cGNSS Metadata Documentation

Procedure Number: 3.2.3.12.3-L3
Created: April 16, 2020
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Approved By: Manoj Samant, May 5, 2020

1. Title cGNSS Metadata Documentation

2. Purpose

This standard operating procedure (SOP) is needed to help the Configuration and Operational Engineering Team (COET) members assign site IDs, create and archive continuous global navigation satellite system (cGNSS) station metadata site logs and level files. COET will need to create and/or update these files after acceptance of documentation for any site visit of a station with a CO-OPS installed cGNSS sensor.

3. Background/History

CO-OPS has begun to install co-located cGNSS sensors at permanent water level stations. COET is responsible for determining the required metadata to be collected and archived in CO-OPS records. COET will work with FOD, OSTEP, and DDET to ensure that all the required information is provided so that COET can create the necessary files that are made available to partners and the public about these stations.

CO-OPS cGNSS is a unique and separate continuously operating real time vertical reference system from the Continuously Operating Reference System known as CORS operated by our sister program office, National Geodetic Survey (NGS). The unique proximity to the coastal environment with potential multipath signal errors and localized subsidence and uplift movement makes compliance with the rigorous CORS guidelines and post processing quality assurance analysis difficult. It is not the intention of CO-OPS to create a CORS compliant system.

It is CO-OPS intention to build the most stable water level observation network possible tied to the national, state, and local spatial reference systems taking advantage of the extensive lessons learned by and experience of NGS and professional land surveyors throughout the country. This systems will be capable of monitoring vertical land motion tied to water level measurements at the highest precision and accuracy possible. To that end, CO-OPS will provide the metadata outlined in this SOP to ensure that cGNSS data collected can easily be shared, compiled, processed, and evaluated by anyone.

4. Scope/Applicability

This SOP provides guidance to COET since the responsibility of aggregating the required metadata and developing the site logs and the Système d'Observation du Niveau des Eaux Littorales (SONEL) level files resides with COET. This SOP is applicable to COET, FOD,

OSTEP, OSM, IDIQ contractors along with the corresponding TR/COR. COET will compile the metadata with information provided from all other groups listed.

5. Main Processes

Site ID: This section documents the process that COET follows as part of their responsibility to assign the site ID for the cGNSS sensor to be included in all documentation stored and distributed to partners. The site ID is unique for every cGNSS sensor and differs from the station ID and is dependent on the region the sensor is located in.

Data Telemetry: This section documents the metadata that is required for COET to ensure that ISD has been provided in order to allow data to be collected from the station and ingested into the database. In addition, this section documents the metadata for the communication system for internal records.

Site Log: This section documents all crucial metadata that is made available to the public and partners through a standardized file that is located with the data files. The site log is published to a FTP site that is made available to partners where they can access the data.

Photos: This section documents the necessary photos and naming conventions for pictures that are to be taken of the cGNSS sensor and its mounting.

Level Files (database): This section documents the level files that contain all necessary information in order to configure the database to store elevations and crucial location information for the cGNSS sensor.

Level files (partner): This section documents the level files that contain all necessary datum references/elevations, location information and descriptions in order for SONEL to develop the bench mark page on their website.

6. Detailed Sub-Processes/Checklists

A. Site ID

Every cGNSS sensor must have an unique site ID, similar to a PID for a bench mark. The site ID cannot be in use by anyone else in the country, not just federal partners. This includes all research institutions, i.e. colleges, as well. Site IDs are 4 digits in length and can be any combination of numbers and letters in any order. For consistency purposes, CO-OPS has requested from our federal partners and the main research institutions to reserve a series of 1000 IDs for potential use. Whereas most organizations are choosing to assign site IDs as some sort of combination that can pinpoint location, city, state or some combination, all of CO-OPS IDs will begin with the letter “N” followed by 3 numbers (N001-N999). The ability to correlate a 4 digit site ID to the existing 7 digit station ID will be made in a future update to DPAS PowerBuilder or in the first release of MMS. Until then, the site ID is to be stored as a comment in the station configuration screen comment box.

