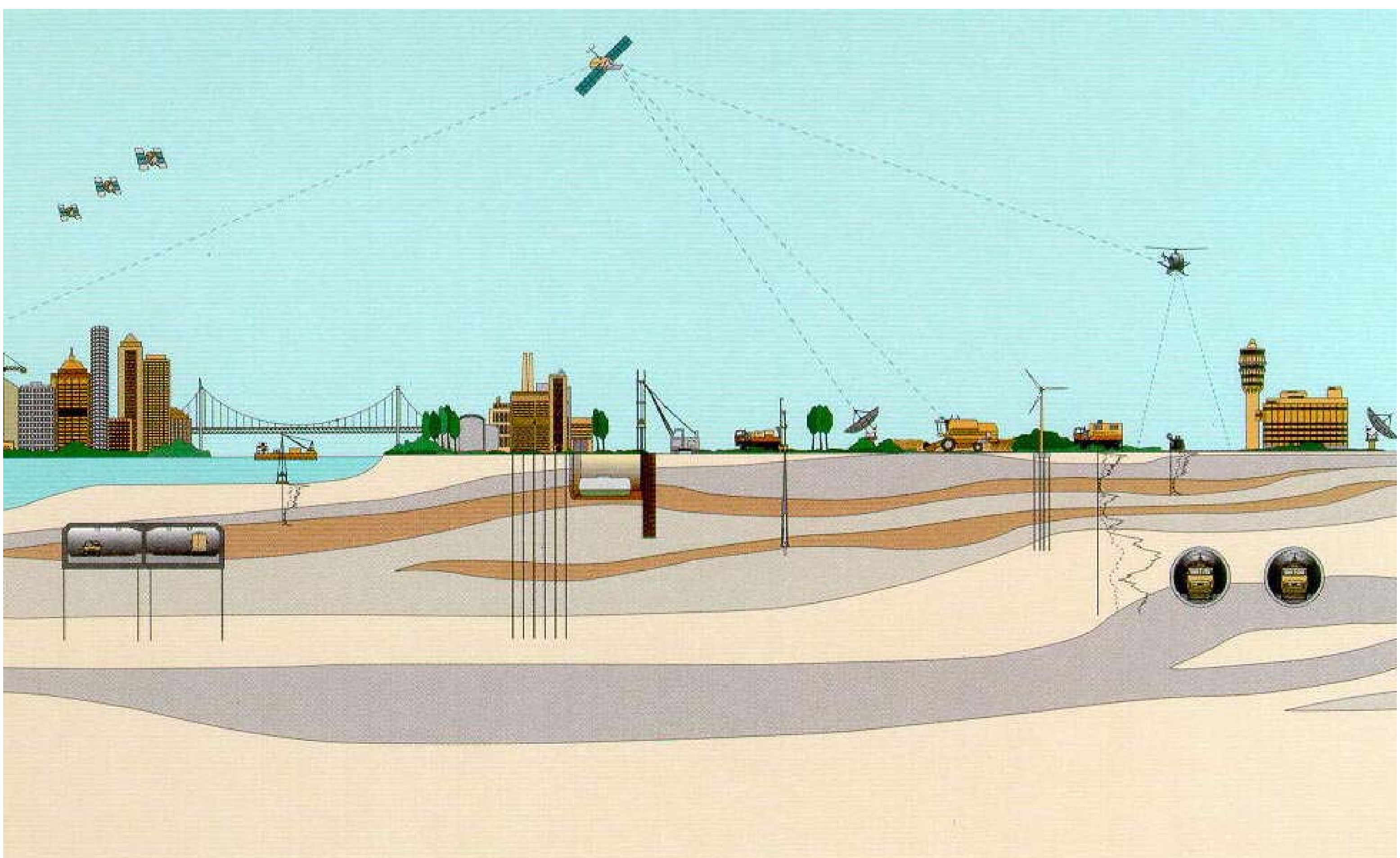
Louisiana Department of Natural Resources,

Coastal Restoration Division

FOR CONTRACTORS
PERFORMING GPS SURVEYS & ESTABLISHING GPS DERIVED ORTHOMETRIC HEIGHTS
Within the

Louisiana Coastal Zone Primary GPS Network

Prepared June 2003



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Section A
Introduction

A.1. Introduction

In an effort to maintain quality, consistency and accuracy when performing GPS surveys on projects contracted for the Louisiana Department of Natural Resources, CRD, it is imperative that all LADNR contractors recognize and follow the recommendations and guidelines established in this booklet. The information in this booklet should not intended to be used as a standard for contractors or surveyors performing GPS surveys for other agencies, federal or local, but as a minimum standard exclusively for surveyors contracted by the LADNR. This booklet was written as a general reference guide and is not intended to be a GPS training manual for individuals on the technical aspects of performing GPS surveys and assumes that survey contractors performing projects for LADNR will employ personnel that are educated and experienced in the basics of geodesy and GPS technology.

For more technical information on GPS-derived heights and in depth guidelines, refer to NOAA Technical Memorandum NOS NGS-58 developed by the National Geodetic Survey (NGS) in November 1997 titled "*Guidelines for Establishing GPS-Derived Ellipsoid Heights*", Version 4.3 and "A *Guide for Establishing GPS-Derived Orthometric Heights*", Version 1.1, as well as the U.S. Army Corps of Engineers Technical Letter No. 1110-1-183 dated April 1, 1998 and titled "*Using Differential GPS Positioning for Elevation Determination*".

A-2. The Louisiana Coastal Zone GPS Network

The LCZ Primary GPS Network was created to serve as a coastal wide GPS network adjusted to a common horizontal and vertical reference datum and is to be employed for establishing permanent secondary deep-rod monuments on a project-by-project basis. The Primary and Secondary control monuments in this network will serve as permanent reference markers for all LADNR projects such as marsh elevation surveys, installation and calibration of staff gages and continuous automatic recording gages (sondes), coastal erosion studies, hydrographic restoration projects, construction of breakwater barriers and water control structures, just to name a few. The 3-D positional values will be determined by the survey contractor using the latest GPS tools and technology and will base that information by utilizing the LCZ Primary GPS Network.

The LCZ Primary GPS Network commenced in 1999 and, at its inception, consisted of the re-adjustment of existing GPS networks that were already established on prior LADNR projects. A coastal GPS network was initially created using an existing NGS network of High Accuracy Reference Network monuments (HARN) and encompassed the western half of coastal Louisiana. This NGS HARN network serves as the backbone to the LCZ Primary GPS Network design. Currently, the Louisiana Coastal Zone GPS Network encompasses South Louisiana from Texas and Mississippi State Lines, south of Interstate 10 and was re-adjusted in August 2001 to incorporate the Continuously Operating Reference Stations (CORS).

LCZ Primary GPS Datasheets can be printed and downloaded from the GIS Interactive Map found on LDNR's SONRIS 2000 website at the following internet address:

http://sonris-www.dnr.state.la.us/www_root/sonris_portal_1.htm

With the advent of new CORS stations by the efforts of the NGS' National Height Modernization Program, efforts to include these stations in the GPS Network should be made by the LDNR Contractor. This could include, but not be limited to submitting GPS static data to NGS OPUS for an independent adjustment as a quality control measure to detect the possibility of gross errors. *(See Section F.2 for more detailed information on OPUS)*

A-3 Datums used for the LCZ Primary & Secondary GPS Network Adjustment

The horizontal datum used in this GPS network adjustment as determined by National Geodetic Survey (NGS) is the North American Datum of 1983 – NAD 83 (1992). NGS states on the NGS Datasheet that the horizontal coordinates were established by GPS observations and adjusted by National Geodetic Survey in September 1992.

The vertical datum referenced to in the vertical adjustment for determining orthometric heights is the North American Vertical Datum of 1988 (NAVD 88). Benchmarks with Vertcon adjustments were not used; only those with NAVD 88 adjustments were constrained to and then applied to the Geoid99 model.

Section B

Minimum Standards for Determining GPS-Derived Heights for the LADNR-LCZ Primary & Secondary Static GPS Network Surveys

B.1 Definition of Heights

There are three types pf heights involved in determining GPS-derived orthometric heights – orthometric, ellipsoid, and geoid.

Webster's dictionary defines **geoid** as the surface within or around the earth that is everywhere normal to the direction of gravity and coincides with mean sea level in the oceans.

The definition of **geoid**, as adopted by NGS, is the equipotential surface of the Earth's gravity field that best fits, in a least squares sense, global mean sea level.

Geoid height values represent the geoid-ellipsoid separation distance measured along the ellipsoid normal and are obtained by taking the difference between ellipsoidal and orthometric height values.

The current geoid model, ***Geoid99,*** is a hybrid model based on the gravimetric model but also incorporating a corrector surface.

Ellipsoid height*, or geodetic height*, is the value at a given point on the Earth's surface and is based on the distance measured along the normal vector from the surface of the reference ellipsoid to the point.

The ***Orthometric height*** of a point on the Earth's surface is the distance from the geoidal reference surface to the point, measured along the line perpendicular (plumb line) to every equipotential surface in between, or normal to the geoid.

B-2 Determining Orthometric Heights using GPS

There are three basic rules, three control requirements, and five procedures that need to be followed when estimating GPS-derived orthometric heights.

B-3 Rules for Estimating GPS-Derived Orthometric Heights:

Rule 1: Follow LADNR's guidelines outlined in this booklet for establishing GPS-derived ellipsoid heights when performing GPS surveys.

Rule 2: Use NGS' latest National Geoid Model, e.g., GEOID99, when computing GPS-derived orthometric heights.

Rule 3: Use the latest LADNR adjusted height values found in the LADNR-LCZ Primary GPS Network Report (and the internet when available) to control the project's adjusted heights.

B-4 Four Control Requirements for Estimating GPS-Derived Orthometric Heights:

Requirement 1: GPS-occupied stations with adjusted orthometric heights derived from the LADNR-LCZ Primary GPS Network should be evenly distributed throughout the project area.

Requirement 2: For project areas less than 20 km on a side, surround project with LADNR-LCZ Primary GPS bench marks, i.e., minimum number of stations is four; one in each corner of project. [NOTE: The user may have to enlarge the project area to occupy enough bench marks even if the project area extends beyond the original area of interest.]

Requirement 3: For project areas greater than 20 km on a side, keep distances between valid GPS-occupied LADNR-LCZ Primary GPS benchmarks to less than 20 km.

Requirement 4: Minimum observation time per session should be 2 hours. This allows for a quality control check utilizing NGS OPUS program for an independent GPS adjustment.

