Guidelines for the Collection and Management of Hydrologic and Meteorologic Data

Hydrologic Data Section

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Cover photograph:

Hydrologic Data Section technicians wearing chest-waders while in waist deep water repairing an automated-recording streamflow monitoring station at the Three Sisters Springs complex, Crystal River, Florida .

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GUIDELINES FOR THE COLLECTION AND MANAGEMENT OF HYDROLOGIC AND METEOROLOGIC DATA

STATEMENT OF INTENT

It is the intent of the Hydrologic Data Section (HDS) at the Southwest Florida Water Management District (District) to collect, record, analyze, manage and archive hydrologic and meteorologic data in accordance with generally accepted procedures consistent with applicable scientific and technical standards of practice, established procedures and/or with procedures described in this document.

PURPOSE

The HDS is responsible for the implementation and maintenance of a network of observation and monitoring stations throughout the District's 16-county area that are used to monitor various hydrologic and meteorologic parameters over time. All data collected are processed, analyzed and validated, then uploaded into the Water Management Information System (WMIS) for general access by District scientists and engineers, natural resource managers, other governmental agencies and the general public. The WMIS is also periodically augmented with hydrologic and meteorologic data from the United States Geological Survey (USGS) and the National Oceanic and Atmospheric Administration (NOAA).

This document applies to HDS personnel and contractor personnel authorized by the HDS to collect hydrologic and meteorologic data for the HDS data collection program.

The source information used in the preparation of this document has relied heavily on the guidelines, procedures, techniques and methods used by other agencies regarding their data collection programs. A list of acronyms used in this document is provided (see Detail 1). Additionally, a list of references and additional informational resources is provided (see Detail 2) and referral to these sources is highly recommended for additional guidance and information regarding data collection and management requirements, procedures, techniques and methodologies.

SCOPE

The scope of this document specifies certain guidelines and minimum requirements that are necessary for the consistent and accurate collection of hydrologic and meteorologic data by the HDS. Elements presented in the document include the minimum requirements and procedures for the documentation and design of the data collection network, requirements for initial and ongoing survey work, requirements for the installation of instrumentation, requirements for the collection of time series data, and requirements for the processing, editing, analyzing, validating, managing and archiving of hydrologic and meteorologic data.

Since the collection of field data can present many challenges, it is critical that all field data be collected using properly installed and acceptable field instrumentation, using consistent and repeatable data collection techniques, and utilizing appropriate quality control methods, in order to provide accurate, cost effective and defensible data for use in the management and protection of the District's water resources and related natural systems.

Sometimes, the greatest value of hydrologic and meteorologic data is only realized long after the data has been collected, when that data is relied upon or referenced in a future study.

TRAINING

All HDS staff, including contractor and cooperator personnel, involved in data collection and management activities shall have the necessary education, experience and skills to perform their assigned job duties. Personnel shall be trained and familiar with the appropriate safety protocols, equipment and procedures, required quality control procedures, and those specific procedures to be conducted for each task.

Training includes, but is not limited to, workshops, seminars, short-courses and by working under the guidance of senior colleagues. Training procedures, training records, and demonstration of capabilities shall be documented.

All HDS staff are required to attend monthly staff meetings.

DATUM

The following is a process to determine the elevations and locations of instrumentation at data monitoring sites. All necessary elevations and locations of instrumentation at data monitoring sites must be determined through the use of permanent and professionally surveyed benchmarks installed with the minimum requirements described in this section. All work performed in the establishment of benchmarks and determination of elevations and locations must be documented and stored in the appropriate District database(s) using established and acceptable database formats.

Surveying

All elevations at data monitoring sites shall be determined through the use of permanent and professionally surveyed benchmarks. All vertical and horizontal surveying shall be completed either under the direct supervision of a Florida licensed Professional Surveyor and Mapper or in accordance with the guidelines indicated within this document.

Permanent Benchmarks

- All benchmarks must be established under the supervision of a Florida licensed Professional Surveyor and Mapper in accordance with applicable minimum technical standards defined in 61G17, Florida Administrative Code (F.A.C.)

- A minimum of two NAVD88 vertical control benchmarks must be established within 500 feet of each data collection device assigned a Site Identification Number (SID), including wells, staff gauges, or other measuring devices. One of the benchmarks shall be located within 100 feet of each device.

- Existing NAVD88 vertical control benchmarks in the vicinity of the site can be used if the benchmark data are published by the National Geodetic Survey (NGS) or established and published by a Florida Professional Survey & Mapper (PSM).

- The vertical accuracy of newly-established or existing vertical control benchmarks shall not exceed +/- 0.10 feet local network accuracy and directly measured to a minimum of two existing NGS or PSM vertical control benchmarks. The surveyor shall publish a datasheet and surveyor's report for all newly-established vertical control benchmarks.

- A corresponding derived NGVD29 elevation (e.g., Vertcon) for each benchmark must be determined and noted in the site documentation records.

- The Surveyor in charge of constructing the monuments shall assure that the materials used will adequately establish a stable monument. If the soil is unstable and cannot be compacted to adequately stabilize the monument, the type of benchmark shall be no less than a metal rod or

metal pipe driven to point of refusal with a concrete collar poured around the rod/pipe at ground level and a disk set in top center of concrete (see Detail 3 for a monument construction checklist). The disk shall display the surveyor's identification number. Refusal shall be defined as several full blows with an eight (8) pound sledge hammer rendering no perceptible movement of the rod/pipe.

- The permanent benchmark shall be documented in a vertical control datasheet (see Detail 4 for an example of the information to be included on the datasheet).

Determining Horizontal and Vertical Information

1) Acceptable Types of Survey Equipment and Methods

   a) A global positioning system (GPS) receiver with differential correction capability (WASS/SBAS), or equipment with greater precision, must be used for determining the horizontal position of the measuring devices.

   b) Differential leveling equipment and standard land surveying techniques must be used to determine all elevations (see Detail 5 and Detail 6 for guidelines on transferring NAVD88 elevations from the benchmarks to the monitoring sites).

2) Protocol for Determining Horizontal Location

   a) The horizontal location (latitude/longitude) of all measuring devices must be recorded. The observer shall record the horizontal accuracy as displayed by the GPS receiver.

   b) Record the PDOP (Position Dilution Of Precision), number of satellites and the displayed accuracy. Record this information two separate times, with 15 minutes between recordings. A minimum of five satellites and a PDOP of less than six shall be required. If offsets are needed, a minimum of four offset points should be obtained (two sets of two points on a line with the measuring device) and the offset distances measured with a tape to the measuring device, with distances recorded to the nearest foot.

Protocol for "Leveling" Measuring Devices

All elevations related to measuring devices must be determined using a minimum of two permanent benchmarks as described above. The field technician shall transfer the NAVD88 elevation from the benchmarks to the devices using closed loop differential leveling techniques between the benchmarks and the appropriate points on the devices (as described below). The procedures for transferring the NAVD88 elevation from the benchmarks to the measuring points (MP) are shown in Detail 5 and 6.

Staff Gauge Sites

- A permanent reference point with elevation shall be established on each staff gauge with appropriate file marks, and recorded in the field book and database. A photograph should be recorded, and the reference point and numerical reading of the staff gauge must be plainly visible in the photograph.

- An elevation reading shall be recorded at an even foot mark of the gauge. Both the elevation and the numerical reading (i.e. 2.00', 3.00', etc.) of the gauge where the elevation reading was taken shall be recorded in the field book and database.

- Water level reading on the staff gauge shall also be noted in the field book and database, along with the time and date of the reading. An elevation reading shall be taken on the ground surface at the base of the gauge and shall be recorded in the field book and database.

- A sketch of the staff gauge location(s) with the latitude and longitude shall be recorded in the field book and database. If applicable, the sketch shall illustrate the location of the gauge in relation to a dock or other semi-permanent structure, either by compass bearing and distance or by distance ties if the gauge is attached to a dock, a description of the location and type of mark identifying the measuring point, and the location of all benchmarks and reference marks.

- Data collection sites may have more than one gauge. All gauges at the site will be surveyed in accordance with the procedures outlined above.

- Survey information to be reported includes 1) gauge locations, 2) information on benchmarks used to determine staff gauge elevations, 3) the elevation of top of supporting structure, 4) ground/dry reading, 5) the water level reading at the time of installation, 6) factor to convert staff gauge readings to NAVD88 and/or NGVD29, if needed, and 7) photographs.

Well Sites

- A permanent MP shall be established at the well from which water levels will be measured. MP elevations for wells shall be measured from the top of the well casing (or other fixed component of the well above the elevation of the well casing), and marked with file marks spaced two inches apart with survey rod readings taken between the file marks. MP's set on removable well caps, spigot handles and other movable and/ or removable components, and/or marked with paint or similar substance, are not acceptable. If a recorder shelter is installed on the well and a survey rod cannot be set on the top of the well casing or PVC riser pipe, the MP shall be set on the floor of the recorder shelter box. A 2" by 2" square marked with black permanent marker pen shall be placed next to the opening of the floor and the elevation established at that point. A brief description and photograph of the MP shall be recorded in the field book and database (the measuring point of the well must be plainly visible in the photograph). An elevation reading shall be taken on the ground surface at the base of the well and shall be recorded in the field book and database.

- A sketch of the well location with the latitude and longitude shall be recorded in the field book and database. At a minimum, the sketch shall illustrate the location of the well in relation to the established bench mark(s) and any semi-permanent structures or other distinguishing feature, by compass bearing and distance.

- Survey information to be documented includes: 1) well locations, 2) information on benchmarks used to determine well elevations, 3) elevation of top of casing (at the measuring point, if applicable), 4) ground elevation at the well, 5) total depth of well (from ground surface) 6) depth of casing (from ground surface), 7) photographs, and 8) if applicable, water quality sampling depth. Although not a surveyed value, the casing material and diameter should also be documented.

Automated-Recorder Sites

- The measuring point will be set on the top of the well casing in the recorder box and marked with a black permanent marker. If the rod cannot be set on the top of the well casing, the measuring point shall be set on the floor of the recorder box. A 2" by 2" square marked with black permanent marker pen shall be placed next to the opening of the floor and the elevation established at that point. The MP elevation shall be written on the recorder box floor next to the MP. A brief description and photograph of the measuring point shall be recorded in the station records and database (the measuring point and numerical elevation shall be plainly visible in the photograph). An elevation reading shall be taken on the ground surface adjacent to the recorder and shall be recorded in the field book and database.

- A sketch of the recorder site location with the latitude and longitude shall be recorded in the field book and database. If applicable, the sketch shall show the location of the recorder in relation to the nearest permanent landmark (e.g., roadway, building, bridge, dock, etc.), either by compass bearing and distance or by distance ties if the recorder is attached to a dock, a description of the location and type of mark identifying the measuring point, and the location of all benchmarks and reference marks.

- Survey information to be reported includes 1) recorder box location, 2) information on benchmarks used to determine recorder elevations, 3) elevation of recorder box floor at the measuring point, 4) ground elevation at the recorder, and 5) photographs. Although not a surveyed value, information on the type of recorder should be reported.

Survey Maintenance

- Due to the possibility of subsidence, the elevation of the wells and gauges should be checked six months after installation, and thence every three years.

- As part of these checks, the two benchmarks are compared to each other (see Detail 5). If any change in the elevations of the benchmarks is determined, the elevations of the benchmarks shall be re-evaluated by a Florida licensed Professional Surveyor and Mapper in accordance with applicable minimum technical standards defined in 61G17, F.A.C.

Documentation Requirements

- All field data shall be recorded in standard bound field books, and transferred to established databases.

- Digital photographs shall be taken at the measuring device site. Multiple photographs shall be taken as the situation warrants when a site contains more than one well, staff gauge, recorder and benchmarks. The photographs shall be JPEG format and the digital files will be named according to the SID. One or more photographs shall illustrate an overall view of the benchmarks, well/staff gauge and/or recorder site and any adjacent distinguishing features to aid in identifying and locating the site. Additional photographs shall be taken showing the benchmark monument, the measuring point and location of the well, the recorder, the staff gauge with level rod held on measuring point to indicate where the elevation measurement was taken, and the identification number or name of the device written on a surface that will be plainly legible in the photograph. The measuring point of the benchmark, well, recorder or staff gauge must be plainly visible in the photographs.

- All applicable site information, elevation, and location information shall be appropriately documented, including:

    - Identification, location, and elevations of all benchmarks used;
    - Identification, location, and elevations of all data collection devices (specific elevations as described throughout this document);
    - Photographs;
    - Sketches or maps;
    - Personnel performing leveling work;
    - Site address, including county;
    - Site Section, Township and Range;
    - Site ownership (including land owner, and group or individual responsible for data collection and site maintenance);
    - SID associated with the device.

MONITORING STATION REQUIREMENTS

The collection of high quality field data is partly a function of the quality of the installation and maintenance of the instruments used to measure the data. This section describes the minimum requirements for the installation of measuring devices for groundwater level, surface water level and flow, and rainfall monitoring.

Surface Water Level Monitoring

Measurements of water level in surface water bodies (e.g., rivers, lakes, wetlands, etc.) are collected by manual observations and by installing automated recording devices (see Automated Recording Devices section, below). The vertical staff gauge is the preferred instrument for manually measuring surface water levels (stage), while a "stilling well" is the preferred instrument used for collecting automated water level measurements in conjunction with a staff gauge.

Continuous measurements of flow in rivers and streams are determined by measuring stage in the flow systems and converting the stage measurements to flow through a pre-determined stage-discharge relationship. The stage-discharge relationship is used to develop a discharge rating curve for the site. Several techniques are available for the determination of the stage-discharge relationship. While these techniques are not included in this document, the specific proposed technique should be documented in the station records and appropriate databases.

The following methods are to be used to install and maintain staff gauges and stilling wells.

Location

Staff gauges and stilling wells located in lakes and flowing systems (e.g., river, streams, etc.) are typically installed as to not interfere with navigation, and are often located near or attached to docks or other semi-permanent structures. In flowing systems, a location that minimizes the potential for clogging with floating debris should be chosen. Staff gauges and stilling wells located in wetlands are typically installed in the deepest part of the wetland, but because of easement limitations, safety reasons or other considerations this may not always be possible. In some cases, multiple staff gauges are used to accommodate systems with highly fluctuating water levels. For all sites, the location should be one that allows the instrumentation to record all likely ranges of water levels, and that allows an observer to read the staff gauge with the naked eye.

Structure and Installation – Staff Gauge

Staff gauges must conform to either USGS Style A (preferred) or Style C standards, and be constructed of 16-gage porcelain-enameled iron or steel (see Detail 7 for guidelines for staff gauge installations). Staff gauges must be attached to a backing plate and mounted to a stable structure in the water body. The staff gauge must be mounted vertical and plumb to the water surface. If more than one staff gauge section is used, adjustments for accuracy between sections should be made by measuring the distance from the middle of one section to that of an adjacent section.

Structure and Installation – Stilling Well

Stilling wells are used in surface water bodies to (either) accommodate instrumentation that automatically collect water level measurements, and/or to minimize the effects of wave action on water level measurements (see Detail 8 for guidelines for stilling well installations). It is essential that the water level in the stilling well correspond to the stage level in the surface water body. Stilling wells must be of sturdy construction, provide a stable platform for water level monitoring instrumentation, be mounted vertical and plumb to the water surface, and meet the following minimum requirements:

- The stilling well should be constructed of schedule 40 polyvinyl chloride (PVC) slotted well screen, with a cap glued onto the bottom. Several holes should be drilled into the cap to allow water flow. A 6- to 10-inch diameter is recommended;
- Have sufficient height to accommodate the maximum stage level anticipated, while deep enough for its bottom to be at least a foot below the minimum stage level anticipated;
- Have intake slots at various stages (elevations) to accommodate widely varying stages;
- Have intake holes of sufficient diameter to assure that the water level in the stilling well will not lag the rise or fall of the water level in the water body;
- Have intake holes of such diameter to damp out short period wave effect or oscillation;
- Have some provision to accommodate periodic cleaning.

Surveying

The staff gauge should be calibrated to the nearby benchmarks, and the elevation of the ground adjacent to the staff gauge should be determined. Refer to the Surveying Requirements section for required procedures. If the elevation values on the staff gauge are not displayed as values of NAVD88 or NGVD29, a correction value to convert the values to NAVD88 and NGVD29 must be stored in the appropriate database. However, it is highly recommended that gauges with values in NAVD88 or NGVD29 be used. Stilling wells installed in conjunction with a staff gauge shall be calibrated to the water level as indicated by the associated staff gauge.

Site Identification

Every staff gauge shall be assigned a unique SID Number and Site Name. The SID number should be obtained prior to gauge installation. The SID number and Site Name shall be clearly and permanently marked on the staff gauge. Stilling wells installed in conjunction with a staff gauge shall bear the same identification as the staff gauge. Any adjustment factor to convert the values on the staff gauge to NAVD88 or NGVD29 shall be documented in site records and recorded in the appropriate database(s).

Maintenance

Staff gauges are designed for lengthy service and, as such, general cleanliness is very important to ensure trouble-free operation. Staff gauges must be kept clean so that all graduations can be read accurately and be handled in a manner that the calibration is not altered. Periodic brushing will keep the gauge readable. At each site visit, the instrument should be closely inspected for problems that would affect the readability, such as corrosion, and perform maintenance as needed.

Stilling wells must be inspected and maintained on a regular basis. The physical integrity of the stilling well components, including the support structure and well screen, shall be checked during each site visit. The exterior and interior well screen shall be inspected and kept free of debris, encrustation, any foreign objects, and the buildup of sand and silt. Any obvious signs of damage or degradation to the support structure, well screen or other components shall be documented, reported, and corrective action(s) taken.

Replacement and Abandonment

Any time the location of a staff gauge is significantly changed, a new SID number shall be required. If a staff gauge is repaired or replaced in the same location as the original, no new SID is required (although resurveying will likely be needed). In the event that a staff gauge is no longer needed for water level monitoring, the staff gauge and any supporting structure shall be removed and the site restored to pre-gauge construction conditions upon completion of staff gauge removal.

Groundwater Level Monitoring

Measurements of water level in groundwater wells are collected by manual observations, or by the installation of automated recorders (see Automated Recording Devices section, below). The HDS

monitors groundwater levels in the surficial aquifer, intermediate aquifer system and the Floridan Aquifer system. Groundwater level measurements are made on static and artesian wells.

Location

The location of groundwater wells monitored by the HDS are typically already established (existing) or have been pre-determined by other District staff prior to inclusion into the HDS monitor well network. However, the existing site and landscape conditions that may affect the water levels to be measured must be properly evaluated for possible affects to groundwater levels. Natural water bodies, manmade ditches or ponds, septic systems, spray fields, adjacent wellfields and other such features may influence the levels measured in monitor wells. Therefore, existing site conditions must be documented and kept with station records.

Structure and Installation – Groundwater Well

The following are general requirements for HDS monitor wells, unless otherwise specified or authorized:

- The well construction characteristics shall be determined or verified prior to initiation of monitoring, and should conform to those standards as set forth in Chapter 40D-3, F.A.C, as feasible. At a minimum, the monitor well casing depth, total depth and open-hole interval(s) shall be known prior to monitoring.
- For operational considerations, the recommended minimum casing diameter for a monitor well shall be two inches.
- The well casing shall extend at least three feet above land surface, as feasible.
- A 3 ft X 3 ft X 6 inch concrete (not cement grout) pad shall be installed around each well. The well should be centered in the pad and the top of the pad should be flush with land surface.
- A metal wellhead protector casing with lockable cap should be placed over and around the well and cemented in place at land surface (See Detail 9 for typical wellhead protector casing diagram). The top of the wellhead protector casing should extend approximately 3.5 feet above land surface or 6 inches taller than the monitor well casing. Cement (or other acceptable material) should be brought up inside the wellhead protector casing to within a few inches below the base of the monitor well casing and well cap. The wellhead protector casing is designed to protect the monitor well from weather, vandalism, fire damage, impacts and/or other detrimental field conditions.

Surveying

The elevation of the top of the monitor well casing and the elevation of the ground adjacent to the monitor well should be determined. Refer to the Surveying Requirements section for required specifications. Note also that wells must be straight and plumb to allow for installation of water level monitoring equipment and for accuracy in tape measurements.

Site Identification

Each well will be assigned a unique SID and Site Name. The SID number should be obtained prior to monitoring. The well shall be labeled using a standardized method that is durable and can be maintained. Information to be included on the label shall include SID Number and Site Name.

Maintenance

All preventive and routine maintenance shall be performed in accordance with best management practices, established DCB procedures, as well as HDS SOP's and IOP's (as applicable) currently located on the DCB L-drive at L:\Hydrodat\SOP_IOP_Files*.*. Monitor wells used for water level measurement shall be inspected and maintained on a routine basis. During each site visit, the physical integrity of the well shall be checked. Any obvious changes to the well measuring point elevation, significant changes in the measured total depth of the well, or any obvious degradation to the well pad or protective casing shall be reported and corrective action(s) taken.

All repairs made to the well, including to the protective casing or concrete pad, shall be properly documented in ELBIS and/or M-PET and a copy placed in the appropriate station records in WMIS. If the total depth of the well is found to be significantly less than the original well construction specifications, a survey will be performed to ascertain the cause (sediment infilling, equipment obstruction, etc.). If it is determined that the well has had significant sediment infilling, the well shall be properly cleaned (e.g., re-developed) in accordance with established DCB procedures before the next regularly scheduled monitoring event. All accessible foreign objects will be removed from the well if possible. If such remediation techniques are unsuccessful, the replacement of the well may be necessary.

Replacement, Abandonment and Site Restoration

If it is determined that a monitor well must be replaced, a well permit to abandon the old well (under Chapter 40D-3) will be needed and a permit for the construction of any new well (also under Chapter 40D-3) will also be needed. As part of the process for the construction of the new well, a new SID number will be assigned.

In the event that the drilling contractor fails to properly construct a well in accordance with specified design plans and/or contractual agreement, for any cause including, but not limited to, the loss of drilling equipment into the well or loss of the hole to caving, or if the well is no longer needed for monitoring purposes, the well shall be plugged in accordance with those standards as set forth in Chapter 40D-3, F.A.C.

It shall be the drilling contractor's responsibility to restore each site to pre-well construction conditions upon completion of well construction.

Precipitation Monitoring

Precipitation is defined as any form of water particle, liquid or solid, that falls from the atmosphere and reaches the ground. It is not fog, dew, rime, or frost because it must fall. It is not cloud or fog because it must reach the ground. Precipitation includes the following forms: rain, drizzle, freezing rain/drizzle, hail, and very occasionally snow.

Precipitation data are intrinsically both difficult to measure accurately and easy to misinterpret. A great deal of care must, therefore, be taken to collect precipitation data in a consistent and precise way, and to annotate the data with as much background detail as possible. Many factors can affect the recorded data values or their interpretation. For example, tipping bucket rain gauges may under-report rainfall when intensities approach six inches (or more) per hour, while poor equipment maintenance or calibration practices can also induce significant errors in data that may be very difficult to identify. Therefore, a well designed and maintained data collection network must ensure that these factors are taken into consideration. Additionally, the measurement frequency by automated instrumentation should be sufficient enough for the data processor to identify extreme rainfall events in order to identify possible underestimation.

