CO-OPS Water Level and Meteorological Site Reconnaissance Procedures

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1. Introduction

The National Ocean Service (NOS), Center for Operational Oceanographic Products and Services (CO-OPS), operates a number of short and long term monitoring systems. CO-OPS provides the infrastructure, science, and technical expertise to monitor, assess, and disseminate coastal oceanographic and Great Lakes products and services necessary to support NOS missions of environmental stewardship, assessment, and prediction; safe navigation; and hazard mitigation.

In order to support the NOS and CO-OPS missions, new water level and met stations are regularly required. The best method for assembling the information needed to install these stations is a reconnaissance. The primary objective of the reconnaissance is to determine the optimal location and configuration for data collection platforms (DCP), antennas, sensors, and support components. For a water level station, recovering historic bench marks and scouting locations for setting new bench marks is also essential. The reconnaissance consists of personnel visiting the site 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.
- Arrange for utilities.
- Prepare a cost estimate and work schedule.
- Allow time for the procurement and fabrication of special support components (if necessary).

If possible, property owners should be contacted in advance to obtain oral or written permission to use or modify the site, otherwise, meet with the property owner as soon as site is visited. An advance letter of permission, permit, security clearance, or some other written instrument may be required by the owner. A license agreement may have to be executed before any work can be done. Even if the site is an existing NWLON station, some advance notice may be required or appreciated by the owner.

Accurate measurements and information is best obtained onsite. The locale can be investigated to determine which particular site will best accommodate the preliminary design and all the other site requirements. Any special installation requirements, such as explosion proof conduit on fuel piers, can also be determined through discussions with local authorities.

Once the reconnaissance information is collected and a report issued, the design is finalized, and a cost estimate and installation schedule can be determined.

2. Background

NOS is a Federal agency devoted to exploring, understanding, conserving, and restoring the Nation's coasts and oceans. NOS promotes safe navigation, supports coastal communities, sustains coastal habitats, and mitigates coastal hazards. NOS balances environmental protection with economic prosperity and leads the effort to ensure that our Nation's coastal areas remain safe, healthy and productive.

CO-OPS establishes standards for the acquisition and processing of water level and current data; collects and documents user requirements that serve as the foundation for all resulting program activities; designs new and/or improved oceanographic observing systems; develops software to improve data processing capabilities; maintains and operates oceanographic observing systems; performs operational data analysis/quality control; produces/disseminates oceanographic products; and archives the resulting oceanographic data.

A water level station is a stand alone system that collects, stores, and transmits water level, meteorological, and other environmental data. The primary requirement of a station is to accurately measure water level information with low power consumption, high reliability, and defined accuracy. The typical station includes an air acoustic water level sensor with protective well, single or dual orifice Paroscientific pressure sensors, or a shaft angle encoder in a sump (Great Lakes); a redundant pressure-based water level sensor; and a data collection platform with Geostationary Operational Environmental Satellite (GOES) transmitter, rechargeable battery, and solar panel. Many stations also include sensors that measure air and water temperature, wind speed and direction, barometric pressure, relative humidity and conductivity. A meteorological (Met) only station is a stand alone system that collects, stores, and transmits meteorological data.

3. Types of Stations

There are several types of stations that CO-OPS maintains. They are:

- Basic Water Level Station
    - Support structure (pier, platform, wharf, etc.).
    - DCP
    - DCP enclosure
    - Water level sensor (acoustic or pressure)
    - Protective well (for acoustic sensor)
    - Protective well brackets
    - Solar Panel
    - GOES antenna
    - Bench mark network (minimum of five marks)
- NWLON Station
    - Basic water level station with acoustic water level sensor
    - Multiple DCPs
    - Redundant pressure water level sensor
    - Bench mark network of ten marks
    - Additional solar panels
    - Barometer