B-5 Five Procedures for Estimating GPS-Derived Orthometric Heights:

Procedure 1: Perform a 3-D minimum-constraint least squares adjustment of the GPS survey project, i.e., constrain to one latitude, one longitude, and one orthometric height value.

Procedure 2: Using the results from the adjustment in procedure 1 above, detect and remove all data outliers. The user should repeat procedures 1 and 2 until all data outliers are removed.

Procedure 3: Compute differences between the set of GPS-derived orthometric heights from the minimum constraint adjustment (using the latest National geoid model, e.g., GEOID99) from procedure 2 above and the LADNR-LCZ Primary GPS benchmarks.

Procedure 4: Using the results from procedure 3 above, determine which bench marks have valid LADNR-LCZ Primary GPS height values. This is the most important step of the process. Determining which benchmarks have valid heights is critical to computing accurate GPS-derived orthometric heights. [*NOTE: The user should include a few extra LADNR-LCZ Primary and/or Secondary GPS benchmarks in case some are inconsistent, i.e., are not valid height values.]*

Procedure 5: Using the results from procedure 4 above, perform a constrained adjustment holding one latitude value, one longitude value, and all valid LADNR-LCZ Primary GPS height values fixed.

[**Note:** Valid LADNR-LCZ Primary GPS height values include, but are not limited to, the following: bench marks which have not moved since their heights were last determined, were not misidentified and are consistent with the LADNR-LCZ Primary GPS Network Survey.]

The use of GPS data and a high-resolution geoid model to estimate accurate GPS-derived orthometric heights will be a continuing part of the implementation of the LADNR-LCZ Primary & Secondary GPS Network.

Section C

Pre-Planning the GPS Survey

C-1 Research Existing LDNR Control

Using the Location Map found in the LCZ Primary GPS Network Report, determine the project area and locate existing Primary control monuments surrounding the project area. Investigate the project area for existing monuments that meet the standard requirements and stability and that could be incorporated in the LCZ Secondary GPS Network.

C-2 Installation of Permanent Deep Rod Monuments

Determine the locations of any proposed permanent deep-rod monuments to be installed and plot the locations on a USC&GS quadrangle. Also plot primary control points and any other control to be relocated from the NGS datasheets. The map will give an idea on logistics and planning for setting the monuments. Materials for the permanent deep-rod floating sleeve monument and procedures for setting the monument can be found in Section E of this booklet.

C-3 Network Design Planning

When permanent GPS Secondary monuments are required in a project area, as specified in the "Scope of Work" for a LADNR project, a GPS network plan is necessary to establish the values of those secondary monuments. The GPS network should be designed as to incorporate a minimum of four Primary Control monuments, one at each extreme corner that is nearest to the project area. Try to keep project areas within a 20-kilometer radius of the Primary GPS control points. The planned GPS network should also include existing Secondary monuments within or adjacent to project area. (See Section B for the minimum standard guidelines as established by LADNR) A GPS Network Plan and Sessions Schedule will be required and must be submitted with the cost proposal to LADNR for approval prior to commencing work.

C-4 Sessions Planning and GPS Schedule

On the Primary GPS control survey, the sessions should be scheduled so that points are occupied for a minimum of 3 hours and a minimum of 2 sessions on different days. The purpose is to ensure different atmospheric conditions (different days) and significantly different satellite geometry (different times) for the two occupations. For example, if the first day occupation were made between 8:00 am to 11:00 am, the second observation would be made on the next day anytime between 1:00 pm and 5:00 pm. If the second observation is not made for a couple of days or even a week, be sure to compensate for the daily 4-minute change in the GPS satellite constellation. It has been shown that the average ellipsoid height of repeat observations is closer to the truth, with a few exceptions, than the ellipsoid height of a single observation.

For Secondary GPS control, the sessions should be scheduled so that points are occupied a minimum of 2 hours and a minimum of 2 sessions at different times of the day with a minimum of 120 minute offset, or on different days, at different times. For example, if the first occupation is made between 8:00 am to 10:00 am, the second observation could be made on the same day anytime after 12:00 noon. If the second observation is not made for a couple of days or even a week, be sure to compensate for the daily 4-minute change in the GPS satellite constellation. Make sure to work around or compensate for periods when PDOP and/or VDOP are high.

Using the Session Schedule form (See Section I) input a proposed start time and session duration time for each session. Travel times should be calculated using a road map to compute distance and travel times between set-ups. Input the GPS operator and in the corresponding row, input the station names of the points that will be occupied by each operator.

Using Trimble's Quickplan program or other GPS planning program, determine for the planned day of survey when any PDOP/VDOP spikes may occur and make a note of the time period. Use the Session Schedule form and plan the travel times to correspond with the period of high Positional Dilution of Precision (PDOP) and high Vertical Dilution of Precision (VDOP). Sessions should be planned during times when the PDOP is less than 7.0 and VDOP is less than 5.0.

Section D
GPS Field Procedures

D.1 GPS Equipment
Fixed height tripods are required to be used for each set-up. Fixed height tripods provide a consistent station occupation method that can reduce the likelihood of antenna height measurement blunders. In the event that a setup cannot be performed with a fixed height tripod because of an obstruction such as a fence, then an adjustable tripod can be used. In this case make certain that the procedure for antenna height measurement using an adjustable tripod is used. (See D.7 Below)

The use of dual frequency receivers can correct GPS measurements for ionosphere based range errors. This will extend the feasible baseline length and resolve integer ambiguities reliably within 20 km. Dual frequency receivers should be used on all baselines longer than 10 km.

Use identical geodetic quality antennas with ground plane. Different makes and models of GPS antennas can have different phase centers. Mixing of different type of antennas can cause errors in the vertical component up to 100 mm. Only if the processing software can account for the phase center difference in the GPS antennas should mixing of antenna types occur. The ground plane on the antenna will reduce the amount of ground reflecting multi-path.

D.2 The GPS Schedule and Log Sheet
The Session Schedule provides a guide as to start and stop times, station name set-ups for each survey technician, travel times and cell phone numbers for the crew. Once a schedule has been planned and established, it is important that any deviation from the schedule such as late start times, power failures, travel delays, etc. should be communicated to the Project Manager or Party Chief so that the schedule can be revised. It is important to remember that the processed data in a GPS session is only as good as the last person that starts collecting data on his GPS receiver and the first person to stop survey. (See Section I for a sample copy)

GPS Log Sheets (See Section I) are the field notes for the GPS survey and should be filled out in their entirety. The information on this sheet is important at the time of check-in, download and processing of the raw data. If problems are encountered with the raw data, the problem can be traced back to a particular GPS receiver that may be malfunctioning or configured incorrectly. The data required to be logged on the GPS Log Sheets by the technician include the following: Operator, Station Name, Monument Type, Julian Date, Session Number, Receiver Serial Number, GPS Antenna Number, Antenna Height, Start and Stop Times, and Session Notes. A Station Sketch with reference ties is required on the back page of the sheet for future relocation and confirmation that the correct monument was used in the survey. If you are occupying an existing Secondary GPS monument, make a note on the GPS Log Sheet as to the condition of the monument. Note if the monument may have been disturbed and report to LADNR if any effort is required to re-ensure its stability.

D.3 Typical Static Survey Session using a Trimble Dual Frequency 4000SSE/SSi and 5700 GPS Receivers
Prior to logging a GPS session, check the configuration settings on your GPS receiver. Typically, a receiver should be set on 15-second sync rate and 15-degree elevation mask. The time zone should be confirmed and if daylight saving time is in effect. Also, check the stamping on the monument cap to confirm that you are set-up at the correct station. Sync rate and elevation mask on the Trimble 5700 Series is defaulted and only requires that a flashcard be installed.

D.4 Set-up

Upon arriving at the GPS point, connect the GPS antenna and power to the receiver and turn the receiver "**ON**". Make sure the antenna is away from all obstructions. Set-up the tripod over the GPS point and level as usual. Remove mounting adapter from the tripod and screw onto the base of the GPS antenna. Attach the antenna and adapter to the tripod and rotate antenna to point the arrow towards north. Check the level of tripod and confirm if it's leveled correctly over the GPS point.

D.5 Start Survey

Receiver should currently be in the "**LOG DATA"** menu. Select "**QUICK-START NOW! (SINGLE SURVEY)".** Confirm that the GPS antenna is connected by noting the diamond shaped symbol at the bottom of the display. (Look between the PWR1 and time display). Also confirm that the data is being collected by selecting the "**MORE"** button twice. You should see which satellites the receiver is tracking and the file size increasing every 15 seconds at the beep.

D.6 Measuring Antenna Height If Using a Variable Height Tri-pod (Only if necessary)

Using the stainless steel meter stick, measure the antenna height by placing point of the stick into center of the GPS monument center point and read the stick at the bottom inside face of the groove beneath the antenna. Note that each division on the stainless steel measuring stick equals 2 millimeters or 0.002 meters. Record the measurement in meters on GPS log sheet and repeat procedure at 120° from previous measurement. Record and repeat until measurements have been made on three equal sides of the antenna. Add the measurements together and divide by three to get an average then record this value on the GPS Log Sheet in the box labeled "AVG Measurements". Now re-measure the height in feet and tenths or inches using measuring tape. Record this value on GPS Log Sheet in the box labeled "Check Measurement". Divide the check measurement by 3.2808 and compare the answer to the average of measurements. IMPORTANT!!! THIS IS YOUR SURVEY QUALITY CONTROL CHECK MEASUREMENT! Make certain that the measurement is recorded properly i.e.: Inches or Feet & Tenths. If the two values differ by more than 0.016 feet or 5 mm, begin the measurement procedure all over again.

If a second session is scheduled on the same GPS Station, it would be advisable to break setup and re-measure the antenna height. This will eliminate the possibility of a wrong antenna height being used for both sessions.

D.7 Measuring Antenna Height If Using a Fixed Height Tri-pod

The fixed height tri-pods are normally measured **<u>2.000 meters</u>** from the bottom tip of pole to the Antenna Reference Point (ARP - True Vertical to the base of the antenna mount).

D.8 Enter Antenna Height and Filename

Select "**LOG DATA"** menu. Select "**CHANGES**" then "**ANTENNA HEIGHT**". Confirm that the units shown in the display is in meters. Enter the antenna height. To confirm correct height, switch units to feet. Once the measurement is displayed in feet, check the GPS Log Sheet in the box labeled "Check Measurement" and confirm that the measurement is close to what was recorded previously. If so, switch the units back to meters.