Each section of the U.S. has been split up into a series of numbers available of the 1000 site IDs. The breakdown is as follows:

N001-N299: East Coast/Carribean

N300-N550: Gulf Coast

N551-N799: West Coast/Pacific

N800-N950: Great Lakes

N951-N999: Other

As opposed to breaking down the regions even further, site IDs will be assigned in each region by assigning the next available number. Once there is a database table to reflect these numbers via an entry in DPAS PB/MMS, a simple database query will inform COET of the next available number in each region. Until that happens, COET will need to keep a manual list of the numbers assigned.

B. Data Telemetry

After COET has assigned a site ID for a new sensor, ISD shall configure the ingestion system to begin to acquire data from the station. The IP address and Port # will need to be provided to the ingestion team. The IP address and port # will be stored along with all other metadata pertaining to the communication equipment. The required metadata for the equipment is the serial number of the modem the make/model of the modem, the service provider, and the make/model/type of the communication antenna. This metadata is crucial to help identify similar configurations should an issue be identified with one of the pieces of equipment. This information should be stored in the DCP configuration screen comment box of the primary DCP until DPAS PB and/or eSite is updated to store this equipment.

C. Site Log (update after every site visit documentation review)

The Site Log is the most important piece of documentation to be maintained and must be updated after any and all site visits where the cGNSS equipment is impacted. The site log is provided to all partners/users of the data and contains details about the site, the equipment itself, maintenance records and anything else of relevance to the equipment (who owns it, maintains it…etc.) and is made available on the CO-OPS FTP site. A Jira ticket must be submitted providing the updated site log requesting it replace the existing one.

The CO-OPS site log is similar, but not identical to the NGS site log. Sections that are not relevant or contain information that CO-OPS doesn't collect have been removed out of the template. Every section should be filled out to the best extent. Nothing is to be deleted from a site log, only additional fields for each section are added. Each section of the site log contains a template section to be copied and updated to reflect the most recent information, with the older information above it. The section number is also incremented in each section with each copy. For example, if you are adding in a new series of information in section 4, the newer one would be numbered as 4.2 with the older information renumbered as 4.1, and with the next newer section would be numbered as 4.3. Having a complete listing of all records/changes will allow users to see when things were changed. Providing a history of all component changes and all other changes will allow the user to understand why changes may be present in the data series.

If information is unknown, the line should remain blank if there was no template information provided in parenthesis (). If there were options or information listed in parenthesis, the line should remain unaltered. The parenthesis are the identified way of indicating if the information is unknown, missing or not required for this site.

The file name for the site log must follow a standard format in order to be easily loaded onto the FTP site. This standard format will allow CO-OPS personnel to search the station files drive and get all records, but also to make it easier for outside users to check if they have the newest version. The file name starts with the 7 digit CO-OPS station id, followed by the 4 digit site ID (starting with a "N"), then the words "cGNSS_Site_log" and then the date of the most recent update in month_day_year format. An example of the station name is:

84526000_N001_cGNSS_site_log_Aug_6_2019

Note that because the site log is also added to the FTP site that contains the data files, there can be no spaces in the file name and underscores are to be used as demonstrated in the example.

The site log is broken down into 10 sections and are explained in detail below:

- Section 0 – Form
    - This section details who generated the most recent version of the form, the date it was prepared, its report type (New/Updated).
    - If the report is updated, a listing of the previous site log and what was modified/added is included.
- Section 1 – Site identification of the GNSS monument
    - This section provides basic information about the site, such as the name, site ID, CO-OPS station ID.
    - Additional type is what is being referenced in levels (The antenna reference point (ARP)), heights, foundation information, and date installed.
- Section 2 – Site Location Information
    - This section provides information about where the sensor is located: city, state, tectonic plate, coordinates…etc.
- Section 3 – GNSS Receiver Information
    - This section contains information about each individual receiver that has been at this site including all basic metadata (S/N, firmware…etc.).
- Section 4 – GNSS Antenna Information
    - This section contains information about each individual antenna that has been at this site including all basic metadata (type, S/N, ARP to phase center offset).
- Section 5 – Surveyed Local Ties
    - This section contains information on Local ties to other markers on the site and listed in ITRF coordinates to 1mm precision in all 3 dimensions. Offsets are given in geocentric Cartesian coordinates (ITRF).
- Section 6 – Collocation Information
    - This section contains information to describe additional collocated cGNSS/CORS information at a station. Most site logs will not have this section filled out.
- Section 7 – Maintenance Records