    - Wind sensor
    - Tower or pole for mounting wind sensor
    - Air temperature sensor
    - Water temperature sensor
    - Relative Humidity
    - Utilities (phone and electric)
- PORTS Water Level Station
    - NWLON Station
    - Conductivity
    - Line of sight radio
    - IP modem
- Met Station
    - DCP
    - DCP enclosure
    - Barometer
    - Wind sensor
    - Tower or pole for mounting wind sensor
    - Air temperature sensor
    - Solar Panel
    - GOES antenna
    - Line of sight radio (for PORTS)
    - IP modem (for PORTS)

4. Equipment Needed

The following equipment, forms, and information is needed to perform a complete reconnaissance:

- Digital Camera/Videotape Recorder
- Published Bench Mark Sheet
- NGS Datasheets for area
- Shovel/digging implement
- Metal detector
- Sample License Agreement/Letter of Permission
- Weighted tape for soundings
- Engineering sketch pad
- Inclinometer
- Carpenters level or plumb bob
- Hand-held GPS
- Compass
- IP Modem Kit which consists of a Verizon IP Modem, AT&T IP Modem, Small Battery, and an Antenna
- Chart section
- NGWLMS Well/Sounding Tube Worksheet
- Site Reconnaissance Field Notes form (Appendix A)
- Meteorological Reconnaissance Form (Appendix B)

5. Office Information

After a general site has been selected for the installation of a water level or met station, the first step is to gather all relevant information. In many cases, the site is an existing or historic water level station, and office files can be consulted for much of the information. To find out if an historic water level station exists, consult the Index of Water Level Stations at http://www.co-ops.nos.noaa.gov/station_index_map.shtml Program requirements may also provide some direction.

If there is a historical site, assemble as much of the following information as possible:

- Tidal datums and bench mark elevations.
- To Reach statement and bench mark recovery notes.
- NGS Datasheets based on point radius.
- Support structure and harbor bottom elevations.
- Support structure plan and sun transit.
- Environmental data.
- Instrument shelter and utilities description.
- GOES transmission information (azimuth and elevation).
- Solar incidence.
- Ancillary sensor(s) requirements.

Tidal datums are required to determine the length and elevation of the protective well. Observed highest/lowest water levels shall be used at long term control stations. Estimated highest/lowest water levels shall be used at short term stations. These estimated values can be determined using a tidal prediction program such as Tides & Currents. Ensure that the tidal datums are based on the National Tidal Datum Epoch (1983-2001). To Reach statements and bench mark recovery notes are needed to find the historic site and recover as many historic bench marks as possible. This information can be found on the CO-OPS published bench mark sheet web page at:
http://tidesandcurrents.noaa.gov/station_retrieve.shtml?type=Bench+Mark+Data+Sheets

Datasheets retrieved from the NGS web site are essential for replacing destroyed historic marks and for providing a connection to the North American Vertical Datum of 1988 (NAVD88). The web site is http://www.ngs.noaa.gov/cgi-bin/datasheet.prl

Support structure and harbor bottom elevations are required as they may impose physical constraints on the protective well and backup sensor mounting assembly elevations and lengths. These elevations typically have been documented for existing NWLON stations and can be determined at historic sites through levels to the bench mark network.

Information on the support structure's orientation and the path of the sun's transit is critical for locating a thermally acceptable site for the protective well.

Descriptions of the instrument shelter and utilities are typically available for NWLON sites and can be used to determine if adequate space and utilities exist for the DCP units.

The GOES satellite antenna azimuth and elevation angles are required to select an antenna site free of obstructions that may interfere with the transmission. GOES satellite azimuths are referenced in true degrees. If a compass is used to position the antenna, the local magnetic declination must be applied.

Solar incidence is needed to provide the proper orientation and elevation of the solar panel to provide maximum charging voltage.

Requirements for ancillary sensors should be determined in advance to allow adequate lead time for site preparation configuration and installation.

Site specific environmental data, particularly on wave climate, is important. Wave data are used in determining well length and elevation. Other types of environmental data may also be useful for design or validation processes.

