Standing Project Instructions
For Coastal and Great Lakes Water Level Stations

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

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1 INTRODUCTION

The National Oceanic & Atmospheric Administration (NOAA) is a bureau of the U.S. Department of Commerce (DOC). The NOAA mission is to understand and predict changes in the Earth's environment and conserve and manage coastal and marine resources to meet our Nation's economic, social, and environmental needs. NOAA's vision in supporting this mission is that of an informed society that uses a comprehensive understanding of the role of the oceans, coasts, and atmosphere in the global ecosystem to make the best social and economic decisions.

The Center for Operational Oceanographic Products and Services (CO-OPS) of the National Ocean Service (NOS) is an organizational element of NOAA. CO-OPS operates and maintains a network of 210 long-term water level measurement stations as part of the National Water Level Observation Network (NWLON) around the coastal United States and the Great Lakes. The NWLON supports the following four NOAA Mission Goals:

- Healthy Oceans
- Climate Adaptation and Mitigation
- Weather Ready Nation
- Resilient Coastal Communities and Economies

CO-OPS also installs and operates short-term water level stations in support of programs such as:

- Hydrographic and Photogrammetric Surveys
- Marine Boundary Determinations
- Treaty Regulation
- Harbor Dredging
- Climate Change
- Long-Term Sea Level Rise
- Habitat Restoration
- Real Time Navigation
- NOS VDatum Program

The data collected and the products derived from these water level stations are used to:

- Ensure safe, efficient, and environmentally sound maritime commerce.
- Provide data and products required by the National Weather Service to meet storm surge flood and tsunami warning responsibilities.
- Enhance navigation through a national network of Physical Oceanographic Real-Time Systems (PORTS®) in major U.S. harbors.

PORTS® is a partnering effort based on the collaboration between NOS and local maritime communities to identify and satisfy user needs for improving the safety and efficiency of maritime commerce and coastal resource management through the integration of real-time environmental observations, forecasts, and other geospatial information. PORTS® have

different sizes and configurations, each designed to meet local user requirements. PORTS® includes sensors, hardware, and associated communications systems which allow the centralized, real-time data acquisition and dissemination of water levels, currents, and other oceanographic and meteorological data. The modular design of each PORTS® installation allows the straight forward integration of additional sensors to meet user requirements.

In carrying out our mission, CO-OPS performs the following:

- Establishes the 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 improved oceanographic observing systems; develops software to improve data processing capabilities.
- Maintains and operates oceanographic observing systems; performs operational data analysis and quality control.
- Produces and disseminates oceanographic products.
- Archives the resulting oceanographic data.

These Standing Project Instructions provide the recurring requirements for installation, operation, maintenance, and removal of water level stations in support of the NWLON, PORTS®, Coastal Oceanographic Applications and Services of Tides and Lakes (COASTAL) Program, hydrographic and photogrammetric survey operations, NOS VDatum and reimbursable special projects. These stations provide critical data to support the following activities:

- Ensure safe navigation
- Determine flow rates to support International treaties
- Determine tidal datums for the National Nautical Charting Program and the National Shoreline Mapping Program
- Determine the baseline from which marine boundaries are delineated
- National Weather Service tsunami and storm surge warning programs
- Coastal resource restoration and management
- Long term sea level trend analyses.

The objective of these Standing Project Instructions is to ensure that all the deployed systems and sensors are maintained in an effective and consistent manner for collecting continuous, reliable, and defect-free data. A major focus of this and future standing project instructions is failure prevention and station long term stability.

We wish to determine the mean time between failures of every major component deployed and predict when that component will more than likely fail based on the parts history, manufacturer recommendations, operating time, environment conditions into which it has been placed (hot, cold, humid, salty, icy, foggy, etc.), long term tests and evaluations, and

field experience. If a component, in our professional judgment, will more than likely fail between inspections, we will look to replace that component with a new or refurbished component and test the removed component back in the lab to see how close we were. This will be an iterative process with ED and FOD working closely as we refine the process and analyze our findings. We will modify our procedures in future years based on the analysis.

1.1 General Data and Reference Datum Requirements

The NOAA Nautical Chart Reference Datum for tidal waters is Mean Lower Low Water (MLLW) based on the latest NOAA National Tidal Datum Epoch (NTDE) of 1983-2001. The NOAA shoreline reference datums are MLLW and Mean High Water (MHW). See http://tidesandcurrents.noaa.gov/publications/glossary2.pdf for descriptions of all tidal datums. All tidal datum computations and water level reductions for shoreline surveys shall be referenced to these datums.

In cases where historic sites are re-occupied, every effort shall be made to collect the new data series on the historic Station Datum (SD). In that case, data can be acquired relative to MLLW for immediate application during the survey. If the historic datum cannot be recovered, an arbitrary SD shall be assigned to the Primary Bench Mark (PBM) and the MLLW datum calculated after 30 to 60 days of water level data are collected.

In non-tidal areas, including the Great Lakes, special low water datums have been defined and are used as chart datum in these locations. For the Great Lakes, a unique Low Water Datum (LWD) for each lake based on the International Great Lakes Datum of 1985 (IGLD 85) is the reference datum. In other non-tidal coastal areas, LWD is determined by subtracting 0.5 ft from the Mean Water Level (MWL), as calculated from the water level data collected in these locations.

Leveling and GPS connections to geodetic datums are made at each water level station, as described in Section 3.6 Geodetic Connections.

1.2 Reference Documents

The following reference documents are referred in various sections of the Standing Project Instructions. The latest version of the documents can be found on the CO-OPS publication page http://tidesandcurrents.noaa.gov/pub.html or the CO-OPS Field Library http://tidesandcurrents.noaa.gov/fieldlibrary/Welcome.

1. NGWLMS Site Design, Preparation, and Installation Manual (NGWLMS Manual), January 1991

2. Xpert DCP User's Manual

3. User's Guide for the Installation of Bench Marks and Leveling Requirements for Water

Level Stations, October 1987

4. User's Guide For Electronic Levels with Translev and WinDesc
5. User's Guide for Writing Bench Mark Descriptions
6. User's Guide for GPS Observations at Tide and Water Level Station Bench Marks
7. CO-OPS GPS Observations Implementation Plan
8. CO-OPS Specifications and Deliverables for Installation, Operation, and Removal of Water Level Stations
9. SOP 5.4.1.4 (A) Sutron Accubar Barometer Field Calibration Procedures
10. Wind Sensor Alignment Procedure for the R. M. Young Wind Sensors
11. Procedure to Establish a Meteorological Sensor Reference Mark and to Measure Meteorological Sensor Heights
12. CO-OPS Water level and Meteorological Site Reconnaissance Procedures
13. User's Guide for 8200 Acoustic Gauge (Installation and Operation)
14. User's Guide for 8200 Bubbler Gauge (Installation and Operation)
15. NGWLMS GOES MESSAGE FORMATTING
16. Standards and Specifications for Geodetic Control Networks", Federal Geodetic Control Committee
17. Spatial Data Modifications and Enhancements, FY05 Functional Requirements Document
18. Revised NGS 3 – Dimensional (3 – D) Rod Mark, National Geodetic Survey, July 1996
19. NWLON/DMS Quality Control Software (QC): Functional Requirements Document
20. NOS Hydrographic Surveys Specifications and Deliverables
21. Water Level Station Specifications and Deliverables for Shoreline Mapping Projects
22. Attachment R, Requirements for Digital Photographs of Survey Control, NGS
23. SOP 3.2.3.5 Upgrading or Installing a New Water Level Station

24. SOP 3.2.3.5 (E7) CO-OPS Evaluation Criteria for Water Level Station Documentation

25. Engineering Bulletin 07-006 Exporting Data from Xpert Family DCP

26. User's Guide for the eSite Report Application

27. SOP 3.2.3.5 E(15) eSite Report User Access to Build, Submit, Reject, Advance, and Approve Steps

28. Engineering Bulletin 07-007 Downloading (Exporting) Data from Xpert Log Files using Xterm

29. Engineering Bulletin 08-001 Standardization of Xpert Log File Sizes

30. Engineering Bulletin 09-003 Update to Xpert Log File Sizes

31. SOP 3.2.3.5 (E8) Procedures for Requesting GOES Platform ID Allocations

32. SOP 5.4.1.1 C Portable Tide Gauge Setup, Configuration, and Data Export Procedure

33. NGS Bluebook, Formats and Specifications of the National Geodetic Survey Data Base

34. SOP 5.3.1.1 Waterlog Field Installation Guide

35. SOP 6.3.2.1.0 Annual Inspection Checklist

36. SOP 5.4.1.5 (N) Inside/Outside Water Level Check for the Great Lakes Gauging Stations

37. ROS # 5.4.1.5(P) Procedure to Establish a Meteorological Sensor Reference Mark and to Measure Meteorological Sensor Heights

38. CO-OPS Numerical Rounding Policy

2 REQUIREMENTS FOR RECONNAISSANCE, INSTALLATION, OPERATION, MAINTENANCE, AND REMOVAL OF WATER LEVEL STATIONS

The following sections point to the references strategic to the reconnaissance, installation, operation, maintenance, and removal of water level and/or meteorological stations.

The term Installer has been defined as a person or field party that performs any of the following tasks: reconnaissance, installation, maintenance, repair, or removal of a water level station. The Installer could be CO-OPS personnel, NOAA ship personnel, Office of Coast Survey (OCS) Navigational Response Teams (NRT), other NOAA personnel, or contractors.

2.1 Reconnaissance

The reconnaissance of water level and meteorological stations shall be performed in accordance with reference *Procedure to Establish a Meteorological Sensor Reference Mark and to Measure Meteorological Sensor Heights*.

2.2 Water Level Sensor Specifications

The following sections provide the sensors and specifications that are used at CO-OPS water level stations.

2.2.1 Primary Water Level Sensor

The primary sensor used at a CO-OPS water level station is one of the following:

- Aquatrak™ self-calibrating air acoustic sensor
- Paroscientific pressure sensor(s) tied into a single or dual orifice gas purged bubbler system
- BEI Motion Systems absolute shaft angle encoder (SAE)
- Design Analysis Associates Inc. WaterLOG Microwave sensor (MWWL) (in a limited capacity as approved)

Currently, the Aquatrak™ acoustic sensor is configured at the majority of tidal water level stations as the primary water level sensor. At stations where the acoustic sensor cannot be used due to the freezing of the waters' surface or the lack of a suitable support structure, a single or dual Paroscientific intelligent pressure sensor(s) is incorporated into a gas purged bubbler system. In the Great Lakes, a sump with a float driven absolute shaft angle encoder is used. A microwave air gap sensor is approved for selected NWLON and PORTS® projects. It is used in a limited capacity at low wave energy locations. At present MWWL sensor is approved for NWLON stations that have average 5-year standard deviation of less than 2 cm for the primary sensor.

