Notice – all items highlighted are changes from previous versions of this SOW

Version 15
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SCOPE OF WORK FOR SHORELINE MAPPING UNDER THE NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

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UNDER THE
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1. INTRODUCTION

This Scope of Work (SOW) includes remote sensing, digital shoreline mapping, surveying, and associated tasks for the U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), National Ocean Service (NOS), National Geodetic Survey's (NGS), Coastal Mapping Program (CMP) in support of NOAA's Nautical Chart production. NOAA's charting responsibilities date back to 1807 when President Thomas Jefferson founded the Survey of the Coast. Over the years the agency name has changed several times, but the enormous responsibility for producing accurate maps and charts of the nation's entire shoreline has remained constant. The Nautical Chart has been called the most fundamental of navigation instruments making the chart's accuracy and completeness essential for maritime safety. A Nautical chart depicts water depths, shoreline, topographic features, navigational hazards, aids to navigation, landmarks, vertical (overhead) clearances and other navigational information. Vessel navigators use charts to determine their position, the location of their destination, and the safest and most economical route between these points. Charts used to be paper products, but are now widely available electronically. Contract personnel working on this contract must have a thorough understanding of Nautical charts as well as familiarity with the specific charts depicting the project area.

This SOW also supports data collection for NGS' Aeronautical Survey Program (ASP), including remote sensing and ground surveys. Airport data is critical to the safety of aircraft in the National Air Space and on the ground. In addition, this SOW supports data collection for NGS' Gravity for the Redefinition of the American Vertical Datum (GRAV-D) program. Data from this SOW may also be used to support the Integrated Ocean Observing System (IOOS), the Integrated Ocean and Coastal Mapping (IOCM) programs, and other NOAA programs.

2. SCOPE

Projects may include one or more phases of shoreline mapping or other surveying and mapping tasks including: planning; collecting remotely sensed data from ground, aircraft, and/or satellite based sensors, with positioning and orientation parameters; conducting ground geodetic surveys using conventional and/or precise Global Positioning System (GPS) methods; installing tide gauges and tidal bench marks, making tidal and leveling observations, and processing this data to determine tidal datums, predicted tide values, and actual tide values; performing AeroTriangulation (AT); performing digital map compilation, with attribution; producing orthophotos; controlling quality, including equipment calibrations; processing data; and writing reports. Projects may also include: airport aerial photography, LIDAR or other remotely sensed data over airports, ground control surveys and obstruction surveys on airports, emergency response to disasters; and/or leveling, gravity surveys, and other special case surveying and mapping tasks. The remotely sensed data may include: LIDAR (see Attachments Y), imagery (see Attachment Z), and/or gravity data. The Project Instructions will define any unique project specific requirements.

3. PROJECT PARAMETERS

3.1 PROJECT LIMITS – Coastal Mapping Program projects may be along any portion of the U.S. shoreline including U.S. possessions in the Caribbean and the Pacific, and other areas of interest. ASP projects may be at any airports across the U.S. including U.S. possessions in the Caribbean and the Pacific, and other areas of interest. Individual project limits will be defined in the Project Instructions and will be outlined on government provided diagrams (paper or digital) of the area. The CMP photo coverage is planned to include all of the shoreline within the project area and all of the land within 2000 feet of that shoreline and sufficiently seaward to include all offshore hazards to navigation (e.g. islands and rocks).

3.2 PRIORITY – Priority, if any, will be defined in the Project Instructions.

3.3 ACCURACY – For the CMP, general guidance on HORIZONTAL accuracy at a 95% confidence level for well defined points compiled in the Geographic Cell (GC) File is:

Harbors, ports, channels, etc.	1 meter,
Approach areas to ports	3 meters,
Open coastal areas	5 meters.

Airport survey specifications are contained in the latest versions of:

A. FAA Advisory Circular: General Guidance and Specifications for Aeronautical Surveys: Establishment of Geodetic Control and Submission to the National Geodetic Survey. AC No. 150/5300-16A, September 15, 2007 (AC-16A);

B. FAA Advisory Circular: General Guidance and Specifications for Aeronautical Surveys: Airport Imagery Acquisition and Submission to the NGS, AC No. 150/5300-17B, September 29, 2008 (AC-17B);

C. FAA Advisory Circular: General Guidance and Specifications for Aeronautical Surveys to NGS; Field Data Collection and Geographic Information System Standards AC No. 150/5300-18B, May 21, 2009 (AC-18B).

For specific requirements, see Project Instructions.

3.4 COMPLIANCE REQUIREMENTS –

A. PROJECT INSTRUCTIONS PRECEDENCE – The Project Instructions shall take precedence over this Scope of Work, since the Project Instructions provide detailed and often unique information about each project (e.g. project limits).

B. TERMS – The following conventions have been adopted for this document. The term “shall” means that compliance is required. The term “should” implies that compliance is not required, but is strongly recommended.

C. MODIFICATION – Requests to exceed or deviate from this SOW or the Project Instructions will be considered if written justification is provided in advance. No deviation is permitted until written approval is received from NOAA. All requests for modification to this SOW and/or the Project Instructions shall be submitted by the Contractor in writing to the Contracting Officer prior to the due date on the Task Order and as soon as identified. Send a copy of the request to the NGS points of contact. If the Contractor anticipates not meeting a required deadline, the Contractor shall request, in writing, an extension from the Contracting Officer. Provide a copy of the extension request to NGS. Extensions may be granted if extenuating circumstances that prevent on-time completion exist.

D. UNUSUAL CIRCUMSTANCES – The Contractor shall also notify NGS immediately of any unusual circumstances that occur during the performance under this SOW which might affect the Deliverables or their quality, and especially of any deviation from this SOW and/or the Project Instructions.

E. ORIGINAL DATA – Observation logs and other records generated during this project are legal records which will be archived by the government. It is very important that these logs be original, legible, neat, clear, and fully completed in indelible black ink. Original data shall be saved, unmodified, whether in hand written or computer recorded form, and shall be marked “ORIGINAL DATA”. In the original records (paper or digital), nothing is ever erased or obliterated. All available spaces on the recording forms should be completed. If a space on a form does not apply, then enter “N.A.” for “Not Applicable”. If a mistake is made on a form, draw a single line ~~through the mistake~~ and write the correction above or to the side. If space is too limited to permit a field correction, restart with a new log sheet, however, the form should not be recopied in the office in order to make a “clean” copy. An explanatory note shall be made, and initialed for all corrections to the original recorded figures. It is essential that all recorded figures be neat and legible. All editing of computer recorded data shall be done on a copy of the original. Always submit the original version of the data, not a handmade copy nor a photocopy nor a digital copy.

F. DATA BACKUP – The Contractor shall back up all data and take steps necessary to ensure the safety of all data, especially original, raw data. The Contractor shall save all data back-ups for six months after NGS has accepted all data for that Task Order. The Contractor shall sanitize all equipment following NIST Special Publications 800-88

Guidelines for Media Sanitization, http://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIS.SP.800-88r1.pdf, that stored data utilized during this project.

G. GOVERNMENTAL RULES AND REGULATIONS – The Contractor shall ensure that they comply with applicable regulations of government agencies, including the:

- Federal Aviation Administration (FAA), https://www.faa.gov/regulations_policies/
- US Coast Guard (USCG), https://www.navcen.uscg.gov/?pageName=navRuleChanges
- Environmental Protection Agency (EPA), https://www.epa.gov/laws-regulations
- Occupation Safety & Health Admin. (OSHA), https://www.osha.gov/html/compliance.html
- National Park Service (NPS), https://www.nps.gov/aboutus/lawsandpolicies.htm
- Homeland Security, https://www.dhs.gov/
- Surface Transportation Board, https://www.stb.gov/stb/index.html

and other federal, tribal, state, commonwealth, and local governmental rules and regulations. The Contractor shall be responsible for identifying, obtaining, completing, and submitting required applications or forms; and for obtaining approval of all necessary permits for work performed under this contract.

H. CYBER SECURITY AND QUALITY ASSURANCE CONTROLS See section 13 Security

3.5 NATIONAL SPATIAL REFERENCE SYSTEM (NSRS) – All surveying, positioning, and mapping shall be tied to the NSRS. See: http://www.ngs.noaa.gov/INFO/OnePagers/One-Pager_NSRS.pdf

A. HORIZONTAL CONTROL – North American Datum 1983 (NAD 83, 2011), Epoch 2010.

B. VERTICAL REFERENCE –

i. North American Vertical Datum 1988 (NAVD 88).

ii. Alaska and other areas outside the continental U.S., see SOW Main Text, Section 6.2.

iii. or other local datum if required by the Project Instructions.

C. TIDAL SHORELINE REFERENCE –

i. MEAN LOWER LOW WATER (MLLW)

ii. MEAN HIGH WATER (MHW)

D. GEOID MODEL – Use the most recent NGS model, currently GEOID12B, see: http://www.ngs.noaa.gov/GEOID/ . For projects in Alaska and other areas outside the conterminous 48 states, see the Project Instructions for any special requirements.

E. NATIONAL SPATIAL REFERENCE SYSTEM (NSRS) – All positioning shall be tied to the NSRS. See https://www.ngs.noaa.gov/INFO/OnePagers/NSRSOnePager.pdf

The contractor shall record all processing steps and software used including version number;

The contractor shall use either the rapid or precise IGS orbit ephemeris for GPS processing.

3.6 REFERENCES AND GLOSSARIES –

A. NOAA's Nautical Charts, Main Page – https://nauticalcharts.noaa.gov/

B. U.S. Chart No. 1 (Chart symbols, abbreviations, and terms) at: https://nauticalcharts.noaa.gov/publications/us-chart-1.html

C. Dates of Latest Editions of Charts: http://www.charts.noaa.gov/RNCs/RNCsIndv.shtml

D. NOAA Chart Catalog and Chart Viewer – View and download and of NOAA's 1,000+ nautical charts: https://nauticalcharts.noaa.gov/charts/noaa-raster-charts.html

E. NOAA Online RNC® Viewer – Seamless online viewer for NOAA RNCs: http://www.nauticalcharts.noaa.gov/mcd/OnLineViewer.html

F. NOAA Center for Operational Oceanographic Products and Services (CO-OPS) web Site: http://tidesandcurrents.noaa.gov/

G. NOAA NGS web Site: http://www.ngs.noaa.gov/

H. U.S. Coast Guard Light List: http://www.navcen.uscg.gov/?pageName=lightLists

I. See Glossaries in Attachments F and M.

J. Manual Of Photogrammetry, Sixth Edition, 2013.

K. Manual of Color Aerial Photography, First Edition, 1968.

L. Water Level Station Specifications and Deliverables for Shoreline Mapping Projects, May 2009, at: https://tidesandcurrents.noaa.gov/publications/Water_Level_Station_Specifications_and_Deliverables_for_Shoreline_Mapping_Projects,_Updated_May_2009.pdf

M. Hydrographic Specifications and Deliverables (see Chapter 4 in particular; the primary CO-OPS reference for shoreline mapping): https://www.nauticalcharts.noaa.gov/publications/docs/standards-and-requirements/specs/hssd-2017.pdf

4. GOVERNMENT SUPPLIED INFORMATION AND MATERIALS

4.1 SOW, WITH ATTACHMENTS (this document).

4.2 PROJECT INSTRUCTIONS – Project Instructions are a separate document providing specific project information, containing any unique project requirements, and may contain any or all of the following information:

A. PROJECT DIAGRAMS – Diagrams (paper or digital) with the project limits marked by NGS. These Diagram(s) of the project area show the shoreline to be compiled; compilation limits, if different from the 2000 foot requirement; and, as required, limits of tide coordination areas (if different from compilation limits);

B. TIDAL ZONING DIAGRAM;

C. TIDAL ZONING MEMO;

D. FLIGHT LINE MAP (CMP and/or ASP);

E. WAYPOINT FILE (CMP and/or ASP);

F. ADDITIONAL INSTRUCTIONS – Instructions regarding tidal coordination, ground control, Gravity for the Redefinition of the American Vertical Datum (GRAV-D), and any other project specific requirements;

G. PROJECT IDENTIFIER – The "Project Identifier," an eleven or twelve character alpha-numeric Identifier (ID) unique to each project (i.e. FL1701A-CM-N);

H. AIRPORT MAPS for Aeronautical Survey Program.

4.3 (removed)

4.4 ELECTRONIC EXPOSURE DATA (VER. 2) FILE CHECKING SOFTWARE – For all contracted aerial imagery acquisitions, the Contractor shall check every Electronic Exposure Data Version 2 (EED2) file with the government supplied software prior to submitting each EED2 file to NGS. The software first checks the EED2 file for proper formatting and valid field entries. The software then computes and displays the aerial photography footprints, enabling reviewers to immediately see positioning, spacing, and/or orientation problems. See Attachment H for documentation on this software as well as the EED2 file format.

4.5 TIDAL SOFTWARE – The contractor may use any software, commercial or proprietary, to calculate the times wherein the tides in the project area are at the appropriate height to acquire tide coordinated imagery. The only restriction on the use of contractor supplied software for this purpose is that the times calculated by such software must coincide with the times calculated by the Government's in-house tide window prediction software. The Government will, at the contractor's request, provide the most current version of the software that the Remote Sensing Division (RSD) uses, and is able to freely distribute, to predict such tide windows. The Government will, at the contractor's request, provide training in the use of the RSD program. Such training will be at a time and place mutually convenient to both the contractor and the Government. See Attachment J for an explanation of tides and tide windows.

4.6 NGS AND NOS SURVEY MARKS – If required and when requested by the Contractor, NGS brass survey disks and/or NGS aluminum logo caps will be supplied to mark horizontal and/or vertical geodetic survey points. If required and when requested by the Contractor, NOS brass survey disks and/or NOS aluminum logo caps will be supplied for use as tidal bench marks.

The Contractor shall acknowledge receipt of Government Supplied Items by inventorying the shipment, signing the Transmittal Letter (TL), and faxing the TL to NGS. At this time Contractors cannot use the Task Order Management and Information System (TOMIS) to acknowledge receipt of Government Supplied Items sent by the Government.

5. <u>TECHNICAL AND COST PROPOSALS</u>

5.1 TECHNICAL PROPOSAL –

A. TECHNICAL – After receiving and reviewing the Project Instructions, the Contractor shall submit a Technical Proposal summarizing their proposed implementation plan. This report shall include at least the following:

i. Contractor planned flight lines with a nautical chart background, if required (see Project Instructions),

ii. proposed ground control methods and locations (using different symbols for: Continuously Operating Reference Stations (CORS), new survey control, old survey control, photo control, and airborne Kinematic Global Positioning System (KGPS) Ground Base Stations, if required).

iii. proposed tide/water level stations, if required,

iv. proposed approximate date range of imagery acquisition,

v. summary of all field and office data collection,

vi. data processing (methods, equipment, hardware, software,

vii. personnel.

B. QUALITY CONTROL PLAN – The Contractor shall have the responsibility for the overall quality of the Project. The Contractor's Final Reviewer and other Contractor personnel, as required, shall become intimately familiar with the Project Instructions, the SOW, the SOW Attachments, and References. The Contractor shall submit a written Quality Control Plan (QCP) prior to beginning work (as part of their Technical Proposal), to include at least the following:

i. checking manually recorded data,

ii. checking data manually entered into a computer system,

iii. checking data at various points in the overall process,

iv. reviewing the compilation data on-line (see Attachment K),

v. comparing the compilation data with the largest scale Nautical charts of the same area,

vi. comparing compilation data with the aerial photographs of the same area,

vii. checking all documents and reports submitted.

The Plan shall include both Quality Control (QC) and Quality Assurance (QA), as defined in Attachment M - Coastal Mapping Program Glossary.

The Contractor shall also describe how data will be backed up and how it will be ensured that original data are not modified. See Section 10, Deliverables.

C. TOMIS SPREADSHEET – The Contractor shall submit a completed TOMIS spreadsheet containing a listing of all Deliverables, percents, and due dates, and in the specified format. See Attachment AI.

5.2 COST PROPOSAL – The Contractor shall submit a proposal with the costs broken down into at least the following categories, for all work required by the Project Instructions:

A. MISSION PLANNING,

B. GPS SURVEY PLANNING,

C. GROUND AND PHOTO CONTROL,

D. TIDES AND WATER LEVELS,

E. AERIAL DATA ACQUISITION (IMAGERY, LIDAR, ETC.),

F. DATA PROCESSING,

G. AEROTRIANGULATION,

H. COMPILATION,

I. FINAL PRODUCT PREPARATION.

Include number of labor hours, labor costs, and non-labor costs for each category.

6. DATA ACQUISITION

6.1 REMOTELY SENSED DATA –

A. AERIAL PHOTOGRAPHY – The Contractor may be required to acquire aerial photography. Aerial photography for the CMP is usually required to meet three main parameters: sun angle of at least 25 degrees, clear sky, and tide coordination. See information below and in Attachments: Z, J, and AF.

i. Flight Line Planning – The Project Instructions may require the Contractor to plan flight lines or may state that NGS has planned the lines.

- Contractor Planned Flight Lines – The Contractor may be required to plan the flight lines given the project area and other information contained in the Project Instructions. Flight line maps shall be depicted with a NOAA nautical chart as the background. The photo coverage shall be planned to include all of the shoreline within the project area, all of the land within 2000 feet of that shoreline, and offshore features such as islands, rocks, man-made obstructions, fixed aids to navigation, piers, and jetties. See Attachment Z for additional requirements.

- Government Planned Flight Lines – If NGS plans the flight lines, NGS will supply flight line maps and waypoint files in standard NGS format (see Attachment Z for format). The Contractor shall review these flight lines to ensure adequate coverage as defined in the paragraph immediately above, and immediately notify NGS of any problems.

ii. Exposure Test and Production – The Contractor shall conduct and submit an exposure test over an area similar to the project area for each type of emulsion and each camera system to be used. After NGS review and approval of the exposure test, the Contractor may begin production photography; see Attachment Z. The Electronic Exposure Data (EED) file shall be sent to NGS within 3 working days via email. The Contractor shall check all manual data entries. See Attachment Z for complete details. Note, the Project Instructions will state if new exposure tests are required for future Task Orders. Normally an unaltered camera system that has already had an Exposure Test in a similar geographic area will not require a newExposure Test.

iii. Tide Coordination – The Project Instructions may require that imagery for the CMP be tide coordinated. When shoreline data is to be compiled using aerial photographs, RGB (Color), Color Infra-Red (Color IR), and/or Black-and-White IR (B&W IR) images may be required to be captured when the water level is at observed or predicted MHW, observed or predicted MLLW, and/or below or between these water levels. Normally NGS allows a tolerance on either side of MHW and MLLW, see Attachments Z and J. See the Project Instructions for detailed project information.

iv. Airborne Positioning and Orientation – All remotely sensed imagery (including color and infrared) for the CMP shall be positioned using airborne Kinematic GPS (KGPS) (with dual-frequency, carrier-phase measurements). Airborne KGPS is normally not required for airport photography.

v. Camera Ports – An aircraft with dual camera ports may be required for CMP projects so that two sensors can collect data simultaneously.

B. OTHER REMOTELY SENSED DATA – The Project Instructions may include requirements for any photographic systems and/or remote or local sensors that convert energy from the electromagnetic spectrum into analog or digital data obtained from any ground, airborne, or space borne satellite platform. Also gravity data may be required. See Project Instructions for specific requirements.

C. PROPERTY OF DATA - All original data, from the instant of acquisition, and other deliverables required through this contract including final data, are and shall remain the property of the United States Government. This includes data collection outside the project area. These items include the contractor-furnished materials.

6.2 GROUND CONTROL SURVEYS –

A. CHECK POINTS – For CMP projects under this SOW, at least four Check Points are required. These points shall have horizontal and vertical positions. In Alaska and other areas outside the continental United States where NAVD 88 bench marks are not available, the Contractor may be required to make GPS ties to existing tidal bench marks. Additional information may be supplied in the Project Instructions. The Check Points shall be approximately evenly spaced in the project area and shall be positioned using specifications listed below. On large projects, use at least one Check Point for every four strips, and at least one near each corner of a block. **These four or more points shall not be used in the aerotriangulation computations, but rather serve as an independent check of the photogrammetric solution.** The Contractor shall hold these back until the aerotriangulation is complete. The Contractor shall compare the ground positions of the Check Points to the results derived from the aerotriangulation solution and shall report these results to NGS in table form in the Aerotriangulation Report.

For ASP projects, Check Points are usually not required.

B. PHOTO CONTROL POINTS – For CMP projects, the Contractor may propose additional ground control points, these to be used in the aerotriangulation. These points are called “Photo Control Points” to distinguish them from the “Check Points” described above. The Contractor shall determine an adequate number and distribution of these Photo Control Points. A description of the plan and the number, type and spacing of these points shall be included in the Technical Proposal. Contractors should use CORS and Online Positioning User Service (OPUS), including OPUS Rapid-Static (OPUS-RS), to position both types of photo ground control. Any updates in this SOW’s OPUS requirements will be included in the Project Instructions. See Attachment O for ground photo control requirements.

If Photo Control Points are required for ASP projects, they will be specified in the Project Instructions.

C. GROUND SURVEYS – See Attachment P for requirements for Ground Control Extension Surveys (marks used to position other marks). In most CMP cases, this type of point should not be required.

D. AIRBORNE KGPS BASE STATIONS – GPS Base Stations are required to control airborne data collections. The Contractor shall use existing CORS, and/or use existing NSRS control points, and/or establish new ground control points, in that order of priority. See Attachment Z for details.

E. OTHER CHECK POINTS – Check Points for other types of sensors will be specified in the Project Instructions.

F. GENERAL – Additional survey related requirements may include: recovering survey marks, setting marks, constructing photo panels, photo identifying control points, writing digital mark descriptions and/or mark recovery notes, using conventional and/or GPS survey methods, including leveling, taking digital photographs during the ground surveys, and preparing: visibility diagrams, GPS observation logs, station sketches, and reports. Detailed specifications for ground control surveys, including recommended forms, formats, and procedures are contained in Attachments O, P, Q, R, S, T, U, V, W, X, AG, and AJ.

G. GROUND SURVEYS AT AIRPORTS – The Contractor may be required to perform ground surveys at airports including: runways, air navigation aids, aircraft obstructions, and other related surveys.

H. GROUND TRUTH FOR REMOTE SENSING – Ground truth for various ground, airborne or space sensors may be required.

6.3 TIDE/WATER LEVEL REQUIREMENTS – See the CO-OPS reference listed in Section 3.6M, above. When required, additional specifications for predicting water levels, observing water levels in real time, installing water level gauges and tidal bench marks, collecting water level data, leveling between bench marks, GPS observations on tidal bench marks, or processing all these observations will be included in the Project Instructions. Data shall be submitted in CO-OPS and NGS specified formats. In any cases where the requirements conflict or would cause duplicate effort, consult Attachment AH and then contact NGS for clarification.

See Attachment J for information on tidal acquisition windows and Attachments: Z and P for other requirements. For additional information on tides and water levels, see the CO-OPS site at: http://tidesandcurrents.noaa.gov/ . In particular, the following pages/links may be helpful:

"Our Restless Tides" – https://tidesandcurrents.noaa.gov/restles1.html

"Fantastic Tidal Datums" – https://tidesandcurrents.noaa.gov/publications/fantastic_tidal_datums.pdf

"Understanding Tides" – http://tidesandcurrents.noaa.gov/publications/Understanding_Tides_by_Steacy_finalFINAL11_30.pdf

Note, predicted tides may not be accurate in time or height. The following is from the CO-OPS Frequently Asked Questions section on the CO-OPS WWW site.

"**Q: How accurate are the predictions?**

"The accuracy of the tide predictions is different for each location. Periodically we do a comparison of the predicted tides vs. the observed tides for a calendar year. The information generated is compiled in a Tide Prediction Accuracy Table. We work to insure that the predictions are as accurate as possible. However, we can only predict the astronomical tides we cannot predict the effect that wind, rain, freshwater runoff, and other short-term meteorological events will have on the observed tides.

"In general, predictions for stations along the outer coast are more accurate than those for stations farther inland; along a river, or in a bay or other estuary. Inland stations tend to have a stronger non-tidal influence; that is, they are more susceptible to the effects of wind and other meteorological effects than stations along the outer coast. An example of an inland station which is difficult to predict is Baltimore, Maryland. This station is located at the northern end of Chesapeake Bay. Winds which blow along the length of the bay have been known to cause water levels to be 1-2 feet above or below the predicted tides.

"Stations in relatively shallow water, or with a small tidal range, are also highly susceptible to meteorological effects and thus difficult to accurately predict. At these stations, short-term weather events can completely mask the astronomical tides. Many of the stations along the western Gulf of Mexico fall into this category. An example is Galveston, Texas. This station is in a bay which is relatively shallow and has a small opening to the sea. At this station it is possible for meteorological events to delay or accelerate the arrival of the predicted tides by an hour or more."

7. DATA PROCESSING

7.1 GROUND PHOTO CONTROL SURVEYS – Data shall be processed with NGS approved software and submitted in required formats. A final report is required. Specifications for ground photo control survey data processing and reports are in Attachment O. Requirements for positioning the GPS Base Station for the ground GPS receiver for the airborne KGPS are found in Attachment Z.

7.2 TIDE/WATER LEVELS – When required by the Project Instructions, tide/water level data shall be processed in accordance with the CO-OPS reference in Section 3.6.M, above, its references, and Attachment J.

7.3 AEROTRIANGULATION – For CMP projects, the Contractor is required to perform the standard processes of aerotriangulation (AT) for all photographs (including color and IR) used in the shoreline mapping project. All imagery (color and IR) for an entire project shall be included in the same AT solution. The Contractor shall include in the project Technical Proposal a plan explaining how the AT work will be performed. Upon completion of the AT, the Contractor shall provide a written report which includes the listed requirements as found in Attachment I. See also requirements regarding Check Points in Section 6.2A above.

Aerotriangulation may be required for ASP projects.

7.4 OTHER DATA – Other types of data shall be processed according to standard industry procedures and any additional requirements as specified in the Project Instructions.

8. <u>OFFICE DATA COLLECTION</u>

8.1 GEOGRAPHIC CELL (GC) – The GC is set of digital files, containing the geometry and attribution of the features extracted from imagery or other remotely sensed source data. The original compilation data will necessarily be in whatever file format is used by the Contractor's digital mapping system, but the data submitted to the government shall be in Esri® shapefile format as defined in Attachment D. The Contractor shall supply two sets of cartographic feature files, the first being for the NGS quality assurance process (interim files) and the second as the final Deliverable product to NGS. The Interim Shapefiles use an attribution schema that can be imported into NGS's digital photogrammetric softcopy workstations for stereoscopic review purposes.

8.2 COASTAL CARTOGRAPHIC OBJECT ATTRIBUTE SOURCE TABLE – The final product shapefiles use the NGS's "Coastal Cartographic Object Attribute Source Table" (C-COAST) attribution schema which is listed in Attachment E. There is a one-to-one translation from the interim to C-COAST attribution. The C-COAST attribution scheme was developed to conform the attribution of various sources of shoreline data into one attribution catalog. C-COAST is not a recognized standard, but was influenced by the International Hydrographic Organization's S-57 Object-Attribute Standard so the data would be more accurately translated into S-57. The glossary for the C-COAST feature attribute description is in Attachment F. The shapefile attributes and attribute values are case sensitive. All shapefile attribute labels shall be upper case. See Attachment D for Interim and Final Shapefile attribute requirements, including character and case sensitivity. General cartographic feature definitions within the CMP are included in a second Glossary in Attachment M.

8.3 FILE NAMING CONVENTION –

A. GENERAL – The Contractor shall clearly label file names on all submitted media. All data submitted shall be labeled with a systematic naming convention. All label and file naming conventions shall be documented and explained with each data submission. All original data shall be marked "ORIGINAL" on the data medium.

B. IMAGE NAMING CONVENTION – All contractor acquired imagery shall follow a STRIP_FRAME image naming convention as follows: **1**30001_00001

The STRIP (prefix) is a **6-digit** designator, where:

Digit **1** holds Data Type as defined:

1 = color/non-tide coordinated
2 = IR/MHW
3 = IR/MLLW
4 = IR/non-tide coordinated
5 = color/MHW
6 = color/MLLW
7 = multispectral/MHW
8 = multispectral/MLLW
9 = multispectral/non-tide coordinated

Digits **2-3** hold Image Scale (flying hgt / focal len)

Digits **4-6** hold the unique Strip #.

Note that any tide stage other than MHW or MLLW is considered non-tide coordinated for this purpose.

The FRAME (suffix) uses the remaining **5-digits** and holds the frame #, which shall be unique within each strip, ensuring each frame will be uniquely named within a project.

C. SHAPEFILES – The Contractor shall request GC file names from NGS via email. NGS will normally respond within five working days of the request.

The Interim Shapefiles, including pilot areas, should be named for the GC identifier that corresponds to a given subdivided region. The Interim Shapefile that was subdivided should be named in the following manner: GCxxxxx where "xxxxx" is a sequential number assigned by NGS.

This final deliverable shapefile shall have the prefix name of the project identifier as defined in the Project Instructions.

The final deliverable shapefile's SOURCE_ID attribute value is the corresponding GC identifier.

8.4 COMPILATION METHODOLOGY – Unless specifically directed, Contractors shall compile all aerial photographic data using stereo models in a digital photogrammetric system that meets the accuracy requirements set forth in this SOW and that produces data in a format(s) compatible with SOCET SET® software (latest version released). Compile within the limits of the stereoscopic neat model. See Attachment K.

8.5 FEATURE COMPILATION –

A. VECTOR COLLECTION INTERVAL AND ACCURACY – As a line of natural shoreline is digitized, the Contractor shall measure vertices frequently enough to ensure that the agreement between the digital shoreline and the shoreline visible on the mapping imagery is equal or better than the allowed discrete point accuracy, for 95% of points along the digital shoreline. Manual point-to-point mode of compilation should be used for all feature extraction, particularly when collecting well-defined points such as corners of a pier or wharf. If stream mode is used, parameters should be carefully set in order to avoid unnecessarily large file sizes. See Attachment K.

B. DISCRETE POINTS – Many well-defined point features, such as landmarks, fixed aids to navigation, and small rocks, serve as check points and supplemental control for various remotely sensed images. The cartographer should exercise extreme care in the measurement of well-defined discrete points. See Attachment K.

C. LINEAR FEATURES CONNECTIVITY – Collected linear data shall be topologically cleaned by removing all erroneous dangles and gaps, caused by inadequate snapping, so that linear features are continuous. Other important general topological considerations include:

i. Line features that cross other line features shall not be split into multiple features where they cross (e.g. overhead cable crossing a shoreline).

ii. Line features must never cross over themselves.

iii. All individual line features compiled to form closed polygons must begin and end precisely at the same node (w/no dangles or gaps).

iv. Multiple instances of a feature with the same attribution occupying the same geographic space (duplicate features) are never allowed in final line and point shapefiles or Chart Evaluation File (CEF).

v. Short (tiny) line features must not be created solely for the purpose of establishing topological connectivity. In general, line features < 0.5 mm at the compilation scale should not be compiled except in specific circumstances (see Attachment K).

D. COMPILATION LIMITS – In all project areas, the features to be compiled include: the shoreline; hazards to navigation in the water (rocks, islands, etc.), physical and cultural features visible from the water and thus of value to the mariner; and other significant features on the land for a distance inland of 2000 feet from the shoreline. All landmarks meeting requirements and within the photo coverage, shall be compiled. See Attachment K.

E. COMPILATION CONTENTS AND LEVEL OF DETAIL – Contents and level of detail are closely related to compilation scale (see Attachment K). In general provide at least the same level of detail as depicted on the largest scale nautical chart(s) of the project area. Additional detail may be required on and along land areas facing navigational channels (those waterways with Aids To Navigation).

Significant types of features include, but are not limited to: shoreline; fixed aids to navigation; landmarks; major roads; major buildings; railroads; canals; bridges; tanks (other than landmarks); pipelines; and power lines. See Attachment K.

F. SUBPROJECTS – CMP projects are often quite large and complex, and are therefore typically divided into subprojects to more readily facilitate application of the resulting data products to NOAA's Nautical Chart suite. The Government will, in almost every case, create the subproject boundaries and assign project names based on the geographic extents.

8.6 DATA SUBMISSION –

A. PILOT AREA – The contractor shall select a Pilot Area and submit this proposed Area as part of their Technical Proposal. This Pilot Area, constituting approximately 10% of a single subproject (assuming the project is subdivided), should contain a representative sample of shoreline and associated features contained in the project as a whole. Once the Technical Proposal is accepted and the notice to proceed has been received, the Contractor shall compile this area and submit Interim Shapefiles (see Attachment D) covering the Pilot Area. The Contractor shall not begin compilation on other portions of the project until NGS approves the Pilot Area compilation. The purpose of the Pilot Area is to ensure the Contractor's understanding of compilation requirements and thereby mitigate the risk of lengthy correction and resubmission cycles.

B. INTERIM SHAPEFILES – After the initial Pilot Area compilation is approved by NGS, the Contractor shall proceed with compilation of the remaining portion of the subproject in which the Pilot Area is contained. Upon completion of Quality Control (QC) tasks the Contractor shall deliver Interim Shapefiles for Government review when the subproject is 100% complete. Remaining subprojects should be submitted thereafter, one area at a time.

C. FINAL SHAPEFILES – See Section 9.2 below.

9. QUALITY CONTROL AND FINAL PRODUCT PREPARATION

9.1 QUALITY CONTROL – The Contractor shall conduct Quality Control (QC) of all the work performed and all Deliverables produced in accordance with the Contractor's Quality Control Plan, submitted with the Technical Proposal and approved by NGS. The Contractor shall check all data to ensure completeness, reliability, and accuracy. Project specific accuracy requirements may be given in the Project Instructions. The Contractor's personnel shall be thoroughly familiar with the SOW; the Project Instructions; the definitions of terms; and material covered in the other references and publications as required. See Section 3.6 for a list of References.

The Contractor shall conduct a thorough quality review of feature compilation prior to submitting all compilation Deliverables to ensure accuracy of delineation, correct feature attribution, completeness, and adherence to all project requirements (see Attachment K). A summary of QC/QA work performed shall be included in the Final Review section of the Project Completion Report (see Attachment L).

9.2 FINAL SHAPEFILE PREPARATION – After the Interim Shapefiles have been reviewed and accepted by NGS, the Final Shapefiles (Attachment D) shall be prepared and submitted. The preparation of the Final Shapefiles typically consists of merging the multiple Interim Shapefiles into a single point shapefile and a single line shapefile; changing the coordinate system; implementing final attribution; topologically cleaning the files of stray dangles and gaps; etc. The actual data processing steps required for a project will depend on the particular systems, software, and methodology used by the Contractor, and may differ from the procedures listed here.

9.3 CHART EVALUATION FILE – The Chart Evaluation File (CEF) is a polygon shapefile corresponding to the largest scale Nautical Chart coverage of the project area. The purpose is to document navigational hazards, landmarks, and coastline features portrayed on NOAA Nautical Chart products whose existence or geographic position cannot be confirmed photogrammetrically, or whose size, shape, orientation or position appear to have changed significantly from the current chart portrayal. The CEF shall contain the necessary annotations made by the compiler during the feature collection process, as described in Attachment K. The annotations in the CEF are used by the Office of Coast Survey to aid in the application of the GC data when updating charts and when performing hydrographic survey operations. Any additional notes that are not relevant to these uses shall not be transferred to the CEF. See Attachment AE, for details and examples.

9.4 PROJECT COMPLETION REPORT (PCR) – The Contractor shall prepare a final report which summarizes all phases of the work performed for the project. If more than one project is assigned in a single task order, then a separate and complete PCR is required for each project. If a project is broken into sub-areas (A, B, C, etc.), then a separate and complete PCR is required for each sub-area. Submit the PCR after all other work has been completed.

The PCR shall conform to all of the requirements outlined in Attachment L, which includes a sample PCR for reference. It is important that the discussion of the work performed includes any unusual circumstances that may have occurred, and any deviations from the SOW, Project Instructions, and/or normal operating procedures. The PCR shall be delivered in the following formats: Microsoft (MS) Word®, and the Adobe Acrobat® Portable Document Format (PDF). NGS will make the PCR (in PDF format) available on the NOAA Shoreline Data Explorer website for download along with the project shapefiles. See Attachment L.

10. DELIVERABLES

The Contractor shall submit all Task Order Deliverables and Weekly Status Reports to NGS using the TOMIS system. All Deliverables shall be named exactly the same as they are listed in TOMIS. All Weekly Status Reports shall be submitted directly to TOMIS by 2:00 pm EST every Monday. All Deliverables smaller than about 10 MB in size shall be submitted to TOMIS as an attachment. This should include almost all digital files, except imagery. Larger files may be compressed and submitted to TOMIS in compressed format. If the Deliverable is still too large after compression, the Contractor shall submit a report to TOMIS expressly stating what the Deliverable is and how the Deliverable is being delivered, i.e. via express mail, Secure File Transfer Protocol (SFTP), etc. The Contractor shall submit the data delivery report to TOMIS the same day that the Deliverable is sent. Use a Transmittal Letter (TL) for all shipments of data outside TOMIS. All electronic provided information by the contractor must undergo malicious software scanning using a commercial anti-virus and anti-spyware software to ensure the information is free of known malicious software. Once the Deliverable is received, NGS will mark it received in TOMIS and an email will be sent confirming receipt of the Deliverable. For complete details, see Attachment AI.

Deliverables too large for submission through TOMIS shall be submitted on DVDs, portable hard drives, or secure FTP servers. To help ensure data longevity, all DVDs used for Deliverable submission shall be archival quality DVDs (DVD+R w/gold, metallic coating; **do not apply paper labels to DVDs**, use only special DVD archival pens with soft-nubs and solvent-free ink to mark on DVDs, marking only in the central, clear portion of discs).

The Contractors shall submit a Deliverable Tracking Spreadsheet in the TOMIS format as part of their Technical Proposal. The Spreadsheet format and procedures for using TOMIS are included in Attachment AI.

All Deliverables shall be submitted to NGS via TOMIS by the Prime Contractor, not from a Sub-Contractor. Shipment of Deliverables to the Prime Contractor enables the Prime Contractor to check all data prior to shipment to NOAA.

TOMIS is not operational for items shipped to the Contractor by NOAA. Upon receiving Government Supplied Items, the Contractor shall check off the items on the TL, sign and date the TL, and fax or email the signed TL back to NOAA. See Section 10.10 below and Attachment AC for details and an example.

All reports except Weekly Status Reports shall be delivered in the following formats: MS Word® and PDF, to provide for immediate ease of use and to help ensure that the data will be available many decades into the future. Contractors shall submit the MS Word and PDF formats together as one Deliverable.

Microsoft Word format to be Version 2007, or later; composed on 8 ½ by 11 inch sized pages; using one-inch margins; using double line-spacing; and using "Times New Roman" font, sized 12 pitch, or equivalent.

10.1 LABOR, EQUIPMENT, ETC. – The Contractor shall provide all labor, equipment, supplies, materials, and transportation to produce and deliver the products required under this SOW.

10.2 GOVERNMENT SUPPLIED ITEMS – The Contractor shall return all Government Supplied Items (GSI) to NGS, except for any paper nautical charts supplied by NGS. This shall NGS will hold back payment of the final 10% of all Task Orders until all Deliverables, including the GSI, are submitted, reviewed, and accepted by NGS.

10.3 STATUS REPORTS

A. WEEKLY TEXT – The Contractor shall submit Weekly Status Reports to NGS via TOMIS every Monday by 2:00 PM Eastern Time, from the date of a Task Order award until the work is complete and accepted by NGS. See Attachment G for details.

B. MONTHLY GRAPHIC – If the contractor was tasked with collecting remotely sensed data, the contractor shall submit graphic(s) showing the status of data collection, on the first Monday of each month via TOMIS. The contractor shall submit a separate graphic for each required dataset (color/RGB, MHW IR, MLLW IR, etc.). The graphic(s) shall show the numbered flight lines; the specific shorelines to be compiled highlighted or drawn in bold, using the shoreline vectors supplied by NOAA; the area of ground coverage; and shall use a NOAA Nautical Chart as background. The graphic(s) shall show all required imagery differentiating the frames acquired from those not yet acquired as follows:

No highlighting = areas not collected,
Orange highlighting = areas collected but not yet accepted by NGS, and
Green highlighting = areas accepted by NGS.

The required formats for the graphic(s) are PDF and JPEG, unless otherwise approved by NGS.

10.4 GROUND PHOTO CONTROL DATA AND REPORT – The Contractor shall prepare a report covering the ground photo control portion of the work. See Attachments O through X, and AJ for detailed instructions for ground surveys and the report. Submit this data and report within six weeks of the conclusion of the ground control survey work. See also Attachment Z and Attachment O. Most projects will require Check Points and may have Ground Photo Control Points and thus this report. This report shall be submitted in paper and digitally in PDF format. Ground photos of photo control points may be submitted as part of the paper and PDF Ground Control Report. Ground photos of NSRS database points (or newly surveyed points to be entered into the NSRS), shall be submitted on a separate DVD, see Section 10.5 below.

10.5 GROUND CONTROL DATA AND REPORT (NSRS MARKS) – The Contractor shall prepare a report covering the ground control survey portion of the work, if any is done. See Attachments O through X and AJ for detailed instructions for ground surveys and the report. Submit this data and report within six weeks of the conclusion of the ground control survey work. See also Attachment Z, DELIVERABLES, and Attachment P. Most projects may not require ground control surveys and thus in that case, this Report would not be required. Photos taken of ground surveyed points (NSRS points) shall be submitted on a separate DVD.

10.6 AERIAL PHOTOGRAPHY ASSOCIATED DELIVERABLES – Deliverables are listed below:

A. EXPOSURE TEST(S) – See Attachment Z;

B. FLIGHT LINE MAPS (Final) – Showing the actual lines flown. See Attachment Z;

C. TABULATION OF AERIAL PHOTOGRAPHY , See Attachment Z;

D. PHOTOGRAPHIC FLIGHT REPORTS (NOAA Form 76-15), See Attachment Z;

E. RAW NAVIGATION FILE, See Attachment Z;

F. ELECTRONIC EXPOSURE DATA (EED) FILES, See Attachment Z. This file should be submitted digitally through TOMIS;

G. AIRBORNE POSITIONING & ORIENTATION REPORT, See Attachment Z;

H. CAMERA CALIBRATION REPORT, if the current version has not already been submitted. See Attachment Z;

I. CAMERA MAINTENANCE LOG, if the current version has not already been submitted. See Attachment Z;

J. CAMERA WINDOW INFORMATION, if the current version has not already been submitted. See Attachment Z;

K. PHOTO FINAL REPORT, See Attachment Z.

Submit all of the above requirements within three weeks of the completion of the aerial photography. Note, the items in the above Sections D, F and K have other specific delivery requirements which, for imagery, are explained in Attachment Z.

10.7 AEROTRIANGULATION DATA AND REPORT – The Contractor shall prepare a report covering the AT portion of the work. The AT files shall include all the files necessary to review the original data using SOCET SET® software. See Attachment I for detailed instructions. Submit this data and report within three weeks of the completion of the AT.

10.8 FULL-RESOLUTION LIDAR SHORELINE INTERIM SHAPEFILE – (If applicable) The Contractor shall supply one Esri 3D shapefile (lines) for each sub-area, consisting solely of segmented, attributed full-resolution lidar shoreline vectors. See Attachment AN.