    - This section provides a brief description of each maintenance event that involves the cGNSS equipment such as installs, remote updates, leveling, on-site visits, component swaps…etc.
    - This section will be updated the most frequently.
- Section 8 – On-Site, Point of Contact Agency Information
    - This section will be identical for all CO-OPS installed cGNSS sites and list COET as primary contact and UST as secondary contact.
- Section 9 – Responsible Agency
    - This section will be identical for all CO-OPS installed cGNSS sites and list COET as primary contact and UST as secondary contact.

Additional information about the NGS site log can be found at the NGS CORS guidelines page at https://www.ngs.noaa.gov/CORS/Establish_Operate_CORS.shtml and selecting 'Log Instructions'.

See Appendix A below for an example of a site log. A template can be found in the Station Templates folder in the 5-Archive folder on the Station Files drive.

D. Photos

CO-OPS has adopted the photo requirements for cGNSS sensors that NGS requires as noted here: https://www.ngs.noaa.gov/CORS/SitePhotos/Html/description.html. Depending on the mounting of the sensors, between 9 and 12 photos are required for each site. The NGS requirements are to be referenced in the project instructions:

When taking photographs, please remember that their purpose is to give a clear view of the equipment being used, how it is assembled, as well as the space around it for someone who has not visited the station. Photographs must be named as described below. The date specification must correspond to when the photograph was taken. If you are unsure please use the letter x as necessary, e.g. 201206xx or 2012xxxx. The convention to use for azimuth direction is 000 - north, 090 - east, etc. Jpeg format is preferred.

In the file name omit the [] which indicates a variable: ssss is the 4-alphanumeric station id, yyyymmdd is the 4-digit year, 2-digit month and 2-digit day that the photograph was taken.

The photographs must include:

[ssss]_monu_[yyyymmdd].jpg - A photograph showing the monument (pillar/braced/building) and antenna. The ground surface of the building or monument and antenna must be visible.

[ssss]_mark_[yyyymmdd].jpg - A photograph showing the mark. If no unique mark exists then a photograph of the threaded section of the mount, either laterally or from above the monument should be taken. If the station has been collecting data then DO NOT REMOVE the antenna and instead ignore this photograph.

[ssss]_ant_monu_[yyyymmdd].jpg - A close-up photograph that shows how the antenna is attached to the monument.

Four oriented photographs taken at the height of ARP surface the antenna should be included in the photograph, but it should not significantly block the ability to view what lies behind the antenna, be sure to stand about 3-5m away.

If you cannot take a photograph including the antenna place the camera directly at the top center of the antenna, and point the camera in the required direction:

[ssss]_ant_000_[yyyymmdd].jpg North (000)
[ssss]_ant_090_[yyyymmdd].jpg East (090)
[ssss]_ant_180_[yyyymmdd].jpg South (180)
[ssss]_ant_270_[yyyymmdd].jpg West (270) (If photographs from additional directions are useful please use the appropriate azimuth in the file name.

[ssss]_ant_sn_[yyyymmdd].jpg - A close-up photograph of the antenna showing its model and serial number.

[ssss]_rec_sn_[yyyymmdd].jpg - A close-up photograph of the receiver showing its model and serial number.

[ssss]_rec_[yyyymmdd].jpg - A photograph of the receiver location.
If the antenna is on a roof, you must include the following:

[ssss]_ant_bldg_[yyyymmdd].jpg - A photograph showing **clearly** how the antenna is attached to the building.

[ssss]_ant_roof_[yyyymmdd].jpg - A photograph showing the antenna and the roof surface.

Examples of the photos can be found at:
https://www.ngs.noaa.gov/CORS/SitePhotos/Html/vith_image.html. As with the case of all stations photos for tidal/water level or current meter stations, all photos should be free of individuals and all work tools/equipment.