The sensor type will be determined after the reconnaissance of the site is completed, the final station design is performed, and CO-OPS has approved the site and the type of sensors. CO-OPS' approval of the type of water level sensor is mandatory for a project.

The sensor measurement range shall be greater than the expected range of water level and the installation shall be designed to measure the full range of extreme water level such as highest observed and lowest observed water level data (100 years, if available). The highest observed may have an additional wave allowance value added as determined by CO-OPS' Engineering Division (ED).

Sensors are calibrated prior to deployment; and the calibration is checked following removal.

The calibration standard accuracy of most sensors is traceable to the National Institute of Standards and Technology (NIST) http://www.nist.gov/calibrations/.

For NWLON water level data, the water level sensor resolution is 1 mm or better. For hydrographic and photogrammetry surveys the required water level sensor resolution is a function of the tidal range in the area which water level data is collected: when the tidal range is less than or equal to 5 m, the required water level sensor resolution shall be 1 mm or better; when the tidal range is between 5 m and 10 m, the required water level sensor resolution shall be 3 mm or better; and when the tidal range is greater than 10 m, the required water level sensor resolution shall be 5 mm or better.

Known error sources for each sensor are handled appropriately through ancillary measurements and/or correction algorithms. Examples of such errors are water density variations for pressure gauges, sound path air temperature differences for acoustic systems, and high frequency wave action and high velocity currents for all sensor types. At a number of NWLON stations, dual gas purged orifices which are mounted a fixed vertical distance apart and connected to two vented Paroscientific pressure transducers are used so that a density correction can be estimated for each sample based on the pressure difference and known gravity.

The orientation of the primary sensor shall be carefully documented in elevation (side) view sketches and photographs, as required. Orientation of the protective well (or sump and intake in the Great Lakes) relative to the wave or current modifiers such as nearby pilings, bulkheads, or other structures in the water shall be photographed and documented. All features in the vicinity of the protective well such as, pilings, other wells, decking, buildings (tide house), etc., which might cause uneven sun/shading of the well and resulting in non-uniformity of temperature inside the well shall also be well photographed and documented.

The Installer shall have all forms and figures submitted using metric units and referenced to the appropriate datum. Other references (e.g. orifice zero or tide staff zero) shall also be shown on the forms with reference to the SD.

2.2.2 Redundant Water Level Sensor

The redundant sensor used at a CO-OPS water level station is one of the following:

- Druck or KPSI pressure sensor tied into a single gas purged bubbler system
- Waterlog relative shaft angle encoder (SAE)
- Design Analysis Associates, Inc. WaterLOG microwave (MWWL) sensor in a limited capacity as approved

At tidal water level stations, the redundant water level bubbler orifices shall be secured structurally independent of the primary water level sensors (i.e. on a separate piling, etc). At Great Lakes stations, the Waterlog shaft angle encoder (SAE) shall be set to read the same as the Electric Tape Gauge (ETG) and the primary SAE.

The cable lengths of all water level and ancillary sensors shall be noted in the eSite Report (Xpert Site Report (Excel) or Tide Station Report) to the nearest tenth of a meter (rounded up to the nearest tenth of a meter value). This will assist with the efficient replacement of cables should a failure occur.

2.2.3 Tsunami Data Requirements

NWLON and other water level stations installed and supporting the NOAA Tsunami Program shall have 1 minute averaged water level data available in addition to the 6 minute data. The 1 minute averaged data will be mainly coming from the primary sensor during the normal operations. In addition, 15 second data from the redundant sensor shall also be made available in the event of a tsunami, or as per the request of National Weather Service (NWS) Tsunami Warning Centers, and the Pacific Marine Environmental Laboratory of NOAA's Office of Atmospheric Research (OAR).

Flash memory storage devices may be appropriate for storing the 15-second data. The sizes of the data files (minimum number of day's data) for 6-minute water level data (SSP.LOG), 1 minute tsunami data (TSU1MIN.LOG), 15 second tsunami data (15SECTSU.LOG), and system log data shall be collected according to Engineering Bulletin 09-003. This Bulletin is available on the ROS Wiki Page and the CO-OPS Field Library.

2.3 Data Collection Platform

The primary Data Collection Platform (DCP) shall acquire and store water level measurements every 6 minutes. The water level measurements shall consist of an average of three minutes of discrete water level samples with the period of the average centered on the six-minute mark (e.g. 00, 06, 12, etc,). In addition to the average measurement, the standard deviation of the discrete water level samples and outliers that comprise the six-minute measurements shall be computed and stored. The six-minute centered average water level data and the standard deviation provide valuable data quality information regarding each measurement.

For NWLON stations, a redundant DCP shall be installed in case of a failure of the primary DCP or sensor, water level data from the redundant DCP or sensor can be retrieved. The redundant DCP also shall acquire and store water level measurements every six-minutes and the water level measurements shall consist of an average of three minutes of discrete water level samples with the period of the average centered about the six minute mark (e.g. 00, 06, 12, etc,).

The primary and redundant DCP, where applicable, shall have a capacity to store at least 30 days of six-minute water level data and meteorological sensor data, if applicable.

2.4 GOES Satellite Transmissions

The ability to monitor water level measurement system performance for near real-time quality assurance is essential for operations. Water level data transmitted via satellite in NOS format (for NOS installed stations) is retrieved and monitored by CO-OPS, and in the case of data gaps,

sensor, or gauge problems corrective actions are taken immediately. At all sites where access to the GOES satellite is available, and according to CO-OPS policy, the measurement system shall be equipped with a GOES transmitter to telemeter the data to NOS. This section is applicable where water level gauges are installed by CO-OPS or CO-OPS' contractors for NWLON, Tsunami, COASTAL, VDatum, Special projects, and NOAA in-house survey projects. This section is not applicable for NOAA contract hydrographic or photogrammetric projects.

The data transmissions shall use the message format detailed in the *NWLON GOES MESSAGE FORMAT* referenced. This format is implemented in the Next Generation Water Level Measurement Systems (NGWLMS), assuring compatibility with the CO-OPS Data Management System (DMS).

The NOS Continuous Operational Real-Time Monitoring System (CORMS) is a 24 x 7 data monitoring operation. It monitors all water level measurement system data transmitted via GOES to ensure the gauges are operating properly. Data not transmitted by GOES but submitted to CO-OPS via diskette, CD-ROM, or other electronic media, must also conform to the format specified in the above document so data can be loaded properly into DMS.

The clock accuracy of a satellite radio system shall be adjusted with a GPS clock for NWLON gauges. For a tide gauge that does not have a GPS clock, or transmits hourly or three hourly, the clock accuracy of a satellite radio system shall be within 5 seconds per month for short-term water level gauges so that adjacent satellite channel overlapping does not occur. Non-satellite radio systems shall have a clock accuracy of better than one minute per month.

2.5 Data Transmission Initiation and Station Database Configuration Requirements

The CO-OPS' Engineering Division (ED) Systems Support and Evaluations Branch (SSEB) maintains the GOES platform ID list for all water level stations in the NWLON. For new NWLON stations, once the location, type of sensors, and DCP are selected, the Configuration and Operational Engineering Team (COET) will assign a station id and SSEB will assign the platform ID and provides the satellite configuration data for the deployment.

For other types of water level stations, such as subordinate stations installed for NOAA in-house hydrographic or photogrammetric surveys, or meteorological (met) only stations, SSEB will also assigns platform IDs, as appropriate. This section pertains to water level stations installed by NOAA ships, CO-OPS, or CO-OPS IDIQ contractors. This section is not applicable for contract hydrographic and photogrammetry stations installed by OCS and National Geodetic Survey (NGS) survey contractors.

COET will assign and/or provide station numbers for equipment setup and testing when the location, which consists of a local name, body of water, and latitude and longitude of the station is reported to COET at least 15 days before throughput testing. COET can be reached by telephone at 301-713-2900, fax: 301-713-4465 or 301-713-4435, or e-mail address at nos.coops.oetteam@noaa.gov.

Requests for GOES platform IDs shall be submitted to NOS DCS Manager Scott Mowery and Chesapeake Instrument Lab (CIL) at least 15 days before throughput testing to allow sufficient time to receive radio frequency assignments. Refer to the *Procedures for Requesting GOES Platform ID Allocations* for procedures on requesting a platform ID. CIL can be reached by telephone at 757-842-4400, fax: 757-436-9292, or e-mail address at CIL@noaa.gov.

Prior to the installation of a station and initiation of GOES data transmissions from the field, critical information needed for database configuration shall be e-mailed or faxed to COET. The critical information required for a stations' initial database configuration in the CO-OPS DMS is station number and name, installation date, latitude/longitude, platform id, transmit time and channel, and the serial numbers of all DCPs and sensors. Submit the critical information listed below with the one-day (24 hr) site report due at the conclusion of the station installation. The Installer may monitor test transmissions during the field unit installation.

Critical Information required for water level station database configuration at CO-OPS Database Management System (DMS):

(1) Station Number and Name
(2) Installation Date
(3) Latitude/longitude
(4) Platform ID, transmit time, channel
(5) Serial numbers of all DCPs, and sensors
(6) Level abstract
(7) Sensor offset C1 (SNS) and Datum Offset C2 (DAT) as entered in the DCP for acoustic sensor or MWWL sensor; and orifice offset(s) for pressure sensors.
(8) Staff-to-gauge Observations (when required)

This station information must be configured for data to be ingested in DMS. Whenever possible, within 24 hours after reporting the above basic information and before the complete inspection package is submitted, the draft (24-hr) eSite Report (Xpert Site Report (Excel) or Tide Station Report) shall be forwarded to COET. The one-day (24-hr) draft eSite Report submission requirement and its purpose is to:

1) Standardize the requirements for all of CO-OPS' field efforts;
2) Provide communications and feedback between COET and the Installer while at the site, so that critical information is verified; and
3) Insure that timely corrective actions and required maintenance actions as described in the station specific Project Instructions can be accomplished by the Installer while at the site.

Generally, COET will respond back to the Installer or provide feedback within 24 hours or earlier during normal business hours. This requirement applies to all types of water level stations and all types of sensors for every type of maintenance - installation, regular scheduled maintenance, emergency maintenance and removal of a water level station, where CO- OPS is expected to receive and/or process the data.

The effective starting date of all operational sensor data series is the date and time when the data is first received after the DMS configuration. It is the responsibility of the Installer to ensure that the required documentation is provided to COET prior to the date when the operational sensor data are needed.

