SECOORA
SOUTHEAST
COASTAL OCEAN OBSERVING
REGIONAL ASSOCIATION

SOUTHEAST WATER LEVEL NETWORK
STANDARD OPERATING PROCEDURES

Water Level Site Reconnaissance - Desktop and Field Procedures

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A. Introduction

The Southeast Coastal Ocean Observing Regional Association (SECOORA) works with partners in the four southeast U.S. states, North Carolina, South Carolina, Georgia, and Florida, to help meet ocean and coastal observing needs. SECOORA is collaborating with project team members, communities, and regional Sea Grant offices to install and operate low-cost, long term water level monitoring sensors throughout the southeast. Water level sensors are a stand alone system that collect, store, and transmit water level data (NOAA 2012).

This document outlines the standard operating procedures (SOPs) for identifying sites for water level sensor installation through desktop and field reconnaissance. The primary objective for the desktop and field reconnaissance is to determine the optimal location for water level sensors. For the installation of water level sensors, the scouting of locations should include identification of appropriate infrastructure for sensor installation as well as recovery of historic benchmarks and scouting locations for setting new benchmarks (NOAA 2012). The reconnaissance measures should be undertaken sufficiently far in advance of site preparation to:

- Locate an acceptable site
- Obtain measurements and information necessary to design the station
- Arrange for any permits/license agreements required
- Test communications modems
- Prepare a cost estimate and work schedule
- Allow time for the procurement and fabrication of special support components (if necessary).

When conducting on-site reconnaissance, property owners (e.g., home owners, business owners, marinas) should be contacted in advance to obtain oral or written permission to access the property. Team members should also meet with the property owner as soon as the site is visited. An advance letter of permission, permit, security clearance, or some other written instrument may be required in some situations. Even if the site already has scientific instrumentation installed, some advance notice may be required or appreciated by the owner (NOAA 2012).

Once the desktop and field reconnaissance information is collected the project team can fully evaluate the site for water level installation, design the sensor mounting bracket, and complete a cost estimate and finalize the installation schedule.

This SOP has a companion document, SECOORA SOP for Acquiring Vertical Elevation for Water Level Sensors, that provides the minimum requirements for surveying sensors and benchmarks in order to determine vertical elevations. This document should be reviewed prior to on-site reconnaissance as it provides information on benchmark identification, a field survey sheet, and considerations for mounting sensors.

B. Types of Water Level Sensors

The primary requirement of a water level sensor is to accurately measure water level information with low power consumption, high reliability, and defined accuracy. The typical station includes a weather resistant, ultrasonic sensor that is compact and housed within a PVC housing. These sensors are designed to report the distance from the sensor face to the surface of the water. The sensors take water level measurements at a minimum rate of 1 Hz (i.e. 1 samples per second) and

transmit averaged water level data every 5-6 minutes. Transmission frequency is dependent on the team operating the sensor.

The water level sensor communication systems vary depending on the location in which the sensor is deployed. Wireless communications can be used in locations where municipal wifi or access to paid wifi is available. Cellular communications work in many locations; however, cellular service can become expensive as more sites are installed. Finally, Long Range Wide Area Networks (LoRaWAN), such as installed in coastal Georgia, can be a communications option.

C. Desktop Reconnaissance

Prior to field reconnaissance, water level team members should conduct a desktop review of the sites to gain an understanding of the area where the sensor may be located.