Confirm the following settings	ANT HEIGHT:	(**Measured Height**) METERS
*If using **<u>adjustable tripod</u>**:*	MEAS TYPE:	**UNCORRECTED**
	ANT TYPE:	COMPACT L1/2 W/GRND PLANE
OR	ANT SERIAL:	(See tag on bottom of antenna)

Confirm the following settings	ANT HEIGHT:	(**2.000**) METERS
*If using **2 meter fixed height tripod**:*	MEAS TYPE:	**TRUE VERTICAL**
	ANT TYPE:	COMPACT L1/2 W/GRND PLANE
	ANT SERIAL:	(See tag on bottom of antenna)

Select "**ACCEPT**" then "**FILENAME**". The first four digits should be the GPS point you are currently at, i.e. "1001" or "DREU". Change to reflect point number or name. The next three digits is today's Julian date. Do not change this! The last digit is the current session number. Enter current session number. Now select "**ENTER**" and "**STATUS**" on keypad. Confirm the filename in the upper left corner of the display.

D.9 Complete GPS Log Sheet

Now you are ready to complete GPS log sheet. Be aware of your scheduled stop time for this session. Also be aware not to stand near and block the GPS antenna or park a vehicle nearby, blocking the antenna view to the sky.

D.10 End Survey

To end survey at scheduled stop time on the Trimble 4000 series, select "**LOG DATA**" from keypad, then "**END SURVEY**", then select "**YES**". Shut off the GPS receiver by pressing down on the green POWER button. To end survey at scheduled stop time on the Trimble 5700 series, select "blue button" on the face of the receiver and confirm the blinking light has stopped.

Section E
Establishing Permanent Deep Rod Monuments

E-1 Setting Monuments to Refusal
Deep Rod Monuments are required for all Secondary Control to be established in a project area as directed and requested by Louisiana Department of Natural Resources, CRD and are to be set to refusal. The depth of refusal will vary from area to area. "**Refusal**" for a rod monument is defined by most federal agencies as *"No more than one (1) foot of further penetration of a rod monument in one (1) minute of impacting with a gasoline powered hammer*". A Pionjar Gas Powered Breaker Drill or approved equal is required for installing the permanent monuments and can be rented from the manufacturer listed below. **Use Berntsen Monuments, Surv-Kap or approved equal.**

When selecting a location for a permanent deep rod GPS monument, be aware that this location is for GPS satellite observations and that there are minimal or no obstructions to block the satellite view. Figure 1 depicts a typical configuration and components when monuments to refusal are being installed in a wetlands area. When monuments to refusal are being installed in areas where the monument is subject to being disturbed, then the monument should be installed flush with normal ground as in Figure 2.

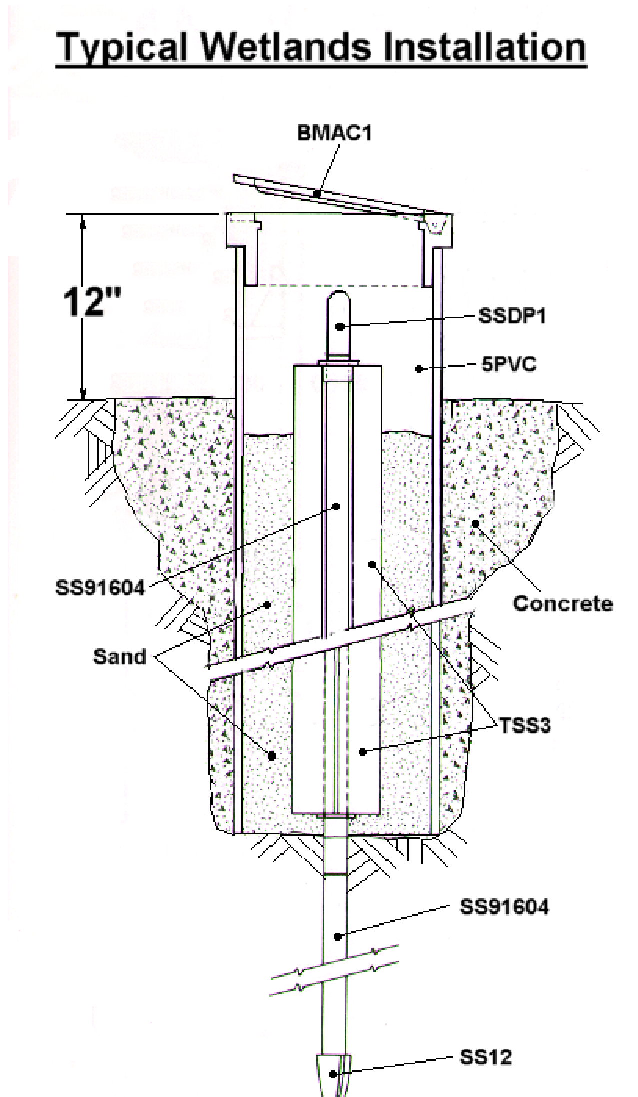


Figure 1

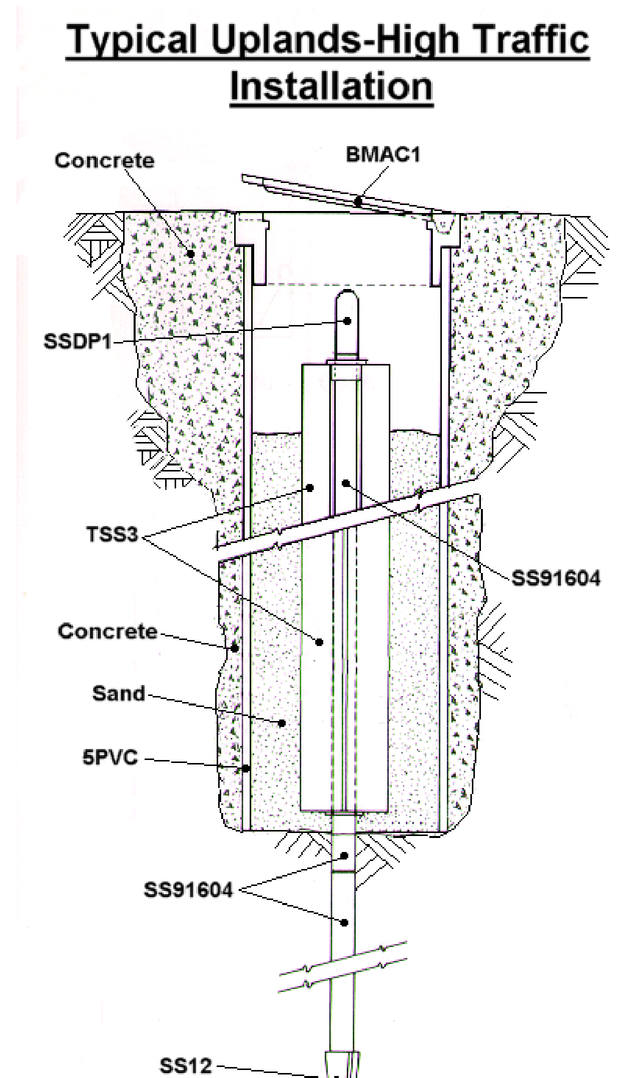


Figure 2

E-2 Monument Components

The table below contains a list of components required and pricing for the installation of deep rod monuments to 48 feet. Be aware that monument depths will vary from area to area depending on the geology and therefore pricing will vary for each monument installation.

Estimated Prices for Monuments

Top Security Floating Sleeve Monument (9/16"Stainless Steel)

Description	Item #	Price ea.	Quantity	Price
9/16" X 4' Stainless Steel Rod	SS91604	$ 23.70	12	$ 284.40
9/16" Stainless Steel Drive Point	SS12	$ 9.95	1	$ 9.95
Stainless Steel Spherical Datum Point	SSDP1	$ 12.00	1	$ 12.00
NGS Style Access Cover	BMAC1	$ 42.39	1	$ 42.39
5" Schedule 40 PVC	5PVC	$ 30.00	1	$ 30.00
Top Security Sleeve	TSS3	$ 11.25	1	$ 11.25
Adhesive for BMC to PVC Pipe	UV6800	$ 9.95	1	$ 9.95
NO-TOX Grease	TSSGREASE	$ 6.95	1	$ 6.95
5' Orange Fiberglass Post	CMB206004	$ 12.70	1	$ 12.70
40 lb Quickcrete		$ 2.00	1	$ 2.00
50 lb All Purpose Sand		$ 2.50	1	$ 2.50
TOTAL COST EACH				**$ 424.09**

Additional Items Required to Set Monuments:

Pionjar 120 Gas Powered Breaker Drill ……$75/Day or $325/Week Rental Plus Shipping

Power Driving Adapter……$90 each

Steel Drive Pin for 9/16" Rods…..$12 each

Steel Letter and Number Stamp Set……$40 each

Berntsen International, Inc. 800-356-7388 www.berntsen.com

E.3 Deep Rod Monument Installation Instructions

The following monument installation procedures can be obtained from the following internet website: http://berntsen.com/pdfs/ngs3d.pdf . These instructions have been taken from:

GEOMETRIC GEODETIC ACCURACY STANDARDS AND SPECIFICATIONS
FOR USING GPS RELATIVE POSITIONING TECHNIQUES (pages 46-48)
Federal Geodetic Control Committee
Rear Admiral Wesley V. Hull, Chairman
Version 5.0: May 11, 1988
Reprinted with corrections: January 5, 2000.

Berntsen International, Inc. –
NGS Three Dimensional Rod Monument Installation Instructions

APPENDIX H.
SPECIFICATIONS AND SETTING PROCEDURES FOR THREE DIMENSIONAL MONUMENTATION

A. MATERIALS REQUIRED FOR SETTING MONUMENT:

1. Rod, stainless steel, 4-foot (1220 mm) sections [SS91604]
2. Rod, stainless steel, one 4 inch (100 mm) [M1DPA]
3. Studs (threads), stainless steel [M13 thread]
4. Datum point, stainless steel [SSDP1]
5. Spiral (fluted) rod entry point, standard [SS-12 Point]
6. NGS logo caps, standard, aluminum [BMAC-1, -5, -6]
7. Pipe, schedule 40 PVC, 5 (or 6) inches (127 mm or 152 mm) inside diameter, 2-foot (610 mm) length [5PVC24] [6PVC24]
8. Pipe, schedule 40 PVC, 1 inch (25 mm) inside diameter, 3-foot (915 mm) length [TSS3]
9. Caps, schedule 50 PVC, (Slip-on caps centered and drilled to 0.567 inch [14 mm] ±0.002 [.05mm]) [TSSEC-Y]
10. Cement, for making concrete
11. Cement, PVC solvent [Eclectic® UV-6800]
12. Loctite (2 oz. bottle)
13. Grease-MIL SPEC G-10924D (B15395A, Grade 7) [Bel-Ray NO TOX AA-1-1]
14. Fine-grained washed or play sand
15. Grease Gun
16. * (Vise grips or pipe wrench (2) to tighten each rod section together)

B. SETTING PROCEDURES:

1. The time required to set an average mark using the following procedures is 1 to 2 hours.

2. Using the solvent cement [Eclectic UV-6800] formulated specifically for PVC, glue the aluminum logo cap [BMAC] to a 2-foot (610 mm) section of PVC pipe [5PVC24]. This will allow the glue to set while continuing with the following setting procedures.