10.9 GEOGRAPHIC CELL: PILOT AREA SHAPEFILE – The Contractor shall supply Esri 3D shapefiles (points, lines) of the Pilot Area for each sub-area. The Pilot Areas become part of the sub-areas. See Attachment D.

10.10 GEOGRAPHIC CELL: INTERIM SHAPEFILES – The Contractor shall supply Esri 3D shapefiles (points, lines) for quality control purposes, one set for each of the project's sub-divided areas, e.g. areas A, B, C, etc. when 100% complete. NGS prefers that the areas be submitted one at a time, with NGS review between each submission. See Attachment D.

10.11 GEOGRAPHIC CELL: FINAL SHAPEFILES – The Contractor shall supply the final set of Esri 2D shapefiles (points, lines), one for each of the Project's sub-divided areas, e.g. areas A, B, C, etc. These shall be submitted after NGS has reviewed and approved the Interim Shapefiles. See Attachment D.

10.12 CHART EVALUATION FILE – Comparison of project imagery and compiled data to largest scale NOAA Nautical Chart coverage of the project area results in creation of a Chart Evaluation File (CEF). See Attachment AE.

10.13 PROJECT COMPLETION REPORT – The final report covering all phases of work performed in the creation of a GC. See SOW Main Text, Section 9.4 and Attachment L. This report should accompany the final data submission.

10.14 TRANSMITTAL LETTER – Transmittal Letters (TL) are not required for Deliverables submitted via TOMIS by Contractors, since email notifications are automatically generated when items are identified in TOMIS as received. For Deliverables submitted outside of TOMIS (larger than 10MB or hardcopies), and for items that NGS ships to the Contractor, a TL shall be used, with the Contractor creating a TOMIS entry stating what was shipped + how shipped. One copy of the TL is sent with the shipment and another copy is emailed or faxed to the office receiving the data. For items sent by NGS, when the data arrives, the Contractor inventories the shipment against the TL, signs, and faxes or emails the TL back to NGS. Both offices should maintain files of TL. A special type of TL is required for hard drives and other government property that are sent back and forth. Both parties should use these forms and follow standard TL procedures in signing and returning a copy to the sender. See Attachments AC and AI.

10.15 TIDE STATION DATA – The Deliverables required by CO-OPS are listed in the reference in Section 3.6.M.

11. <u>DELIVERY SCHEDULE</u>

11.1 DATE – All Deliverables (Section10) shall be submitted to NGS, via TOMIS, by the project completion date listed in the Task Order. If the Contractor anticipates that the project will not be complete by the deadline date, the Contractor shall request an extension prior to the deadline. Extensions will normally be granted if there are extenuating circumstances. Reports and data sets should be submitted within three weeks of completion of that portion of the project. All materials submitted by the Contractor shall be delivered at the Contractor's expense.

11.2 REQUESTS FOR MODIFICATIONS – All requests for modification shall be submitted by the Contractor in writing to the Contracting Officer (with a copy to NGS) prior to the due date and as soon as possible.

11.3 MODIFICATIONS – In the event the schedule is exceeded due to causes beyond the control and without fault or negligence of the Contractor, as determined by the Contracting Officer, the Task Order will be modified in writing and the Task Order completion date will be extended one (1) calendar day for each calendar day of delay.

12. POINTS OF CONTACT:

Gregory E. Stinner
Contracts Technical Manager & COR
National Geodetic Survey
ATTN: N/NGS; SSMC3, Sta. 8615
1315 East-West Highway
Silver Spring, Maryland 20910
240-533-9651
Fax: 301-713-4175
email: gregory.stinner@noaa.gov

Mike Espey, Chief, Applications Br.
Remote Sensing Division,
National Geodetic Survey
ATTN: N/NGS3; SSMC3, Sta. 8321
1315 East-West Highway
Silver Spring MD 20910
240-533-9609
Fax: 301-713-2183
email: mike.espey@noaa.gov

13. SECURITY

13.1 INFORMATION SYSTEM SECURITY –

A. The Assessment and Authorization (A&A) requirements of Clause 48 CFR 1352.239-72 do not apply, and a Security Accreditation Package is not required.

B. The Contractor must describe how it implements a secure data processing of the information being collected, processed (methods, equipment, hardware, IT security methodology for securing the system(s), and software) and transmittedusing the following cyber security standards that they may use as a framework:

1. National Institute of Standards and Technology (NIST)
2. International Organizational of Standardization and International Electrotechnical Commission (ISO/IEC)
3. American National Standards Institute (ANSI)
4. Instrumentation, Systems, and Automation society (ISA)
5. Publicly Available Specification For IT and Cyber Security (PAS)
6. American Institute of CPA's (IACPA)/SOC2 compliance
7. Center for Internet Security (CIS)
8. General Data Privacy Regulation (GDPR)
9. Sarbanes-Oxley (SOX)
10. Global Technology Audit Guide (GTAG)

If the contractor does not use any of the above frameworks to implement security controls; they are asked to please address the following:

1. Hardware & Software inventories
2. Secure configuration for Hardware & Software
3. Vulnerability assessment & remediation
4. Controlled use of Privilege accounts
5. Auditing & Audit logs
6. Malware Defense
7. Securing Ports, Protocols, and services
8. Data protection
9. Account monitoring and control
10. Secure configuration of Network Devices
11. Control Access based on Need to know
12. Application Security
13. Incident Response and Management

13.2 NOAA BUILDING SECURITY - When visiting NOAA offices, all contractors must obtain a Visitor's Pass by showing show the Security Officer a valid picture ID (drivers license, military ID, etc.). Visitors will be required to sign-in at the building security desk, process through the walk-through magnetometer, and have their items x-rayed or searched. Visitors are issued a time expiring NOAA Visitor Badge valid for one day only. For additional information see: http://www.osec.doc.gov/osy/noaa/1.htm .

14. PLACE OF PERFORMANCE

Field work will take place within the project area, as required. Office work will be in facilities provided by the Contractor.

15. PERIOD OF PERFORMANCE

Work shall begin when the Contractor receives a Task Order against an existing task order.

Notice – all items highlighted are changes from previous versions of this SOW

ATTACHMENT A

AIRPORT AERIAL

PHOTOGRAPHY

REMOVED

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Notice – all items highlighted are changes from previous versions of this SOW

ATTACHMENT B

SAMPLE PROJECT

INSTRUCTIONS

REMOVED

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Notice – all items highlighted are changes from previous versions of this SOW

ATTACHMENT C

COASTAL AERIAL FILM

PHOTOGRAPHY

REQUIREMENTS

REMOVED

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Notice – all items highlighted are changes from previous versions of this SOW

November 2017

ATTACHMENT D

SHAPEFILE REQUIREMENTS

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

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ATTACHMENT D: SHAPEFILE REQUIREMENTS

1. INTRODUCTION

For each Geographic Cell (GC) the contractor shall supply two sets of Esri® shapefiles, one for NGS quality control purposes (interim files) and the other as the final deliverable product to NGS. The final product shapefiles shall be supplied to NGS after the interim shapefiles have been reviewed and approved by NGS personnel. The final delivery shapefiles are the approved interim shapefiles with additional informative data fields and re-attribution of features to comply with NGS's Coastal Cartographic Object Attribute Source Table (C-COAST). The glossary for the C-COAST feature attribute description may be found in Attachment F. The final set of deliverable shapefiles shall consist of the entire project area having one shapefile containing linear data and if applicable, a second shapefile containing point data. The data fields and attributes are character and case sensitive for both the interim and final shapefiles.

2. INTERIM SHAPEFILES

The interim shapefiles shall all be 3D shapefiles, sent in incremental submissions. The first interim shapefiles should include an area with a good representation of different types of features. The results of the NGS review should be received by the cartographer(s) before continuing into other areas of the project, thereby reducing the number of repeatable edits. These interim shapefiles will be imported into NGS's digital photogrammetric workstations for stereoscopic review purposes, and thus the need to be in the 3D format. The unique requirements for the interim shapefiles include:

2.1 COORDINATE SYSTEM AND DATUM – The interim shapefiles shall be in the same coordinate system, datum(s), zone, projection and units as the aerotriangulation output.

2.2 SHAPEFILE NAMING CONVENTION – Each ***feature class*** that is used within C-COAST will be a separate shapefile. The shapefiles shall have the following names and be of the specified ***geometry type*** (line, point).

LINE SHAPEFILES:

1) Shoreline
2) Alongshore_Feature
3) Obstruction_Linear
4) Cultural_Feature_Miscellaneous
5) Transportation
6) Natural_Feature_Miscellaneous
7) Danger_Area
8) Aquatic_Vegetation_Area
9) Contour
10) Cartographic_Limit

POINT SHAPEFILES: 11) Obstruction_Point
12) Freestanding_Marine_Feature
13) Landmark
14) Aid_To_Navigation
15) Vertical_Measurement

2.3 SHAPEFILE ATTRIBUTION (listed by ***class***; see 2.2 above for correct ***geometry type***)

1) Shoreline
Attribute: TYPE
Data type: Text
Width: 39
Domain: Mean_High_Water
Mean_High_Water_Approximate
Apparent_Marsh_Or_Swamp
Apparent_Mangrove_Or_Cypress
Bulkhead_Or_Sea_Wall
Bulkhead_Or_Sea_Wall_Ruins
Canal_Navigable
Canal_Navigable_Approximate
Canal_Non_navigable
Drydock_Permanent
Glacier
Great_Lake_Or_Lake_Or_Pond
Great_Lake_Or_Lake_Or_Pond_Approximate
Lock
Mean_Water_Level
Ramp
Rip_Rap
River_Or_Stream
River_Or_Stream_Approximate
Slipway
Wharf_Or_Quay
Wharf_Or_Quay_Ruins
Undetermined
Undetermined_Approximate
Shoreline_Alongshore_Feature_Boundary

Attribute: INFORMATIO
Data type: Text
Width: 50
Domain: Ancillary Information (e.g. Describing a feature)

2) Alongshore_Feature
Attribute: TYPE
Data type: Text
Width: 45
Domain: Pier
Pier__Floating
Pier_Ruins
Breakwater_Bare
Breakwater_Covers_Uncovers_Or_Submerged
Bridge__Fixed
Bridge_Fixed_Ruins
Bridge_Fixed_Under_Construction
Bridge_Footbridge
Bridge_Footbridge__Ruins
Bridge_Footbridge__Under_Construction
Bridge_Opening
Bridge_Opening_Ruins
Bridge_Opening_Under_Construction
Bridge_Pontoon
Bridge_Pontoon_Ruins
Bridge_Pontoon_Under_Construction
Fender
Gate
Groin_Bare
Groin_Covers_Uncovers_Or_Submerged
Jetty_Bare
Jetty_Covers_Uncovers_Or_Submerged
Marine_Railway_Bare
Marine_Railway_Covers_Uncovers_Or_Submerged
Training_Wall
Undetermined_Alongshore_Feature

Attribute: INFORMATIO
Data type: Text
Width: 50
Domain: Ancillary Information (e.g. Describing a feature)

3) Obstruction_Linear
Attribute: TYPE
Data type: Text
Width: 37
Domain: Platform_Floating
Platform_Mineral
Platform_Observation
Platform_Ruins

Platform_Undetermined
Wreck_Hull_Bare
Wreck_Hull_Covers_Uncovers
Wreck_Submerged
Ruins_Undetermined_Bare
Ruins_Undetermined_Covers_Uncovers
Ruins_Undetermined_Submerged
Obstruction_Bare
Obstruction_Covers_Uncovers
Obstruction_Submerged
Permanently_Docked_Vessel
Crib_Bare
Crib__Covers__Uncovers
Crib_Submerged
Fish_Facility_Fish_Stakes
Fish_Facility_Fish_Trap
Floating_Barrier_Oil_Barrier
Floating_Barrier_Boom

Attribute: INFORMATIO
Data type: Text
Width: 50
Domain: Ancillary Information (e.g. Describing a feature)

4) Cultural_Feature_Miscellaneous
Attribute: TYPE
Data type: Text
Width: 32
Domain: Building
Tank
Silo
Levee_Or_Dike
Cable_Overhead
Cable_Submerged
General_Transport_Ferry_Cable
General_Transport_Aerial_Cable
General_Transport_Conveyor_Belt
Grain_Elevator
Pipeline_Submerged_Or_Surface
Pipeline_Overhead
Dam
Fort
Fence
Wall

Attribute: INFORMATIO
Data type: Text
Width: 50
Domain: Ancillary Information (e.g. Describing a feature)

5) Transportation
Attribute: TYPE
Data type: Text
Width: 19
Domain: Road
Road_Path
Railroad
Railroad_Abandoned
Tunnel_Entrance

Attribute: INFORMATIO
Data type: Text
Width: 50
Domain: Ancillary Information (e.g. Describing a feature)

6) Natural_Feature_Miscellaneous
Attribute: TYPE
Data type: Text
Width: 27
Domain: Marsh_Or_Swamp_Extent
Mangrove_Or_Cypress_Extent
Glacier_Extent
Cliff_Or_Bluff
Stream_Perennial
Stream_Intermittent
Rapids
Waterfall
Sand_Dune
Lava_Extent
Landslide_Extent

Attribute: INFORMATIO
Data type: Text
Width: 50
Domain: Ancillary Information (e.g. Describing a feature)

7) Danger_Area
Attribute: TYPE
Data type: Text
Width: 26
Domain: Foul
Ledge_Or_Reef Covers Uncovers
Ledge_Or_Reef Submerged
Wreckage_Bare
Wreckage Covers__Uncovers
Wreckage Submerged
Shallow_Or_Shoal
Breakers

Attribute: INFORMATIO
Data type: Text
Width: 50
Domain: Ancillary Information (e.g. Describing a feature)

8) Aquatic_Vegetation_Area
Attribute: TYPE
Data type: Text
Width: 14
Domain: Kelp
Grass

Attribute: INFORMATIO
Data type: Text
Width: 50
Domain: Ancillary Information (e.g. Describing a feature)

9) Contour
Attribute: TYPE
Data type: Text
Width: 30
Domain: Depth_Contour
Depth_Contour Approximate
Elevation_Contour
Elevation_Contour_Approximate

Attribute: INFORMATIO
Data type: Text
Width: 50
Domain: Ancillary Information (e.g. Describing a feature or modifying Depth Contour to be MLLW)

10) Cartographic_Limit
Attribute: TYPE
Data type: Text
Width: 20
Domain: Feature_Limit
Low_Visibility_Limit
Source_Data_Limit

Attribute: INFORMATIO
Data type: Text
Width: 50
Domain: Ancillary Information (e.g. Describing a feature)

11) Obstruction_Point
Attribute: TYPE
Data type: Text
Width: 31
Domain: Rock_Bare
Rock_Covers_Uncovers
Rock_Submerged
Obstruction_Bare
Obstruction_Covers_Uncovers
Obstruction_Submerged
Coral_Covers_Uncovers
Coral_Submerged
Snag_Or_Stump_Submerged
Wreck_Mast_Bare
Wreck_Mast_Covers_Uncovers

Attribute: INFORMATIO
Data type: Text
Width: 50
Domain: Ancillary Information (e.g. Describing a feature or defining an obstruction)

12) Freestanding_Marine_Feature
Attribute: TYPE
Data type: Text
Width: 32
Domain: Pile_Bare
Pile_Covers_Uncovers
Pile__Submerged
Dolphin_Bare
Dolphin_Ruins__Bare
Dolphin_Ruins_Submerged

Dolphin_Ruins_Covers_Uncovers
Tripodal_Bare
Stake_Bare
Stake_Covers_Uncovers
Stake_Submerged

Attribute: INFORMATIO
Data type: Text
Width: 50
Domain: Ancillary Information (e.g. Describing a feature)

13) Landmark
Attribute: TYPE
Data type: Text
Width: 16
Domain: Tower
Water_Tower
Chimney_Or_Stack
Cross
Dish_Antenna
Dome_Or_Cupola
Flagpole
Flare_Stack
Grain_Elevator
Mast
Silo
Spire_Or_Minaret
Tank
Windmill
Other

Attribute: VALUE
Data type: Text
Width: 20
Domain: Landmark
Recommended_Landmark

Attribute: INFORMATIO
Data type: Text
Width: 50
Domain: Ancillary Information (e.g. Describing a feature)

14) Aid_To_Navigation
    Attribute: TYPE
        Data type: Text
        Width: 24
        Domain: Daybeacon
            Marine_Light Pile
            Marine_Light Tripodal
            Marine_Light Tower
            Marine_Light Lighthouse

    Attribute: INFORMATIO
        Data type: Text
        Width: 50
        Domain: Ancillary Information (e.g. Describing a feature)

15) Vertical_Measurement
    Attribute: TYPE
        Data type: Text
        Width: 21
        Domain: Spot_Elevation
            Sounding
            Sounding Wreck
            Sounding_Rock
            Sounding Obstruction
            Sounding_Coral

    Attribute: INFORMATIO
        Data type: Text
        Width: 50
        Domain: Ancillary Information (e.g. Describing a feature)

Example of interim shoreline attribute table:

Shoreline

FID	Shape	SS_ID	TYPE	INFORMATIO
18	Polyline ZM	134	Rip_Rap	
19	Polyline ZM	135	Bulkhead_Or_Sea_Wall	
20	Polyline ZM	136	Mean_High_Water	
21	Polyline ZM	137	Rip_Rap	
22	Polyline ZM	139	Apparent__Marsh_Or_Swamp	
23	Polyline ZM	140	Mean_High_Water	
24	Polyline ZM	154	Mean_High_Water	
25	Polyline ZM	155	Mean_High_Water	

3. FINAL DELIVERABLE SHAPEFILES

The final deliverable shapefiles shall merge all the approved interim **line** shapefiles into one 2D shapefile and all the approved interim **point** shapefiles into another 2D shapefile. See section 2.2 for a listing of which classes are lines and which are points. Polygon shapefiles shall not be used. The final delivery shapefiles are the approved interim shapefiles with additional information about the shoreline data and a re-attribution of features to comply with NGS's C-COAST. Note that for Recommended Landmarks (excluding Charted Landmarks) the TYPE field and the VALUE field from the interim shapefile are merged to form the ATTRIBUTE field in the final shapefile. The cartographer shall not use C-COAST features or attributes with a ~~strikeout~~ since they are reserved for importing from other sources, such as vectorized historic shoreline manuscripts, into the NGS shoreline database. These final deliverable shapefiles will eventually be imported into the NGS shoreline database and be made available through the NOAA Shoreline Data Explorer website. The unique requirements for the final deliverable shapefiles include:

3.1 COORDINATE SYSTEM AND DATUM – The final shapefiles shall be in geographic decimal degrees using double precision and referenced to the NAD 83 horizontal datum (or its official replacement by NGS).

3.2 SHAPEFILE NAMING CONVENTION – There shall be two final shapefiles, which shall be named using the project identifier supplied by the government, with a suffix "_a" for the lines shapefile and a suffix "_p" for the points. Project identifiers will use the format "LLYYNNA-TT-S" where:

LL – two character abbreviation for state/territory (WI = Wisconsin, PR = Puerto Rico, etc.)
YY – two digit year identifier (16 = 2016, 17 = 2017, etc.)
NN – two digit sequence number (e.g. 01 = 1st project planned in state/territory that year)
A – one character sequential subproject designation *if applicable* (A, B, C, etc.)
TT – two character project type (CM = conventional mapping, TB = topobathy, etc.)
S – one character identifier for project acquisition source (N = NOAA, C = contractor, etc.)

3.3 SHAPEFILE ATTRIBUTION – Submit one project shapefile for all point features and another for all line features. Polygon shapefiles are not permitted. The final shapefiles shall include the following data fields, *ordered as they are listed below:*

Attribute_Label: DATA_SOURC
Data type: Text
Width: 1
Definition: Data Source describing the type of imagery used in compilation
Domain: A-AERIAL PHOTOGRAPHY - Film used in stereoplotter
D-DIGITAL PHOTOGRAPHY - Scanned from film or from digital camera
M-MULTIPLE SOURCES - Other sources i.e. Satellite, LIDAR, IFSAR, HyperSpectral Scanner, etc.

Attribute_Label: FEATURE
Data type: Integer
Width: 5
Definition: Cartographic feature code number from the Coastal Cartographic Object Attribute Source Table's (C-COAST) attribution scheme
Domain: 1 - 212 See Attachment E for the assigned numbers associated with each C_COAST attribute

Attribute_Label: EXTRACT_TE
Data type: Text
Width: 1
Definition: Technology used to extract feature from source
Domain: A-ANALOG PLOTTER
B-ANALYTICAL PLOTTER
S-SOFTCOPY

Attribute_Label: RESOLUTION
Data type: Integer
Width: 5
Definition: Integer indicating level of generalization (use '0' = full resolution) For this SOW the value of this attribute shall always equal 0.
Domain: 0 - 5

Attribute_Label: CLASS
Data type: Text
Width: 32
Definition: C-COAST Feature class
Domain *(line features)*:
SHORELINE
ALONGSHORE FEATURE
OBSTRUCTION LINEAR
CULTURAL FEATURE MISCELLANEOUS
TRANSPORTATION
NATURAL FEATURE MISCELLANEOUS
DANGER AREA
AQUATIC VEGETATION AREA
CONTOUR
CARTOGRAPHIC LIMIT

(point features):
OBSTRUCTION POINT
FREESTANDING MARINE FEATURE
LANDMARK
AID TO NAVIGATION
VERTICAL MEASUREMENT

Attribute_Label: ATTRIBUTE

Data type: Text

Width: 50

Definition: C-COAST Feature attribute description

Domain *(line features)*:

Man-made.Bulkhead Or Sea Wall
Man-made.Bulkhead Or Sea Wall.Ruins
Man-made.Canal.Navigable
Man-made.Canal.Navigable.Approximate
Man-made.Canal.Non-navigable
Man-made.Drydock.Permanent
Man-made.Lock
Man-made.Ramp
Man-made.Rip Rap
Man-made.Slipway
Man-made.Wharf Or Quay
Man-made.Wharf Or Quay.Ruins
Natural.Apparent.Marsh Or Swamp
Natural.Apparent.Mangrove Or Cypress
Natural.Glacier
Natural.Great Lake Or Lake Or Pond
Natural.Great Lake Or Lake Or Pond.Approximate
Natural.Mean High Water
Natural.Mean High Water.Approximate
Natural.Mean Water Level
Natural.River Or Stream
Natural.River Or Stream.Approximate
Undetermined
Undetermined.Approximate
Shoreline/Alongshore Feature Boundary
Breakwater.Bare
Breakwater.Covers/Uncovers Or Submerged
Bridge.Fixed
Bridge.Fixed.Ruins
Bridge.Fixed.Under Construction
Bridge.Footbridge
Bridge.Footbridge.Ruins
Bridge.Footbridge.Under Construction
Bridge.Opening
Bridge.Opening.Ruins
Bridge.Opening.Under Construction
Bridge.Pontoon
Bridge.Pontoon.Ruins
Bridge.Pontoon.Under Construction

Fender
Gate
Groin.Bare
Groin.Covers/Uncovers Or Submerged
Jetty.Bare
Jetty.Covers/Uncovers Or Submerged
Marine Railway.Bare
Marine Railway.Covers/Uncovers Or Submerged
Pier
Pier.Floating
Pier.Ruins
Training Wall
Undetermined Alongshore Feature
Crib.Bare
Crib.Covers/Uncovers
Crib.Submerged
Fish Facility.Fish Stakes
Fish Facility.Fish Trap
Floating Barrier.Oil Barrier
Floating Barrier.Boom
Obstruction.Bare
Obstruction.Covers/Uncovers
Obstruction.Submerged
Platform.Floating
Platform.Mineral
Platform.Observation
Platform.Ruins
Platform.Undetermined
Permanently Docked Vessel
Ruins.Undetermined.Bare
Ruins.Undetermined.Covers/Uncovers
Ruins.Undetermined.Submerged
Wreck.Hull.Bare
Wreck.Hull.Covers/Uncovers
Wreck.Submerged
Building
Cable.Overhead
Cable.Submerged
Dam
Fence
Fort
General Transport.Aerial Cable
General Transport.Conveyor Belt
General Transport.Ferry Cable
Grain Elevator

Levee Or Dike
Pipeline.Submerged Or Surface
Pipeline.Overhead
Silo
Tank
Wall
Road
Road.Path
Railroad
Railroad.Abandoned
Tunnel Entrance
Cliff Or Bluff
Glacier.Extent
Landslide.Extent
Lava.Extent
Mangrove Or Cypress.Extent
Marsh Or Swamp.Extent
Rapids
Sand Dune
Stream.Intermittent
Stream.Perennial
Waterfall
Breakers
Foul
Ledge Or Reef.Covers/Uncovers
Ledge Or Reef.Submerged
Shallow Or Shoal
Wreckage.Bare
Wreckage.Covers/Uncovers
Wreckage.Submerged
Kelp
Grass
Depth Contour
Depth Contour.Approximate
Elevation Contour
Elevation Contour.Approximate
Feature Limit
Low Visibility Limit
Source Data Limit

(point features):

Coral.Covers/Uncovers
Coral.Submerged
Rock.Bare
Rock.Covers/Uncovers

Rock.Submerged
Snag Or Stump.Submerged
Obstruction.Bare
Obstruction.Covers/Uncovers
Obstruction.Submerged
Wreck.Mast.Bare
Wreck.Mast.Covers/Uncovers
Dolphin.Bare
Dolphin.Ruins.Bare
Dolphin.Ruins.Submerged
Dolphin.Ruins.Covers/Uncovers
Pile.Bare
Pile.Covers/Uncovers
Pile.Submerged
Stake.Bare
Stake.Covers/Uncovers
Stake.Submerged
Tripodal.Bare
Chimney Or Stack
Chimney Or Stack.Recommended Landmark
Cross
Cross.Recommended Landmark
Dish Antenna
Dish Antenna.Recommended Landmark
Dome Or Cupola
Dome Or Cupola.Recommended Landmark
Flagpole
Flagpole.Recommended Landmark
Flare Stack
Flare Stack.Recommended Landmark
Grain Elevator
Grain Elevator.Recommended Landmark
Mast
Mast.Recommended Landmark
Other
Other.Recommended Landmark
Silo
Silo.Recommended Landmark
Spire Or Minaret
Spire Or Minaret.Recommended Landmark
Tank
Tank.Recommended Landmark
Tower
Tower.Recommended Landmark
Water Tower

Water Tower.Recommended Landmark
Windmill
Windmill.Recommended Landmark
Daybeacon
Marine Light.Lighthouse
Marine Light.Pile
Marine Light.Tower
Marine Light.Tripodal
Sounding
Sounding.Coral
Sounding.Obstruction
Sounding.Rock
Sounding.Wreck
Spot Elevation

Attribute_Label: INFORM
Data type: Text
Width: 50
Definition: Ancillary Information (e.g. Describing or defining a feature). For certain features specific rules govern the exact text that shall be entered in this attribution field. See Attachment K.
Domain: Free text

Attribute_Label: HOR_ACC
Data type: Text
Width: 6
Definition: Horizontal positional accuracy (meters) as reported in the PCR (see Attachment L)
Domain: 0 - 200

Attribute_Label: SRC_DATE
Data type: Text
Width: 8
Definition: Date of source imagery (YYYYMMDD) for the feature
Domain: 18340101 - Present

Attribute_Label: SOURCE_ID
Data type: Text
Width: 8
Definition: Geographic Cell Identifier Number, or GC number (e.g. GC12345). The value of this attribute will be assigned by NGS upon granting permission to proceed with compilation.
Domain: Free text

Attribute_Label: EXT_METH
Data type: Text
Width: 1
Definition: Method used to extract feature from source
Domain: M-MONO
S-STEREO

Example of an attribute table for final deliverable line shapefile:

TX1505A-CM-N_a

FID	Shape *	DATA_SOURC	FEATURE	EXTRACT_TE	RESOLUTION	CLASS	ATTRIBUTE	INFORM	HOR_ACC	SRC_DATE	SOURCE_ID	EXT_METH
611	Polyline	D	10	S	0	SHORELINE	Man-made.Rip Rap		1.8	20170225	GC11309	S
639	Polyline	D	10	S	0	SHORELINE	Man-made.Rip Rap		1.8	20170225	GC11309	S
145	Polyline	D	53	S	0	ALONGSHORE FEATURE	Pier.Fixed		1.8	20170225	GC11309	S
554	Polyline	D	10	S	0	SHORELINE	Man-made.Rip Rap		1.8	20170225	GC11309	S
655	Polyline	D	20	S	0	SHORELINE	Natural.Mean High Water		1.8	20170225	GC11309	S
552	Polyline	D	10	S	0	SHORELINE	Man-made.Rip Rap		1.8	20170225	GC11309	S
668	Polyline	D	2	S	0	SHORELINE	Man-made.Bulkhead Or Sea Wall		1.8	20170225	GC11309	S
29	Polyline	D	53	S	0	ALONGSHORE FEATURE	Pier.Fixed		1.8	20170225	GC11309	S
337	Polyline	D	91	S	0	OBSTRUCTION LINEAR	Ruins.Undetermined.Covers/Uncovers	Pier ruins	1.8	20170225	GC11309	S
103	Polyline	D	53	S	0	ALONGSHORE FEATURE	Pier.Fixed		1.8	20170225	GC11309	S
322	Polyline	D	91	S	0	OBSTRUCTION LINEAR	Ruins.Undetermined.Covers/Uncovers	Piles	1.8	20170225	GC11309	S
144	Polyline	D	53	S	0	ALONGSHORE FEATURE	Pier.Fixed		1.8	20170225	GC11309	S
88	Polyline	D	53	S	0	ALONGSHORE FEATURE	Pier.Fixed		1.8	20170225	GC11309	S
543	Polyline	D	206	S	0	CONTOUR	Depth Contour	MLLW	1.8	20170225	GC11309	S
70	Polyline	D	53	S	0	ALONGSHORE FEATURE	Pier.Fixed		1.8	20170225	GC11309	S
324	Polyline	D	92	S	0	OBSTRUCTION LINEAR	Ruins.Undetermined.Submerged	Pier ruins	1.8	20170225	GC11309	S
194	Polyline	D	53	S	0	ALONGSHORE FEATURE	Pier.Fixed		1.8	20170225	GC11309	S
233	Polyline	D	53	S	0	ALONGSHORE FEATURE	Pier.Fixed		1.8	20170225	GC11309	S

4. <u>ENTERING DATA IN ATTRIBUTE FIELDS</u>

All shapefile database (.dbf) records shall have values entered into each attribute field according to the valid case sensitive domains of the fields as defined in 2.3 and 3.3. Generally, the Information (INFORM) field may be left blank, except for certain features/instances which are governed by specific requirements as stated in Attachment K.

The HOR_ACC attribution field entry for each feature shall normally be the reported accuracy for the block of imagery used to compile the feature unless another method is required by NGS for a given project. This value is the circular error (meters) at the 95% confidence level as reported in the COMPILATION section of the Project Completion Report. (See Attachment L, Section 4.7)

Notice – all items highlighted are changes from previous versions of this SOW

September 2017

ATTACHMENT E

COASTAL CARTOGRAPHIC OBJECT ATTRIBUTE TABLE (C-COAST) FEATURES

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Code	C-COAST ***CLASS*** / Attribute	S-57 Code
	SHORELINE	
1	Man-made	SLCONS
2	Man-made.Bulkhead Or Sea Wall	SLCONS;catslc 10
3	Man-made.Bulkhead Or Sea Wall.Ruins	SLCONS;catslc 10;condtn 2
4	Man-made.Canal.Navigable	CANALS;catcan 1
5	Man-made.Canal.Navigable.Approximate	CANALS;catcan 1;quapos 4
6	Man-made.Canal.Non-navigable	CANALS;catcan 2
7	Man-made.Drydock.Permanent	DRYDOC;status 1
8	Man-made.Lock	LOKBSN
9	Man-made.Ramp	SLCONS;catslc 12
10	Man-made.Rip Rap	SLCONS;catslc 8
11	Man-made.Slipway	SLCONS;catslc 13
12	Man-made.Wharf Or Quay	SLCONS;catslc 6
13	Man-made.Wharf Or Quay.Ruins	SLCONS;catslc 6;condtn 2
14	Natural	COALNE
15	Natural.Apparent.Marsh Or Swamp	COALNE;catcoa 8;quapos 4
16	Natural.Apparent.Mangrove Or Cypress	COALNE;catcoa 7;quapos 4
17	Natural.Glacier	COALNE;catcoa 6;quapos 4
18	Natural.Great Lake Or Lake Or Pond	COALNE;inform Lakeshore
19	Natural.Great Lake Or Lake Or Pond.Approximate	COALNE;quapos 4
20	Natural.Mean High Water	COALNE;inform Meanhighwater
21	Natural.Mean High Water.Approximate	COALNE;quapos 4
22	Natural.Mean Water Level	COALNE;inform Meanwaterlevel
23	Natural.River Or Stream	COALNE;inform River
24	Natural.River Or Stream.Approximate	COALNE;quapos 4
25	Undetermined	COALNE
26	Undetermined.Approximate	COALNE;quapos 4
27	Undetermined.Estimated	COALNE;quapos 9
28	Shoreline/Alongshore Feature Boundary	COALNE;quapos 4
	ALONGSHORE FEATURE	
29	Breakwater.Bare	SLCONS;catslc 1;watlev 2
30	Breakwater.Covers/Uncovers Or Submerged	SLCONS;catslc 1;watlev 3
31	Bridge	BRIDGE;catbrg -999
32	Bridge.Fixed	BRIDGE;catbrg 1
33	Bridge.Fixed.Ruins	BRIDGE;catbrg 1;condtn 2
34	Bridge.Fixed.Under Construction	BRIDGE;catbrg 1;condtn 1
35	Bridge.Footbridge	BRIDGE;catbrg 9
36	Bridge.Footbridge.Ruins	BRIDGE;catbrg 9;condtn 2
37	Bridge.Footbridge.Under Construction	BRIDGE;catbrg 9;condtn 1
38	Bridge.Opening	BRIDGE;catbrg 2
39	Bridge.Opening.Ruins	BRIDGE;catbrg 2;condtn 2
40	Bridge.Opening.Under Construction	BRIDGE;catbrg 2;condtn 1
41	Bridge.Pontoon	BRIDGE;catbrg 6
42	Bridge.Pontoon.Ruins	BRIDGE;catbrg 6;condtn 2

43	Bridge.Pontoon.Under Construction	BRIDGE;catbrg 6;condtn 1
44	Fender	SLCONS;catslc 14
45	Gate	GATCON
46	Groin.Bare	SLCONS;catslc 2;watlev 2
47	Groin.Covers/Uncovers Or Submerged	SLCONS;catslc 2;watlev 3
48	Jetty.Bare	SLCONS;catslc 4;watlev 2
49	Jetty.Covers/Uncovers Or Submerged	SLCONS;catslc 4;watlev 3
50	Marine Railway.Bare	SLCONS;catslc 13;watlev 2
51	Marine Railway.Covers/Uncovers Or Submerged	SLCONS;catslc 13;watlev 3
52	Pier	SLCONS;catslc 4
54	Pier.Floating	PONTON
55	Pier.Ruins	SLCONS;catslc 4;condtn 2
56	Training Wall	SLCONS;catslc 7
57	Undetermined Alongshore Feature	SLCONS

OBSTRUCTION POINT

58	Coral.Covers/Uncovers	UWTROC;natsur 14;watlev 4;quasou 2
59	Coral.Submerged	UWTROC;natsur 14;watlev 3;quasou 2;valsou -999
60	Rock	UWTROC;natsur 9
61	Rock.Bare	LNDARE
62	Rock.Covers/Uncovers	UWTROC;natsur 9;watlev 4;quasou 2;valsou -999
63	Rock.Submerged	UWTROC;natsur 9;watlev 3;quasou 2;valsou -999
66	Snag Or Stump.Submerged	OBSTRN;catobs 1;watlev 3;quasou 2;valsou -999
67	Obstruction.Bare	OBSTRN;watlev 2;height -999
68	Obstruction.Covers/Uncovers	OBSTRN;watlev 4;quasou 2
69	Obstruction.Submerged	OBSTRN;watlev 3;quasou 2;valsou -999
70	Wreck.Mast.Bare	WRECKS;catwrk 4;watlev 2;height -999
71	Wreck.Mast.Covers/Uncovers	WRECKS;catwrk 4;watlev 4;height -999

OBSTRUCTION LINEAR

72	Crib.Bare	OBSTRN;catobs 4;watlev 2;height -999
73	Crib.Covers/Uncovers	OBSTRN;catobs 4;watlev 4;quasou 2
74	Crib.Submerged	OBSTRN;catobs 4;watlev 3;quasou 2;valsou -999
75	Fish Facility.Fish Stakes	FSHFAC;catfif 1
76	Fish Facility.Fish Trap	FSHFAC;catfif 2
78	Floating Barrier.Oil Barrier	OILBAR;catolb 2
212	Floating Barrier.Boom	OBSTRN;catobs 10;watlev 7;valsou -999
81	Obstruction.Bare	OBSTRN;watlev 2;height -999
82	Obstruction.Covers/Uncovers	OBSTRN;watlev 4;quasou 2
83	Obstruction.Submerged	OBSTRN;watlev 3;quasou 2;valsou -999
84	Platform.Floating	PONTON;inform Floating platform
85	Platform.Mineral	OFSPLF;catofp 2
86	Platform.Observation	OFSPLF;catofp 3
87	Platform.Ruins	OFSPLF;catofp -999;condtn 2
88	Platform.Undetermined	OFSPLF;catofp -999
89	Permanently Docked Vessel	HULKES
90	Ruins.Undetermined.Bare	OBSTRN;condtn 2;watlev 2;height -999
91	Ruins.Undetermined.Covers/Uncovers	OBSTRN;condtn 2;watlev 4;quasou 2

92	Ruins.Undetermined.Submerged	OBSTRN;condtn 2;watlev 3;quasou 2;valsou -999
93	Wreck.Hull.Bare	WRECKS;catwrk 5;watlev 2;height -999
94	Wreck.Hull.Covers/Uncovers	WRECKS;catwrk 5;watlev 4;quasou 2;valsou -999
211	Wreck.Submerged	WRECKS;watlev 3;quasou 2;valsou -999

FREESTANDING MARINE FEATURE

97	Dolphin.Bare	MORFAC;catmor 1
98	Dolphin.Ruins.Bare	MORFAC;catmor 1;condtn 2;watlev 2
99	Dolphin.Ruins.Submerged	MORFAC;catmor 1;condtn 2;watlev 3
100	Dolphin.Ruins.Covers/Uncovers	MORFAC;catmor 1;condtn 2;watlev 4
101	Pile.Bare	PILPNT;catple 3
102	Pile.Covers/Uncovers	OBSTRN;catobs 1;watlev 4
103	Pile.Submerged	OBSTRN;catobs 1;watlev 3
104	Stake.Bare	PILPNT;catple 1
105	Stake.Covers/Uncovers	OBSTRN;catobs 1;watlev 4;quasou 2;valsou -999
106	Stake.Submerged	OBSTRN;catobs 1;watlev 3;quasou 2;valsou -999
107	Tripodal.Bare	PILPNT;catple 4

LANDMARK

108	Chimney Or Stack	LNDMRK;catlmk 3;convis 1
109	Chimney Or Stack.Recommended Landmark	LNDMRK;catlmk 3;convis 1
110	Cross	LNDMRK;catlmk 14;convis 1
111	Cross.Recommended Landmark	LNDMRK;catlmk 14;convis 1
112	Dish Antenna	LNDMRK;catlmk 4;convis 1
113	Dish Antenna.Recommended Landmark	LNDMRK;catlmk 4;convis 1
114	Dome Or Cupola	LNDMRK;catlmk 15;convis 1
115	Dome Or Cupola.Recommended Landmark	LNDMRK;catlmk 15;convis 1
116	Flagpole	LNDMRK;catlmk 5;convis 1
117	Flagpole.Recommended Landmark	LNDMRK;catlmk 5;convis 1
118	Flare Stack	LNDMRK;catlmk 6;convis 1
119	Flare Stack.Recommended Landmark	LNDMRK;catlmk 6;convis 1
120	Grain Elevator	SILTNK;catsil 3;convis 1
121	Grain Elevator.Recommended Landmark	SILTNK;catsil 3;convis 1
122	Mast	LNDMRK;catlmk 7;convis 1
123	Mast.Recommended Landmark	LNDMRK;catlmk 7;convis 1
124	Other	LNDMRK;catlmk -999
125	Other.Recommended Landmark	LNDMRK;catlmk -999
126	Silo	SILTNK;catsil 1;convis 1
127	Silo.Recommended Landmark	SILTNK;catsil 1;convis 1
128	Spire Or Minaret	LNDMRK;catlmk 20;convis 1
129	Spire Or Minaret.Recommended Landmark	LNDMRK;catlmk 20;convis 1
130	Tank	SILTNK;catsil 2;convis 1
131	Tank.Recommended Landmark	SILTNK;catsil 2;convis 1
132	Tower	LNDMRK;catlmk 17;convis 1
133	Tower.Recommended Landmark	LNDMRK;catlmk 17;convis 1
134	Water Tower	SILTNK;catsil 4;convis 1
135	Water Tower.Recommended Landmark	SILTNK;catsil 4;convis 1
136	Windmill	LNDMRK;catlmk 18;convis 1

137	Windmill.Recommended Landmark	LNDMRK;catlmk 18;convis 1

AID TO NAVIGATION

138	Daybeacon	BCNLAT;inform Daybeacon position
139	Marine Light.Lighthouse	BUISGL;functn 33
140	Marine Light.Pile	BCNLAT;inform Light position
141	Marine Light.Tower	BCNLAT;inform Light position
142	Marine Light.Tripodal	BCNLAT;inform Light position

CULTURAL FEATURE MISCELLANEOUS

143	Building	BUISGL;functn -999
144	Cable.Overhead	CBLOHD
145	Cable.Submerged	CBLSUB
146	Dam	DAMCON;catdam 2
147	Fence	FNCLNE;catfnc 1
148	Fort	FORSTC;catfor 2
149	General Transport.Aerial Cable	CONVYR;catcon 1
150	General Transport.Conveyor Belt	CONVYR;catcon 2
151	General Transport.Ferry Cable	FERYRT;catfry 2
152	Grain Elevator	SILTNK;catsil 3
153	Levee Or Dike	DYKCON
154	Pipeline.Submerged Or Surface	PIPSOL
155	Pipeline.Overhead	PIPOHD
156	Silo	SILTNK;catsil 1
157	Tank	SILTNK;catsil 2
158	Wall	FNCLNE;catfnc 4

TRANSPORTATION

161	Road	ROADWY
162	Road.Path	ROADWY;catrod 4
163	Railroad	RAILWY;status -999
164	Railroad.Abandoned	RAILWY;status 4
166	Tunnel Entrance	TUNNEL

NATURAL FEATURE MISCELLANEOUS

167	Cliff Or Bluff	SLOTOP;catslo 6
168	Glacier.Extent	ICEARE;catice 5
169	Landslide.Extent	LNDRGN;catlnd 13
170	Lava.Extent	LNDRGN;catlnd 14
171	Mangrove Or Cypress.Extent	VEGATN;catveg 7
172	Marsh Or Swamp.Extent	LNDRGN;catlnd 2
174	Rapids	RAPIDS
175	Sand Dune	SLOGRD;catslo 3;natsur 4
176	Stream.Intermittent	RIVERS;status 5
177	Stream.Perennial	RIVERS;status 1
178	Waterfall	WATFAL;convis 1

DANGER AREA

179	Breakers	WATTUR;catwat 1
180	Foul	OBSTRN;catobs 6;watlev 4;quasou 2;valsou -999
207	Ledge Or Reef.Covers/Uncovers	SBDARE;watlev 4
208	Ledge Or Reef.Submerged	SBDARE;watlev 3
209	Shallow Or Shoal	CTNARE
187	Wreckage.Bare	WRECKS;catwrk 3;watlev 2;height -999
188	Wreckage.Covers/Uncovers	WRECKS;catwrk 3;watlev 4;quasou 2
189	Wreckage.Submerged	WRECKS;catwrk 3;watlev 3;quasou 2;valsou -999

AQUATIC VEGETATION AREA

191	Kelp	WEDKLP;catwed 1
210	Grass	WEDKLP;catwed 3

CONTOUR

206	Depth Contour	DEPCNT;valdco 0;inform MLLW
193	Depth Contour.Approximate	DEPCNT;valdco 0;quapos 4;inform MLLW
194	Elevation Contour	LNDELV;elevat -999;verdat 16
195	Elevation Contour.Approximate	LNDELV;elevat -999;verdat 16;quapos 4

VERTICAL MEASUREMENT

196	Sounding	SOUNDG;quasou 1;valsou -999
197	Sounding.Coral	SOUNDG;watlev 3;quasou 1;valsou -999
198	Sounding.Obstruction	OBSTRN;watlev 3;quasou 2;valsou -999
199	Sounding.Rock	UWTROC;natsur 9;watlev 3;quasou 1;valsou -999
200	Sounding.Wreck	WRECKS;watlev 3;quasou 1;valsou -999
201	Spot Elevation	LNDELV;elevat -999;verdat 16

CARTOGRAPHIC LIMIT

202	Feature Limit	M_COVR;catcov 1
203	Low Visibility Limit	M_COVR;catcov 2
204	Source Data Limit	M_COVR;catcov 1
205	User Added Line	blkclo

November 2017

ATTACHMENT F

GLOSSARY OF TERMINOLOGY USED IN THE COASTAL CARTOGRAPHIC OBJECT ATTRIBUTE SOURCE TABLE (C-COAST)

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

ATTACHMENT F: C-COAST DEFINITIONS BY CLASS

SHORELINE

The intersection of the land, including man-made waterfront structures, with the water surface. The shoreline depicted on NOS maps and charts represents the line of contact between the land and a selected water elevation. In areas affected by tidal fluctuations, the shoreline is the interpreted or derived mean high water line. In confined coastal water of diminished tidal influence, the mean water level line may be used. In non-tidal waters, the line represents the land/water interface at the time of survey. In areas where the land is obscured by marsh grass, cypress or similar marine vegetation, the actual shoreline can not be accurately represented. Instead, the outer limit line of the vegetation area is delineated (where it would appear to the mariner as the shoreline) and is referred to as the apparent shoreline. (2)

Accurate

A modifier that indicates shoreline delineated in a regular, sufficiently controlled survey of any date. Shoreline features with no accuracy modifier should be considered **Accurate** unless specified **Approximate** or **Estimated**. (6)

Apparent

The outer limit line of a vegetation area, such as marsh or mangrove, delineated as shoreline; the shoreline as it would appear to the mariner. (5)

Approximate

A modifier that indicates shoreline which does not meet the definition of **Accurate**, but is generally considered to be within 100 feet (30.5 meters) of its correct geographic location. Used to denote shoreline obscured by shadows or line-of-sight blockage, such as under bridges. (6)

Bulkhead Or Sea Wall

An embankment or wall for protection against waves or tidal action along a shore or water front. (6)

Canal

An artificial waterway with no flow, or a controlled flow, used for navigation, or for draining or irrigating land. (6)

Drydock

An artificial basin fitted with a gate or caisson, into which vessels can be floated and the water pumped out to expose the entire vessel. Also called graving dock. (5)

Estimated

A modifier that indicates shoreline which is generally considered to be outside of 100 feet (30.5 meters) of its correct geographic location .