Once a general location has been selected, use nautical charts, quad maps, and aerial photographs to search for likely structures

6. Site Visit

After compiling all information possible in the office, it is time to visit the site. Upon arrival at the general location, proceed to the site determined from the office documents. Seek out the owner or owner's representative of the structure most likely for the installation, introduce yourself and explain your purpose. Ask permission to make measurements and determine which method the owner wishes to use to grant permission for CO-OPS to install equipment on the owner's property. Use the Site Reconnaissance Field Notes form in Appendix A to record all information.

Even if the site is an existing NWLON station, some advance notice for maintenance or inspection may be required or appreciated by the owner. A statement involving partnerships with the NOAA National Weather Service (NWS) and others should be included in that communication. For example, if NWS has special requirements or needs with the meteorological sensors at a particular site, CO-OPS needs to give the nearest Weather Forecasting Office (WFO) advance notice of the reconnaissance so that they can consider having a representative on site to provide input on proper placement for winds. For NWLON stations, this placement will be subject to funding availability, as typically the winds will be co-located with the NWLON station.

To obtain data representative of a station's surroundings, local conditions must not be artificially influenced by surrounding materials and/or obstructions (e.g., concrete, buildings, snow, etc). The sensor exposure will strive to minimize or eliminate the effects of manmade or geographical

obstructions. Sensors should not be located near cultivated land to reduce contamination by dust and dirt. Note that the primary stakeholder (e.g. a PORTS partner) for this installation sets the requirements and these requirements must be followed even if they conflict with WFO needs, or even if the resulting location will not provide data representative of the general area. The stakeholder must be informed of any localized effects on the measurements based on their siting requirements.

Following receipt of owner permission, perform the following measurements at the structure:

- Pier/Bulkhead surface above harbor bottom
- Pier/Bulkhead surface above water surface
- Time of Pier/Bulkhead to water surface measurement
- Piling diameter
- Pier stringer size and separation
- Pier deck width
- IP Modem signal strength. Connect the IP Modem Kit to your laptop or a loopback, then contact the instrument lab and let them communicate to the modem and determine signal strength. Perform this for each service provider IP Modem in the kit. Record the service provider and the respective signal strength.
- GPS latitude/longitude of station & bench mark locations. Record position to the tenth of a second.

Record contact information for the following individuals:

- Facility owner
- Local contact – the person who must be notified whenever the station is visited.

Make the following observations:

- For wind sensor installations, choose an area free of obstructions that affect the path of the wind. If this is not possible, note the obstruction in the attached sensor obstruction diagram. Verify positioning with any associated partnership representatives.
    - If a sensor is near an obstruction and there are no other site alternatives, then ensure that there are no obstructions in the direction of the prevailing wind. Contact DMAT to determine the prevailing wind direction for that site.
- IP Modem signal strength. Connect the IP Modem Kit to your laptop or a loopback, then contact the instrument lab and let them communicate to the modem and determine signal strength. Perform this for each service provider IP Modem in the kit. Record the service provider and the respective signal strength.
- GPS latitude/longitude of station & bench mark locations. Record position to the tenth of a second.
- Take digital photographs of the proposed DCP/sensor location and benchmarks.

Also take digital photographs of the following:

- Proposed location of protective well
- Recovered bench marks
    - Bench mark faces

    - At least two distance photos from different directions showing landmarks in the background.
- Locations for new marks