Pre-Field evaluation

1. Use Google maps or GIS to review the area of interest. Specifically look for infrastructure in flood prone areas to determine if there is potential for mounting a water level sensor on an existing structure. Example infrastructure includes bridges, pilings, docks, etc.
2. You can also review the NOAA subordinate sites to determine if there is a subordinate tide prediction location nearby as this may be a useful place to install a station. The water level data from the station can be compared to the NOAA predictions. To find subordinate locations, you can use the NOAA Tide Predictions website or map interface.
3. Use the Environmental Response Management Application (ERMA) to determine if the proposed location/area for the sensor is within National Historic Register site boundaries. Locations that are within a National Historic Register area should be avoided as permitting and National Environmental Policy Act (NEPA) constraints make installation of sensors within these areas difficult.
4. For potential water level sensor installation sites, identify benchmarks (BMs) in the vicinity of the proposed site. There are several online sites that provide BM information. Your team should review these prior to field reconnaissance to help you identify BMs near the area of interest.
    a. NOAA Geodetic Survey (NGS) Map: https://noaa.maps.arcgis.com/apps/webappviewer/index.html?id=190385f9aadb4cf1b0dd8759893032db
    b. NOAA CO-OPS Map: http://tidesandcurrents.noaa.gov/stations.html?type=Bench+Mark+Data+Sheets
5. When looking online, determine if there is at least one (1) established BM surveyed to NAVD88 near the area of interest. Ideally the location will have 3 BMs surveyed to NAVD88; however, one is sufficient. Two additional BMs that are not to NAVD88 standards can be recovered or two can be installed by the survey team so that a total of 3 BMs are available for each site.
6. BMs should be 60 meters (m) to 1 kilometer (km) from the potential sensor mounting location, with at least 60 m separation between BMs. The team will need to survey the sensor (once installed) and the BMs in order to obtain vertical elevations.
7. Using the NGS map, CO-OPS map (links 4 a and b above) or state DOT websites, list the address or GPS coordinates of the benchmarks, or zoom to your area of interest. The CO-OPS map identifies locations by state and BMs near existing CO-OPS sites (harmonic and

subordinate) are identified. The NGS map provides more detailed datasheets for BMs and the CO-OPS website.

a. Depending on which mapping tool you use, existing BMs will be identified on the map as circles, triangles, or pins. Select the benchmarks near your area of interest to review the datasheet for the benchmark. The datasheet will provide you with details about the benchmark (elevation, BM description, how to locate it in the field) so that you can recover the BM while in the field.
b. At least one of the 3 BMs should be an existing mark with a NAVD88 tie, such as a state Geodetic Survey, Department of Transportation (DOT) or NOAA National Geodetic Survey (NGS) BMs.
c. Try to avoid using BMs on the same structure as the location for the water level sensor (e.g., pier, bulkhead, etc.), to better ensure independence between the sensor and BM. This also helps to minimize the chance of disturbance or loss of multiple marks over the same time (e.g., if a road was re-paved or a bulkhead damaged).
d. Print the BM datasheet so that you can take it to the field with you as the location details can be found in the Station Description to help recover the BM.
    i. An example NGS datasheet for a BM found near Fort Pulaski, GA is found here: https://www.ngs.noaa.gov/cgi-bin/ds_mark.prl?PidBox=CK3760
    ii. An example CO-OPS datasheet for a BM near Fort Pulaski, GA is found below the map on this page: https://tidesandcurrents.noaa.gov/benchmarks.html?id=8670870&type=BenchMarkSheets
e. If 3 BMs are not available, you will need to use google maps or field reconnaissance to determine location(s) for establishing a new BM if the area of interest is chosen for installation of a water level sensor. The technical details for establishing a new benchmark is beyond the scope of this document.

8. It is also recommended to review flood maps which document projected storm surge elevation for the area. This will help you identify the height above water that the water level sensor should be mounted. These elevations can be found by referencing Flood Information Rate Maps of the area: https://msc.fema.gov/portal/search.

D. Field Reconnaissance

Field reconnaissance is a vital step in planning for the successful installation of water level sensors. The result of the field reconnaissance should be the creation of a field reconnaissance summary and design recommendations for the installation of the water level sensor. The summary must include information which aids in furthering design efforts such as: recovered BMs, sketches and measurements of the proposed sites and existing facilities, and structural information. Photographs, existing drawings, local contact information and other
relevant data should be included in the summary as well (NOAA 2015).

Site Visit Planning

Based on the results of the desktop reconnaissance, schedule time to visit area(s) of interest with at least one other project team member. It is often advantageous to arrange reconnaissance trips when also scheduling maintenance trips for other nearby stations, though this is not always feasible. Planning activities include:

- Schedule the site visit based on the property owner or other representative availability.