For the installation of the primary sensor, a leveling connection shall be made between the Primary Bench Mark (PBM) and the sensor zero for the purpose of determining the sensor zero height with respect to the SD. The acoustic sensor zero is the Aquatrak™ Leveling Point (AQLP), which is the top edge of the collar on which the Aquatrak sensor rests. The Microwave Water Level Leveling Point (MWWL LP) is the top edge of the leveling collar, which where the sensor rests. On the ETG, the sensor zero is the ETG reading reference mark, also known as the Zero of the Electric Tape Gauge (ZETG). The Paroscientific pressure sensor zero is the vertex of the V-notch in the side of the orifice, or the bottom of the top parallel plate. To make a leveling connection to this sensor zero, a rod stop called the orifice staff stop or leveling point - can be leveled as part of the leveling run- is installed at a point above the sensor zero and a calibrated steel tape measurement is made between the sensor zero and the orifice staff stop. Using the height obtained for sensor zero with respect to the SD, the datum offset (also known as Coefficient C2 or DAT), or the orifice offset shall be calculated.

The field crew shall then submit the eSite report, Xpert site report (Excel), or Tide Station report via e-mail or fax. Include a copy of the level abstract (and water level transfer form for Great Lakes stations) to COET in addition to a phone call to COET so that sensor parameters can be properly setup in DMS prior to the beginning of the accepted data collection.

The Installer shall contact COET (contact information is provided above at the beginning of the section) and CORMS at telephone 301-713-2540, fax 301-713-4392, or e-mail corms@noaa.gov

a) Before performing any maintenance at a station
b) After the maintenance is completed
c) When a station is installed
d) When a station is removed.

The above procedure is a requirement. If this procedure is not followed prior to the beginning of data transmission, data losses may occur. When the station sensors are properly configured in DMS, the data is accessible through the CO-OPS' diagnostic tool web page - DiagTool.

Changes to the satellite platform ID, the DCP telephone number, or the DCP IP address, shall be reported to COET, CIL, SIL, ISD OPS, and the supporting Field Operations Division (FOD) office immediately via telephone, e-mail, or fax.

The Installer/tester shall follow the appropriate throughput testing requirements as described in *SOP 3.2.3.5 Upgrading and Installing a New Water Level Station*.

2.6 Station Installation

The installation of water level station DCPs and sensors shall be accomplished according to *NWGWLMS Site Design, Preparation, and Installation Manual*, *Xpert DCP User's Manual*, and the manufacturer's instructions, as applicable. Nearly all of the NWLON stations have the Sutron Xpert System (Xpert DCP as primary and Xpert Dark as redundant DCP).

All new station installations, except short-term hydro/photo stations, shall undergo an engineering design review in accordance with Section 3 of the ROS. FOD and NWLON O&M contractor engineering design packages for station upgrades and installations shall be reviewed and approved by the CO-OPS Field Engineering Review Subcommittee before any work actually begins on the site.

The Installer shall obtain all required permits and permissions using CO-OPS approved agreement templates (found on the ROS web page for in-house projects and available via the Contract Manager) for the installation of the water level sensor(s), DCPs, bench marks, and utilities, as required. The Installer must also provide copies of signed agreements, permits, and permissions to ED and the supporting FOD office as part of the design review process. A complete reconnaissance report and station design heights shall also be submitted. The Installer shall be responsible for security and/or protective measures, as required, for protecting the government furnished equipment and facility while installing, maintaining or removing a water level station.

The water level station and its various components (tide house, DCP(s), sensor(s), meteorological tower, bench marks, and pertinent access facilities such as railings, steps, etc., as appropriate), when designed or installed by contractors, shall be installed and maintained as prescribed by manufacturers installation manuals, appropriate local building codes, or as specified by the Contracting Officer's Representative (COR), if applicable. The water level station and all installed components shall be structurally sound for the intended application, secure, and safe to use for NOS, local partners, and the public, as appropriate.

The Installer must provide CO-OPS with the GPS position, as noted below in Section 2.9, of all tide gauges and sensors installed before data collection begins, including those not specified in the Statement of Work. In cases where gauge location(s) needs to be, different from that specified in the Statement of Work, Installer shall consult with CO-OPS prior to the installation.

Digital photographs of water level station components (station, DCP(s), sensor(s), well, supporting structure, equipment, and bench marks) shall be taken and submitted. GPS photos shall be taken according to the *User's Guide for GPS Observations at Tides and Water Level Station Bench Marks*.

A minimum of four photos for each bench mark shall be taken: close-up of the disk face; chest or waist level view of disk and setting; and horizontal views of the location of the bench mark from two different (perpendicular) cardinal directions. Photos shall also be taken of station components such as protective wells, staffs, tide house(s), shelter(s), met towers, DCPs, sensors, etc. One general location photo shall be taken showing the water level station in relationship to

its supporting structure and the local body of water. All digital photographs shall be submitted in JPEG format. All digital station photo files should be named such that the name of the file will indicate the station number and the type of photo taken. For example, the acoustic sensor photo for DCP1 at Los Angeles shall be named as 94106601 A1 Sensor.jpg. Photos should not include people, tools, and vehicles in the background. Photos must be taken during sunlight.

The station components and bench mark photographs are required when a new station is installed. The bench mark photographs shall be updated whenever any changes are noticed, such as damaged bench mark disk, or changes to settings, scenery, etc, or as requested in the station specific requirements. Photographs of the underwater components showing the amount of marine fouling shall be taken annually.

All digital station bench mark photo files should be named such that the name of the file will indicate the station number, dash, PID number (if available), dash, stamping or designation, dash, photo type, dash, date, dot.jpg. For a new mark, the PID is not applicable as it is unavailable. A close-up photo showing the face and stamping of the bench mark is photo type 1, an eye level photo showing the bench mark and its setting is photo type 2, and a horizontal view of the bench mark showing nearby landmarks is photo type 3. For photo type 3 include the cardinal direction (N, NE, S, SE, etc) that the camera is pointing. If more than one type of photo is taken for a given view, then re-name them as 1A, 1B, 2A, 2B, 3A, 3B, etc. If a PID is available, then use the designation instead of the stamping for the naming of the file. Use a maximum of 30 alpha numeric characters to the left of the dot. If you are exceeding 30 alpha numeric characters in the name, then truncate the stamping or designation so that the maximum number of characters in the name are 30 (including spaces and hyphens). For example, the bench mark E close-up photo for the Seattle water level station should be named as 9447130-7130E1990-1-20090101.jpg.

Sample file names for photo files:

Disk face photo of a new bench mark without a PID	9414290-4290A2008-1-20090101.jpg
Eye level view photo of an existing bench mark with a PID	9410660-DY2512-BM N-2-20090101.jpg
North direction photo of an existing bench mark without a PID	9447130-7130E1990-3N-20090101.jpg

In addition, place a caption on each photograph, indicating the stamping or designation of the mark, the PID, the photo type with cardinal direction, and the date of photograph taken. The WinDesc program for electronic leveling has a function to assist with the photo caption.

The above naming convention for the bench mark photo files shall be applicable for all of CO-OPS' work and OCS hydrographic surveys. For NGS Shoreline mapping projects, contractors shall follow the NGS specifications for file naming of bench mark photos.

NGS Coastal Mapping Surveys require a slightly different file naming convention as described in Attachment R of the NGS Specs which is located at http://www.ngs.noaa.gov/ContractingOpportunities/SOW_Main_Text_V13B_new.pdf. All photos collected for NGS Coastal Mapping Surveys for both contract and in-house projects shall be named according to NGS convention.

A completed water level measurement station installation consists of the following:

a) The installation of the water level measurement system [water level sensor(s), primary and redundant DCP as appropriate, satellite transmitter, ancillary sensors if applicable, other equipment as necessary and its supporting structure, and a staff (if required), as specified in the Annual Station Specific Requirements, or as specified in the contract documents].

b) The recovery and/or installation of the required minimum number of bench marks and a level connection between the bench marks, Primary Bench Mark (PBM), and the water level sensor(s), or tide staff as appropriate. The minimum number of bench marks or specific marks to be leveled will be specified in the Annual Station Specific Requirements, contract documents, or as specified in the *User's Guide for the Installation of Bench Marks and Leveling Requirements for Water Level* Stations (See section 3.3 Levels for additional leveling requirements).

c) The collection of GPS observations at a minimum of four hours on one bench mark and submission of the data through OPUS DB for publishing.

d) Validation by CO-OPS of complete data transmissions, and proper data ingestion into DMS, as evidenced by the data display on the CO-OPS website.

e) The preparation and submission of the installation documentation and data to CO-OPS ED COET and supporting FOD field office. Refer to Section 4 for the requirements timelines, documentation deliverables, and points of contacts.

The Installer shall follow the appropriate sections of *SOP 3.2.3.5 Upgrading and Installing a New Water Level Station*.

2.7 Station Maintenance Requirements

Water level station standard annual maintenance shall be accomplished in accordance with the Appendix F of the *NWGWLMS Site Design, Preparation, and Installation Manual*, and the most recent version of the Annual Inspection checklist or as instructed by the Contracting Officer's Representative (COR), or the Task Manager (TM). A PDF file or digitally scanned copy of the completed AI checklist shall be submitted for each station annual inspection. The specific maintenance requirements for each water level station will be specified in the Annual Station Specific Requirements for individual task orders for contracts.

A major focus of the annual inspection is failure prevention and station long-term stability. To

accomplish this, the crew chief, TM or COR will check with COET and the appropriate Instrument Lab to determine if any component is scheduled for replacement because it may close to the time when it is predicted to fail. If a component is scheduled for replacement, then that component will be swapped out with a good component provided by the appropriate Instrument Lab.

CO-OPS shall monitor the near-real time water level gauge data daily for indications of sensor malfunction or failure, and for degraded or invalid data, when the data is disseminated via GOES telemetry using the NOS satellite message format. This includes data from CO-OPS NWLON stations, and stations supporting hydrographic and photogrammetric surveys where CO-OPS or CO-OPS contractors, Navigational Response Teams (NRT), or NOAA Ships install the subordinate water level gauges. CO-OPS shall not monitor the subordinate stations installed for NOAA contract hydrographic/photogrammetric survey projects by NOAA contractors. This monitoring can be performed by accessing the CO-OPS' diagnostic tool web page - DiagTool. The data are typically available for review via the web within one to four hours after the configuration of the DCPs and sensors in DMS during the normal business hours, after the installation of the DCPs and sensors in the field, and once data is reviewed and CORMS turns on dissemination.

Safety of personnel is of utmost importance and safety gear as necessary shall be used when required.

During annual maintenance visits to a station having an acoustic sensor, the Aquatrak™ sensor and matching calibration tube shall be replaced. For stations where wind sensors are installed, wind sensor nose cones shall be replaced during the annual maintenance. The Ultrasonic wind sensor leads (if in question) shall be cleaned with a contact cleaner with a zero residue base. All applicable sensor serial numbers (inside the tide or gauge house) shall be verified by the Installer (recorded by one person and confirmed by a second person in the field party). The serial numbers of the DCP boards and sensors are recorded and verified during the installation, and only when equipment is replaced during maintenance is the re-verification of the serial numbers required.