3. Glue the PVC cap with a drill hole [TSSEC-Y] on one end of the 3-foot (915 mm) section of schedule 40 PVC pipe 1-inch (25mm) inside diameter [TSS3]. Pump the PVC pipe full of grease. Thoroughly clean the open end of the pipe with a solvent, which will remove grease. Then glue another cap with drill hole on the remaining open end. Set aside while continuing with the next step. *(*NOTE: This step can also be done in advance, prior to going into the field.)*

4. ***IMPORTANT:*** **Use proper eye and ear protection!** Using a power auger or post hole digger, drill or dig a hole in the ground 12 - 14 inches (300 mm - 350 mm) in diameter and 3-1/2 feet (1100 mm) deep.

5. Attach the standard spiral (fluted) rod entry point [SS-12 point] to one end of the 4-foot (1220 mm) section of stainless steel rod [SS-916-04] with the standard 3/8-inch (10 mm) stud [M-13 thread]. On the opposite end, screw on a short 4 inch (100 mm) piece of rod [M-1 DPA] which will be used as the impact point for driving the rod. Drive this section of rod with a reciprocating driver such as a *Pionjar 120, Cobra 148, Wacker BHB 25* or another machine with an equivalent driving force.

6. Remove the short piece of rod used for driving [M-1-DPA] and screw in a new stud [M-13 thread]. Attach another 4-foot (1220 mm) section of rod [SS-916-04]. Tighten securely *(*using vise grips or pipe wrenches*). Reattach the short piece of rod [M-1-DPA] and drive the new section into the ground.

7. Repeat step 6 until the rod refuses to drive further or until a driving rate of 60 seconds per foot (300mm) is achieved. The top of the rod should terminate about 3 inches (75 mm) below ground surface.

8. When the desired depth of rod is reached, cut off the top removing the tapped and threaded portion of the rod leaving the top about 3 inches (75 mm) below ground surface. The top of the rod must be shaped to a smooth rounded (hemispherical) top, using a portable grinding machine to produce a datum point. The datum point must then be center punched to provide a plumbing (centering) point. NOTE: For personnel that may not have the proper cutting or grinding equipment to produce the datum point, the following alternative procedure should be used if absolutely necessary. When the desired depth of the rod is obtained (an even 4-foot [1220 mm] section), thoroughly clean the thread with a solvent to remove any possible remains of grease or oil that may have been used when the rod was tapped. Coat the threads of the datum point with Loctite and screw the datum point into the rod. Tighten the point firmly with vise grips to make sure it is secure. The datum point is a stainless steel 3/8-inch (10 mm) bolt [SSDP-1] with the head precisely machined to 9/16 inch (14 mm).

9. Insert the grease filled 3-foot (915 mm) section of 1-inch (25 mm) PVC pipe sleeve [TSS3] over the rod. The rod and datum point should protrude through the sleeve about 3 inches (75 mm).

10. Backfill and pack with fine-grained washed or play sand around the sleeve [TSS3] to about 20 inches (500 mm) below surface. Place the 5-inch (127 mm) PVC [5PVC24] and logo cap [BMAC] over and around the 1-inch (25 mm) sleeve [TSS3] and rod. The datum point [SSDP-1] should be about 3 inches (75 mm) below the cover of the logo cap.

11. Place concrete around the outside of the 5-inch (127 mm) PVC [5PVC24] and logo cap [BMAC], up to the top of logo cover. Trowel the concrete until a smooth neat finish is produced.

12. Continue to backfill and pack with sand inside the 5-inch (127 mm) PVC [5PVC24] and around the outside of the 1-inch (25 mm) sleeve [TSS3] and rod to about 1 inch (25 mm) below the top of the sleeve.

13. Remove all debris and excess dirt to leave area in original condition. Make sure all excess grease is removed and the datum point [SSDP-1] is clean.

14. Install a fiberglass witness post 2 to 3 feet adjacent to and behind the installed monument.

[SS-916-04] = Berntsen model number of material specified.
Note: These are to be used only as a guideline for geodetic surveys using GPS relative positioning techniques.
**Items in italics are added procedures recommended by Berntsen International.*

Pionjar 120 Gasoline Powered Breaker Drill can be rented from
Berntsen International - Call Toll Free 800-356-7388 www.berntsen.com
Weight 57 lbs (Shipping Weight 100 lbs)
Drives Stainless Steel Rods to Refusal
Rental Charge: $75/Day - $325/Week - $1,100/Month Plus Shipping to and from

SECTION F

Downloading, Processing & GPS Network Adjustment

F-1 Downloading / Check-in Raw Data Files

Prior to downloading the raw GPS data from the receivers, organize your GPS Log Sheets by date and session times. Create a project file connect the PC to the GPS receiver. Prior to transferring the data files, check the filenames, Julian date and session numbers are correct. Once the files have transferred, confirm that the filenames, antenna type and antenna heights are correct for each GPS occupation. Occasionally, an operator may forget to input the antenna height or numbers may have been input incorrectly. Always verify antenna height measurements to be correct. If the antenna height is in question, the observation should be removed altogether as to not affect the results of the network adjustment. Consider re-observation of any GPS data that may be in question.

F-2 Processing the GPS Data Files using OPUS

What is OPUS? The National Geodetic Survey operates the On-line Positioning User Service (OPUS) as a means to provide GPS users easier access to the National Spatial Reference System (NSRS).

OPUS allows users to submit their GPS data files in RINEX format to NGS, where the data will be processed to determine a position using NGS computers and software. Each RINEX file that is submitted will be processed with respect to 3 CORS sites. The sites selected may not be the nearest to your site but are selected by distance, number of observations, site stability, etc. The position for your data will be reported back to you via e-mail in both ITRF and NAD83 coordinates as well as UTM and State Plane Coordinates (SPC) northing and easting.

OPUS is completely automatic and requires only a minimal amount of information from the user:

1. The email address where you want the results sent
2. The RINEX file that you want to process (which you may select using the browse feature)
3. The antenna type used to collect this RINEX file (selected from a list of calibrated GPS antennas)
4. The height of the Antenna Reference Point (ARP) above the monument or mark that you are positioning
5. As an option, you may also enter the state plane coordinate code if you want SPC northing and easting.
6. As an option, you may select up to 3 base stations to be used in determining your solution.

Once this information is complete you then click the Upload button to send your data to NGS. Your results will be emailed to you in a few minutes. You may upload one RINEX file at a time.

Each file is submitted independently via the Internet and the final adjusted solution is returned to the user within minutes. This allows the user with an independent quality control check prior to performing an adjustment using Trimble TGO or GPSurvey. It should be cautioned that the results from the OPUS adjustment are to be used for QC purposes only and should not be relied on as the final adjusted position. Also, if more than one point is being submitted to OPUS, be aware that baselines will not be created between those points in your network.

If you are processing the data within a week of data collection, the data will be processed using the broadcast ephemeris. The final processed baselines should be resubmitted for adjustment when the precise ephemeris is available. The web address for submitting GPS data for processing is http://www.ngs.noaa.gov/OPUS/index.html

F-3 Downloading Continuously Operating Reference Station (CORS) Data Files

Locate the NGS CORS stations within or adjacent to your GPS network at the following Internet web address: http://www.ngs.noaa.gov/CORS.

F-3 Processing the GPS Data Files using GPSurvey

If you are processing the data within a week of data collection, the data will be processed using the current broadcast ephemeris (automatically downloaded with the raw data files. The final processed baselines should be re-processed using the precise ephemeris. There is an 8-day latency for the precise orbit data and can be downloaded from NGS' website at the following Internet address:
http://www.ngs.noaa.gov/GPS/GPS.html

Upon completing the downloading and check-in process and confirming that all antenna heights, filenames, etc. to be correct, processing the raw data files can now begin. Select and load only the files that were observed during the same session. After the files have been loaded, using the "Setup Controls", verify that "All Baselines" is selected and that the elevation mask is set to 15 degrees. Process the data files one session at a time. View the "Detailed Baseline Summary" in the "Project Report" and note the satellites with cycle slips and "noisy" data or short observation times. Return back to the processing menu, select the same session and remove these satellites. Re-process the session again and check the "Detailed Baseline Summary" once more. Check the "Final Solution Type" for each baseline and verify that it is "Fixed". If the solution type was "Float" for a baseline then review the satellite data once more and note any satellite that may be corrupting the data. Continue this procedure until the results of all the baseline solution is "Fixed".

The idea of the processing stage is to eliminate or "filter out" most of the corrupted satellite data by analyzing each processed baseline. The causes of the data becoming corrupt may vary and can be caused by a satellite being unhealthy, multi-path, obstructions from trees or buildings, etc., breaking the satellite signal to the GPS receiver.

F-4 GPS Network Adjustment

Select the network adjustment and load the "Current Network". Select "Special Controls" under the "Adjustment Menu", and then select "Global Adjustment Controls". Set the "Univariate Sigma Scalar" to "1.96" and the "Bivariate Sigma Scalar" to "2.45". By doing this, the standard errors listed in the adjustment output represent what we could expect to repeat 95% of the time.

Use the following procedures for determining the three dimensional values for the GPS network.

Five Procedures for Estimating GPS-Derived Orthometric Heights:

Procedure 1: Perform a 3-D minimum-constrained least squares adjustment of the GPS survey project, i.e., constrain to one latitude, one longitude, and one orthometric height value.

Procedure 2: Using the results from the adjustment in procedure 1 above, detect and remove all data outliers. The user should repeat procedures 1 and 2 until all data outliers are removed.