The following methods are to be used to install and maintain rainfall monitoring stations.

Location (Sitting and Exposure)

Rainfall instruments should be installed as close to ground as possible without being subject to splash. Rainfall gauges should not be located under power lines, close to trees, or near buildings, which may obstruct or alter the amount of rainfall being measured. To avoid problems with excessive wind, instruments should not be located on the top of buildings. Instruments should be installed at a distance from obstructions of at least two (preferably four) times the height of the object above the top of the gauge.

Structure, Installation and Instrumentation

Rainfall gauges shall be installed on a stable structure with solid support that does not shake or sway in the wind, in accordance with the manufacturer's instruction. Rainfall gauges should be installed such that the receiver is exposed in a level, horizontal plane.

The tipping-bucket type rainfall gauge is the HDS preferred standard for rainfall measurements. The tipping-bucket type rainfall gauges consist of a lightweight container or bucket divided into two equal compartments (buckets) and balanced atop a horizontal axis. Two stops, one under each end of the container, limit the container's movement. The rainfall that is caught by the receiver runs through an outer funnel into one of the two compartments until the bucket becomes unbalanced and tips to its other position. This places the second compartment in position to receive rain from the funnel and at the same time drains the collected water from the first compartment. The tipping of the bucket actuates a contact closure (switch) and produces a recordable event. The time between tips represents the rate of rainfall depending upon the capacity of each compartment.

Surveying

A GPS receiver with differential correction capability (WASS/SBAS), or equipment with greater precision, must be used for determining the horizontal position of all rainfall measuring devices. All necessary surveying requirements must be performed in compliance with the guideline found in the section of this report on surveying.

Site Identification

Every rainfall monitoring station shall be assigned a unique SID and Site Name, which should be obtained prior to station installation. The SID must be clearly and permanently marked on the rain gauge device.

Preventative Maintenance

General cleanliness is very important to ensure trouble-free operation of rainfall gauges. Gauges must be kept clean so that measurements can be read accurately. The receiver of the instrument should be checked for horizontal alignment and levelness, as a leaning gauge can compromise measurement accuracy. If the gauge does not appear to be exposed in a level horizontal plane, repairs should be immediately performed and documented. At each site visit, the instrument should be closely inspected for problems that would affect the accuracy of the measurement. If a problem is found, the technician must enter this information into their field notes so maintenance can be scheduled. Manufacturer's specific guidelines for maintenance and calibration should be observed.

Semi-annual (Six-Month) Field Maintenance Requirements

Once every six months, the following maintenance shall be performed in addition to the "Preventative Maintenance" work referenced above:

- Perform a field calibration test with a known volume of water in accordance with established HDS field operating procedures. If the instrument is found to be out of calibration, it should be replaced with a calibrated instrument (no adjustments should be made in the field).
- Timing intervals and dates of records must be checked.

Annual Maintenance and Calibration Requirements

Once per year each instrument shall be replaced with a calibrated instrument. The rain gauge shall be taken out-of-service and brought to the HDS work shop for annual maintenance activities, including cleaning the outer funnel, insect screens, and drains, wiping them free of all debris and obstructions. The tipping bucket and inner funnel should be cleaned and cleared of all insect materials, especially spider webbing on the side of the tipping bucket. The bucket mechanism should

be moved from side to side to ensure that the pivot pin has enough play for it not to bind, yet not fall out. Calibration of the tipping bucket shall be performed by passing a known amount of water through the tipping mechanism at various rates and by adjusting the mechanism to the known volume. Manufacturer's specific guidelines for maintenance and calibration should be observed. If the instrument cannot be properly serviced and calibrated by District personnel, it shall be sent to the manufacturer for servicing and calibration.

Replacement and Abandonment

Any time the location of a rainfall monitoring station is significantly changed, a new SID is required. If a measuring device is repaired or replaced in the same location as the original, no new SID is required.

Automated-Recording Devices

Certain data collection monitoring sites contain instruments that automatically collect and store hydrologic and meteorologic data. Equipment and sensors deployed by the HDS at automated-recording sites can continuously record surface water levels, groundwater levels, rainfall and other hydro-meteorological parameters.

Location

Location guidance for automated-recording devices is the same as the gauge or well for which it is installed**.**

Structure, Installation and Instrumentation

Automated-recording devices are installed at groundwater monitoring sites, surface water monitoring sites and rainfall monitoring sites. Equipment and devices installed typically consist of an aluminum equipment shelter with stabilizing structure used for housing and protecting sensitive electronic instrumentation from weather, theft/vandalism, fire damage, ultraviolet radiation degradation, and/or other detrimental field conditions; a data storage device (i.e., data-logger) used for electronic storage of data; one or more sensors (i.e., devices used to measure a specific hydrologic or meteorologic parameter); and other ancillary equipment, such as a power source (rechargeable batteries), solar panel(s) for recharging batteries, lightning protection and grounding device(s), electrical conduit, wiring, et cetera.

The HDS preferred instrumentation (sensor) for monitoring surface water and groundwater levels is (either) a "shaft encoder with float/pulley" or a "submersible pressure transducer." The preferred instrument for measuring rainfall is the "tipping-bucket" rain gauge (refer to Precipitation Monitoring section above).

Aluminum Equipment Shelter

An aluminum equipment shelter and support structure shall be installed in conjunction with the installation of automated-recording devices. The equipment shelter can be mounted on top of a groundwater well or surface water stilling well casing, or other stable structure that does not shake or sway in the wind. The shelter should be secured with (either) 4x4 pressure-treated lumber support legs and/or 3-inch diameter aluminum pipe/tubing. The shelter floor must be level and shall be clearly marked with the location of the measuring point and corresponding elevation (with relevant datum information). All wiring shall be buried at least 18 inches below ground level and secured within conduit, with water-resistant seals at all ends. The equipment shelter should be well-grounded, and equipment protected from induction surges through the use of voltage spike suppressors. An ionization rod is recommended to further protect the equipment from lightning. All construction materials should be made of non-corrosive metals (aluminum and/or galvanized or stainless steel) to minimize repairs. Equipment shelters should be kept locked to prevent unauthorized access to equipment. A District Logo or other identifying marking should be prominently displayed on the shelter and clearly visible with the naked-eye.

In some cases, a NEMA-4 equipment box mounted to a galvanized metal pole can be used to house recording instruments, rather than installing an aluminum equipment shelter. All sensor wiring shall be protected within conduit, secured to a mounting pole and buried at least 18 inches below ground level. The support pole shall be completely vertical, extend at least 4 feet into the ground and be cemented at the base.

All water level recording devices should be installed using the manufacturer's instructions and in accordance with established HDS procedures.

Data-Logger

A data-logger is a device that coverts and records sensor signals into a digital data format. The data-logger is typically installed within the equipment shelter box and can be mounted onto the shelter floor by removable bolts or screws.

Shaft-Encoder with Float/Pulley

A shaft-encoder with float/pulley is a device that measures the distance from a float on the surface of the water to a fixed point above the water surface. It uses a float and counterweight suspended over a pulley by a flexible line or tape. As the water level rises or falls, the float moves proportionally causing the pulley to rotate. The pulley is attached by a shaft to an electronic encoder that records the water-level measurements digitally and stores the values in a data-logger memory. A shaft/encoder with float/pulley can be installed onto a well or stilling well within an equipment shelter box and can be mounted onto the shelter floor with removable bolts or screws. The shelter floor must be permanently marked to indicate which side of the pulley assembly is dedicated for the float and which side is dedicated to the counterweight.

Submersible Pressure Transducer

A submersible pressure transducer is a device that converts water pressure into an electrical signal that is then converted into a water level measurement. The HDS uses submersible pressure transducers that are "compensated" for atmospheric pressure, meaning that one side of the pressure sensor diaphragm is vented to the atmosphere, thus compensating for changes in atmospheric pressure and measuring water pressure only. These transducers use a tube in the cabling to vent the transducer to the atmosphere, eliminating the need for atmospheric pressure corrections. A desiccant capsule is incorporated into the venting tube to prevent atmospheric moisture from entering the transducer.

Ancillary Equipment

The type of ancillary equipment installed, such as a power source (e.g., rechargeable batteries), solar panel(s) for recharging batteries, lightning protection devices, etc., shall be on a site-specific basis.

Maintenance

- All equipment shelters shall be kept locked when not in use. The exterior and interior areas and surfaces of the equipment shelter box and associated platform structure shall be kept clean and free of debris, overgrown vegetation, animal/insect infestation or nesting materials, and any foreign objects.

- The data-logger (and other electronic instrumentation, as appropriate) must be effectively grounded to prevent damage to the unit due to surges caused by nearby lightning strikes. If a malfunctioning data-logger unit or corrupted data-logger memory is encountered, the unit should be replaced with a new unit and the problem unit sent back to the manufacturer for repair or replacement.

- The float/encoder equipment is designed for lengthy service without maintenance. However, general cleanliness is very important to ensure trouble-free operation. The technician shall make the following checks during each site visit:

  o Inspect the instrument closely and remove all foreign materials, such as corrosion or insect debris. Be especially observant for spider webs and paper- or mud-wasp nests on float lanyards and tapes.
  o The float tape must be checked regularly to ensure that it is in good condition in terms of spine alignment and does not show any evidence of fatigue or bending (kinks) in the tape. Wave action or kinks in the tape will make the perforated tape slip.
  o If any problems are noted, the equipment must be adjusted or replaced, and a description of any changes must be documented by the technician in their field notes.

- Submersible pressure transducers generally require minimal maintenance, but problems can arise if they are not checked periodically. The technician shall make the following checks during each site visit:

  o Verify that the vent line has not been bent or kinked and is not clogged.
  o Ensure that the vent line desiccant is dry and in good condition. If not, replacement of the desiccant shall be necessary.
  o Under most circumstances, common problems that arise can only be resolved by replacing the transducer. Common problems include: water leaking into the transducer housing; open or short circuits that can result in erratic data values, zero values, or default values; grounding problems; diaphragm failure; voltage surges; faulty shielding that allow electromagnetic impulses to corrupt the signal from the sensor to the data logger; and over-range problems that occur when sensor output increases beyond the anticipated maximum output programmed into the data-logger. Should any of these problems be encountered, the equipment must be adjusted or replaced, and a description of any corrective action(s) must be documented.
  o If a pattern of instrument drift is noticed during routine data collection, especially if the drift is significant, the transducer must be replaced with a new unit, and the old transducer sent back to the manufacturer for repair or replacement. Small amounts of linear drift can be corrected in processing of the data if identified in the field and properly noted. Occasionally, data shifts can occur suddenly by mistakes made in the field by technicians. These include setting the wrong elevation value or time on the recorder before leaving the site, accidentally moving the transducer to the wrong depth, or not properly securing the transducer cable to prevent slippage down the well. Data shifts resulting from mistakes made by field staff usually can be easily identified by the time of occurrence and comparison of the technician's field notes, and normally can be corrected during processing of the data.

- All preventative and regular maintenance shall follow established HDS procedures and the manufacturer’s instructions for the specific instrumentation installed.

Surveying

Surveying should be consistent with the requirements outlined above for the gauge or well for which it is installed.

Station Identification

Station Identification should be consistent with the requirements outlined above for the gauge or well for which it is installed.

Surface Water Flow Monitoring

The District and USGS operate and maintain active surface water flow (or discharge) monitoring sites that provide instantaneous 15-minute intervals and mean daily flow data. Accurate flow or

discharge estimates are essential elements of water resource planning, development and management. Flow values are either directly measured or derived from water level measurement data. The rate of flow will change based on the elevation of the water surface, the velocity of the water, and the size of the water body (e.g., river, stream, canal, etc.). The amount of surface water that moves through a location per unit of time is usually expressed in cubic feet per second (cfs). Flow data are either measured or estimated using mathematical equations. Although manual flow measurements do not typically require installation of structures, installation of staff gauges and stilling wells in conjunction with surface water flow monitoring may be required.

Location

The location of manual flow measurements at a flowing surface water body is dependent on the site-specific conditions at the time of measurement, including: 1) safety; 2) the field technician's knowledgeable decisions regarding the best suitable channel cross-sectional area; 3) site access; 4) adequate streamflow; 5) uniformity of streamflow distribution; 6) flow turbulence; 7) flow direction; 8) obstructions; 9) bottom roughness/softness; and 10) the type of measurement equipment used.

The site location for manual flow measurements should be established, and as practicable, the same location should be used for all subsequent manual flow measurements.

Structure and Installation

For staff gauges and stilling wells, refer to the Surface Water Level Monitoring section for applicable requirements and procedures.

Typical Specifications for Flow Measurement Techniques/Equipment

Devices used for manual flow measurements include mechanical current meters (e.g., Price AA and Pygmy meter), electromagnetic current meters, and acoustic meters. Currently, most field measurements are made with acoustic Doppler instrumentation, while mechanical current meters are used only when acoustic meters are not applicable, are unavailable or for measurements in emergency situations.

Most flow measurement equipment comes with clear specifications in terms of accuracy and precision. Unfortunately, these specifications do not reflect the actual measurement uncertainty. The actual precision is a function of the measuring environment and needs to be evaluated based on direct observations whenever necessary. In cases when this is not possible, the measurement uncertainty must be established based on partial data from direct measurements.

Typically, the manufacturer's specifications of instrument accuracy are either given in terms of full-scale percentage or in terms of percentage of reading. An instrument with 10 ft/s range and 0.5% full-scale accuracy has an absolute error tolerance of 0.05 ft/s, applicable throughout the range of velocities. As a result, at low velocities, the same instrument would have accuracy below 0.5%.

The following are acceptable measurement techniques:

- Acoustic Doppler Current Profiler (ADCP) measurements that are performed following the guidelines established in the most recent ADCP Manuals by RD Instruments (1994) or later, and the (USGS) Quality Assurance Plan, Lipscomb (1995). The ADCP is a very recent flow-monitoring device, therefore, the technician should adopt flow measuring strategies in compliance with the RD Instruments' Manual. Otherwise, the methodology shall be discussed and agreed upon with HDS staff before implementation.

- Acoustic Current Meter (ACM) measurements that are conducted as defined in the ACM Manual by EG&G Marine Instruments (1993) or later and/or as directed by District staff. Any other measurement technique using the ACM shall be submitted for HDS approval before implementation.

- Price AA and Pygmy Current Meters used to determine stream velocity that are maintained according to USGS TWRI Calibration and Maintenance of Vertical Axis Type Current Meters by G.F. Smoot and C.E. Novak. Measurements of velocity in streams made using the Price-AA meter will be made as described in the USGS TWRI, Discharge Measurements at Gaging Stations by Buchanan and Somers. All meters will be cared for and maintained using USGS TWRI, Care and Maintenance of Vertical Axis Current Meters for guidance.
- Measurements using the Dye-Dilution Technique that are conducted as described in the most recent version of the Model 10-AU-005 Field Fluorometer User's manual or in the USGS Techniques of Water Resources Investigations by Kilpatrick and Cobb (1985). Any other flow measurement approach using the Dye-Dilution Technique shall be submitted for District approval before implementation.

The following are acceptable methodologies and standards:

- Daily mean streamflow, measured in cubic feet per second (cfs), will be calculated using discharge ratings and shift curves by discharge measurements and point-of-zero-flow (PZF) as described in USGS TWRI Computation of Continuous Records of Streamflow by E.J. Kennedy.

- Shift adjustments that are applied and discharge computed according to USGS TWRI Computation of Continuous Streamflow Records by E.J. Kennedy, and USGS Water Supply Paper 2175 Measurement and Computation of Streamflow: Volume 2. Computation of Discharge by S.E. Rantz and others.

- The techniques and policies described in the USGS TWRI Discharge Measurements at Gaging Stations by T. J. Buchanan and W.P. Somers and USGS Water Supply Paper 2175 Measurement and Computation of Streamflow: Volume 1. Measurement of Stage and Discharge by S.E. Rantz and others will be rigidly adhered to.

- Standard discharge measurement notes will be completed for each measurement and include SID number, station name, sequential measurement number, date, time inside, outside and recorder readings at the beginning and end of each measurement, spin test, total area, width, mean velocity, discharge, and remarks. All measurements will include notes as to the quality of the measurement, control conditions in the stream that may affect the gauge height/discharge relation, and a PZF (if applicable).

Surveying

For staff gauges and stilling wells, refer to the Surveying Requirements section for requirements and procedures.

Station Identification

Station Identification should be consistent with the requirements outlined above for the associated staff gauge.

Maintenance

- All stage/discharge sites will be assigned a District SID. All correspondence and data records will carry this SID.
- The streambed of the cross-sectional area of the flow measurement site should be kept clear

and free of submerged aquatic vegetation, weed growth, debris and foreign objects. The stream banks on each side of the measurement site should be kept cleared of shrubs and high grass over a somewhat larger reach.

Telemetry-Equipped (SCADA) Monitoring

Telemetry equipment is installed at some automated-recorder stations where data availability on a near real-time basis is needed for critical hydrometeorological and/or operational decision making purposes. Telemetry-equipped stations utilize the District's Supervisory Control and Data Acquisition (SCADA) system to transmit and receive information on groundwater levels, surface water levels, rainfall and other hydrometeorological data from field locations. The system operates on a twenty-four hour basis via cellular telemetry and area Telecommunications Service Providers (TSPs). SCADA site data are collected at each site on a pre-determined frequency interval (e.g., 15-minute, 30-minute, hourly, daily, etc.) and relayed to update the SCADA database hourly or daily, depending on project needs. The telemetry system is a polled system supporting ad-hoc data retrieval in addition to scheduled events. The SCADA system incorporates versatile poll scheduling capable of simultaneous TCP\IP (Internet) communications and concurrent TELCO (Telephone Company) modem connections maximizing capacity.

Location

Location guidance for telemetry-equipped stations shall be consistent with the gauge or well for which it is installed.

Structure, Installation and Instrumentation

Telemetry equipment is deployed at some automated-recorder stations in accordance with the gauge or well for which it is installed. Telemetry-equipment, such as modems, radio transmitter, antenna, wireless cellular equipment, and other accessory equipment shall be installed in accordance with established HDS procedures and the manufacturer's instructions for the specific instrumentation installed. A recorder shelter box shall be installed to house and protect the recording and telemetry instrumentation from weather conditions, vandalism, fire damage, ultraviolet radiation degradation, and/or other detrimental field conditions.

Telemetry equipment deployed at monitoring stations can vary depending on ever changing and rapid advances in technology, as well as site-specific conditions. Typical telemetry components of current SCADA telemetry systems are indicated in Detail 11.

Equipment Procedures and Maintenance:

Establishing near real-time access at a new instrumented site is a straightforward process, as follows:

1) Determination of the appropriate telemetry technology for the application (wireless cellular or TELCO). TELCO installations will require coordination with the District business unit responsible for TELCO line installations to order the service from the local area provider.
2) Installation of modems, as well as the necessary electrical connections to the site power system. Wireless modems will require the installation of an external antenna.
3) Connecting the modem to the Campbell data-logger with a serial interface cable.
4) Testing local connections at the site.(Note: As of this writing, SCADA standard serial parameters for data collection are 1200 Baud Rate, 8 Data Bits, 1 Stop Bit and No Parity).
5) Recording the phone number or IP and PakBus addresses and providing it to the SCADA System Developer for configuration in the SCADA application.

Additions or modifications to the SCADA tag database can only be performed on a SCADA Development System by an authorized account holder.

Remote telemetry commissioning and troubleshooting procedures are similar, as follows:

1) Determining whether the communications devices (modems) can establish communications.
2) When a communication link is established, determining whether the quality of the link can support operations.
3) Once communications issues are eliminated, determining whether the communicating system components are operating correctly.

Personnel responsible for the operation and installation of SCADA telemetry components will need familiarity with respective tools and procedures.

If a SCADA site is suspect (SCADA shows communication errors, data readings are stale or a problem has been reported) basic communication should be checked. For TCP/IP sites this is usually a “ping” test, a request using the ICMP protocol designed for testing, not data transport. It should be noted ICMP is frequently disabled on firewalls to prevent its malicious use for denial of service attacks.
TELCO sites can be dialed with handsets, computers and other equipment to determine if communication lines are operational. With networking and firewall issues eliminated, non-responding ping test will require a site visit to determine equipment status (available power, antenna condition, etc.); faulty TELCO lines are reported to the service provider for repair.

Once rudimentary testing is completed, if problems still exist, the quality of the connection should be checked to determine if it is capable of supporting data communications. Quality issues, such as dropped lines or dropouts, noise and weak signal, etc., can cause intermittent communications and high retry rates. The SCADA and support software incorporate tools for communications statistics and diagnostics. Obscure or difficult problems may require loopback testing, port monitoring and packet analysis.

With known good communications, other issues can be isolated, bad data-logger or corrupted data-logger memory, mal-functioning modem terminal server (conversion between Ethernet packet and serial port protocol) and system software driver issues. Software debuggers and diagnostics can uncover many of these problems when used skillfully.

Surveying

Surveying should be consistent with the requirements outlined above for the gauge or well on which the telemetry device is installed.

Station Identification

Station identification should be consistent with the gauge or well for which the telemetry-device is installed.

DATA COLLECTION REQUIREMENTS

Data collection is the process of gathering data by manual measurements, automated-recording devices and telemetry. Data collection involves obtaining field measurements at data collection monitoring stations. The results of the data collection process include measurements, observations, and instrument readings.

Proper field data collection techniques, data handling, and database management are critical to the value of field data. This section describes the procedures to be used to collect field data regarding surface water levels, groundwater levels, and rainfall.

Field Preparation

Field technicians typically have predetermined field schedules to visit data collection monitoring stations on a monthly or semi-monthly (every two weeks) basis. Technicians also perform other

special tasks related to monitoring stations (e.g., installations, repairs, upgrades, etc.) based upon a schedule prepared by the HDS field technician supervisor. When a special task or work order is assigned, the field technician will coordinate completion of the assignment based upon:

1) Personnel availability (when assistance or coordination of activities involve other staff or parties);
2) Equipment availability (e.g., canoe, boat, ATV, etc.);
3) Status of call-ahead stations (i.e. property access permission).

When the daily data collection run or special task for the day has been established, the technician will load the necessary equipment into their pre-assigned vehicle and complete their daily work assignments.

Site Arrival

The first step in the data collection process once the technician has arrived at the site is the identification of the site. The sites are identified based upon written descriptions, photographs, and/or maps located in file folders, or by Garmin GPS location. The technician must verify that the proper site (e.g., well, gauge, etc.) is located prior to the start of the data collection process or special work assignment. **The proper identification of the site is a critical step in the data collection process.**

The technician's vehicle should be parked as close to the site as possible. If the site is located at a bridge or roadside, extra care should be taken to park in a safe location. When possible, park the vehicle behind a guard rail or as far off the road as possible. When parking on a bridge, turn on the strobes which are located on the front and rear of every field vehicle and place orange caution cones around the vehicle. Caution vests are also available and should be worn at all times.