Necessary repairs or alterations to the stations and equipment shall be made and documented on the eSite Report (or Xpert Site Report (Excel) or Tide Station Report).

Repairs or alterations required by the Standing Project Instructions or the Annual Station Specific Requirements, but not completed, shall be documented, along with the reasons for the incompletion, on the approved eSite Report (or Xpert Site Report (Excel) or Tide Station Report). Each field party crew chief shall provide COET a draft eSite report (or Xpert Site Report (Excel) or Tide Station Report), within one day of completion of maintenance and leveling operations.

The report(s) shall be completed by the Installer before leaving each station; and reviewed by the field crew leader or contractor supervisor after the completion of the maintenance visit but prior to submission. The reviewed station package shall then be submitted to ED and the

supporting FOD field office within 1 month after the completion of the maintenance, or as specified in the contract documents.

A minimum of 30 days of 6 minute water level data and 15 days of 1 minute tsunami water level data shall be downloaded during each maintenance trip for NWLON stations and the data shall be forwarded to COET as described in Section 4.2.2 Documentation Requirements. Engineering Bulletin # 07-007 "*Downloading (Exporting) Data from the Xpert Log Files using Xterm*" provides information regarding how to download the data from Xpert DCP.

Sizes of the Xpert Log Files (ssp.log, tsu1min.log, and System.log) shall be configured according to the Engineering Bulletin 09-003 "*Update to Xpert Log File Sizes*".

Approved primer and anti-fouling paint shall be used on all new protective wells and all submerged protective fiberglass/PVC components that will be in water, excluding the acoustic sensor calibration/sounding tube.

For dual orifice pressure sensor configurations, the vertical stability and elevation to the leveling points from each orifice shall be verified, including the distance between the two orifices. To do so, measure the elevation of each orifice to the staff-stop or leveling point using a steel tape graduated in millimeters. Two independent readings shall be taken and they should not vary more than 3 mm, then report the average of the two readings. If the two readings vary more than 3 mm, then take additional readings until two readings are obtained within 3 mm. The mounting assembly for the two orifices shall be checked for structural integrity and the orifices shall be cleaned of biofouling.

When first arriving at a station to perform annual maintenance, check and record the voltage for each battery on all DCP units. Then remove A/C and solar power to the primary, redundant, and auxiliary systems allowing them to run totally on battery power**.** After the units have had approximately an hour of transmit loads on the Xpert DCP and at least 2 hours for the 9210 DCP, recheck the voltage. If the battery voltage has dropped significantly (i.e. below 11.7 volts), replace it. Also write the date of the installation with permanent marker on each battery, and record this date on the site report. Check all marine grade batteries to ensure that adequate water is in each cell. Use only distilled water for replacement.

Batteries shall be replaced every four years during the maintenance trip for NWLON stations, where practical, or make arrangements to replace them at another time. The condition of a newly installed battery shall be checked using the procedure described in the above paragraph during the 2nd or 3rd year maintenance trip, and if the battery condition passes the test described above then replace the battery during the 4th year after the installation. Of course, if a battery does not pass the condition test as described above, then it shall be replaced immediately during that trip and the date of replacement shall be duly noted on the eSite Report (or Xpert Site Report (Excel) or Tide Station Report).

All repairs, adjustments, replacements, cleaning, or other actions potentially affecting sensor output or collection of data shall be documented in writing using approved maintenance forms

(refer to Section 5 for requirements for deliverables for water level station documentation and timelines) and retained as part of the water level data record. This documentation shall include, but not be limited to, the following information: date and time (UTC) of the beginning and the end of the maintenance activity; date and time of adjustments of the sensors; changes in the configuration of the DCP - such as a new datum or sensor offset, or setting the time; personnel conducting the work; parts or components replaced; component serial numbers; tests performed and test results; etc.

Proper NOAA identification signage with an emergency phone number (800)367-6622 or (301) 713-2540 shall be placed on each tide house or shelters. Replace illegible signs.

A completed station visit for maintenance (scheduled or emergency) consists of the following:

a) The maintenance or repair of the water level measurement system (water level sensor(s), primary and redundant DCP as appropriate, satellite transmitter, ancillary sensors if applicable, other equipment as necessary and its supporting structure, and a staff if applicable), and as specified here in the Standing Project Instructions, the Annual Station Specific Requirements, or as specified in the contract documents.

b) For scheduled maintenance, the recovery and/or installation of the required minimum number of bench marks and a level connection between the bench marks, PBM, and the water level sensor(s), or tide staff is required. The minimum number of bench marks or specific marks to be leveled will be specified in the Annual Station Specific Requirements, contract documents, or as specified in *User's Guide for the Installation of Bench Marks and Leveling Requirements for Water Level Stations, October 1987* (See Section 3.3 Levels for additional leveling requirements).

   For emergency maintenance, recovery of bench marks and levels are generally not required, unless maintenance is done which may affect the elevation of the AQLP, MWWL LP, or orifice(s) for pressure sensor(s), in which case leveling, to the PBM, water level sensor, and at least 2 other marks, is required.

   For scheduled maintenance, GPS observations on one of the bench marks maybe required if specified in the Annual Station Specific Requirements, or in the contract documents.

c) CO-OPS verification of complete data transmission throughput following maintenance, from station to the DMS ingestion.

d) The preparation and submission of the installation documentation and data to CO-OPS ED COET and supporting FOD field office. Refer to Section 4 for the requirements timelines, documentation deliverables, and points of contacts.

The maintenance party shall follow the appropriate sections of the SOP 3.2.3.5 (E3).

2.7.1 Additional Requirements for NOAA Sentinels

NOAA Sentinels are water level observing stations which have been strengthened to deliver real-time storm tide data during severe coastal events. Elevated atop substantial single pile platforms, these stations are specifically designed to withstand category four hurricanes. NOAA Sentinels measure and disseminate real-time water level and meteorological observations. All of this information helps coastal authorities prepare for, mitigate, and respond to storm tides generated by severe coastal storms.

The following are the additional maintenance requirements for the NOAA Sentinel stations currently installed in the Gulf of Mexico:

Every Year:

- Examine the anode and the anode attachment points. Inspect the attachment points for excess corrosion and inability to remove fasteners. Provide measurements of the smallest cross sectional area of the anode. Provide underwater photos of the anode and close-ups of any excessive anode shrinkage or attachment point corrosion.

Every 2 years:

- Inspect all painted surfaces for rust. Document significant rust areas in the eSite report (or Xpert Site Report (Excel) and provide photos of the occurrences. The repair of significant rust areas shall be added to the following year's project instructions along with procedures for coating repair.

- Inspect all galvanized surfaces for rust. Document significant rust areas in the eSite Report (Xpert Site Report (Excel) and provide photos of the occurrences. Repair spot rust with a wire brush and cold galvanizing.

- Inspect all welds for rust and cracks. Provide photos and document excessive rust and cracks.

- Check all fasteners on the protective well clamps, including half-moon clamps, adjustable arms, and attachment to clamp brackets. Tighten if loose.

- Check the fasteners holding the solar panel mount to the railing. Tighten if loose.

- Check all fasteners holding the enclosure to the support stand and the stand to the deck grating. Also check the bracketing system along the upper portion of the enclosure. Tighten if loose.

- Check all fasteners on the Rohn tower. Tighten if loose.

- Examine the underside of the high platform. Inspect the high platform bridge bolts for looseness and rust. Document and tighten any loose bolts.

- Examine the galvanized conduit for rust and cracks. Check also for water in the conduit entering the bottom of the enclosure.

- Examine the solar panel and Rohn tower flexible conduits for cracks and loose fitting/tubing connections.

- Grease the davit and winch. Examine for corrosion.

Every 5 Years:

- Replace the battery pack in the Aid to Navigation light.

2.7.2 Additional Requirements for Great Lakes Stations

- The shaft angle encoders shall be inspected to insure the offset pulleys are not binding. Lift the float tape off of the offset pulley and free spin the unit. If any binding occurs, replace the bearing in the center of the gear. In addition and while the float tape is off of the encoder gear and pulley, spin the encoder shaft to represent both a 2 meter increase and a 2 meter decrease in the readings from the present reading. Then match the reading with the ETG reference and reset the tape back on the gear and pulley. After this process, remember to check the tape at the float connection to ensure that it has not kinked. This rotation procedure will ensure that the oil lubrication around the enclosed encoder bearings remains fluid. NOTE: - This test should only be performed during the time period that the DCP is not calculating the water level reading. This time period, for computing the water level reading, is 90 seconds before and after the allotted 6 minute interval. Also check to see that the float tape length has been installed such that the float neither tops out nor the counterweight bottom out before reaching its extreme limitations.

- The float shall be inspected for corrosion and leaks; replace as necessary.

- When closing off the intake valve note how many turns it takes to close off the intake as well as how many turns it takes to fully open it. This shall be reported in the remarks on the inspection sheet and on a tag placed on the valve handle. Also note the difficulty in turning the valve such that it can be predicted when the valve would become unusable and need replacement.

- A water level transfer (inside/outside check) shall be performed at each station and documented on the Site Report. The inside/outside water level must agree within 0.006 m. The best time to perform a transfer is in the early morning or late evening when the water level is most calm. The above check must be followed and actions taken to correct any discrepancies. Refer to the Inside/Outside Water Level Check for the Great Lakes Gauging Station SOP.

- When diving at gauge sites measure and report the elevation of the intake invert and valve invert on IGLD 85, if not previously noted. NOTE: The invert elevation is the point where

the water level can no longer be measured accurately. If the intake has a gooseneck at the end this measurement should be taken at the lowest point in the curve at the top of the gooseneck, not the opening.

- Install rubber flaps over all locks on gauge shelters for protection against the weather. The locks shall be inspected and lubricated to enable easy access.

- Check gauge houses inside, outside, and around the doorframe for openings in the mortar and caulk as required. Submit a statement of work to FOD for any work recommended for completion by a contractor.

- Check gauge house structure, door, and frame for rust and paint chips. Scrape and paint as necessary.

2.8 Ancillary Sensor Metadata

The meteorological sensor site selection and measurement guidelines are listed in the *CO-OPS Water level and Meteorological Site Reconnaissance Procedures and Procedure to Establish a Meteorological Sensor Reference Mark and to Measure Meteorological Sensor Heights*. Specific metadata for ancillary sensors is required as detailed below. The Installer shall make note of this data in the remarks section of the Ancillary Sensor boxes in the eSite report (or Xpert Site Report (Excel) or Tide Station Report). Metadata documentation shall be completed during the annual inspections, or emergency maintenance visits, as appropriate, for all stations with ancillary sensors. A unique Sensor Reference Mark (SRM) may be selected at each station and all the required measurements can be referenced to that SRM. The SRM must be connected via levels to the PBM. Then ED will relate the sensor elevations to SD and other datums as appropriate. Refer to *the Procedure to Establish a Meteorological Sensor Reference Mark and to Measure Meteorological Sensor Heights*.