Procedure 3: Compute differences between the set of GPS-derived orthometric heights from the minimum constraint adjustment (using the latest National geoid model, e.g., GEOID99) from procedure 2 above and the LADNR-LCZ Primary GPS benchmarks.

Procedure 4: Using the results from procedure 3 above, determine which bench marks have valid LADNR-LCZ Primary GPS height values. This is the most important step of the process. Determining which benchmarks have valid heights is critical to computing accurate GPS-derived orthometric heights. [*NOTE: The user should include a few extra LADNR-LCZ Primary and/or Secondary GPS benchmarks in case some are inconsistent, i.e., are not valid height values.]*

Procedure 5: Using the results from procedure 4 above, perform a constrained adjustment holding one latitude value, one longitude value, and all valid LADNR-LCZ Primary GPS height values fixed.

[**Note:** Valid LADNR-LCZ Primary GPS height values include, but are not limited to, the following: bench marks which have not moved since their heights were last determined, were not misidentified and are consistent with the LADNR-LCZ Primary GPS Network Survey.]

The use of GPS data and a high-resolution geoid model to estimate accurate GPS-derived orthometric heights will be a continuing part of the implementation of the LADNR-LCZ Primary & Secondary GPS Network.

F-5 Expected Accuracies

Table 1	**Horizontal**	**Horizontal**	**Horizontal**	**Vertical**	**Vertical**
Spatial Accuracy Classification	**0.005-0.020 meters**	**0.020-0.050 meters**	**0.050-0.500 meters**	**0.005-0.050 meters**	**0.050-0.500 meters**
Network Control:					
Minimum number of stations and quadrants:	3	3	2	4	2
Maximum distance between project's outer boundary and network control stations:	50 km.	50 km.	50 km.	20 km.	20 km.
Initial Position:					
Maximum 3-D error for the NAD83 coordinates input for the initial station in any baseline solution:	10 m.	20 m.	50 m.	10 m.	20 m.
Baseline Connections:					
A baseline observation must be made between any two stations (1 and 2) where their spacing is less than (__)% of the otherwise shortest direct connection to either station:	10%	N/A	N/A	30%	20%

Table 2	**Horzontal**	**Horizontal**	**Horizontal**	**Vertical**	**Vertical**
Spatial Accuracy Classification	**0.005-0.020 meters**	**0.020-0.050 meters**	**0.050-0.500 meters**	**0.005-0.050 meters**	**0.050-0.500 meters**
Repeat Station Observations percent of number of stations					
Two times:	100%	100%	80%	100%	100%
Three or more times:	10%	10%	0%	50%	25%
Sidereal time displacement between occupations (start time to next start):	60 min.	45 min.	20 min.	120 min.	60 min.
Repeat Baseline Measurements					
Percent of total number of independent baselines:	5%	5%	5%	10%	10%
Satellite Constellation Mask					
Minimum mask angle, degrees above local horizon:	15	15	10	18	15
Minimum number of satellites observed during 75% of occupation:	5	5	4	5	5

Maximum PDOP during 75% of occupation:	5	5	5	4	5
Antenna Setup					
Maximum centering error (measured and phase center):	3 mm	5 mm	7 mm	5 mm	5 mm
Independent plumb point check required:	Y	Y	N	Y	N
Maximum height error (measured and phase center):	5 mm	5mm	5 mm	3 mm	5 mm
Number of independent antenna height measurements per occupation:	2	2	2	2	2
Photograph (close up) and/or pencil rubbing required for each mark occupation:	Y	Y	N	Y	N

SECTION G
Deliverables

G.1 GPS Survey Report
Upon completion of a project, a GPS Survey Report shall be provided to the Louisiana Department of Natural Resources, CRD in a digital format and written to a compact disk (CD) attached to four (4) copies of 8 ½” x 11” bound booklet.

The GPS Survey Report shall contain and not be limited to the following information:

G.2 Methodology Report
The Methodology Report shall be in a digital format, such as Microsoft Word, and written to the compact disk (CD) along with hard copies, signed and stamped by the Registered/Professional Land Surveyor in the State of Louisiana who was directly involved with the project. The hard copies shall be bound in the GPS Survey Report.

The report shall contain but not be limited to the following information:
(Include dates for each job task and key personnel involved)

- ***Project Description***
- ***Pre-planning the GPS Network***
- ***Information on Monument Reconnaissance***
- ***The GPS Static Survey***
- ***Equipment used for data collection***
- ***Downloading, Processing and GPS Network Adjustment procedures***
- ***GPS Network Accuracy Results***

G.3 Monument Information Datasheets
Information Datasheets shall be created for each newly established monument for the project. The Datasheet shall be in a digital format such as Microsoft Word and written to a compact disk (CD) hard copies bound in the final GPS Survey Report. (See Section I for a sample copy)

The information to be included on the Datasheet will be as follows:

- ***Location Map with monuments location plotted***
- ***Monument Name***
- ***Written directions to the monument***
- ***Monument Description/Type***
- ***Date that monument was established***
- ***Contractors Name***
- ***Adjusted NAD83 Geodetic & Lambert Coordinate (LSZ) Positions***
- ***Adjusted NAVD88/LDNR-LCZ Position***
- ***Adjusted Orthometric Height from CORS Adjustment***
- ***Adjusted Orthometric Height from OPUS Adjustment***
- ***Monument Photograph***

G.4 Drawing Files
A map shall be created for the project area with all monuments clearly labeled and plotted using the final adjusted coordinates. The drawing files shall be in a digital format such as AutoCAD (*.dwg or *.dxf) and written to the compact disk (CD) along with hard copies each bound in the final GPS Survey Report and folded to 8 ½” x 11”.

The information to be included on the Project Map will be as follows:

- ***Project Name***
- ***Contractor Name***
- ***Digital aerial or USGS Quadrangle with monuments plotted correctly***
- ***Monument Names***
- ***Horizontal and Vertical Datum***
- ***Map Date***
- ***Map Scale***
- ***North Arrow***

G.5 Field Notebook Records

All existing and newly established GPS monuments utilized on the project shall be documented and recorded neatly and legible in a transit field book. Copies of the field notebook shall be included in the final bound GPS Survey Report. (See Section I.5 for a sample copy)

The information to be included on the field notebook will be as follows:

- ***Project name***
- ***Date of installation or survey***
- ***Crew members***
- ***Sketch of location with monument referenced to physical features such as power poles, fence posts, structures, etc.***
- ***Monument name stamping***
- ***"Drive To" description***
- ***Monument type description***
- ***Number of rods, rod size and total depth to refusal***

G.6 Final Adjusted GPS Data

A tabulation sheet containing the final adjusted results of all GPS Primary and Secondary Control points in the project network holding to a minimum of three LCZ Primary GPS Monuments fixed shall be included in the final bound GPS Survey Report. The tabulation shall include the following information:

- ***GPS Station Name***
- ***Latitude/longitude (NAD83)***
- ***Geoid99 Height (Mtrs)***
- ***Ellipsoid Height (Mtrs)***
- ***Orthometric Height (Mtrs & Feet)***
- ***Published Elevation & Differences***
- ***OPUS Results and Comparisons to GPS Adjustment Results***

Also, a tabulation sheet containing the final adjusted results of all GPS Primary and Secondary Control points in the project network holding to a minimum of three CORS Stations fixed shall be included in the final bound GPS Survey Report. This sheet shall include the same information as the previous tabulation.

The final adjusted GPS project shall be archived in digital format and written to compact disk (CD) and shall be included in the final bound GPS Survey Report. Also the GPS data should be exported in "Rinex" format and shall be included in the final bound GPS Survey Report.

SECTION H
Common Errors to Avoid

H.1 Increasing Field Accuracies

Meeting the minimum standards can be difficult and sometimes impossible when errors are introduced into a survey. The cause is usually faulty equipment and/or careless field procedures. If the equipment is faulty, the errors are compounded with every set-up. Eliminating these errors will insure meeting the minimum standards required as well as reducing the time spent trouble shooting where problems exist.

The first step to increasing field accuracies should begin with the equipment being used. Regular maintenance and calibration checks will save hours of frustration. Time is Money!

H.2 Eliminating Systematic Errors due to Faulty Equipment

- Tripod:
  Insure the stability of your tripod. Frequently check for loose screws and play in the mounting head. Check lock-down screws, pivot joints and feet.

- Tribrach:
  Check that plumb bob aligns with optical plumb. Also check that bulls eye bubble is level with instrument.

- Prism Poles:
  Bull's eye bubble should be checked for vertical accuracy. Also check that centering point is tight.

H.3 Common Errors to Avoid

These are common BAD PRACTICES that corrupt survey integrity and should be eliminated altogether!

- Set-up on the wrong station
- Setting GPS Monuments under obstructions
- Transporting tribrachs and/or instruments attached to tripod
- Leaving equipment unattended
- Unleveled Tripod
- Not tightening lock-down screws on tripod
- GPS Antenna height miss-measurement and not checked using QC procedure
- Not communicating problems such as late start time with Party Chief or Project Manager
- Hurrying up to save time

SECTION I

Standard Forms & Sample Documents

I.1 Typical GPS Sessions Schedule Form

GPS Sessions Schedule Form

Client - Project – Location

OPERATOR	PHONE #	Session 1	Travel	Session 2	Travel	Session 3
	JULIEN DATE-SESSION#	**001-1**		**001-2**		**001-3**
START SESSION:		**8:00 AM**		**10:00 AM**		**12:30 PM**
DURATION & TRAVEL		1:00	*1:00*	*1:30*	*1:00*	*1:00*
END SESSION:		**9:00 AM**		**11:30 AM**		**1:30 PM**

I.2 Typical GPS Log Sheet for Adjustable Tripods

USE THIS FORM IS USING ADJUSTABLE TRIPODS WITH TRIBRACHS

GPS LOG SHEET

Job No. ______ Date ______ Operator ______

Client ______ Job Description ______

Location ______

SESSION INFO

Station No. ______ (4 Characters) **Julian Date** ______ (3 Characters) **Session No.** ______ (1 Character)

Long Name ______

Monument Description ______

Receiver Type ______ Receiver Serial No. ______

Antenna Type ______ Ant. Serial No. ______

Antenna Height Measurements to Bottom Inside Notch of Ground Plate

Reading 1 ______ Meters **Average of Readings** ______ Meters

Reading 2 ______ Meters *Check Reading ______ Ft.Tenths or Inches

Reading 3 ______ Meters ***Note: Record all readings on log sheet prior to key-in receiver**

Start Time ______ Stop Time ______ Session Time ______

Time	Pdop	Satellites in View

Time	Note any Power Failures, Weather Conditions, etc.