6.1 Meteorological Sensor Siting Requirements:

Wind

- The standard mounting elevation is 9 - 10 m (30 - 33 ft) above the ground in open, level terrain. Small gradual slopes are acceptable. If local restrictions prevent installing the sensors at the 10 m (33-ft) standard, install them no less than 6 m (20 ft) above the ground.
- A horizontal distance of ten times the height of an obstruction should be maintained, between the wind sensor and the obstruction, for the surrounding area to be considered open terrain. An obstruction can be manmade (building) or natural (tree).
- If the sensor is to be mounted on the roof of a building, it should be mounted at a height of 6 m (20 ft) above the highest structure. This is to remove the sensor from the area in which the air flow is affected by the building. For tall buildings where this guideline cannot be met, a 3 to 5 m (10 to 15 ft) mast should be mounted on the side of the building with the prevailing wind.
    - If the 6-m guideline cannot be met then the sensor should be mounted 1.5 times the building height above ground. E.g. if the building height is 15 ft above the ground then the sensor should be 23 ft above ground (8 ft above the building roof), though higher elevation, if possible, is preferable.
- If the sensor is to be mounted on a tower, the sensor should be above the tower or on a boom. The boom should be twice as long as the maximum diameter or diagonal of the tower, and should be directed into the prevailing wind.

Air Temperature/Relative Humidity

- Standard mounting elevation is 1.2 to 2.0 m (4.0 to 6.5 ft) above grade.
- The sensor should be mounted over a plot of open level ground at least 9 m (30 ft) in diameter. The ground beneath the sensor should be short grass or natural earth, not asphalt, concrete, areas of standing water, etc.
- The distance between the sensor and any obstruction should be at least 4 times the height of the obstruction (40 m for a 10-m obstruction). It should be at least 30 m (100 ft) from large paved areas and not close to steep slopes.
- If mounted on a tower, the sensor should be on a tower boom at least as long as the tower diameter.
- Temperature sensors should have downward facing aspirated shields.
    - Try to avoid mounting on a rooftop, but if there is no other location then mount at least 1.5 times the height of the building. E.g. if the building height is 15 ft above the pier then the sensor should mounted 23 ft above ground (~8 ft above the building roof), though higher elevation, if possible, is preferable.

Barometer

Site selection is not required for the sensor as it is mounted inside the unit and vented to the outside.

Visibility

The sensor location is vital because the visibility sensor measures a small sample volume between the transmitter and receiver heads, and thus only represents the visibility at a single location. Therefore, a site survey via discussions with the local Port Authority and/or Weather Forecast Office personnel is crucial in order to make an informed siting decision.

- Standard mounting elevation is 2.5 – 3.5 m (8 – 11.5 ft) above ground (3 m is preferred).
- The sensor should be a minimum of 100 m from any large buildings or constructions that radiate heat and/or obstruct precipitation droplets. Avoid trees, which can cause changes in the microclimate.
- Avoid obstacles in line-of-sight of the transmitter and receiver units. For a 2.5- m pole, a radius of approximately 9 m should be free of obstacles.
- The sensor should be as far as possible from strobe lights and other modulated light sources. (The FS11 sensor can be mounted over water, according to the manufacturer).
- Do not locate in an area that is subject to localized obstructions to vision, such as smoke or soot.
- Mount on a platform as free as possible from jarring and vibration.
- Point the receiver in a northerly direction.

Water Temperature

- For a location that has an acoustic sensor installed, the thermistor should be sited inside the well and attached to the end of the sounding tube. For a location that has a pressure or ParoScientific sensor installed, the thermistor should be installed close to the depth of the bubbler orifice. For the Great Lakes, install at a standard depth of 1.5 m (5 ft) below LWD.
- For water temperatures at a station to represent most the thermal patterns, the sensor should be sited in a central location where there is sufficient flow and water is not stagnant.
- Do not place water temperature sensor in direct sunlight as it may cause the sensor to register high.
- Be aware of nearby drainage or other types of manmade discharge that may impact water temperature.

7. Documentation

Submit the following documentation upon completion of the reconnaissance:

- Site Reconnaissance Field Notes
- Bench Mark recovery notes
- All digital photos of bench marks, proposed DCP & well locations, and proposed bench mark installation locations if insufficient marks recovered.