Photos shall be taken of the supporting structure and all of the ancillary sensors installed. The photos should include as many of the four cardinal compass directions as possible, with the file name indicating the direction of the view, e.g. 87617241 Met tower looking south.jpg. Photos and sensor elevations must be submitted by CO-OPS to the National Data Buoy Center (NDBC) in a timely manner before NDBC will accept the met data into its quality control process. Annual photos of the met mast and ancillary sensors are not required once the sensors have been installed. Wind sensors shall be aligned according to the *Wind Sensor Alignment Procedure for the R. M. Young Wind Sensors* reference document.

Ancillary Sensor	Sensor Elevation Reference Point
Air temperature	Center of the sensor above SRM to the nearest +/- 15 centimeter.
Water temperature	Center of the sensor above the station datum as derived from subtracting the distance from the leveling point to the center of the sensor from the C2 value, to the nearest centimeter.
Barometric pressure	Surface of the pressure port above Station Datum (see Barometer Calibration Guidelines) to the nearest +/- 15 centimeter. This sensor's elevation is derived via leveling.
Wind Speed/Direction/Gust	Center of the sensor above SRM to the nearest +/- 15 centimeter. Note any major physical obstructions in the vicinity of the sensor.
Conductivity	Center of the loop above the station datum to the nearest centimeter.
Relative humidity	Center of the sensor above the SRM to the nearest centimeter.
Air Gap	Sensor zero above the structure's low steel as determined from trigonometric levels to the nearest centimeter.
Visibility	Center of the sensor above SRM to the nearest +/- 15 centimeter.

2.9 Obtaining and Recording Positions of Stations, DCP, Sensors, and Bench Marks Using a Hand-Held GPS Receiver

Latitude and longitude of the station, DCP, all sensors, and bench marks shall be recorded using a hand-held GPS receiver and recorded as degrees, minutes, seconds, and tenth of seconds (e.g. 45 degrees, 34 minutes, 32.6 seconds). The positions of the primary and backup DCP and all sensors that are installed in a tide house (gauge house) shall be recorded as that of a station. This position will be obtained in front of the tide house (gauge house) at the center of the front door/front wall of the tide house (gauge house). The front portion of the roof of the tide house (gauge house) may also be used as applicable if the GPS satellites are blocked from the structure. For a standalone DCP or met sensors that are 3 m (10 ft) or greater from the station, obtain positions and report appropriately on the Site Report.

For barometers which are generally installed in the tide house, report the latitude and longitude as that of the station, but report the elevation above station datum as obtained from leveling.

For Aquatrak sensors, Microwave Water Level sensors, or Paroscientific sensors that are installed 3 m (10 ft) or greater from the station location, obtain the positions of the sensors at the center of the sensor. If the Aquatrak sensor or Paroscientific sensor is installed inside a

tide house (gauge house), then report the latitude and longitude as that of the station, but report the elevation above station datum.

For bench marks, obtain positions using the hand-held GPS receiver by placing the receiver on the (horizontal) bench mark. For bench marks that are installed vertically, obtain the position as close to the mark as satellite coverage will allow.

Handheld GPS units come with either patch antennas or quadrifilar antennas. The proper method for holding the GPS unit is vertically if the unit has a quadrifilar antenna, or horizontally if the unit has a patch antenna. Holding the unit otherwise will degrade the reception of the satellite signals and reduce the accuracy of the position obtained.

Take a digital photo of the GPS unit display for each location acquired. This will ensure verification of the latitude and longitude is entered into the eSite report or Xpert Site Reports (Excel).

2.10 Gauge Removal

The Installer shall remove a water level station, if required, and as specified in the Annual Station Specific Requirements, or as specified in the contract documents. A complete removal of the water level measurement station consists of the following:

a) Closing levels – a level connection between the PBM and all the bench marks in the local leveling network at the station, the water level sensor(s), and/or staff, if applicable.

b) Removal of the water level measurement system and restoration of the premises, assuming reasonable wear and tear. The property owner shall be notified prior to removal and thanked for supporting our programs.

c) Generally, GPS observations on one bench mark are done during the installation for short term stations. If GPS observations are not done during the installation phase, and GPS observations are required, then GPS observations shall be done during the gauge removal time. Generally, GPS observations are required only one time for short term stations. For NWLON and long term stations, the frequency of the GPS observations is determined by the rate of sea level change at the station and if the GPS observations are required for a specific year, those will be listed in the station specific annual project instructions.

d) The preparation of all documentation and data and submission to CO-OPS (ED and supporting FOD field office) in a timely fashion (refer to Section 4 for requirements for timelines, documentation, and points of contacts).

e) Return of all government equipment to appropriate supporting CO-OPS' FOD field office(s) within 15 days of station removal.

3 BENCH MARKS AND LEVELS

3.1 Reference Documents

Bench marks and level operations shall be performed in accordance with the *User's Guide for the Installation of Bench Marks and Leveling Requirements for Water Level Stations, October 1987*. CO-OPS electronic/barcode level operations shall be performed in accordance with *User's Guide For Electronic Levels with Translev and WinDesc* and the Leica Manual for the DNA03 level. Help files for the TOPCON and Trimble level instruments can be found in the WinDesc and Translev programs available from NGS.

Bench mark descriptions shall be written in accordance with Appendix E of the *User's Guide For Electronic Levels with Translev and WinDesc* for bench marks that are connected using both electronic and optical levels. Descriptions for Great Lakes bench marks shall be written in accordance with the NGS Bluebook, Formats and Specifications of the National Geodetic Survey Data Base http://www.ngs.noaa.gov/FGCS/BlueBook/, since those marks are not published by CO-OPS.

3.2 Bench Marks

Unless specified otherwise in the work order or contract documents, the total number of bench marks in the leveling network shall be a minimum of ten marks for the NWLON stations and a minimum of five marks for subordinate stations installed for hydrographic and photogrammetry surveys, special projects, or contract projects, unless otherwise directed by ED.

Descriptions shall be checked by verifying distances with tape measurements in metric units, verifying cited landmarks and using a compass to confirm directions.

The handheld GPS coordinates of each mark shall be entered in the WinDesc description file for electronic levels and optical levels. The latitude and longitude fields of the bench mark shall be reported in the following format: degrees/minutes/seconds and tenths of seconds. For example, 40 degrees, 45 minutes, 35.2 seconds.

New bench mark sketches shall use CO-OPS' standard bench mark sketch title block, or electronic equivalent. If a digital sketch is used, submit the digital file in JPG format with the leveling files and photos. Submission of the bench mark sketch is required only at the installation of a new water level station. Changes in the bench mark network will be documented in the NGS WinDesc file submitted with each bench mark leveling event.

CO-OPS has photos of nearly all bench mark disk faces, setting, and location shots of NWLON and active subordinate station tidal bench marks. The station specific requirements shall note any additional photos needed to achieve a complete photo gallery of each mark.

If a bench mark is discovered disturbed or mutilated during the visit to a station, include it in the

level run to determine if it is holding its elevation relative to the PBM and report it to COET and the supporting FOD field office. COET will make a decision and inform the Installer via the next set of Station Specific Requirements regarding the action that needs to be taken: destroying the mark, if it is a NOS mark, or dropping the mark from the leveling network for other marks. If the PBM has been disturbed, contact COET immediately for further direction.

Before installing a new mark, perform a 1.6 kilometer (1 mile) radial search from the tide station (DCP) location at NGS web site, http://www.ngs.noaa.gov/datasheet.html to check if any NAVD 88 marks are available that are not part of the local leveling network. Inclusion in the local leveling network of an existing mark(s) that has a NAVD 88 elevation, if it is located within a 1.6 km (1 mile) leveling distance of the station location, is desirable and shall be preferred over installing a new mark. If the bench mark is replaced, then the stamping of the bench mark shall have a new letter designation (assigned by COET) and the present year so that the new stamping is different from the original stamping of the mark, or the stamping of other marks in the local leveling network.

Digital photographs of bench marks shall be taken as described in Section 2.7 Station Installation.

3.3 Levels

All leveling shall be performed with electronic/barcode systems, to Second Order, Class I or Third Order standards, in accordance with NGS standards for geodetic leveling, and the CO-OPS *User's Guide for the Installation of Bench Marks and Leveling Requirements for Water Level Recording Stations, NOAA/NOS October 1987*. All CO-OPS and contractor field crews are required to use the NGS WinDesc description and Translev leveling software. Refer to the *User's Guide for Electronic Levels with Translev and WinDesc.*

Two or three meter barcode rods shall be used for Second Order levels whenever possible at all stations. At stations where two or three meter level rods cannot be utilized due to airline size restrictions, justification for use of Third Order barcode rods and levels shall be documented in the eSite Report (or Xpert Site Report (Excel) or Tide Station Report). For stations in AK, HI, and Pacific Island areas the Second Order Class I leveling requirement is waived and the Third Order levels are acceptable.

If digital bar-code leveling systems are to be used, the model should have been previously evaluated by the Federal Geodetic Control Subcommittee (FGCS). These systems include the Leica NA3003, Leica DNA03, Topcon DL101C, Trimble DiNi 12, Zeiss DiNi 10, DiNi 11, DiNi 12 and DiNi 12T. Bench mark descriptions and leveling output must be in an NGS-supported format to enable processing and adjustment of the levels by NGS. Station bench mark descriptions and recovery notes shall be submitted in computer-readable form using WinDesc software. The basic WinDesc usage instructions are built into the program under the HELP menu when you run WinDesc. Field book and field abstract software are required and are dependent on the leveling equipment used for this project. Translev is an NGS program that facilitates the process of editing, formatting and checking digital leveling observation data and creates abstracts, bok files, and

VERTOBS datasets for submission to the NGS. WinDesc and Translev are the two programs currently being used by CO-OPS to submit leveling data to NGS. NGS training is available if needed. These NGS programs are available online at http://www.ngs.noaa.gov/PC_PROD/pc_prod.shtml.

CO-OPS will provide appropriate training to contractors in the use of the WinDesc and Translev software for leveling operations, Second-order Class I leveling connections shall be made from the primary water level sensor (AQLP, MWWL LP, or pressure sensor orifice [staff stop], and in the Great Lakes the ETG RM and the Spike RM) to a minimum of 5 bench marks on an annual basis, including the primary bench mark (PBM). In the case of pressure sensors as primary sensors, the elevation of orifice zero to orifice staff stop(s) shall be measured annually using a calibrated steel tape with millimeter graduations, elevation of the orifice staff stop(s) to the PBM shall be determined using conventional leveling equipment.

As described in the *User's Guide for the Installation of Bench Marks and Leveling Requirements for Water Level Stations, October 1987* Section 3.3, Page 18, levels are required and shall be performed for the seven cases listed. Particular emphasis is placed on performing check levels as per the specific project requirements or no later than 6 months after the establishment of a new water level station. This is required for declaring a newly installed water level station operational.