USE BACK OF THIS SHEET TO MAKE STATION SKETCH, REFERENCE TIES & DESCRIPTION

I.3 Typical GPS Log Sheet for Fixed Height Tripods

USE THIS FORM IS USING FIXED HEIGHT TRIPODS

GPS LOG SHEET

Job No. ______ ______ Operator ______

Client ______ Job Description ______

Location ______

SESSION INFO

Station No. (4 Characters)	Julian Date (3 Characters)	Session No. (1 Character)

Long Name ______

Monument Description ______

Receiver Type ______ Receiver Serial No. ______

Antenna Type ______ Ant. Serial No. ______

Antenna Height Measurement is **TRUE VERTICAL** to Bottom of Antenna Mount if Using Fixed Height Tripod

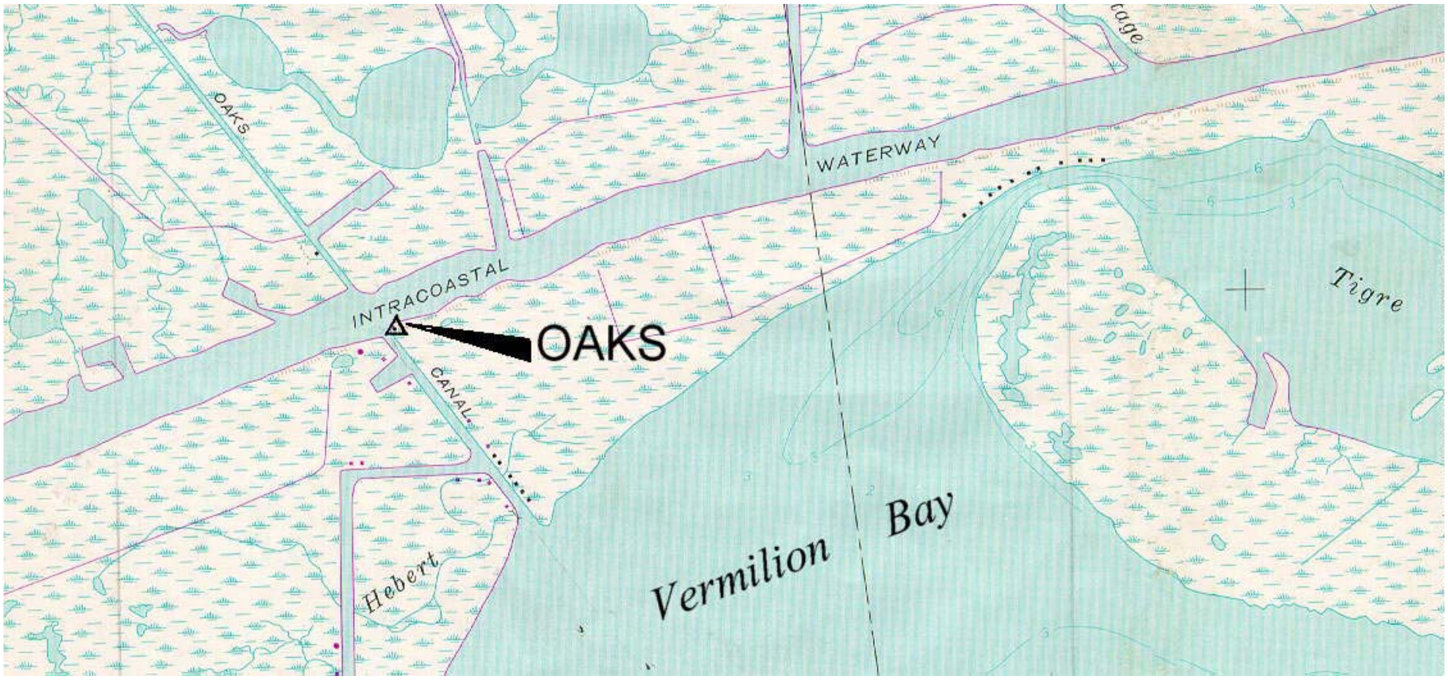
Reading 1	NA	Meters	Fixed Hgt 2 Meter Tripod	2.000	Meters
Reading 2	NA	Meters	Check Reading	6.562	Feet/Tenths
Reading 3	NA	Meters	Note: Record all readings on log sheet prior to entering in receiver		

Start Time ______ Stop Time ______ Session Time ______

Time	Pdop	Satellites in View

Time	Note any Power Failures, Weather Conditions, etc.

USE BACK OF THIS SHEET TO MAKE STATION SKETCH, REFERENCE TIES & DESCRIPTION



VICINITY MAP Scale: 1" = 2000' Reproduced from USC&GS "TIGRE LAGOON" Quadrangle

Station Name: "OAKS CANAL"

Monument Location: The station is located north of Vermilion Bay in Iberia Parish, Louisiana, set on the spoil bank behind a protective rock barrier at the southeast junction of Intracoastal Waterway and Oaks Canal.

Monument Description: Aluminum cap attached to a steel rod driven to refusal within a 6" PVC sleeve and protective cover set in concrete and stamped "OAKS".

Date : October 2000

Monument Established By: John Chance Land Surveys, Inc.

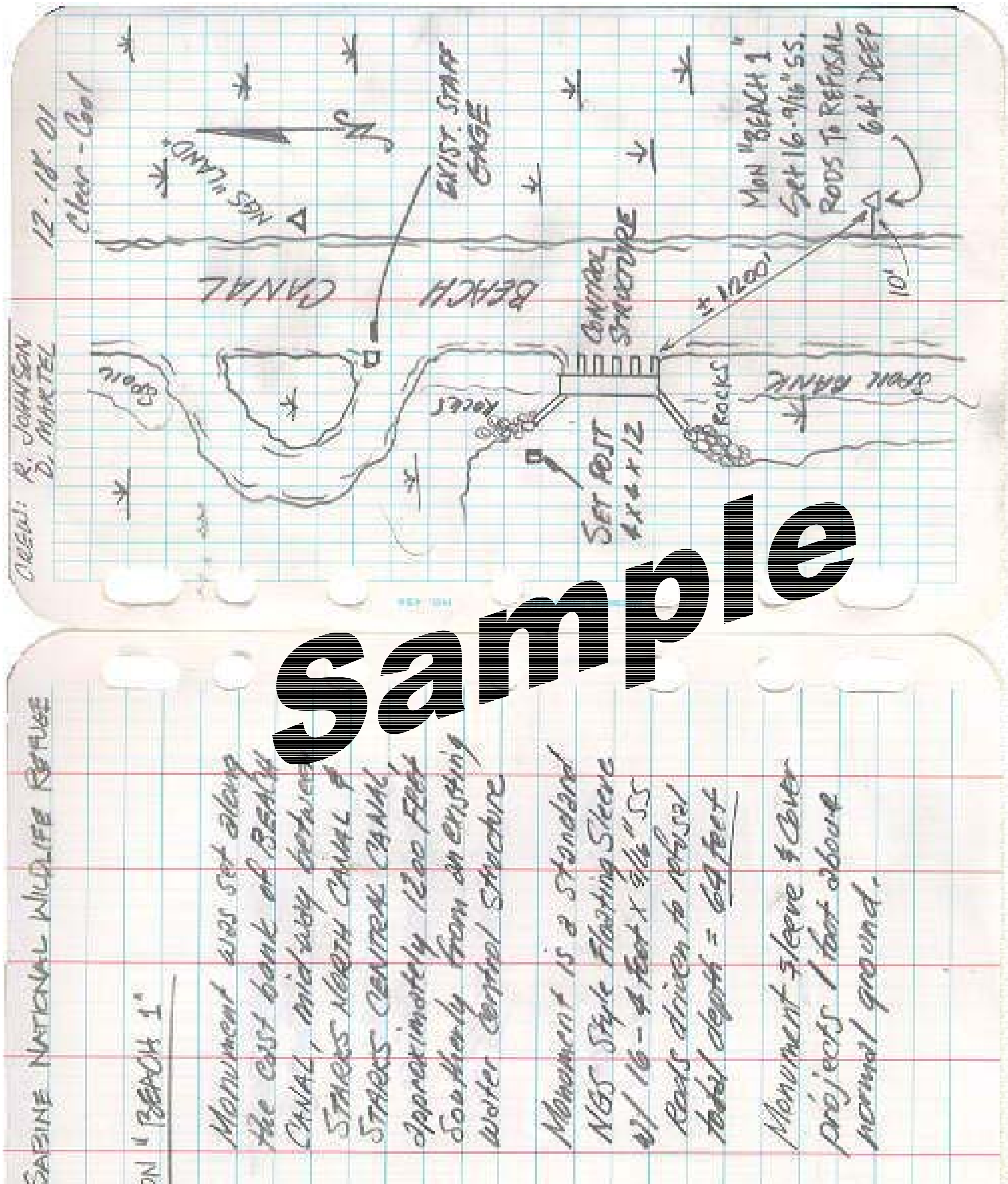
Adjusted NAD 83 Geodetic Position
Lat. 29°49'57.675848" N
Long. 91°59'11.129944" W