Glacier

A mass of snow and ice continuously moving from higher to lower ground.

Great Lake Or Lake Or Pond

The Great Lakes, and other small and large bodies of water entirely surrounded by land, both natural and artificial. (6)

Lock

An enclosure as in a canal used in raising or lowering ships as they pass from one level to the other. (5)

Mangrove Or Cypress

An area composed of one of several genera of tropical trees or shrubs which produce many prop roots and grow along low lying coasts in shallow water or a deciduous conifer which thrives in swamps and tidal flows. Mangroves are typically found in the tropical or sub-tropical regions. They occur both in estuaries and along open coastlines. Mangroves dominate three quarters of tropical coastlines. Because of their sensitivity to sub-freezing temperatures, mangroves in the continental United States are limited to the Florida peninsula and isolated growths along the coast of southern Louisiana and south Texas. (6, **12, 13**)

Man-made

Composed of artificially constructed features or non-natural materials.

Marsh Or Swamp

An area made up of spongy land saturated with water. It may have a shallow covering of water, usually with a considerable amount of vegetation appearing above the surface. (6)

Mean High Water

A tidal datum. The average of all the high water heights observed over the National Tidal Datum Epoch (19 years). For stations with shorter series, simultaneous observational comparisons are made with a control tide station in order to derive the equivalent datum of the National Tidal Datum. (2)

Mean Water Level

A datum. The mean surface elevation as determined by averaging the heights of the water at equal intervals of time, usually hourly. Mean water level is used in areas of little or no range in tide. (10)

Natural

Composed of naturally occurring materials, or created, or appearing to have been created, by natural processes.

Navigable

Affording passage to a craft; capable of being navigated. (5)

Non-navigable
Not affording passage to a craft; incapable of being navigated. (5)

Permanent
Lasting or intended to last indefinitely. (6)

Ramp
A sloping structure that can be used as a landing place, at variable water levels, for small vessels, landing ships, or a ferry boat, or for hauling a cradle carrying a vessel. (6)

Rip Rap
A layer of broken rock, cobbles, boulders, or fragments of sufficient size to resist the erosive forces of flowing water and wave action. (6)

River Or Stream
A natural channel through which water flows (5)

Ruins
A structure in a decayed or deteriorated condition resulting from neglect or disuse; a damaged structure in need of repair. (5)

Shoreline/Alongshore Feature Boundary
The demarcation of the inland limit, along the SHORELINE, of an ALONGSHORE FEATURE.

Slipway
A prepared and usually reinforced inclined surface on which keel- and bilge-blocks are laid for supporting a vessel under construction. (6)

Undetermined
Of unspecified and/or unknown composition.

Wharf Or Quay
A structure serving as a berthing place for vessels consisting of a solid or open wall of concrete, masonry, wood, etc. (6)

<u>ALONGSHORE FEATURE</u>
An object that intersects, abuts, or is adjacent to and seaward of the shoreline.

Bare
Always dry; not covered at high water under average meteorological conditions. (6)

Breakwater
A structure protecting a shore area, harbor, anchorage, or basin from waves. (6)

Bridge
A structure erected over a depression or an obstacle such as a body of water, railroad, etc., to provide a roadway for vehicles or pedestrians. (5)

Covers/Uncovers Or Submerged
Covered at high water under average meteorological conditions.

Fender
A protective structure designed to cushion the impact of a vessel and prevent damage, for example, cushioning devices adjacent to bridges. (6)

Fixed
Attached to the land or seabed and having a permanent horizontal and vertical alignment. (6)

Floating
Resting on the surface of the water; buoyant. (8)

Footbridge
A bridge structure intended only for pedestrian traffic. (6)

Gate
A moveable barrier across an opening or passageway. (8)

Groin
A low artificial wall-like structure of durable material extending from the land to seaward for a particular purpose, such as to prevent coast erosion. (6)

Jetty
A structure built out into the water to restrain or direct currents, usually to protect a river mouth or harbor entrance from silting. (5)

Marine Railway
A track, usually sloping, for hauling a cradle carrying a vessel out of the water so that the hull can be exposed. (5)

Opening
Refers to a bridge, a portion of which moves to allow marine traffic to pass through the waterway it crosses. (6)

Pier

A long, narrow structure extending into the water to afford a berthing place for vessels, to serve as a promenade, etc. (6)

Pontoon

A floating structure, usually rectangular in shape used, for example, to support a bridge. (5)

Ruins

A structure in a decayed or deteriorated condition resulting from neglect or disuse; a damaged structure in need of repair. (5)

Training Wall

A wall or bank, often submerged, built to direct or confine the flow of a river or tidal current, or to promote a scour action. (6)

Under Construction

In the process of being built. (6)

Undetermined Alongshore Feature

Unspecified and/or unknown type of feature.

<u>OBSTRUCTION POINT</u>

In marine navigation, any object, such as a sunken rock or pinnacle, that hinders or prevents movement, particularly anything that endangers or prevents passage of a vessel. (6)

Bare

Always dry; not covered at high water under average meteorological conditions. (6)

Coral

The hard calcareous skeletons of many types of marine polyps. (6)

Covers/Uncovers

Periodically extending above and being submerged below the surface of the water. Also referred to as dries or uncovers. (6)

Mast

A straight vertical piece of timber or a hollow cylinder. (6)

Obstruction

An OBSTRUCTION POINT feature, the nature of which may be uncertain.

Rock

Any formation of natural origin that constitutes an integral part of the lithosphere. The naturally occurring material that forms firm, hard, and solid masses. (6)

Snag Or Stump

A tree, branch or broken pile embedded in the ocean floor, river, or lake bottom, thereby forming a hazard to vessels. (6)

Submerged

Always under water; covered by water at all times under average meteorological conditions. (6)

Wreck

The ruined remains of a vessel which has been rendered useless. (5)

OBSTRUCTION LINEAR

In marine navigation, any continuous, non-isolated danger that hinders or prevents movement, particularly anything that endangers or prevents passage of a vessel. (6)

Bare

Always dry; not covered at high water under average meteorological conditions. (6)

Boom

A floating barrier used to protect a river or harbour mouth or to create a sheltered area for storage purpouses. (6)

Covers/Uncovers

Periodically extending above and being submerged below the surface of the water. Also referred to as dries or uncovers. (6)

Crib

A permanent structure set in the water, framed with wooden beams and usually filled with rocks or boulders. A crib is generally used to anchor log booms or support other constructions, e.g. submerged outfalls, water intakes, etc. (6)

Fish Facility

A structure in shallow water related to the fishing industry. (6)

Fish Stakes

A group of poles or stakes placed in shallow water to outline a fishing ground or to catch fish. (6)

Fish Trap
A structure (usually portable) for catching fish. (6)

Floating
Resting on the surface of the water; buoyant. (8)

Floating Barrier
A structure resting on the surface of the water which may be used to constrain the movement of water-borne objects or materials.

Hull
The main structure of a vessel. (1)

Mineral
Relating to a structure associated with oil and gas exploration, production, etc.

Observation
Relating to a structure which provides visual access to the surrounding area, e.g., a duck blind.

Obstruction
An OBSTRUCTION LINEAR feature, the nature of which may be uncertain.

Oil Barrier
A floating tube-shaped structure, with a curtain hanging under it, below the surface, which prevents the spread of oil. (6)

Permanently Docked Vessel
A ship or other marine vessel which is attached to a pier, wharf, etc., and which does not or is not intended to move. Examples could include museum ships or floating restaurants.

Platform
A structure erected on or over the seabed. (7)

Ruins
A structure in a decayed or deteriorated condition resulting from neglect or disuse; a damaged structure in need of repair. (5)

Submerged
Always under water; covered by water at all times under average meteorological conditions. (6)

Undetermined
An unspecified and/or unknown type of feature.

Wreck

The ruined remains of a vessel which has been rendered useless. (5)

FREESTANDING MARINE FEATURE

A fixed, isolated object consisting of an oblong member or group of members, and related to maritime functions.

Bare

Always dry; not covered at high water under average meteorological conditions. (6)

Covers/Uncovers

Periodically extending above and being submerged below the surface of the water. Also referred to as dries or uncovers. (6)

Dolphin

A post or group of posts used for mooring or warping a vessel, or as an aid to navigation. (6)

Pile

A long heavy timber or section of steel, wood, concrete, etc. forced into the earth, which may serve as a support, as for a pier, or a free standing pole within a marine environment. (6)

Ruins

A structure in a decayed or deteriorated condition resulting from neglect or disuse; a damaged structure in need of repair. (5)

Stake

A thin, elongated wood or metal pole embedded in the bottom to serve as a marker or support. (6)

Submerged

Always under water; covered by water at all times under average meteorological conditions. (6)

Tripodal

A single structure comprising 3 or more piles held together and forced into the earth or seabed. (6)

LANDMARK

Any fixed natural or artificial object, generally on land, which is prominent from seaward and can be used in determining a vessel's direction or position. The term excludes objects expressly erected for navigational purposes such as lights or day beacons.

Chimney Or Stack

A vertical structure containing a passage or flue for discharging smoke and gasses. (6)

Cross

A monument, or other structure in the form of a cross. (6)

Dish Antenna

A parabolic antenna for the receipt and/or transmission of high frequency radio signals. (6)

Dome Or Cupola

A hemispherical or spheroidal structure rising from a building. (6, 7)

Flagpole

A staff or pole on which flags are raised. (6)

Flare Stack

A tall structure used for burning-off waste oil or gas. (6)

Grain Elevator

A structure used for storing grain. Usually a tall frame, metal, or concrete structure with a compartmented interior. (6)

Mast

A straight vertical piece of timber or a hollow cylinder. (6)

Other

Of an unspecified nature.

Recommended Landmark

A fixed object which may be of value for inclusion on a NOAA nautical chart, since it may be useful in determining a vessel's direction or position.

Silo

A cylindrical tower used for storing fodder or grain. (6)

Spire Or Minaret

A tall conical or pyramid-shaped structure often built on the roof or tower of a building, especially a church or mosque. (6)

Tank

A fixed container generally used for storing liquids. (6)

Tower

A relatively tall structure which may be used for observation, support, storage, communication, etc. (6)

Water Tower

A tower with an elevated container used to hold water. (6)

Windmill

A wind driven system of vanes attached to a tower-like structure (excluding wind-generated power plants). (6)

AID TO NAVIGATION

A fixed, man-made structure or device designed to assist in determining a vessel's position and safe course, and to warn of dangers or obstructions.

Daybeacon

An unlighted, fixed structure which is equipped with a daymark (a marker presenting one of several standard shapes and colors) for daytime identification. (3)

Lighthouse

A building on some conspicuous point of the coast, a pier or jetty, an island or rock, from which a light is exhibited at night as an aid to navigation. (7)

Marine Light

A luminous device which may be used at night or in poor visibility to assist in maritime navigation.

Pile

A long heavy timber or section of steel, wood, concrete, etc. forced into the earth, which may serve as a support, as for a pier, or a free standing pole within a marine environment. (6)

Tower

A relatively tall structure which may be used for observation, support, storage, communication, etc. (6)

Tripodal

A single structure comprising 3 or more piles held together, and forced into the earth or seabed. (6)

CULTURAL FEATURE MISCELLANEOUS

Any man-made object which may be of importance to the mariner, but is not included in other classes.

Aerial Cable

Overhead cables supporting buckets, cable cars, etc. (6)

Building

A relatively permanent structure, roofed and usually walled, designed for some particular use. (6)

Cable

An assembly of wires or fibers, or a wire rope or chain. (6)

Conveyor Belt

A moving chain or band along which material or people are transported. (6)

Dam

A barrier to hold back water and raise its level to form a reservoir, or to prevent flooding. (6)

Fence

A man-made barrier used as an enclosure or boundary, or for protection. (6)

Ferry Cable

The guide cable for a ferry that follows a fixed route. (6)

Fort

A fortified structure, building, or partition able to be defended against an enemy. (6)

General Transport

A device used in the movement of materials or people.

Grain Elevator

A structure used for storing grain. Usually a tall frame, metal, or concrete structure with a compartmented interior. (6)

Levee Or Dike

An artificial embankment to contain or hold back water. (6)

Overhead

Refers to an object which is supported by pylons and passing over or nearby navigable waters.

Pipeline

A string of interconnected pipes used for the transport of matter, usually oil or gas. (5)

Silo

A cylindrical tower used for storing fodder or grain. (6)

Submerged

Always under water; covered by water at all times under average meteorological conditions. (6)

Submerged Or Surface

Refers to an object which lies at or below the water level, or upon the land.

Tank

A fixed container generally used for storing liquids. (6)

Wall

A fence constructed from masonry or stone. (6)

TRANSPORTATION

The means of carrying, moving, or conveying from one place to another. (8)

Abandoned

No longer used for the purpose intended; disused. (7)

Path

A way or track for walking or light vehicle traffic. (6)

Railroad

A set of parallel rails on which a train or tram runs. (8)

Road

An open way with a prepared surface for the passage of vehicles. (6)

Tunnel Entrance

The visible terminus of a passage that is buried under the seabed, laid over the sea floor, or bored under the ground. (6)

NATURAL FEATURE MISCELLANEOUS

Any non-man-made object which may be of importance to the mariner, but is not included in other classes.

Cliff Or Bluff

A line marking the top of a slope that rises abruptly for a considerable distance above the water or surrounding land. (6)

Extent

The spatial limits of an area feature.

Glacier Extents

See feature definition in the Shoreline Class. This represents the back (landward) limits of this area feature.

Intermittent Stream

A type of stream that only flows for part of the year and is usually symbolized on a map with a line of blue dashes and dots. (6)

Landslide

The scar left by a mass of land which has slid down a steep slope; may include the mass of land which has also slid. (6)

Lava

The substance that results from the cooling of molten rock. (6)

Mangrove Or Cypress Extents

See feature definition in the Shoreline Class. This represents the back (landward) limits of this area feature.

Marsh Or Swamp Extents

See feature definition in the Shoreline Class. This represents the back (landward) limits of this area feature.

Perennial Stream

Lasting indefinitely; enduring. A type of stream that flows throughout of the year and is usually symbolized on a map with a solid blue line. (8)

Rapids

Any portion of a stream with accelerated current, descending rapidly, but without a break in the slope of the bed sufficient to form a waterfall. (5)

Sand Dune

A mound, ridge, or hill of drifted sand along the coast. (6)

Waterfall

A sudden descent of water over a step in the bed of a river. (6)

DANGER AREA

A spatial extent in the marine environment which may contain hazards or perils to maritime navigation.

Bare

Always dry; not covered at high water under average meteorological conditions. (6)

Breakers

Waves that break over areas of shallow water. (6)

Covers/Uncovers

Periodically extending above and being submerged below the surface of the water. Also referred to as dries or uncovers. (6)

Foul

An area of numerous unidentified dangers to navigation which are not individually located . (6)

Ledge

A rocky formation continuous with and fringing the shore. (6)

Reef

A rocky or coral elevation dangerous to surface navigation which may or may not uncover at the sounding datum. A rocky reef is always detached from shore; a coral reef may or may not be connected with the shore. (7)

Shallow

An area composed of unconsolidated material where the depth of water is relatively less than its surroundings. (5)

Shoal

An offshore hazard to surface navigation composed of unconsolidated material. (6)

Submerged

Always under water; covered by water at all times under average meteorological conditions. (6)

Wreckage

The scattered remains of one or more stranded or sunken vessels.

AQUATIC VEGETATION AREA

A spatial extent in the marine environment characterized by the presence of living plant matter which in its natural form grows under water or is inundated with water.

Grass

Any grasslike marine alga. Eelgrass is one of the best known seagrasses. (6)

Kelp

A giant plant sometimes 60 meters long with no roots, it is anchored by hold-fasts or tendrils up to 10 meters long, that cling to rock. Gas filled bubbles on fronds act as floats keeping the kelp just below the surface. (6)

<u>CONTOUR</u>

A line connecting points of equal value.

Accurate

A modifier that indicates contours delineated in a regular, sufficiently controlled survey of any date. Contour features with no accuracy modifier should be considered **Accurate** unless specified **Approximate**. (6)

Approximate

A modifier that indicates a contour which does not meet the definition of **Accurate**, but is generally considered to be within 100 feet (30.5 meters) of its correct geographic location. Used to denote contours obscured by shadows or line-of-sight blockage, such as under bridges. (6)

Depth Contour

A line connecting points of equal water depth. (6)

Elevation Contour

A line connecting points of equal elevation. (5)

<u>VERTICAL MEASUREMENT</u>

An expression of the distance of an isolated point above or below a specified datum. (6)

Coral

The hard calcareous skeletons of many types of marine polyps. (6)

Obstruction

In marine navigation, any object, the nature of which is undetermined, that hinders or prevents movement, particularly anything that endangers or prevents passage of a vessel.

Rock

Any formation of natural origin that constitutes an integral part of the lithosphere. The naturally occurring material that forms firm, hard, and solid masses. (5)

Sounding

Measured or charted depth of water. (5)

Spot Elevation

A measured point indicating the height above a specified vertical datum. (5)

Wreck

The ruined remains of a vessel which has been rendered useless. (5)

CARTOGRAPHIC LIMIT

A user-defined line drawn for cartographic convention or due to source data limitations.

Feature Limit

The extent of feature delineation.

Low Visibility Limit

The extent of compilation restrictions due to an obscured or inadequate data source.

Source Data Limit

The extent of the data source used for compilation.

User Added Line

A connection of linear features created during the GIS processing to eliminate gaps for the purpose of maintaining continuity.

REFERENCES

The following is a list of sources from which many of the definitions in this glossary were derived. The number in parentheses following a definition refers to the numbered entries below. The absence of a number after a definition indicates that the term was defined by National Geodetic Survey/Remote Sensing Division personnel.

1. Bradford, Gershom. *The Mariner's Dictionary*. New York: Weathervane Books, 1972.

2. "Coastal Mapping Program Operations Manual, Chapter 12, Cartographic Feature Definitions". 2nd Edition. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, National Geodetic Survey, Remote Sensing Division, August 1999.

3. "Coast Pilot Manual". 5th Edition. Washington, DC: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, 1994.

4. (removed)

5. *Hydrographic Dictionary, Part I, Volume I, English, Special Publication No. 32*. 5th Edition. Monaco: International Hydrographic Organization, 1994.

6. *IHO Transfer Standard for Digital Hydrographic Data, Special Publication No. 57*. 3rd Edition. Monaco: International Hydrographic Bureau, 1996.

7. "Nautical Chart Manual, Volume Two: Definitions, Abbreviations, Symbology & References". 7th Edition. U.S. Department of Commerce, Coast and Geodetic Survey, 1992. Digital update January 31, 2009

8. *The Random House College Dictionary*. Revised Edition, Jess Stein ed. New York: Random House, 1980.

9. AC 150/5300-18B – "General Guidance And Specifications For Submission Of Aeronautical Surveys To NGS: Field Data Collection And Geographic Information System (GIS) Standards", on-line at: http://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.information/documentID/74204

10. Tide and Current Glossary - http://co-ops.nos.noaa.gov/publications/glossary2.pdf (January 2000).

11. Wood Products Council (May 2, 2000).

12. Coastal Mangrove-Marsh Shrubland *Conservation Habitats & Species Assessments*. Louisiana Department of Wildlife & Fisheries. December 2005. http://media.wlf.state.la.us/pdfs/experience/Coastal%20Mangrove-Marsh%20Shrubland.pdf .

13. Mangrove Swamps - http://www.epa.gov/owow/wetlands/types/mangrove.html

Notice – all items highlighted are changes from previous versions of this SOW

December 2017

ATTACHMENT G
WEEKLY STATUS REPORT

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

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ATTACHMENT G: WEEKLY STATUS REPORT PAGE

ATTACHMENT G: WEEKLY STATUS REPORT

1. GENERAL

1.1 FORMAT - The Prime Contractor shall submit project status reports via the Task Order Management and Information System (TOMIS) every Monday by 2:00 PM Eastern Time, from the date of a Task Order award until the work is complete and accepted by NGS. These reports shall show the status of each Deliverable, and the status of the Quality Control of the Interim Shapefiles, in order to help track the progress. A suggested format is shown below (the percent complete and date are required).

Submit the status report to TOMIS as an attachment in Microsoft (MS) Word, MS Excel, or Adobe Acrobat® Portable Document Format (PDF). The table boxes shown below are not required, but ensure that the information is in columns so that it is more readable. Note that if two or more task orders are active they should be shown in the same table or spreadsheet.

Prime Contractor Firm Name:____
Sub-Contractor(s) Firm Name:____

Project Identifier & Location Dates:	TX1401/South TX (sample)	CA1401/SF Bay Area (sample)
Date Task Order Awarded		
Date Project Due		

Project ID Project Deliverables	TX1401 (Approx. % Complete)	Date Complete or Planned Complete	CA1401 (Approx. % Complete)	Date Complete or Planned Complete
Deliverable #1	100%	1 MAR 14		
Deliverable #2	75%	1 APR 14		
Deliverable #3		1 MAY 14		
Deliverable #4		1 NOV14		
Interim Shapefile QC		1 DEC14		
Overall Completeness		15 DEC 14		

1.2 EXAMPLE - Sample projects, percentages and dates filled in above.

1.3 ALL PROJECTS - Include the above information for each project underway; add 2 columns for each project.

1.4 CHANGES - Highlight entries that have been changed from the previous week in green.

1.5 ITEMS OF CONCERN – Highlight item(s) of concern in red.

2. DELIVERABLES SUBMITTED

List deliverables submitted

3. FUTURE PLANS

Briefly state plans for the coming week.

4. COMMENTS

Include comments/unusual circumstances/approved modifications from this SOW or Project Instructions.

5. SPECIAL REQUESTS

Special requests, such as orders for film products, should be submitted to NGS in a separate email and just mentioned in this Weekly Status Report.

Notice – all items highlighted are changes from previous versions of this SOW

November 2017

ATTACHMENT H

ELECTRONIC EXPOSURE DATA VERSION 2 (EED2) FILE CHECKING SOFTWARE

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

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ATTACHMENT H: EED2 FILE CHECKING SOFTWARE

1. GENERAL – The EED2 File Checking Software enables users to view photographic footprint plots of their photography as well as ensure that EED2 files are in the correct National Geodetic Survey (NGS) format. The program currently does not have the capability to load a background map, although it may in future versions.

In the software, fields are tested for minimum and maximum allowable values, for correct data type (alpha or numeric), number of characters, punctuation, etc. This software will not catch all problems with an EED2 file, so additional review and validation may be necessary.

2. INSTRUCTIONS – The instructions for installation of the program are as follows:
   2.1 No installation or setup is required; simply place the program in any folder.
   2.2 Open the program by double clicking the icon.
   2.3 Select a file to check.
      A. Click on File - Load EED2 file
      B. Navigate to the EED2 file on your hard drive. By default the program will list files with the ".csv" extension and beginning with EED2_

3. CHECKING FOR AND CORRECTING ERRORS

   3.1 All errors and warnings are detected and displayed in a report that is written to the same folder as the EED2 file that is selected and displayed on the screen. Errors are identified by the line in the file and specific data field in which they occur.

   3.2 Errors can be fixed by (a) fixing the source data and regenerating the file in whatever manner was used to generate the file initially, (b) editing the EED2 file in a text editor, or (c) editing the file in Excel©.

   3.3 Editing the EED2 file in Excel can result in the removal of zeros at the end of decimal numbers. For example, a number initially created in the file as 36.326310 will become 36.32631 when the file is edited and saved in Excel. If that value should be to 6 decimal places the field will now be reported as warning. When an unusually number of detections are made for a specific field they will be reported as a group error.

   3.4 Continue editing the EED2 file and re-running the EED2_Viewer until all errors have been resolved.

4. WORKING WITH THE GRAPHIC DISPLAY – Provided no errors are initially encountered, flight lines and photo centers are displayed for visual verification of acquired data. The functions associated with the graphic display are straightforward. Below are the instructions for using the graphic display:

4.1 SETTINGS TAB

A. Click Properties.

B. Under this heading there are multiple settings that can be chosen.

C. Under the Frames section of the Properties dialog, choose what to view on the display, i.e. the footprints, flight lines, or photo centers. Any or all three can be displayed simultaneously.

D. Under the Highlighted section of the Properties function, choose what is to be highlighted when viewing the main screen.

E. Apply and accept changes, then Exit.

4.2 UNITS TAB

A. Click Cursor.

B. Choose the format in which the Latitude and Longitude is to be displayed. The Latitude and Longitude are then shown at the bottom of the main screen in the format chosen. Note, this format can be changed as many times as needed.

4.3 GENERAL FUNCTIONALITY

A. Right-clicking anywhere on the main screen or Overview screen will give the option to Pan, Identify, Print, Zoom In (2X), or Zoom Out.

i. If the Identify button is clicked, the properties of the frame are shown in the boxes of the "selected frame" area under the Overview screen.

ii. All of these functions, except Print, are available as clickable buttons above the Overview screen on the right of the main screen.

iii. The Identify, Pan, Zoom In, and Zoom Out functions are reflected on the main screen only. For instance, if the Zoom function is used in the Overview screen it zooms in on the main screen, but not on the Overview screen. The Overview always remains the same.

B. Under the selected frame on the Overview screen, highlighted data within the frame can be chosen. The choices are None, Frame Only, or Flight Line. The Frame Only function highlights only the frame. The Flight Line function highlights all frames in the flight line. This differs from the options under the Settings tab. The highlight options under the Settings tab outlines the image, flight line, or photo center. The selected frame highlight fills either the frame or the flight line of the frame.

C. You can optionally use rhe Create SHP File button to create a shape file that can be viewed in ArcMap to verify foot relative to known shoreline or other backdrops.

These directions should provide a general overview of program functionality. If problems are experienced while checking an EED2 file, the file should be emailed to the Contracting Officer's Representative (COR) so that NGS can troubleshoot. Please notify NGS if problems are encountered with the software, so a new version of the program may be issued.

ANNEX 1

ELECTRONIC EXPOSURE DATA VER. 2 (EED2) FILE FORMAT

ROLL NUMBER (FYI: For digital imagery, a roll is equivalent to a flight.)

For each camera used, NGS will assign a unique camera designation character "xx" which shall be used in the roll number. The roll number will be a 7-character string consisting of:

- **two** digit year;
- **two** digit camera designation number;
- **one** character camera type (**C** = color; **I** = color IR; **R** = black/white IR; **P** = Oblique Port; **S** = Oblique Starboard)
- and a **two** digit sequence number.

For each successive roll per year/camera/camera type designation, the sequence number shall be incremented by one (e.g. 1712R01, 1712R02, etc.). Please note the first 4 characters of the roll number will be the camera ID for purposes of linking to camera calibration information. (Note: The term 'camera' refers to a specific camera and a specific calibration. If the camera is recalibrated during image acquisition a new camera number must be obtained from NGS.)

EED2 SPECIFICATIONS

Each roll shall have an accompanying EED2 file. The file shall be in ASCII format capturing the attributes of each frame/image in the order they appear on the roll. The file shall be named using "**EED2_**" + **roll number** + "**.csv**" (e.g. **EED2_1712R01.csv**). Each frame of photography (image) shall have a record in the file. Within each record, a comma shall separate each data field. No commas will be used in the contents of any field. The number of decimal places shown is the *minimum* number required; more are acceptable, *with one caveat*: when a CSV file can be edited by Excel, and Excel will truncate zeros at the end of the decimal portion of a number, e.g. Excel will read the value "32.453500" and save it as "32.4535". The EED2 file checking software takes this into consideration and will only flag as an error if an unexpectedly large number of records fails to meet the minimum number of digits following the decimal points for a particular field. EED2 files shall include the following data fields, formatted as specified below:

NOTE: The *first* record in the file shall be the following header record, verbatim --
Time,ImageId,Latitude,Longitude,Heading,Altitude,Acquisition,Flight Line ID,Tide Stage,Date,Ground Elev,ReflightFlag,Recommended,Notes

Notice – all items highlighted are changes from previous versions of this SOW

Field#	Title	Format	Description	Sample Field Length
1	Time	tttttt.ttt	GPS week seconds	0 to 604,800
2	ImageId	dssfff_sssss	See Section 8.3B (p.19) of this SOW for STRIP_FRAME image naming convention	130005_00002 *
3	Latitude	dd.ffffff	Image center, decimal degrees, north is positive	-90 to 90
4	Longitude	ddd.ffffff	Image center, decimal degrees, west is negative	-180 to 180
5	Heading	hhh.h	Azimuth in decimal degrees	0 to 360
6	Altitude	ffffff	Meters above mean seal level	up to 6 digits
7	Acquisition	pppppppp	Root project ID as provided	NC1701
8	Flight Line ID	LID sc-nnn	LID, scale, sequential number at that scale **	BWI 30-001 (up to 12 chars)
9	Tide Stage	ttttt	Planned tide stage coordination	MHW, etc. ***
10	Date	dd-MMM-yyyy	day-MONTH-year (month in CAPS)	07-JUN-2017
11	Ground Elev	fffff	Ground elevation of target ****	-400 to 9000
12	ReflightFlag	ttttttt	Code for line to refly/reflown *****	up to 7 characters
13	Recommended	R	Recommended for use in compilation? ******	1 character (Y, N, or D)
14	Notes	ttttt	Information of note about flightline	up to 80 characters

* ImageId is also to be the name of the image file but w/o extension (e.g. 130005_00002.tif → ImageId 130005_00002)

** LID = *optional, for airport mapping projects only*; 3 to 4 letter identifier for the airport
scale = flying height/focal length, expressed in thousands w/o "1:xx," (e.g. 1:30,000 = **30**)
sequential number = nth line in the project at that scale (e.g. 30-005 is the 5th line at 1:30,000 in the project)

*** Acceptable values: MHW, MLLW, BMHW (below MHW), MSL, NONE (no tide coordination or tide stage N/A)

**** Ground Elev is generally "0" for coastal mapping projects.

***** Acceptable values: **ToRefly** (line *will be* reflown), **Refly** (line reflown), **ToPatch** (selected image *will be* reflown), **Patch** (image reflown, partial line), or <blank> if none of the above apply

****** When lines are reflown/patched, multiple images covering the same area result. However only ONE image is to be recommended for use in compilation. This flag indicates which image is recommended for use. Acceptable values are: **Y** (recommended), **N** (not acceptable), **D** (duplicate acceptable but not recommended)

Sample record:

```
   1      |    2      |    3     |     4      |     5     | 6  |   7   |     8      |  9  |     10     | 11 | 12 | 13 | 14
316238.94,C10657056,38.237975,-122.582722,140.646927,3101,NC1701,BWI 30-001,MLLW,07-JUN-2017,0,ToRefly,Y,clouds
```

CAMERA CALIBRATION INFORMATION

Each roll shall also have a brief file containing the camera calibration information necessary to form footprints for viewing and verification. This file will begin with the camera ID (first 4 characters in roll number), followed by _ccBrief.txt. For example, for the roll 1712R01, the brief camera calibration file would be “1702_ccBrief.txt”. This file shall reside in the same folder as the EED2 file when the verification program is executed.

The contents of the file will be as follows, *with all numbers shown to be replaced* with the corresponding values from the actual camera calibration. (Note: All values shall be to the number of decimals as they appear in camera calibration.)

> f (focal length in mm): 60.442
> Pixel size (in microns): 6.8
> Z (From line 'image size "Z" pixels x "Y" lines): 7212
> Y (From line 'image size "Z" pixels x "Y" lines): 5408

Again, the 60.442, 6.8, etc. will be replaced by the actual calibration values for the roll.

Notice – all items highlighted are changes from previous versions of this SOW

November 2017

ATTACHMENT I

AEROTRIANGULATION

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

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ATTACHMENT I: AEROTRIANGULATION PAGE

ATTACHMENT I: AEROTRIANGULATION

1. AEROTRIANGULATION METHODS

1.1. STANDARD INDUSTRY PRACTICES – The contractor shall follow the standard and accepted practices of analytical aerotriangulation (AT) with all blocks of images (both IR and Color) used for the shoreline mapping project. The contractor shall utilize the latest camera calibration data when performing AT to properly account for any distortions in the interior orientation of the camera system.

1.2. SUBDIVIDING BLOCKS – If necessary, the contractor may request permission to divide the project imagery into sub-blocks for AT purposes. This might be desirable, for instance, when different areas of the project have different accuracy requirements. Dividing a project into sub-blocks should not be done as a matter of course, however, but only if time and cost efficiency savings would result. The contractor shall perform a separate accuracy assessment for each sub-block.

1.3. SYSTEM REQUIREMENTS – The photogrammetric software used must be capable of outputting the horizontal (X and Y) RMS values of the standard deviations for each measured ground point, including all pass points and tie points. These values are required to compute the accuracy for each photogrammetric block (see Section 4.8.C).

2. FLIGHT LINE LAYOUT

A number of issues associated with shoreline mapping can significantly affect the quality of the AT solution, and must be taken into account when planning the photogrammetric project. Aerial surveys for shoreline mapping projects shall follow the meandering coast using shorter flight lines oriented parallel to the shoreline. Avoid single flight lines, in favor of parallel overlapping pairs of flight lines. Careful flight line planning will take into account irregularly shaped land areas, as well as the elevation and azimuth of the sun in relation to the water areas, and how the relationship changes during the scheduled aerial survey mission.

3. CONTROLLING THE IMAGERY

3.1. AIRBORNE CONTROL – The Contractor is required to use integrated standard airborne kinematic carrier-phase differential GPS data with high-accuracy IMU data in order to accurately determine the X, Y, Z positional coordinates and the Omega, Phi, Kappa orientation angles, i.e. direct georeferencing (DG), for each camera station at the time of exposure (see Attachment Z, Section 16). The contractor shall incorporate these appropriately weighted exposure values into the analytical block adjustment.

3.2. GROUND CONTROL POINTS – The Contractor shall determine whether or not ground control points are required, and if so, the number and locations of the points necessary to adequately supplement the DG.

3.3. PHOTOGRAMMETRIC CHECK POINTS – As part of the Ground Control Survey, the Contractor is required to locate and position at least four independent photo-identifiable check points for each block of the project, see SOW Section 6.2. These points shall be measured in the AT, but **shall not** be held as control in the final analytical adjustments.

4. AEROTRIANGULATION REPORT FORMAT

The AT Report consists of a few pages of narrative describing the project and the work performed during the AT phase, and a number of annexes showing a geographic depiction of the stereo coverage, ground control, flight lines, and the computation of horizontal accuracy. The report should be written soon after the AT work is complete, so that the details are still fresh in the mind of the photogrammetrist. See the sample AT Report in Annex 1.

4.1. TITLE – The AT Report shall have a title section near the top of the first page that includes the words "Aerotriangulation Report", along with the Project Identifier and the date (month and year) the report was completed, as in the following example:

Aerotriangulation Report
VA1601-CM-C
July 2001

4.2. AREA COVERED – This section shall contain a brief description of the limits of the project area. The description should include place names as required. Include a reference to the AT Report's Annex 1 – Project Coverage Diagram.

4.3. IMAGERY – This section shall contain descriptive information for the images used in the AT, including:

- Number of images used in the AT
- Number of flight lines
- Type of imagery (color, IR, etc.)
- Flying height
- Date(s) of images
- Source(s) of the images (government or contractor)
- Camera(s) used
- Tide coordination (Mean High Water, Mean Lower Low Water, or non-tide coordinated)

Also include a statement regarding the adequacy of the imagery for AT. Factors which should be considered in the adequacy statement include: coverage, exposure, resolution, overlap, metric quality. Include a reference to the AT Report's Annex 2 – Flight Line Diagram.

4.4. CONTROL – This section shall indicate what type(s) of control were used in the AT. Include in the discussion any unusual difficulties or problems related to controlling the AT.

A. DG – Discuss the overall adequacy of using the DG data to control the block adjustment. Include a reference to the Airborne Positioning and Orientation Report for further details. (See Attachment Z, Section 16.4.3)

B. GROUND CONTROL – Discuss the adequacy of surveyed ground control points (horizontal and vertical) to supplement the DG control of the block adjustment. Include any additional vertical control determined from water levels. Include a reference to the Ground Surveys Report. (See Attachment O, Section 13)

4.5. METHODOLOGY – Briefly describe AT methodology including: dates when the AT process was begun and completed, hardware and software versions used, whether the images were adjusted as a single block vs. multiple sub-blocks, whether or not automatic tie point generation was used, and other significant information documenting the process.

4.6. ANALYSIS OF RESULTS – This section shall discuss the analysis of each adjustment. Discuss any deviations from standard procedures or specifications, and comment on any rejected or removed points. This section shall include a comparison between the adjusted AT results and the surveyed photogrammetric check points. The contractor shall state the overall horizontal accuracy of the final block adjustment at the 95% confidence level, in meters rounded to the nearest hundredth, as computed in Annex 3. This value should be less than or equal to half of the allowed final accuracy for the project. No fewer than 10% of the stereo models shall be reviewed to ensure the horizontal and vertical integrity of the AT solution. The models reviewed should be evenly distributed throughout the project and should include models at the intersections of flight lines. If the AT was divided into sub-blocks, a separate analysis and accuracy statement shall be provided for each adjusted block.

4.7. PROJECT DATABASE – The Project Database is the collection of data files and other information required for and resulting from the AT phase of the project. This section of the report shall state that a Project Database exists and includes the following data files and other information:

– Project identifier
– Camera calibration data
– Directly georeferenced exterior orientations (see 5.1)
– Adjusted exterior orientation parameters for each frame (see 5.2)
– Block adjustment report (see 5.3)
– Horizontal and vertical datums, coordinate system, and projection used

4.8. ANNEXES – Each annex in the AT Report shall be on a separate page and shall include a title (ex. "Project Coverage Diagram") and the Project Identifier (ex. "VA1601-CM-C"). Annexes 1 and 2 shall include a simple map base showing the shoreline and a limited number of geographic feature names labeled to orient the reader. A north arrow shall also be included. Additional requirements for each annex are below.

A. ANNEX 1 - PROJECT COVERAGE DIAGRAM – This diagram shall depict an outline of the approximate stereo coverage of the images used in the AT. This diagram shall also depict and label the ground control points (if any) and the photogrammetric check points used.

B. ANNEX 2 - FLIGHT LINE DIAGRAM(S) – This diagram shall depict the project flight lines included in AT, with the flight line IDs and starting and ending image IDs for each line. This diagram shall also include a table with a row for each flight line and a column for each of the following:

– Flight line ID
– Starting and ending image IDs
– Date flown

If multiple data types (e.g. color and IR) were included in the AT, then separate tables should be included with the diagram, listing the lines, images, and dates for each imagery type and tide level. Alternatively, the different imagery types and tide levels can be included as separate diagrams/annexes (2A, 2B, etc.).

C. ANNEX 3 - HORIZONTAL ACCURACY COMPUTATION – The Horizontal Accuracy Statement reported in the Analysis Of Results section is based on the predicted circular horizontal accuracy of all adjusted points in the AT solution. This circular accuracy equals the radius of the 95% confidence circle as calculated from the horizontal (X and Y) root-mean-square (RMS) values of the standard deviations for all triangulated points, and rounded to the nearest hundredth of a meter. This Annex demonstrates the calculation procedures, and explains the computational methods. The 95% confidence circle radius shall be computed and reported for each block, if more than one photo block was adjusted separately.