Note: If the monitoring station is located within or accessed through a citrus grove, staff must follow the District's citrus canker sanitation protocol (see Detail 12).

Field Data Verification Requirements

In order to ensure continued accuracy of recorded data, routine site visits are critical. The typical frequency of data verification visits is once per month.

During each site visit, the technician shall perform the following actions;

- Verify that the SID number is clearly and permanently marked on the well or gauge or within the equipment shelter.

- Verify data recorded indicates which datum (NGVD29, NAVD88, or unadjusted reading) is the basis for the reading.

- Verify that wells have a clearly marked measuring point (MP) on the casing of the well or on the floor of the equipment shelter. The elevation of the MP shall be clearly labeled on the well or the floor of the equipment shelter. All measurements of water level shall be taken from this point.

- Ensure that graduated stainless steel tapes and/or electronic measurements tapes used for water level measurements have a graduated scale precision, resolution and accuracy of measurement of 0.01 foot. Both graduated stainless steel measuring tapes and graduated electronic measuring tapes are used by HDS personnel for determining depth to water in groundwater wells and surface water stilling wells. Steel tapes must be long enough to measure deep water levels at ground water sites. Etched markings shall be graduated in hundredths of a foot or millimeters. Some tapes have both scales on opposite sides of the tape. Measuring tapes shall be kept clean and free of debris, and wiped off after each use. It is important to keep the

tapes tightly wound on the reel to prevent kinking. Serious kinking of the tape will adversely affect measurements of depth to water. Field measurement tapes should be checked annually and verified against a standard calibrated reference tape for excessive stretch or wear.

- A hand-held pressure gauge can be used for measuring water levels in artesian (flowing) wells. All hand-held pressure gauges shall be capable of performing within a standard measurement resolution of four digits with floating decimal and a measurement accuracy standard of ± 0.05 percent of full scale, plus one least significant digit including linearity, repeatability, and hysteresis. Hand-held pressure gauges should be kept clean and free of debris, wiped off after use, and should be kept in the manufacturer's padded "carrying-case" when not in use so as to prevent damage to the device's sensitive internal components.

- For automated-recording devices, sensor data stored on the data-logger shall be manually downloaded to the field computer at non-telemetry sites; whereas, sensor data at telemetry (SCADA) sites is automatically downloaded by SCADA on a pre-determined basis (e.g., hourly, daily, etc.).

- Verify the time, as set on the data-logger, is correct and is set relative to Eastern Standard Time (EST) year-round. No changes are to be made for Daylight Savings Time. If the data-logger time is off, it must be reset to the correct Eastern Standard Time.

- Electronic data files (ELBIS files) created in the field each day on the technician's field computer shall be downloaded to the appropriate folder onto the centralized computer system (currently the DCB L-drive) at the end of each work day upon returning from the field.

Field Data Collection Procedures

The field technician should have the field computer turned on, with the "ELBIS (Electronic Log Book Information System)" program selected. From the ELBIS menu, the SID is looked up in the computer and selected, and the technician begins the data collection and entry procedures regarding the parameter being measured. A general overview of ELBIS is provided in Detail 10. A more instructional ELBIS User's Manual and other ELBIS information are currently located on the DCB L-drive at L:\Hydrodat\ELBIS*.*. The SID should be double-checked prior to data entry to make sure the correct site is chosen in the field computer.

Surface Water Level Measurements – Manually Read

Manual surface water level measurements are collected by use of a staff gauge (see Detail 7 and appropriate HDS IOP's). Surface water data are recorded in elevation relative to a standard reference (datum) and the units are in feet.

Frequency

The typical frequency of surface water level measurements is semi-monthly (twice per month) or monthly, depending on project needs.

Precision and Accuracy

The precision requirement for a manual surface water level measurement is ± 0.01 feet. The accuracy requirement is ± 0.01 feet.

Process

During each site visit and when collecting manual surface water level measurements, the technician shall perform the following actions:

- Visually inspect the monitoring site and the condition of the gauge for problems that could affect the accuracy of the measurements. Clean the face plate, as necessary (see maintenance instructions in previous section). Look for and note damage or signs of the gauge having been disturbed. If the gauge shows signs of having been disturbed, it will be necessary to reset the gauge and then re-establish the gauge elevation by standard survey methods (see Survey section). If the gauge condition is normal and the water surface is on the gauge, observe and record the gauge reading as described below.

- A surface water level measurement, as read on the gauge, shall be recorded by the technician to the nearest 0.01 foot accuracy onto the field computer into ELBIS using the appropriate data-entry procedure. The ELBIS program will automatically calculate the water level elevation and the date and time.

- If there is no water at the gauge, the technician shall indicate this condition in ELBIS and by documenting this condition as a "comment" in ELBIS, such as:

    - Comment: Water level is below staff gauge, but water is visible in the lake/wetland system; or
    - Comment: Staff gauge is dry and no visible water remains in the lake/wetland system.

- Secure site before leaving.

Groundwater Level Measurements – Manually Read

Manual water level measurements at groundwater sites (i.e., wells) are collected by using a graduated stainless steel tape with chalk, a graduated electronic measurement tape, or a hand-held pressure gauge (see Detail 13 and appropriate HDS IOP's). Each measurement instrument has its accuracy and limitations. Groundwater level data are recorded in feet and/or pound-per-square-inch (psi).

Frequency

The typical frequency of manual groundwater level measurements is semi-monthly (twice per month) or monthly, depending on project needs.

Precision and Accuracy

The precision requirement for a manual groundwater level measurement is ± 0.01 feet. The accuracy requirement is ± 0.01 feet.

Process

During each site visit and when collecting manual groundwater level measurements, the technician shall perform the following actions:

- Visually inspect the monitoring site and well condition for problems that could affect the accuracy of the measurements (see maintenance instructions in previous section). Look for and note damage or signs of the well having been disturbed. If the well shows signs of having been disturbed, it will be necessary to have the well assessed for damage, corrective actions taken as needed, and resurveyed (see Survey section). If the well condition appears normal, observe and record the well water level reading as described below.

- A groundwater level measurement shall be recorded by the technician to the nearest 0.01 feet resolution onto the field computer into ELBIS using the appropriate data-entry procedure. The ELBIS program will automatically calculate the water level elevation and the date and time.

- When collecting a manual water level measurement using a graduated stainless steel tape, the technician shall manually unroll the tape down the well casing until the bottom section of the tape contacts the water, thereby wetting the tape surface. In order to identify the depth to water, the tape shall be rubbed with chalk as it descends the casing. The length of tape down the well is read at the MP, and the HELD measurement value shall be entered into ELBIS. As the tape is reeled up from the well casing, the technician shall identify the line denoting dry chalk and the wet tape. The tape scale is read at this line and the WET measurement value is entered into ELBIS. The ELBIS program will automatically calculate the depth to water and the corrected water level elevation. To ensure the water level is correctly measured, this procedure shall be repeated at least two times, holding the tape at a different scale level each time. The calculated depth to water and corrected water level elevation should not vary by more than 0.05 foot between readings. If variance between two readings is greater than 0.05 foot, the well should be re-measured until the readings fall within this tolerance. The final recorded value shall be the mean of the two closest reading.

- When collecting a manual water level measurement using a graduated electronic measuring tape, the technician shall manually unroll the tape down the well casing until the bottom section of the tape contacts the water. When the probe enters the water, an electrical circuit is completed. Contact with the water surface is indicated by a sharp needle deflection on a meter and/or audio alert. Depth indication is provided by numbered metal tags securely crimped to the cable at intervals of five feet. When the water level is between two marks, a pocket tape is used to measure from the nearest point of the line to the point that was measured. The length of tape down the well is read at the MP, and the HELD measurement value is entered into ELBIS. For the WET measurement value, a Zero (0) value is entered into ELBIS when using an E-tape. The ELBIS program will automatically calculate the depth to water, the corrected water level elevation, and the date and time. To ensure the water level is correctly measured, this procedure should be repeated at least two times. The calculated depth to water and corrected water level elevation should not vary by more than 0.05 foot between readings. If variance between two readings is greater than 0.05 foot, the well should be re-measured until the readings fall within this tolerance. The final recorded value shall be the mean of the two closest reading.

- When collecting a manual water level measurement using a hand-held pressure gauge, the technician shall manually connect the gauge to the top of the well using a semi-rigid walled tube with appropriate connect/disconnect fittings. The gauge shall be held so that the dial is vertical and the water inlet is at the bottom. The gauge shall be positioned such that the center of the gauge is at the same elevation as the MP, and the psi reading shall be entered into ELBIS. The ELBIS program will automatically calculate the water level elevation, date and time. To ensure the water level is correctly measured, this procedure should be repeated at least two times. The calculated water level elevation should not vary by more than 0.05 foot between readings. If variance between two readings is greater than 0.05 foot, the well should be re-measured until the readings fall within this tolerance. The final recorded value shall be the mean of the two closest reading.

- The technician shall record all manually collected water level measurements to the nearest 0.01 foot accuracy onto the field computer into ELBIS using the appropriate data-entry procedure. The ELBIS program will automatically calculate the water level elevation and the date and time.

- If there is no water in the well, the technician shall indicate this condition in ELBIS and by documenting this condition as a “comment” in ELBIS, such as:

    - Comment: Well is dry

- Secure site before leaving.

Groundwater or Surface Water Level Measurements - Automated-Recording Devices

Automated-recording stations collect water level measurements from sensors deployed in wells and stilling wells and record and store those measurements onto a data-logger for download. Surface water level (stage) data are also used to estimate water flows in streams, rivers and at control structures.

Frequency

The typical frequency of data verification visits is once per month, but may vary depending on project needs. The typical “sensor” recording interval for groundwater and surface water (non-flowing) level measurements is once-per-hour, starting at the top of the hour. At surface water bodies (flowing) sites where discharge is calculated, the typical recording interval is 15-minutes, starting at the top of the hour.

Precision and Accuracy

The precision requirement for a water level sensor measurement is ± 0.01 feet. The accuracy requirement is ± 0.01 feet.

Process

During each site visit and when collecting manual groundwater or surface water level measurements at automated-recording stations, the technician shall perform the following actions:

- Visually inspect the monitoring site and condition of the well/staff gauge for problems that could affect the accuracy of the measurements, looking for and noting damage or disturbance to the well/gauge or monitoring equipment (see maintenance instructions in previous section). If the well/gauge or monitoring equipment shows signs of having been damaged or disturbed, it will be necessary to have the well/gauge assessed for damage, repaired or replaced as necessary, and resurveyed (see Survey section). All problems encountered (or work performed) on instruments must be noted in the technician's field notes in ELBIS and/or M-PET, along with any site observations that might explain the cause of the problem or reason(s) for the work. This information is critical to making corrections to the source data.

- If the well or gauge condition appears normal, the technician shall observe and record the water level reading as described below.

- Verify that the time, as set on the data-logger, is correct and is set relative to Eastern Standard Time (EST) year-round. No changes are to be made for Daylight Savings Time. If the data-logger time is off, it must be reset to the correct Eastern Standard Time.

- Verify the condition of the battery, as well as instrumentation setup and wiring connections. If the battery voltage is below 12 volts or other prescribed level(s), the battery may need to be replaced.

- Collection of a manual water level measurement at the staff gauge or in the well in accordance with the procedures for manual water level measurements described above.

- Verify that the water-level elevation, as manually measured from the associated staff gauge or well, and the “as found” water level measurement as reflected by the data-logger are within prescribed tolerances. If the difference in water-level readings between the recorder value and the manually measured value is greater than 0.05 feet, the recorder shall be adjusted to reflect

the manually measured elevation. All adjustments made shall be documented in the technician's field notes, along with any site observations that might explain the discrepancy.

- Transfer (i.e., download) the data stored on the data-logger to the field computer at non-SCADA sites.

- If a pattern of instrument drift is noticed, especially if the drift is significant, the instrument (i.e., encoder or pressure transducer) shall be replaced with a new unit, and the old instrument sent back to the manufacturer for repair or replacement. Small amounts of linear drift can be corrected in processing of the data if identified in the field and properly noted. Occasionally, data shifts can occur suddenly by mistakes made in the field by technicians. These include setting the wrong elevation value or time on the recorder before leaving the site; for encoders, putting the float assembly on backwards or not securing the tape to the pulley; and for pressure transducers, accidentally moving the transducer to the wrong depth or not properly securing the transducer cable to prevent slippage down the well. Data shifts resulting from mistakes made by field staff usually can be easily identified by the time of occurrence and comparison of the technician's field notes, and normally can be corrected during processing of the data.

- Secure site before leaving.

Precipitation Measurements – Automated-Recording Devices

Rainfall measurements are collected by tipping-bucket rain gauges and are stored on data-loggers at automated-recording stations deployed throughout the District.

Frequency

The typical frequency of data verification visits is once per month, while the typical sensor recording interval for tipping-bucket rain gauges is 15-minutes, starting at the top of the hour.

Precision and Accuracy

Tipping-bucket rain gauges shall have a precision of measurement of 0.01 inch or less. Devices shall have an accuracy standard for measurement of total rainfall between two observations to within 0.01 inch or less, and at intensities of ± 1 mm/hour; ± 5% for >20 mm. For rainfall rates of less than one inch an hour, the instrument shall have an accuracy of plus or minus 3 percent, whereas for rain rates greater than one inch an hour, it shall have an accuracy of plus or minus 5 percent.

Process

During each site visit, the technician shall perform the following actions:

- Visually inspect the monitoring site and condition of the rain gauge for problems that could affect the accuracy of measurements, looking for and noting damage or disturbance to the gauge or monitoring equipment (see maintenance instructions in previous section). If the gauge or monitoring equipment shows signs of having been damaged or disturbed, it will be necessary to have the gauge assessed for damage, repaired or replaced, as necessary. All problems encountered (or work performed) on instrumentation shall be documented in the technician's field notes in M-PET, along with any site observations that might explain the cause of the problem or reason(s) for corrective action(s). This information is critical to making corrections to the source data.

- Additionally, the technician shall perform the following actions:

1) Visually check for 45-degree clearance above collector.
2) Visually check the collector cup screen(s) and funnel. Clean, as necessary, and document condition (clean or dirty) in field notes.
3) Re-level the instrument, if necessary (collector must be vertical), as a leaning gauge can compromise measurement accuracy. If the gauge does not appear to be exposed in a level horizontal plane, repair should be immediately performed and documented.
4) Make sure the small drain holes at the bottom of the gauge are not plugged with dirt or other material (drill them larger if plugging becomes a chronic problem).

- Verify the site ID number is clearly and permanently marked within the equipment shelter.

- Connect the field computer to the data-logger and check and record the "as found" value and time as reflected by the data recorder. At non-SCADA sites, the technician shall download the rainfall data stored on the data-logger onto the field computer.

- Verify that the time, as set on the data-logger, is correct and is set relative to Eastern Standard Time (EST) year-round. No changes are to be made for Daylight Savings Time. If the data-logger time is off, it must be reset to the correct Eastern Standard Time.

Surface Water Flow Monitoring

The SWFWMD, in cooperation with the USGS, maintains a network of streamflow monitoring stations within the District's jurisdictional boundaries. The streamflow monitoring stations provide instantaneous 15-minute and mean daily flow data that is used by District engineers and scientists for hydrologic modeling, management of Minimum Flows and Levels (MFL's), flood control and other water management activities.

Frequency

The typical frequency of manually collected field surface water flow measurements (and associated manual staff gauge measurements) is monthly, but may vary based on project needs. The typical sensor recording interval for automated-recording devices on stilling wells is 15-minutes, starting at the top of the hour.

Precision and Accuracy

General flow measurement methods, including precision and accuracy standards, are described in standard textbooks, USGS Water-Supply Paper 2175, and the Techniques of Water-Resources Investigations of the United States Geological Survey (TWRI's); in Chapters A1 through A19 of Book 3, and Chapters A2 and B2 of Book 8. These may be accessed from http://water.usgs.gov/pubs/twri/. The methods are consistent with the American Society for Testing and Materials (ASTM) standards and generally follow the standards of the International Organization for Standards (ISO).

Process

When manual field surface water flow measurements are collected, the technician shall perform the following actions:

- Measure stream discharge, including a point-of-zero-flow (PZF) determination. To the maximum extent possible, streamflow shall be recorded during the same week of the month of measurement (e.g., 3rd week of the month).

- Verify measurement plots on current discharge-rating. Make second measurement if not within 5% of rating. Document why measurement does not agree with current rating.

- On an annual basis, collect at least one low base flow (non-zero) manual flow measurement and one high-water manual flow measurement.

- Compare flow measurements to the existing rating equations and identify the need for new rating equations. Develop new discharge rating, if needed.

- Define and justify any shifts to the current rating.

- Record water stage (relative to NGVD29) and/or flow (CFS) at a minimum frequency of one reading per hour.

- Use approved USGS methods for all discharge measurements and discharge ratings, as described above.

- Measure flow using current meters approved by the District Project Manager, as described above.

- Standard discharge measurement notes will be completed for each measurement and include SID number, station name, sequential measurement number, date, time inside, outside and recorder readings at the beginning and end of each measurement, spin test, total area, width, mean velocity, discharge, and remarks. All measurements will include notes as to the quality of the measurement, control conditions in the stream that may affect the gauge height/discharge relation, and a PZF (if applicable).

- Annually, provide a report that summarizes all activities pertaining to manual field flow measurements, rating analysis and flow data Quality Assurance/Quality Control (QA/QC).

- The SID number must be clearly and permanently marked on staff gauges and within the equipment shelter for stilling wells.

- Manual and automated-recording surface water level measurements at staff gauges and stilling wells shall be collected in accordance with the procedures, techniques and precision described above.

DATA REPORTING AND MANAGEMENT

Procedures have been established to ensure that all hydrologic and meteorologic data are thoroughly reviewed and appropriate quality assurance/control checks are completed prior to release of the data files.

Field Data

Field data is hydrologic or meteorologic data that has been collected from a field monitoring station. The method of collection can vary from manual collection, automated-recording devices, or telemetry based systems reporting data values on a near real-time basis. Field data has had little or no quality checks performed on them and are considered less reliable.

Manual field data are collected by field technicians throughout the workday and readings are entered into ELBIS and stored onto a portable field computer. At the end of each workday the field computer's data files are downloaded to a centralized computer system. Field data files are filed by SID numbers.

Automated-recording devices store data onto a data-logger at such installations. At non-telemetry sites, this data is downloaded on a pre-determined basis (e.g., monthly, etc.) by the field technician onto a field computer. At telemetry (SCADA) sites, data stored on the data-logger is downloaded at least daily onto a centralized computer system.

Each night, the field data files that are stored onto the centralized computer system are downloaded into a temporary Hydstra file. Within 90 days, field data is processed and validated.

A visual review of the data in temporary Hydstra files is performed to ensure that the field data is associated with the correct SID number, that typographical errors have not been made, and that data anomalies do not exist or have been explained. If necessary, corrections are made to the data and documented. At this time any pertinent Data Analyst comments or data qualifier codes are also added to the database (see Detail 14).

Validated Data

Validated data is any hydrologic or meteorologic data that has been collected from a field monitoring station and has passed through a set of quality assurance and data validation procedures. Data validation can vary from simple data collection location verification and maximum/minimum range-checking to more robust automated data pre-processing. For small volumes of data, a system consisting of manual review of control information and random data value checking has been established. For larger volumes of data, an automated validation process has been established. Validated data are filed in permanent Hydstra files.

The following is a description of some validation checks performed by the HDS staff.

- Unique SID# - A unique SID# has been established for every monitor site. All field data records include the SID# so the collected data can be attributed to the appropriate monitoring site.

- Data record – The start date of an incoming period of record should be checked against the end date of the last period of record received. This check serves two purposes. First, the continuity of the period of record is maintained. Gaps or overlaps in the period of record can be identified and resolved. Second, unmatched end-to-start dates of consecutive periods of record might be an early indication that the periods of record may not have been collected at the same location.

- Minimum and maximum values – Although a very high or very low data value may not necessarily indicate an abnormality, minimum and maximum values have been established for each monitoring site. Any exceedance of these values is investigated.

- Data units – Consistent data units are used to reduce errors or inconsistencies, which can occur when conversions from one unit of measurement to another is introduced.

- On a daily basis, field technician “Comments” that are entered into ELBIS that day are compiled into a report located on the L-drive at: “L:\HydroDat\HYDRO\DataReport\output\CommentsRpt.” The “comments” are checked and corrective action(s) taken, as necessary.

- At least each 90 days, graphical plots of all HD collected sites are made for the previous four months of data. Correction resets, spikes, missing data, or other obvious mistakes (i.e. two different readings on the same day) are checked and corrective action(s) taken, as necessary.

- Automated processes produce daily reports regarding data reporting, data checks, identify problems, and perform QA/QC (see Detail 15 for a listing of computerized programs).

Audits

Quarterly Audit

- During each 90-day period (quarterly), a Data Analyst shall review graphical plots of all data collected at HDS sites for the prior four-month period. All questionable data shall be investigated, such as outlier values, correct resets, spikes, missing data, or other obvious mistakes (i.e. two different readings during the same day/time). All necessary corrective action(s) to the data shall be taken.

- The Field Technician Supervisor shall ensure that field data collection activities are performed in accordance with established DCB policies and procedures and/or with the procedures described in this manual. The Field Technician Supervisor shall coordinate field activities to assure completion of tasks within established time frames. The Field Technician Supervisor shall identify quality control problems and initiate and monitor corrective actions.

- As part of each HDS staff's Quarterly Work Plan (QWP) review process, the Hydrologic Data Section Manager or Field Technician Supervisor (as appropriate) shall review HDS personnel's quarterly performance related to the data collection program, and take the appropriate action(s) to improve the data collection program.

Annual Audit

Each year during the month of September, the Hydrologic Data Section Manager shall conduct an annual review of hydrologic performance during the current fiscal year. This review shall include but not be limited to the following:

- Changes to the Hydrologic Data Section's Data Collection SOP Manual;
- Implement review procedures to monitor and verify accurate manual and automated data entry and recordkeeping for those data collection activities indicated in this manual;
- Review of the current fiscal year's quarterly deficiencies/inefficiencies and corrective action(s) during current fiscal year;
- Hydrologic workload changes
- Stakeholder feedback and response.

External Agency Data

External agencies source data (e.g. NOAA, USGS, etc.) loaded into the District's WMIS database is not validated. All questions regarding the collection, accuracy, precision or reliability of data from external agencies shall be referred to those agencies.

DETAIL 1

Acronym List

Acronyms

ELBIS - Electronic Log Book Information System

EST - Eastern Standard Time

DCB - Data Collection Bureau

FAC - Florida Administrative Code

GPS - Global Positioning System

HDS - Hydrologic Data Section

IOP - Internal Operating Procedure

ISO - International Organization of Standards

MP - Measuring Point

M-PET - Maintenance Productivity Enhancement Tool, which is the next generation of Computerized Maintenance Management System (CMMS).