All of the bench marks in the leveling scheme shall be leveled within a two year period. This may be accomplished by leveling to the PBM and four marks one year, then to the PBM and the remaining marks the next year. In some cases, it may be practical to level to all the marks the second year to reach the furthest marks from the station. A level connection to Continuously Operating Reference Station CORS marks shall also be made once every two years, if those marks are within 1.6 km (1 mile) leveling distance from the water level station. The Installer shall be responsible for ensuring that every mark in the station bench mark network is leveled at least once every two years.

The primary water level sensor shall be connected to the station bench marks by levels. The levels shall be run upon sensor installation, in conjunction with annual maintenance levels, if obvious sensor movement is noticed during regular/emergency maintenance, and upon sensor removal. The levels to the sensor(s) may be a spur run(s) from any bench mark(s); it is not necessary to have the spur run directly from the PBM to the sensor(s). If leveling starts at the sensor then it is not considered a spur run.

At Great Lakes sites where a spike is unavailable for use in performing a water transfer, (see section 3.1 for a description of procedures to perform water transfers), the water level in the sump shall be compared to the water surface outside the sump by differential leveling and the use of the water level transfer program (h2o-tran). A difference exceeding $\pm$0.006 meters indicates a possible restriction in flow, which must be corrected. This instruction must be recognized and initialed. Note: this procedure can best be accomplished in the early morning or late evening when the water is most likely to be calm.

When abstracting the raw level data using the electronic digital level system, the PBM shall always be selected as the starting mark, and the AQLP, MWWL LP, orifice staff stop, or ETG, as the case may be, shall always be selected as the ending mark. If the original RAW file is edited before processing, the original file (XXXXXXXo.RAW or XXXXXXX.GSI) shall be stored in a separate subdirectory named "Original RAW", and submitted with the edited RAW (XXXXXXX.RAW or XXXXXXX.GSI) file and other level files.

While using the electronic levels, any changes made to the description file (XXXXXXX.DES) require that the levels be reprocessed and submitted to COET. Dates of the DES file must be chronologically consistent with the abstract ABS and other files generated. The date of the DES file cannot be later than the date of the ABS file.

Newly installed barometric sensors shall be included in the level run as a spur. Barometric pressure sensors shall be leveled, or their height otherwise determined in relationship to station datum, during installation, or if the barometer is moved to a new location. Barometric sensors at Great Lakes stations shall be leveled, or their height otherwise determined in relationship to DYNAMIC/IGLD 85. Since small changes in elevation do not change the height correction, the original leveling requirement to the barometer every five years is not needed. The elevation of Mean Sea Level (MSL) above Station Datum in the header information for the specific annual requirements for each station is based upon the 1983-2001 tidal datum epoch. The Barometer C2 shall be computed to include both the calibration corrections and height corrections. The Installer shall ensure that the new elevation is also correct on the Site Report section for calculation of the barometer C2. The barometer C2 shall be updated in the DCP during the annual inspections. The SSN for the barometric sensor shall be xx10 if it is included in the electronic leveling, where xx is the part number. At Great Lakes stations, the "Barometer Installation Worksheet – Great Lakes" shall be used to compute the Height of the Barometer above the ETG. Refer to *SOP 5.4.1.4 (A) Sutron Accubar Barometer Field Calibration Procedures* for additional information.

3.3.1 Leveling to NOAA Sentinels and Elevated Platforms

Leveling connections on Sentinels and other elevated platforms require a combination of steel-taped height differences between the AQLP, MWWL LP, or a TBM at deck level ("deck" TBM) and a TBM near ground level ("ground" TBM), and a standard level run between the "ground" TBM and bench mark network.

To level from the AQLP or MWWL LP to a TBM that can be included in the standard level run a TBM shall be chosen that can be leveled to the existing bench mark network using the standard barcode rod. This "ground" TBM shall be named and described per *User's Guide for Writing Bench Mark Descriptions* so that surveyors can level to the exact same TBM in future level runs during the maintenance of the Sentinel or elevated platform. The point where the taped measurement is made is critical in this description. This TBM shall also be placed in a position where a taped measurement can be made from the TBM to the AQLP or MWWL LP. If this is not possible, another TBM at the deck level of the Sentinel or elevated platform shall be chosen, then named and described per the *User's Guide for Writing Bench Mark*

Descriptions, again with care to include the point of measurement in the description. This "deck" TBM shall be connected to the AQLP or MWWL LP using standard leveling procedures.

The steel taped distance from the "ground" TBM to the AQLP (or MWWL LP) or "deck" level TBM shall be performed on a windless day. A plumb bob shall be dropped from the AQLP (or MWWL LP) or "deck" TBM to insure that the steel tape is held as vertical as possible. A set of five readings each shall be made by a minimum of two people for a total of ten readings. Each reading shall have the zero of the steel tape positioned at the high point of the "ground" TBM and the elevation shall be read from the tape at the AQLP (or MWWL LP) or the high point of the "deck" TBM. The steel tape shall also be moved away from the TBMs and repositioned for each reading. The ten readings shall be averaged to acquire the height between the "ground" TBM and the AQLP (or MWWL LP) or "deck" TBM.

The averaged steel tape height shall be entered into the DNA03 so that it is abstracted in to the level run. This is done by manually entering a zero for the staff height on the "ground" TBM as the **Backsight**, then entering the **positive** value of the averaged steel tape height for the Foresight of the **Forward Run**. During the **Backward Run**, enter zero for the **Backsight**, then a **negative** value of the averaged steel tape height for the **Foresight**. This will put the height of the AQLP or "deck" TBM into the abstract when the levels are processed using Translev.

3.3.2 Leveling to Temporary Bench Marks (TBM)

Due to leveling to meteorological sensors and water level sensors connected to DCPs other than DCP 1, the designation for TBMs shall be changed to include the full 8 digit station number: XXX XXXXY, where XXX XXXX is the Station ID, and Y is the DCP number. For example: If the barometer is installed on DCP 1 at 8410140 Eastport, the designation shall be TBM 841 01401 Barometer. If the barometer is installed on DCP 2, the designation shall be TBM 841 01402 Barometer. This format shall be used for all sensor TBMs.

In addition, there have been several new water level TBMs added that are standardized in the following table. Use the designations below to correctly identify the orifice and microwave water level leveling point at a water level station. Due to the character limitations in WinDesc and Translev, it may be also be necessary to assign an alias.

Leveling Point (LP) Designation	Leveling Point Alias	Sensor Zero Measurement Point Designation
TBM xxx xxxxy Aquatrak LP	Aquatrak LP	N/A
TBM xxx xxxxy Single Orifice LP	Single Orifice LP	Single Orifice Zero
TBM xxx xxxxy Dual Orifice LP*	Dual Orifice LP	Upper Orifice Zero
		Lower Orifice Zero
TBM xxx xxxxy Upper Orifice LP**	Upper Orifice LP	Upper Orifice Zero

TBM xxx xxxxy Lower Orifice LP**	Lower Orifice LP	Lower Orifice Zero
TBM xxx xxxxy MWWL LP	MWWL LP	N/A

*For Dual Paros installations sharing the orifice LP use the designation TBM xxx xxxxx Dual Orifice LP.

**For Dual Paros installations with separate orifice LPs for the upper and lower orifice, use the designations TBM xxx xxxxx Upper Orifice LP and TBM xxx xxxxx Lower Orifice LP.

3.4 Datum Offsets and Accepted Orifice Offset

The leveling connection to an acoustic sensor shall be done at the AQLP. The AQLP is defined as the top shoulder of the mounting plate collar on the calibration tube. The leveling connection to a MWWL sensor shall be done at the MWWL Leveling Point (LP). The MWWL LP is located on the top of the flange as shown in the picture below (Figure 1).

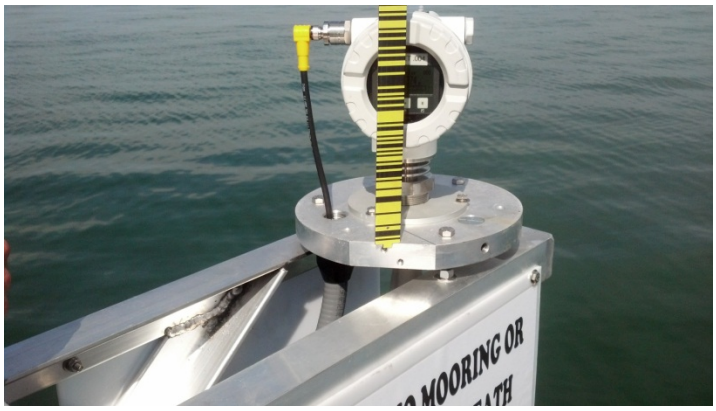

Figure 1: MWWL Leveling Point

In order to facilitate rod holding, a prefabricated leveling fixture may be slipped over the acoustic sounding tube to rest on the leveling point. The height of the leveling fixture, as inscribed on the fixture, shall be compensated for in the leveling record (abstract). The level abstract shall show the elevation of the leveling point only. A barcoded rule or stainless steel rule, with metric graduation (mm) and the zero at the end of the rule, as appropriate, may be used in lieu of the leveling fixture by holding the rule directly on the leveling point. In cases where the leveling point is too high for a rod shot, the leveling fixture designed for a down shot shall be utilized and the readings recorded to reflect the down shot. Use of other leveling fixtures and leveling techniques must be approved in advance by ED.

The AQLP elevation above station datum is defined as the Datum Offset and is computed by algebraically adding the PBM elevation above SD to the acoustic sensor elevation above/below the PBM. The Datum Offset is also referred to as Coefficient C2 for the Sutron 9210 DCP and as DAT coefficient for the Sutron Xpert DCP. C2 will not be changed unless the elevation differs by greater than $\pm$ 0.006 meters and only then after notification and review by ED.

The leveling connection to an ETG shall be done at the reading mark (RM). A barcoded rule (60 cm scale) or stainless steel rule, with metric graduation (mm) and the zero at the end of the rule, as appropriate, may be used by holding the rule directly on the RM.

The orifice zero elevation for the Paroscientific pressure sensor(s) above or below the SD is defined as the Accepted Orifice Offset and is computed by algebraically adding the PBM elevation above SD to the (sensor) orifice zero elevation above/below the PBM. The orifice zero elevation is considered to be the point of the V on the brass orifice or the bottom of the top parallel plate. For dual orifice systems the orifice offsets are established for both lower (N1) and upper (T1) pressure sensors. Accepted Orifice Offset(s) will not be changed unless the elevation differs by greater than $\pm$ 0.006 meters and then only after notification and review by ED.