Example computation:

The root mean square of all standard deviations of triangulated ground points:
RMS(x) = 0.415 meters *RMS(y) = 0.337 meters*

The value for the confidence circle radius is given by the following expression:
$$R = K * Sx$$
where Sx is defined as the larger of the two (X and Y) RMS values (0.415 m. in this case), and K is interpolated using the C ratio from the Table of Cumulative Probability.

The C ratio equals the smaller of the RMS values divided by the larger:

$$C = 0.337 / 0.415 = \mathbf{0.812}$$

The following line (95% probability level) from the Table of Cumulative Probability was used to determine the value of K by a simple linear interpolation between the two nearest values of C:

C	*0*	*0.1*	*0.2*	*0.3*	*0.4*	*0.5*	*0.6*	*0.7*	***0.8***	***0.9***	*1.0*
K (95%)	*1.95996*	*1.96253*	*1.97041*	*1.98420*	*2.00514*	*2.03586*	*2.08130*	*2.14598*	***2.23029***	***2.33180***	*2.44775*

$$\begin{aligned} K &= \mathbf{2.23029} + [(\mathbf{0.812} - \mathbf{0.8}) / (\mathbf{0.9} - \mathbf{0.8}) * (\mathbf{2.33180} - \mathbf{2.23029})] \\ &= 2.23029 + [(0.012 / 0.1) * 0.10151] \\ &= 2.23029 + (0.12 * 0.10151) \\ &= 2.23029 + 0.01218 = 2.24247 \\ K &= 2.242 \\ R &= K * Sx = 2.242 * 0.415 = 0.930 \end{aligned}$$

The Radius of the 95% Confidence Circle = 0.93 meters

5. AEROTRIANGULATION DATA FILES

Certain data files used for the resulting from the AT of the imagery shall be delivered along with the AT Report (Section 4.7). These data files shall be delivered in the ASCII formats defined below through NOAA's Task Order Management Information System (TOMIS).

5.1 DIRECTLY GEOREFERENCED EXTERIOR ORIENTATIONS – The DG EO file, or pre-adjusted exterior orientations, contains the frame ID (strip and image), coordinates (in project units), orientations in decimal degrees (DD), time (in week seconds), latitude (DD), longitude (DD) and the standard deviation (sigmas in units of the camera coordinates and orientations) of the computed camera centers. The file shall be an ASCII file with each data entry separated by at least one space character.

The DG EO file shall have the following format:

Line_Image Time Lat Long X Y Z O P K Xσ Yσ Zσ Oσ Pσ Kσ
…

545001_21273 319119.964 30.387905611 -81.431915909 458505.481127 3361848.823944 2322.731385 -0.106855 0.052518 -117.155298 0.006432 0.007765 0.017472 0.003000 0.003031 0.009047

545001_21274 319128.436 30.384856848 -81.425089129 459160.073613 3361508.490508 2323.503156 -0.106852 0.084805 -118.350025 0.006476 0.007831 0.017588 0.002990 0.003019 0.009012

5.2. ADJUSTED EXTERIOR ORIENTATIONS – The adjusted EO file contains the results of the AT that has been performed for a block of images. It has one line of data for each image containing the Frame ID (Line_Image), the X, Y, Z coordinates of the camera position in the project units and the camera orientations omega, phi, kappa, in DD units. The file shall be an ASCII file with each data entry separated by at least one space character.

The adjusted EO file shall have the following format:

Line_Image X Y Z O P K
...

545001_21273 458505.551 3361848.904 2322.501 -0.10993 0.04727 -117.30977
545001_21274 459160.154 3361508.571 2323.253 -0.10875 0.06986 -118.27932

5.3. BLOCK ADJUSTMENT OUTPUT FILE – This file (report) is typically produced automatically by the photogrammetric adjustment software upon completion of the block network adjustment and shall contain the AT inputs (frame, control and image measurement data) and resultant network adjustments (frame, ground coordinates of image measurements and fit to control). It also shall contain the standard deviations for ALL image measurements included in the adjustment (values needed to calculate the 95% CC).

An example of this file would be the "Solution Accuracy Quality Report" file (***.rep**) produced by SOCET SET.

Sample Aerotriangulation Report:

Aerotriangulation Report
WA1401A-CM-N
December 2016

AREA COVERED

Project WA1401A-CM-N is a Coastal Mapping Program (CMP) project which covers Hood Canal, from Port Townsend to Dabob Bay, in Washington, and is a subproject of a larger acquisition project, WA1401-CM-N, which includes coverage of Hood Canal from Port Townsend to Annas Bay. Aerotriangulation (AT) tasks were restricted to a single sub-block of imagery within subproject WA1401A-CM-N, covering only the Port of Bangor, Washington. For a depiction of the extent of imagery included in the block for which AT was completed, see the Project Location Diagram (*Annex 1*).

IMAGERY

Project imagery aerotriangulated for WA1401A-CM-N consisted of two flight lines (50-010 & 50-019) of natural color (RGB) digital imagery, which included eighteen individual “frame” images in coordination with Mean High Water (MHW) and Mean Lower Low Water (MLLW) tide levels. The MHW imagery was acquired on July 26th and August 10th, 2014 and MLLW imagery was acquired on June 30th, 2014.

All imagery was acquired with the NOAA King Air aircraft, using an Applanix DSS 439 camera system at an altitude of 10,000 feet, giving an approximate ground sample distance (GSD) of 0.36 meters. Flight lines were flown with an end lap of 60% and side lap of 30%. Photographic coverage, resolution, overlap, and metric quality were adequate for performance of the AT phase. The layout of aerotriangulated imagery is shown in the Flight Line Layout Diagram (*Annex 2*).

CONTROL

All RGB imagery was controlled using airborne kinematic GPS and IMU positioning techniques, e.g. direct georeferencing (DG), with sufficient accuracy to control the digital adjustment. See the Airborne Positioning and Orientation Reports (APOR) for the various flight dates for further information.

METHODOLOGY

Imagery was bridged using digital AT methods to establish the network of photogrammetric control required for the compilation phase. This work was initiated and completed in December 2016. Both color strips were bridged in one block. Measurements were made utilizing a stereo-enabled PC-based graphics workstation with the SOCET SET (ver. 5.6) suite of digital photogrammetric software. The Multi-Sensor Triangulation (MST) module of SOCET SET was used to perform point measurements and AT adjustment, and evaluate the accuracy of the adjustment. The mensuration phase consisted of using both the Automatic Point Measurement (APM) and the Interactive Point Measurement (IPM) methods.

ANALYSIS OF RESULTS

The RMS of the standard deviations of the residuals for each aerotriangulated ground point was calculated using the MST AT statistics. These values were used to compute a predicted horizontal circular error at the 95% confidence level of 0.59 meters (*Annex 3*).

All three photogrammetric check points in the project were visible and measured in the adjusted imagery. The coordinates of these check points were not constrained at all in the block adjustment, but were treated as pass points, and adjusted coordinates were computed. The adjusted coordinates were compared to the surveyed coordinates, and the differences are shown below:

POINT	ΔX	ΔY	ΔZ
Wharf	+0.34	+0.08	+0.33
Bangor Gab Chim	+0.12	-0.36	+0.35
Keyport Firing Tr	-0.31	+0.34	-0.29

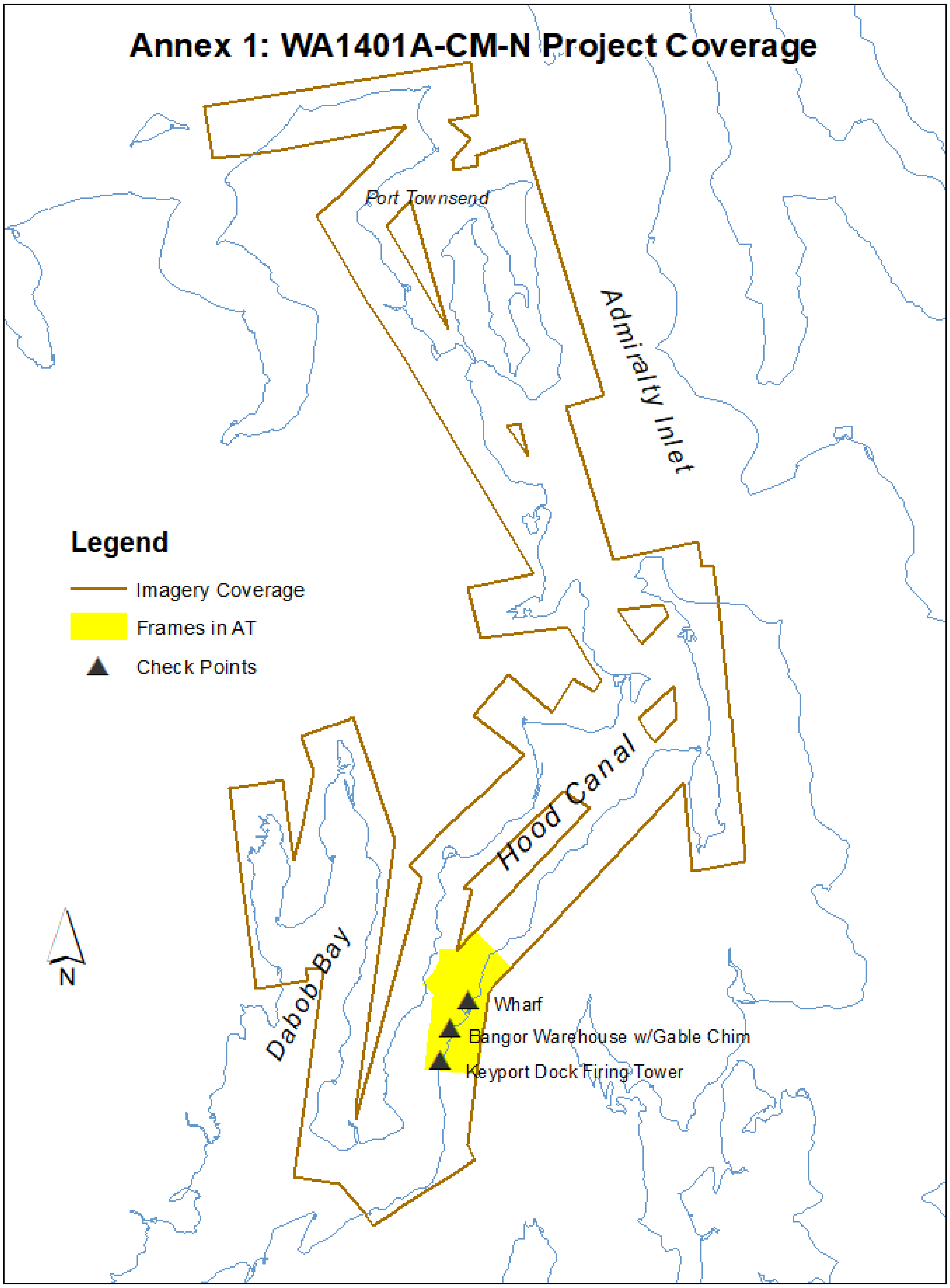
Select stereo models from each strip of images were examined in SOCET SET to ensure the horizontal and vertical integrity of the MST adjustment, and to verify the suitability of the data for use in the compilation phase.

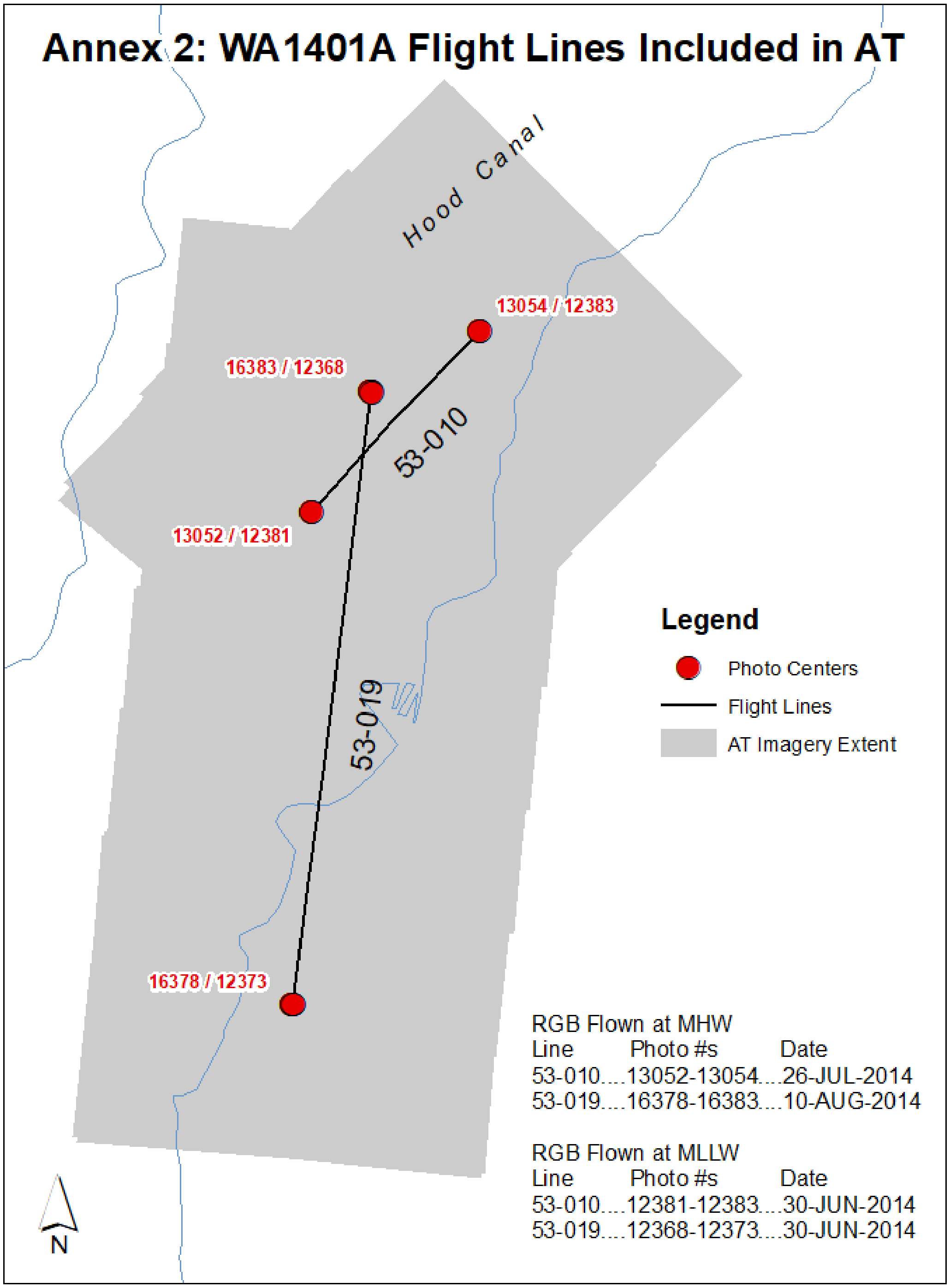
PROJECT DATABASE

A project database was created under the Project Identifier WA1401A-CM-N and includes the following:

Project Parameters and Options
Camera Calibration Data
DG Exterior Orientation (EO) Data
Adjusted EO Parameters
Block Adjustment Summary Data

Positional data is based on the North American Datum of 1983 (NAD83) and is referenced to the UTM coordinate system (Zone 10).


Annex 1: WA1401A-CM-N Project Coverage
Port Townsend
Admiralty Inlet
Legend
Imagery Coverage
Frames in AT
Check Points
Hood Canal
Dabob Bay
N
Wharf
Bangor Warehouse w/Gable Chim
Keyport Dock Firing Tower


Annex 2: WA1401A Flight Lines Included in AT
Hood Canal
13054 / 12383
16383 / 12368
53-010
13052 / 12381
53-019
16378 / 12373
Legend
Photo Centers
Flight Lines
AT Imagery Extent
RGB Flown at MHW
Line Photo #s Date
53-010....13052-13054....26-JUL-2014
53-019....16378-16383....10-AUG-2014
RGB Flown at MLLW
Line Photo #s Date
53-010....12381-12383....30-JUN-2014
53-019....12368-12373....30-JUN-2014
N

ANNEX 3: Horizontal Accuracy Computation

WA1401A-CM-N – Hood Canal, Dabob Bay to Port Townsend, WA

The Horizontal Accuracy Statement reported in the Analysis of Results is based on the predicted circular horizontal accuracy of adjusted points in the aerotriangulation solution. This circular accuracy equals the radius of the 95% confidence circle as calculated from the horizontal (x & y) root-mean-square (RMS) values of the standard deviations for all triangulated ground points, rounded to the nearest tenth of a meter.

The root mean square of all standard deviations of triangulated ground points:

RMS(x)=0.251 meters RMS(y)=0.232 meters

The value for the confidence circle radius is given by the following expression:

R=K*Sx

Where Sx is defined as the larger of the two (X and Y) RMS values, and K is interpolated using the C ratio from the Table of Cumulative Probability.

The C ratio equals the smaller of the RMS values divided by the larger:

C=0.232/0.251=0.924303

The following line (95% probability level) from the Table of Cumulative Probability was used to determine the value of K by a simple linear interpolation between the two nearest values of C:

C	0	.1	.2	.3	.4	.5	.6	.7	.8	.9	1.0
K(95%)	1.95996	1.96253	1.97041	1.98420	2.00514	2.03586	2.08130	2.14598	2.23029	2.33180	2.44775

K =2.33180+[(0.924303–0.9)/(1.0–0.9)*(2.44775–2.33180)]
=2.33180+(0.24303*0.11595)
=2.33180+0.028179
K =2.35998
R=K*Sx=2.35998*0.251=0.592

The Radius of the 95% Confidence Circle = **0.59 meters**

Notice – all items highlighted are changes from previous versions of this SOW

December 2017

ATTACHMENT J
TIDE COORDINATIONREQUIREMENTS

TO

SCOPE OF WORK FOR SHORELINE MAPPING

UNDER THE

NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION

NATIONAL GEODETIC SURVEY

NATIONAL OCEAN SERVICE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

U.S. DEPARTMENT OF COMMERCE

TABLE OF CONTENTS

ATTACHMENT J: TIDE COORDINATION REQUIREMENTS

1. GENERAL - The purpose of this section is to provide the requirements for tide coordinated imagery/data acquisition.

Discussions of tide types can be found on the NOAA CO-OPS web site at:

- https://co-ops.nos.noaa.gov/restles1.html
- https://tidesandcurrents.noaa.gov/publications/Water_Level_Station_Specifications_and_Deliverables_for_Shoreline_Mapping_Projects,_Updated_May_2009.pdf
- https://co-ops.nos.noaa.gov/publications/Computational_Techniques_for_Tidal_Datums_handbook.pdf

Coordination of remotely sensed data acquisition with the stage of tide is necessary to be able to confidently delineate the two required tide lines.

2. SUN ANGLE, CLOUD COVER, VISIBILITY, AND OTHER ATMOSPHERIC PHENOMENA - When obtaining imagery with a film camera the angle of the sun with respect to the horizon MUST be 30°or higher. When obtaining imagery with a digital camera the angle of the sun with respect to the horizon MUST be 25°or higher. When acquiring tide coordinated imagery using an active imagery system sun angle is not a consideration.

For the requirements regarding cloud cover and visibility see SOW Attachment Z § 14.1 and § 14.4.

The aerial survey crew must make themselves aware that the surf conditions, also called sea-state, at the time of attempting aerial data acquisition are normal for the project area. A calm sea state is preferred. No off-shore storm should be creating an unusual surf condition in the project area.

3. METHODS OF OBTAINING TIDE COORDINATED IMAGERY

3.1 PASSIVE IMAGERY SYSTEMS - Are those systems that rely on reflected sunlight to provide image illumination.

A. DIGITAL PHOTOGRAPHY - Digital Photography requires the use of a metric quality digital aerial camera. See SOW Attachment Z for Digital Imagery Acquisition Requirements.
B. HYPERSPECTRAL SCANNER - No current technical requirements or technical specifications exist as yet for obtaining tide coordinated imagery with a hyperspectral scanner. As such, they are unacceptable for obtaining operational shoreline mapping data at this time.

3.2 ACTIVE IMAGERY SYSTEMS - Are those systems that provide their own image illumination.

A. LIDAR - For specifications and requirements concerning LIDAR acquisition see SOW Attachment Y.

B. SAR (Synthetic Aperture Radar) - For specifications and requirements concerning SAR acquisition see SOW Attachment AO.

3.3 TABULATION OF IMAGERY REQUIREMENTS:

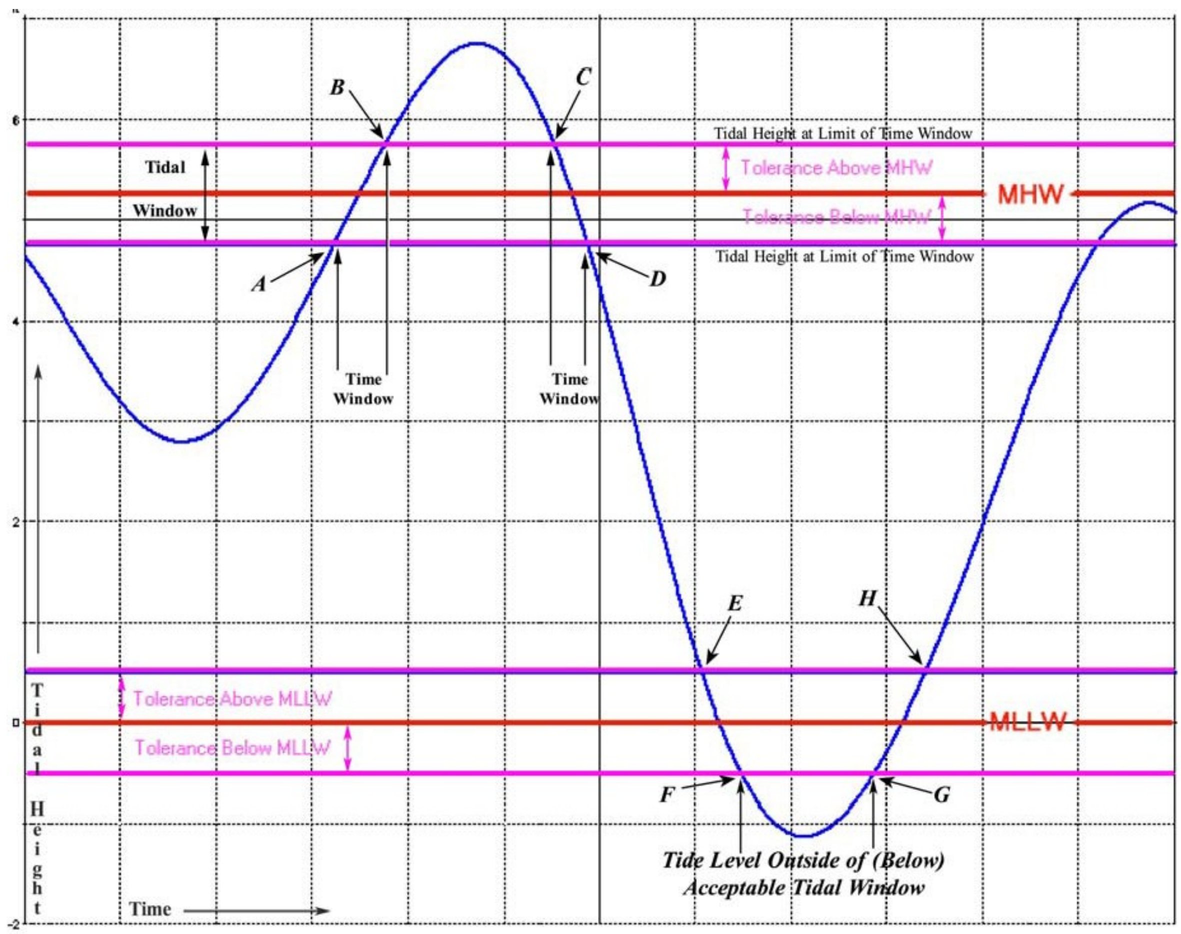
	Solar Illumination Required	Cloud Free	Clear (8mi.) Visibility	Tide Coordination
Film Photography	Yes, Sun Angle > 30□	Yes	Yes	Yes
Digital Photography	Yes, Sun Angle > 25□	Yes	Yes	Yes
LIDAR	No	Clouds allowed above aircraft	Yes	Yes
Hyperspectral	No Specs	No Specs	No Specs	Yes
SAR	No	No, but no thunderstorm clouds	No	Yes

The above table shows the basic phenomena that must come together to allow shoreline imagery acquisition.

4. <u>TIDAL PREDICTION</u> - NGS requires that all tide coordinated imagery be obtained within a height tolerance, within which the tidal level is considered to be at either MHW or MLLW. All tide coordinated imagery must be acquired while the stage of tide is within a calculated range or tolerance of MHW or MLLW. Even with this tolerance it may be necessary to break up a project area into several sub-projects. Each sub-project may need to be flown at different times to acquire imagery within the required tolerance.

Because the tolerance is plus or minus some calculated value, the combination of the plus and minus is referred to as the predicted tide window, or tidal window.

Typical Tidal Curve



The above diagram shows the relation of the ± tolerance value in relation to the MHW and MLLW in a tidal cycle. As the level of the tide rises from its previous low point it enters the predicted MHW tide window at point A. Imagery can be obtained beginning at this point. The tide continues to rise, eventually reaching point B, rising above the tide tolerance, and exiting the tidal window. As the cycle continues and the tide begins to fall again it enters a second MHW tidal window at point C. The tide continues to fall until it reaches point D and exits the second tidal window. Similarly, the tide continues to fall until it reaches point E and enters a MLLW window. It continues to fall until it reaches point F and passes out of the predicted window. Upon rising to point G the tide again enters the predicted window until it reaches point H. Note that not all tide cycles contain two tidal imagery windows. The low water level indicated by the curve on the left side of the diagram does not drop far enough to reach the predicted MLLW window. The curve at the extreme right of the diagram reaches the predicted MHW window, but stays inside it for the entire high water period. Most tide cycles contain no usable tide windows, and most commonly those that do contain windows only have one. The relationship of the ± tolerance to the MHW is the same as the tolerance to the MLLW.

4.1 DATA NEEDED TO CALCULATE A PREDICTED TIDE WINDOW - There are three sets of data that are needed to correctly calculate a predicted tide window.

1) The time when the sun will rise above 30°/25° and when it will set to 30°/25°;
2) The heights of predicted highs and lows of tidal movement and the times when they occur, usually for an entire month; and
3) The calculated height tolerance within which imagery can be obtained, and the local tide gauge water level and datum data as given on the CO-OPS web site. An example of the CO-OPS data can be found at: https://tidesandcurrents.noaa.gov/inventory.html?id=1617433

Similar data is available for every tide gauge in the National Water Level Observation Network (NWLON).

It is of no consequence which set of data is determined first, so long as the data is all at hand for input to which ever computer program is used to calculate the predicted tide windows.

To determine the sun angle NGS uses a commercial program that is, unfortunately, no longer available on the open market. The Contractor can use any available sun angle calculator. There is an effective one on the U.S. Naval Observatory web site at: http://aa.usno.navy.mil/data/docs/AltAz.php

For greater precision in predicting tidal windows it is necessary to calculate rising and setting times for the sun for several dates through the month. This is especially true near the solstices.

It is important to note that all times used in this process must be based on a 24 hour clock.

NGS does all calculations for tide predictions in Local Standard Time (LST) not daylight savings or Greenwich Mean Time. This is done to provide a standard that all of the NGS aerial survey flight missions can follow. The Contractor is free to use any time standard they may choose. The contractor shall label the time standard that they use in all forms submitted in relation to that data.

To calculate the height tolerance and the monthly highs & lows NGS uses a program written in-house. The Contractor may use any software, commercial or proprietary, to calculate the times wherein the tides in the project area are at the appropriate height to acquire tide coordinated imagery. The only restriction on the use of contractor supplied software for this purpose is that the times calculated by such software must coincide with the times calculated by the Government's in-house tide window prediction software. The Government will, at the Contractor's request, provide the most current version of the software that the Remote Sensing Division (RSD) uses, and is able to freely distribute, to predict such tide windows. The Government will, at the Contractor's request, provide training in the use of the RSD program. Such training will be at a time and place mutually convenient to both the Contractor and the Government.

4.2 TIDAL TOLERANCE CALCULATION – If using the NGS tide window prediction program the Contractor does not need to calculate the tide tolerance. The program makes the calculation. However, because it is necessary to have the tolerance value available when determining whether or not the actual stage of tide during imagery acquisition was within tolerance, the process for calculating it is provided here.

The numerical values needed to calculate the tidal tolerance for each tide station can be found on the CO-OPS web site in the DATUM section for each NWLON tide gage. Example calculations are provided here to further understanding of this concept. For these examples Clearwater, Florida; Savannah River Entrance, Georgia; and San Francisco, California for the month of June 2004 will be used.

The appropriate numerical values might also be found included in commercial tide prediction programs within their data for each tide station.

Example: Clearwater, Florida (Diurnal Tide)
Find the published value for the Mean Range: Clearwater = 1.8 ft

When the Mean Range of the tide station is 5 feet or less, imagery shall be obtained within a tolerance of ± 0.5 ft. of the MHW and MLLW. For the example: MHW imagery could be obtained at Clearwater when the tide stage is between 1.3 ft. and 2.3 ft. (1.8 ft ± 0.5ft) The MLLW could be obtained when the water level is between +0.5 ft and -0.5 ft. MLLW defined as beinga water level of 0.0 ft.

Example: Savannah River Entrance, Georgia (Semi-diurnal Tide)
Find the published value for the Mean Range: Savannah River Ent. = 6.9 ft

When the Mean Range of the tide station is greater than 5 feet, imagery shall be obtained within a tolerance of ± 10% of the mean range. For example: MHW imagery could be obtained at Savannah River Ent. when the tide stage is between 6.21 ft and 7.59 ft. (6.9 - .69 = 6.21 and 6.9 +
.69 = 7.59) The tolerance being 10% of 6.9 or 6.9 x .1 = ±.69 ft.
Imagery to capture the MLLW could be obtained when the water level is between -.69 ft and +.69 ft.

Example: West Coast; San Francisco (Golden Gate) (Mixed Tide)
Due to the diurnal inequality of tides in Alaska and on the West Coast, the Mean Range of tide must be computed. This is done as follows:

Find the published Mean Range and Mean Tide Level for San Francisco (Golden Gate). Mean range = 4.10 ft. Mean Tide Level = 3.2 ft

The new Mean High Water Level, and thus the new Mean Range = 1/2 the original Mean

Range
+ the Mean Tide Level. (4.10 / 2) + 3.2 or 2.05 + 3.2 = 5.25 ft.

Because the new Mean Range is greater than 5 feet the tolerance is calculated as 10% of 5.25 ft. or ±0.52 ft. If the new Mean Range was 5 feet or less the 0.3 ft tolerance would have been used.

5. TIDAL ZONING AND TIDE ZONES - Because water levels and/or the time of a tide can vary considerably within a project area, NGS will supply a Preliminary Tidal Zoning diagram to the Contractor. The diagram delineates various areas within a project area in which all of the tidal parameters are equal. Each zone can be considered to be a subordinate tide station to the main station on which its corrector values are calculated. Tide predictions for each zone used are then calculated as if the zone is a separate tide station. The correctors provided are: High Tide Time Corrector, Low Tide Time Corrector, and Range Corrector.

The diagram below shows the preliminary tide zones for Narragansett Bay, Rhode Island. Each of the Red polygons is a tide zone. Each zone has a block of data associated to it by an arrow. The block of data contains the Tide Zone Name, the High Tide Time corrector value, the Low Tide Time Corrector, the Range Corrector, and the main tide station used to calculate the correctors. The main tide stations are shown as gold stars on the diagram. Their label is shown in blue. The black lines running north to south are flight lines, which may or may not appear on a diagram.

The High Tide Time Corrector is ± the number of minutes that MHW occurs within the zone relative to the time it occurs at the primary tide station. A positive value indicates that the high water event within the zone occurs after that of the primary tide station. A negative value indicates that the high water event occurs before that at the primary station.

The Low Tide Time Corrector is ± the number of minutes that MLLW occurs within the zone relative to the time it occurs at the primary tide station. The relationship of the ± time is the same as for high water.

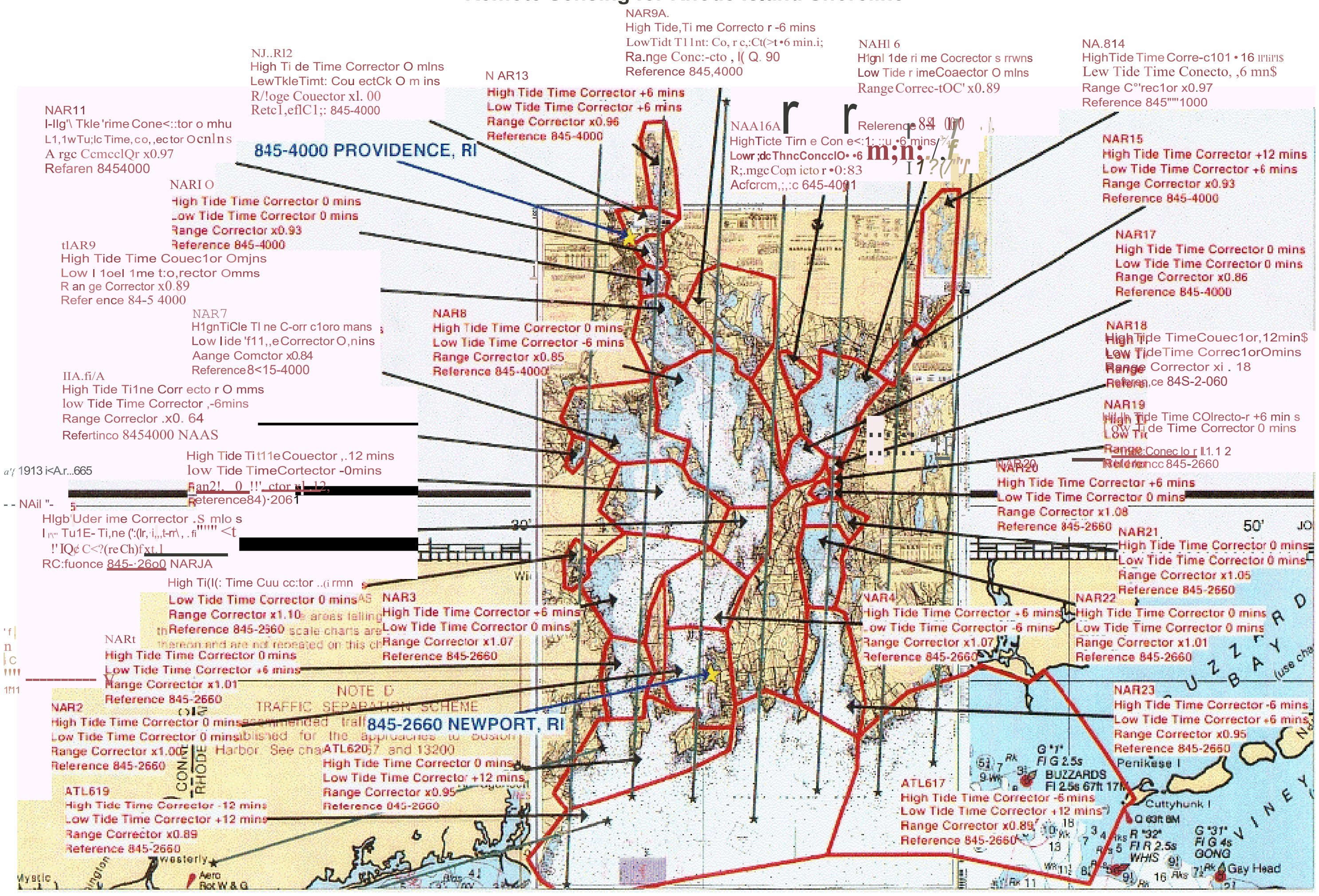
The Range Corrector is the ratio of height of the water within the zone to the height of the water at the primary station at any given time.

Because the tide zones are calculated for hydrographic surveys, it is not practical to use every zone when determining the predicted imagery tide windows. Clearly, an aircraft can obtain data from an entire zone or zones much faster than can a hydrographic survey vessel.

The Contractor needs to determine, at a minimum, the predicted time of tide for the two zones nearest to the ends of a flight line. If a comparison of the times within the two zones shows that there is sufficient time to fly the whole flight line while the two zones are within the proper range, and there is no intervening obstruction to the free flow of the tide between the two zones, the Contractor can assume that all of the zones in between are also within the proper range. If there is an intervening obstruction or some other choke point, the Contractor should calculate the predicted tides for the zone, or zones, immediately adjacent to the obstruction. The Contractor can, of course, calculate the predicted tides for as many zones as it takes to be assured that the predicted tides will be within the necessary range for the entire mapping project.

Notice – all items highlighted are changes from previous versions of this SOW

Preliminary Tidal Zoning for Project RI0301
Remote Sensing for Rhode Island Shoreline



6. REAL TIME MONITORING OF TIDE GAUGES - In certain areas of the country such as the Gulf Coast or the North Slope and West Coast of Alaska the tidal range may be so small or so affected by weather that predictions are not useful. In such cases the only way to obtain imagery within the appropriate tolerance may be to observe a tide gauge before and during the imagery flight mission. This is accomplished in one of two ways: 1) Physically monitoring one or more tide gauges in the project area and 2) Monitoring a real-time tide gauge through a radio or cell phone link or from an internet web page. Real time monitoring of tide gauges may be required by NGS. If so, a requirement will be included in the individual Project Instructions. If NGS does not require real time monitoring the Contractor is not precluded from suggesting its usage in their Technical Proposal.

6.1 PHYSICAL MONITORING - Physical monitoring requires a person or persons to be at a tide gauge before the expected level of tide occurs. The person stays in contact with the flight crew via radio or cell phone. The person then keeps the flight crew informed of the actual stage of tide on a continuing basis, telling them when it is proper to begin taking imagery and also when to stop.

6.2 MONITORING NOAA REAL TIME TIDE GAUGES - In certain areas of the country NOAA has real time tide gauges that can be monitored by the flight crew via radio, cell phone, or internet connection. By monitoring these gauges the flight crew can tell if the tides are running true to the predictions and can thus tell when it is appropriate to begin or stop taking imagery. These tide gauges are listed on the CO-OPS web site: https://tidesandcurrents.noaa.gov/ .

6.3 MONITORING CONTRACTOR INSTALLED REAL TIME TIDE GAUGES – The Contractor may be required to install one or more tide gauges that can be monitored in real time for certain special projects. If such is the case, the requirement will be stated in the Project Instructions.

7. POST MISSION ACTUAL TIDE LEVELS - The Contractor may be responsible for determining the actual tidal level when imagery was taken, and for ensuring that the imagery falls within the allowable tolerance for an NOS primary tide gauge or a monitored subordinate gauge, or a tide zone. The actual level of tide can be obtained from the CO-OPS web site at: https://tidesandcurrents.noaa.gov/ in the left column.

Choose the tide station and tide zone used for the original predictions. Get the height and time given in the CO-OPS six minute verified tide listing for the primary station used for the predictions. Apply the tide zone correctors to the time and height of the actual data and compare to the height prediction for the time the imagery was taken to determine if it was actually within the tolerance.

It may be necessary to do this only with the zones at the ends of actually flown flight lines. However, depending on the complexity of the shoreline in the project area it may be necessary to determine the actual water level for several tide zones on a flight line. If there was a break in a flight line it will be necessary to determine the actual water levels for both times and dates that the line was flown.

8. CONTRACTOR INSTALLED TIDE GAUGES - The Contractor shall, when required by the Project Instructions, install tide gauges. Tide gauge installation shall be in accordance with the CO-OPS publication: Specifications and Deliverables for Installation, Operation, and Removal of Water Level Stations. This publication is available at URL:
https://tidesandcurrents.noaa.gov/publications/
Water_Level_Station_Specifications_and_Deliverables_for_Shoreline_Mapping_Projects,_Updated_May_2009.pdf
Tide gauges shall be installed at locations that will be determined by consultation between NGS and the Contractor.

9. CONTRACTOR DETERMINED TIDAL DATUM - The Contractor shall, when required by the Project Instructions, determine the local tidal datum for the project area. Datum computation shall be in accordance with CO-OPS publication: Computational Techniques for Tidal Datums Handbook. This publication is available at URL: https://tidesandcurrents.noaa.gov/publications/Computational_Techniques_for_Tidal_Datums_handbook.pdf

10. QUALITY ASSURANCE / QUALITY CONTROL - The Contractor shall be responsible for all Quality Control / Quality Assurance of the tidal and geospatial data created and submitted in the course of a project.

NGS will provide the Contractor training in how to calculate the predicted tide windows at a mutually acceptable time and place. After training, the Contractor shall submit predictions to NGS so that NGS can be confident that the Contractor fully understands the procedure for calculating the tolerance. When NGS is satisfied that the Contractor can successfully make the calculations, they will notify the Contractor that submission of tide window data is no longer necessary. The Contractor shall be fully responsible to ensure that all tide coordinated imagery is obtained within the acceptable tolerance windows.

The Contractor shall obtain actual verified times and heights of tides for the time of imagery acquisition from the verified and accepted data set available at CO-OPS web site. The verified and accepted data set is generally available within a month for primary stations and subordinate stations or within a week if the primary and/or subordinate stations are monitored and are listed with priority processing on CO-OPS Hydro Hot List. The actual water level height data will be calculated to ensure the imagery was taken within the tolerances.

NGS will check a sampling of the Contractor's actual verified times and heights of tide using the Tabulation of Aerial Photography that the Contractor submits, or by other electronic means.

July 2018

ATTACHMENT K

FEATURE COMPILATION

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Notice – all items highlighted are changes from previous versions of this SOW

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ATTACHMENT K: FEATURE COMPILATION PAGE

Notice – all items highlighted are changes from previous versions of this SOW

ATTACHMENT K: FEATURE COMPILATION

1. INTRODUCTION

The primary goal of the NOAA Coastal Mapping Program is to provide maps of the shoreline, and associated natural and cultural features of the coast, in support of NOAA's nautical chart production. The digital shoreline data produced through the Shoreline Mapping Contract include hazards and aids to navigation, and port infrastructure critical to the safe and economical use of the marine transportation system. This mapping data shall be created through digital compilation and attribution from stereo aerial imagery, and possibly other remote sensing sources. The contractor shall follow the procedures described in the Quality Control Plan for the project to ensure that data of the highest quality is delivered.

2. SYSTEM REQUIREMENTS

The contractor shall perform feature compilation using high quality softcopy photogrammetric mapping systems. The hardware and software used shall be capable of achieving the accuracy requirements of the project. The digital format in which the original data is compiled will be determined by the contractor's particular mapping system, but when the compiled data is delivered it shall be in the Esri® shapefile format as defined in Attachment D. The set of shapefiles containing the compiled data are generally referred to as the Geographic Cell (GC).

3. PREPARATION

Prior to beginning feature compilation, certain materials and information should be made readily available to the compiler to aid in the successful completion of this phase of the project.

3.1. AEROTRIANGULATED IMAGERY – The feature compilation shall be accomplished using the aerotriangulated images of all imagery types (color, IR) acquired that cover the project area. It is also desirable for the compiler to have a copy of the Aerotriangulation Report, as it contains information useful for feature compilation.