NAVD88 - North American Vertical Datum of 1988

NEMA – National Electrical Manufacturers Association

NGS - National Geodetic Survey

NGVD29 - National Geodetic Vertical Datum of 1929

NOAA - National Oceanic and Air Administration

PSM - Florida Professional Survey & Mapper

PSI - Pound Per Square Inch

PZF - Point Of Zero (0) Flow

SCADA - Supervisory Control and Data Acquisition System

SID - Site Identification

SOP - Standard Operating Procedure

USGS - United States Geological Survey

Vertcon - A computer program that computes the modeled difference in orthometric height between NAVD88 and NGVD29 for a location in the contiguous United States

WMIS - Water Management Information System

DETAIL 2

References and Additional Resources

References and Additional Informational Resources

Buchanan, T.J., and Somers, W.P. 1984. Discharge Measurements at Gauging Stations. U.S. Geological Survey, Techniques of Water-Resources Investigations Book 3, Chapter A8

Cunningham, W.L., and Schalk, C.W., comps., 2011, Groundwater technical procedures of the U.S. Geological Survey: U.S. Geological Survey Techniques and Methods 1-A1, 151 p.

Freedman, L.A., et al., 2004, Use of Submersible Pressure Transducers in Water-Resource Investigations, U.S. Geological Survey Techniques of Water-Resources Investigations, Book 8, Chapter A, 52 p.

Hancock, Michael C., P.E., (2009, October 26 - personal communication via email). Transmittal of document "Proposed Data Collection Standards for the Consolidated Permit_Oct 23 2009," Southwest Florida Water Management District.

Inter-District Data Collection Focus Group, St. Johns River Water Management District, South Florida Water Management District, Southwest Florida Water Management District, Guidelines for Collection of Hydrologic and Meteorologic Data, Volumes 1 (Field Applications) and Volume 2 (Data Management), 1994 and 2001

Office of Surface Water Technical Memorandum No. 2006.01 – Memorandum for Collection, Quality Assurance, and Presentation of Groundwater Data, 2005, U.S. Geological Survey, Water Resources Division

Sauer, V.B., and Turnipseed, D.P., 2010, Stage Measurement at Gaging Stations: U.S. Geological Survey Techniques and Methods book 3, chap. A7, 45 p.

Technical Procedure No. Q205, QA/QC of Groundwater Data Procedures, South Florida Water Management District, October 2006

Turnipseed, D.P., and Sauer, V.B., 2010, Discharge measurements at gaging stations: U.S. Geological Survey Techniques and Methods book 3, chap. A8, 87 p.

U.S. Army Corps of Engineers and South Florida Water Management District, 2009. Comprehensive Everglades Restoration Plan. http://141.232.10.32/pub/restudy_eis.aspx

U.S. Bureau of Reclamation. 1997. Water Measurement Manual. U.S. Department of the Interior, Bureau of Reclamation, Denver, Colorado

World Meteorological Organization, 1994, Guide to Hydrological Practices: Data Acquisition and Processing, Analysis, Forecasting and Other Applications, WMO-No. 168

DETAIL 3

NAVD88 Vertical Control Benchmark Monument Construction Checklist

Benchmark Site Selection:

Set two site benchmarks. One of the site benchmarks should have unobstructed GPS visibility. The first benchmark should be located within 100 feet of the hydrologic data measuring device; the second benchmark should be located within 500 feet of the hydrologic data measuring device. The purpose of the NAVD88 benchmarks is to provide an elevation reference for site calibration; two benchmarks will provide a check between benchmarks.

- **Must check for underground utilities, especially when setting benchmarks in right-of–ways!**
- Benchmarks should be set in an area with good GPS visibility whenever possible.
- Benchmarks should be set close to the hydrologic data measuring device as possible with a witness post set adjacent to each monument.

Benchmark Monument Construction

The Surveyor in charge of constructing the monuments will assure that the materials used will adequately establish a stable monument. If the soil is unstable and cannot be compacted to adequately stabilize the monument, the type of benchmark shall be no less than a metal rod or metal pipe driven to point of refusal with a concrete collar poured around the rod/pipe at ground level and a disk set in top center of concrete. The disk shall display the surveyor's identification number. Refusal shall be defined as several full blows with an 8 pound sledge hammer rendering no perceptible movement of the rod/pipe.

- **Benchmark material used:**

  _____ Feet of Metal Rod/ Pipe _____ Benchmark Disk stamping

  Field Book & Page: _____

- **Latitude/Longitude of monument (use DGPS receiver):**

  Benchmark Name: _____ Lat: _____N Long: _____W

  Accuracy: +/- _____ PDOP: _____ Number of Satellites: _____

  Describe the GPS receiver (ex: Garmin 76, WASS enabled): _____

  Describe the Location of the benchmark relative to the hydrologic data measuring device:

- **Digital photos:**

  Photo 1 of vicinity; and Photo 2 of Benchmark disk with GPS unit in the view showing the Latitude and Longitude in photograph.

  File name of Photo 1- _____, Photo 2- _____

- **Additional information:**

  Site access, land owner information, any existing bench marks in area, any special considerations that need to be made at the benchmark location site.

DETAIL 4

Sample Site Vertical Calibration Survey Information

PROJECT TITLE: **NAVD88 Migration (B134)**
PURCHASE ORDER: **08POSOW1430**
WORK ORDER NAME: **FY2008, Work Order NO. 3 North District Hydrological Data Collection Sites Vertical Calibration Survey.**
WORK ORDER NUMBER: **3**
CONSULTANT NAME: **MACTEC Engineering & Consulting, Inc.**
PROJECT MANAGERS: **James F. Owens, PLS (SWFWMD)**
Thomas M. Jennings, PLS (MACTEC)

Southwest Florida Water Management District

2379 Broad Street
Brooksville, Florida 34604

HYDROLOGIC DATA SECTION
SITE CALIBRATION SURVEY FORM

SITE INFORMATION		
SITE NAME: **WITHLACOOCHEE RIVER AT TRILBY**	SITE I.D. (SID): **23546 (Recording Well)**	
UID_TYPE / UID_SITE_ID: **FLO / 122**	DATE OF SURVEY: **September 29, 2008**	
LATITUDE: **N 28° 28 48.37"**	LONGITUDE: **W 82° 10' 39.80"**	
COUNTY: **HERNANDO**	SECTION: **14** TOWNSHIP: **23 S**	RANGE: **21 E**
LAND OWNER NAME: **FDOT R/W**	LAND OWNER ADDRESS: **N/A**	

NAVD 88 MEASUREMENT POINT INFORMATION	
DESCRIPTION OF MEASUREMENT POINT	NAVD88 ELEVATION (ORTHOMETRIC HEIGHT)
1.) **Set 2" square box with magic maker on the floor of recorder box on the East rim of opening in floor.**	**79.42** (US FEET)
2.) **Natural ground at recorder**	**47.9** (US FEET)

NAVD 88 SITE BENCHMARK INFORMATION		
BENCHMARK NAME / AGENCY: **"A 662" / SWFWMD**	NAVD 88 ELEVATION: **65.663**	(US FEET)
LATITUDE:**N 28° 28' 38.08918" Existing NGS mon. (Primary Station)**	LONGITUDE: **W 82° 10' 42.64415"**	
BENCHMARK NAME / AGENCY: **(F 0122 A) / SWFWMD**	NAVD 88 ELEVATION: **78.434**	(US FEET)
LATITUDE: **N 28° 28' 46.85" Existing FDOT disk – SE (RPBM)**	LONGITUDE: **W 82° 10' 39.79"**	
BENCHMARK NAME / AGENCY: **(F 0122 B) / SWFWMD**	NAVD 88 ELEVATION: **78.567**	(US FEET)
LATITUDE: **N 28° 28' 50.45" Existing FDOT disk – NW (RPBM)**	LONGITUDE: **W 82° 10' 39.03"**	

SURVEYOR'S NOTES AND CERTIFICATION

1.) The *Measurement Point elevations* established at each calibration site as a part of this Calibration Project (referenced above), and as contained on these report sheets, were established in accordance with Southwest Florida Water Management District (SWFWMD) specifications as outlined in the Scope of Services. These elevations are displayed to the nearest hundredth (1/100th) of a foot (except for ground shots), and may be considered accurate to the level of precision as displayed.

2.) The Vertical Datum of these *Measurement Point elevations* is referenced to the North American Vertical Datum (NAVD) of 1988, and is based on the high precision GPS static network (established as part of the North District Vertical Control Survey by MACTEC in 2007) which included direct occupation 53 NGS 1st and 2nd Order Benchmarks held as fixed vertical control. These control values were supplemented by 19 additional 3rd Order closed loop level runs from NGS-published 1st and 2nd Order Benchmarks to GPS Primary Network stations as a quality control measure to check GPS-derived orthometric heights. Elevations were placed on Secondary "Reference Point Bench Marks" (RPBM's) established in the immediate vicinity of each hydrological monitoring station site through 3rd Order closed loop level runs from the Primary Network Stations. Calibration operations involve 3rd Order leveling procedures based on these previously-established RPBM's, are closed loop, and include checks of the height differences between these on-site control monuments.

3.) The Horizontal Datum of the data is referenced to the North American Datum (NAD) of 1983/2007, and is based on the final GPS Primary Station (212) network (established as part of the North District Vertical Control Survey) of 1261 measured static vectors incorporating 19 National Geodetic Survey (NGS) High-Accuracy Regional Network (HARN) Stations held as fixed horizontal control. Horizontal locations of all calibration sites and RPBM's are based on these Primary Control Stations, and were established during calibration operations through a combination of differentially-corrected GPS measurements and conventional total station measurements to retro prisms, with geometric checks and redundancy of measurements. These newly-established locations, while displayed to the nearest foot (to avoid truncation error for users), should be considered accurate to a precision of well within the +/- 10 feet specified by client (SWFWMD).

4.) The list of sites to be calibrated, and their designations (SID #'s, UID #'s, etc.) were provided by client (SWFWMD), as were other support materials, including all aerial orthophotography (dated 2007).

5.) This report is not valid without the signature and original raised seal of the Florida Registered Land Surveyor indicated below.

THIS SPECIFIC PURPOSE SURVEY IS CERTIFIED TO THE SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT AS MEETING OR EXCEEDING, IN QUALITY AND PRECISION, THE STANDARDS APPLICABLE FOR THIS WORK, AS SET FORTH IN CHAPTER 61G17-6, FLOIRDA ADMINISTRATIVE CODE.

2/24/09
Signature Date

Thomas M. Jennings, PLS
Florida Professional Land Surveyor
License Number LS 4551

REPORT FORM COMPILATION: **Anthony D. Waters**
Survey Technician

SHEET INDEX

MACTEC, Inc.
4150 N. JOHN YOUNG PARKWAY ORLANDO, FL.
(407) 522-7570 Fax: (407) 522-7576
LB # 6969

SHEET 1 OF 5

PROJECT TITLE: NAVD88 Migration (B134)
PURCHASE ORDER: 08POSOW1430
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WORK ORDER NUMBER: 3
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Southwest Florida Water Management District

2379 Broad Street
Brooksville, Florida 34604

HYDROLOGIC DATA SECTION
SITE CALIBRATION SURVEY FORM

SITE INFORMATION	
SITE NAME: WITHLACOOCHEE RIVER AT TRILBY	SITE I.D. (SID): 23546 (Recording Well)
UID_TYPE / UID_SITE_ID: FLO / 122	DATE OF SURVEY: September 29, 2008
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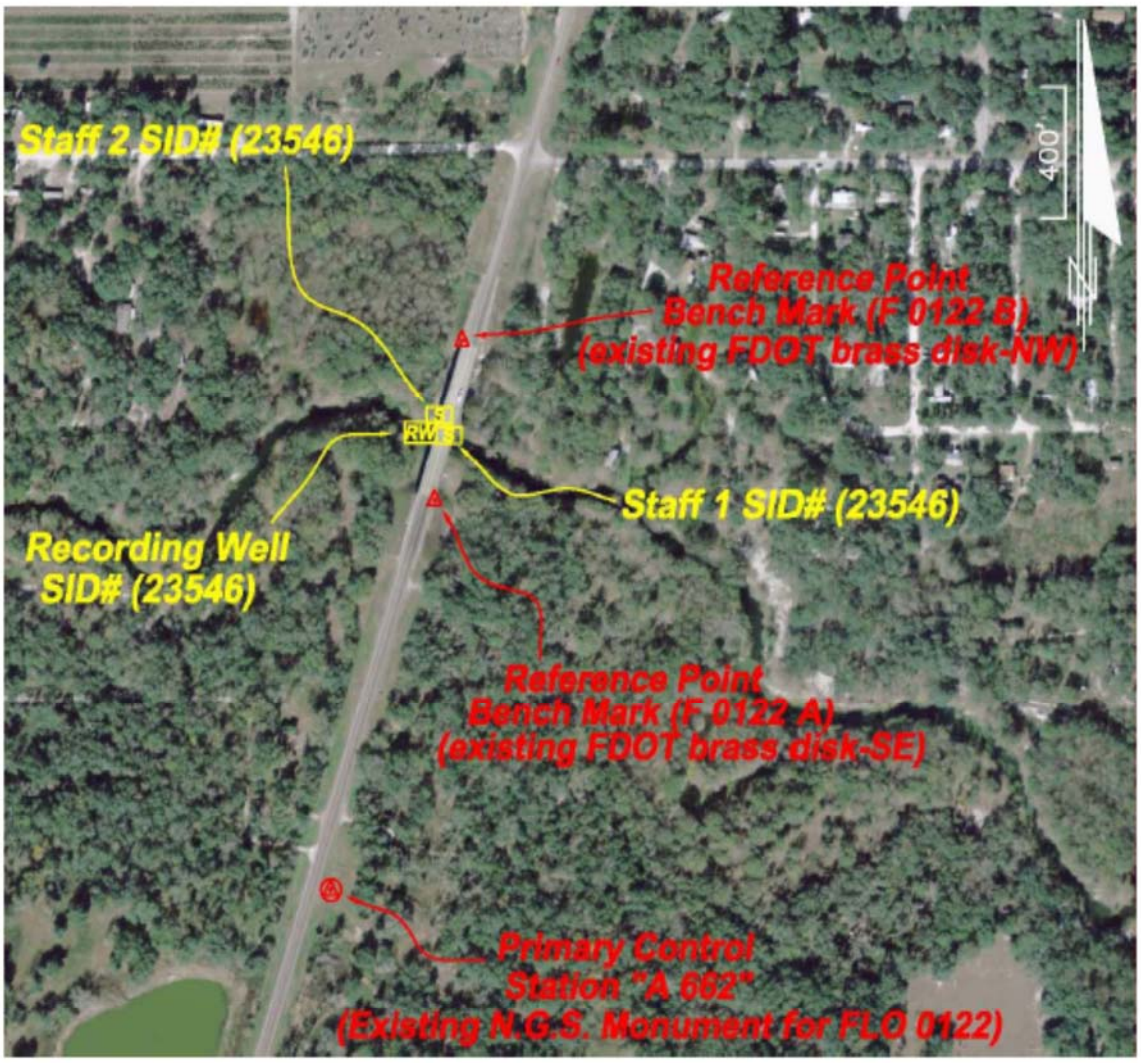
COUNTY: HERNANDO	SECTION: 14 TOWNSHIP: 23 S RANGE: 21 E
LAND OWNER NAME: FDOT R/W	LAND OWNER ADDRESS: N/A

SITE LOCATION AERIAL OVERLAY



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SHEET 2 OF 5

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SITE PHOTOGRAPHS

PHOTOGRAPH 1 –
LOOKING: SOUTH

PHOTOGRAPH 2-
LOOKING: WEST

PHOTOGRAPH 3 –
LOOKING: WEST

PHOTOGRAPH 4 –
LOOKING: WEST

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SHEET 3 OF 5

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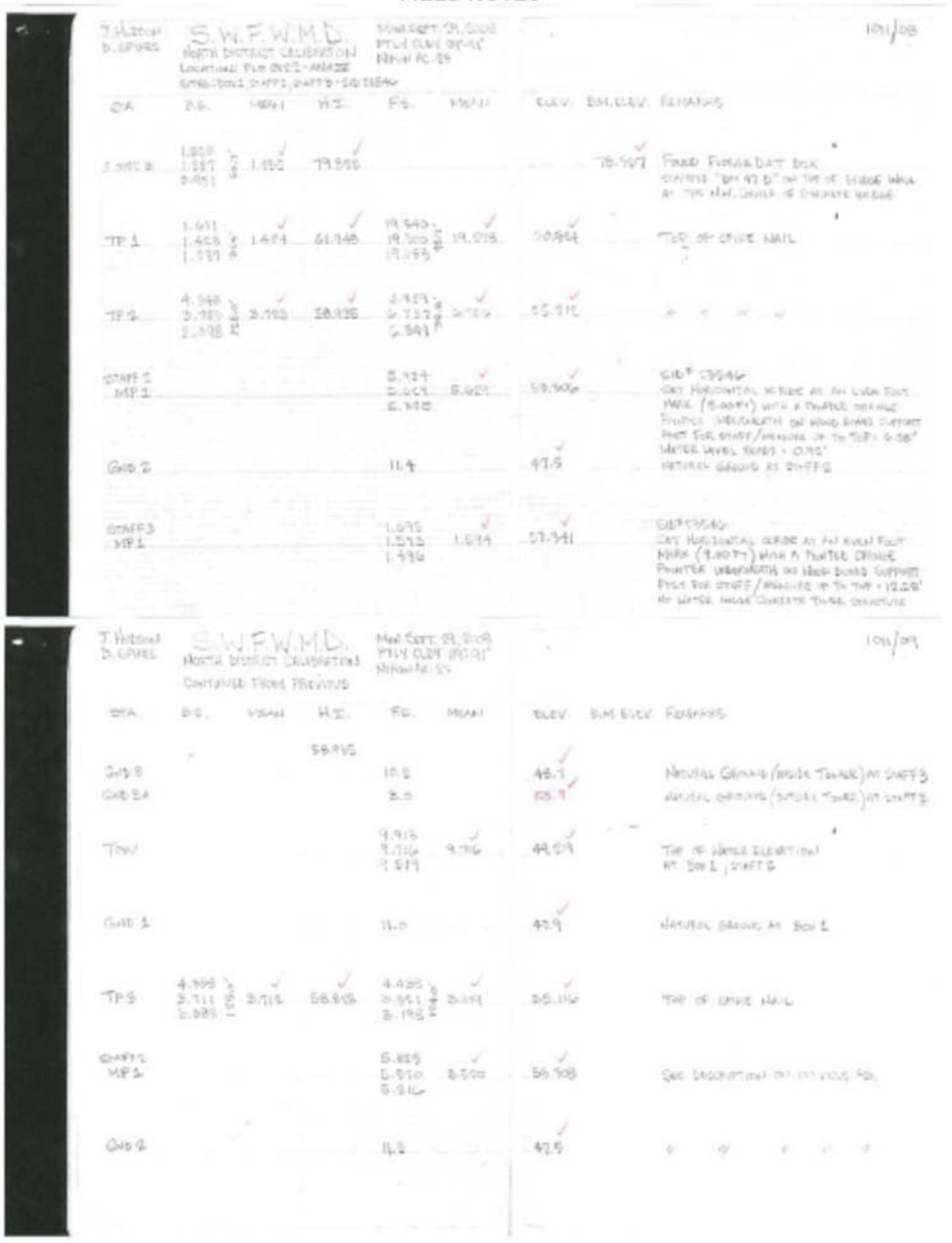
FIELD NOTES



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SHEET 2: SITE LOCATION AERIAL OVERLAY
SHEET 3: SITE PHOTOGRAPHS
SHEET 4-5: FIELD NOTES

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SHEET 4 OF 5

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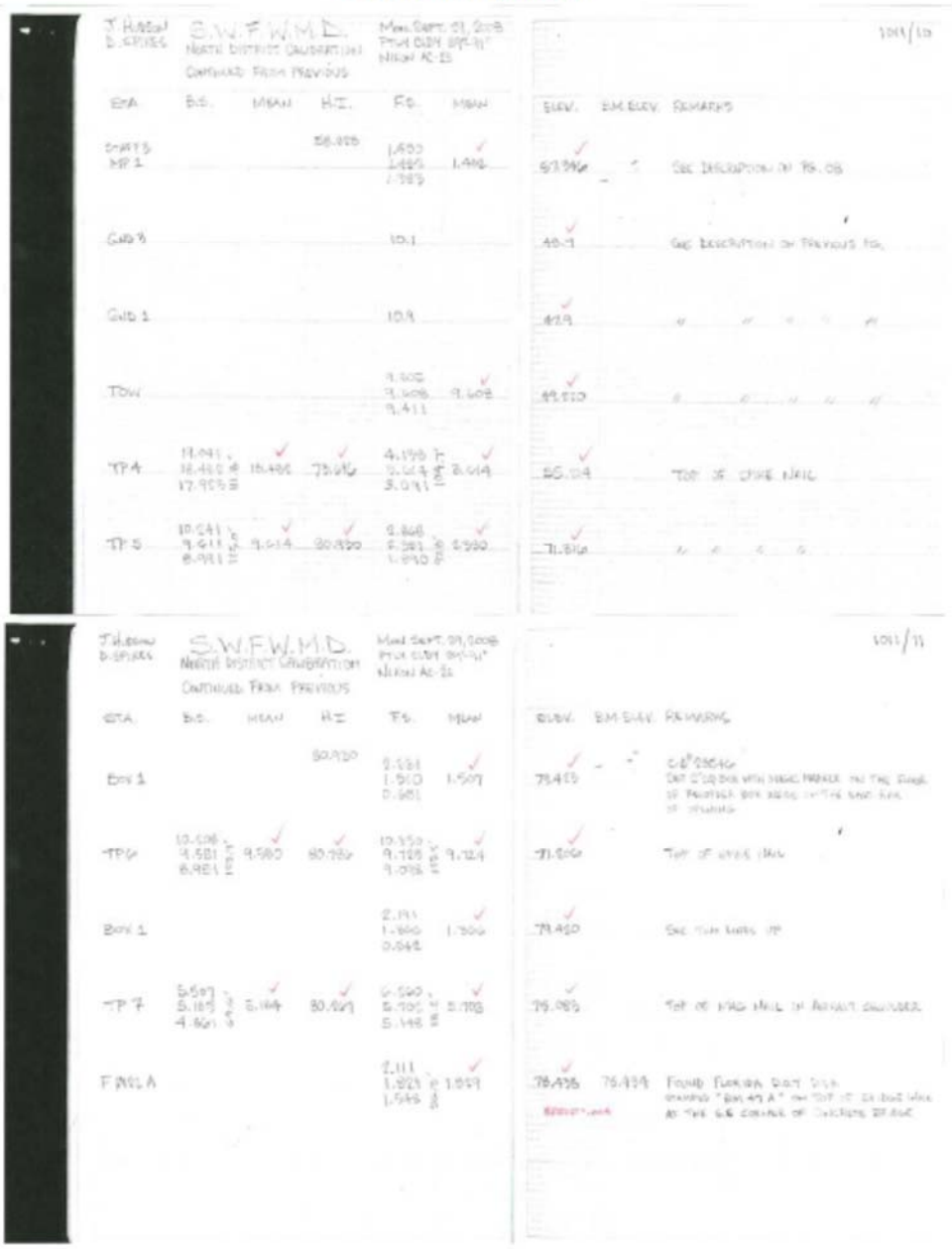
FIELD NOTES (CONT.)