E. Leveling (database)

The cGNSS sensor is to be included in the leveling survey at the installation visit, during the next scheduled maintenance, and at (to be determined) interval. The leveling point of the ARP and any other noted reference points shall be included in the abstract file and have unique SSN numbers. The SSN for the ARP is zz80 where zz is the part number as noted in the Dynamic Project Instructions. Any additional antenna survey points should use the next consecutive SSN numbers beginning at zz81.

The full suite of levels files should be submitted to COET in addition to be included in the eSite report in which COET will ensure the ARP and other reference points have been properly added to the bench mark elevations tab prior to the approval of the site report.

The ARP and other references are to be properly described in the WinDesc file for entry into the database tables via DPAS PowerBuilder. COET members are to ensure metadata and levels are accurate during the standard documentation review and reject it accordingly and/or generate additional project instructions.

F. Leveling (partner information)

In addition to the level files for inclusion in the database, an additional level file is to be generated by COET to be sent to SONEL for inclusion on their website. This level file is only to be generated and sent for Global Sea Level Observing System (GLOSS) stations and is to be submitted in Json5 format. This format contains a series of opening and closing brackets of various types and spacing and the correct brackets need to be followed. The file is to be called stn_YYY where 'YYY' is the Permanent Service for Mean Sea Level (PSMSL) ID.

The first section of the file contains the basic site information: the PSMSL ID, the name of the site (station name), its position in decimal degrees and the reference frame. The PSMSL ID can be found at https://www.psmsl.org/data/obtaining/ and by finding the correct location on the table.

All remaining sections contain information about the bench marks or the sensors and include the bench mark name (designation), the organization (logo agency), alternative name and organization, the type, position, reference frame, description and the elevation information. The alternative name information is left blank unless there is an assigned PID to the mark, at which point it is to be included and the organization listed should be NOAA NGS. The type of mark refers to either the primary tide gauge bench mark (TGBM) or just a TGBM. The primary TGBM is the PBM at the station.

When referring to the cGNSS sensor, the type is to be listed as GNSS, and when referring to the primary water level sensor at the station it is to be listed as XXX Water Level sensor where XXX is the sensor type (Acoustic, Microwave, Pressure, Shaft Angle Encoder). The positions should be listed in decimal degrees. The description should include the complete description as stored in DPAS PB. If there are "" in the description, a \ needs to be included before the "and after". For example if the information includes "TP 15330", it should be entered as \"TP 15330\".

The elevations provided for the marks, primary water level sensor and cGNSS sensor will need to be on the following datum references: Station Datum, MSL, and MLLW. If a bench mark has had a GPS/GNSS session conducted, the ellipsoid elevation should also be included. Each elevation provided should include the datum reference, type, date measured, measured by, method, and accuracy in meters. The elevation is entered in the line labeled h_meters and should include 4 decimal places. The type line will be listed as elevation if it is surveyed in or ellipsoidal height if it was generated by GPS/GNSS. The date measured should list the year in 4 digits (i.e. 2019). "Measured by" identifies the organization who performed the levels. If an IDIQ contractor performs the levels, it should still be listed as NOAA CO-OPS. For the ellipsoidal heights, list the organization who conducted the most recent shared session on the OPUS website. Method will either be "leveling" or "GNSS" depending on how it was measured. Finally, accuracy in meters will be 0.006 for the leveled sections, and the ellipsoidal accuracy will be listed as the +/- accuracy for the ellipsoid height on the shared solution.

As with all documentation, this generated file is to be verified by another member of COET prior to submission to SONEL. The file should also be tested in an online parser (https://jsonparseronline.com/) to ensure that all brackets are properly closed out.

The point of contact at SONEL is Médéric Gravelle (mederic.gravelle@univ-lr.fr) with a cc to Guy Woppelmann (guy.woppelmann@univ-lr.fr), COET, and the CO-OPS Observing System

Manager (OSM). If the file is being submitted for the first time to set up a new station in their system, the most recent site log, station photo, and bench mark sketch should also be included. The email should also include the GLOSS and PSMSL IDs. GLOSS IDs can be found on the GLOSS website at https://www.gloss-sealevel.org/gloss-station-handbook.

See appendix B below for an example of a SONEL leveling file.