3.2. PROJECT INSTRUCTIONS – The compiler shall be fully aware of any unique requirements associated with the particular project as defined in the Project Instructions. These unique requirements may include, but are not limited to:

- The different photographic emulsions or other remote sensing systems used
- Areas of tide coordination
- The largest scale NOAA nautical charts that cover any part of the project area
- The limit of feature compilation
- Target scale and level of detail for feature selection and generalization
- Horizontal and vertical accuracy requirements
- The completion date

3.3. CHART EVALUATION FILE – During feature compilation, the compiler shall compare the project imagery with the largest scale NOAA nautical charts covering the project area. For any portion of the project area covered by both larger and smaller scale charts, only the largest scale chart should be used in the comparison. The compiler shall create a Chart Evaluation File (CEF) in order to document significant changes to, or non-confirmation of the existence of important charted features (see Attachment AE for CEF specifications). Features compiled in the GC that are confirmed to be charted in their correct shape and location generally do not need to be included in the CEF.

3.4. ACTUAL TIDE/WATER LEVELS – The compiler will usually need to know what the actual measured tide/water levels were at the time the images were acquired for all areas of the project, and not simply the predicted tide/water levels. Knowledge of the differences between the tide/water level in an image and the Mean Lower Low Water (MLLW) and Mean High Water (MHW) tidal datums, or lake Low Water Datum, in the area is necessary for the compiler to accurately interpret and position the shoreline and associated features. When required, the actual tide levels shall be determined according to the specifications in Attachment J. The required tide level information should also be available from the Tabulation of Aerial Photography prepared by the contractor following the imagery acquisition (see Attachment C, Section 11.4).

3.5. ADDITIONAL REFERENCE SOURCES – See the SOW Main Section 3.6 for additional references needed for feature compilation. The compiler should become especially familiar with U.S. Chart No. 1 as an aid to understanding the symbology of features on the chart.

4. GENERAL FEATURE COMPILATION

4.1. REQUIRED FEATURES – In general, the contractor shall compile those relatively permanent and fixed features visible in aerial imagery that are useful for marine navigation, and are commonly depicted on NOAA nautical charts. These features include: Shoreline (both natural and man-made), alongshore port infrastructure, obstructions, landmarks, fixed navigational aids, dangerous areas, and other significant cultural and natural features in the coastal zone. Though in some cases certain movable features (opening bridges, lock gates, floating piers, platforms, and barriers) should be compiled, in general those features that are temporary in nature (seasonal piers) or do not remain in a fixed position (cargo cranes, barges, buoys, etc.) should not be compiled. The compiler should use available resources along with the guidance in this SOW to judge whether a feature is of a permanent and fixed nature, and is required to be compiled. Also see SOW Main Section 8 for Office Data Collection requirements.

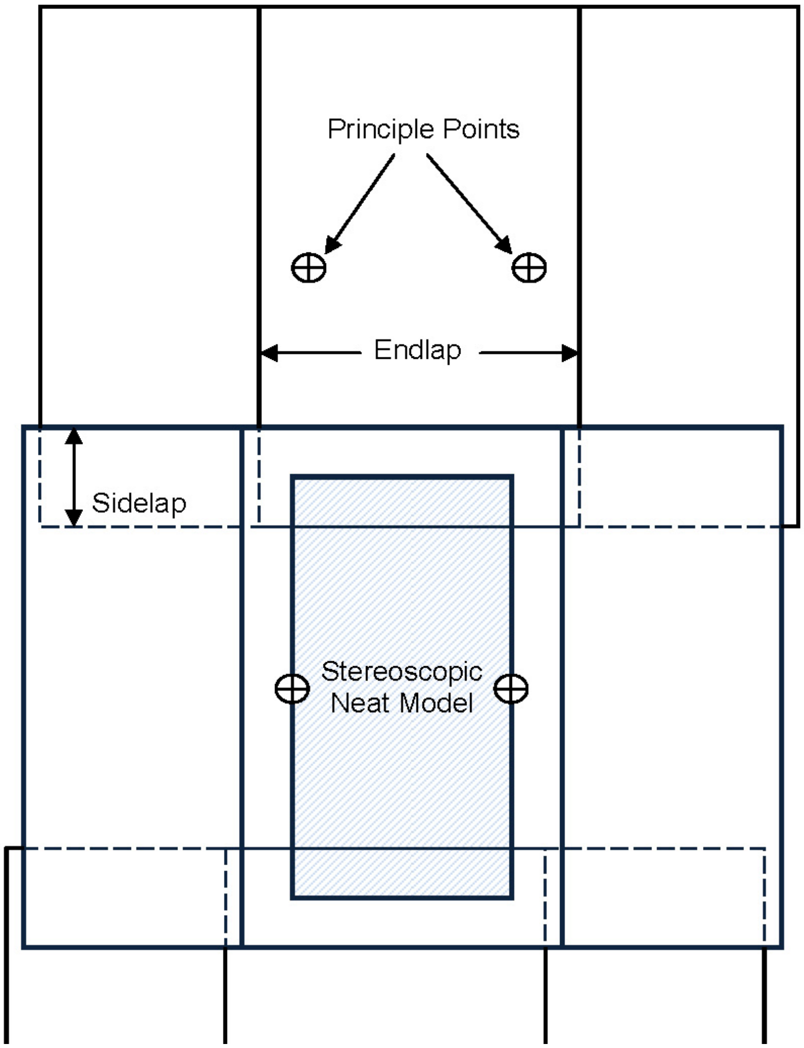
A. MILITARY INSTALLATIONS – Apart from features already shown on the chart, features in the Natural_Feature_Miscellaneous class, and lights in the USCG Light List, the compiler shall not collect any features landward of the shoreline located within an active military reservation, unless explicit permission to do so is provided in the Project Instructions.

4.2. FEATURE ATTRIBUTION – All compiled features must be correctly classified with the appropriate attribution according to the requirements in Attachment D. A glossary of terms used in the Coastal Cartographic Object Attribute Source Table (C-COAST) attribution scheme is included in Attachment F.

A. INFORMATION FIELD – Certain features are recommended or required to have additional descriptive text (nomenclature) entered into the Information (INFORMATIO or INFORM) attribution field of C-COAST. Specific guidance is provided in Section 5 below as to when an Information field entry is needed, but the following table provides a brief summary on how to populate this field:

Feature	Required?	Text Format (Case)	Examples
General features see § 5.8.A.iv, 5.8.K, 5.10.E	**Optional** – as needed or required by SOW	**Sentence case** (or as charted)	• Bridge support • Fort McHenry (as charted) • USS Torsk (as charted) • Abandoned light house • Covered slips • Boathouse
'Undetermined' see § 5.2.K, 5.4.C, and 5.4.K	**YES** (if possible)	**Sentence case**	• Mobile crane support • Recreational platform • Pier ruins
General Obstruction see § 5.3.E, 5.4.L, and 5.5	**YES**	**Sentence case**	• Tree • Concrete ruins • Row of piles • Crib
Danger Area – 'Foul'	**YES**	**Sentence case**	• Rocks • Stumps • Other – aquaculture pens
Depth Contour	**YES**	**CAPS**	• MLLW
Charted Landmark see § 5.6.A, 5.6.D	**YES**	**CAPS**	• CUPOLA • TR • TV TOWER • SOUTH STACK (OF TWO)
Recommended Landmark see § 5.6.E.ii	**YES** (Always)	**CAPS** (No abbreviation)	• CUPOLA • TOWER • WATER TOWER • TANK
Aids to Navigation see § 5.7.B, 5.7.D	**Optional**	**Sentence case** (or as charted)	• Possible new light • AERO (as charted/required)

4.3. STEREOSCOPIC NEAT MODEL – For the best accuracy, features should be compiled within the limits of the stereoscopic neat model, which is understood to be a rectangular shaped area between adjacent principal points and extending halfway into each sidelap area (see diagram below). Errors caused by image distortion typically increase the closer one compiles to the edge of the stereo model. When compiling features, the compiler should attempt to stay within the limits of the stereoscopic neat model as much as is practical.



4.4. VECTOR CONNECTIVITY – Certain types of linear features are required to connect (snap) exactly to themselves or each other, in order to provide topologically clean data from which a user can easily build polygons for a Geographic Information System (GIS). Specific guidance is provided in Section 5 below as to which features require vector connectivity.

4.5. COMPILATION SCALE – The Compilation Scale is used to determine the general level of detail and feature generalization the compiler should use in a particular area of a project. Many features have guidelines for their collection based on a particular map distance at the Compilation Scale. This Compilation Scale will normally be defined in the Project Instructions, which takes precedence over this attachment to the SOW, but generally the following rule is used:

> For any portion of a project area the Compilation Scale within that portion is equal to the scale of the largest scale chart or chart inset that includes that portion. However, the Compilation Scale will be neither smaller than 1:24,000 nor larger than 1:2,500.

Example 1: For the area of Zarembo Island, the largest scale chart covering that area is chart 17382 at 1:80,000 scale. The Compilation Scale would therefore be equal to the minimum allowed scale of 1:24,000.

Example 2: The harbor at Rockport Landing is shown on a 1:10,000 scale inset on chart 18620. The portion of the project area covered by the inset would be mapped at a Compilation Scale of 1:10,000, equal to the scale of the inset.

4.6. ACCURACY – The compiler should take great care to measure the features in the imagery as accurately as possible, while keeping in mind the required level of detail as represented by the Compilation Scale.

A. ACCURACY REQUIREMENTS – The horizontal accuracy requirements for a project will be defined in the Project Instructions, which may include different accuracy requirements for different portions of the project area. The actual accuracy (see below) shall be equal to or better than the accuracy requirements as defined in the Project Instructions. See SOW Main Section 3.3.

B. DETERMINING ACTUAL ACCURACY – The actual horizontal accuracy for a project is defined to be two times the horizontal circular error (95% confidence level) as computed from the aerotriangulation results (see Attachment I, Section 4.8.C). This doubling of the computed error is intended to account for any additional positioning error introduced during the compilation process. If project images were divided into separate blocks for aerotriangulation, then features compiled from different blocks will likely have different accuracies. The contractor shall determine the actual accuracy for each block of images.

C. WELL-DEFINED POINTS – The term "well-defined points" refers to small, sharp, clear features that can be unambiguously measured to a high level of precision in the imagery as well as in the field. Well-defined points might be actual point type features such as piles, fixed navigational aids, or certain types of landmarks like spires, crosses, or flagpoles. Or a well-defined point might be an intersection of clearly identifiable linear features, such as the square corner of a pier, bulkhead, wharf, or other features with sharply defined edges; or maybe the perpendicular intersection of a railroad line with the painted centerline of a narrow road.

D. REPORTING ACCURACY – The reported accuracy of a project is a predicted accuracy based on tested methodology. It is understood that the stated accuracy applies to well-defined points compiled in the GC, and not necessarily to other compiled features that are less sharply defined. Nevertheless, the actual horizontal accuracy (as determined in B above) shall be entered into the "HOR_ACC" data field for **all features** in the final delivered shapefiles, based on the image block from which the features were compiled. The actual horizontal accuracy is also reported in the Compilation section of the Project Completion Report (see Attachment L, Section 4.7).

4.7. BARE, COVERS/UNCOVERS, AND SUBMERGED – Many features are compiled using different attribute types based on the relationship between the features' elevation and a particular vertical (usually tidal) datum. These include some features in the following classes: Alongshore Feature, Obstruction Point, Obstruction Linear, Danger Area, and Freestanding Marine Feature. These features are classified as Bare, Covers__Uncovers, or Submerged; though some may combine the latter two into one classification: Covers__Uncovers_Or_Submerged. Some of these feature types are lines and some are points. A point feature is always compiled using just one TYPE code based on the elevation of its highest point. A linear feature may have different portions at various heights relative to the vertical datum, in which case the different parts should be compiled as individual connected linear sections using the appropriate feature types. The definitions of Bare, Covers/Uncovers, and Submerged in Attachment F apply to all feature types with the exception of ledges, reefs, discrete rocks, and coral heads. Due to their particularly hazardous nature, these features have different specifications for Bare, Covers/Uncovers, and Submerged, depending on which coast of the United States the project is located, as indicated below. Note that ledges and reefs may only be Covers/Uncovers or Submerged, never Bare.

CLASSIFICATION OF ROCK, CORAL, LEDGE, & REEF (Based on the height of the top of the object rounded to the nearest foot)			
	BARE	COVERS/UNCOVERS	SUBMERGED
Atlantic & Gulf of Mexico	More than 1 foot above MHW	From exactly 1 foot above MHW to exactly 1 foot below MLLW	More than 1 foot below MLLW
Pacific	More than 2 feet above MHW	From exactly 2 feet above MHW to exactly 2 feet below MLLW	More than 2 feet below MLLW
Great Lakes	More than 4 feet above Low Water Datum	From exactly 4 feet above LWD to exactly 2 feet below LWD	More than 2 feet below Low Water Datum
Other Non-Tidal Areas	Above water level at time of imagery capture	NOT APPLICABLE	At or below water level at time of imagery capture

The project instructions may supersede these specifications based on water level coordination requirements in a particular area, especially in the Great Lakes region.

5. CARTOGRAPHIC FEATURE COMPILATION GUIDELINES

This section contains collection guidance for all of the features in the C-COAST attribution scheme that the contractor is expected to compile. It is intended to help answer the most common questions of the new shoreline compiler, and provide a useful reference to the more experienced compiler. However, every project is unique, and a document such as this cannot cover every possibility. The shoreline compiler is likely to have many more questions that cannot be answered here, and he or she is strongly encouraged to contact the NOAA representative assigned to the project whenever additional guidance is needed. Any additional guidance provided by the NOAA representative is intended to clarify, not supersede the feature compilation guidelines in this SOW document or in the associated Project Instructions. The features referred to in this section will be in the sequence and attribution format of the Interim Shapefiles as presented in Attachment D, Section 2.3. Refer to the glossaries in Attachments F and M of the SOW, for definitions of many of the terms discussed in this section.

5.1. SHORELINE – The shoreline is the primary product of the Coastal Mapping Program, and is the most important feature type compiled under this contract.

A. GENERALIZATION AND CONTINUITY – The shoreline may be compiled using any combination of attributes in the Shoreline feature class. Each compiled shoreline vector shall be classified with the most appropriate attribute type according to the rules and guidance provided in this section of the SOW. However, the compilation of very short shoreline features (less than 0.5 mm in length at the compilation scale) should generally be avoided. For instance, when compiling a stretch of natural shoreline, if a short (< 0.5 mm) length of bulkhead (or rip rap, or minor residential boat ramp, etc.) is encountered, it can usually be ignored, and the natural shoreline should be compiled as though the bulkhead were not there. Similarly, very small horizontal deviations in an irregular shoreline (e.g. rocky, or marshy) should be slightly generalized to produce a smoother line with a level of detail appropriate to the designated Compilation Scale for the area. .

The shoreline shall be compiled as a continuous unbroken line representing the boundary between a land area and a body of water. This concept of the shoreline as a boundary is useful, as the line must always represent land on one side and water on the other side. To maintain this topology the shoreline can never split, or fork, into two lines; and two shorelines can never converge into one. A shoreline can only end by closing on itself, as when surrounding an island or lake; or when connecting to a cartographic limit line (see section 5.15). Adjoining lines shall connect exactly, endpoint to endpoint, typically by snapping the endpoints together during compilation. To avoid unnecessarily short features, adjoining shoreline vectors that were compiled with the exact same attribution for all fields should usually be merged together. There shall be no duplicate segments, overlapping segments, dangles, or gaps in the shoreline.

B. APPROXIMATE TYPES – The contractor is required to produce a complete and continuous shoreline within the project area. But sometimes the shoreline cannot be accurately compiled, because it cannot be seen or interpreted for a significant portion of its length due to being obscured by features such as wide bridges, buildings, overhanging cliffs, etc., or even by shadows cast from them. If, under these conditions, the compiler judges that the shoreline can still be compiled within 30 meters of its true position, then the shoreline should be compiled using an appropriate "Approximate" shoreline code. There are several C-COAST "Approximate" codes available:

Mean_High_Water__Approximate
River_Or_Stream__Approximate
Great_Lake_Or_Lake_Or_Pond__Approximate
Canal__Navigable__Approximate
Undetermined__Approximate

Even though these codes are available, the compiler should make every attempt to minimize use of them by examining obscured areas on all available images for the best possible view, or by adjusting image display settings.

C. ISLETS – A separate area of natural shoreline with longest dimension less than 0.5 mm at the compilation scale is too small to show as a linear shoreline feature, but shall instead be compiled as a bare rock feature in the Obstruction_Point class (see 5.3 below). If the bare area does not appear to be composed of solid rock, but rather appears to be of a less consolidated nature, then the islet should still be compiled using the Rock_Bare code, but shall have a description of the area (e.g. "Marsh islet") entered into the Information field. If several of these small islets are grouped within 0.5 mm of each other, the compiler may delineate them with a generalized shoreline around the whole group.

D. MEAN HIGH WATER – The Mean_High_Water attribute is used to delineate the line where a tidally influenced body of open water intersects the natural solid ground when the water level is equal to the local MHW tidal datum. The MHW attribute is not used for shoreline in non-tidal areas (such as lakes or some rivers), or in areas where the water does not intersect with dry ground (as with marshes or glaciers), or where the shoreline is engineered (as with bulkhead, rip rap, ramps, etc.).

i. The Ideal Case – When mapping the MHW line from aerial imagery the ideal situation would be to have the water level exactly equal the MHW elevation at the time the imagery was acquired, for the water to be perfectly still and unchanging during the imagery acquisition, and for the imaging system to show a perfectly sharp contrast between areas of water and areas of dry land.

ii. Reality – In practice the tidal dynamics in the project area are often not fully defined, and the changing tides and wave action cause the water level to vary, so imagery is rarely collected exactly at the local MHW stage. In addition, shallow water is semi-transparent causing a gradual change in brightness between land and water in an aerial image, rather than a sharp contrast. These effects are minimized through use of tide-coordinated black and white IR (BWIR) imagery with the appropriate filters to maximize the contrast between land and water. But even so, this can only narrow the zone of possible choices for delineating the MHW line.

iii. Interpretation – A certain amount of interpretation based on knowledge, training, and experience is still required. The compiler should know the actual tide/water levels in the images, how the tide has varied over time (rising or falling), and how it varies from one area to another throughout the project.

iv. Berms – Distinct beach features such as berms and debris lines can aid in the interpretation of the MHW line. Many sandy beaches have a visible berm located slightly landward of the MHW line, but this must not be confused with a storm berm, debris line, or vegetation line which may be seen on the backshore further inland. A beach may have no berm or several berms.

v. Tone & Texture – When distinct beach features are not present, differences in tone and texture may help distinguish the foreshore from the backshore. Depending on beach sediments, wave action in the swash zone tends to make the foreshore area appear darker and smoother than the backshore.

vi. Wave Action – The run-up and retreat of waves must also be taken into account by the compiler. If the actual tide level is at MHW then the shoreline would be delineated approximately half-way between the average run-up and retreat limits of the waves. If the actual tide level is slightly *below* MHW then the shoreline would be delineated closer to the run-up limit. Conversely, if the actual tide level is slightly *above* MHW, then the shoreline would be compiled closer to the retreat limit of the waves.

vii. Elevation – If the elevations of the actual water level in the image and the local MHW datum can be determined to a high degree of confidence, then this knowledge can often assist in the interpretation of the MHW line, especially in limited areas where very few other visual clues are present. But the shoreline should not be contoured over broad areas unless the stereo models are very level and the detailed tidal dynamics of the area are very well known.

viii. Tidal Rivers – Natural shorelines in rivers with a tidal cycle are compiled using the Mean_High_Water attribute up to the limit of tidal influence. That is, upstream to the point where changes in water level due to the tide no longer affect the position of the shoreline (officially, where the tide range becomes less than 0.2 ft.) This point, called the head of tide, is inexact and typically determined by the compiler based on information at hand, including stereo observations of the elevation of the water surface and surrounding terrain and vegetation. Beyond the head of tide the natural shoreline of a river is compiled using the River_Or_Stream attribute (see 5.1.O below). Generally, tidal rivers and embayments need not be compiled beyond a point where opposing shorelines become less than 0.5 mm apart at the compilation scale.

E. APPARENT SHORELINE – Wetlands often occur in low lying areas near the coast subject to regular or frequent inundation, and are usually heavily vegetated with plants adapted to grow in saturated conditions. There is usually a considerable amount of vegetation growing up through the water, appearing above the surface, and obscuring the ground below. Theoretically, a MHW shoreline could be delineated by measuring the extent of the inundated area when the tide is at MHW, but this line is very difficult to see (even from the ground) due to the dense vegetation. Also, depicting a true MHW shoreline in a wetland area would not be very useful to the navigating mariner, as the line on the chart would not represent any feature that could actually be seen from the vessel. Instead, the shoreline is collected along the seaward limit of the wetland, where the open water meets the vegetation. This is where the shoreline appears to be from the mariner's point of view, and is thus termed the Apparent Shoreline. Note that Apparent Shoreline is different from the aquatic vegetation feature types, which normally grow under the water but may be visible at or above the surface, especially at low tide stages. See section 5.12 below on the Aquatic_Vegetation_Area feature class.

i. Types of Apparent Shoreline – There are two types of Apparent Shoreline in C-COAST, Marsh_Or_Swamp and Mangrove_Or_Cypress. See their definitions in Attachment F. Mangrove/Cypress is difficult to distinguish from woody vegetation of the more generic Marsh/Swamp types, and sole reliance on aerial imagery for interpretation is generally not recommended. Local knowledge of the area being mapped is the best resource for interpretation of wetland types, but the symbology and labels depicted on the existing NOAA nautical charts, and other ancillary data sources, are often very helpful as well. It is important to distinguish areas of Mangrove/Cypress on the chart because the surrounding area is more likely to contain hazardous submerged stumps or snags.

ii. Interpretation – When mapping most types of shoreline, the land-water interface is most clearly distinguished using BWIR imagery due to the high reflectivity contrast between dry land and open water in this range of the spectrum. But for Apparent Shoreline the reflectivity signatures between open water and wetland vegetation are not as stark, particularly at high tide levels when the wetland area is at its most inundated. In this case, natural color imagery is usually better for delineating the seaward extent of the vegetation.

iii. Application – At the endpoints of an Apparent Shoreline vector, where it connects with another shoreline type, it must also connect with the appropriate extent line (Marsh_Or_Swamp__Extent or Mangrove_Or_Cypress__Extent) from the Natural_Feature_Miscellaneous class. See section 5.10.A below for more details on wetland extent lines.

iv. Sliver Marshes – Sometimes wetland vegetation grows in a narrow strip just along the shore with dry/higher land a short distance inland. While the seaward limit of vegetation would represent an apparent shoreline, it is generally not possible to depict these narrow slivers of wetland on the nautical chart. If the compiled wetland extent line would not extend at least 0.5 mm inland (at the compilation scale) from the apparent shoreline, then the wetland area shall be ignored, and the shoreline shall be compiled using a different natural shoreline type.

v. Marsh Areas Bounded by Man-made Shoreline Types – Occasionally a seaward facing edge of a marsh area may be bounded by a hardened shoreline to function as a protective barrier. In such cases, the shoreline should be coded using the actual type, such as Rip Rap or Bulkhead, with the wetland extent line (see Section iii above) compiled coincident with this portion of shoreline.

F. BULKHEAD – Bulkhead is the most common type of man-made shoreline. As stated in the glossary, Bulkhead_Or_Sea_Wall refers to an embankment or wall constructed for protection against waves or tidal action along a shore or water front. A bulkhead can be either sloping or vertical, and may be constructed from a variety of materials, such as concrete, steel, or wood. The face may be solid, or of open-pile construction. When a bulkhead is vertical it should be compiled along the top edge of the face, not down at the water level, allowing for the most accurate delineation of the bulkhead's horizontal position. A sloping bulkhead should be delineated along the face approximately where the water would be at the MHW tide stage, or at the waterline for non-tidal areas.

A bulkhead in ruins may appear unconsolidated, similar in appearance to rip rap, and should be compiled using the Bulkhead_Or_Sea_Wall__Ruins code. Also, a bulkhead is typically not used for berthing, launching, or landing vessels. Other feature codes apply to shoreline used for these purposes, and for the interiors of dry docks or locks. As such, the compiler will often need to determine how a shoreline is being used, and not just how it appears.

G. CANAL – A canal is a man-made waterway, but it can often be mistaken for a natural shoreline. When a canal is cut through the land as a simple ditch, without any additional development of the shoreline (such as constructing a bulkhead or rip rap), it has the appearance of a natural stream bank. The characteristic that distinguishes the waterway as a canal is its overall shape. Natural streams tend to meander along winding paths of varying width and curvature, while canals are made with straight lines and broad curves. Canals usually have a fairly constant width, and may intersect other canals at near right angles. Canals are classified as either navigable or non-navigable. Non-navigable canals are used for drainage or irrigation, and only need to be compiled if they connect with navigable waterways. In reality, the canal code is not used very often, since it is often superseded by other types of man-made shoreline (bulkhead, rip rap, etc.), by apparent shoreline when the canal is cut through a wetland area, or by Mean_High_Water shoreline in areas of clear tidal influence.

H. DRY DOCK – A permanent dry dock is a fixed basin into which ships can be floated and secured. Then the dry dock is closed and the water pumped out to expose the hull of the ship, typically for repair or maintenance. When a dry dock is open it is full of water, and appears similar to a bulkhead or wharf. The difference is that a dry dock will have a mechanism at its entrance, such as a gate or caisson, which can be used to seal the basin and allow the water to be pumped out. Dry docks are easier to identify when they are closed and dry, especially if a ship is inside being repaired. The top edge of the interior of the basin (inside the gate) is compiled using the shoreline feature type Drydock__Permanent.

I. GLACIER – This shoreline feature type is used to delineate the line where a marine glacier meets the sea. This line is the interface between the ice mass and the water. The seaward face of a glacier is typically a tall vertical wall of ice, subject to frequent change as the river of ice flows and icebergs calve off. The top of the face often overhangs the base, making it difficult to delineate the interface at the surface of the water. But the exact position of the glacial shoreline is not that important; since the face never remains fixed for very long, it is always considered to be an approximate line. It is usually easiest to compile along the top edge of the face, though the endpoints must be down at the normal shoreline elevation to connect to any adjacent shoreline of a different type. The Glacier code is not used for the landward limits of the ice. Similar to an Apparent Shoreline vector, a Glacier vector must be paired with Glacier__Extent lines (from the Natural_Feature_Miscellaneous class) connected at its endpoints. See 5.10.B below for more details on glacier extent lines.

J. LAKE OR POND – A lake or pond is any non-tidal body of water mostly or completely surrounded by land. Lakes and ponds shall be compiled at the land-water interface using the feature type Great_Lake_Or_Lake_Or_Pond. Generally, any lake or pond close enough to the coastline to be a useful feature to the mariner for orientation, or connected to the coastline by a navigable waterway, or containing marine facilities (e.g. piers, wharves), shall be compiled. As indicated by its name, this feature type is used for all bodies large and small, from Lake Superior to small non-navigable ponds, as long as they meet the criteria above.

K. LOCK – A lock is used where the surface of a navigable waterway changes level, to allow vessels to be raised or lowered from one water level to the other. A lock is constructed as a basin with gates at each end, which can be closed to allow water to be pumped in or out, raising or lowering the water level in the lock basin. The shoreline between the gates, inside the basin, is compiled using the feature type Lock. This shoreline is usually vertical, and is best compiled along the top edge.

L. MEAN WATER LEVEL – This feature type shall only be used to delineate the shoreline if the contractor is directed to do so in the Project Instructions, or after consultation with NOAA personnel assigned to monitor the compilation phase of the project. Mean_Water_Level is occasionally used in place of Mean_High_Water in ocean areas (not lakes or rivers) with little or no tide range, where the MHW level cannot be accurately determined; most commonly in certain back-bays and lagoons where a tidal signal is uncertain or irregular. The Mean_Water_Level code, as used in the Coastal Mapping Program, should not be misconstrued as representing the Mean Sea Level tidal datum, or any other tidal-datum-based shoreline. Rather it is simply used to delineate the land-water interface at the time of the imagery in these non-tidal ocean areas.

M. RAMP – A Ramp is a sloping area of shoreline used for landing or launching vessels. It is typically constructed of concrete, and is associated with a parking or driveway area (usually paved) on its landward side. Often small piers or fenders project into the water on either side of the ramp to help direct the movement of the vessel, or of the equipment used for hauling the vessel in or out of the water. In tidal areas, the Ramp line shall be compiled at the MHW level along the slope. In non-tidal areas the Ramp is simply delineated along the land-water interface in the imagery. Small private/residential boat ramps should typically not be compiled, unless already depicted on the NOAA chart.

N. RIP RAP – Rip rap can be mistaken for natural shoreline since it has a sloping surface and a rough texture, and it is often placed along a naturally curving shore. But it can be distinguished by the regularity of the texture and relative steepness of the slope. Rip rap can be made of rock, concrete, or other materials, but a particular layer will tend to be homogeneous in size, depth, and construction. In tidal areas a Rip_Rap shoreline should be delineated along the MHW level of the slope. Since rip rap usually has a fairly steep slope, the horizontal position of the waterline should not vary much with the tide level.

O. RIVER OR STREAM – This code should be used to compile the shoreline of non-tidal rivers and streams which are wide enough to be depicted at scale as double-line features, with a distance of 0.5 mm or more separating the lines at the compilation scale. As stated above

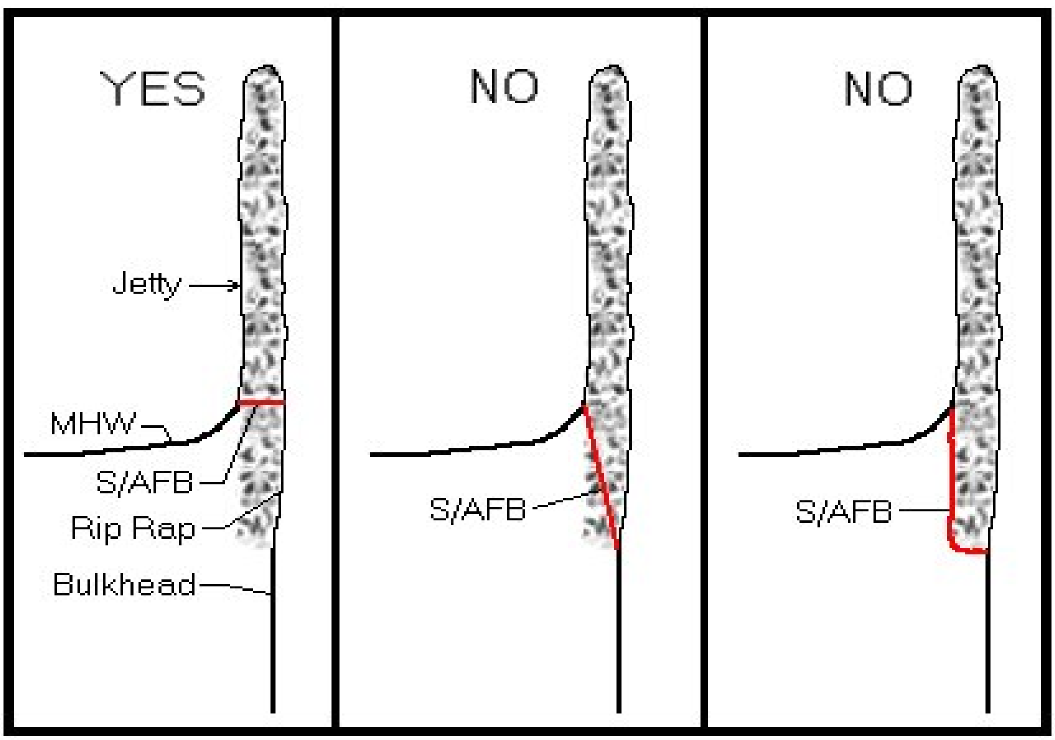
(5.1.D.viii), tidal rivers are compiled using the Mean_High_Water shoreline type up to the Head of Tide. The River_Or_Stream feature type is used beyond the Head of Tide, upstream to where the banks narrow to less than 0.5 mm separation at compilation scale. At that point the compiler should pinch the stream down by collecting a point in the middle of the water, and then continue compiling downstream on the other bank. See section 5.10.D below for guidance on compiling streams less than 0.5 mm wide.

P. SLIPWAY – A slipway has a sloping hard surface leading down to the water and appears similar to a ramp, though it is not used for general landing and launching of vessels. Rather a slipway is used for construction or repair of a ship. There will often be rails, blocks, and other structures to support a ship under construction. In tidal areas a Slipway shoreline is delineated along the MHW level of the slope. Slipways are often associated with Marine Railways (see 5.2.I below).

Q. WHARF OR QUAY – A wharf or quay provides a place for vessels to berth against one side in order to load or unload passengers or cargo, in other respects it may appear similar to a bulkhead. A wharf or quay is distinguished from a bulkhead by how it is used. Therefore, a compiler must recognize various characteristics that indicate the shoreline's purpose. The presence of a ship tied up alongside in the process of loading or unloading cargo or passengers is an unmistakable sign. Also large amounts of bulk cargo, shipping containers, cranes, conveyor systems, and other equipment for handling cargo are often found on a wharf or quay. Note that a pier is also used for berthing vessels in a similar way, but a pier is generally a longer, narrower structure that projects out from the shoreline, on or over the water, to provide berthing space on one or both sides. By its strict definition, a wharf or quay is part of the shoreline, having only one long side running parallel to the general trend of the coast, and which may project out a bit, but normally no more than its width along the shore. That being said, for the purposes of this SOW, a large pier-like structure that projects out from the shore, and appears to be of solid construction down to the base (not of open construction with water underneath), shall be compiled as Wharf_Or_Quay shoreline, as opposed to Pier, even if the feature is labeled as a pier on the nautical chart (see section 5.2.C below).

R. UNDETERMINED – When the compiler is unable to confidently interpret the type of shoreline along a significant length of its extent, then one of the "Undetermined" shoreline types should be used. Most often this is due to the shoreline being obscured in some way, so the "Undetermined" feature type is almost never used without the "Approximate" modifier (see 5.1.B above). This feature type is most often used for shoreline under wide bridges and piers where the type of shoreline cannot be interpreted or inferred within the obscured area. As with "Approximate" shoreline, the compiler should minimize use of "Undetermined" shoreline types as much as possible. For example, if a short length of shoreline is obscured by a narrow bridge or pier (<1.0 mm wide at the compilation scale), then it is usually not necessary to classify the obscured segment as "Undetermined", especially when the shorelines visible on either side of the obscured area are both of the same type (Bulkhead, Rip Rap, etc.) But if a significant length of shoreline is obscured by a wide bridge or pier (>1.0 mm wide at the compilation scale), then it may be necessary to classify the obscured segment using the Undetermined__Approximate attribute code, especially if the shoreline types are inconsistent on either side of the obscured area, and/or the shoreline does not appear to pass straight under the alongshore feature in a linear fashion.

S. SHORELINE / ALONGSHORE FEATURE BOUNDARY (S/AFB) – The purpose of this feature code is to provide an imaginary line connecting gaps in the shoreline, caused by certain wide alongshore features, in order that the shoreline will be continuous. Some alongshore feature types (Breakwater, Groin, and Jetty) do not have a true land-water interface (shoreline) running underneath them, but are solid down to the ground. They project directly out from the shore, but since they are in the Alongshore Feature class, they cannot substitute for Shoreline. When these features are wide enough to compile as closed outlines (more than 0.3 mm wide at the compilation scale), a gap results in the shoreline where the feature abuts the land. This gap shall be closed by a straight line segment using the S/AFB code, coincident with the segment of the Alongshore Feature line compiled along the inland limit of the feature. One should attempt to depict this inland limit in such a way as to minimize the length of imaginary shoreline digitized, while still maintaining a realistic outline of the feature. The vertices of both the Alongshore Feature and S/AFB lines must connect (snap) exactly to each other, and to the compiled shoreline from which it projects. See example diagram below:



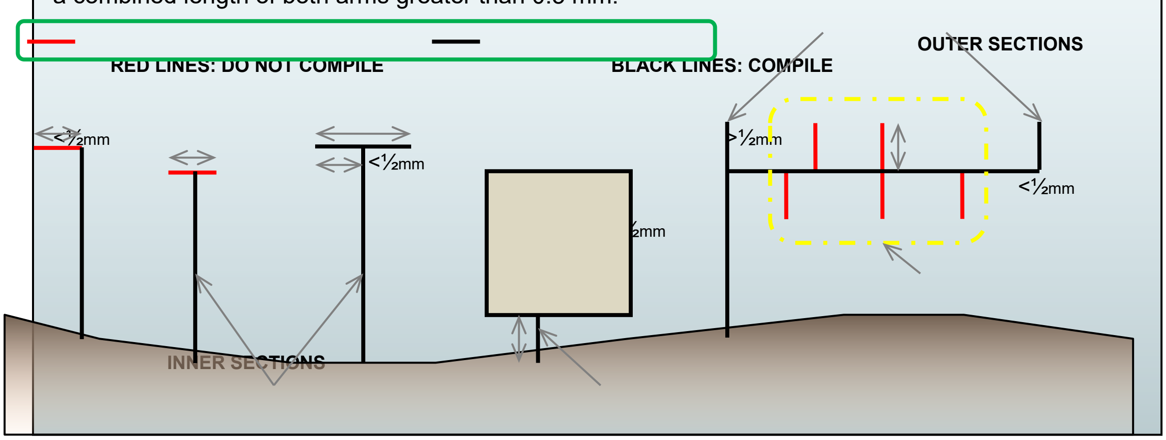
Some large projecting piers also are solid to the ground, with no water flowing and thus no true land-water interface running underneath. But as explained in sections 5.1.Q above and 5.2.C.ii below, these piers shall be compiled as part of the shoreline using the code Wharf_Or_Quay, not as Alongshore Features, and thus do not require an S/AFB line.

5.2. ALONGSHORE FEATURE – Alongshore Features include various objects constructed in the water near the shore that may cross over the shoreline, abut the shoreline directly, or be completely surrounded by water.

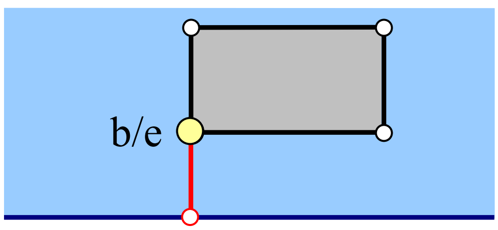
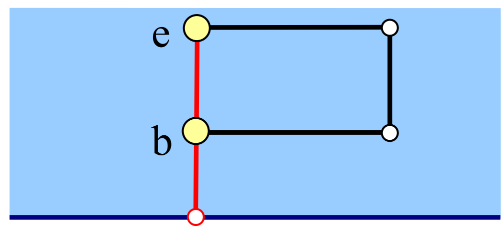
A. WIDTH/LENGTH LIMIT – Alongshore features may generally be compiled as either a single line along the center of the object or as an outline around the perimeter of the object, depending on the width of the feature and the compilation scale. All alongshore features narrower than 0.3 mm at the compilation scale shall be compiled as a single line along the center. Alongshore features of equal or greater width than 0.3 mm at the compilation scale shall be compiled as a closed outline around the perimeter. This width specification is intended to result in depiction of alongshore features in at least as much detail as is already charted. In general, if an alongshore feature is charted as a closed outline (double-line delineation) *without excessive exaggeration*, then that is the preferred method of compilation. Additionally, some alongshore features may have a combination of wide sections and narrow sections, so it may be necessary to compile a feature as separate connected sections, some parts as single-line and some parts as double-line.

Generally alongshore features with a length less than 0.5 mm at the compilation scale shall not be compiled (see diagram below). Alongshore features that project less than 0.5 mm from the shoreline shall not be compiled. This includes very long structures parallel to shore whose furthest seaward extent is still less than 0.5 mm from the shoreline. On the other hand, if any part of the feature is at least 0.5 mm seaward from the nearest point of shoreline, then the entire structure shall be compiled. No alongshore feature shall be compiled entirely landward of the shoreline (with the exception of Marine Railways). And alongshore features with individual sections less than 0.5 mm in length, but whose collective length is greater than 0.5 mm, shall be compiled such that the attribute of the longest section is used for the entire feature.

All of these alongshore features project more than 0.5 mm from the shoreline, but contain sections that are less than 0.5 mm in length. Small connector sections shall be compiled. Small outer sections that project seaward from the main structure shall be compiled, but inner sections shall not. Small sections that are parallel to the shore shall not be compiled, except for the end of a T-structure having a combined length of both arms greater than 0.5 mm.



B. CONNECTIVITY – Double-line alongshore features shall have no gaps, dangles, or overlaps. Features consisting of multiple connected sections (such as main piers with one or more attached finger piers) shall be compiled such that the sections snap together exactly at vertices. Alongshore features that meet the shoreline at the same elevation (as opposed to crossing over) shall connect (snap) exactly at vertices on the shoreline. Specific compilation and connectivity rules have been developed for double-line alongshore features to aid NOAA in applying the features, with proper symbolization on the raster nautical chart, and with correct attribution in the Electronic Navigational Chart (ENC). Generally if an alongshore feature (or section of one) is compiled as a closed line that begins and ends at the same point, then it will be considered an area feature surrounding a solid surface. But if a section of an alongshore feature is compiled as an open line, beginning and ending at different points, then it will be considered a narrow perimeter feature surrounding an interior area of open water (see diagrams below).

Area pier (double-line delineation)	**Perimeter pier** (single-line delineation)
	
This shows a pier in two sections, including a small linear portion (red) extending from shore and connecting to a larger section (black), which is a solid surface, more than 0.3 mm wide at the compilation scale. The larger section is compiled as one segment beginning (b) and ending (e) at the same vertex, thus representing a polygon.	This shows another pier in two sections, although in this case *both* sections of pier surface are less than 0.3 mm wide. To ensure that the pier is properly symbolized on the chart as "open" (water in the interior) rather than a solid surface, the black segment is intentionally delineated with *separate* beginning and ending points.