At Great Lakes stations, the Dynamic Height of the ETG RM, plus or minus the Hydraulic Corrector, at all lake stations, defines the IGLD 85 datum offset. In the Great Lakes Rivers and Connecting Channels stations the "Dynamic Height = IGLD 85", Hydraulic Correctors are not applied. This datum offset is applied to the Primary Water Level C2 and should only be changed by ED after reviewing the abstract and Water Level Transfer form.

When using the electronic/barcode leveling system, all five decimal places shall be used to determine the Datum Offset on the approved site report. After adding or subtracting the difference between the leveling point and PBM, to the elevation of the PBM above the SD, round off the five place value of the Datum Offset to four places. Rounding shall be done to the even number, for example: 1.53455 is rounded to 1.5346. A note shall be made to the effect that the existing Datum Offset was retained in the DCP, or the new Datum Offset was entered with date and UTC time it was entered. When new Datum Offset is entered into the DCP, additional notification is required as listed below under Section 3.5 Movement. For stations that have the Paroscientific pressure sensor(s) as primary sensor(s), the change of accepted orifice offsets shall be documented on the Site Report with date and UTC time, and additional notification is required as listed below under Section 3.5 Movement.

If optical leveling equipment is used, then all elevations shall be recorded to the tenth of a millimeter level (e.g. 12.3457 m) on the leveling abstract.

After documenting the dynamic elevation for the ETG and SPIKE at Great Lakes stations, round to four places and apply these elevations to the "Water Level Transfer" program. Then apply the Hydraulic Corrector utilizing the sign, negative or positive in the program. This elevation is now the hydraulically corrected reference elevation, Zero Electric Tape Gauge (ZETG) and is then rounded to three places and entered in the DCP as Primary Water Level C2. C2 will not be changed unless the elevation differs by greater than $\pm$ 0.003 meters and then only after notification and review by ED.

When setting up the encoder offset at Great Lakes stations, the C2 in the Xpert DCP (sensor 14, coefficient 2 in the 9210 DCP) will need to be zeroed (0.000). The encoder gear will then be turned to reference 6.000 M on the display. Then an ETG reading will be obtained and subtracted from the 6.000 M reference. This difference, called the initial C2, is then stored in

the Xpert DCP (sensor 14 coefficient 2 in the 9210 DCP). All ETG/Display readings have to be within 0.003 m. If not, the set up procedure must be performed again. NOTE: This procedure can best be accomplished in early morning or late evening when the water is most likely to be calm or by closing off the valve.

The accepted PBM elevation above IGLD85 in meters shall be used as the starting elevation on the level abstract at Great Lakes stations. This method results in all bench mark elevations referenced directly to IGLD85.

At coastal sea level stations, the accepted PBM elevation above the SD in meters shall be used as the starting elevation on the level abstract. This method results in all bench mark elevations referenced directly to the SD. "Old" (before sensor swap) and "new" (after sensor swap) AQLP connections, if required, shall be treated as spurs. Regardless of whether the acoustic sensor head is swapped or not, the leveling shall be done only once after the sounding tube has been cleaned and everything is put in place. For stations that have acoustic sensors installed, upon initial inspection of the station, if the Installer suspects a movement of the well or that of the AQLP, then leveling shall be done twice, once before disturbing the well or sounding tube for cleaning and then after repairing the well or cleaning the sounding tube. For stations that have pressure sensor(s) installed, upon initial inspection of the station, if the Installer suspects a movement of the orifice(s), then leveling shall be done twice, once before disturbing the orifice(s) and then after repositioning/securing of the orifice(s). For stations that have MWWL sensor installed, upon initial inspection of the station, if the Installer suspects a movement of the sensor, then leveling shall be done twice, once before disturbing the sensor and then after repositioning/securing of the sensor.

3.5 Movement

The movement of an entity, such as (a) AQLP, (b) MWWL LP, (c) pressure orifice zero, or (d) bench mark is defined as change in elevation of the entity in excess of 0.0060 m (0.020 foot) as obtained by comparing the current difference in elevation of the entity with PBM, with the previous difference in elevation of the entity with PBM. For acoustic and MWWL sensors this difference shall be compared to what is stored in the DCP and appropriate action shall be taken as described below. For pressure sensor orifices this difference shall be compared with the accepted orifice offset as listed on the site report (and stored in DMS) because the accepted orifice offset is not stored in the DCP and appropriate action as described below shall be taken.

The movement shall be noted in the remarks box of the leveling section of the approved site report. If the Datum Offset determined from the latest level run indicates a deviation exceeding 0.0060 meter from the value presently stored in the field unit, and the PBM has remained stable, the new Datum Offset shall be entered into the field unit (no verification levels required) after consultation with ED. If the PBM is determined to be unstable, and other bench mark differences remain within the 0.0060 m allowable, the Datum Offset in the field unit shall not be changed. The suspected movement of the PBM shall be specifically noted, as instructed above, for further action by ED COET. At Great Lakes stations, if the Primary Water Level Coefficient 2 (C2) determined from the latest levels indicates a deviation exceeding 0.003 meter from the

value presently stored in the field unit, and the PBM has remained stable, contact ED within 24 hours and provide the leveling abstract and Water Level Transfer.

ED COET and the supporting FOD field office shall be notified by phone or e-mail immediately when the Datum Offset is changed in the DCP, or the accepted orifice offset has changed more than +/- 0.0060 m. An e-mail (nos.coops.oetteam@noaa.gov), fax copy of the level abstract (fax 301-713- 4465), and a phone call (telephone 301-713-2900) if possible, must be received by ED COET and supporting FOD field office within 24 hours of the change. Contact information for FOD field offices are listed in Section 4.2.3.

3.6 Geodetic Connections

Water level datums are local vertical datums which may vary considerably within a geographical area. A geodetic datum is a reference surface relative to which heights are determined. The North American Vertical Datum of 1988 (NAVD 88) is the accepted vertical datum of the National Spatial Reference System (NSRS) for the conterminous United States and Alaska and is officially supported by NGS. The relationships of tidal datums to geodetic datums such as NAVD 88 and to ellipsoid heights (above GRS 80 ellipsoid) support many hydrographic, coastal mapping, and engineering applications including monitoring of sea level changes, the deployment of GPS Electronic Chart Display and Information Systems (ECDIS), and the NOS Vertical Datum (VDatum) transformation tool.

Existing Geodetic Bench Marks (GBM) in the vicinity (up to 1.6 km (1 mile) leveling distance) of a water level station (primary and subordinate) shall be searched for and recovered. If a mark is either not recovered or not used in the survey/project, a separate report shall be made using the NGS on-line Mark Recovery Entry Form at http://www.ngs.noaa.gov/ngs-cgi- bin/recvy_entry_www.prl

The connection to geodetic datums involves the following three leveling ties:

1. NAVD 88 Level Tie
2. NAD 83 GPS Tie
3. NAVD 88 GPS Tie

An orthometric level connection and ellipsoidal GPS tie are required at each water level station (primary and subordinate) which has at least one Geodetic Bench Mark (GBM) located nearby (within 1.6 km (1 mi) leveling distance of a water level station).

The required “NAVD 88 Level Tie” is described in this document and the required “NAD 83 GPS Tie” and “NAVD GPS Tie” are described in Reference 6.

3.6.1 NAVD 88 Level Tie

There are two parts for this requirement as described below in A and B.

(A) NAVD 88 Level Tie: At all water level stations, a valid level tie to at least two GBM is required on each set of levels, where appropriate GBM marks are available within 1.6 km (1 mi) leveling distance of the station location. A GBM is defined as a bench mark that exists, is useable, is available in the NGS database, has a Permanent ID (PID), and has a NAVD 88 elevation published on the datasheet. At many NWLON stations, the Primary Bench Mark (PBM) is a GBM. At the majority of NWLON stations, there are two or more tidal bench marks that are also GBM, thus increasing the chance that the geodetic level tie would be valid.

Make a Second-Order, Class 1 level tie to NAVD 88 for all NWLON stations in the conterminous United States and Caribbean Islands. A Third-Order tie is used for all NWLON stations in Alaska, Hawaii, and Pacific Island areas.

At stations supporting hydrographic or shoreline mapping surveys, or other special projects, the tie shall be consistent with the accuracy of the levels required for the project (e. g. Second Order Class I or Third Order levels).

The Translev leveling program includes a check function that will tell the user if a two mark tie to NAVD 88 has been successful. Information on performing a valid level tie is also provided in the Federal Geodetic Control Committee (FGCC) Standards and Specifications for Geodetic Control Networks, listed at the following website:
http://www.ngs.noaa.gov/FGCS/tech_pub/1984-stds-specs-geodetic-control-networks.htm#3.5

Section 3.4 of "User's Guide for the Installation of Bench Marks and Leveling Requirements for Water Level Stations, October 1987" provides the same information regarding on how to perform a valid level tie. The information in the User's Guide is easy to follow as it is written in non-technical language.

The Second Order, Class 1 tie is a requirement for digital levels to be accepted into the NGS database. Short level runs to the sensor, PBM, and two marks are excluded from this requirement since they are usually meant to verify sensor stability only. Since a level connection to GBMs with dynamic heights defines the International Great Lakes Datum of 1985 (IGLD 85) datum offset at each station in the Great Lakes, a valid connection to at least two GBMs (within a mile of station location) is required at each site.

A note shall be made in the remarks of the leveling section of the Site Report that a valid tie was achieved or not achieved. If a valid tie is not achieved, an explanation shall be provided and/or recommendations made for making a valid tie in the future.

If a successful NAVD 88 level tie is performed, then NAVD 88 elevations for all the bench marks in the local leveling network (10 for NWLON and 5 for subordinate stations) can be determined for the NOS Vertical Datum transformation (VDatum) program.

If the water level station does not have two or more GBMs within 1.6 km (1 mi) leveling distance of the station location, then the NAVD 88 level tie requirement is waived.

(B) NAVD 88 Level connection: An orthometric level connection is required at each water level station (primary and subordinate) which has at least one GBM located within 1.6 km (1 mi) leveling distance of a water level station. If the water level station has two or more GBM within 1.6 km (1 mi) of radial distance of the station location, then perform a NAVD 88 Level Tie (as described above in A) which fulfills the requirement for NAVD 88 level connection.

A successful NAVD 88 level connection to a GBM will help determine the approximate NAVD 88 elevations for the all the bench marks in the local leveling network (10 for NWLON and 5 for subordinate stations) for the NOS VDatum program.

If there are no GBM within 1.6 km (1 mi) leveling distance of the station location, then the requirement for NAVD 88 level connection requirement is waived.

3.6.2 Leveling at CORS

For any NGS Continuously Operating Reference System (CORS) reference bench mark that is located within 1.6 km (1 mi) leveling distance of a water level station DCP, a leveling connection shall be made to the tidal bench marks in the water level station network every two years.

Information about NGS CORS stations can be obtained at http://www.ngs.noaa.gov/CORS/.