All documentation aggregated or developed should be stored in the Station Files archive for the station in a folder called cGNSS_Documentation in the root folder outside of the site visit folder for each station. For example, if the site visit took place on January 5th, 2020 at 8729840 Pensacola, the folder structure would be K:\5-Archive\2020\8729840 Pensacola, FL\cGNSS_Documentation.

7. Quality Assurance/Control

ED/COET are responsible for the quality assurance of the documentation. In the event that information is not available for the documentation, project instructions will be developed to ensure the information is acquired during the next site visit.

8. Management/Responsibility

Responsibility for updating this SOP resides with COET.

Appendix A: Site Log Example

N302 Site Information Form (site log)
Center for Operational Oceanographic Products and Services

0. Form

Prepared by (full name) : Adam Grodsky (COET)
Date Prepared : 2020-03-24
Report Type : UPDATED
If Update:
Previous Site Log : 8729840_N302_cGNSS_site_log_Aug_7_2019
Modified/Added Sections : 1, 7.2, 7.3

1. Site Identification of the GNSS Monument

Site Name : Pensacola, FL
Site ID : N302
CO-OPS Station ID : 8729840
Monument Description : ARP
Height of the Monument : 7.9910 m
Monument Foundation : (Setting Class)
Foundation Depth : (XX) m
Marker Description : (CHISELLED CROSS/DIVOT/BRASS NAIL/etc)
Date Installed : (YYYY-MM-DDTHH:MMZ) (if time unknown, just do date)
Geologic Characteristic : (BEDROCK/CLAY/CONGLOMERATE/GRAVEL/SAND/etc)
Bedrock Type : (IGNEOUS/METAMORPHIC/SEDIMENTARY)
Bedrock Condition : (FRESH/JOINTED/WEATHERED)
Additional Information : Height of monument is on station datum.
To reference other datums see
https://tidesandcurrents.noaa.gov/datums.html?id=8729840

2. Site Location Information

City or Town : Pensacola
State or Province : FL
Country : USA
Tectonic Plate : North American
Approximate Position (ITRF)
X coordinate (m) :
Y coordinate (m) :
Z coordinate (m) :
Latitude (N is +) : +302415.8
Longitude (E is +) : -0871240.3
Elevation (m,ellips.) :
Additional Information :

3. GNSS Receiver Information

3.1 Receiver Type : TRIMBLE ALLOY
Satellite System : GPS

Serial Number : 5824R40031
Firmware Version : 5.33
Elevation Cutoff Setting : 0 deg
Date Installed : 2019-08-01
Date Removed : (CCYY-MM-DDThh:mmZ)
Temperature Stabiliz. : (none or tolerance in degrees C)
Additional Information : Initial system installation

3.x Receiver Type : (A20, from rcvr_ant.tab ; see instructions)
Satellite System : (GPS+GLO+GAL+BDS+QZSS+SBAS)
Serial Number : (A20, but note the first A5 is used in SINEX)
Firmware Version : (A11)
Elevation Cutoff Setting : (deg)
Date Installed : (CCYY-MM-DDThh:mmZ)
Date Removed : (CCYY-MM-DDThh:mmZ)
Temperature Stabiliz. : (none or tolerance in degrees C)
Additional Information : (multiple lines)

4. GNSS Antenna Information

4.1 Antenna Type : TRM115000.00
Serial Number : (A*, but note the first A5 is used in SINEX)
Antenna Reference Point : BAM
Marker->ARP Up Ecc. (m) : 0.0000
Marker->ARP North Ecc(m) : 0.0000
Marker->ARP East Ecc(m) : 0.0000
Alignment from True N : (deg; + is clockwise/east)
Antenna Radome Type : (A4 from rcvr_ant.tab ; see instructions)
Radome Serial Number :
Antenna Cable Type : (vendor & type number)
Antenna Cable Length : (m)
Date Installed : 2019-08-01
Date Removed : (CCYY-MM-DDThh:mmZ)
Additional Information : (multiple lines)