C. PIERS – Piers may be fixed/permanent, floating, or in ruins. The entire extent of a pier shall be compiled, even any portion that may be landward of the shoreline. However no pier shall be compiled with its full extent landward of the shoreline. If the compiler has strong reason to believe that a pier is temporary or seasonal, then it should not be compiled; though if permanent piles are visible which may support the pier, they *may* need to be compiled as individual piles.

i. Connection To Shoreline – Piers that *connect* to the shoreline, or to any other feature, shall always have an endpoint snapped to a vertex of the feature from which it projects. Piers that imagery shows *crossing over* the shoreline need not be snapped.

ii. Shoreline Under Piers – A large pier of open construction, that crosses over the shoreline may obstruct the compiler's view of the shoreline beneath, and may require the use of an "Approximate" and/or "Undetermined" shoreline feature type (see 5.1.B and 5.1.R) in the obscured area. A large pier of solid construction, which does not have an actual land-water interface running underneath, shall be compiled as shoreline (see 5.1.Q Wharf Or Quay above), and not as an Alongshore Feature – Pier.

iii. Finger Piers – Often a large pier will have a number of smaller "finger piers" extending from it. Most finger piers should only be compiled if their lengths are greater than or equal to the 0.5 mm minimum length for Alongshore Features, and there is at least 0.5 mm separation between them. Though, some small finger piers that project seaward from the outer sections of a larger pier structure should be compiled, even if less than 0.5 mm in length (see diagram in 5.2.A above). If the finger piers are long enough to compile, but are closer together than 0.5 mm, then it will be necessary to compile only a representative selection of them. Usually in this case compiling every other finger pier is sufficient. If the finger piers are obscured by a roof (covered slips) then only the main/central pier should be compiled (see example in 5.8.A.iv – Buildings on Piers below). In cases where structures designed to lift or support boats out of water extend from or are parallel to piers, these should be compiled whenever they meet the compilation specifications above, and the term "Boat lift" should be entered into the Information field.

iv. Floating Piers – Small piers in areas with variable water levels are often constructed so that the pier floats on the surface, rising and falling with the changing water level. Often floating piers will have a fixed part connected to the shore, and an articulated sloping section that connects the fixed part to the floating part. Floating piers are most easily distinguished in imagery acquired at low water stages, since in that situation a pier appearing down near the water level would have to be floating, otherwise at higher water levels the pier would be covered, making it unsuitable as a mooring structure.

v. Pier In Ruins – A pier, or section of a pier, that appears to be dilapidated, often with portions of its surface deck broken or missing, and no longer appears to be used as a functional mooring structure, should usually be compiled as Pier__Ruins. A feature compiled with this Pier__Ruins code must be mostly bare at high water. If, on the other hand, pier ruins are visible, but are mostly situated below MHW, then the feature shall be compiled as Ruins__Undetermined__Covers__Uncovers or Ruins__Undetermined__Submerged, with "Pier ruins" entered into the Information field (see 5.4.K below). A general rule of thumb is if "more water than pier" is visible among the ruins at MHW, then compile it as Ruins__Undetermined; but if "more pier than water" is visible, then compile it as Pier__Ruins. If an area of widely scattered pier ruins is visible in the water, then it may be more appropriate to compile as a Foul Area. Note that this guidance on pier ruins also applies to bridge ruins (see 5.2.E.v below).

D. BREAKWATERS – A breakwater is a structure often found at the seaward side of a harbor or other anchorage area, placed to protect the area from waves. It may extend from the shore, or from another feature such as a pier, or it may stand out in the water by itself. Some breakwaters are not associated with harbors, but are constructed just seaward of and parallel to a natural shoreline in order to mitigate erosion, and encourage shore deposition (beach growth) behind the breakwaters. A breakwater is usually bare, but some may have parts that cover and uncover, or are submerged. It is often made of piled up stone, but may be built from a variety of materials, though it is usually fixed and solid. The compiler can often see a distinct calming of the wave action on the protected side of a breakwater compared with the seaward side. A breakwater is not normally used for mooring vessels, but occasionally one may see a vessel anchored beside, or even tied to a breakwater.

i. Floating Breakwaters – In some areas a floating structure is used in place of a conventional fixed and solid breakwater. While this type of feature may even be labeled as a breakwater on the chart, it shall not be classified using the Breakwater feature attribute. Instead these features shall be compiled as Obstruction_Linear – Floating_Barrier__Boom, with "Floating breakwater" entered into the Information field (see 5.4.I).

ii. Lobster Pounds – A special type breakwater constructed for the specific purpose of trapping lobsters. When compiling lobster pounds, the breakwater code shall be used with "Lobster pound" entered in the Information field.

E. BRIDGES – There are four types of bridges: Fixed, Opening, Footbridge, and Pontoon. Each of these types can be further classified as intact, in ruins, or under construction. The compiler should generally only compile bridges that cross over some body of water, in particular those wide enough to compile as double-line delineations. The water body does not need to be navigable, but it must be more than a simple drainage culvert. Minor culverts shall be ignored. Solid causeways are not compiled as bridges. An intact bridge can never be completely offshore with no connection to the land, though a bridge in ruins or under construction can be entirely surrounded by water. Bridges which significantly obscure the shoreline may require the compiler to use an "Approximate" or "Undetermined" shoreline feature type underneath (see 5.1.B and 5.1.R above).

i. Bridge Supports – Bridge abutments and supports (pylons) visible within navigable waterways should be compiled using the Bulkhead_Or_Sea_Wall code with "Bridge support" in the information field. If supports are only partially visible, portions that are obscured and impossible to accurately position should be compiled using the Undetermined__Approximate code. (This code should be minimized as much as possible by using all available stereo models to view the bridge.) If no part of the feature is visible, it should not be compiled. Bridge supports landward of the shoreline can be ignored.

ii. Roads and Bridges – A road or railroad overpass that does not cross a body of water shall not be compiled as a bridge. A road or railroad supported by a bridge shall not be compiled on or through the bridge, but shall connect (snap) to the bridge at both ends. Roads or railroads that cross under bridges (or other roads for that matter) should be continuous with no break for the underpass. See 5.9 below for more on roads.

iii. Opening Bridges – Bridges having sections which open to permit passage of vessels shall have each individual section compiled independently. All sections shall be connected (snapped) at the corner vertices of adjoining sections, and attributed in the following manner:

a. Fixed – Portions of a bridge which are permanently fixed (typically the non-moving sections attached to the shore) shall be compiled as Bridge__Fixed.

b. Opening – The movable section of a bridge that opens, typically the center section, to allow large vessels (exceeding a stated vertical clearance) to pass, shall be compiled as Bridge__Opening, except in the case of an opening pontoon bridge (see below). The opening section of an operational bridge shall always be compiled in the closed position, even if it appears open in the imagery.

c. Permanently Open – Occasionally a bridge will be permanently closed to traffic, and locked in the open position to allow free movement of vessels. A permanently open swing bridge shall be compiled in the open position, with "Permanently open" entered into the Information field. The permanently open sections of bascule and lift bridges shall not be compiled.

iv. Pontoon Bridges – This attribute code shall be used for any bridge, or section of bridge, supported on anchored structures that float on the surface of a water body. Vessels typically cannot pass under sections of bridges supported by pontoons. In cases where a section of a pontoon bridge is able to be moved (floated) open to allow for the passage of vessels, the opening portion shall be compiled (in the closed position) as a separate feature using the same Bridge__Pontoon code as the non-opening portion, but with "Opening section" entered into the Information field.

v. Bridge in ruins – Features compiled using any of the types of bridge "Ruins" codes must be mostly bare (above MHW). Bridge ruins that are mostly below MHW (covers/uncovers or submerged) shall be compiled using the attribute code Ruins__Undetermined, in the Obstruction_Linear class. Follow the same guidance provided for Pier in Ruins (5.2.C.v) above.

F. FENDERS – Fenders are often found under bridges to protect the supporting structure from collisions with vessels; and at the entrances to locks and ferry terminals, to help guide vessels into a narrow opening. They usually appear as rather narrow linear structures, often with slight curves especially at the ends. Fenders at locks and ferry terminals are usually attached to the outer lock or pier structure, extending into the water on one or both sides of the entrance channel. Fenders under bridges may be connected to the bridge supports, but often are not connected, standing free just beside the supports. Fenders are often obscured by bridges. The compiler shall delineate as much of the fender as can possibly be seen in the imagery. If the fender can be seen on both sides of a bridge, and the obscured part is not too long, the compiler might be confident that the fender continues in a straight line under the bridge, and the obscured section could be delineated. But if the compiler is not confident of the existence or position of the obscured portion of the fender, then that section should not be compiled, as there are no "approximate" feature types in the Alongshore_Feature class.

G. GATES – These features are found at the entrances of locks and permanent dry docks. Gates are used to seal these openings, and are therefore always delineated as connected (snapped) to the lock or dry dock structure. A gate shall be compiled in the closed position, even if it appears open in the imagery. If a gate is in two parts, then each part shall be collected as a separate feature, though they should normally snap together.

H. GROINS AND JETTIES – These features are similar in that they both extend into the water from the shoreline in order to direct the alongshore current flow, and to control the scouring and deposition patterns of coastal sediments. The difference is that a jetty is typically constructed at the entrance to a river, channel, or harbor in order to maintain the opening and protect it from silting; while a groin is usually a much smaller structure designed to control beach erosion. Like breakwaters, groins and jetties are fixed and solid, may have bare parts and covered or submerged parts, and they are usually made of piled boulders or concrete blocks.

I. MARINE RAILWAY – A marine railway is a sloping track used for hauling a vessel out of the water, or for lowering a vessel into the water. Generally, the portion of a marine railway visible seaward of the shoreline should be compiled using the Covers__Uncovers _Or_Submerged code, and any part that is landward of the shoreline should be compiled using the Bare code (an exception to the requirement that Alongshore Features not be compiled wholly landward of the shoreline). In any case, a marine railway shall always be compiled as a single-line along the center of the track, never as an outline (an exception to the width limit specification for Alongshore Features). Sometimes a vessel or empty cradle can be seen, which simplifies the identification of this feature type, but often the only sign is a set of tracks sloping down into the water. They are most often located in port areas, where vessel repair and maintenance facilities are commonly available. The sloping shoreline along which a marine railway runs should usually be classified as a Slipway (see 5.1.P above).

J. TRAINING WALL – The function of a training wall is similar to that of a groin. But a training wall is different in that it is often submerged and separated from the shoreline, and may be aligned at various angles to the shoreline, rather than just perpendicular to the shoreline like the typical groin. Training walls are also relatively rare, and may only be seen in projects that include large rivers or areas with strong tidal currents, where dredged channels are subject to frequent heavy silting. Training walls may be referred to by other local terms, such as Wing Dam or Pile Dike.

K. UNDETERMINED – This feature type shall be used for other man-made near shore structures that seem to be in the Alongshore Feature category, but cannot be fit into any of the classifications above. This code shall not be used for other structures in the coastal zone that are included in other feature classes, such as obstructions and cultural features. If the Undetermined_Alongshore_Feature type is used then the compiler should enter descriptive information about the feature into the Information field, if possible.

5.3. OBSTRUCTION POINT – An obstruction is a potentially hazardous natural or man-made object that hinders, endangers, or prevents the passage of a vessel. It may be above or below the water line, but it will always be fixed to or lying on the seabed, not floating.

Maximum size: An obstructing feature cannot be compiled as a point unless it is smaller than 0.5 mm at the compilation scale. A feature equal to or larger than 0.5 mm would have to be compiled as a line using a different feature class. The size of a feature is determined by the longest dimension of the object's outline as it would appear at the level of the shoreline (usually MHW).

Distance from shore: New (uncharted) obstructions shall only be compiled if they are at least 1 mm seaward of the shoreline (at the compilation scale). Any uncharted obstructions closer than 1 mm, or on the landward side of the shoreline, shall be ignored. Although, if an obstruction is already charted and is visible in the imagery, then it should be compiled, even if it is less than 1 mm from the shore.

Distance from other features: A point obstruction shall not be compiled within 0.5 mm of another compiled feature. With a small group of obstructions that are too close together to compile individually, the most navigationally significant (most prominent and seaward) ones that are at least 0.5 mm from each other should be compiled. With a larger group, a representative pattern of the most significant obstructions should be compiled within a Foul area (see 5.11.A). If a feature in one of the other point classes is in the same location as an Obstruction_Point feature (such as when an Aid_To_Navigation is fixed to a rock) then the other feature takes precedence and the obstruction is not compiled.

Note that when classifying a point type obstruction as Bare, Covers/Uncovers, or Submerged, only rocks and coral heads use the specifications in the table in section 4.7 above. The classification of all other obstructions is based on the definitions of these terms in the C-COAST Glossary (Attachment F).

A. ROCK – In most projects rocks are the most common obstructions a compiler will see. A rock is a discrete object, separated from other rocks by deep water or unconsolidated sediments. A bare rock should be compiled at the center point of the area above the shoreline level (usually MHW). This center point is not necessarily at the highest point of the rock, nor is it usually at the center of the entire visible rock mass. A covering or submerged rock should be compiled at the center point of the entire rock mass visible in the imagery. High points on ledges and reefs should be compiled as rocks (Bare or Covers/Uncovers) if they protrude a significant amount above the feature, and are thus of value to the mariner. Note that a <u>non-rocky</u> natural islet (small clump of marsh, bare sand bar, etc.) that meets the specifications above for an Obstruction Point may need to be compiled as a bare rock feature, with an appropriate description entered into the Information field (see Section 5.1.C above).

B. CORAL – A discrete head of living coral is compiled using the same rules of application as a rock, except that it can never be bare, as the organisms that make up the coral would die if allowed to dry out. A bare coral head is assumed to be dead, and is compiled using the Rock__Bare feature code. It is difficult to distinguish coral from non-living rock without extensive local knowledge of the project area, but it is generally found in the warmer waters of the lower latitudes. Coral is common throughout southern Florida, and islands in the Caribbean and tropical Pacific. Charts in these regions will often have labels and symbols indicating areas of coral. The compiler should use this information from the charts, and other available sources, to help differentiate rock from coral in the imagery. Note that in many Pacific islands the natural rock is often basalt, which is much darker (even black) compared to most corals.

C. SNAG/STUMP – This feature can only be Submerged. If a stump is visible and determined to be bare or covers/uncovers, it shall be compiled as a general "Obstruction__Bare" or "Obstruction__Covers__Uncovers", with "Stump" entered into the Information field. See the glossary in Attachment F for the definition of Snag or Stump, but it should be noted that this feature, like any other obstruction, must be fixed to the bottom. A log/branch that is floating or resting on the bottom shall not be compiled.

D. WRECK MAST – Occasionally with a sunken shipwreck only a mast is still visible. In this case the wreck is compiled using one of the Wreck__Mast feature codes (Bare or Covers/Uncovers). Note that this feature does not include a submerged type. In reality, the Mast feature is very rare, and it is highly unlikely that the compiler will have the occasion to use it. If a wreck is encountered, it is much more common to see a significant area of the wreck's hull, which would be outlined as a linear obstruction.

E. GENERAL OBSTRUCTION – Any other point obstruction that cannot be classified as any of the above feature types, or as a feature in another point class, shall be compiled as an Obstruction__Bare, Obstruction__Covers__Uncovers, or Obstruction__Submerged. The compiler shall enter descriptive information about the feature into the Information field of the GC. For example, an individual bare tree (or small group of trees) standing in the water at least 1 mm (at the compilation scale) from the shoreline would be collected as an Obstruction__Bare, with "Tree" (or "Trees") entered into the Information field.

5.4. OBSTRUCTION LINEAR – An obstruction is a potentially hazardous natural or man-made object that hinders, endangers, or prevents the passage of a vessel.

Size limit: An obstruction can only be compiled as a line or area feature if its size is equal to or greater than 0.5 mm at the compilation scale. A feature smaller than 0.5 mm would have to be compiled as a point using a different feature class.

Distance from shore: A new (uncharted) obstruction shall only be compiled if its furthest extent is at least 1 mm seaward of the shoreline (at the compilation scale). Any uncharted obstructions closer than 1 mm, or on the landward side of the shoreline, shall be ignored. Although, if an obstruction is already charted and is visible in the imagery, then it should be compiled, even if it is less than 1 mm from the shore.

A. FLOATING FEATURES – This class includes a number of floating feature types, such as platforms, vessels, and floating barriers. In general, the compilation of floating objects is not desirable within the NOAA Coastal Mapping Program, since providing a highly accurate position (at the time of imagery) of a feature that is temporary or moves about, is of little use to marine navigation. Nevertheless, in certain exceptional cases it is required to delineate floating obstructions; such as when confirming the existence and position of previously charted features, or when the compiler has access to older imagery that shows a feature in the same position as in current imagery. But in most cases, when the compiler identifies one of these floating obstructions that is not already on the chart, and has no reasonable expectation that the object is permanent, then it should not be compiled.

B. (section removed)

C. PLATFORM – Platforms must be separated from the shoreline, and completely surrounded by water. If any part of a platform-like object connects to or crosses over the shoreline, then it cannot be a platform, and probably should be collected as a Pier. A mineral platform could be a massive oil or gas drilling structure, or a small maintenance landing beside a well-head. Observation platforms are typically elevated to provide a view of the surroundings, and may support a roof, though the sides are normally of open construction. Any other platforms that do not fit in the named categories should be collected as Undetermined, with descriptive text entered into the Information field. A platform in ruins should also include a description of its former function if known (e.g. "Wellhead ruins"). All non-floating platforms shall be compiled as enclosed polygons, without regard for feature width. A narrow (single-line) mooring structure extending from a larger platform, should usually be compiled as a Pier.

D. WRECK – The outline of the hull of a single wrecked ship is compiled using this feature type. An area of multiple wrecks, or broken and scattered remains of a vessel, would be delineated using the Wreckage code (see 5.11.D below). For charting purposes, submerged (or sunken) refers to a wreck, or part of a wreck, that is below the sounding datum for the chart. Wrecks may be sloping, and are often compiled with their Bare, Covers/Uncovers, or Submerged portions delineated as individual, connected sections.

E. PERMANENTLY DOCKED VESSEL – A vessel should only be considered to be permanently docked if some fixed structure has been constructed around it or in its path which physically prevents the vessel from being moved. It may still be able to float up and down with changing water levels. This code shall only be used to outline the vessel itself. The enclosing structure would be compiled using some other appropriate code. A Permanently Docked Vessel must be located seaward of the shoreline. A vessel displayed on land is not an obstruction, but it could possibly be a building.

F. CRIB – See the glossary in Attachment F for a good description of this feature. Note that most cribs are too small to show as a line, and should be collected as a point type obstruction, with "Crib" entered into the Information field. Cribs that do meet the minimum size requirement shall be delineated as a closed (snapped) outline.

G. FISH STAKES – This row, outline, or area of stakes may appear like a fence in shallow water. The stakes may be used to define a fishing area, as supports for netting, or as a system for catching or confining fish. A collection of stakes may be the remains of a fish trap that is no longer functional (see section H below).

H. FISH TRAP – Fish traps can vary greatly in size, from small basket-like devices only a meter or two long, to extensive structures many tens of meters across. They are found in shallow water, most typically in or near the mouth of a stream or narrow inlet. Only large fish traps are likely to be identifiable in the imagery. They may be constructed of various materials and designs, but generally consist of some fencing or netting supported by piles or stakes, arranged in the waterway in such a manner as to funnel fish through a small opening into a larger area or chamber from which they cannot easily escape. Some fish traps are floating structures. Most fish traps should not be compiled. Only those that are fixed in place and *known to be permanent* should be compiled.

I. FLOATING BARRIER – These features appear as long thin objects floating on the surface, either curving, or as a series of connected straight segments. They are often secured at one or several points along their lengths. A floating barrier may be compiled as a closed or open linear feature. As with other floating features it should only be compiled under the circumstances defined in Section A above. A feature compiled using the code Floating_Barrier__Boom shall have descriptive text entered in the Information field to further classify, *if the type of boom is known*.

J. FLOATING DRY DOCK – (section removed)

K. UNDETERMINED RUINS – This is a general code used for any fixed obstructing linear feature in the water that is in a ruined state, and that cannot be fit into any other category of ruined structure, in this or in another feature class. This feature may be compiled as a single line along the center of a narrow length of ruins, or as a closed or open outline around an area of ruins. If the Ruins_Undetermined feature type is used then the compiler should enter descriptive information about the feature into the Information field, if possible. This feature type is used for pier and bridge ruins that lie mostly below the MHW datum, and are compiled as covers/uncovers or submerged.

L. GENERAL OBSTRUCTION – Any other linear obstructions that cannot be classified as any of the above feature types or as a feature in another linear class, shall be compiled as an Obstruction__Bare, Obstruction__Covers__Uncovers, or Obstruction__Submerged. The compiler shall enter descriptive information about the feature into the Information field of the GC.

5.5. FREESTANDING MARINE FEATURE – This feature class includes Piles, Dolphins, and Stakes (also Tripodals which are a special case of Dolphins). Freestanding Marine Features shall only be compiled if they are in the water, at least 0.5 mm (at compilation scale) seaward of the shoreline and any alongshore features. Any Freestanding Marine Feature closer than 0.5 mm to the shoreline or to an alongshore feature shall be ignored, unless the feature is already charted. Freestanding Marine Features also shall not be compiled within 0.5 mm of each other. In the case of a small group of these features that are too close together to compile individually, only the most navigationally significant ones that are at least 0.5 mm from each other should be compiled. A larger group or long row of many Freestanding Marine Features should be delineated by a closed outline around the group, or by an open line along the row, using the Obstruction code (in the Obstruction_Linear class) with the type of feature entered into the Information field (ex. "Row of piles"). A large group of closely spaced stakes that are used for the collection or confinement of fish would be delineated with the Obstruction_Linear type Fish_Stakes.

The compiler should generally not compile piles, rows of piles, or pilings immediately adjacent to or between piers and other alongshore features, even if the piles are more than 0.5 mm from the pier and are spaced at least 0.5 mm apart. Since mariners expect to encounter numerous piles in the vicinity of alongshore features, their inclusion would only create unnecessary congestion of detail on the chart products. In these areas only the most seaward piles that are relatively isolated, hazardous, or otherwise significant, or piles that are already charted should be compiled.

If a Freestanding Marine Feature (such as a pile) is simply functioning as a support structure for an aid to navigation (such as a daybeacon), then the aid to navigation takes precedence and shall always be compiled, while the supporting Freestanding Marine Feature shall be ignored.

Freestanding Marine Features shall always be collected at the top center of the feature. Piles and Stakes can be collected as Bare, Covers/Uncovers, or Submerged; but, except for those in ruins, Dolphins (and Tripodals) can only be collected as Bare. Individual stakes are quite small, and often cannot be seen in aerial imagery.

It is common to encounter Dolphins that are too large to be compiled as point features. A Dolphin having a length equal to or larger than 0.5 mm (in its longest dimension) shall be compiled as a closed outline, using the Bulkhead_Or_Sea_Wall code in the Shoreline feature class, with "Dolphin" entered into the Information field.

5.6. LANDMARK – The requirement for compiling Landmarks in coastal mapping projects has two purposes: Verifying the existence, identity, and position of currently charted landmarks; and Recommending the addition of new landmarks to the chart.

A. CHARTED LANDMARKS – The compiler shall search within the limits of the stereo imagery for all landmarks shown on the nautical charts covering the project area. For each landmark identified, the compiler shall verify that the type of feature seen in the image agrees with the type of landmark shown on the chart (ex. "TOWER"), and shall accurately compile the landmark using the appropriate feature code. The compiler shall enter the full label, as it is shown on the largest scale chart, into the Information field of the compiled landmark, <u>using all uppercase letters</u>. If a charted landmark's label or position does not match the feature in the image, then the compiler shall compile the landmark with the correct position and attributes, and shall make a notation in the Chart Evaluation File (CEF) indicating that the charted position or label is incorrect. When a label is incorrect, the compiler should enter a suggested new label into the Information field that appropriately describes the feature. For any landmarks not found, the compiler shall add an appropriate notation to the CEF. This allows landmarks that no longer exist to be permanently removed from the chart.

B. NAMES AND DESCRIPTIONS – A charted landmark will have a label with a Primary Name, and possibly a Secondary Name and/or Description as well. The primary name is that most likely to identify the nature of the object for the majority of chart users. The secondary name is an alternate name for the object which may be useful to some marine interests. The description is an explanatory term which elaborates on the primary name. Secondary names and descriptions are enclosed in parentheses.

An example of a primary name with a description could be:

8 GRAIN ELEV (HIGHEST PART)

Or a primary name with both a secondary name and a description:

○ Stack (Flare)
(Westerly of two)

Sometimes when a landmark is both well-known and unusually prominent, the proper name of the object may be shown as the primary charting name:

EMPIRE STATE BLDG

But in general proper names are usually only used as secondary names:

BUILDING (RITZ TOWER)

C. ACCURACY, SYMBOLS, AND LABELS – There are three levels of positional accuracy associated with charted landmarks (Accurate, Approximate, and Inexact). These accuracy levels are represented on the nautical chart by the symbology and labeling of the landmark features.

i. Accurate Position – A Landmark that has a positional accuracy within 10 feet (3 m.) of its correct geographic location is symbolized on the chart by an encircled dot, and it is labeled using all uppercase lettering, as in the following example:

8 STACK (TALLEST OF THREE)

ii. Approximate Position – A Landmark that has a positional accuracy within 100 feet (30 m.) of its correct geographic location, but does not meet the specifications for an Accurate Landmark, is symbolized on the chart by a small (1 mm) open circle, and it is labeled using uppercase for the first letter and lowercase for the rest of each word (title case) in the primary and secondary names. Only the first letter of the first word would be capitalized (sentence case) for any parenthetical description labels, as in the following example:

○ Radio Tower (Center of five)

iii. Inexact Position – An object located with less accuracy than that required by the "Approximate" specification (but normally better than 300 feet) is usually not charted unless it is determined to meet a critical need. If shown, an Inexact Landmark is symbolized in the same manner as an Approximate Landmark, but the abbreviation "PA" is included in the label to emphasize the object's weak positional accuracy, as in the following example:

○ Tank PA

D. UPGRADING LANDMARKS – If the compiler locates a landmark in the imagery that is shown on the chart with an Approximate or Inexact position symbol, the compiler shall accurately compile the landmark, and enter the full charted label into the Information field <u>using all uppercase lettering</u>. This will indicate to the NOAA chart compiler that the symbology and label of that landmark need to be upgraded to the "Accurate Position" type.

E. RECOMMENDED LANDMARKS – In areas within the project where the nautical charts show few or no landmarks or navigational aids, and a prominent feature is identified in the imagery that would be of landmark value to the mariner, it may beneficial to compile the feature as a Recommended_Landmark. In general the charts already include sufficient landmarks, and the compilation of new Recommended Landmarks is usually not necessary or desirable.

i. Selection – Prominence is the first requisite for a landmark. Landmarks selected for charting should be visible over a large area from the sea and should be easily identifiable. Because ease of positive identification is also important, an unusual or unique feature may qualify as a landmark because it is easy to identify even if it is not particularly prominent. Radio towers and stacks are most useful for this purpose as they are not only good daytime references but their flashing red and strobe lights can be seen for long distances at night.

ii. Type And Label – The compiler shall encode any Recommended Landmarks using the most appropriate feature type from the list in C-COAST. See the Glossary in Attachment F for definitions of the various landmark types. The compiler shall enter a suggested new label into the Information field (using all uppercase lettering) that appropriately describes the recommended landmark feature. For Water Tower landmarks use “TANK” for the recommended label. Never use abbreviations in recommended landmark labels.

iii. Spacing – Dense spacing of landmarks is neither useful nor desired. For example, many smoke stacks all close together and plotted as landmarks would be very difficult for the mariner to identify individually. The selection of a few easily identifiable stacks with appropriate descriptors may be more useful to the mariner than the charting of many closely spaced stacks. The same is true of radio towers.

iv. Features To Avoid – Temporary and moveable structures shall not be recommended as landmarks. These might include: cranes used for construction, exploratory drill rigs, or dredges. Signs and signboards, in general, do not make good recommended landmarks. However, an unusually conspicuous sign, especially in an area devoid of other suitable landmarks, or signs supplying navigational information may be considered as landmarks.

F. GENERAL COLLECTION – Landmarks are normally compiled at the most prominent point of a feature, usually the center of the highest point. With some features, such as tall thin towers or masts, it can be difficult to see the very top. In such a case the compiler should collect the point as close to the top as can be accurately measured. Sometimes, especially for features with open lattice construction like radio towers, it is easiest to center the compilation cursor on the feature at ground level, and then raise the elevation (Z) of the cursor to as close to the top as can be seen. Landmarks are usually on land, but they are occasionally charted in the water. For a landmark in water, the structure might be thought of as an obstruction, but in this case the Landmark feature class takes precedence, and an Obstruction_Point feature would not be compiled.

5.7. AID TO NAVIGATION – See the Glossary in Attachment F for definitions in this class.

A. AUTHORITY – The waters of the United States and its territories are marked to assist navigation by the U.S. Aids to Navigation System. This system employs a simple arrangement of colors, shapes, numbers, and light characteristics to mark navigable channels, waterways, and obstructions adjacent to these. The United States Coast Guard (USCG) is the principal authority for the establishment and maintenance of this system. Complete information concerning aids and their characteristics can be found in the USCG Light List publications. See SOW Main Section 3.6 for a link to on-line copies of the Light Lists. An aid to navigation (ATON) which is not established and maintained by the USCG or an equivalent authority (private aid) is identified on the chart by the label "Priv".

B. REQUIREMENTS – Daybeacons and fixed lights (both public and private) shown on the charts that can be clearly identified in the project imagery shall be compiled. Floating aids (e.g. buoys) shall not be compiled. The purpose of the requirement to compile ATONs in coastal mapping projects is simply to verify the existence and position of fixed aids that are already shown on the nautical charts. The nautical charts and the USCG Light Lists shall be the principal sources used to determine if a feature seen in the imagery is an ATON. Aerial imagery alone is not sufficient for the identification of most ATONs, therefore the compiler shall not attempt to compile any new ATONs that are not already shown on the chart or in the Light List. If the compiler strongly suspects that a feature in the imagery is an uncharted fixed light or daybeacon (or fixed channel marker, sign, etc.), then it may be collected as a Freestanding Marine Feature with "Possible new light" or other description entered into the Information field.

C. CHART SYMBOLS – Fixed lights are charted as a standard 0.7 mm black dot with an accompanying teardrop shaped magenta flare. Daybeacons are charted as either small triangles or squares, which may be green or magenta filled (corresponding to green or red daymarks), or open with no fill color (for daymarks of other colors). Daybeacons in the Intracoastal Waterway may be colored yellow. All ATONs are also labeled on the chart with identifying characteristics (e.g. name, color, height, etc.). See U.S. Chart No. 1 and the USCG Light List for further explanation and depictions of the symbology and labeling of ATONs on nautical charts.

D. AERONAUTICAL LIGHTS – Navigational aids for aircraft are occasionally shown on nautical charts. When they are visible from the water they make can useful aids for marine navigation as well. Aeronautical beacons are usually located on a high structure at an airport, and will be shown on the chart using the standard fixed light symbol, and the label "AERO". Additional characteristics, such as the light color, may be in the label as well. Aeronautical Lights shall always be compiled using the Marine_Light__Tower code, with "AERO" entered into the Information field (other characteristics of the light should not be entered).

5.8. CULTURAL FEATURE MISCELLANEOUS – There are many man-made features in the coastal area (in the water, over the water, or on land) that may be useful for, or an impediment to safe marine navigation. Those cultural features that are typically shown on the nautical chart, but cannot be categorized in any of the other feature classes, shall be compiled using the various feature types in this class.

A. BUILDING – Most buildings visible in aerial imagery should not be compiled, with a few notable exceptions (see below). Those that are compiled should be delineated as accurately as possible around the top edge (roof line) of the building, snapping the beginning and end points together to form a closed polygon. If a significant building depicted on the chart appears in the imagery to have been torn down, modified, or replaced, then the new or modified building(s) – if any – shall be compiled, and the compiler should make an appropriate notation in the CEF.

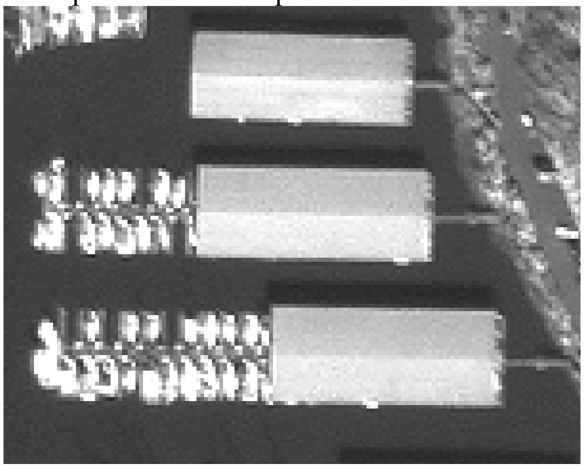
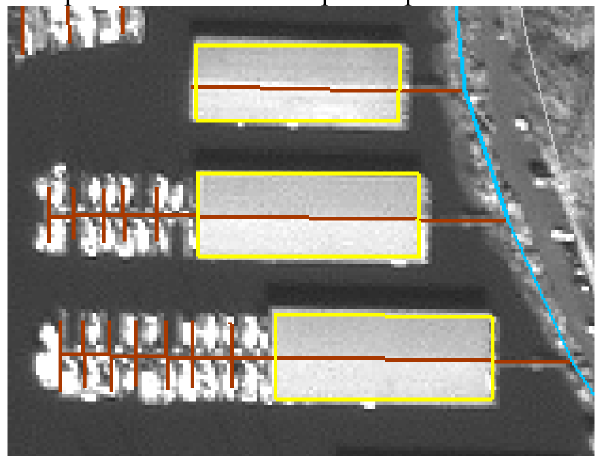
i. Minimum Size – Under no circumstances shall any building with its longest dimension less than 0.5 mm long at the compilation scale be compiled.

ii. Large Buildings – Large prominent buildings close to the shoreline of navigational significance should be collected, especially if they are already depicted on the nautical chart. In developed areas most buildings along the shoreline are not navigationally significant and should not be compiled; the compiler will use their judgment as to which, if any, buildings to collect. Buildings that are known hospitals should be labeled "Hospital" in the Information field.

iii. Small Buildings – Small buildings such as houses are rarely collected, except in remote areas devoid of other objects of landmark value. But even so, only the most prominent small buildings that are visible from the water and which fulfill the minimum size requirement should be considered.

iv. On Piers or Over Water – All buildings constructed on piers or over the water (up on piles), and that fulfill the minimum size requirement, shall be compiled. Often these structures are built to cover boat docking facilities, in which case the feature should be compiled as a building with one of the following entered into the Information field:

- "Boathouse" – this type of structure typically has walls and a large door, similar to a garage for boats, with the capacity to house 1-2 boats.
- "Covered slip" – this structure is usually nothing more than a roof held up by corner supports, with no walls, sheltering a single boat slip or dock.
- "Covered slips" – if numerous slips are covered, there is often a network of piers underneath, which cannot be seen; but usually the main/central pier can be assumed to follow a straight line along the middle, and should normally be compiled as in the example below:

Example of covered slips in IKONOS	Compilation of covered slips and piers
	

Other regular buildings on piers or over the water that do not cover boat slips are not required to have any special nomenclature entered into the Information field. Note that boathouses are not the same as houseboats. Boathouses are used to shelter docked boats and are permanently fixed to the shoreline or to a pier. Houseboats (also called floating homes) are considered to be vessels that can be driven or towed to another location, and they shall not be compiled.

B. TANK – These features are usually either the more common cylindrical shape for storing liquids such as water or petroleum, or the less common hemispherical shape for storing gases. Compile the outline of cylindrical tanks at the top, and compile hemispherical tanks at their widest part, which is generally at the ground. As with buildings, only prominent navigationally significant tanks visible from the water should be compiled. Some tank farms along the shoreline can be quite large, so the compiler should use his or her judgment as to which tanks to collect. No tank with a diameter less than 0.5 mm at the compilation scale shall be compiled.

C. SILO – A silo, being cylindrical, may appear similar to a tank, but it is generally much taller than it is wide, and often has a domed roof. A silo should generally be a distinct and separate feature. If a silo is part of a connected array of silos then the entire structure should be compiled as a grain elevator (see below), rather than a group of individual silos. Compile silos only if they are prominent and visible from the water, and at least 0.5 mm in diameter at the compilation scale. They should be delineated at the widest part just below the domed section.

D. WATER TOWER – (section deleted)

E. LEVEE OR DIKE – These two terms are considered synonymous in the Coastal Mapping Program. These features appear as regular narrow linear ridges, generally running parallel to the shoreline. They are usually found in areas of relatively flat topography that are naturally subject to seasonal flooding, especially around marshes and along inland waterways. They typically rise at least 2 meters above the surrounding terrain, though older or poorly maintained levees may be heavily obscured by overgrown vegetation. Charted levees that are visible in the imagery should be compiled. Uncharted levees should only be compiled if they are navigationally significant. Levees shall be delineated as a single line along the top center of this feature. Roads, walls, or fences are sometimes constructed along the top of a levee. In such a case the levee feature shall be compiled, and the other features omitted. A causeway is not considered a levee, and should simply be compiled as a road or railroad (see 5.9 below).

F. CABLE – Cables in this category include power and communication wires and support cables (including guy wires) not involved in the transport of people or materials. There are two types of cable, overhead and submerged.

i. Overhead Cables – All cables suspended above the ground that cross or run along the shoreline, or that cross any charted waterway, including single-line streams, shall be compiled as Cable__Overhead. The entire portion of a cable over water shall be compiled to the shore, and continued landward a minimum of 3.0 mm at the compilation scale, at least to the first supporting structure. A continuous cable that alternately crosses over the water and land in multiple places should be compiled as a continuous feature, rather than broken into disconnected segments. Cables that are completely over the land, and do not cross over any charted waterway or stream, shall not be compiled. Cable supporting structures that are in the water shall be compiled as piles, obstructions, or landmarks, as appropriate. Supporting structures on the land shall only be compiled if already charted. Cables are compiled at their actual elevation, normally as a single line with vertices collected at the top of each support. A group of closely spaced parallel cables should be generalized to a single line in the middle of the group. Cable lines may split, cross, and converge, but parallel cables should not be collected with less than 0.5 mm separation between them at the compilation scale.

ii. Submerged Cables – Submerged (or submarine) cables may interfere with marine navigation or may be damaged by a vessel or anchor. The submerged portion of a submarine cable usually cannot be seen in aerial imagery, unless the water is exceptionally clear. But sometimes the cable can be seen where it emerges from the water and crosses the shoreline. As much of a submarine cable as can be seen in the water, and a short length on land, shall be collected as Cable__Submerged, so long as the compiled line extends at least 1.0 mm seaward of the shoreline at the compilation scale.

G. GENERAL TRANSPORT – General transport has three categories: ferry cable, aerial cable, and conveyor belt. These features involve the transport of material and/or people. Ferry cables are hazardous to other vessels, and are often visible at or near the surface of the water, though they may be submerged. Ferry cables shall be compiled wherever they are seen. Aerial cables and conveyor belts shall be compiled only if and where they cross over the water, and for a short distance landward. If these features connect to another compiled cultural feature (such as a building, tank, silo, or grain elevator) then they should be collected over the land to the other connected feature. A general transport feature should be collected as a single line at its actual elevation. As with cables, the lines may split, cross, and converge, but a group of parallel features spaced closer than 0.5 mm should be generalized to a single line in the middle of the group.

H. GRAIN ELEVATOR – This feature is generally very tall, and is comprised of several cylindrical structures (similar to silos) grouped in an array. It will usually have one or more conveyor belts leading from the top of the structure, and connecting different parts of the structure. Compile a grain elevator in a similar manner as a building, delineating the outer edge of the top. If there is evidence that the elevator is not used for storing grain, but rather for some other dry bulk material (such as cement), then the Grain_Elevator attribute should still be used, but the compiler should enter "Cement elevator", or some similar note into the Information field.

I. PIPELINE – There are two types of pipelines: Overhead and Submerged_Or_Surface. A single pipe can have portions of it compiled as either subcategory, since a pipe could be overhead and then go below the water. Pipelines are generally compiled in the same manner as cables in section F above. Pipelines that are completely over the land, and do not cross the shoreline, shall not be compiled.

J. DAM – A dam is typically a barrier to navigation, therefore it is usually not required to compile any shoreline behind a dam, unless the shoreline has changed significantly from that shown on the chart, or the area behind the dam is used for marine navigation, as indicated by the presence of boats, piers, etc. in the imagery. A dam narrower than 0.5 mm at the compilation scale shall be collected as a single line down the middle of the feature. A wider dam shall be compiled as a closed outline at its actual size and shape. A dam line cannot substitute for shoreline. Where the face of a dam compiled as a closed outline meets the shoreline, both features shall be compiled as congruent lines. Normally the shoreline feature code Bulkhead_Or_Sea_Wall should be used. A compiled road that runs along the top of a dam should be continued unbroken over the dam feature.

K. FORT – Many charts have forts of historical significance that were built near the shoreline, especially at harbor entrances. All non-active forts shall be compiled in a similar manner to buildings. If the name of the fort is known then it should be entered into the Information field. See Section 4.1.A regarding restrictions on feature compilation in active military installations.

L. FENCE OR WALL – Fences and walls shall only be compiled if they extend at least 0.5 mm into the water or if they are particularly large and prominent. If a fence or wall crosses the shoreline, then a short length on the landward side should be collected as well. A fence or wall shall be collected as a single line along the top center of the feature.

5.9. TRANSPORTATON – See the Glossary in Attachment F for definitions in this class.

A. ROAD – Generally only major public highways within 2000 feet of the shoreline, and roads leading from highways toward the shore, need to be compiled. In urban areas with numerous roads and highways, only the first major hard surface road that runs parallel to the shoreline, and other significant roads leading from the major road toward the shoreline, need to be compiled. Compiling a dense network of roads is not acceptable, and at no time shall two parallel roads be compiled within 0.5 mm of each other at the compilation scale. In remote areas, where few roads exist, usually most of the roads within 2000 feet of the shoreline would be considered important enough to compile, but this determination shall be left up to the compiler's judgment. All roads leading to bridges and boat ramps shall be compiled. A small undivided road shall be delineated as a single line along the centerline of the roadway. Larger roads with a median separating the lanes of traffic moving in opposite directions, shall be delineated with a line along the center of each set of lanes of the same traffic direction, so long as the two lines are at least 0.5 mm apart. Even very wide roads with many lanes in each direction are collected with only two lines, one for each set of lanes in the same direction. A road passing under another road (overpass) or bridge shall continue unbroken beneath the other feature. A road leading to a bridge shall not be compiled over or on the bridge, but shall stop at (and snap to) one end of the bridge, and start again on the other side. On the other hand, a road leading toward a boat ramp is not required to continue all the way to the ramp, and it does not need to connect (snap) to the shoreline. To provide topological continuity, connecting roads should snap to each other at their intersections. Roads under construction should generally not be compiled.

B. ROAD PATH – A non-hard surface road often used for light vehicle traffic. A path should only be compiled if reasonably considered to be of importance to the mariner, such as if it leads to a boat ramp, or in remote areas where there are few (if any) hard surface roads. In such situations paths would be delineated using the same general rules as roads (see 5.9.A above).

C. RAILROAD – All charted railroads and other major railroads shall be compiled at least to the 2000 foot compilation limit, and possibly farther if the same railroad comes closer to the shoreline again farther down the line. It is up to the compiler's judgment to determine which railroads are "major", but generally the closer a rail is to the shoreline, the more important it is to compile. All railroads that lead to bridges and marine facilities shall be compiled. A railroad leading to a bridge shall stop at (and snap to) one end of the bridge, and start again on the other side. Urban subway, light-rail, and streetcar tracks shall not be compiled unless charted, or they lead to a bridge or marine facility. Railroad lines shall be delineated as a single line along the center of the track halfway between the two main rails. Parallel railroad lines shall not be compiled within 0.5 mm of each other at the compilation scale. If there are two railroads closer than this limit, one should be collected and the other ignored. If they start farther apart, and then come together within the 0.5 mm limit, select one to continue, and merge the second one into the first. If there are multiple parallel railroads, show the outermost railroads, and as many interior railroads as are judged important enough to collect, so long as they are not within 0.5 mm of each other. A railroad yard shall be collected in a similar fashion, delineating only the outer perimeter railroads, and whatever interior railroads are judged necessary in order to provide cartographic continuity with the lines entering or leaving the yard.