As of 2010, there are a limited number of water level stations in this category, but NGS and CO-OPS are attempting to secure funding to establish additional co-located sites to support long-term sea level trends monitoring.

3.6.3 GPS Connections

An orthometric level connection and ellipsoidal GPS tie are required at each water level station (primary and subordinate) which has at least one GBM located nearby (within 1.6 km (1 mi) leveling distance of a water level station).

GPS connections involve the following two ties:

1) NAD 83 GPS Tie
2) NAVD 88 GPS Tie

The required “NAD 83 GPS Tie” and “NAVD GPS Tie” are described in the *User’s Guide for GPS Observations at Tide and Water Level Station Bench Marks*.

4 SCHEDULE, REPORTS, AND DELIVERABLES

4.1 Schedule and Reports

Operations schedules are prepared for all water level stations each September for the upcoming fiscal year. Schedules for FOD and contractor operations are combined to produce one composite plan for CO-OPS. Overall accomplishments are compared to the plan on a monthly basis and reported to CO-OPS management.

Contractors shall provide ED COET and the supporting Instrument Lab and FOD field office a proposed annual schedule for accomplishing the indicated work in the station specific annual project instructions, or task orders, at the beginning of the task order with updates on a monthly basis, or as specified in the contract documents. Changes to the schedule must be requested in advance and approved by the COR or CO-OPS.

Operations related to the indicated work in the station specific annual project instructions, or task orders, shall be discussed in a monthly activities report, or as specified in the contract documents.

4.2 Deliverables – Timelines, Documentation, and Points of Contacts

4.2.1 Timeline Requirements

Wherever communications allow, the one-day (24 hr.) draft eSite Report (or Xpert Site Report (Excel) or Tide Station Report) along with level abstract shall be forwarded to COET within 24 hours after the following maintenance activities:

a) Installation of a water level station;
b) Completion of regular scheduled annual maintenance;
c) Completion of emergency maintenance;
d) Completion of check levels; or
e) Removal of a water level station.

The purpose of the one-day (24 hr.) draft Site Report is to:

1) Standardize the requirements for all of CO-OPS' field efforts;
2) Provide feedback by COET to the Installer while at the site, so that critical information is verified; and
3) Insure that timely corrective actions and required maintenance actions as described in the station specific Project Instructions can be accomplished by the Installer while at the site.

Generally, COET will respond back to the Installer or provide feedback within 24 hours or earlier during normal business hours during the work week. This requirement applies to all types of water level stations and all types of sensors for every type of maintenance - installation,

regular scheduled maintenance, emergency maintenance and removal of a water level station, where CO- OPS is expected to receive and/or process the data.

CO-OPS has developed a web-based electronic site report (eSite Report) that interacts with DMS. Refer to the *User's Guide for the eSite Report Application* and the *SOP 3.2.3.5 E(15) eSite Report User Access to Build, Submit, Reject, Advance, and Approve Steps*.

The Installer is required to submit the required documentation as described below in Section 4.2.2 to CO-OPS ED COET and the supporting FOD field office or the Task Manager within 30 calendar days of completion of water level station installation, maintenance, repair, removal, GPS observations, or as specified in the contract documents, whichever is earlier.

All data and documentation submitted to CO-OPS shall be retained by the Installer for a period of not less than three years or as stipulated in the contract, whichever is longer.

4.2.2 Documentation Requirements

The standard water level station documentation package includes the following:

1) Transmittal letter (PDF format)
2) eSite Report, or Water Level Station Xpert Site Report, or Tide Station Report (eSite report in web based electronic format, Water Level Station Xpert Site Report in Microsoft Excel format or Tide Station report in Microsoft Excel format)
3) Sensor test worksheet (PDF format)
4) Sensor elevation drawing (PDF format) showing sea floor, pier elevation, and sensor elevation if the sensor is mounted vertically.
5) Water level transfer form (for Great Lakes stations only - PDF format)
6) Barometer Installation Worksheet (for Great Lakes stations only - PDF format)
7) Bench mark Diagram (PDF format) – Large-scale bench mark location sketch of the station site showing the relative location of the water level gauge, staff (if any), bench marks, and major reference objects found in the bench mark descriptions. The bench mark diagram shall include an arrow indicating north direction, a title block that includes: the station name and number, NOAA chart number, USGS Quad name, field unit, date created, drawn by, and latitude and longitude (obtained from hand-held GPS receiver) of the gauge, and label of the body of water. (Required for newly installed stations only – PDF format.)
8) Bench mark descriptions with handheld GPS coordinates (d/m/s.s format) (electronic file - WinDesc).
9) "Station to Reach" statement in Microsoft Word format.
10) Digital photographs of each bench mark disk (four views), station, DCP, equipment, underwater components, and vicinity (JPEG format).
11) Levels (electronic files) including leveling equipment information and field notes of precise leveling, if applicable.
12) Abstract of precise leveling (electronic format).
13) Datum offset computation worksheet or Staff/Gauge difference work sheet as

appropriate showing how sensor "zero" measurement point is referenced to the bench marks.

14) Staff to gauge observations, if applicable (Microsoft Excel format)
15) Calibration certificates for Invar leveling rods, if applicable (PDF format)
16) Calibration records for sensors, if applicable (PDF format)
17) Agreements, MOU, contract documents, utilities/pier agreements, etc., if applicable (PDF format)
18) Other information as appropriate, or as specified in the contract (PDF format)
19) Water level data download in specified format
20) GPS Deliverables - the OPUS published datasheet and 4 photos of the GPSBM in electronic format for each observation session as described in the User's Guide for GPS Observations at Tide and Water Level Bench Marks.
21) Annual Inspection (AI) checklist (Applicable for all CO-OPS' NWLON AI).
22) Diving Documents (DAMP, Dive Plan, etc.).

The station documentation shall be submitted in digital format only. All GPS data and documentation shall be published to NGS OPUS.

Water level data downloaded for NWLON, PORTS, Tsunami, COASTAL, or in-house projects shall be in accordance with the *Engineering Bulletin 07-006 Exporting Data from Xpert Family DCP*. Water level data downloaded and submitted to CO-OPS for contract hydrographic and photogrammetry survey projects for validation shall be in accordance with the *NOS Hydrographic Surveys Specifications and Deliverables.*

Generally, for established NWLON stations or long term water level stations (more than 1 year), "To Reach" statement need only be submitted if these items have been revised during the station maintenance or removal, because these items are required and are generally submitted with the installation station package.

When using the electronic/barcode system, all digital files created using the WinDesc and Translev programs shall be submitted. At stations where the automated or manual levels are used, Precise Leveling sheets of actual runs (NOAA Form 75-29) and Abstract of Precise Levels (NOAA Form 76-183) shall be completed and submitted along with the WinDesc description file.

For submission in electronic format, the station documentation shall be organized by various folders under the main station number folder, and then pertinent information shall be placed in the various folders and submitted on a digital media, such as DVD/CD-ROM, FTP sites, etc.

Here is an example of submission of the electronic folders for San Francisco tide station:

9414290 San Francisco 2010 Annual Inspection
/ Transmittal letter
/ eSite Report, Xpert Site Report (Excel) or Tide Station Report
/ Sensor test worksheet

- / Sensor elevation drawing
- / Water level transfer form
- / Barometer Installation worksheet
- / Bench mark Diagram (new installations only)
- / Bench mark descriptions (WinDesc)
- / "Station To Reach" Statement
- / Photographs of bench marks, station, DCP, equipment, and vicinity in digital format
- / Levels (raw electronic files) and field notes of precise leveling
- / Abstract of precise leveling
- / Datum offset computation worksheet or Staff/Gauge difference work sheet (elevation of sensor zero measurement point referenced to bench marks)
- / Staff to gauge observations, if applicable
- / Calibration certificates for Invar leveling rods, if applicable
- / Calibration records for sensors, if applicable
- / Agreements, MOU, contract documents, utilities/pier agreements, etc., if applicable
- / Other information as appropriate, or as specified in the contract
- / Water level data (6-minute, hourly heights, high/low, monthly means, station datum)
- / GPS deliverables, as applicable
- / Annual Inspection Checklist
- / Diving Documents
- / GPS deliverables, include the OPUS published datasheet, and four (4) photos of GPSBM

4.2.3 Points of Contact for Deliverables

All required deliverables listed in Section 4.2.2 above shall be submitted to the proper point of contact as listed in the project instructions, contract documents, if applicable; or to NGS or CO-OPS (see below) within 15 business days of the GPS observations, installation, maintenance, or a removal of a water level station, or as specified in the Statement of Work or contract, whichever is earlier. All GPS data and documentation shall be published to NGS OPUS.

(A) For all work done by NOAA (FOD, NOAA ships, NRT, other NOAA personnel) submit one copy of all the documentation including the GPS deliverable in digital media, such as DVD/CD- ROM, FTP sites, etc., to:

Chief, Engineering and Development
Branch
CO-OPS, N/OPS1, SSMC 4, Station
6507
1305 East-West Highway
Silver Spring, MD 20910-3821
Tel: 301-713-2897 x 190

(B) For all CO-OPS' IDIQ contract work deliverables, submit one copy of all the documentation including the GPS submission in digital media, via Task Order Management Information System (TOMIS) to the Contracting Officer's Representative (COR) and Task Manager. The COR and Task Manager contact information is listed below:

Marty Welch
Contracting Officer's Representative
CO-OPS, N/Staff
SSMC 4, Station # 6544
1305 East-West Highway
Silver Spring, MD 20910-3281
Tel # 301-713- 2897 X 129

For East Coast task orders, submit to:
Task XXX Manager
NOAA, NOS, CO-OPS, Field Operations Division-Atlantic Operations Branch
672 Independence Parkway
Chesapeake, VA 23320
Tel: 757-436-0200

For West Coast task orders, submit to:
Task XXX Manager
NOAA, NOS, CO-OPS, Field Operations Division-Pacific Operations Branch
7600 Sand Point Way, NE
Bin C15700
Seattle, WA 98115
Tel: 206-526-6360

(C) For OCS contract hydrographic survey projects, submit one copy of all the deliverables (water level data, station documentation, and GPS deliverable) in digital media, such as DVD/CD-ROM, FTP sites, etc., to:

Chief, Engineering and Development Branch
CO-OPS, N/OPS1, SSMC 4, Station 6507
1305 East-West Highway
Silver Spring, MD 20910-3233
Tel: 301-713-2900 x 190

(D) For NGS contract shoreline mapping survey projects, submit one copy of all the deliverables (water level data, station documentation, and GPS deliverable) in digital media, such as DVD/CD-ROM, FTP sites, etc., to:

Mr. Greg Stinner
Contracting Officers Representative
NOAA/NOS/National Geodetic Survey
SSMC 3, Station # 8609
1315 East-West Highway
Silver Spring, MD 20910-3281
Tel: 301-713- 3167