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SHEET 5 OF 5

DETAIL 5

Benchmark Ties Guidelines

Operations Department

Hydrologic Data Section

Benchmark Ties

Guidelines for

THIRD-ORDER LEVELING TIES FROM VERTICAL SURVEY CONTROL STATIONS (NAVD88 BENCHMARKS) TO NEARBY HYDROLOGIC DATA COLLECTION DEVICES

Southwest Florida
Water Management District

WATERMATTERS.ORG · 1-800-423-1476

May 2009
Jim Owens
Tammy Plazak

Introduction

The purpose of these guidelines is to provide the information necessary to transfer an elevation from an existing NAVD88 benchmark to a nearby hydrologic data collection device. The existing benchmarks must be "close by" which is defined as no more than four "set-ups" of the leveling instrument.

Benchmark Level Tie (3rd Order)

Recover the existing benchmarks located near the hydrologic data collection site. For SWFWMD sites, the following web link will provides an interactive map of the SWFWMD Survey Control: http://bsm02.freac.fsu.edu/imf2/FREAC/SWFWMD.jsp ; zoom to the site location and view the datasheets using the identify function. The NAVD88 Benchmark Control Forms and the Hydrologic Data Collection data sheets are indexed by SID number and saved in PDF format.
Using the procedures outlined in this document, verify the elevation difference of the existing benchmarks by leveling between the benchmarks, and transfer the NAVD88 elevation to the measuring point at the hydrologic data collection device.
Record rod readings to hundredths of feet (0.01). The model, type of instrument, and serial number of instrument and rods (e.g., fiberglass, aluminum, single piece, etc.) shall be entered on the "Observations of Bench Mark Ties" form where indicated. The leveling instrument should be checked for collimation error on a regular basis.

Observing Sequence for Leveling

1. Remove equipment from travel cases, attach level instrument to tripod, and let equipment acclimate to local conditions. Perform instrument check per manufacturer's instructions. Set up the instrument about halfway between the stations, but no more than 200 feet away from either point or from one of the points and a turning pin in the case of multiple setup requirements. Backsight distance to foresight distance imbalance shall be less than 15 feet. Accumulated backsight to foresight distance imbalance shall be less than 30 feet in the case of multiple setups

2. Plumb the level rod on the highest point of the 1st Benchmark. In the following example, the first Benchmark is called "123456A." Record the designation of the benchmark (stamped on the disk) and its published elevation (from the survey datasheet) noting the reference vertical datum and units of measure.

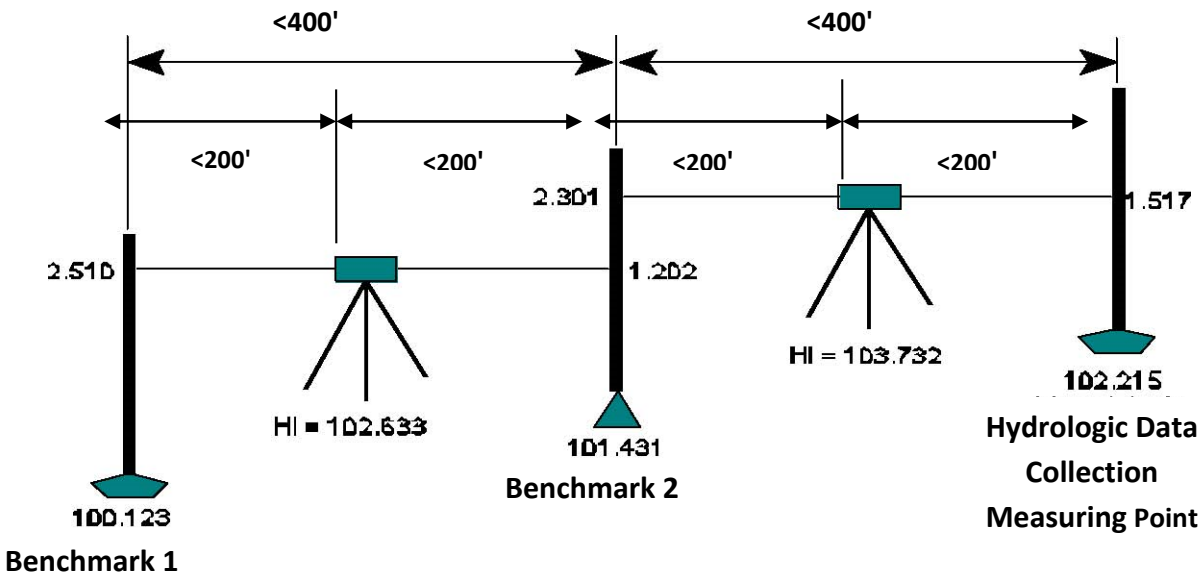


Figure 1 1st Benchmark ("123456A") to 2nd Benchmark ("123456B") level tie for distances over 400 feet. **Note:** Backsight-foresight distance imbalance should be less than 15 feet, and the accumulated backsight-foresight setup imbalance should be less than 30 feet.

3. Backsight Reading: Observe the intersection of the top, middle and bottom wire with the rod scale as the backsight reading. Record the rod reading to the nearest one hundredth of a foot. Compute and record the average of the three readings. The average should be within one hundredth (0.01) of the middle wire rod reading. If the average of the three numbers is not within one hundredth of a foot, the recordings should be re-observed. Compute the stadia distance from the point to the instrument (top wire – bottom wire x 100 = distance in feet).

4. Compute height of instrument, HI, which is the sum of the backsight and the published elevation.

5. Plumb the rod on the highest point of the 2nd Benchmark. Record the designation of the 2nd Benchmark, e.g., "123456B," or "TP1" (for turning point 1 in the case of multiple setups).

6. Foresight Reading: Observe the intersection of the top, middle and bottom wire with the rod scale as the foresight reading. Record the rod reading to the nearest one hundredth of a foot. Compute and record the average of the three readings. The average should be within one hundredth (0.01) of the middle wire rod reading. If the average of the three numbers is not within one hundredth of a foot, the recordings should be re-observed. Compute the stadia distance from the point to the instrument (top wire – bottom wire x 100 = distance in feet).

7. Compute the elevation of the 2nd Benchmark, or turning point, which is the difference o the HI minus the foresight.

8. Reset and re-level the instrument. Level backward from the 2nd Benchmark to the 1st Benchmark, in the same manner as steps 2 through 7.

Note: The elevation computed for the 1st Benchmark as a result of the backward leveling shall differ from the published elevation by no more than +/- 0.05 x sqrt of the distance in miles between the benchmarks, eg,: 0.05 x(sqrt of 1) = 0.05 feet.

9. To determine the elevation of the measuring point at the hydrologic data collection device (well or staff gauge), level forward and backward from one of the benchmarks to the measuring point in the same manner as steps 2 through 8.

Data Submission

The following **must be supplied** by the field technician:

1. The completed "**OBSERVATIONS FOR TIES TO EXISTING NAVD88 BENCHMARKS AT HYDROLOGIC DATA COLLECTION SITE**" form. (See Appendix D)

2. Digital copies of benchmark and measuring point photographs.

DETAIL 6

Worksheet for Third-Order Leveling Ties from Vertical Survey Stations (NAVD88 Benchmark) To Nearby Hydrologic Data Collection Devices

Appendix D. OBSERVATIONS FOR TIES TO EXISTING NAVD88 BENCHMARKS AT HYDROLOGIC DATA COLLECTION SITE

DATE OF FIELD OBSERVATIONS: | SURVEYED BY: | FIELD OBSERVATIONS BY:

LEVELING EQUIPMENT (MAKE/MODEL/ SERIAL NUMBER):

LEVELING FROM 1ST BENCHMARK TO 2ND BENCHMARK:

POINT DESCRIPTION	BACKSIGHT		HEIGHT OF INSTRUMENT	FORESIGHT		ELEVATION	REMARKS
	TOP=						
1ST BENCHMARK	MIDDLE=	AVERAGE=					DESCRIBE BENCHMARK
	BOTTOM=						PHOTOGRAPH NO.
	TOP=			TOP=			
TURNING POINT 1	MIDDLE=	AVERAGE=		MIDDLE=	AVERAGE=		DESCRIBE TURNING POINT
	BOTTOM=			BOTTOM=			
	TOP=			TOP=			
2ND BENCHMARK	MIDDLE=	AVERAGE=		MIDDLE=	AVERAGE=		DESCRIBE BENCHMARK
	BOTTOM=			BOTTOM=			PHOTOGRAPH NO.
	TOP=			TOP=			
TURNING POINT 1	MIDDLE=	AVERAGE=		MIDDLE=	AVERAGE=		DESCRIBE TURNING POINT
	BOTTOM=			BOTTOM=			
				TOP=			
1ST BENCHMARK				MIDDLE=	AVERAGE=		DESCRIBE BENCHMARK
				BOTTOM=			
		SUM BACKSIGHTS			SUM FORESIGHTS	LOOP CLOSURE	

LEVELING FROM BENCHMARK TO MEASURING POINT:

POINT DESCRIPTION	BACKSIGHT		HEIGHT OF INSTRUMENT	FORESIGHT		ELEVATION	REMARKS
BENCHMARK	TOP=						
"123456"	MIDDLE=	AVERAGE=					DESCRIBE BENCHMARK
	BOTTOM=						
	TOP=			TOP=			
SU NUMBER	MIDDLE=	AVERAGE=		MIDDLE=	AVERAGE=		MEASURING POINT AT SU#
	BOTTOM=			BOTTOM=			DESCRIBE MEASURING POINT
							PHOTOGRAPH NO.
BENCHMARK				TOP=			
"123456"				MIDDLE=	AVERAGE=		CHECK BACK TO BENCHMARK
				BOTTOM=			
		SUM BACKSIGHTS			SUM FORESIGHTS	LOOP CLOSURE	

DETAIL 7

Guidelines for Staff Gauge Installation

Specification Purpose

The purpose of this technical procedure is to describe the general procedures for installing a vertical staff gauge (see Figures 1 and 2), to ensure proper hydrologic data collection at a surface water site.

General Requirements

- Staff gauges shall be of a sturdy construction, be easy to operate and maintain, and shall be of such a design that they can be effectively used under the site's prevailing environmental conditions and be readable for all anticipated water levels.
- Staff gauges shall conform to either USGS Style A (preferred) or Style C standards (see Figure 3), and shall be constructed of 16-gage porcelain-enameled iron or steel.
- The standard measurement resolution for a staff gauge shall be 0.01 foot.

Background

Staff gauges are installed in surface water bodies associated with District projects or programs for the purpose of measuring water levels. The type of staff gauge commonly used at the District is the "Vertical Staff Gauge," which consists of porcelain enameled iron sections, securely bolted or fixed to a secure backing or staff, and are precisely graduated and accurately located for scalar measurement sections (see Figure 4). Staff gauges are generally installed (either) as a stand-alone gauge or affixed to an existing permanent structure (e.g., dock, pier, bridge piling, etc.). This procedure describes the installation of a "stand-alone" staff gauge.

Staff gauges are used for water level readings in two common applications:

1. As the primary gauge at a surface water site to monitor water levels; or
2. As a primary water level gauge in conjunction with a stilling well at automated-recorder sites, to verify the measurement from the stilling well.

The staff gauge is the primary gauge and is the standard from which the water level data is collected. Water level data shall be referenced to either height or elevation.

Site Research Prior To Gauge Installation

To the maximum extent practicable, the following research is recommended prior to staff gauge installation:

1. Examination of existing hydrological data regarding the site (e.g., WMIS database, reports, etc.) to determine historical maximum and minimum water levels.
2. Field investigation of site conditions, including identification of high water marks, determination of bottom characteristics, etc. Look for maximum depth close to shore.
3. Determination of the most suitable location for the staff gauge. The location should be in an area deep enough to provide the full range of water level conditions, without creating a hazard to navigation. If it is an observer site or on private property, consult with the observer and/or landowner regarding a suitable location. Make sure the observer will be able to read the staff gauge at the proposed location. In any case, the staff gauge location must meet any hydraulic requirements for its application and must therefore be chosen with care.
4. Determine the best method for installing the staff gauge and the equipment need for the installation.
5. Locate, or have installed, a Permanent Benchmark which will be needed for determining the elevation of the staff gauge (see Figure 5). Benchmark construction and distance from the staff gauge location must comply with District benchmark standards.

Installation Procedures

I. Materials Needed

- Gauge section(s)
- 1” x 8” pressure-treated wood backing-board for mounting staff sections. The backing-board shall be painted black with an epoxy paint.
- 3” x 0.125” aluminum or galvanized pipe/tubing. Length of pipe/tubing will be site specific.
- Mounting brackets/bolts for attaching backing-board to staff.
- Stainless screws; aluminum/stainless bolts, nuts, flat/lock washers, brackets, etc., to affix staff sections to backing-board.
- District ID plate.

II. Equipment Needs

- Jet pump or post driver
- Boat (as applicable); hip/chest waders or dry suit
- Cordless drill, drill bits, hacksaw and other assorted tools (wrenches, screwdriver(s), pliers, etc.) necessary to complete staff gauge installation
- Carpenters level
- Graduated steel measuring tape
- Laser leveling equipment

III. Installation

The staff gauge must be positioned vertically and secured sufficiently to a stationary object or driven into the bottom sediments to eliminate vertical and horizontal movement.

1. Assemble all necessary materials and equipment for the installation of the staff gauge.
2. Attach 3-inch pipe brackets to backing-board with necessary stainless hardware.
3. Attach gauge sections to the backing-board with necessary stainless/aluminum screws, nuts/bolts, brackets, etc., making sure gauge sections used will cover the anticipated range of water level fluctuation. Gauge sections are prone to variations in scale so calibrate the assembly of sections by using a graduated steel measuring tape across the sections and adjust the gap between them to the measuring tape. NOTE: Gauge sections must be affixed in a manner that allows adjustment for calibration to elevation requirements (i.e., tuning it to Datum).
4. Install the District ID plate on top of the staff or backing-board.
5. Place the 3-inch aluminum/galvanized pipe (staff) at the location of gauge placement. The staff must be positioned upright and vertical. [Note: The staff gauge should be installed separate from a dock if it is a recorder site and it should be with-in reach of the dock for easy cleaning and reading.]
6. Using jet pump or post driver, advance staff vertically downward into the substrate, checking vertical alignment and correctness with the carpenter’s level during the advancement process. The staff must be driven into the substrate to a sufficient depth (approximately 3 or 4 feet or sediment refusal, whichever occurs first) to prevent vertical or horizontal movement under all prevailing environmental conditions at the site. The height of the staff must be planned to remain above extreme high water levels and from becoming inundated or submerged.
7. Attach the backing-board (with gauge sections) to the staff, adjusting it up or down in the water so that the gauge sections will be able to measure increasing/decreasing water levels.
8. Set a reference point on the backing-board at a specific gauge reading point.
9. Use laser level equipment and established Benchmark to determine the true elevation of the reference point.

10. Adjust gauge sections on the backing-board to the correct elevation relative to the reference point.

IV. Documentation:

- Draw a map of site with distance and directions to the Benchmark.
- Take pictures of the completed staff gauge and monitoring station.
- Fill out a miscellaneous field note with a description of the staff, WL readings, etc.
- Record GPS location (i.e., latitude/longitude) position.

V. Update field folder

Figure 1: Staff gauge located in a surface water body

Figure 2: Staff gauge located adjacent to a stilling well and recorder shelter

Figure 3: USGS Style A and C Gauge Sections

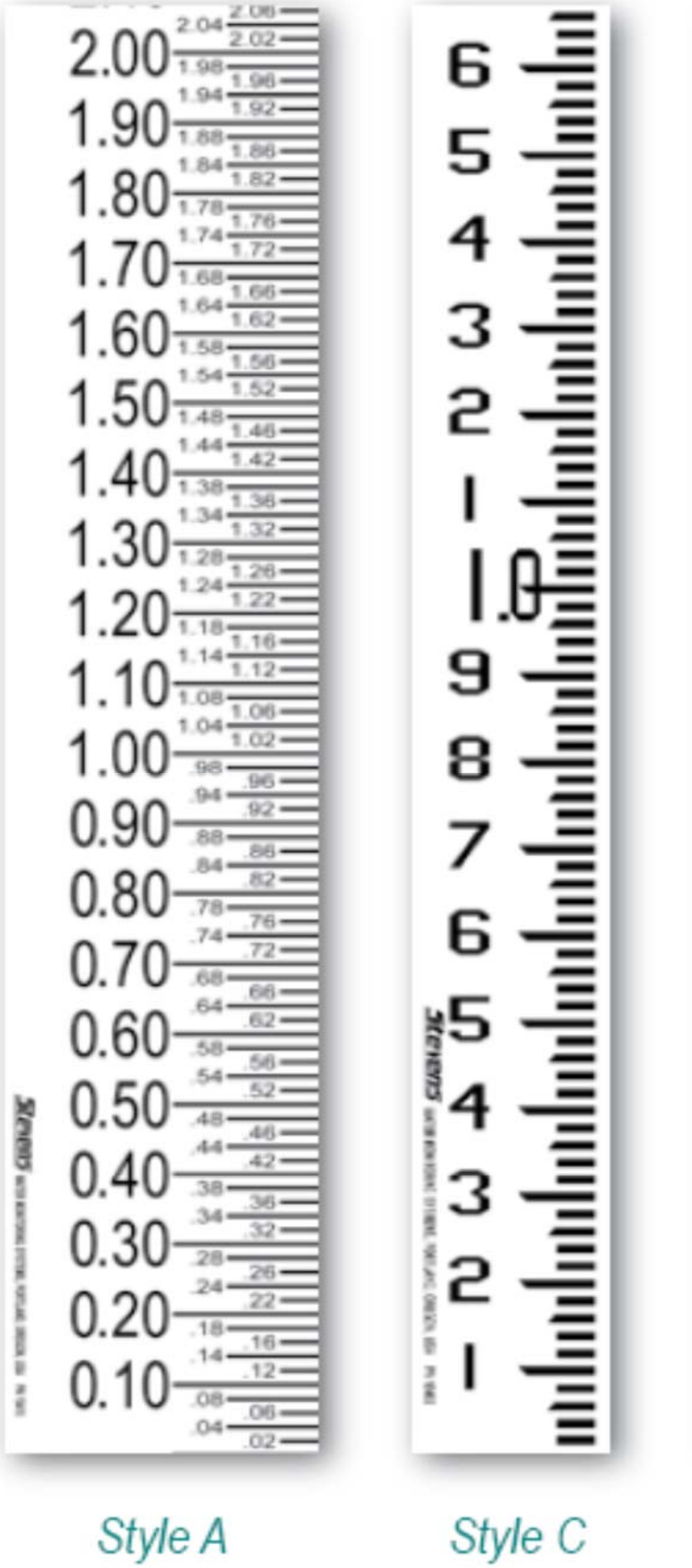
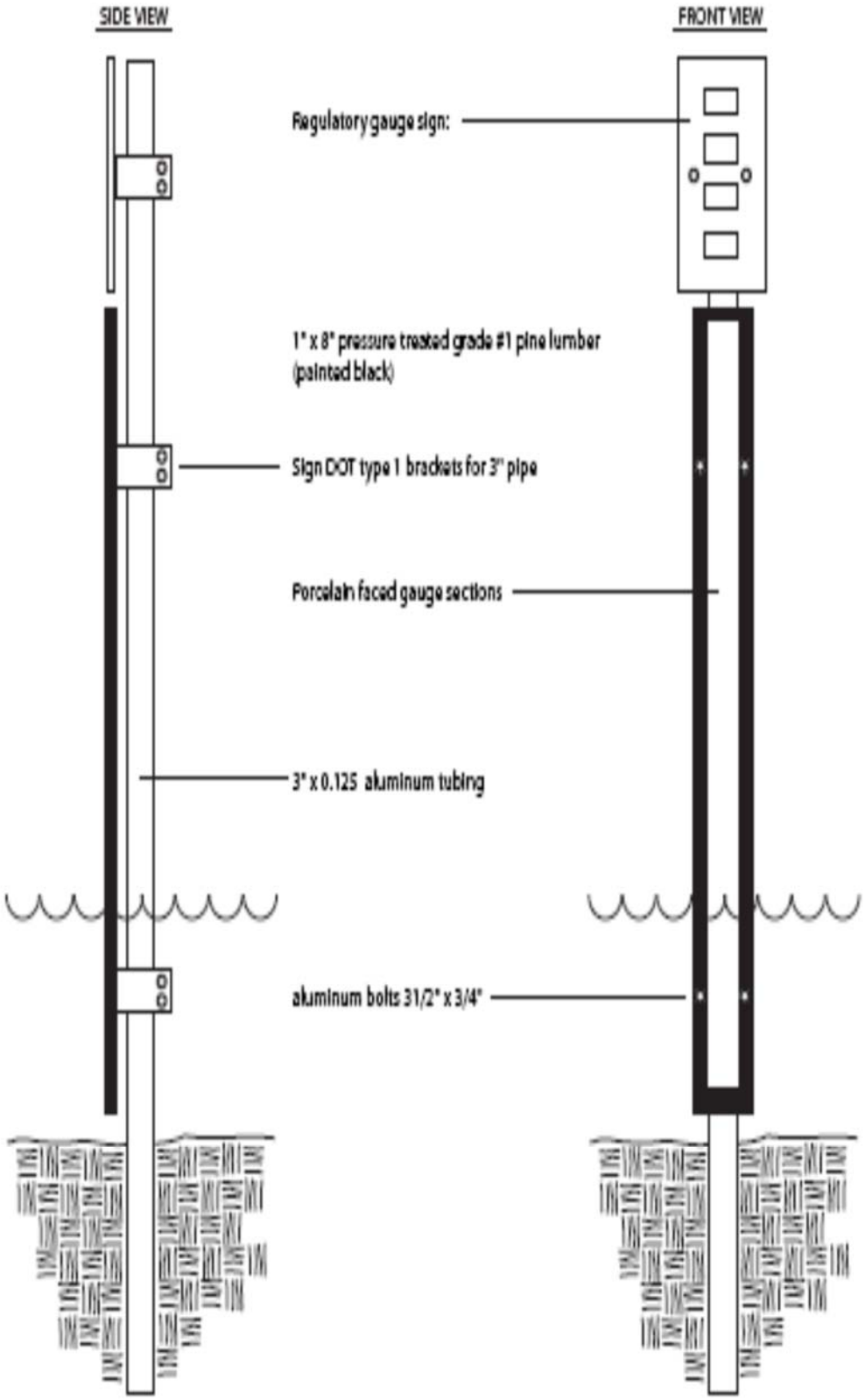