D. RAILROAD ABANDONED – Abandoned railroads are those that are no longer in active use. Sometimes they may be identified by the presence of vegetative growth or other debris on the tracks, or by areas where the tracks have been removed or paved over at road crossings.

Abandoned railroads are compiled in a similar manner as active railroads, but only if they are already charted and are visually prominent.

E. RUNWAY – Runways are delineated as a closed outline around the outer edges of the runways themselves. Multiple intersecting runways should be compiled as a single outlined area. Taxiways, and other aircraft movement areas that are not used for takeoffs and landings, should not be compiled. Only paved runway systems immediately adjacent to the shoreline shall be compiled.

F. HELICOPTER PAD – (section deleted)

G. TUNNEL ENTRANCE – When a road or railroad that is being compiled enters a tunnel, the road or railroad feature shall be ended. The tunnel entrance shall be compiled as a single line across the roadway delineating the headwall and wing walls in their actual size and configuration. The endpoint of the road or railroad shall connect (snap) exactly to the tunnel entrance. Tunnel entrances that are not associated with compiled roads and railroads shall be ignored.

5.10. NATURAL FEATURE MISCELLANEOUS – There are many natural features on coastal lands that may be useful for marine navigation. Those natural features that are typically shown on the nautical chart, but cannot be categorized in any of the other feature classes, shall be compiled using the various feature types in this class.

A. WETLANDS – A wetland area is classified as one of two categories, marsh/swamp or mangrove/cypress. On the nautical chart these areas are shown with a dashed outline and an identifying label: Marsh, Mangrove, Swamp, or Cypress. Marsh areas have a green tint, while the other types of wetlands are charted with a gold tint. Pictorial marsh or mangrove symbols may also be used. See section 5.1.E.i above for interpretation guidance of the different types. The landward extents of a wetland area shall be delineated using the Marsh_Or_Swamp__Extent or Mangrove_Or_Cypress__Extent feature codes. This line shall follow the boundary between the wetland area and the higher dry ground bordering it, or between two wetland areas of different types. In the latter case, both extent codes (Marsh/Swamp and Mangrove/Cypress) shall be used to delineate the common border of the adjacent wetlands as two coincident lines. The wetland extents line(s) shall connect exactly (snap) to the endpoints of the corresponding apparent shoreline feature, to form a closed polygon. Wetlands that do not connect directly to the shoreline generally need not be compiled, unless charted. If the wetland area is just a sliver along the shore, and does not extend at least 1.0 mm inland (at the compilation scale) from the shoreline, then the wetland shall not be compiled (see section 5.1.E.iv). If the wetland area extends inland beyond the limit of compilation, then the wetland polygon would be cut short, and closed off using a Cartographic Limit line.

B. GLACIER EXTENT – The inland extent of a marine glacier shall be delineated using the Glacier_Extent code. This extent line shall always be paired with a line where the glacier meets the sea, compiled as Glacier in the Shoreline class (see 5.1.I above), snapping to its endpoints and forming a closed polygon. Often the glacier will extend inland beyond the 2000 foot limit of compilation, in which case the glacier extent lines should be cut short and the polygon closed off using a Cartographic Limit line. Land-locked glaciers, which do not have a face meeting the sea, shall not be compiled.

C. CLIFF/BLUFF – See the glossary in Attachment F for a definition of this feature. Technically, the feature is considered a Bluff if it is not rocky and a Cliff if it is rocky, but in the Coastal Mapping Program the two terms are synonymous. The slope should be very sharp and conspicuous. Cliffs and Bluffs are useful to the mariner as a locating reference, especially where they alternate with low-lying coast along the shoreline. The Cliff/Bluff line should be compiled as a single line along the top edge of the slope. Ideally there would be a sharp change in the slope of the land (from mostly vertical to mostly horizontal) at this line, but in reality the slope often changes somewhat gradually, and it is difficult to determine exactly where the line should be placed, especially if there is heavy tree cover. The compiler should use his or her judgment to decide approximately where along the top of the slope the Cliff/Bluff line would appear from the mariner's perspective. It should be noted that the Cliff/Bluff line is not a contour line. The elevation will often change up and down along the edge, and the line will frequently disappear and reappear.

D. STREAM – The two stream type codes (intermittent and perennial) shall be used to depict single-line streams only, that is streams less than 0.5 mm wide at the compilation scale. Streams that are connected to the shoreline, and are at least 0.5 mm wide, are considered to be shoreline themselves and shall be compiled using an appropriate code in the Shoreline class. Use of the Stream code in the Natural_Feature_Miscellaneous class is not required, and is, in fact, discouraged for most projects. However, there are exceptions. Normally, small bodies of water that are not connected by a navigable waterway to the coastline need not be delineated <u>unless</u> they contain mappable marine facilities. Therefore any small, disconnected water bodies that <u>do</u> contain mappable facilities should be delineated, and if they connect to the shoreline via a narrow (single-line) stream, this code should be used to depict the stream. Another exception is often applied in remote areas (especially in Alaska), where a narrow stream running down to the shoreline may be used to help define the nature of the coastal zone or to aid in orientation. A stream should generally be compiled as a continuous line, and should not be broken, even when delineated under a possibly obscuring bridge.

E. RAPIDS AND WATERFALLS – Rapids and waterfalls shown on the chart can indicate the limit of the navigable portion of a waterway, or when visible from the sea, they can be useful points of reference to the mariner, especially in remote areas. Visible rapids and waterfalls on wide compiled rivers and streams shall be indicated by collecting a line in the water perpendicular to the stream, snapping to the banks, using the appropriate feature code. For single-line streams the rapids/waterfall line shall be drawn 1.5 mm in length at the compilation scale, perpendicular to and centered on the stream. For sharply dropping waterfalls with a horizontal extent in the direction of the stream flow that is less than 1 mm at the compilation scale, a single waterfall line is sufficient. For rapids and waterfalls extending farther (at least 1 mm) along the length of the river or stream, two lines shall be delineated across the water: one indicating the upstream extent of the turbulent area, and another indicating the downstream extent. When these two lines are used to indicate the upper and lower extents of a rapids or waterfall area, the portion of the shoreline or stream vector(s) lying between the two lines shall have the term “Rapids” or the term “Waterfall” entered into the Information field.

F. SAND DUNE – Sand dunes, due to their shifting nature, are normally not compiled. But in some areas, large, prominent, and relatively stable sand dunes may be a useful reference to the mariner and may be compiled. The compiler should delineate sand dunes only when they are very high (at least dozens of meters) and extensive. If collected, the extent of the sand dune area shall be outlined as a closed polygon.

G. LAVA/LANDSLIDE – Prominent landslides and lava flows often show up as scars on an otherwise vegetated terrain. When charted, these features can be useful as orientation references for the navigating mariner, as they can often be identified from a significant distance away. All charted and new landslide and lava flow areas, that are visible from seaward, shall be delineated as closed polygon features.

H. MORAINE – (section deleted)

5.11. DANGER AREA – This class includes various features of the natural environment that are hazardous to navigation, and are compiled as areas rather than discrete points. Note that application of all compiled danger area limits to NOAA nautical charts will usually result in any soundings and depth contours that are within the danger area limits being removed from the chart as an indication to the mariner that the area is too hazardous for navigation. Therefore, danger area limits should not be compiled lightly, without careful consideration of the impact on the charted bathymetry.

A. FOUL – Rocks, boulders, coral heads, and various other features can pose a danger to navigation and should be compiled. Where individual dangers to navigation are too closely spaced (at the compilation scale) to be compiled as separate features, then a foul line should be compiled around the area. The longest dimension of a foul area must be at least 1.0 mm long, and the furthest extent of a foul area must be at least 1.0 mm from the shoreline at the compilation scale in order to be compiled. A foul area adjacent to the shoreline shall be delineated as an open outline with its end points snapped to vertices on the shoreline (or ledge/reef/MLLW if it exists). Foul areas shall never cross or be delineated within compiled ledge/MLLW areas. Foul areas disconnected from the shoreline, or surrounding a reef or island, shall be delineated as a closed (snapped) outline. Within a foul area particularly prominent dangers may be compiled if their individual depiction would be useful to the mariner, especially if they are already charted, but usually just outlining the area with a foul line is sufficient. All foul lines shall have the type of obstruction indicated in the Information field, using *only* the following valid terms: Rocks, Kelp, Piles, Ruins, Trees, Stumps, Snags, or Other. If Other is used, additional descriptive text shall be entered, e.g. "Other – Aquaculture pens". Furthermore, the above valid terms may be used in combination, e.g. "Rocks and kelp", etc.

B. LEDGE OR REEF – A ledge or reef is a consolidated, rocky formation generally below the level of the shoreline, either extending from the shore or foreshore (ledge) or detached from the foreshore (reef). The seaward limit of a ledge/reef is where the relatively flatter and shallower part suddenly "drops off" steeply into deeper water. See section 4.7 above for guidance on classifying a ledge or reef as Covers/Uncovers or Submerged. The seaward limit of a ledge or reef shall be delineated when the line extends at least 0.5 mm from the shoreline at the compilation scale. High points on ledges or reefs should be compiled as rocks (Bare or Covers/Uncovers) if they protrude significantly above the surrounding formation and are thus of value to the mariner for use as points of orientation. When compiling a ledge area, the ends of the compiled line shall snap to vertices on the shoreline, whereas a reef shall be compiled as closed outline. The longest dimension of a reef must be at least 0.5 mm at the compilation scale. A reef smaller than the minimum size shall be compiled as a rock or coral head. The compiler should collect ledges and reefs from the imagery acquired closest to the sounding datum (usually MLLW) to depict the largest extent of the features.

C. REEF – (section combined with LEDGE above)

D. WRECKAGE – Usually wrecks should be compiled as individual features in the Obstruction class, but if an area contains numerous closely-spaced wrecks or pieces of one or more broken/scattered wrecks, then it should be compiled as a Wreckage area. A wreckage area directly adjacent to shore shall be compiled as an open outline with endpoints snapped to vertices on the shoreline. A wreckage area detached from the shore should be compiled as a closed outline.

E. SHALLOW OR SHOAL – This attribute is used for an area of unconsolidated material that is submerged (below the sounding datum), but is relatively shallow, and extends at least 1.0 mm from the shoreline at the compilation scale, or if detached from shore, must be at least 1.0 mm long at the compilation scale. Use of this feature type in tidal areas is strongly discouraged, as the MLLW line and other depth contours provide a better indication of the depth of the sea floor. This code is generally only used in non-tidal areas, such as the Great Lakes, or in some back-bay areas where the tide is irregular or undefined, and only when the feature is an impediment to navigation and when there is a significant difference (distinct line) separating the shallower and deeper waters. Shallow or shoal shall not be used as a substitute for Depth Contour (MLLW) lines in tidal areas, even if tide-coordinated IR imagery or bathymetric lidar data are not available.

F. SHOAL – (section combined with SHALLOW above)

G. BREAKERS – Waves breaking immediately along the shore do not in themselves indicate a danger, but an extensive area of breakers farther offshore may indicate an area of shallow/hazardous rocks or shoal. All images that show the area should be examined to be sure the breakers are not caused by wind. If waves are observed breaking in the same location on successive images, a hazardous submerged feature is probably the cause, and the approximate area should be delineated as a closed outline. Breakers on a compiled reef or shoal shall not be delineated.

5.12. AQUATIC VEGETATION AREA – Living vegetation located in the water may be considered hazardous to surface navigation as it may obscure dangerous hazards beneath the water surface, or vessels may become entangled or damaged in densely vegetated waterways. Certain types of aquatic vegetation may also serve as an indicator for possible dangers to navigation such as rocky bottoms. Offshore limits of vegetation areas shall be enclosed to form a polygon. When vegetation areas occur directly adjacent to the shore, only the outer limits extending from the shore need be compiled, with endpoints snapped to vertices on the shoreline or to other compiled features which border vegetation areas. To be considered for extraction, vegetation areas shall measure at least 1.0 mm in the longest dimension at the compilation scale, and shall extend at least 1.0 mm from the shoreline. There are two varieties of aquatic vegetation included in C-COAST, Kelp and Grass. See the Glossary in Attachment F for descriptions.

5.13. CONTOUR – This feature class includes attributes for both bathymetric depth contours and topographic elevation contours. For the NOAA Coastal Mapping Program only depth contours are generally included, and then only the zero-depth contour (representing the MLLW line on the nautical charts) is normally required. Other (non-zero) depth contours and elevation contours shall only be compiled if the contractor is given specific instructions to do so.

In shoreline mapping projects where collection of the MLLW line is required, it is most often compiled from near-infrared (NIR) aerial imagery that was acquired during a window of time when the local tide level was within a small range (tolerance) above or below the MLLW tidal datum. Alternatively, the MLLW line may be derived by extracting the zero-depth contour from high-resolution aerial bathymetric lidar data. When either of these methods are used, the compiled line will normally meet the accuracy requirements for a surveyed MLLW line (depicted on the nautical charts as a line of black dots defining the seaward edge of the foreshore), and the attribute Depth_Contour should be used.

If the collection of a MLLW line is required, but the compiler judges that the usual accuracy requirement (within 20 meters of its true position) cannot be achieved, perhaps due to the image being obscured by long shadows, or if the image was collected when the tide level was slightly outside of the acceptable tolerance, then the MLLW line should be compiled using the Depth_Contour__Approximate attribute.

The Depth_Contour and Depth_Contour__Approximate attributes shall only be used to delineate MLLW lines in areas with “soft” bottom characteristics (i.e. sand or mud) or around man-made features sloping gently into the water, such as breakwaters and jetties. Where the MLLW line corresponds with “hard” consolidated seabottom, the Ledge_Or_Reef__Covers/Uncovers attribute should be used instead. A MLLW line shall only be delineated when the furthest extent of bare ground exposed at low tide is at least 0.5 mm from the shoreline at the compilation scale. Narrow, fringing, low-water areas that never extend more than 0.5 mm from the shoreline, shall not be compiled. Depth contours which come together in a roughly parallel manner to form narrow channels shall not be compiled beyond a point where opposing contours become less than 0.5 mm apart at the compilation scale, and contours which form separate areas less than 0.5 mm apart at compilation scale shall be aggregated to form larger areas. The endpoints of a MLLW line shall be snapped to vertices on the shoreline or other compiled features to clearly and unambiguously indicate the extent of the foreshore area.

All compiled depth contour lines must have the depth value entered into the Information field. For the zero-depth contour, this should be “MLLW”. If other (non-zero) depth contours are required, the project instructions will define how the depth values should be entered.

5.14. VERTICAL MEASUREMENT – Feature codes in this class shall only be used if the contractor is given specific instructions to do so.

5.15. CARTOGRAPHIC LIMIT – Features in this class will not be used to update the nautical chart, but are compiled simply to provide the user of shoreline data an indication of the geographic extent of the other compiled features, and of the source imagery from which the features were compiled. No features either part or whole, may be compiled beyond the outermost Cartographic Limit line(s), which, combined, should form a closed polygon around the perimeter of a project area. Features compiled up to a Cartographic Limit line shall connect (snap) to the line.

A. FEATURE LIMIT – Large polygon features on the land (marshes, glaciers, etc.) within the extent of the source imagery, yet extending well beyond the 2000 foot limit for compilation, shall not be compiled significantly beyond that limit to prevent the unnecessary delineation of irrelevant detail. Where these polygon features are cut short, the compiler shall use a Feature Limit line to close off the polygon. The endpoints of this artificial limit shall be coincident with (snapped to) the endpoints of the polygon feature which it completes. A Feature Limit line shall also be used to delineate the designated boundary of a sub-project area, where the source imagery of the larger acquisition project extends beyond the sub-project area currently being compiled.

B. LOW VISIBILITY LIMIT – When smoke, clouds, or other degradations in imagery limit or prevent the ability to successfully delineate features; the compiler shall enclose the problem area with a Low Visibility Limit line. The endpoints of this line shall coincide to form a closed polygon, or, if at the boundary of the sub-project area or at the limit of source imagery, the endpoints shall connect (snap) to the other respective Cartographic Limit line. No other features shall be compiled within the extent of a low visibility area.

C. SOURCE DATA LIMIT – The compiler shall delineate the limits of stereoscopic neat model coverage using a Source Data Limit line, thus defining the full geographic extent of a project. If multiple imagery types (color, IR) are used in a project and the extents of coverage significantly differ between the different types, then further Source Data Limit lines shall be used to delineate the limit(s) of each imagery type.

Notice – all items highlighted are changes from previous versions of this SOW

November 2017

ATTACHMENT L

PROJECT COMPLETION REPORT

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

TABLE OF CONTENTS

ATTACHMENT L: PROJECT COMPLETION REPORT

1. INTRODUCTION – A Microsoft Word format document shall be required. NOAA will forward the report to the agency archives. References to individuals by name should be held to a minimum when completing the Project Completion Report (PCR). General references to organizational units should be made in lieu of names of personnel. For contracted projects, the company name may be used in lieu of operational units within the company.

In all sections of the PCR, discuss any unusual circumstances and any deviations from the Project Instructions, the Supplemental Instructions, or normal hardware and software operations.

2. GENERAL REQUIREMENTS – Final review personnel, whether contractor or agency, shall have overall responsibility for the content and assembly of the PCR. The designated project final reviewer shall have access to the original documents in all phases of the project so that accurate summaries are included in the PCR. Submit the PCR after all other work is completed.

3. PROPER SEQUENCE OF ASSEMBLY – The sequence of topics, as they apply, shall be as follows:

Introduction
Project Design
Field Operations (aerial aquisition and ground surveys)
Data Processing (GPS/IMU, lidar, etc.; subsections by data type if applicable)
Aerotriangulation
Compilation
Quality Control / Final Review
End Products and Deliverables

4. SPECIFIC REQUIREMENTS

4.1 REPORT HEADING – The heading shall consist of the following: First line - **NOAA COASTAL MAPPING PROGRAM**; Second Line - **PROJECT COMPLETION REPORT**; Third line, **PROJECT LLYYNNA-TT-S** where "LLYYNNA-TT-S" is the Project Identifier from the Project Instructions. The fourth line of the report heading shall consist of the project name, taken from the project instructions. Project naming includes locality of the project and the state. See the sample PCRs, included as Annexes.

4.2 INTRODUCTION – The introduction section should provide a general description of the location of the Geographic Cell (GC), referring to selected ports, water bodies, or other major geographic features within the project to help the reader locate the project. If the project is a subproject of a larger project, this should be indicated. An overview of the project's purpose is also required.

4.3 PROJECT DESIGN AND PLANNING – This section shall consist of a general synopsis of the project planning phase, including an indication of the party/organization responsible for planning the project, the reason the project was planned, and a description of instructions issued for project data acquisition. Include a description of any unique or unusual circumstances impacting project design, requirements, and/or execution.

4.4 FIELD OPERATIONS – Field operations consist of two distinct functions: ground surveys and the aerial mission. The narrative for this section should state what the field operation consisted of, e.g., recovery and/or establishment of horizontal control, aerial acquisition, or both, as well as responsible party/organization. Specify dates when field operations were conducted (month/year). Discuss the data acquisition methodologies, the types of data collected, and equipment used. If the project imagery all has the same ground sample distance (GSD), the value shall be provided in this section rather than the Image Sources table. If the project is a subproject of a larger acquisition project, differentiate data used specifically for the subproject from the overall acquisition. This section should also describe any unique or unusual circumstances during field operations which have impact upon project methods and/or final data products.

4.5 DATA PROCESSING – A brief summary of the data processing (i.e. GPS/IMU, lidar, orthophotos, etc.) shall include the following for each type of data processed: responsible parties and dates of processing (month/year), post mission data reduction procedures, equipment and/or software used. References shall be included for all resulting reports further describing processed data (e.g. Airborne Positioning and Orientation Report). This section shall include subsections if multiple data types were processed (e.g. GPS/IMU *and* lidar). A statement giving the horizontal datum and reference system used in the project shall be included.

4.6 AEROTRIANGULATION – This section of the PCR should begin with a broad statement of the purpose and scope of aerotriangulation for this project, as well as describe the procedures and technology used, including hardware and software. Discuss any unique requirements related to aerotriangulating the project. Specify responsible party/organization as well as when this phase was completed. An accuracy statement defining the predicted horizontal circular error at the 95% confidence level shall be included in the summary, along with a description of how the accuracy was determined. Include a reference to the aerotriangulation report if one was written.

4.7 COMPILATION – Specify the responsible party/organization and the date (month/year) of completion of feature data compilation, as well as all hardware, software (include versions), and methods used to compile features and assign attribute codes. Include a standard statement indicating attributional compliance with the Coastal Cartographic Object Attribute Source Table (C-COAST).

An accuracy assessment of all compiled feature data shall be provided in this section of the PCR. Traditionally in the CMP, horizontal accuracy is based on the 95% confidence level, and is derived using a variety of methods, depending on the available ground control as well as how the control is applied (aerotriangulation, 2D georeferencing to control, direct georeferencing, etc.). The method(s) used to derive horizontal accuracy shall be stated.

An Imagery Sources table shall be provided which lists image data sources and provides descriptive information. Imagery sources shall be organized in the table such that each row consists of one flight line/strip (or portion of a line if it was patched), arranged chronologically from earliest (top) to latest (bottom). When color/IR data is acquired in tandem, each single row should present information on BOTH emulsions. The following information shall be included for each flight line: date (mm/dd/yyyy) and time (hh:mm of first and last photo in GMT/UTC) of acquisition, roll number, first/last image numbers (w/strip IDs if rolls not used), scale/GSD if *multiple* values exist in the project, and tide/lake water levels. A footnote shall be included specifying units and reference datum for tide/lake water levels given in the table, as well as which gauges were used in the tide/lake level analysis. The elevation of the Mean High Water (MHW) tidal datum or the lake Low Water Datum (LWD) in the project area shall also be stated.

4.8 QUALITY CONTROL / FINAL REVIEW – Specify when the quality control (QC) review was completed and by whom. Describe the quality control process employed, including analysis of the aerotriangulation results and interpretation/attribution of feature data in the GC. Conclude with a brief description of the evaluation of final GIS data, including assessment of GIS topological connectivity, comparison with NOAA nautical charts and other ancillary data, and creation of the Chart Evaluation File (CEF). List all charts used, providing chart number, name, edition and scale. Include references to any insets used, in particular noting the scale.

4.9 END PRODUCTS AND DELIVERABLES – This section of the report lists final products and their delivery destinations. The major products typically listed are:

Remote Sensing Division Electronic Data Library:

- Ground Control Report
- Airborne Positioning and Orientation Report (APOR)
- Aerotriangulation Report
- Project Completion Report (PCR)
- GIS Project Delivery
- GC##### in shapefile format
- Chart Evaluation File in shapefile format

NOAA Shoreline Data Explorer

- GC##### in shapefile format
- Metadata file for GC#####
- Project Completion Report in Adobe (PDF) format

ANNEX 1

NOAA COASTAL MAPPING PROGRAM PROJECT COMPLETION REPORT

PROJECT NY1409-TB-C

Coney Island to Montauk, New York

Introduction

NOAA Coastal Mapping Program (CMP) Project NY1409-TB-C provides a highly accurate database of new digital shoreline data for a portion of the Eastern Coastline of the United States extending from Coney Island to Montauk, New York. Project NY1409-TB-C is the northernmost part of a topographic/bathymetric lidar mapping initiative to provide updated shoreline data from Winyah Bay, South Carolina to Montauk, New York in the wake of Hurricane Sandy. The Geographic Cell (GC) may be used in support of the NOAA Nautical Charting Program (NCP) as well as geographic information systems (GIS) for a variety of coastal zone management applications.

Project Design

NY1409-TB-C was designed to support:

1) Application of topographic/bathymetric (topobathy) data acquired under the Sandy Supplemental Topo-Bathy project at the National Geodetic Survey (NGS),
2) Chart update activity of the Marine Chart Division (MCD),
3) Bathymetric data assessment by the Hydrographic Surveys Division (HSD).

NGS formulated the Project Instructions for this project following the guidelines of the "Scope of Work, Shoreline Mapping for the Coastal Mapping Program" (SOW), Version 14A, dated October 24, 2012. The instructions discussed the project's purpose, geographic area of coverage, scope and priority; data acquisition, processing, accuracy, and compilation requirements; product delivery and reporting instructions; and contact and communication information.

Field Operations

The field operations for NY1409-TB-C were conducted by Johnson Mapping Inc. personnel and consisted of acquisition of topobathy lidar data, digital aerial imagery, static and kinematic GPS data, and Inertial Measurement Unit (IMU) data. Static GPS data were collected to support aerial data acquisition and processing operations, as well as to assess the accuracy of post-processed lidar data.

Lidar Data Acquisition
The topobathy lidar acquisition was conducted from November 11, 2013 through July 27, 2014 and consisted of a total of 262 lidar acquisition missions for airborne laser point cloud data. Lidar was captured with an approximate nominal point density of ≥ 4 pulses per square meter through the use of the Riegl VQ-820G sensor. The data were collected within a +/- 2 hour time window of the Mean Lower Low Water (MLLW) tide stage at a nominal altitude of 1,000 feet with a 50% swath overlap.

Digital Aerial Imagery Acquisition
The digital imagery acquisition for NY1409 was conducted from April 25, 2014 through June 8, 2014 and consisted of a total of ten flight lines of natural color imagery, tide coordinated within 25% of the Mean Range. Imagery was captured at a nominal altitude of 10,000 feet with a ground sample distance (GSD) of 0.30 meters through the use of Intergraph *Z/I Imaging* large format Digital Mapping Cameras (DMC) with a focal length of 120 millimeters.

Ground Control
A total of 126 ground control points were established in the NY1409-TB-C project area using a combination of traditional static, fast-static, rapid-static, real-time kinematic, and post processed kinematic GPS techniques. Survey field work was performed between November 23, 2013 and June 03, 2014. A Ground Survey Report is on file with other project data within the NGS Remote Sensing Division (RSD) Electronic Data Library.

GPS Data Processing

Acquisition aircraft were equipped with either an Applanix POSAV Model 510 IMU and/or a dual-frequency Trimble BD960 to collect the ABGPS and IMU data. NGS CORS, and several Cooperative CORS stations, were used for base stations on the project, with at least two of these CORS stations being used to process each POSAV dataset to achieve the final photo center locations. The GPS/IMU data was processed by Johnson Mapping Inc. personnel from May-June 2014. For further information refer to the Airborne Positioning and Orientation Report (APOR) on file with other project data within the RSD Electronic Data Library.

Lidar Data Processing

LIDAR point cloud data for all of the areas acquired under the Sandy Supplemental Topo-Bathy project were processed by Johnson Mapping Inc. personnel from January 2014 to September 2015 using the following steps:

1) Riegl RiProcess software was utilized to transform the lidar point cloud into a mapping projection and check the calibration stability.
2) Terrasolid software was utilized for assessing relative and absolute accuracies between overlapping lifts and relative with each lift, initial point cloud classification, editing of the lidar point cloud, and for classification of water surface, erroneous returns, bathymetric surface and bare earth points.

3) Refraction correction was performed through Dewberry's Lidar Processor.
4) Additional QC, point classification, and formatting were performed with GeoCue, Terrasolid, and Global Mapper Software.
5) NOAA VDatum software was used to convert the vertical datum of the lidar points from NAD83 ellipsoid to local MHW and MLLW tidal datums.
6) QTModeler and custom ArcGIS Scripts were used to produce bare earth MHW and MLLW digital elevation models (DEMs) at a 1 meter grid resolution and the extraction and formatting of MHW and MLLW Shoreline Shapefiles.
7) Accuracy Assessment: the lidar point cloud was compared to higher accuracy ground control points to determine vertical uncertainties of the data set, and then compared to the morphologic slope around the derived shoreline at 91,460 sample sites in the project area (63,748 MHW and 27,712 MLLW sites) to determine the uncertainty of the vectors. Based on this assessment:
    a. MHW lidar derived shoreline vectors meet a horizontal accuracy ranging from 1.0 to 2.8 meters at 95% CE,
    b. MLLW lidar derived shoreline vectors meet a horizontal accuracy ranging from 1.3 to 4.2 meters at 95% CE.

The journal article "Lidar-Derived National Shoreline: Empirical and Stochastic Uncertainty Analyses" (2010), published in the Journal of Coastal Research, contains more detailed information, and is on file in the RSD Electronic Data Library.

Aerotriangulation

The overall Sandy Supplemental Topo-Bathy project was divided into two parts for AT purposes: a southern section and a northern section. Project NY1409-TB-C was included in the northern section. The aerotriangulation (AT) phase of the project was performed by Johnson Mapping Inc. from January-March 2015, using digital AT methods to establish the network of photogrammetric control required for the compilation phase. The Intergraph ImageStation Automatic Triangulation (ISAT) software (ver. 6.1) was used to perform automatic point measurements and interactive point measurements of tie points. See the *AT North Report* for the Sandy Supplemental Topo-Bathy project on file with other project data within the RSD Electronic Data Library for more information.

The Root Mean Square (RMS) of the standard deviations in both X and Y directions were calculated and used to determine a predicted horizontal circular error at the 95% confidence level (95% CE) of 0.29 meters for the NY1409 sub-block. Positional data is referenced to the North American Datum of 1983 (NAD 83). Stereo-models were examined and found to have acceptable levels of parallax for mapping purposes.

Compilation

The data compilation phase of this project was completed by Johnson Mapping Inc. in August 2015 and accomplished in two phases: 1) Automated extraction from topo-bathy lidar, and 2) manual extraction using digital stereo imagery.

1) Lidar Shoreline approach: MHW and MLLW shoreline vectors (in shapefile format) for the outer coastline were delineated using the DEMs discussed above (LiDAR processing section) along with a Raster-to-Vector (R2V) script implemented within ESRI ArcGIS 10.2 software. Subsequently, digital orthoimagery and/or stereoscopic imagery were used to review, edit, and attribute the lidar shoreline vectors. The lidar derived shoreline data were limited to terrain features at the land/water interface and did not include engineered, elevated features such as bulkheads, piers, bridges, landmarks, etc. The MHW ("Shoreline") and MLLW ("Contour") shape files were then imported into BAE Systems SOCET SET (SS) software (version 5.6.0), and a Feature Database (FDB) was created.

2) Manual Compilation approach: The manual data compilation phase was accomplished using a Digital Photogrammetric Workstation (DPW), which consists of a stereo-enabled PC-based graphics workstation running the Windows 2007 operating system and SOCET SET suite of digital photogrammetric software (version 5.6.0). The FDB, created above, was populated with additional features compiled using the SS Feature Extraction software module based on imagery analysis of the processed digital images and information extracted from the appropriate NOAA Nautical Charts, the U.S. Coast Guard Light List and other ancillary sources. Feature attribution was assigned in compliance with the Coastal Cartographic Object Attribute Source Table (C-COAST), which provides the definition and attribution scheme for the full range of cartographic features pertinent to the CMP. Selected features were further modified with additional descriptive information to refine general classification. Features compiled using this method meet a horizontal accuracy of 0.6 meters at the 95% confidence level. This accuracy is derived by doubling the 95% CE computed from the AT solution.

The following table provides information on the imagery used to complete this project:

Date	Time (UTC)	Flight Line	Photo ID	Tide Level*
04/28/2014	16:27 – 16:29	30-107	0021 – 0013	0.1 m.
04/28/2014	16:37 – 16:47	30-109	0001 – 0051	0.0 m.
04/28/2014	17:02 – 17:03	30-109	0122 – 0128	0.2 – 0.0 m.
04/28/2014	17:21 – 17:25	30-110	0115 – 0096	0.0 m.
04/28/2014	17:29 – 17:34	30-110	0072 – 0048	0.1 m.
04/28/2014	17:36 – 17:44	30-110	0040 – 0001	0.1 – 0.0 m.

06/07/2014	13:34 – 13:36	R30-107	0012 – 0001	0.2 m.
06/07/2014	13:43 – 13:47	R30-106	0001 – 0020	0.2 m.
06/07/2014	14:11 – 14:14	R30-105	0015 – 0001	0.3 m.
06/07/2014	14:22 – 14:26	30-104	0001 – 0024	0.3 m.
06/07/2014	14:40 – 14:41	30-101	0004 – 0001	0.3 m.
06/07/2014	14:45 – 14:47	30-102	0001 – 0011	0.3 m.
06/07/2014	15:22 – 15:23	R30-108	0004 – 0010	0.3 – 0.4 m.
06/08/2014	12:48 – 12:53	R30-110	0095 – 0073	0.2 m.
06/08/2014	12:57 – 12:59	R30-110	0047 – 0041	0.2 m.
06/08/2014	13:15 – 13:18	30-103	0019 – 0001	0.4 m.

* Water levels are given in meters above MLLW and are based on verified observations recorded by the NOS tide gauges at Sandy Hook, Montauk, and Newport, with time and height offsets applied to discrete tidal zones in the project area. The elevation of the MHW tidal datum along the outer coast in the project area varies between 0.72 – 1.55 meters above MLLW. The “R” prefix for the flight line ID indicates re-flights of lines or portions of lines.

Quality Control / Final Review

Quality control tasks were conducted by Johnson Mapping Inc. personnel, and the final QC review was completed in February, 2016. The review process included analysis of AT results and assessment of the identification and attribution of digital feature data within the GC according to image analysis, using Stereo and Ortho-image data, and criteria defined in C-COAST. The quality control process concluded with an inspection of topological connectivity within the GC using ArcGIS 10.2 software. All project data was evaluated for compliance to CMP requirements.

Comparisons of the largest scale NOAA nautical charts with orthomosaics, natural color photographs, and compiled project data resulted in creation of the Chart Evaluation File (CEF). The following nautical charts were used in the comparison process:

- 12350, Jamaica Bay and Rockaway Inlet, NY, 1:20,000 scale, 60th Ed., Aug. 2011
- 12352, Shinnecock Bay to East Rockaway Inlet, NY, 1:40,000 scale, 35th Ed., Feb. 2016
- 12358, Shelter Island Sound & Peconic Bays, NY, 1:40,000 scale, 21st Ed., Jul. 2011
- 12402, New York Lower Bay – Northern Part, NY, 1:15,000 scale, 12th Ed., Jun. 2012
- 13205, Block Island Sound and Approaches, RI-CT-NY, 1:80,000 scale, 40th Ed., Jul. 2014
- 13209, Block Island Sound and Gardiners Bay, NY, 1:40,000 scale, 27th Ed., May 2014
  Including 1:7,500 scale inset of Montauk Harbor

End Products and Deliverables

The following specifies the location and identification of the products generated during the completion of this project:

Remote Sensing Division Electronic Data Library

- Ground Control Report
- Airborne Positioning and Orientation Reports (APOR)
- Aerotriangulation Report
- Project Completion Report (PCR)
- Project database
- GC11176 in shapefile format
- Chart Evaluation File (CEF) in shapefile format

NOAA Shoreline Data Explorer

- GC11176 in shapefile format
- Metadata file for GC11176
- Digital copy of the PCR in Adobe PDF format

End of Report

ANNEX 2

NOAA COASTAL MAPPING PROGRAM
PROJECT COMPLETION REPORT

PROJECT WA1401A-CM-N

Hood Canal, Port Townsend to Dabob Bay, Washington

Introduction

NOAA Coastal Mapping Program (CMP) Project WA1401A-CM-N provides highly accurate digital shoreline data for Hood Canal, from Port Townsend to Dabob Bay, Washington. This project is a subproject of a larger project, WA1401-CM-N, which covers Hood Canal from Port Townsend to Annas Bay, Washington. The Geographic Cell (GC) may be used in support of the NOAA Nautical Charting Program (NCP) as well as geographic information systems (GIS) for a variety of coastal zone management applications.

Project Design

Photographic mission instructions for WA1401-CM-N were formulated by the Requirements Branch (RB) of the Remote Sensing Division (RSD) following the guidelines of RSD's Photo Mission Standard Operating Procedures. The instructions discussed the project's purpose, geographic area of coverage, scope and priority, image requirements, Global Positioning System (GPS) data collection procedures and guidelines, instructions for data recording and handling, and mission communication protocols. RB created a Project Layout Diagram, flight maps and input files for the aircraft flight management system.

Field Operations

The field operations consisted of the collection of static and kinematic Global Positioning System (GPS) data, Inertial Measurement Unit (IMU) data, and the acquisition of aerial imagery. The tide coordinated photographic mission operations were conducted in July and August 2014 for the Mean High Water (MHW) imagery, and in June and July 2014 for the Mean Lower Low Water (MLLW) imagery, with the NOAA King Air (N68RF) aircraft. Nineteen strips each of color (RGB) and infrared (IR) digital images, at both the MHW and MLLW tide stages, were acquired concurrently with an Applanix Digital Sensor System (DSS) 439 dual camera system at a nominal altitude of 10,500 feet, resulting in an approximate ground sample distance (GSD) of 0.37 meters.

Direct Georeferencing Data Processing

The GPS/IMU data was collected and processed by RSD personnel to yield precise positions and orientations of camera centers for direct georeferencing (DG) of the imagery as well as to provide a control network necessary for aerotriangulation. A local GPS base station was established for use as a reference station for kinematic GPS processing operations. The position of the base station was determined using the NGS Online Processing User Service (OPUS), which computed fixed baseline solutions from nearby CORS stations. The kinematic GPS data was processed using Applanix POSPAC (ver. 6.2) software in July, 2014 for MLLW imagery and August and September, 2014 for MHW imagery. For further information refer to the Airborne Positioning and Orientation Reports (APOR) on file with other project data within the RSD Electronic Data Library.

The processed GPS/IMU data were used to derive precise exterior orientation (EO) values of the camera centers suitable for digital feature extraction. The predicted horizontal accuracy of the imagery was determined by propagating sensor EO and image measurement uncertainties through the photogrammetric collinearity equations using the Exterior Orientation Total Propagated Uncertainty (EO-TPU) tool developed by NGS. Using this tool, the predicted horizontal uncertainty at the 95% confidence level for all project imagery was calculated to be 1.5 meters. NGS third-order geodetic control was used to verify the horizontal integrity of the directly georeferenced (DG) data. All stereo models were examined and found to have acceptable levels of parallax for mapping purposes. All positional data is referenced to the North American Datum of 1983 (NAD 83).

Aerotriangulation

Routine softcopy aerotriangulation methods were applied to establish a network of precise camera positions and other control for mapping, and to provide model parameters and orientation elements required for digital compilation. This work was performed by RSD Applications Branch (AB) personnel in December 2016 utilizing a softcopy photogrammetric workstation. Color imagery covering the portion of the project within the port area of Bangor, Washington, was measured and adjusted using the Multi-Sensor Triangulation (MST) module of BAE Systems' SOCET SET (v 5.6.0) software. Upon successful completion of this process, the MST module provided the standard deviations for each aerotriangulated ground point, which were used to compute a predicted horizontal circular error at the 95% confidence level of 0.4 meters. An Aerotriangulation Report with a diagram depicting the block of adjusted imagery was written and is on file with other project data within the RSD Electronic Data Library.

Compilation

The data compilation phase of this project was accomplished by a member of AB in January 2017. The Feature Extraction module was used within SOCET SET (v 5.6.0) photogrammetric software. Feature identification and the assignment of cartographic codes were based on image analysis of the project digital images and information extracted from the appropriate NOAA Nautical Charts, U.S. Coast Guard Light List and other ancillary sources. Feature attribution was assigned in compliance with the Coastal Cartographic Object Attribute Source Table (C-COAST), which provides the definition and attribution scheme for the full range of cartographic features pertinent to the CMP. Selected features were further modified with additional descriptive information to refine general classification.

Spatial data accuracies for project WA1401A-CM-N were determined according to standard Federal Geographic Data Committee (FGDC) practices. Cartographic features compiled from the aerotriangulated imagery, covering the port area of Bangor, were compiled to meet a horizontal accuracy of 0.8 meters at the 95% confidence level. This predicted accuracy of compiled well-defined points is derived by doubling the circular error calculated from the aerotriangulation statistics. The rest of the feature data within this project was compiled to meet a horizontal accuracy of 3.0 meters at the 95% confidence level, a predicted accuracy derived by doubling the horizontal uncertainty calculated from the EO-TPU tool.

The following table provides information on the imagery used to complete this project:

Date	Time (UTC)	Color Imagery		Infrared Imagery		Tide Level*
		Roll	Images	Roll	Images	
6-30-2014	19:03 – 19:05	14NC57	12024 – 12037	14NR48	08775 – 08788	0.0 – 0.1 m
6-30-2014	20:18 – 20:19	14NC57	12264 – 12271	14NR48	08999 – 09022	-0.2 m
6-30-2014	20:39 – 20:41	14NC57	12303 – 12315	14NR48	09054 – 09066	-0.2 – 0.0 m
6-30-2014	20:46 – 20:47	14NC57	12316 – 12325	14NR48	09067 – 09076	-0.1 m
6-30-2014	20:52 – 20:55	14NC57	12326 – 12347	14NR48	09077 – 09098	-0.1 m
6-30-2014	21:00 – 21:03	14NC57	12348 – 12367	14NR48	09099 – 09118	-0.1 m
6-30-2014	21:08 – 21:10	14NC57	12368 – 12380	14NR48	09119 – 09131	0.0 m
6-30-2014	21:15 – 21:18	14NC57	12381 – 12403	14NR48	09132 – 09154	0.0 m
6-30-2014	21:22 – 21:25	14NC57	12404 – 12425	14NR48	09155 – 09176	0.1 m
6-30-2014	21:30 – 21:31	14NC57	12426 – 12434	14NR48	09177 – 09185	0.1 m
7-26-2014	16:35 – 16:38	14NC58	12435 – 12451	14NR49	09186 – 09202	-0.1 – 0.0 m
7-26-2014	16:42 – 16:44	14NC58	12452 – 12468	14NR49	09203 – 09219	-0.2 – 0.0 m
7-26-2014	16:49 – 16:53	14NC58	12469 – 12496	14NR49	09220 – 09247	-0.2 – 0.0 m
7-26-2014	16:59 – 17:01	14NC58	12497 – 12511	14NR49	09248 – 09262	-0.1 m
7-26-2014	19:01 – 19:04	14NC59	12882 – 12900	14NR50	09630 – 09648	-0.2 m
7-26-2014	19:10 – 19:15	14NC59	12901 – 12936	14NR50	09649 – 09684	-0.1 – 0.1 m
7-26-2014	19:20 – 19:21	14NC59	12937 – 12946	14NR50	09685 – 09694	0.2 m
7-26-2014	19:28 – 19:29	14NC59	12947 – 12956	14NR50	09695 – 09704	0.0 m
7-26-2014	23:36 – 23:39	14NC60	13030 – 13051	14NR51	09778 – 09799	2.6 – 2.8 m
7-26-2014	23:43 – 23:47	14NC60	13052 – 13074	14NR51	09800 – 09822	2.7 – 2.9 m
7-26-2014	23:51 – 23:53	14NC60	13075 – 13083	14NR51	09823 – 09831	2.7 – 2.9 m

7-26-2014	23:57 – 23:58	14NC60	13084 – 13093	14NR51	09832 – 09841	2.8 m
7-27-2014	00:03 – 00:06	14NC60	13094 – 13112	14NR51	09842 – 09860	2.7 – 2.8 m
7-27-2014	16:51 – 16:53	14NC61	13302 – 13318	14NR52	10050 – 10066	-0.1 m
8-08-2014	22:07 – 22:10	14NC67	15765 – 15779	14NR58	12513 – 12527	2.7 m
8-08-2014	22:25 – 22:31	14NC67	15789 – 15824	14NR58	12537 – 12572	2.3 – 2.9 m
8-08-2014	22:36 – 22:39	14NC67	15825 – 15841	14NR58	12573 – 12589	2.4 – 2.7 m
8-08-2014	22:46 – 22:48	14NC67	15842 – 15858	14NR58	12590 – 12606	2.5 – 2.7 m
8-08-2014	22:55 – 22:58	14NC67	15859 – 15875	14NR58	12607 – 12623	2.4 m
8-08-2014	23:03 – 23:05	14NC67	15876 – 15885	14NR58	12624 – 12633	2.4 m
8-08-2014	23:11 – 23:15	14NC67	15886 – 15913	14NR58	12634 – 12661	2.4 – 2.9 m
8-09-2014	23:31 – 23:32	14NC68	16287 – 16294	14NR59	13035 – 13042	3.3 – 3.4 m
8-09-2014	23:48 – 23:50	14NC68	16326 – 16338	14NR59	13074 – 13086	2.5 – 3.4 m
8-10-2014	00:14 – 00:15	14NC68	16339 – 16348	14NR59	13087 – 13096	3.4 m
8-10-2014	00:20 – 00:23	14NC68	16349 – 16370	14NR59	13097 – 13118	3.4 m
8-10-2014	00:28 – 00:29	14NC68	16371 – 16383	14NR59	13119 – 13131	3.3 – 3.4 m
8-10-2014	22:56 – 22:59	14NC70	16501 – 16520	14NR61	13249 – 13268	2.8 – 2.9 m
8-10-2014	23:05 – 23:07	14NC70	16521 – 16534	14NR61	13269 – 13282	3.0 m

*Tide levels are given in meters above MLLW and were calculated using the Pydro software tool with a TCARI grid referenced to verified water level observations at NOS gauges. The height of the MHW tidal datum in the project area varies between 2.39 – 3.17 meters above MLLW.