- Obtain verbal or written permission to access the area of interest, if needed.
- Create maps or print screen grabs from desktop reconnaissance so that you can more easily find the potential location(s) for the sensor and BMs once in the field. Make sure that the maps also include any geologic features of reference to help with site selection. If needed, mark flood boundaries on the map or note flood elevations.
- Print BM datasheets so that you can find them once in the field. If there are photos of BMs within the datasheet, print those as well.
- Research potential communications methods for the area of interest (cellular, local wireless connection).
- Make a packing list of all the items you should take to the field for the field reconnaissance and have them ready to go for the scheduled visit. Take a sensor mounting frame with you to assure that the locations you are evaluating will support, or can be modified to support, the water level sensor, solar panel, etc. Take a field notebook to sketch the site and a Field Reconnaissance form to record details about the site. The linked Field Reconnaissance form is an example and can be tailored for individual use.
- A basic list of field items is provided in the SECOORA SOP for Acquiring Vertical Elevation of Water Level Sensors (pages 1-2) and they include:
    - RTK/RTN with dual frequency GNSS receiver/antenna on a tripod that can connect into the real-time network and is properly aligned to the national spatial reference system (NSRS)
        - Make sure your RTK/RTN has antenna calibration is available through NOAA National Geodetic Survey. Look up the brand and model of your RTK/RTN here: https://www.ngs.noaa.gov/ANTCAL/
        - RTK/RTN must be able to output data in GNSS Vector Exchange file format (e.g., .gvx format https://geodesy.noaa.gov/data/formats/GVX/index.shtml).
    - Camera or phone with a camera
    - List of benchmarks with known coordinates or addresses and photos so they can be found once in the field
    - Pen/pencil
    - Yellow or orange paint to mark new benchmarks if they have to be added
    - Two carpenters levels (12 in and 3 ft)
    - Sharpie or other marker
- Review the Survey and Taping Guide prior to field reconnaissance. This guideline provides considerations for sensor installation to help minimize the amount of error when determining vertical elevations.

Site Visit

The steps, as described in NOAA 2015, for a field reconnaissance trip to assess potential locations for water level sensor deployment are:

- Meet with local contact and/or facility representative to discuss project scope, facility impacts, permissions, schedule, unique site safety, security, and environmental compliance/impact concerns, historical wind, storm surge flood, storm water runoff, and inundation observations/elevations that have impacted the area or the facility's operation and structural design, etc. Discuss other logistic concerns such as access times or concerns (seasonal or daily), other facility uses that may impact data quality or data communications, site safety and security concerns, utilities logistics, and other restrictions the owner/representative may have.
    - If the person you are meeting with does not have the authority to approve the installation of the water level sensor, then you will need to request the contact details

for that person and receive approval prior to installation if the site is deemed acceptable.

- Determine strength of cell phone or wireless signal at the potential location. Poor cellular service or wireless strength may be cause to not use the proposed site. If you have an IP modem kit, use the IP Modem Kit to measure the cellular signal strength. Connect the IP Modem Kit to your laptop or other type of IP interface to determine signal strength. Perform this for each service provider IP Modem in the kit.
- Check with the facility representative to determine if any nearby radio frequency (RF) may potentially interfere with wireless communications. If so, note type of operations, and if possible, the RF band/frequency range and frequency (how often) the interference may occur (i.e., intermittent, twice daily, etc.).
- Evaluate the site at high tide and low tide for tidally influenced locations to help identify appropriate sensor mounting height and assure there is water below the sensor on low tide.
- The sensor mounting location should have open, southern exposure so that the sensor can be surveyed.
- Check for potential shading issues for solar panels at the proposed location. Identify a source of power, if feasible, when solar panels are not an option.
- Photograph all potential installation locations and the surrounding area. Photographically document every part of the recon location that can be seen, including from a distance, to document the recon location in relation to open water.
- Collect all measurements of support structures, surroundings, and the nearby water column that will be required to complete a station design.
- Using a field notebook and Field Reconnaissance form (example Word version), sketch the existing supporting infrastructure for each potential installation location and take any measurements required for sensor mounting designs. When collecting measurements to support the site design effort, take into consideration the structural components (e.g., metal, wood, PVC), footprints, and structural stability required for the sensors and support equipment to be installed.
    - Collect measurements of facility structures, surroundings, and the nearby water column that will be required to complete a station design. Describe the structural components of the facility which could impact the sensor's performance or how the equipment will be fastened to the facility structure. Non-critical objects such as cleats or existing conduit typically do not need to be measured in detail unless they present an obstruction to installation, however their general location(s) and size(s) should be measured and photographed.
    - Measurements and information needs for Pier/Dock structures as water level sensor mounting sites include:
        - Pier width and length
        - Size, material, condition, and location of deck boards and pilings
        - Cross bracing location, size, condition
        - Spacing of pilings on other structural features that could impact sensor performance
        - Existence of wave barriers and rough estimate of the location of the barrier
        - Size of the railings and other vertical structures.
    - Measurements and information needs for Concrete Pier and Bulkhead structures as water level sensor mounting sites include:
        - Bulkhead width and length