- Site view drawing showing proposed DCP location(s); proposed protective well locations; North directional arrow; recovered bench marks; proposed bench mark install location(s); and solar incidence at protective well location(s).
- Meteorological Sensor Reconnaissance and Sensor Obstruction forms and submit to the Operational Engineering Team of the Engineering Division, and to the Federal Engineering Review Subcommittee (FERS) for review.

Appendix A – Site Reconnaissance Field Note

National Oceanic and Atmospheric Administration
National Ocean Service
Center for Operational Oceanographic Products and Services

Site Reconnaissance Field Notes

GENERAL SITE INFORMATION			
Station Number	**Station Name**	**Date**	
Project Name	**Station Type**		**Permanent; Temporary; NWLON; Navigation; Hydro; COASTAL; Other**
Site Name	**Site Location** **City** **County** **State** **Zip code**		
How To Reach			
Property Owner: **Address:** **Phone:** **Cell Phone:** **Fax:**	**Local Contact:** **Address:** **Phone:** **Cell Phone:** **Fax:**		
Communications or Agreements Made To Date			**Contact dates?** **Letter, phone or meeting?** **Details of Discussion?** **Follow-up needed?** **MOU or permits needed?**

SITE DESCRIPTION		GEOGRAPHIC/OCEANIC DESCRIPTION	
Facility	**Public; Private; Government; Industrial; Commercial; Residential** **Accessibility**	**Geographic & Hydraulic Features**	**Open Coast; Sheltered Harbor; Bay; Sound; Marsh** **Tide Range; Wave Height; Currents**
Support Structure	**Bulkhead; Pier; Pilings; Other** **Wood; Concrete; Steel** **Measurements & Sizes** **Additional Bracing Necessary?**	**Shoreline/Bottom Characteristics**	**Sand; Sediment; Gravel; Stone; Rocks; Bedrock** **Bottom Slope** **Shifting Shoals? Erosion? Scouring?**
Structure Height **Above Bottom =** **Above Water Surface =** **Time of Measurement =** **Water Depth**		**Marine Growth**	**Light; Heavy; Kelp; Weeds; Barnacles; Mussels**
		Proposed Sensor & DCP Locations	

INSTRUMENTATION	SUPPORT STRUCTURES
Data Collection Platform To Be Installed	**Type Of Shelter To Be Used**
Sensor(s) To Be Installed	**Type & Length Of Well**
	Clamps Required

TOOLS/SUPPLIES	
Special Tools or Equipment Required	**Boat** **Jet Pump** **Pneumatics** **Hydraulics** **Generator** **Welder** **Diving**
Supply List	**Lumber** **Hardware** **Pipes**
Nearby Supplies/Services	

VERTICAL CONTROL/BENCHMARKS	
Level Procedures to be Performed	**2nd Order, Class 1** **3rd Order, Class 1** **Other**
Bench Marks (Designation/Stamping/Mark Type/Setting/Stability Code/Handheld GPS)	**# Recovered** **# to be Installed** **Estimated length of run** **Quality of Bench Marks** **Static GPS Suitability**

SERVICES/UTILITIES	
Telephone Requirements	**# of lines required** **Origination Point** **Length of run** **Overhead/trench** **Estimated cost** **Type of cable** **Type of conduit**
Telephone Company Info	**Name** **Number** **Mail Address** **Contact**
IP Modem	**Service Provider** **Signal Strength**
Electrical Requirements	**# of lines required** **Origination Point** **Length of run** **Overhead/trench** **Estimated cost** **Type of cable** **Type of conduit**
Electrical Contractor Info	**Name** **Number** **Mail Address** **Contact**
Other Contractors Info	**Marine** **Concrete** **Diving** **Welding** **Price quotes received**
Additional Information	

Appendix B – Meteorological Reconnaissance Form

This form may be found in ROS Step 3 under Section 3.1.1 as

3.1.1.2 CO-OPS Meteorological Reconnaissance Form (FL)

or in the Field Reference Library as filename

3.1.1.2_CO-OPS_Meteorological_Reconnaissance_Form.pdf