Figure 4: Diagram of staff gauge



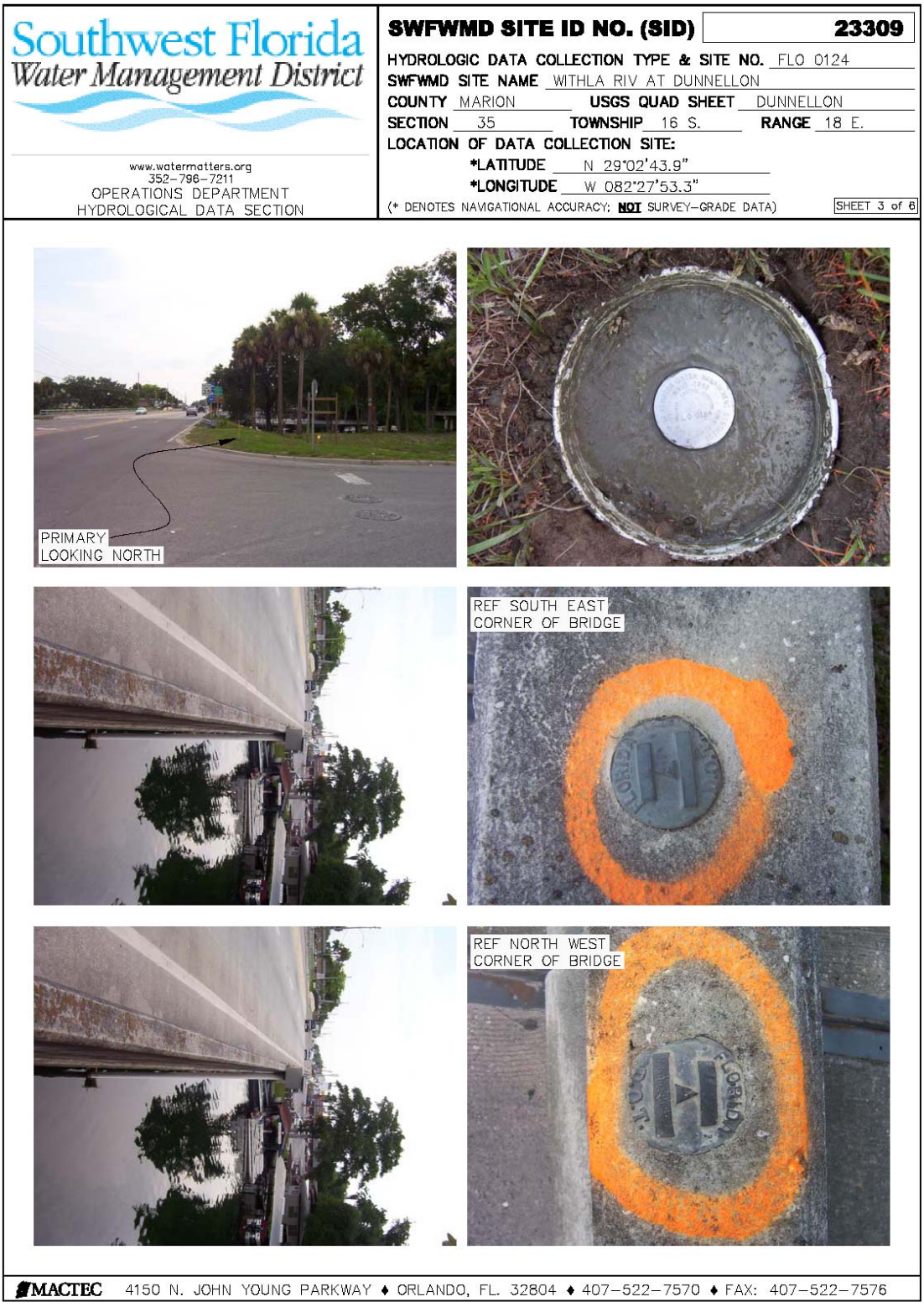


Figure 5: Location of Existing Benchmark on Withlacoochee River

DETAIL 8

Guidelines for Stilling Well Installation

Specification Purpose

The purpose of this procedure is to establish guidelines for the preparation and installation of stilling wells, so as to ensure proper hydrologic data collection at surface water body sites.

Background:

Stilling wells are instruments used to record water level readings in a surface water body (e.g., lake, pond, stream, etc.) to obtain an accurate stage level and minimize the effects of wave action (see Figure 1). If a station is equipped with a water-stage recorder and a stilling well, it is essential that the water level in the stilling well correspond to the stage in the water body. Where the stilling well accommodates a float for a float-operated recorder, it is recommended that the stilling well meet the following conditions: a) have sufficient height to accommodate the entire range in stage at the station and be vertical; b) have intake slots/holes at various stages (elevations) to accommodate widely varying stages; c) have intake slots/holes of sufficient slot size or hole diameter to assure that the water level in the well will not lag the rise or fall of the water level in the stream; d) have intake holes of such diameter to damp out short period wave effect or oscillation; and e) have some provision to accommodate periodic cleaning.

Procedure:

A stilling well must be positioned vertically and secured sufficiently to eliminate vertical and horizontal movement (see Figures 2 and 3).

Material List:

- 6-inch to 10-inch Schedule 40 PVC slotted (0.10 or 0.20 slot) well screen. Length of well screen used will be site specific;
- 6-inch to 10-inch Schedule 40 PVC end cap;
- 3-inch diameter aluminum tubing. Length of tubing used will be site specific;
- 5-inch aluminum strapping. Length of strapping is determined in the field;
- Mounting clamps and bolts to fit the size of the PVC well screen;
- Brackets if mounting to a platform;
- 6-inch to 10-inch flange to connect PVC well screen to recorder shelter box;
- PVC glue and PVC cleaner.

Equipment List:

- Jet pump or aluminum pipe-driver;
- Boat (if needed);
- Cordless drill, drill bits, hacksaw and other assorted tools (wrenches, screwdriver(s), pliers, hammer, etc.) necessary to complete installation;
- Aluminum shelter box;
- Bolts to mount shelter;
- Carpenters level.

Surface water sites may require the construction of docks or other supports to install a stilling well. Materials used should be pressure-treated lumber and non-corrosive materials and hardware. Supports for a dock or other structure should be jetted in to ensure they will not yield during abnormally high flows. The height of the structure must be planned to remain above

extreme high water levels, and to keep the top of the stilling well and recorder from becoming inundated or submerged. Likewise, the dock should be constructed into an area deep enough to provide the full range of water level conditions, without creating a hazard to navigation. The stilling well should be constructed of schedule 40 PVC slotted well screen (i.e., 6- to 10-inch diameter is recommended), with a cap glued onto the bottom. Several holes should be drilled into the cap to allow water flow.

Installation:

- Cut PVC slotted well screen to appropriate length and glue end-cap to bottom of PVC screen;
- Drill several ¼-inch hole in the bottom of end-cap;
- Level and jet or drive in aluminum tubing to refusal, creating a four post structure. Attach support pressure-treated wood;
- Use appropriate brackets to mount stilling well to 4x6 PT;
- Use appropriate PVC flange to mount on top of stilling well;
- Use appropriate shelter to mount to flange;
- Mount to platform;
- Use appropriate brackets to mount stilling well to platform.

Figure 1: Stilling Well and Staff Gauge Facility

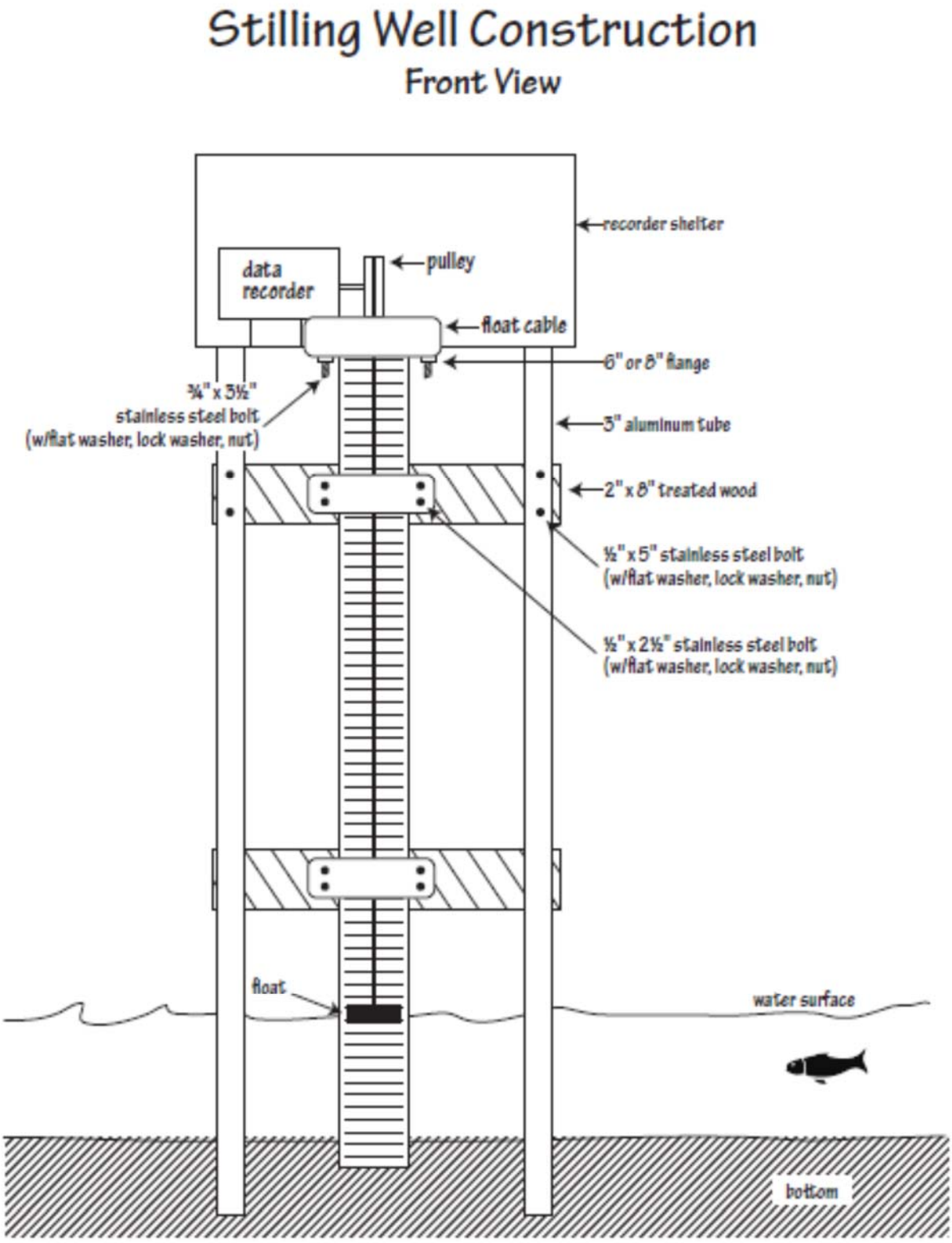


Figure 2: Stilling Well - Front View

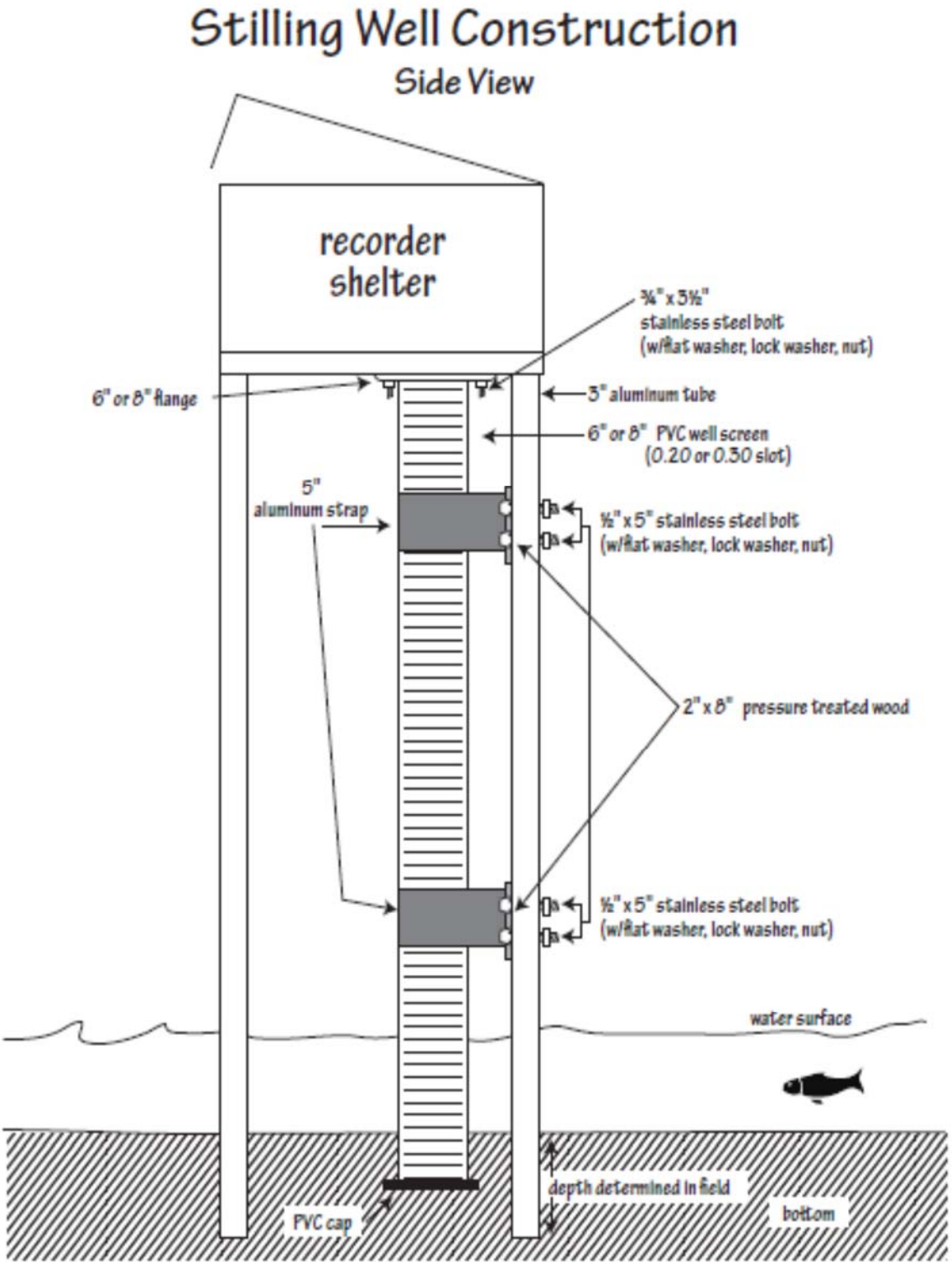
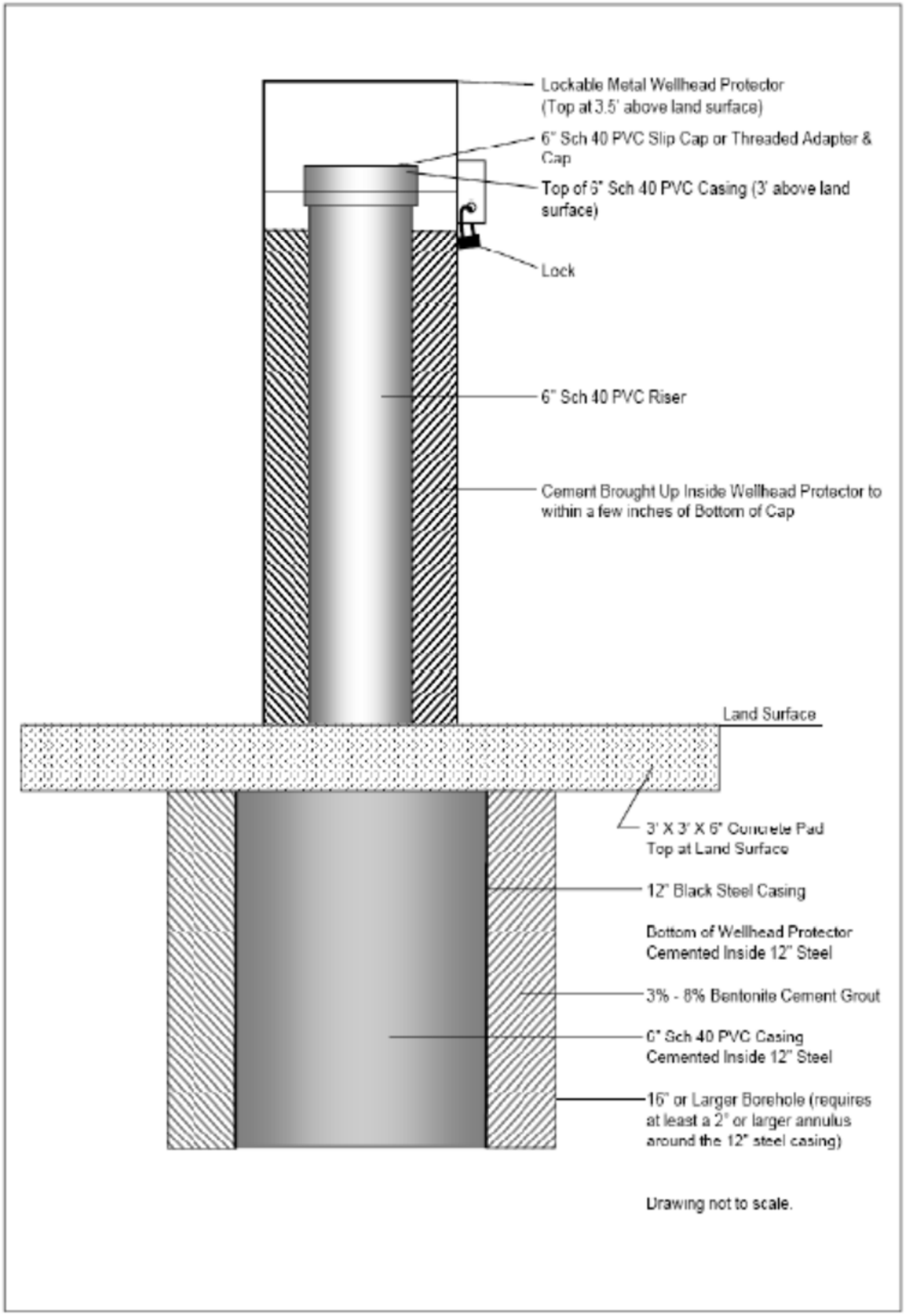


Figure 3: Stilling Well – Side View

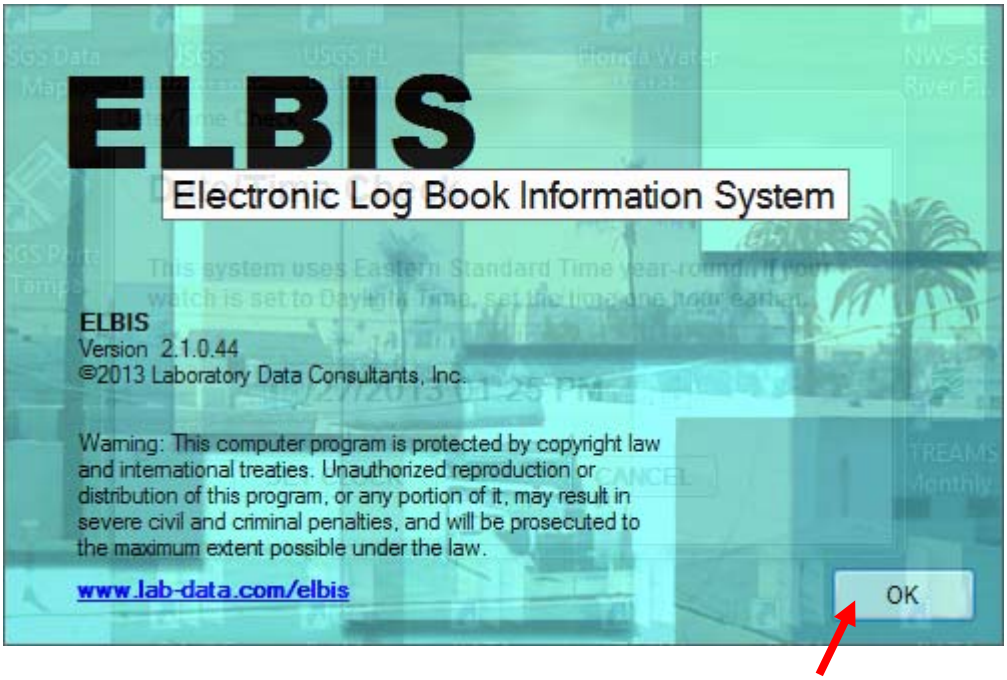
DETAIL 9

Diagram of Typical Wellhead Protector

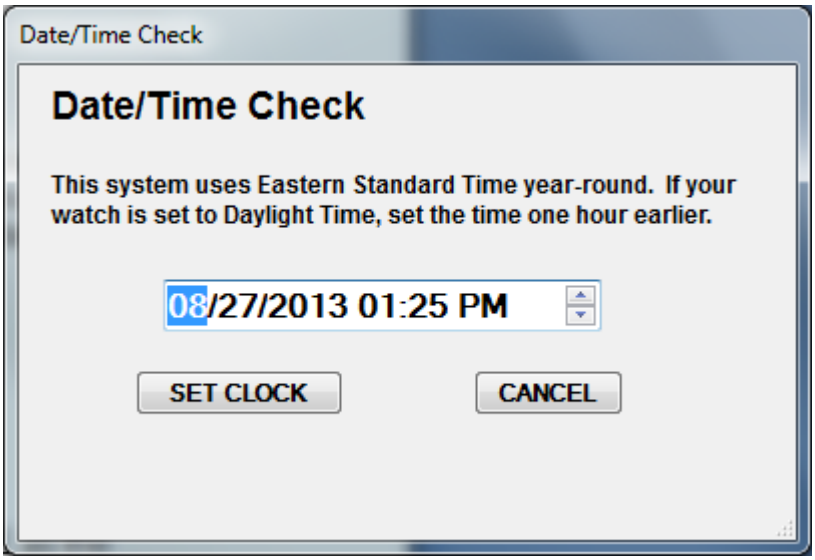

Lockable Metal Wellhead Protector
(Top at 3.5' above land surface)
6" Sch 40 PVC Slip Cap or Threaded Adapter & Cap
Top of 5" Sch 40 PVC Casing (3' above land surface)
Lock
6" Sch 40 PVC Riser
Cement Brought Up Inside Wellhead Protector to within a few inches of Bottom of Cap
Land Surface
3' X 3' X 6" Concrete Pad
Top at Land Surface
12" Black Steel Casing
Bottom of Wellhead Protector Cemented Inside 12" Steel
3% - 8% Bentonite Cement Grout
6" Sch 40 PVC Casing
Cemented Inside 12" Steel
16" or Larger Borehole (requires at least a 2" or larger annulus around the 12" steel casing)
Drawing not to scale.