4.x Antenna Type : (A20, from rcvr_ant.tab ; see instructions)
Serial Number : (A*, but note the first A5 is used in SINEX)
Antenna Reference Point : (BPA/BCR/XXX from antenna.gra ; see instr.)
Marker->ARP Up Ecc. (m) : (F8.4)
Marker->ARP North Ecc(m) : (F8.4)
Marker->ARP East Ecc(m) : (F8.4)
Alignment from True N : (deg; + is clockwise/east)
Antenna Radome Type : (A4 from rcvr_ant.tab ; see instructions)
Radome Serial Number :
Antenna Cable Type : (vendor & type number)
Antenna Cable Length : (m)
Date Installed : (CCYY-MM-DDThh:mmZ)
Date Removed : (CCYY-MM-DDThh:mmZ)
Additional Information : (multiple lines)

5. Surveyed Local Ties

5.x Tied Marker Name :
Tied Marker Usage : (SLR/VLBI/LOCAL CONTROL/FOOTPRINT/etc)
Tied Marker CDP Number : (A4)
Tied Marker DOMES Number : (A9)
Differential Components from GNSS Marker to the tied monument (ITRS)
dx (m) : (m)
dy (m) : (m)
dz (m) : (m)
Accuracy (mm) : (mm)
Survey method : (GPS CAMPAIGN/TRILATERATION/TRIANGULATION/etc)
Date Measured : (CCYY-MM-DDThh:mmZ)
Additional Information : (multiple lines)

6. Collocation Information

6.x Instrumentation Type : (GPS/GLONASS/DORIS/PRARE/SLR/VLBI/TIME/etc)
Status : (PERMANENT/MOBILE)
Effective Dates : (CCYY-MM-DD/CCYY-MM-DD)
Notes : (multiple lines)

7. Maintenance Records

7.1 Date : 2019-08-01/2019-08-01
Event : Installation and Leveling

7.2 Date : 2019-11-14/2019-11-14
Event : Reset receiver to address communication problems.

7.3 Date : 2020-01-15/2020-01-15
Event : Reset receiver.

7.x Date : (CCYY-MM-DD/CCYY-MM-DD)
Event : (TREE CLEARING/CONSTRUCTION/etc)

8. On-Site, Point of Contact Agency Information

Agency : NOAA/Center for Operational Oceanographic Products and Services
Preferred Abbreviation : NOAA/CO-OPS
Mailing Address : NOAA,SSMC4-6335
: 1305 East-West Hwy.
: Silver Spring, MD 20910, USA
Primary Contact
Contact Name : Configuration and Operational Engineering Team
Telephone (primary) :
Telephone (secondary) :
Fax :
E-mail : nos.coops.oetteam@noaa.gov
Secondary Contact
Contact Name : User Services Team
Telephone (primary) :

Telephone (secondary) :
Fax :
E-mail : Tide.Predictions@noaa.gov
Additional Information : (multiple lines)

9. Responsible Agency (if different from 8.)

Agency : NOAA/Center for Operational Oceanographic Products and Services
Preferred Abbreviation : NOAA/CO-OPS
Mailing Address : NOAA,SSMC4-6335
: 1305 East-West Hwy.
: Silver Spring, MD 20910, USA
Primary Contact
Contact Name : Configuration and Operational Engineering Team
Telephone (primary) :
Telephone (secondary) :
Fax :
E-mail : nos.coops.oetteam@noaa.gov
Secondary Contact
Contact Name : User Services Team
Telephone (primary) :
Telephone (secondary) :
Fax :
E-mail : Tide.Predictions@noaa.gov
Additional Information : (multiple lines)