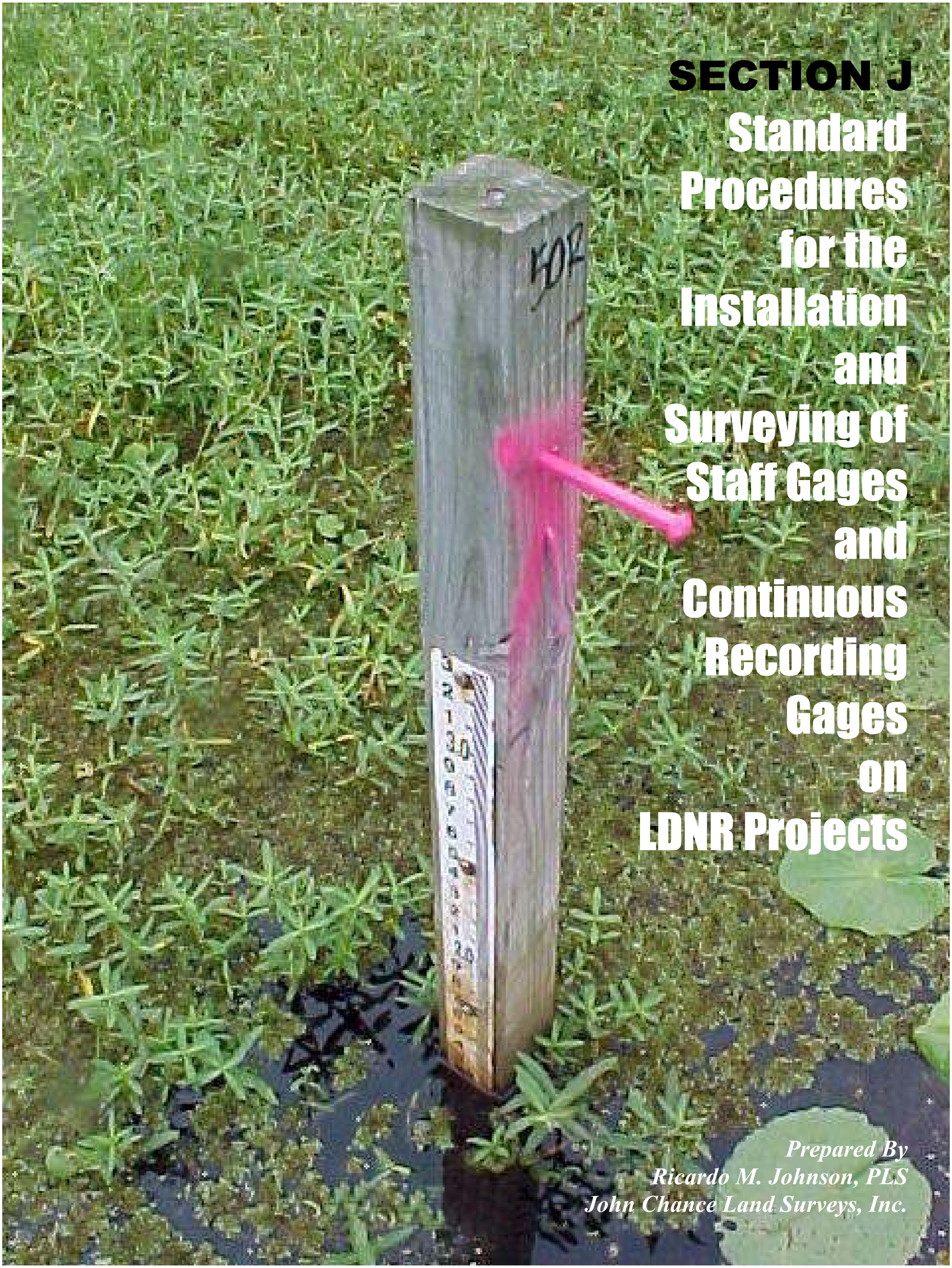
Adjusted NAD 1983 Datum
LSZ (1702) Feet
N= 485,238.16
E= 3,073,763.34

Adjusted NAVD88 (Feet) /Geoid99
Elevation = 3.07

I.4 Sample Monument Datasheet

I.5 Sample Field Notes



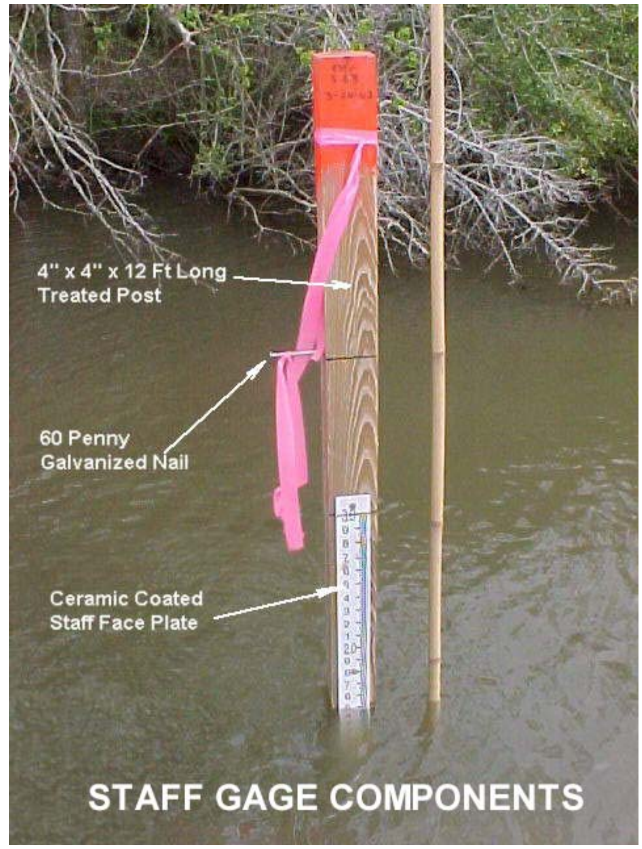


SECTION J

Standard Procedures for the Installation and Surveying of Staff Gages and Continuous Recording Gages on LDNR Projects

Prepared By
Ricardo M. Johnson, PLS
John Chance Land Surveys, Inc.

SECTION J
New Staff Gage Installation



J.1 Materials Required
The standard components that are required by LDNR for a typical new staff gage installation are as follows:

- 4" x 4" x 12 foot long treated post
- Galvanized 60d Nail (TBM)
- ¼" x 3" long Stainless Steel Screws
- Ceramic Coated Staff Gage Plate

J.2 Tools Required for the Installation
Tools required to install the new staff gage on site are as follows:

- Post Driver (Man-Killer)
- Cordless Drill with 1" Drill Bit
- Carpenter's Hand Level
- Ratchet with 3/8" Socket
- Vise Grip
- Combination Square
- Permanent Marker
- Tape Measure
- Hand Saw

J.3 Installation
The first step for installing a new staff gage is to find a suitable site. Considerations for finding the proper location are maximum protection from boat traffic, proper water depth for the post length to be installed, proximity of a GPS monument or bench mark to be referenced from for differential leveling procedures and satellite visibility if Real-Time Kinematic (RTK) procedures are to be used for elevation determination.

Using the hand saw, saw cut a "V" at the base of the 4 x 4 post . This makes for easier installation while driving the post into the water bottom. Once a location has been selected, place the post driver over the top end of the post and the bottom point in the water bottom (approximately 2-3 feet deep) while a helper keeps vertical plumb using the hand level. The Post should be driven until the top of the post is about 4 to 5 feet above the top of water, occasionally checking plumb.

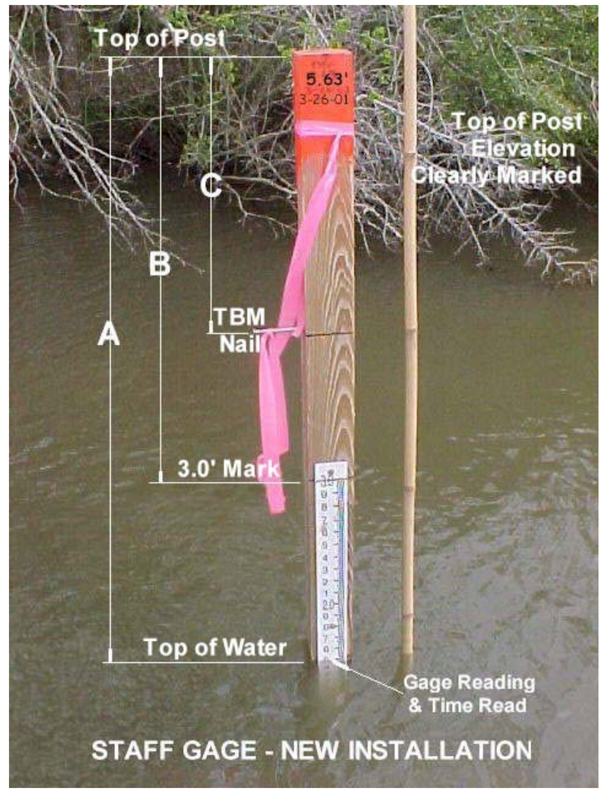
J.4 Top of Post Measurements With RTK
After setup of RTK Base Station on a known GPS bench mark and the Rover unit is in fixed mode and receiving differential corrections, perform a quality assurance check near the base station to confirm positions are being correctly delivered. Upon confirmation, carefully measure the Rover's GPS antenna pole from the Base of the antenna mount to the base of the bracket of the bulls-eye

bubble and make a note of this value. Use value as the measured rover antenna height. The base of the bulls-eye bubble is more stable for performing shots on the gage versus using the point of the pole.

Place the base of the bulls-eye bracket of the RTK Pole flush with the Top of the 4 x 4 Post and enter the “Point Number” and Feature Code (Top of 4x4 Post), then select “Measure” in the “Topo Mode” on the Data Controller (should be about a 3-5 second measurement). Switch the measurement mode to “Observed Control” and enter the same point number adding the letter ”A” after it and select “Measure”. Once the measurement has been taken (about 3 minutes), compare the elevation to the previous shot. If the elevation differs by more than 0.04 feet, retake the measurement until a satisfactory tolerance is attained.

J.5 Installation of TBM Nail

Using the permanent marker, write the elevation and the date at the top of the post. Subtract 4.00 from the top of post elevation and note the number…Example: 5.63 – 4.00 = 1.63. *(See measurement “C” in photo at right)*. Use this value to measure down from the top of the post and place a mark on the side of the post. Use the combination square to draw a line at this point. Drill a ¼” hole with the drill, aligning the top of the hole with the bottom of the line and install TBM at the 4.00 foot mark using a 60d galvanized nail. Place the base of the bulls-eye bracket of the RTK Pole flush with the top shank of the 60d galvanized nail and enter the “Point Number” and Feature Code (60d Nail), then select “Measure” in the “Topo Mode” on the Data Controller (should be about a 3-5 second measurement).