        - Location of bollards, cranes, rail, davits or any other components in proximity of proposed location which could impact the sensor mounting design
        - Number and size of any pilings that line the offshore end of the bulkhead in proximity of proposed location (if applicable)
        - Note size of railings and other vertical (potential mounting support) structures
        - Measure to any other infrastructure which might be a part of the proposed installation design (i.e., bracket anchor point, leveling point, etc.)
        - Note any exposed rebar or cracking concrete
    - Clamp a mounting device to the structure at the potential water level location. Use the RTK and see if you have enough clearance to set up the RTK and reach the leveling point on the mounting device. The goal is to be able to survey directly to the sensor or sensor mounting device to obtain the vertical elevation.
        - See the SECOORA Survey and Taping Guide for sensor mounting considerations.
    - Use the handheld GPS to acquire the latitude and longitude of the proposed location. Record the position in the field notebook in degrees, minutes and seconds, precise to the tenth of a second (DD MM SS.s) or in decimal degrees, precise to five decimal places (DD.ddddd)
- From the deck level of the potential structure where the sensor will be mounted, measure to the water's surface. Include the measurement in the field notebook and note the date, time to the nearest minute, and time zone used (i.e., UTC, EDT, PST, etc.). This information is used to determine the height of the structure with respect to tidal datums. When considering flood potential, height above water, etc., the team can make a more informed decision on the best part of the structure to mount the water level sensor.
    - It is good to view the site during high tide and low tide to evaluate the water level at minimum and maximum ranges.
    - Does the potential mounting site have water below it during low tide?
    - How high will the sensor need to be mounted to appropriately record the water level at high tide?
- Review the measurements on site and ensure the preferred location meets the minimum sensor siting criteria. If the measurements are close or do not meet the minimum sensor siting criteria, collect measurements at alternate location(s).
- Search for existing BMs and potential BM(s) locations if three (3) existing BMs are not available.
    - Using historic BM data and the BM datasheets printed during the desktop recon, find as many marks as possible within a 1 km radius from the proposed site.
    - Take digital photos of the BMs. Be sure to include some of the surrounding area in the photos so that you can find the BMs in the future.
- Make notes about safety and ease of access for operations and maintenance to keep future recurring costs minimal. Do not place sensors in locations that are unsafe for survey crews, students, etc. access.
- While on site, discuss the latest plans for the facility including future improvements and construction schedules with the facility representative. Understanding the facility's plans for the site will ensure resources are invested in as responsible and sustainable a way as possible. To ensure the viability of the design alternatives and recommendations, provide them to the facility representative for concurrence before moving forward with design efforts.

Logistics Information

While not critical for water level sensor site reconnaissance, collecting logistics information can be critical to efficient installation execution. Some examples of critical logistics information include but are not limited to:

- Methods of personnel transportation to the site (e.g., car, boat)
- Shipping methods and points of contact for them, known and preferred (from local contacts)
- Lodging options
- Location of hardware stores or other locations to obtain supplies locally
- Contact information for renting a small boat (if needed)
- Local or nearest EMS, hospital

E. Written summary of the field reconnaissance

A brief (4-6 paragraphs) summary detailing the field reconnaissance should be written once the team returns to the office. The synopsis should include:

- Completed Field Reconnaissance form (example form found here: https://secoora.org/wp-content/uploads/2023/05/Example-Field-Reconnaissance-Form_2023-05-03.docx)
- Scanned copies or images of the field notes, location sketches, and measurements
- Photos and video taken during the field reconnaissance
- Summary of discussion with the facility representative
- Any additional site specific considerations learned during the reconnaissance that could impact sensor mounting
- Determination if the site is suitable for water level sensor installation

F. References

NOAA 2012: Sevary, B.L., CO-OPS Water Level and Meteorological Site Reconnaissance Procedures. Updated February 2012.

NOAA 2015: Sevary, B.L., Field Reconnaissance Procedure for Observing System Installation and Planning. Updated September 2020.