Appendix B: SONEL Level File Example


```
{
  "site": {
    "psmsl_id": "246",
    "name": "Pensacola",
    "position": {
      "latlon": "30.40439 -87.21119",
      "ReferenceFrame": "NAD83(2011)"
    },
    "organization": "NOAA",
    "benchmarks": [
       {
         "name": "872 9840 M",
         "organization": "NOAA NOS",
         "alternativeName": {
           "name": "PID BG4867",
           "organization": "NOAA NGS"
         },
         "type": "primaryTGBM",
         "position": {
           "latlon": "30.40639 -87.21278",
           "ReferenceFrame": "NAD83(2011)"
         },
         "description":" The primary bench mark is a disk set in the grassy knoll on the east side of Jefferson Street in between the sidewalk and the parking lot, 63.00 m (206.69 ft) south of the centerline of Cedar Street, 35.40 m (116.14 ft) NNW of the centerline of Gimble Street, 9.45 m (31.00 ft) ENE of the centerline of south Jefferson Street, and 0.17 m (0.56 ft) east of a witness post.  The bench mark is 0.15 m (0.5 ft) below ground level, crimped to the top of a stainless steel rod driven 7.3 m (23 ft), and encased in a 5-inch PVC pipe with aluminum cover and concrete kickblock.",
         "heights": [
           {
             "h_meters": "4.36800",
             "datum": "STND",
             "type":"elevation",
             "Date_Measured": "2019",
             "Measured_By": "NOAA CO-OPS",
             "method": "Leveling",
             "accuracy_meters": "0.006"
           },
           {
             "h_meters": "1.79900",
             "datum": "Local MLLW 1983-2001",
             "type":"elevation",
             "Date_Measured": "2019",
             "Measured_By": "NOAA CO-OPS",
             "method": "Leveling",
             "accuracy_meters": "0.006"
           },
           {
```

```
          "h_meters": "1.61100",
          "datum": "Local MSL",
          "type":"elevation",
          "Date_Measured": "2019",
          "Measured_By": "NOAA CO-OPS",
          "method": "Leveling",
          "accuracy_meters": "0.006"
        },
        {
          "h_meters": "-25.722",
          "datum": "NAD83(2011) Ellipsoid",
          "type":"ellipsoidal height",
          "Date_Measured": "2020-01-30T12:00:00Z",
          "Measured_By": "NOAA NGS",
          "method": "GNSS",
          "accuracy_meters": "0.004"
        }
      ]
    },
    {
      "name": "872 9840 TIDAL 8",
      "organization": "US Coast and Geodetic Survey",
      "alternativeName": {
        "name": "PID BG1732",
        "organization": "NOAA NGS"
      },
      "type": "TGBM",
      "position": {
        "latlon": "30.40853 -87.21333",
        "ReferenceFrame": "NAD83(2011)"
      },
      "description": "The bench mark is a disk set vertically in the south face of the concrete foundation of the T. T. Wentworth Building, 17.17 m (56.33 ft) east of the centerline of Jefferson Street, 14.94 m (49.02 ft) east of the east curb line of Jefferson Street, 10.30 m (33.79 ft) west of the centerline of the south entrance to the T. T. Wentworth Building, 9.14 m (29.99 ft) north of the north curb of Zarraggossa Street, 0.24 m (0.79 ft) east of the SW corner of the building, and 0.27 m (0.89 ft) above ground.",
      "heights": [
        {
          "h_meters": "6.41560",
          "datum": "STND",
          "type":"elevation",
          "Date_Measured": "2019",
          "Measured_By": "NOAA CO-OPS",
          "method": "Leveling",
          "accuracy_meters": "0.006"
        },
        {
          "h_meters": "3.84660",
          "datum": " Local MLLW 1983-2001",
          "type":"elevation",
```

```
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      "type": "TGBM",
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       "ReferenceFrame": "NAD83(2011)"
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      "description": "The bench mark is a disk set vertically in the south face of the Escambia County Courthouse, 19.10 m (62.66 ft) west of the west curb of Palafox Street, 4.72 m (15.5 ft) north of the north curb of Government Street, 0.37 m (1.2 ft) west of the SE corner of the building, and 0.76 m (2.5 ft) above the level of the walk.",
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        "organization": "NOAA NGS"
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      "type": "TGBM",
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        "ReferenceFrame": "NAD83(2011)"
      },
      "description": "The bench mark is a disk set in the top of the west end of the north concrete door sill of a vacant building 115 (used to be a meat packing company) located at the SW corner of the intersection of Garden and Tarragona, 13.87 m (45.51 ft) west of the west curb of Tarragona Street, 6.60 m (21.65 ft) east of the NW corner of the vacant building, 4.88 m (16.01 ft) south of the south curb of Garden Street, and 0.24 m (0.79 ft) above the level of the sidewalk.",
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          "accuracy_meters": "0.006"
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        "organization": "NOAA NGS"
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        "ReferenceFrame": "NAD83(2011)"