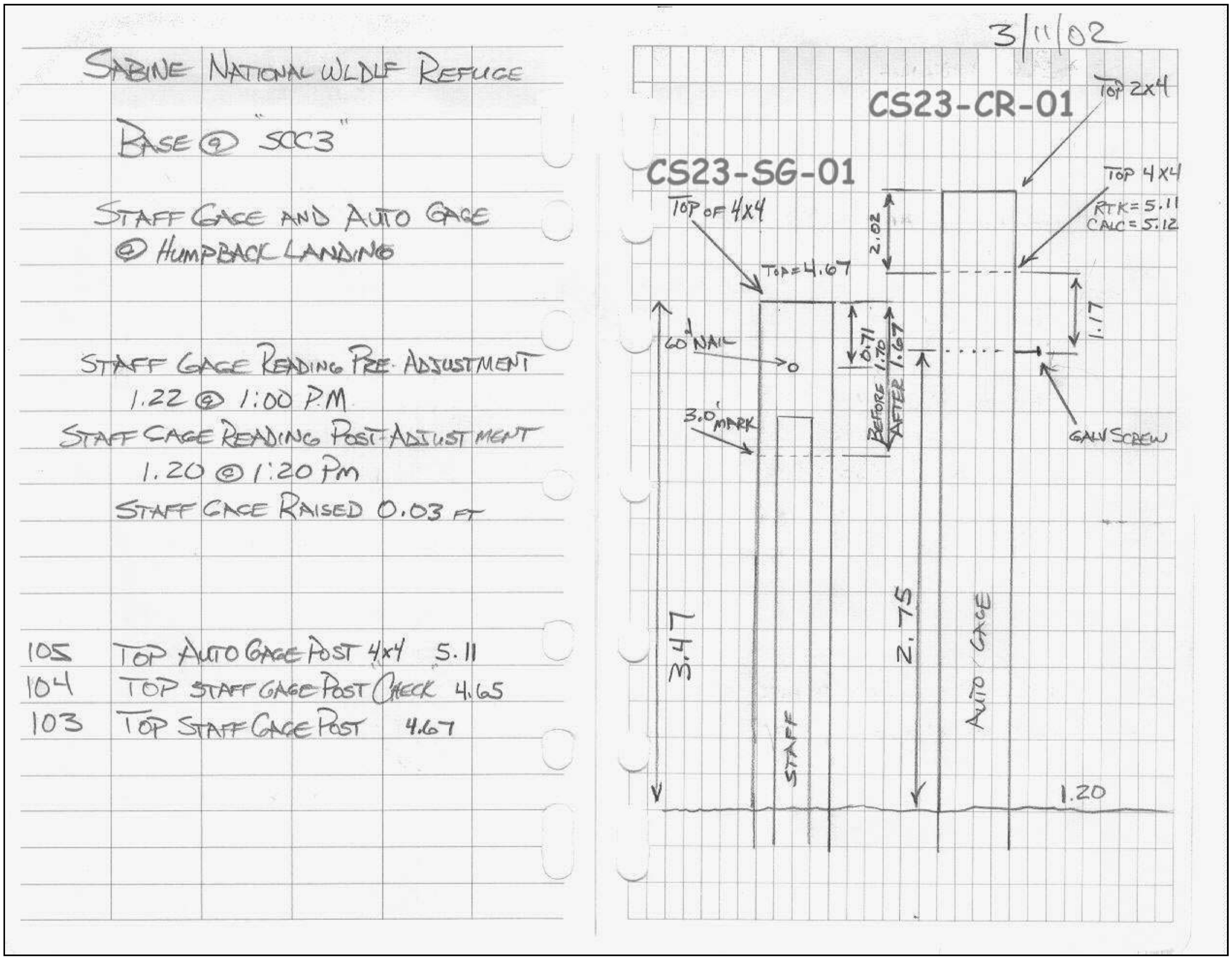
J.6 Installation of the Staff Plate

Subtract 3.00 from the top of post elevation and note the number…Example: 5.63 – 3.00 = 2.63. *(See measurement “B” in photo at right)*. Use this value to measure down from the top of the post and place a mark on the side of the post. Use the combination square to draw a line at this point. Place the Staff plate on the 4x4 post and align the 3.00-foot gage reading with the 3.00’ Mark. While holding the staff plate in place, drill into the post through the top hole of the plate, about ½” deep. Attach the plate to the post using a ¼” stainless steel bolt leaving about 1/16” of the bolt away from the brass washer on the plate. Note: Compressing the screw to the plate will cause the ceramic coating to chip and premature corrosion to the staff plate. Attach 2 more screws to the plate to complete installation of staff plate.

J.7 Record Measurements and Sketch in Field Notes

All measurements should be recorded in the field book. Included should be date of survey, names of crew members, name of gage, RTK Base location, gage reading and time read, measurements A, B and C after installation, RTK point numbers and elevations observed with check shots included, and a front view sketch with measurements shown. *(See Section J.8)*

J.8 Example of Field Notes Required



J.9 Examples of Types of Staff Gage Installations

Example 1
Photo at left is an example of a new ceramic staff gage plate attached to a home-made wooden staff gage at a revised elevation. Note the reset date and elevation marked on the top of the old gage and 60d galvanized reference nail installed.

Example 2
Photo at right is an example of a new ceramic staff gage plate attached to a timber piling at a revised elevation. Note the homemade wooden staff gage attached to the timber piling in the rear of the photo.

Example 3
Photo at left is an example of a new ceramic staff gage plate attached to a timber piling at a floodgate. Note the TBM using a PK nail with flagging at the top of the post and at the 4 foot mark.

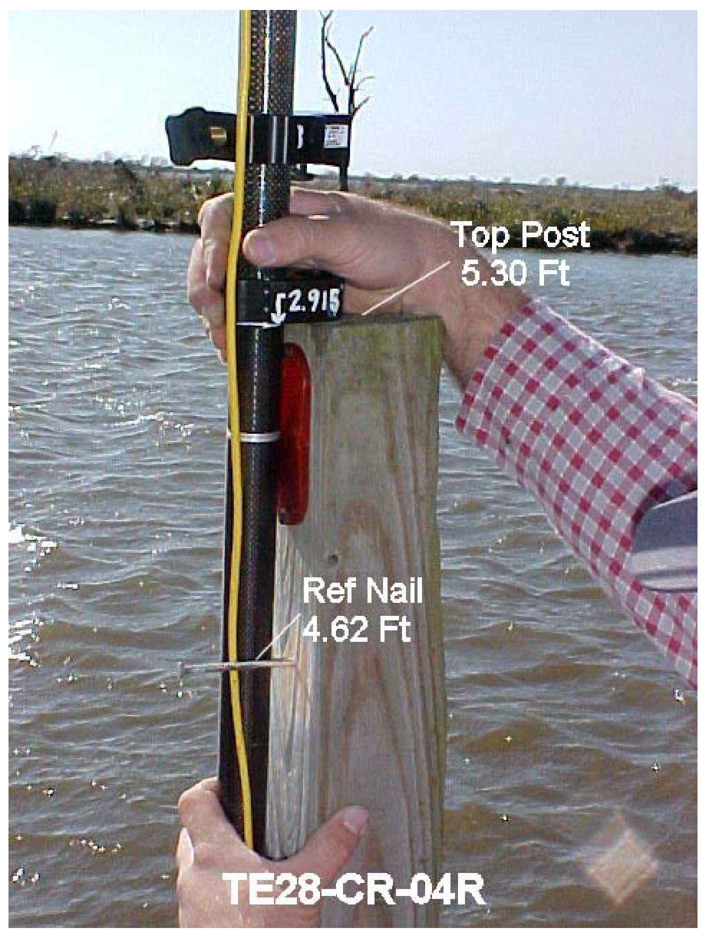
Example 4
Photo at the right is RTK being performed on a staff gage post at the reference 60d nail. The bottom of the bulls-eye bubble is set on the shank of the nail. To the left is a continuous recorder gage.

Example 5
Photo at left is an example of a new ceramic staff gage plate attached to a 4x4 post. To the left is a continuous recorder gage tied to a transmitter.

Example 6
Photo at the right shows a TBM boatspike installed into a timber post at a water control structure. This TBM was used to set a staff gage at the structure by measuring down to the top of water.

Example 7
Photo at left is an example of a new gage installation in the Terrebone and Barataria Basins. A ceramic staff gage plate attached to a 2x4 treated board which is attached to a 2” galvanized pipe that is driven into firm bottom.

Example 6
Photo at the right shows RTK Survey being performed to determine the elevation at the top of a 4x4 treated post at a continuous recorder. Once the elevation was determined, measurements were taken from the top of the post to the reference nail and top of water to determine those elevations, as noted.



SECTION K
LDNR Offices

Office of the Secretary		
Office of the Secretary Main Office Baton Rouge	617 North 3rd Street, 12th Floor P.O. Box 94396 Baton Rouge, LA 70804-9396	(225) 342-4503
Office of Coastal Restoration and Management		
Office of Coastal Restoration & Management Main Office Baton Rouge	617 North 3rd Street, 10th Floor P.O. Box 44487 Baton Rouge, LA 70804-4487	(225) 342-1375
Coastal Restoration Division Main Office Baton Rouge	617 North 3rd Street P.O. Box 44027 Baton Rouge, LA 70804-4027	(225) 342-7308
Coastal Restoration Division Field Office Abbeville	124 N State Street Abbeville, LA	(337) 893-3643
Coastal Restoration Division Field Office New Orleans	University of New Orleans UNO Box 1102 Science Bldg., Room 2048 New Orleans, LA 70148	(504) 283-1771
Coastal Restoration Division Field Office Thibodaux	1440 Tiger Drive, Suite B Thibodaux, LA 70301	(504) 447-0991
Coastal Management Division Main Office Baton Rouge	617 North 3rd Street P.O. Box 44487 Baton Rouge, LA 70804-4487	(800) 267-4019 (225) 342-7591
Coastal Management Division Field Office New Orleans	1600 Canal Street New Orleans, LA 70112	(504) 568-5689
Coastal Management Division Field Office Lafayette	Drawer 42930 USL Lafayette, LA 70504	(337) 262-5656
Coastal Management Division Field Office Houma	2124 Grand Caillou Road Houma, LA 70363	(504) 857-3627
Coastal Management Division Field Office Lake Charles	P. O. Box 90255, MSU Lake Charles, LA 70609	(337) 475-5298
Office of Conservation		
Office of Conservation Main Office Baton Rouge	617 North 3rd Street, 9th Floor P.O. Box 94275 Baton Rouge, LA 70804-9275	(225) 342-5540
Office of Conservation District Office Lafayette	825 Kaliste Saloom Road Lafayette, LA 70508	(337) 262-5777
Office of Conservation District Office Shreveport	1525 Fairfield Avenue Suite 668 Shreveport, LA 71101-4388	(318) 676-7585
Office of Conservation District Office	122 St. John Street Monroe, LA 71201	(318) 362-3111

Monroe		
Office of Mineral Resources		
Office of Mineral Resources Main Office Baton Rouge	617 North 3rd Street, 8th Floor P.O. Box 2827 Baton Rouge, LA 70804-2827	(225) 342-4615
Office of Mineral Resources Lafayette	803 Coolidge Boulevard, Suite 150 Building 8 - Lafayette Oil Center Lafayette, LA 70503-2335	(318) 262-2000