DETAIL 10

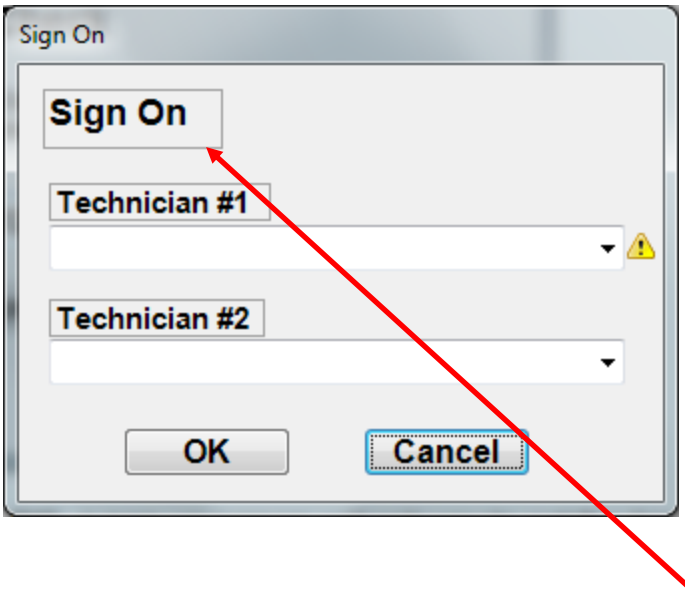
ELBIS Quick Overview



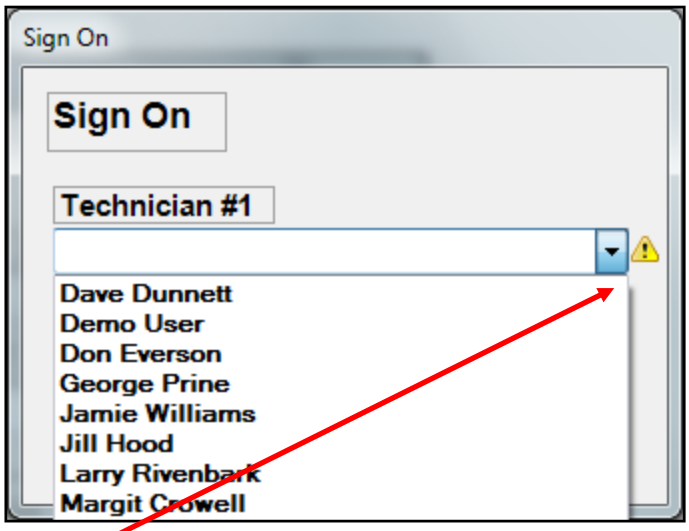
When the program is started, a main ELBIS screen is displayed (above). The technician clicks the “OK” button to access the program.



A pop-up screen will prompt the technician to set the time and date, as necessary. If the ELBIS date/time-clock is off, the technician must make the appropriate corrections and then click on “**SET CLOCK**.” If the ELBIS date/time is correct, the technician will click “**CANCEL**.”



The next screen after the time-clock screen is the **"Sign On**" screen.



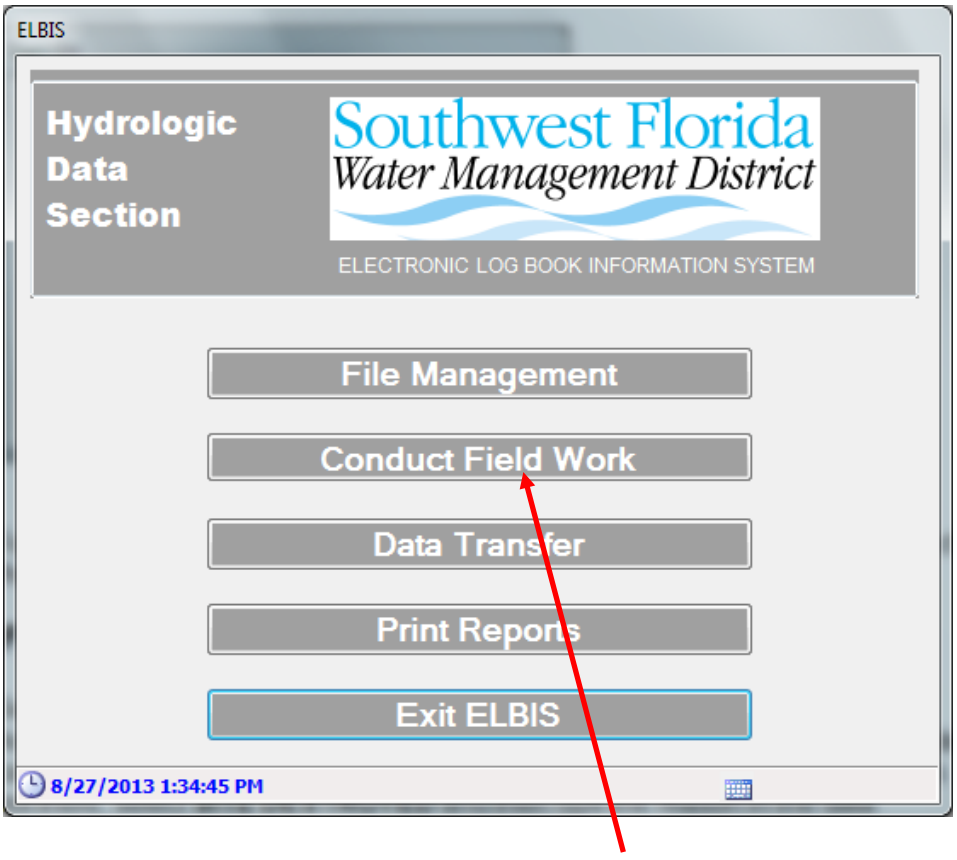
To sign into ELBIS, the technician clicks on the drop-down menu icon and then clicks onto their name.

IMPORTANT: The use of ELBIS on the technician's portable field computer is to provide field staff with a convenient tool for getting manually collected "instantaneous" field data into the appropriate District computerized database(s). The ELBIS program automatically performs various calculations regarding data collection activities, including automatically "date/time" stamping the entered field data. It is intended to be used for entering field data for a specific monitoring site "at the time and on the date the data is actually collected," and is not set-up or appropriate for entering field data hours or days after the actual data collection event has occurred.

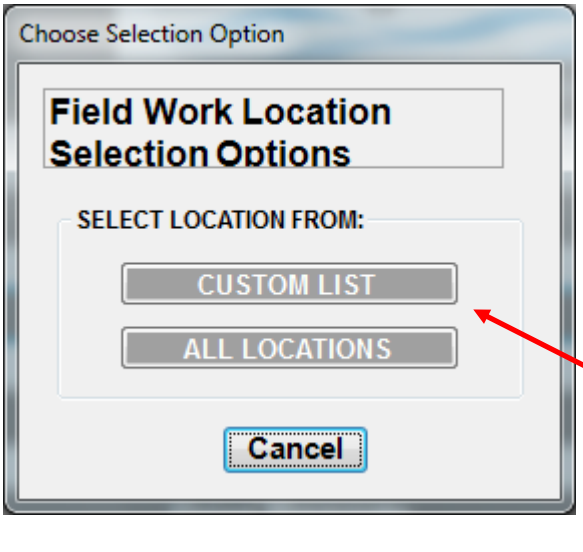
Therefore, field technicians shall NOT use ELBIS for entering field data hours or days after it was actually collected and just placing a comment into ELBIS that indicates the data was actually

collected at a different time, or date, or monitoring site, without prior authorization from the HDS Field Supervisor or Manager.

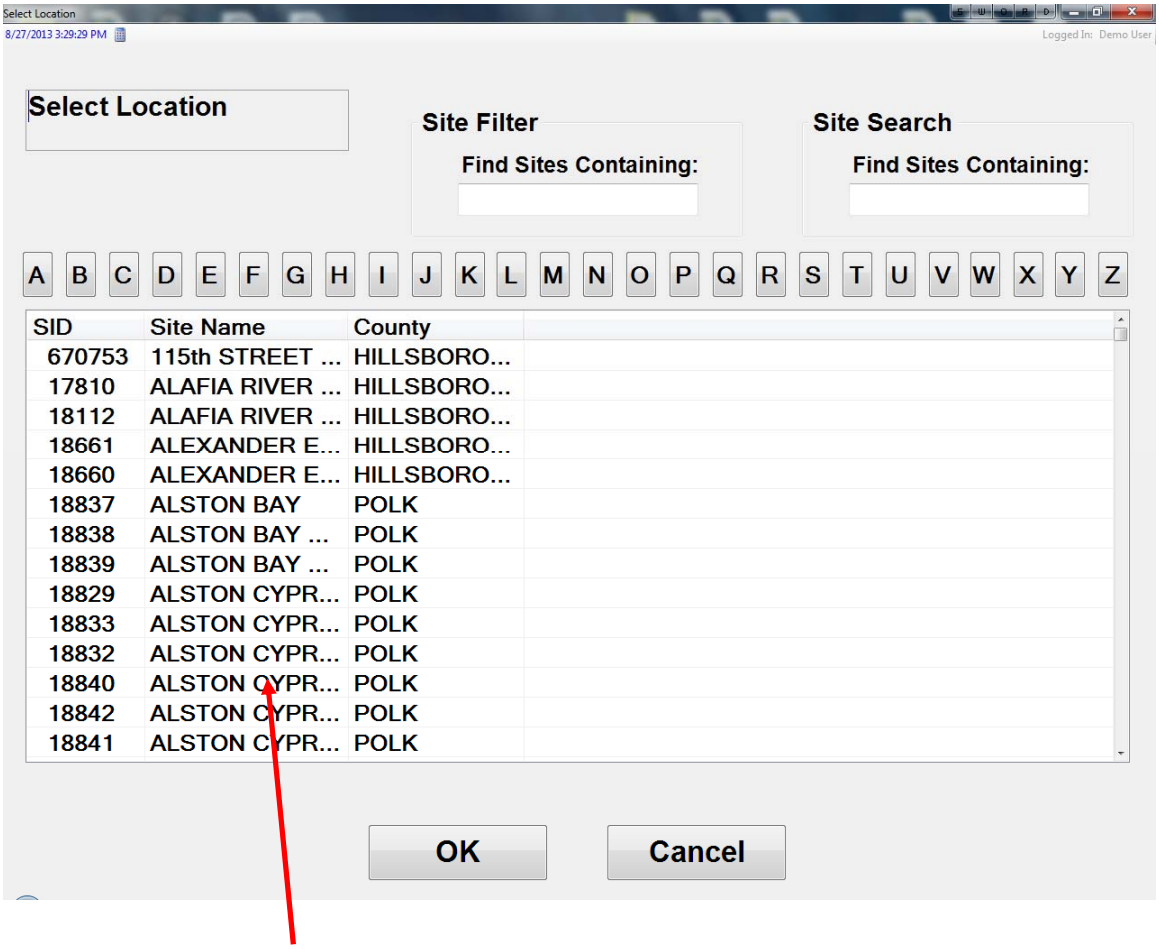
In the event that the field technician is unable to enter field data into ELBIS at the actual time that it is collected, then the field technician shall record (hand written) the field data (at the time of collection) into a "standard field book" or other pre-approved documentation method, and shall include the following data collection information: SID#, field data value, date/time of data collection, all calculations necessary for the measurements, as well as any other pertinent measurement information that ELBIS would record or calculate, such as "HELD" measurement(s), psi values and/or technicians comments. Using a standard field book is important, as it is constructed of waterproof and durable pages that will be archived, while it is unacceptable to document the collected field data onto scraps of paper, post-it notes, or other unapproved method. When the technician is unable to utilize ELBIS for entering their field data, the technician shall email the field data measurements and an explanation to the appropriate HDS office staff as soon as feasible, so office staff can enter the data into the appropriate database(s) with the correct "date/time" information.



Once the technician clicks onto their name in the previous screen, a new screen is displayed that allows them to select "**Conduct Field Work**." They can click on this button, which brings up the "**Field Work Location Selection Options**" screen (below).

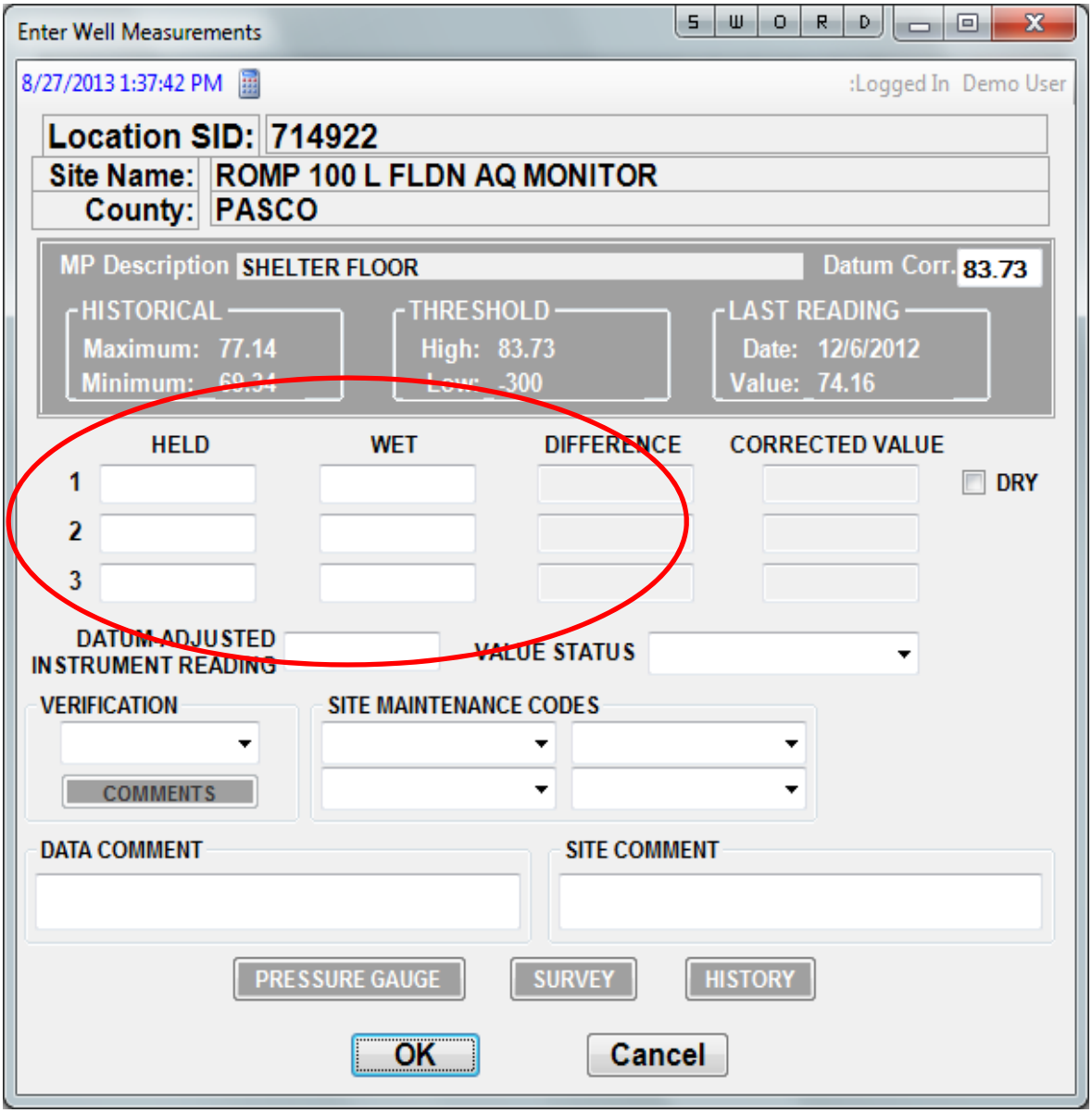


The technician can then select the monitoring site by clicking-on (either) a "**Custom List**" of sites they can create, or from the "**All Locations**" list.



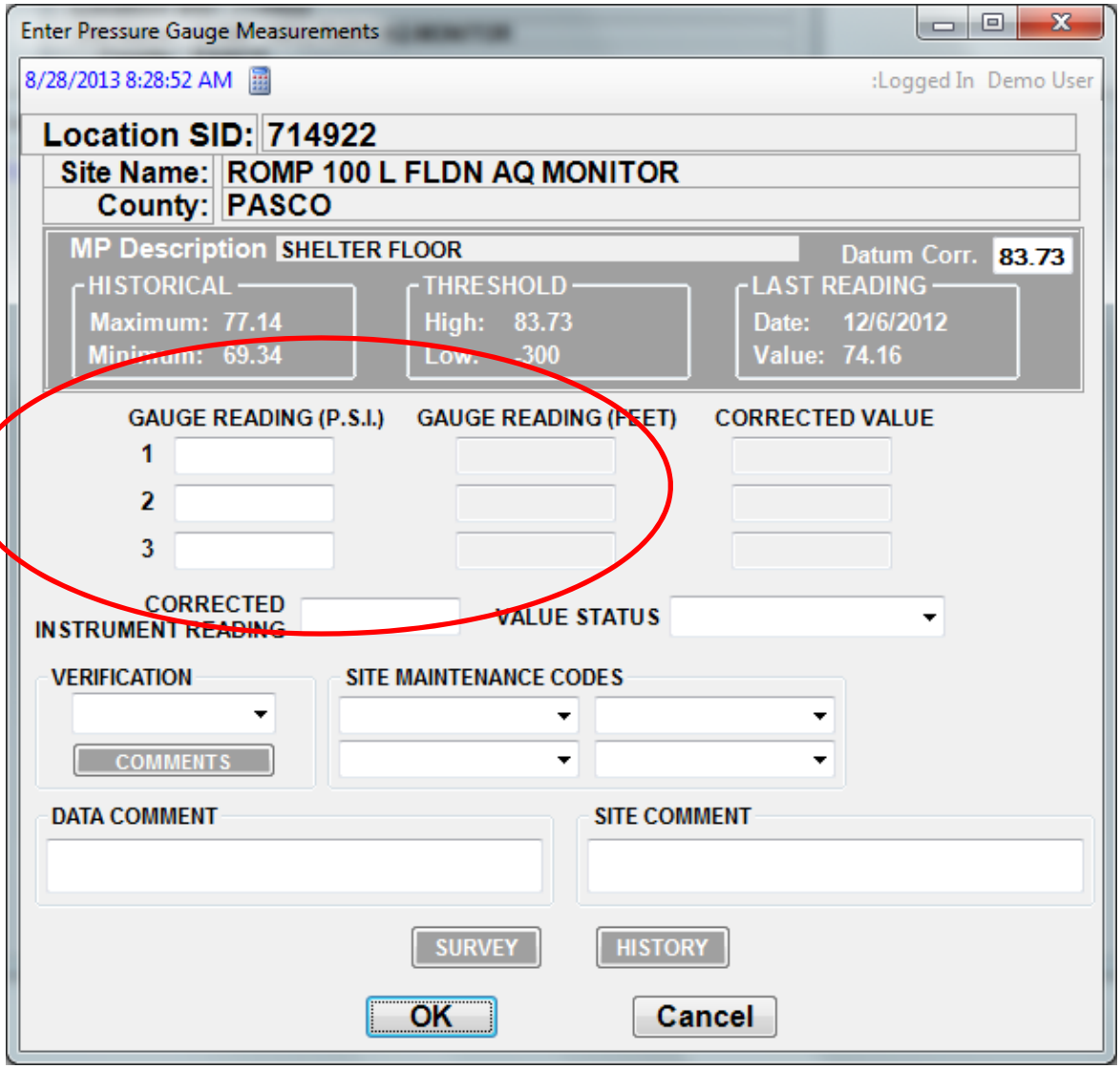
Next, a list of data collection sites is displayed from which the technician can select and click-on the appropriate monitoring site.

Well Sites (Non-flowing)



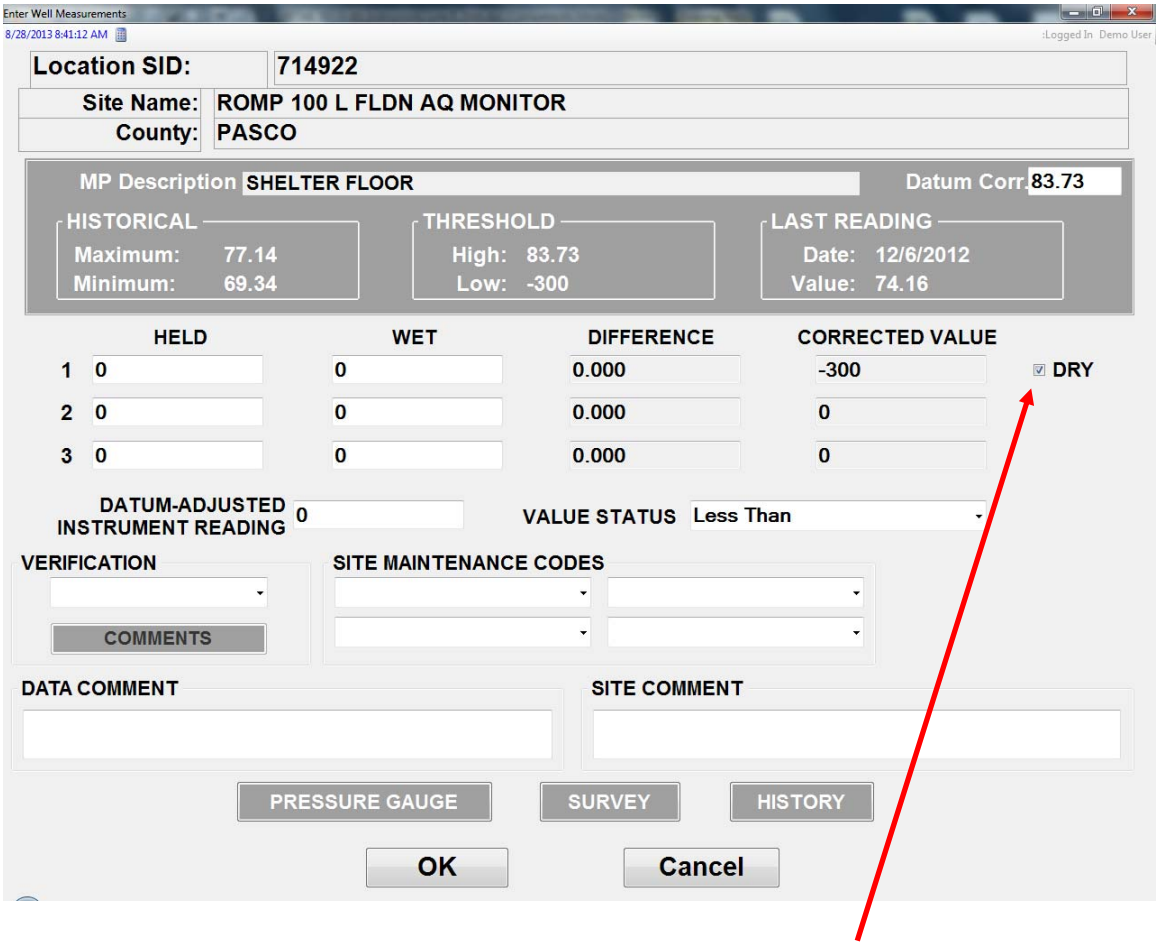
The above screen is used by the technician to enter water level measurements at non-flowing well sites.