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      "description": "The bench mark is a disk set in the top of a concrete post, 0.48 m (1.57 ft) x 0.46 m (1.51 ft) projecting 0.64 m (2.10 ft) on the grounds of the City Plaza, 34.50 m (113.19 ft) south of the south curb line of Government Street, 30.73 m (100.82 ft) NW of the NW corner of the granite base of William Dudley Chipley Memorial, and 9.75 m (31.99 ft) east of the east curb line of Palafox Street.",
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          "type":"elevation",
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          "Measured_By": "NOAA CO-OPS",
          "method": "Leveling",
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       "organization": "NOAA NGS"
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      "type": "TGBM",
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       "ReferenceFrame": "NAD83(2011)"
      },
      "description": "The bench mark is a disk set vertically in the south face of the concrete foundation of the Courthouse, 13.19 m (43.27 ft) north of the centerline of Chase Street, 3.65 m (11.98 ft) east of the SW corner of the building, 0.3 m (1.0 ft) west of the west edge of a basement window which is just west of the basement entrance, and 0.95 m (3.12 ft) above ground level.",
      "heights": [
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        "method": "Leveling",
        "accuracy_meters": "0.006"
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        "datum": "Local MLLW 1983-2001",
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        "Date_Measured": "2019",
        "Measured_By": "NOAA CO-OPS",
        "method": "Leveling",
        "accuracy_meters": "0.006"
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        "datum": " Local MSL",
        "type":"elevation",
        "Date_Measured": "2019",
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        "method": "Leveling",
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    "organization": ""
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    "ReferenceFrame": "NAD83(2011)"
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      "method": "Leveling",
      "accuracy_meters": "0.006"
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      "datum": "Local MLLW 1983-2001",
      "type":"elevation",
      "Date_Measured": "2019",
      "Measured_By": "NOAA CO-OPS",
      "method": "Leveling",
      "accuracy_meters": "0.006"
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      "datum": " Local MSL",
      "type":"elevation",
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      "method": "Leveling",
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      "datum": "NAD83(2011) Ellipsoid",
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       "organization": ""
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       "ReferenceFrame": "NAD83(2011)"
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      "description": "The benchmark is a disk set in a concrete pier, 18.10m (59.4 ft) West from the railroad centerline, 12.63m (41.4 ft) East from the western edge of the pilots pier, and 0.50m (1.6 ft) South from the North edge of the pier.",
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        "method": "Leveling",
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        "method": "Leveling",
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        "ReferenceFrame": "NAD83(2011)"
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      "description": "The bench mark is a rod set in the grassy hole on the East side of Commendencia Street in between the street and the drainage pond, 70.30m (230.5 ft) NNE of the center of railroad gate 3 of Port of Pensacola, 28.30m (93 ft) NNE of an electrical transformer box numbered 75, 21.60m (70.8 ft) ESE of a street light pole numbered 21, 17.60m (57.7 ft) West of the western rail of the railroad leading to railroad gate 3 and 8.00m (26.2 ft) East of the centerline of Commendencia Street.  NOTE - Access to the datum point is 4 inches (10 cm) below ground level, being the top of a stainless steel rod driven 27.40m (89.9 ft) to refusal, inside a sleeve extending 0.91 m (3.0 ft) and encased in a NOS logo cap.",
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      "type": "TGBM",
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        "ReferenceFrame": "NAD83(2011)"
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      "description": "The bench mark is a disk set in the concrete foundation of Port Facilities building number 4 on the right as you enter the main gate of the port, 28.40m (93.2 ft) East of the Western chain link perimeter fence, 17.30m (56.8 ft) SE of a metal holding tank on stilts near the SW corner of a loading dock, 8.80m (28.9 ft) East of the Eastern most rail track running North to South along the Western side of building 4, and 0.63m (2.1 ft) West of the Western wall of building 4.",
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      "organization": "NOAA CO-OPS",
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      "position": {
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       "ReferenceFrame": " NAD83(2011)"
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        "datum": "STND",
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          "datum": "Local MLLW 1983-2001",
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