Well Sites (Artesian or Flowing)



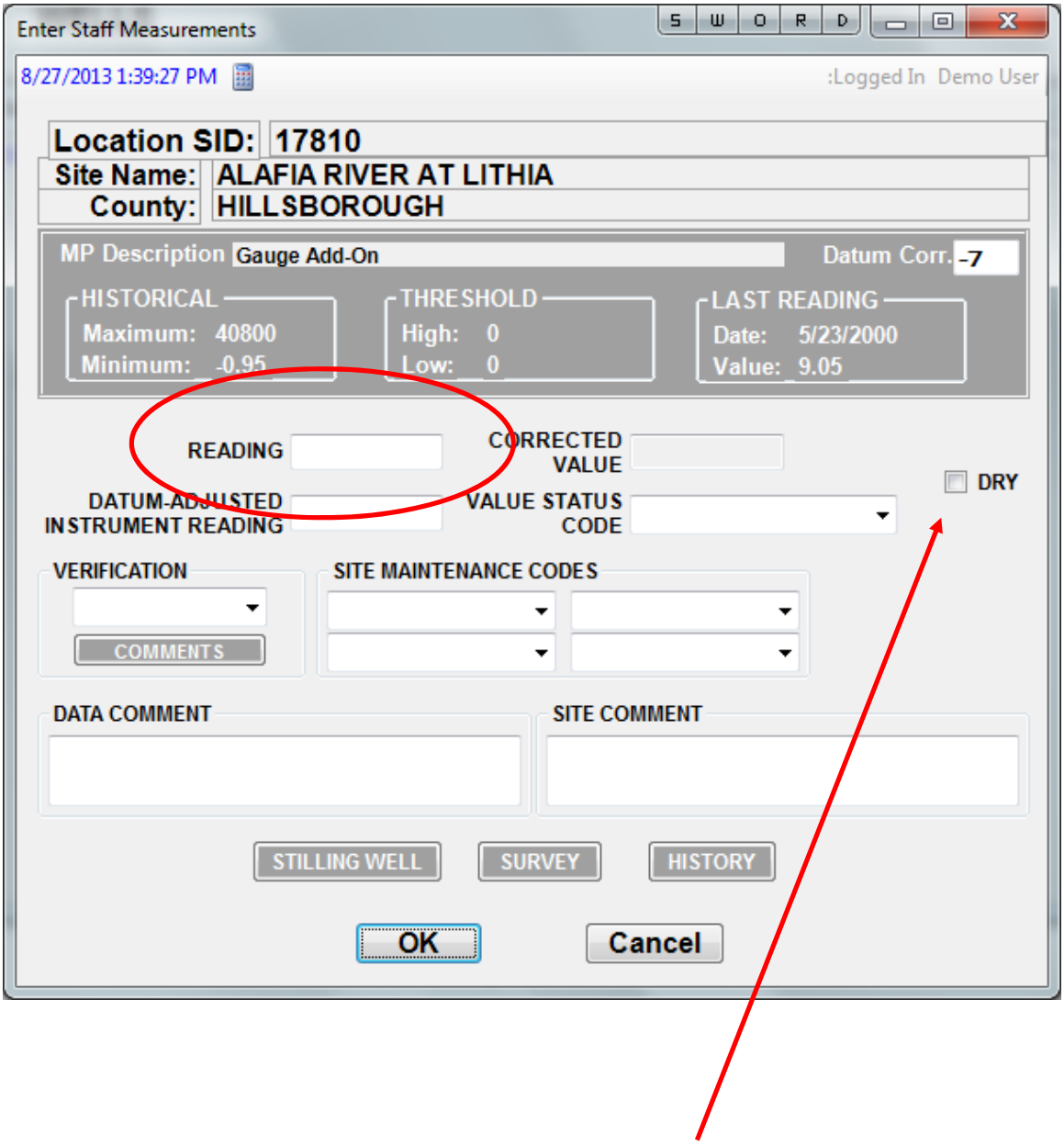
The above screen is used by the technician to enter pressure gauge readings, in psi, at artesian (flowing) well sites.

Well Sites (Dry Well)



At dry wells, the technician checks the **DRY** Box. This will put zeros in the held and wet, but it should go to the database as the correct reading.

Staff Gauge Sites



The above screen is used by the technician to enter staff gauge readings.

If the gauge is dry, the technician will check the **DRY** box.

DETAIL 11

Typical Components of SCADA Telemetry Systems

The SCADA system provides a network of real-time water level and rainfall data collection stations. The District has standardized on Campbell Scientific, Inc research-grade dataloggers coupled with telemetry constituting remote-terminal units (RTUs) for data collection operations. Wireless telemetry is provided by AT&T and Verizon, the premier carriers for two leading cellular technologies. Choosing between the two competing networks guarantees the best performance for the localized area available from resource rich companies. Land line (TELCO) communications are provided by local area TSPs. SCADA TELCO lines and USRobotics 5686E 56K faxmodems used to dial remote site locations are located at the Brooksville, Tampa and Bartow District offices. A bank of TELCO modems is connected to each SCADA server in the system for a total of 21 available units. Although the modems are distributed across different TELCO systems and geographically separate, they are logically pooled for SCADA operations. Long distance service is provided by the local TSP or Division of Management Services. TELCO modems used at remote data collection sites are provided by Campbell Scientific, Inc. and have design features such as voice-synthesized data reporting and low power requirements optimized for battery\solar powered remote telemetry.

A data collection site must be instrumented with compatible electronics to qualify as a District SCADA site. Sensor data must be present in the datalogger memory in a format transferable to the master SCADA system. The SCADA system must incorporate software (called driver software) capable of interfacing to and controlling the selection and transfer of RTU data. The District adheres to standardized telemetry equipment selection to minimize support, management and maintenance issues and cost.

Standardized components of the SCADA telemetry system shown are:

SCADA server hardware:

- Dell Precision T-3500 , Intel Xeon CPU W3550 3.07 GHz 4GB
- Comtrol Rocket Port serial port card (high density serial ports)
- Dell Network Interface
  Maintaining hardware standards contributes to reliable telemetry operation, differing hardware frequently operates with subtle differences and timing causing problems that are difficult to detect.

SCADA server software:

- Windows 7 Professional Operating System
- Vipre Enterprise Antivirus
- Comtrol (serial multiport card driver and utilities)
- Remotely Anywhere (remote control software)
- Sunbelt Software (Vipre Antivirus)
- Trihedral Engineering Ltd. (VTS core SCADA software and application)
- Oracle (Oracle database client)
  Maintaining core system software standards also contribute to reliable telemetry operation. Modern software must rely on the operating system services to handle interfacing to I\O (Ethernet and serial port communications) devices for consistency and security. Antivirus and driver software can be complex to configure for trouble free operation. Remote control software must operate within the enterprise security specification.

SCADA support software:

- Campbell LoggerNet (datalogger configuration software)
- Sierra Wireless Airlink AceManager (Airlink IP modem configuration software)
  Campbell LoggerNet software is the only full featured product available for all configuration tasks for Campbell datalogger products. This OEM developed product can also be used for data acquisition and is useful for comparison troubleshooting. The Airlink AceManager software provides a user friendly GUI interface for IP modem management.

SCADA site telemetry equipment

- Sierra Wireless Airlink “Raven” IP modems with serial port (AT&T & Verizon)
- Campbell Scientific COMxxx TELCO modems
  The District has standardized on Sierra Wireless Airlink IP modems for TCP/IP telemetry. The District has also standardized on the Campbell COMxxx series TELCO modems. Most TELCO installations are older sites using array based dataloggers that are no longer in production (CR10x and CR510). Most new sites are TCP/IP cellular based and use the newer, table based datalogger (CR800 and CR1000) which support the Campbell PakBus(packet based) network.

DETAIL 12

Citrus Canker Sanitation Protocol

CITRUS CANKER SANITATION PROTOCOL

The following recommendations/procedures have been developed as a result of concerns about the potential for District employees/vehicles working within citrus groves to spread citrus canker. Groves in all areas of the District are susceptible to contamination.

Staff must make contact with grove owners or managers prior to any entry. Every District employee/vehicle shall be sanitized prior to entering and when exiting any citrus grove. Sanitation is required by Florida Department of Agriculture and Consumer Services rule upon entering or exiting groves within the quarantine areas. It is highly recommended by DACS and the Institute of Food and Agricultural Sciences outside the quarantine areas, which staff shall follow until further notice.

District employees should enter citrus groves only when necessary and contact with citrus trees and other vegetation should be minimized or avoided. Grove owners should be contacted prior to entering groves to determine what precautions the owner/manager is following and to let them know that we are sanitizing prior to entering his grove. Some groves have vehicles which are only used within the grove and access for other vehicles is restricted. If a grove owner's vehicle is used, employees must still sanitize their hands, arms, clothes, shoes and equipment.

Vehicle/Employee Sanitation

1) **Read and follow label directions on the sanitation product labels.**
2) Wear the required protective equipment (face shield and rubber gloves) when handling or mixing either of the concentrated products and when spraying vehicles with the Gallex 900 solution. Do not get either product in your eyes. If you do get it in your eyes, flush eyes with water for 15 minutes.
3) Mix 2.4 ounces of the GX 1027 antibacterial soap product per gallon of water. Use this mixture to wash your hands and arms for 20-30 seconds then rinse with water. Also, use the diluted mixture in a spray bottle to spray your sleeves if wearing a long sleeve shirt, pants, or legs if wearing shorts, shoes, especially the soles. No rinsing is necessary.
4) Mix one ounce of the Gallex 900 solution per gallon of water in a one or two gallon pump up sprayer. Make sure that you properly rinse the measuring cup by filling it with clean water and emptying it three times into the sprayer. Use this diluted mixture to spray the tires, axles, fenders, bumpers, sides and any other parts of the vehicle which may have contacted the ground or vegetation within the grove.
5) All field equipment must be sprayed with the Gallex 900 solution utilized for sanitizing vehicles

Vehicle Sanitation Kit

Each vehicle which will be used within a citrus grove should have the following supplies:

- Face shield
- Rubber gloves
- Spray bottle (two)
- Pump-up sprayer, one or two gallon
- Small (one to four ounce) measuring cup
- Plastic gallon jugs of water, three or more (save empty jugs and refill with tap water)
- Paper towels
- Eye wash bottle

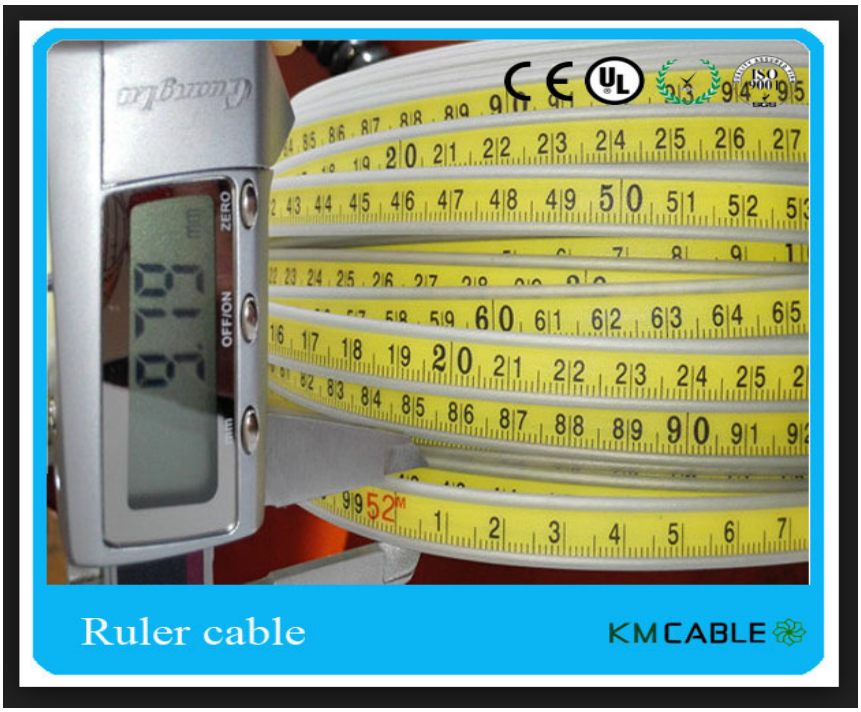
DETAIL 13

Manual Water Level Measurement Devices

Example: Graduated Stainless-Steel Tape

Example: Graduated Electronic Measuring Tape

Example: Graduated Measuring Tape Scaled in Feet



Example: Portable (hand-held) Pressure Gauge

DETAIL 14

Data Quality Codes

QUALITY CODE		QUALITY DESCRIPTION
1		Good continuous records
2		Good-quality edited data
26		Good daily-read records
30		Irregular time-rate data
76		Reliable interpolation
77		Correlation with other station
79		Fewer than 24 values in daily aggregate
80		Accumulated
81		Wet day w/i accumulated rainfall period
82		Linear interpolation across record gap
83		Verification value
84		Could not locate site
85		Canker alert -- no site access
86		Site destroyed
87		Weeds too high to read gage
88		No access to site
89		Gage missing
90		Less than
91		Greater than
93		Unknown date
95		Estimated
96		Override
97		Surveyed
98		Below gauge or sensor
99		Value not verifiable
140		Data unchecked
149		Outside of measurable limits
150		Rating table extrapolated
151		Data missing
153		Above staff gauge
154		Out of service
200		Data to be deleted
201		Data not recorded
254		Rating table exceeded
255		No data exist

DETAIL 15

List of Computerized Programs for Data Reporting and QA/QC

TYPE	SAS PROGRAM	FUNCTION	OUTPUTS	REQUENCY	AUTOSCHEDULED
EXEC	l:\hydrodat\hydro\Ridge_Hydrographs\programs\monthly_ridge_lakes_hydrographs_v1.sas	Creates hydrograps of monthly mean Lk Wales Ridge lake levels in context of their minimum levels	Pdf file, email	Monthly	no
QAQC	c:\scadasas\program\QAQCPGM.sas	Processes SCADA data for upload to Hydstra, ftps data to ACOE, USF, TBW. Creates email of Tsala Apopka levels to news org. Manages file accumulations in several folders.	Text files, SAS files,	Daily	yes
EXEC	c:\scadasas\program\Rain_event_program_SASV9.2_v1.sas	Creates table and plot of rain totals on occasions when District rain gage totals are needed up to within an hour of report time.	Pdf file, email	as needed	no
EXEC	c:\scadasas\program\DailyHydroReport_SASV9.2_v1.sas	Creates tables of elevations for surface waters with structures, gage rainfall statistics on several time scales, and discharge of District rivers. Plots of daily rainfall, and annual river discharge.	Pdf file, email	Daily	yes
USGS	d:\gs_data\programs\DV_create_a_dataset_of_usgs_dv_data_v1.sas	Creates from scratch the USGS daily value data for all District USGS sites, and loads to Hydstra.	csv file	as needed	no
USGS	d:\gs_data\programs\WK_overlay_new_and_changed_data_to_Hydstra_v1.sas	Replaces USGS daily value data in Hydstra with any edited data flagged by USGS as changed or updated; includes new daily data values.	csv file	weekly	yes
USGS	d:\gs_data\programs\WK_run_usgsxml_v1.sas	Produces xml file for transfer of any changed USGS data to WMIS	SAS dataset, Hydstra updates	weekly	yes
USGS	d:\gs_data\programs\RT_create_a_dataset_of_hourly_usgs_data_v1.sas	loads daily realtime USGS data to Hydstra	SAS dataset, Hydstra updates	daily	yes
USGS	d:\gs_data\programs\MO_overlay_new_and_changed_data_to_Hydstra_v1.sas	loads monthly changes to USGS data (approval and value change) to SAS dataset, and then to Hydstra	SAS dataset, Hydstra updates	monthly	yes
USGS	d:\gs_data\programs\DV_lastmodified_create_a_dataset_of_usgs_dv_data_v1.sas	loads last modified data to Hydstra	SAS dataset, Hydstra updates	daily	yes
USGS	d:\gs_data\programs\RD_create_a_dataset_of_usgs_dv_data_v1.sas	loads recent daily values to Hydstra	SAS dataset, Hydstra updates	daily	yes
USGS	d:\gs_data\programs\GW_and_QW_usgs_get_and_load_to_hydstra_v1.sas	retrieves GW and QW manual USGS data to Hydstra	SAS dataset, Hydstra updates	monthly	no
HCR	l:\hydrodat\hydro\HCR_lakes\programs\HydroLakeLevels_SASV9.2_v1.sas	Hydrologic Condtions lakes levels report	pdf file, report	monthly	no
HCR	l:\hydrodat\hydro\HCR_lakes\programs\ProvisionalLakeReport_SASV9.2_v2.sas	Hydrologic Condtions lakes levels report (provisional lakes set)	pdf file, report		no
HCR	l:\hydrodat\hydro\HCR_springs\programs\load tampa bay water data.sas	Loads TBW springs data to Hydstra for HCR springs reporting	csv file	monthly	no
HCR	l:\hydrodat\hydro\HCR_springs\programs\HCR_springs_report_SASV9.2_v2.sas	Hydrologic Conditions springs report	pdf file, report	monthly	no
HCR	l:\hydrodat\hydro\HCR_streams\programs\Hydro_Report_Streamflow_SASV9.2_v1.sas	Hydrologic Conditions streamflow report	pdf file, report	monthly	no
HCR	l:\hydrodat\hydro\HCR_streams\programs\Provisional_Streamflow_Report_SASV9.2_v1.sas	Hydrologic Conditions streamflow report (provisional data)	pdf file, report	monthly	no
HCR	l:\hydrodat\hydro\HCR_streams\programs\60day_discharge_SASV9.2_v2.sas	60-day discharge for selected rivers	pdf file, report	monthly	no
HCR	l:\hydrodat\hydro\HCRrain\programs\create rainfall csv files v4.sas	produces .csv files summarizing period of record data for counties and regions	csv file	monthly	no
HCR	l:\hydrodat\hydro\HCRrain\programs\HCR_Rainfall_Report_by County_SAS9.2_v3.sas	Hydrologic Conditions rainfall report	pdf file, report	monthly	no
HCR	l:\hydrodat\hydro\HCRwells\programs\HCR_wells_by_County_SAS9.2_v2.sas	Hydrologic Conditions well levels report	pdf file, report	monthly	no

EXEC	l:\hydrodat\hydro\freeze_map\programs\Dover_Region_Freeze_Report_SASV9.2_v3.sas	produces Dover region well levels report during freeze events	pdf file, report	as needed	no
NEXRAD	l:\hydrodat\hydro\nexrad_recent\programs\batch_daily_data_from_vieux_ftp_site_SASV9.2_v1.sas	retrieves and loads daily rainfall totals for pixels in the District. 60-day period	SAS and MS Access datasets	daily	yes
NEXRAD	l:\hydrodat\hydro\nexrad_recent\programs\batch_15min_data_from_vieux_daily_xml_files.sas	saves individual daily 15-minute rainfall pixel totals to SAS datasets. 60-day period	SAS datasets	daily	yes
NEXRAD	l:\hydrodat\hydro\nexrad_recent\programs\Maintain_database_of_Vieux-reported_gage_errors.sas	Currently not used	text report	daily	yes
REG	l:\hydrodat\hydro\reg_rivers\programs\Regulatory_Rivers_Report_SASV9.2_v1.sas	produces Regulatory Rivers 8-week discharge report (4 production rivers)	pdf file, report	weekly	yes
REG	l:\hydrodat\hydro\reg_rivers\programs\7-day_Reg_Rivers_Report_SASV9.2_v2.sas	produces Regulatory Rivers 7-day discharge report	pdf file, report	weekly	yes
REG	l:\hydrodat\hydro\reg_rivers\programs\Regulatory_Rivers_Report_All_Rivers_SASV9.2_v3.sas	produces Regulatory Rivers 8-week discharge report (total 12 major rivers and streams)	pdf file, report	weekly	yes
REG	l:\hydrodat\hydro\recovery\programs\well_elevation_recovery_25th_pctl_SASV9.2_v2.sas	produces weekly aquifer recovery index report for wells in the District	text report	weekly	no
REG	l:\hydrodat\hydro\recovery\programs\make_recovery_map_SASV9.2_v1.sas	Map and symbols for individaul recovery well percentile rankings	pdf file, report	monthly	no
REG	l:\hydrodat\hydro\cume_rain\programs\6-Month Rainfall Totals Report_SASV9.2_v4.sas	cumulative 6-month rainfall totals report	pdf file, report	monthly	no
REG	l:\hydrodat\hydro\cume_rain\programs\12-Month Rainfall Totals Report_SASV9.2_v4.sas	cumulative 12-month rainfall totals report	pdf file, report	monthly	no
REG	l:\hydrodat\hydro\cume_rain\programs\24-Month Rainfall Totals Report_SASV9.2_v4.sas	cumulative 24-month rainfall totals report	pdf file, report	monthly	no
REG	l:\hydrodat\hydro\cume_rain\programs\36-Month Rainfall Totals Report_SASV9.2_v4.sas	cumulative 36-month rainfall totals report	pdf file, report	monthly	no
REG	l:\hydrodat\hydro\cume_rain\programs\48-Month Rainfall Totals Report_SASV9.2_v4.sas	cumulative 48-month rainfall totals report	pdf file, report	monthly	no
REG	l:\hydrodat\hydro\cume_rain\programs\60-Month Rainfall Totals Report_SASV9.2_v4.sas	cumulative 60-month rainfall totals report	pdf file, report	monthly	no
REG	l:\hydrodat\hydro\cume_rain\programs\1-10 year Rainfall Totals Report_SASV9.2_v4.sas	cumulative multiple year rainfall totals report	pdf file, report	monthly	no
HYDSTRA	l:\hydrodat\hydro\datareport\programs\elbus_upload.sas	uploads daily manual values from field tech Elbis laptops	csv file	daily	yes
QAQC	l:\hydrodat\hydro\datareport\programs\tech_site_completions_report_runs_from_elbusdata.sas	reports sample completion progress for manual sites by technician	pdf or text file report	daily	yes
HYDSTRA	h:\programs\Prepare_and_load_campbell_data_to_svrimp.sas	uploads Campbell data files to Hydstra	csv file	daily	yes
HYDSTRA	h:\programs\xml_filer\run_wknd_archxml_v2.sas	produces the .xml file of Hydstra archive file data for upload to WMIS	xml file	weekly	yes
HYDSTRA	h:\programs\xml_filer\run_weekly_commout_v3.sas	produces file of all comments for updating WMIS hydrologic data	csv file	weekly	yes
HYDSTRA	h:\programs\xml_filer\run_daily_tfilexml.sas	produces the .xml file of Hydstra t-file (provisional) data for upload to WMIS	xml file	daily	yes
REG	d:\event_intensity\programs\event rainfall comparator runs from scada data.sas (SCADA DATA)	compares rain event totals for varying periods to duration-frequency tables	pdf file, report	as needed	no
REG	d:\event_intensity\programs\event rainfall comparator runs from hydstra data.sas (HYDSTRA DATA)	compares rain event totals for varying periods to duration-frequency tables	pdf file, report	as needed	no
REG	d:\event_intensity\programs\event rainfall comparator runs from nexrad data.sas (NEXRAD DATA)	compares rain event totals for varying periods to duration-frequency tables	pdf file, report	as needed	no