Quality Control / Final Review

Quality control tasks were conducted during all phases of project completion by a senior member of AB. The final QC review was completed in February 2017. The review process included analysis of aerotriangulation results and assessment of the identification and attribution of digital feature data within the GC according to image analysis and criteria defined in C-COAST. The quality control process concluded with an inspection of topological connectivity within the GC using ArcGIS 10.3.1 software. All project data was evaluated for compliance to CMP requirements.

Comparisons of the largest scale NOAA nautical charts with natural color and infrared images and compiled project data resulted in creation of the Chart Evaluation File (CEF). The following nautical charts were used in the comparison process:

18458, Hood Canal, South Point to Quatsap Point, 1:25,000 scale, 17th Ed., Oct. 2010
18464, Port Townsend, 1:20,000 scale, 25th Ed., Jul. 2006
18471, Approaches to Admiralty Inlet, 1:40,000 scale, 11th Ed., Dec. 2007

18476, Puget Sound to Dabob Bay, 1:40,000 scale (incl. 1:5,000 inset), 6th Ed., Sep. 2011
18477, Puget Sound Entrance to Hood Canal, 1:25,000 scale, 5th Ed., Aug. 2001

End Products and Deliverables

The following specifies the location and identification of end products generated during the completion of this project:

Remote Sensing Division Electronic Data Library

- GIS Product Delivery
- Airborne Positioning and Orientation Report (APOR)
- Aerotriangulation Report
- GC11273 in shapefile format
- Project Completion Report (PCR)
- Chart Evaluation File in shapefile format

NOAA Shoreline Data Explorer

- GC11273 in shapefile format
- Metadata file for GC11273
- Digital copy of the PCR in Adobe PDF format

End of Report

Notice – all items highlighted are changes from previous versions of this SOW

Dec. 28, 2017

ATTACHMENT M
COASTAL MAPPING PROGRAM GLOSSARY

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

ATTACHMENT M: COASTAL MAPPING PROGRAM GLOSSARY

abutment, bridge - A supporting or buttressing structure, as in the center or at the end of a bridge. Synonym bridge pier. (see Sources of Definition [COD – pages M39 and M40] #6)

accuracy - The quality or state of being accurate or exact; exactness. The degree of conformity with a standard, or the degree of perfection attained in a measurement. Accuracy relates to the quality of a result, and is distinguished from precision which relates to the quality of the operation by which the result is obtained.

adjustment - Equitable distribution of errors and known distortions, which affect a computed result.

aerotriangulation (aerial triangulation) - Triangulation for the extension of horizontal and (or) vertical control accomplished by means of aerial photographs.

aid to navigation - A device external to a boat or vessel designed to assist in determination of position, a safe course, or to warn of dangers. Examples are: lighthouses, lights, buoys, daybeacons, radiobeacons, and electronic devices.

Airborne Global Positioning System (Airborne GPS) - A system using a GPS receiver mounted in an aircraft with one or more GPS receiver(s) on the ground, which produces data used to navigate the aircraft and/or position the photo centers.

altitude (aerial photography) - Vertical distance above the datum, usually mean sea level, of an object or point in space above the earth's surface.

Area Navigation Approach (ANA) - Airport surveys which provide runway, obstruction, geodetic control, navigation aid, and other information to support precision and nonprecision instrument approach procedure development for conventional aircraft using area navigation systems, such as GPS. In addition these surveys provide positions and elevations for selected navigational aids associated with the airports.

analog instruments - Devices that represent numerical quantities by means of physical variables; e.g., by translation; by rotation, as in a mechanical gear system; and by voltage or current as in analog networks that use resistance to represent mechanical losses, capacitors and inductors to store energy and simulate the action of springs, etc. Analog is contrasted with analytical and digital. Wild B-8 stereoscopic plotters are examples of photogrammetric analog instruments.

analytic aerotriangulation - A method for accurately determining the ground positions of objects throughout a strip or block of overlapping aerial photographs, using relatively few known ground positions, by means of digital calculations based on coordinate measurements of pertinent image positions on each photograph. This method differs from the more conventional instrument method that is based on measurements of a stereographic model which is perfected or solved through use of an analog device (first-order stereoscopic plotter). The analytic method offers certain worthwhile advantages occurring from automation, digital accuracy, least-square adjustment, and freedom from mechanical discrepancies contributed by the plotting instrument.

analytical stereoplotter - A stereocomparator which allows photogrammetric mensuration through application of mathematical solutions utilizing computer real-time or applications programs replacing the optical/mechanical components of the conventional analog stereoscopic instrument. The precision of devices available on the commercial market vary greatly to meet the requirements and fiscal limitation of the user. The analytical stereoplotter was invented by Dr. U. V. Helava and first described in a 1957 paper.

angle of view - Twice the angle whose tangent is one-half the length of the diagonal of the format divided by the calibrated focal length. (see SOD 7)

archived data (digital) - The data that has been purged from an on-line data base, written to magnetic tape or other storage media and placed in a library facility. This data has been determined to be no longer valid for active program purposes, but transferred to the library based on policy requirements.

attribute - A characteristic of a feature, such as numbers or text. (see SOD 8)

awash - Flush with or washed by the waves. (see SOD 18)

azimuth (angle) - The direction of one point or object, with respect to another where the direction of the line is expressed as the clockwise angle from 0^{o} to 360^{o}, from the reference meridian. The azimuth angle is measured from South (NAD 83) in geodesy and North (NAD 83) in navigation. Either is acceptable in cadastral surveys. Quadrantal azimuths are properly called bearings; half-circle azimuths are used in astronomy. The reference meridian can be assumed, grid, magnetic, astronomic, or geodetic.

azimuth mark (geodetic) – A geodetic monument carrying a mark whose azimuth from a given point is known either by measurement or by definition. (see SOD 9)

bathymetry - The art and science of measuring water depths to determine the configuration of the sea floor.

Bench Mark (BM) - A marked vertical control point which has been located on a relatively permanent material object, natural or artificial, and who's elevation above or below an adopted datum has been established. It is usually monumented to include bench mark name or number, date, and the name of the responsible agency.

block adjustment - The adjustment of strip coordinates or photograph coordinates for two or more contiguous strips of photographs.

block of photographs - Two or more overlapping strips of photography.

breakwater - A structure protecting a shore area, harbor, anchorage, or basin from waves. May be floating or constructed upon the bottom. A breakwater may be attached to or separated from the shore.

bridge - A lawful bridge over navigable waters of the U.S., including approaches, fenders, and appurtenances thereto, which is used and operated for the purpose of carrying passenger, road or railroad traffic. (see SOD 5)

> Bascule bridge - A single or double leaf span (usually counterbalanced), with the shoreward ends hinged, allowing the span to be elevated vertically, or nearly vertically. (see SOD 5)
> Draw bridge - A general name for bridges of which part or the entire span of the bridge may be raised or drawn aside to allow ships to pass through. (see SOD 18)
> Fixed bridge - A single or multiple span bridge without a moveable span. It has fixed vertical and horizontal clearance. (see SOD 5)
> Lift bridge - A moveable bridge which is capable of being lifted vertically to allow vessels to pass beneath. (see SOD 18)
> Pontoon bridge - A bridge supported on pontoons. (see SOD 5)
> Swing bridge - A bridge that can be rotated in a horizontal plane about a vertical pivot to allow vessels to pass. (see SOD 18)

calibration - The act or process of determining certain specific measurements in an instrument or device by comparison with a standard, for use in correcting or compensating errors or for purposes of record.

calibration constants (photogrammetry) - The results obtained by calibration which give the relationship of the principal point to the fiducial marks of a camera and the calibrated focal length of the lens-camera unit.

camel - A device let down between the side of a ship and a wharf or pier or another ship to protect from chafing when lying alongside or to take the shock of a bump when going alongside. Also called "fender". (see SOD 18)

camera - A light-proof chamber or box in which the image of an exterior object is projected upon a sensitized plate or film or light sensor, through an opening usually equipped with a lens or lenses, shutter, and variable aperture. aerial camera - A camera specially designed for use in aircraft. The prefix "aerial" is not essential where the context clearly indicates an aerial camera rather than another type of camera.

cartographic license - The freedom to select, adjust, add, or omit map features within allowable limits to attain the best cartographic expression. License must not be construed as permitting the cartographer to deviate from specifications.

cartography - The art and science of expressing graphically and/or digitally by means of maps and charts (graphic and electronic), the known physical features of the Earth or another celestial body; usually including the works of man and his varied activities.

certified digital data - Digital data which has undergone a review process which guarantees that the data meet requirements specified in the project instructions, will meet or exceed the intended application by the user, and that all attributes associated with each digital record within the data set has been verified as correct. Additional procedures and requirements are unique within each of the Marine Charting Division branches because of the major differences in data acquisition and processing systems.

chart – A *map* designed for use in navigation, especially a nautical chart or an aeronautical chart. (see SOD 9)

chart, aeronautical - A chart intended primarily for air navigation. The chart portrays all information (topographic features and aeronautical data) necessary for the safe conduct of aircraft.

chart, nautical - A chart intended primarily for marine navigation. The chart portrays all information (bathymetric data, topographic features and marine navigation data) necessary for the safe conduct of waterborne navigation.

chart comparison print – A marked-up copy of the largest scale nautical chart of the project area. The Print is used by the compiler to identify charted features to be investigated, to mark charted features found and not found, and to mark changes to features.

chart evaluation file - The purpose of the Chart Evaluation File (CEF) is to document navigational hazards, landmarks, fixed aids, and coastline features portrayed on NOAA nautical chart products whose existence or geographic position cannot be confirmed photogrammetrically, or whose size, shape, orientation or position appear to have changed significantly from the current chart portrayal. This is a GIS file (ESRI shapefile) with pre-defined attributes.

coast - General region of variable width that extends from the land/water interface inland to the first major change in terrain features.

(U.S.) Coast and Geodetic Survey (USC&GS) - A former name of the National Ocean Service. The organization was known as: The Survey of the Coast from its foundation in 1807 to 1836. Coast Survey from 1836 to 1878, Coast and Geodetic Survey from 1878 to 1970, and National Ocean Survey from 1970 to 1985. In 1985, it was named National Ocean Service (NOS). From 1965 to 1970, the Coast and Geodetic Survey was a component of the Environmental Science Services Administration (ESSA). NOAA became the successor to ESSA in 1970. The National Ocean Survey was a component of the National Oceanic and Atmospheric Administration (NOAA). NOS is a component of NOAA, U.S. Department of Commerce.

coast line (coastline) - According to Public Law 31 defined as the line of ordinary low water along that portion of the coast which is in direct contact with the sea and the line marking the seaward limit in inland waters. Also considered as the line of contact between land and sea without regard to a specified vertical datum. In NOS, the term is considered synonymous with shoreline.

coastal zone (coastal zone management) - The coastal waters (including the lands therein and there under) and the adjacent shorelands (including the waters therein and there under), strongly influenced by each and in proximity to the shorelines of several coastal states, and includes islands, transitional and intertidal areas, salt marshes, wetlands, and beaches. The zone extends, in the Great Lakes, to the international boundary between the United States and Canada, on either coast, seaward to the outer limit of the United States territorial sea. The zone extends inland from the shorelines only to the extent necessary to control shorelands, the uses of which have a direct and significant impact on the coastal waters. Excluded from the coastal zone are lands the use of which is by law subject solely to the discretion of or which is held in trust by the Federal Government, its officers, or agents.

compilation - The production of a new or recompiled digital or traditional paper map, chart, or related product from remote sensors (aerial, satellite; photographs, LIDAR, IFSAR, etc.) and geodetic control data by use of photogrammetric instruments. Also called photogrammetric compilation; stereo compilation. (see SOD 7)

compilation, digital -Same as above in digital format.

conformal projection - A projection that retains shapes and angles; e.g. depicting small areas, such as lakes and ponds, with the same shapes as they have on the globe. To do so, the parallels and meridians must meet at right angles, and the local scale around any point must not vary. Most modern maps, particularly at larger scales, are constructed on conformal projections because of the importance of true shape and direction.

contour (mapping) - An imaginary line on a land surface connecting points of equal elevation; also, the line representing this feature on a map or chart (properly called a contour line). depression contour - a closed contour inside of which the ground is at a lower elevation between adjacent contours. accurate contour - a contour line which is accurate within one-half of the basic contour interval; also called normal contour. approximate contour - a contour line is substituted for a normal contour whenever its accuracy is questionable. carrying contour - a single contour line representing two or more contours, used to show vertical or near-vertical topographic features, such as steep slopes and cliffs.

control, geodetic - A system of horizontal and/or vertical control stations that have been established and adjusted by geodetic methods and in which the shape and size of the earth (geoid) have been considered in positional computations.

control, horizontal - Control with horizontal positions only. The positions may be referenced to the geographic parallels and meridians or to other lines of reference, such as plane coordinate axes.

control, photo - Any station in a horizontal and/or vertical control system that is identified on a photograph and used for correlating the data shown on that photograph; also termed photo control point, picture control point, and ground control point.

control, photogrammetric - Control established by photogrammetric methods as distinguished from control established by ground or other methods.

control, vertical - The measurements taken by surveying methods for the determination of elevation only with respect to an imaginary level surface, usually mean sea level.

control points (photogrammetry) - Any station (in a horizontal - and/or vertical-control system) that is identified on a photograph and used to aid in fixing the attitude and/or position of a photograph or group of photographs. Sometimes identified as supplemental control point, photo control point, picture control points, and ground control point.

control station, horizontal - A station (survey mark) whose position has been accurately determined in X and Y, or latitude and longitude.

coordinate system - A set of rules for specifying how coordinates are to be assigned to points. The rules usually specify an origin of coordinates, and a set of axes from which distances or angles are measured to yield coordinates. (see SOD 9)

Coordinated Universal Time (UTC) - A time referencing term which supersedes, but is generally equivalent to Greenwich Mean Time (GMT). The new UTC time scale is almost perfectly constant, since it is based upon ultra-stable atomic clocks. GMT was based upon a form of solar time keeping and was roughly the same as UTC.

Continuously Operating Reference Stations (CORS) - The NGS network of Continuously Operating GPS Reference Stations (CORS) that provide Global Positioning System (GPS) carrier phase and code range measurements in support of 3-dimensional positioning activities throughout the United States and its territories. (see SOD 10)

crab - The angle between the aircraft track or flight line and the fore and aft axis of a vertical camera, which is in line with the longitudinal axis of the aircraft. (see SOD 11)

culture (mapping) - Features of the terrain that have been constructed by man. Included are such items as roads, buildings, canals, boundary lines, and in a broad sense, all names and legends on a map.

CUSP - The acronym for Continually Updated Shoreline Product. CUSP is vector-based, fully attributed polyline data product generated from the most current shoreline of the United States and its territories. The shoreline is derived by remote sensing techniques from NOAA and non-NOAA contemporary sources. Where applicable, CUSP will reference a mean-high water shoreline based on vertical modeling or image interpretation using both water-level stations and/or shoreline indicators.

Dangling arc - An arc having the same polygon on both its left and right sides and having at least one node that does not connect to any other arc. It often occurs where a polygon does not close properly, where arcs do not close properly (an undershoot), or were an arc was digitized past its intersection with another arc (an overshoot). A dangling arc is not always an error; for example, it can represent a cul-de-sac in a street network. (see SOD 12)

datum - Any quantity or set of such quantities that may serve as a reference or basis for calculation of other quantities. chart datum -a datum to which depths (soundings) in a hydrographic survey or on a chart are referred. geodetic datum - a set of constants specifying the coordinate system used for geodetic control, i.e., for calculating coordinates of points on the Earth. tidal datum - a surface with a designated elevation from which heights or depths are reckoned, defined by a certain phase of the tide.(see SOD 9)

day of year - The sequentially numbered day of the year. The date of source required as an attribute for each digital record within a data set. Day of year is often confused with Julian Day.

depth curve - A line on a map or chart connecting points of equal depth below the hydrographic datum. Also called bathymetric contour or isobath. (see SOD 7)

Descriptive Report (DR) - A collection of NOAA forms, tabulated and narrative reports which summarize the activities and practices executed in the completion of a map. The report summarizes the unique and standard methods, requirements, and procedures performed to achieve an acceptable level of quality for acceptance of the shoreline map and associated data. A DR was prepared for each shoreline map produced within a project. This requirement was superceded on February 16, 1989 with the approval of Section 14, Project Completion Report of the Coastal Mapping Program Operations Manual.

diapositive (photogrammetry) - A positive photograph on a transparent medium, usually polyester or glass. The term is generally used to refer to a transparency used in a plotting instrument, a projector, or a comparator.

Differential Global Positioning System (DGPS) - The technology of increasing the accuracy of the GPS electronic navigation system by monitoring the system error from a known, fixed location and transmitting corrections to system users. (see SOD 13)

Digital Elevation Model (DEM) - A numerical model of the elevations of points on the earth's surface. Digital records of terrain elevations for ground positions at regularly spaced horizontal intervals. (see SOD 7)

Digital Terrain Elevation Data (DTED) - A uniform matrix of terrain elevation values produced in an NGA format. Level 2 post spacing is one arc second latitudinally. Level 1 post spacing is three arc seconds latitudinally, longitudinal spacing varies with latitude. (see SOD 7)

digital photogrammetric workstation -See "softcopy workstation".

digital terrain model (DTM) - A statistical representation of the continuous surface of the ground by a large number of selected points with known rectangular coordinates in an arbitrary coordinate field. (see SOD 7)

digitize - To use numeric characters to express, or represent data; e.g., to obtain from an analog representation of a physical quantity, a digital representation of the same quantity.

disk, survey - A thin metal plate about 9 cm in diameter, with a stem attached to the center of the bottom used to indicate a survey point. The plate is slightly convex (in vertical), usually round (in horizontal) and contains the mark for which survey information is known, or to be determined. The plate usually also contains a designation, year, and the name of the agency setting the plate. It is usually made of bronze, brass, or aluminum and may be set in a drill hole or embedded in concrete.

dock - A dock (not the same as a pier) is the water area between two piers; also called a slip. Or a water basin for reception of vessels, such as a dry dock.

dolphin - A post or group of posts (or pilings), used for mooring or warping a vessel, as an Aid To Navigation, or as protection for other vessels or structures. The dolphin may be in the water, on a wharf, or on land. (see SOD 13)

editing, map – The process of altering, adapting, or refining attribute or spatial data in its preliminary stages to ensure accuracy, completeness, and conformity to a standard.

ellipsoid - A closed surface, whose planar sections are either ellipses or circles. (12). Reference ellipsoid - an ellipsoid of specified dimensions and associated with a geodetic reference system or a geodetic datum. (see SOD 7)

emulsion - A suspension of light-sensitive silver chloride or silver bromide usually in a gelatin, which is used for coating photographic film, plates, and papers.(see SOD 2)

ephemeris - A tabulation of the locations and related data for a celestial body for given epochs (dates) at uniform intervals of time. (see SOD 9)

exposure station -The three-dimensional position of the perspective center of an aerial camera at the time of exposure. Also called camera station or air station.

exterior orientation - The three-dimensional position and rotation of an aerial camera's perspective center at the time of exposure, expressed by ground coordinates in a specified map projection, and three rotation angles (il, <l, and K) around the coordinate axes.

feature – An object located on the surface of the earth, such as roads, building, lakes, and rivers. (see SOD 8)

feature attribute - A characteristic of a feature, for example, the size or material of an object.(see SOD 8)

feature collection - The process of identifying, delineating, labeling various types of natural and human-made phenomena from remotely-sensed images. (27)

fender - A device let down between the side of a ship and a wharf or pier or another ship to protect from chafing when lying alongside or to take the shock of a bump when going alongside. Also called "camel". (see SOD 18)

fiducial mark - Index marks, rigidly connected with the camera body, which form images on the negative. These images are used to determine the position of the optical center or principal point of the imagery. All called collimating marks. (see SOD 7)

field evaluation - A quality assurance operation in which field observations are compared with office interpretation of the same data. The scope and criteria for field evaluation operations is defined in the approved field evaluation instructions for each test.

field of view - The angle between two rays passing through the perspective center (rear nodal point) of a camera lens to the two opposite sides of the format. Not to be confused with angle of view. (see SOD 7)

final review - The office function during which all quality control efforts are evaluated in the culmination of project products and associated data accepted for registration and dissemination. The final reviewer evaluates maps, digital cartographic feature files and other products, and completes the Project Completion Report.

flight maps - Maps are generated during the planning phase depicting the proposed location and direction of flight for executing aerial photography. Information on photograph scale, type of film emulsion, aerial camera criteria, endlap and sidelap percentages and the approximate number of exposures required to meet desired coverage of the project site is included.

focal length - The distance measured along the optical axis from the rear nodal point of the lens to the film plane, when a very distant object is sharply focused on the film plane. (see SOD 2)

foreshore - That part of the shore or beach which lies between the low water mark and the upper limits of normal wave action.

forward motion compensation - An aerial camera feature which compensates for the forward motion of the aircraft during the time the shutter is open for each exposure.

foul area - An area of numerous uncharted dangers to navigation. The area marked serves a warning to the mariner that all dangers are not charted individually and that navigation through the area may be hazardous. The term “foul” should not be applied to a soft continuum with indefinite boundaries such as mud or sand; to areas congested with marine vegetation such as kelp or grass in water’ or to materials not likely to cause damage to a vessel. (see SOD 5)

geodetic control - See “control, geodetic”.

Geographic Information System (GIS) - The generic term used for a system of computer software programs and equipment that is used to acquire, store, manipulate, analyze, and display spatial data. (see SOD 7)

geoid - The figure of the earth considered as a sea level surface extended continuously through the continents. The actual geoid is an equipotential surface to which, at every point, the plumbline (direction in which gravity acts) is perpendicular. It is the geoid which is obtained from observed deflections of the vertical and is the surface of reference for astronomical observations and for geodetic leveling.

georeferencing – To georeference something means to define its existence in physical space. That is, establishing its location in terms of map projections or coordinate systems. The term is used both when establishing the relation between raster or vector images and coordinates but also when determining the spatial location of other geographical features. Examples would include establishing the correct position of an aerial photograph within a map or finding the geographical coordinates of a place name or street address. This procedure is thus imperative to data modeling in the field of geographic information systems (GIS) and other cartographic methods. When data from different sources need to be combined and then used in a GIS application, it becomes essential to have a common referencing system. This is brought about by using various georeferencing techniques. Most georeferencing tasks are undertaken either because the user wants to produce a new map or because they want to link two or more different datasets together by virtue of the fact that they relate to the same geographic locations. (see SOD 19)

Global Navigation Satellite System (GNSS) – GNSS is a standard term for world-wide navigation and positioning systems using satellites. As of 2010, these systems include the U.S.' Global Positioning System, the Russian GLONSS, China's COMPASS, the European Union's Galileo, India's IRNSS, and Japan's QZSS, all in different stages of development.

Global Positioning System (GPS) - A navigation and positioning system, consisting of 24 or more satellites, with which the three-dimensional position and the velocity of a user at a point on or near the Earth can be determined in real time, or more accurately, after post-processing. Its reference system is World Geodetic System 1984 (WGS 84). The user's receiver will require tracking of a minimum of four of the satellites from any location at any time to establish position and velocity (three on the surface of the ocean). (see SOD 7)

Global Reference System 1980 (GRS 80) – GRS 80 is the reference ellipsoid adopted by the XVII General Assembly of the International Union of Geodesy and Geophysics in December 1979.

graving dock - A form of dry dock consisting of an artificial basin fitted with a gate or caisson, into which vessels can be floated and the water pumped out to expose the vessels bottoms. (6)

Gravity for the Re-definition of the American Vertical Datum (GRAV-D) - GRAV-D is an ambitious project initiated by the National Geodetic Survey of NOAA to collect and monitor gravity data suitable for the re-definition of the vertical datum of at least the United States, if not for the entire North American continent. The GRAV-D project consists of three major campaigns: (1) High-resolution "snapshot" of gravity (predominantly airborne campaign); (2) Low-resolution "movie" of gravity (episodic re-visits of absolute gravity sites; and (3) Regional partnership surveys . See: http://www.ngs.noaa.gov/GRAV-D/ .

Greenwich Mean Time (GMT) - Mean solar time at the meridian of Greenwich, England. It has been used as a basis for standard time throughout the world. Also called Zulu Time. See "Coordinated Universal Time"

groin – Narrow, roughly shore-normal structure built to reduce longshore currents, and/or to trap and retain littoral material. Most groins are of timber or rock and extend from a SEAWALL, or the backshore, well onto the foreshore and rarely even further offshore. See also "jetty".

gyro-stabilized mount - A device which allows an aerial camera to be maintained in a desired attitude within an airborne vehicle.

H - Height or elevation of camera stations above sea level datum, unless specified otherwise; also an orthometric height.

horizontal control - See "control, horizontal".

horizontal datum – A set of *constants* specifying the *coordinate* system used for geodetic control, i.e., for calculating coordinates of points on the Earth. At least eight constants are needed to form a *complete datum*: three to specify the location of the origin of the coordinate system, three to specify the orientation of the coordinate system, and two to specify the dimensions of the reference ellipsoid. (14)

hydrographic survey - A survey having for its principal purpose the determination of data relating to a body of water for the purpose of promoting safe navigation. A hydrographic survey may consist of the determination of one or several of the following classes of data: depth of water configuration and nature of the bottom, velocity of currents; heights and times of tides and water stages; location of aids and dangers to navigation and survey purposes; configuration of marginal land areas, and determination of local disturbances effecting a magnetic compass. Information on geographic names and harbor facilities is also often documented.

hydrography - The art and science which deals with the measurement and description of the physical features of the oceans, seas, lakes, rivers, and other waters and their littoral areas. Special emphasis is placed on the elements that effect safe navigation and commerce, and the publication of this information for use in navigation. Hydrography encompasses nautical or offshore surveying; determining winds, tides, and currents, as well as cartography.

hyperspectral sensor – A sensor that acquires data in a large number of very narrow, contiguous spectral bandpass channels, such as the AVIRIS with 224 spectral bands. While some definitions attempt to distinguish hyperspectral imagers from multispectral imagers based on some defined number of spectral bands, a better, if somewhat less concrete, distinction is that hyperspectral data enable the techniques and algorithms of imaging spectroscopy to be applied.

image - The record of the likeness of any natural or manmade features, objects and activities by the use of a camera or sensor. (see SOD 2)

index map - (project) A small scale map of the project depicting the configuration of project maps and containing map coordinate identification information.

Inertial Measuring Unit (IMU) – An IMU is a navigation device that utilizes accelerometers and a computer to determine the position, orientation, and velocity of the device the IMU is mounted upon. IMUs are often used with airborne remote sensing devices to continuous monitor their orientation.

Infrared (IR) film - Film carrying an emulsion especially sensitive to "near-infrared." Land appears light and water dark, making infrared film particularly useful for shoreline mapping. (see SOD 7)

inset - A small map placed within the border of a physically larger map. Most often refers to a small graphic depicting a specific area of the mother graphic at a larger scale. It may also refer to the graphic representation of a small area, falling outside, but coincident to the limits of a designate host graphic and plotted within the limits of that graphic, at either the same or differing scale, to prevent the need for a separate graphic.

Interferometric Synthetic Aperture Radar (IFSAR) - A SAR technique using the phase difference of SAR observations of a same scene taken from slightly different sensor positions. The interferogram derived from different scenes has the potential to detect small changes on the Earth's surface. (see SOD 14)

interior orientation - The determining (analytically or in a photogrammetric instrument) of the interior perspective of the photograph as it was at the instant of exposure. Elements of interior orientation are the calibrated focal length, location of the calibrated principal point, and the calibrated lens distortion. (see SOD 7)

International Great Lakes Datum of 1985 (IGLD 85) - See "Low Water Datum".

International Terrestrial Reference Frame (ITRF) - The International Terrestrial Reference System (ITRS) is a world spatial reference system co-rotating with the Earth in its diurnal motion in space. The International Earth Rotation and Reference Systems Service (IERS), in charge of providing global references to the astronomical, geodetic and geophysical communities, supervises the realization of the ITRS. Realizations of the ITRS are produced by the IERS ITRS Product Center (ITRS-PC) under the name International Terrestrial Reference Frames (ITRF). ITRF coordinates were obtained by combination of individual TRF solutions computed by IERS analysis centers using the observations of Space Geodesy techniques : GPS , Very Long Baseline Interferometry (VLBI) , Satellite Laser Ranging (SLR), Lunar Laser Ranging (LLR) and Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS). They all use networks of stations located on sites covering the whole Earth. (see SOD 19)

isobath - An imaginary line connecting points of equal depth below the surface of a body of water, or line drawn on a map to portray those imaginary lines of equal depths. Isobath and discrete depths are analyzed in the generation of depth curves depicted on nautical charts. See also "Depth Curve".

jetty – On open coastline, a structure extending into a body of water, which is designated to prevent shoaling of a channel by littoral material and to and to direct and confine the stream or tidal flow. Jetties are built at the mouths of rivers or tidal inlets to help deepen and stabilize a channel. See also "groin".

Julian day - The consecutive number of each day commencing January 1, 4713 BC. The Julian day number denotes the number of days elapsed since noon on the initial day of the epoch; e.g. noon on May 17, 1985 marks the beginning of Julian day 2,446,203. For NOS purposes, the sequential 3-digit day number of the year should be referred to as the "day-of-the-year" rather than Julian day.

kappa (K) - In the exterior orientation of a photograph, the rotation about the z-axis.

Kinematic GPS (KGPS) – KGPS is a surveying technique based on carrier phase GPS measurements of satellite signals. The method requires a GPS receiver over a known survey point and then enables the user to position moving GPS receivers.

Lambert conformal conic projection - A projection devised in 1772 by Johann Heinrich Lambert. It assumes a cone intersecting (secant to) the Earth along two parallels passing through the mapped area. The axis of the cone coincides with the Earth's axis. Scale is correct along both standard parallels, too small between them, and too large beyond them. Because scale is correct along two parallels, the Lambert projection is often preferred to the simple conic projection with only one standard parallel. Because of the north-south distortions, the Lambert projection is most suitable for mapping areas that are elongated east-west.

latitude - 1. Angular distance measured on a meridian; distance, north or south to 90 degrees, from the equator. The length of a degree of latitude varies due to the flattened figure of the earth, being 68.704 statute miles at the equator, and 69.407 at the poles. 2. The orthographic projection of a course upon the meridian (either true or assumed) of a survey. It is equal to the length of the course multiplied by the cosine of the bearing. 3. The perpendicular distance from a point of the bearing.

ledge - A rocky formation connected with and fringing the shore, and generally uncovered at the sounding datum. (see SOD 4)

line - a series of related points, the path of a moving point. A line has only one dimension; length. (see SOD 13)

linear - Of or pertaining to a line; or, having a relation such that a change in one quantity is accompanied by an exactly proportional change in a related quantity. (see SOD 13)

linear least squares transformation -A statistical technique that calculates a curve of best fit for given points. The curve minimizes the sum of the squares of the deviations of the points from the curve.(see SOD 14)

lock - A basin in a waterway with caissons or gates at each end by means of which vessels are passed from one water level to another.

longitude - The angle between the plane of a given meridian and the plane of an arbitrary initial meridian, generally the meridian of Greenwich, England. It may be measured as the angle at the poles between the two meridians, as the arc of the equator intercepted between the meridians, or as the arc of a parallel of latitude intercepted between the meridians.

low water - The minimum height reached by a falling tide. The low water is due to the periodic tidal forces and the effects of meteorological, hydrologic, and/or oceanographic conditions. For tidal datum computational purposes, the minimum height is not considered a low water unless it contains a tidal low water.

Low Water Datum (LWD) - 1. The dynamic elevation for each of the Great Lakes and Lake St. Clair and the corresponding sloping surfaces of the St. Mary's, St. Clair, Detroit, Niagara, and St. Lawrence Rivers to which are referred the depths shown on the navigational charts and the authorized depths for navigation improvement projects. Elevations of these planes are referred to the International Great Lakes Datum of 1985 (IGLD 85) and are: Lake Superior - 601.1 feet, Lakes Michigan and Huron - 577.5 feet, Lake St. Clair - 572.3 feet, Lake Erie - 569.2 feet, and Lake Ontario - 243.3 feet. 2. An approximation of mean low water that has been adopted as a standard reference for a limited area and is retained for an indefinite period regardless of the fact that it may differ slightly from a better determination of mean low water from a subsequent series of observations. Used primarily for river and harbor engineering purposes. Boston low water datum is an example.

Lower Low Water (LLW) - The lowest of the low waters (or single low water) of any specified tidal day due to the declinational effects on the Moon and Sun.

Lower Low Water Datum (LLWD) - An approximation of mean lower that has been adopted as a standard reference for a limited area and is retained for an indefinite period regardless of the fact that it may differ slightly from a better determination of mean lower low water from a subsequent series of observations. Used primarily for river and harbor engineering purposes. Columbia River lower low water datum is an example.

lunar day - The time of the rotation of the Earth with respect to the Moon, or the interval between two successive upper transits of the Moon over the meridian of a place. The mean lunar day is approximately 24.84 solar hours in length, or 1.035 times as great as the mean solar day.

magnetic declination – See "variation".

map - A representation (usually on a flat medium) of all or a portion of the earth or other celestial body, showing the relative size and position of features to some given scale or projection; also, a representation of all or part of the celestial sphere. A map may emphasize, generalize, or omit the representation of certain features to satisfy specific requirements. Maps are frequently categorized and referred to according to the type of information which they are designed primarily to convey, to distinguish them from maps of other types.

topographic map - A map which represents the horizontal and vertical positions of the features represented; distinguished from a planimetric map by the addition of relief in measurable form. A topographic map shows mountains, valleys, and plains; and in the case of hydrographic charts, symbols, and numbers to show depths in bodies of water.

contour map - A topographic map which portrays relief by means of contour lines.

planimetric map - A map which represents only the horizontal positions for the features represented; distinguished from a topographic map by the omission of relief in measurable form.

base map - A map showing certain fundamental information, used as a base upon which additional data of specialized nature are compiled with or placed for purpose of comparison or geographical correlation. Also, a map containing all the information from which maps showing specialized information can be prepared; a source map.

cadastral map - A map showing the boundaries of subdivisions of land, usually with the bearing and lengths thereof and the areas of individual tracts, for the purposes of describing and recording ownership. A cadastral map may also show culture, drainage and other features relating to the value and use of land.

hydrographic map - A map showing a portion of the waters of the earth, including shorelines, the topography along the shores and of the submerged portions, and as much of the topography of the surrounding country as is necessary for the purpose intended.

map manuscript - The original drawing of a map as compiled or constructed on a suitable medium from various data, such as ground surveys or photographs, and from which direct reproduction copies may be made.

special-purpose map - Any map designed primarily to meet specific requirements. Usually the map information portrayed on a special-purpose map is emphasized by omitting or subordinating nonessential or less important information. A word or phrase is usually employed to describe the type of information which a special-purpose map is designed to present; e.g. route, tax, or index map.

map projection -An orderly system of lines on a plane representing a corresponding system of imaginary lines on an adopted terrestrial datum surface. A map projection may be derived by geometrical construction or by mathematical analysis. (see SOD 7)

marina - A harbor facility for small boats, yachts, etc. where supplies, repairs, and various services are available.

mark - (1) A dot, the intersection of a pair of crossed lines, or any other physical point corresponding to a point in a survey; (2) The object, such as a disk, on which the mark is placed; (3) The entire monument, consisting of the mark, the object on which it occurs and the structure to which the object is fastened.

mean - The average of a number of quantities, obtained by adding the values and dividing the sum by the number of quantities involved. Also called average, arithmetic mean. (see SOD 13)

Mean High Water (MHW) - A tidal datum. The average of all the high water heights observed over the National Tidal Datum Epoch (19 years). For stations with shorter series, simultaneous observational comparisons are made with a control tide station in order to derive the equivalent datum of the National Tidal Datum Epoch.

Mean High Water Line (MHWL) - The line on a chart or map which represents the intersection of the land with the water surface at the elevation of the MHW.

Mean Low Water (MLW) - A tidal datum. The average of all the low water heights observed over the National Tidal Datum Epoch (19 years). For stations with shorter series, simultaneous observational comparisons are made with a control tide station in order to derive the equivalent datum of the National Tidal Datum Epoch.

Mean Lower Low Water (MLLW) - A tidal datum. The average of the lower low water heights of each tidal day observed over the National Tidal Datum Epoch (19 years). For stations with shorter series, simultaneous observational comparisons are made with a control tide station in order to derive the equivalent datum of the National Tidal Datum Epoch.

mean range of tide (Mn) - The difference in height between MHW and MLW.

Mean Sea Level (MSL) - A tidal datum. The arithmetic mean of hourly heights observed over the National Tidal Datum Epoch. Shorter series are specified in the name; e.g., monthly mean sea level and yearly mean sea level.

Mean Water Level (MWL) - The mean surface elevation as determined by averaging the heights of water at equal intervals of time, usually hourly, over the National Tidal Datum Epoch. Mean water level is used in areas of little or no range in tide.

merged (digital data) - The combination of two or more digital files by automated data processing techniques. The process generates one digital data file which is equal in the number of data records to the sum of the individual files before merging. Merged digital files may be the combination of digital data files representing different stereographic models or a combination of digital data files created from the same stereographic model.
Examples of merged digital data are:

1. digital discrete point and linear data from different stereographic models merged to provide one digital file which represents a photogrammetric survey of a specified geographic area,

2. a merge of digital photobathymetric data files to provide one digital file for plotting machine processing in the generation of a photobathymetric data overlay.

meridian - A north-south reference line, particularly a great circle through the geographical poles of the earth. A meridian is a line connecting points having the same longitude. The prime meridian passes through longitude 0 degrees. (see SOD 13)

micron - A unit of length equal to one-millionth of a meter. (1 see SOD 13

mixed tide - Type of tide with a large inequality in either the high and/or low water heights, with two high water and two low waters occurring each tidal day. In strictness, all tides are mixed but the name is usually applied to the tides intermediate to those predominantly semidiurnal and those predominantly diurnal.

monument - A structure that marks the location of a point determined by surveying. In the case of a disk in concrete, the monument would be the entire structure. Mark, monument, and station can mean the same thing.

mosaic - An assembly of overlapping aerial photographs which have been matched to form a continuous photographic representation of a portion of the Earth's surface. (see SOD 7)

multispectral imager – A imaging sensor that can detect and quantify electromagnetic radiation simultaneously in several spectral bands. (see SOD 14)

nadir - The point at which a vertical line through the perspective center of the camera lens pierces the plane of the photograph. Also, nadir point. Ground nadir - The point on the ground vertically beneath the perspective center of the camera lens. (see SOD 2)

National Aerial Photography Program (NAPP) - See "National High Altitude Photography (NHAP) Program" below.

National Geodetic Vertical Datum of 1929 (NGVD 29) - The former fixed reference adopted as a standard geodetic datum for elevations determined by leveling, now replaced by the North American Vertical Datum of 1988 (NAVD 88). The NGVD 29 datum was derived from a general adjustment of the first-order leveling nets of both the United States and Canada. In the adjustment, mean sea level was held fixed as observed at 21 tide stations in the United States and 5 in Canada. The geodetic datum is fixed and does not take into account the changing stands of sea level. Because there are many variables affecting sea level, and because the geodetic datum represents a best fit over a broad area, the relationship between the geodetic datum and local mean sea level is not consistent from one location to another in either time or space. For this reason, neither NGVD 29 nor NAVD 88 should be confused with mean sea level.

National High Altitude Photography (NHAP) Program - The National High Altitude Photography (NHAP) program was initiated in 1980 and coordinated by the U.S. Geological Survey (USGS) to acquire aerial photography of the 48 conterminous states every five years. This interagency program was designed to eliminate duplicate efforts in various government programs and to maximize the use of government funds to build a uniform archive for multiple uses. In 1987 the program name was changed to the National Aerial Photography Program (NAPP) in recognition of modifications in the user requirements and flight specifications. NHAP photography was acquired at 40,000 feet above mean terrain and flight lines were centered on the 1:24,000-scale USGS map series. Two different camera systems were used; a 6 inch focal length lens was used to acquire black-and-white film at an approximate scale of 1:80,000 and an 8.25 inch lens was used to acquire color-infrared film at an approximate scale of 1:58,000. A duel port camera system was used to acquire simultaneous coverage. NAPP photography is acquired at 20,000 feet above mean terrain with a 6 inch focal length lens. The flight lines are quarter quad-centered on the 1:24,000-scale USGS maps. NAPP photographs have an approximate scale of 1:40,000, and are flown in black-and-white or color infrared, depending on state or federal requirements.

National Map Accuracy Standards - see “United States National Map Accuracy Standards”.

National Spacial Reference System (NSRS) - The National Spatial Reference System (NSRS), defined and maintained by the National Geodetic Survey (NGS), is a consistent National coordinate system that specifies latitude, longitude, elevation, scale, gravity, and orientation throughout the Nation, as well as how these values change with time. (see SOD 10)

National Tidal Datum Epoch - The specific 19-year period adopted by the National Ocean Service as the official time segment over which tide observations are taken and reduced to obtain mean values; e.g., mean lower low water, etc., for tidal datums. It is necessary for standardization because of periodic secular trends in sea level. The present National Tide Datum Epoch is 1983 through 2001. It is reviewed annually for possible revision and must be actively considered for revision every 20 - 25 years. Tidal datums in certain regions with anomalous sea level changes (Alaska, Gulf of Mexico) are calculated on a Modified 5-Year Epoch.

neatline - That border line which indicates the limit of the body of a map or chart. (see SOD 13)

neat model - In a stereoscopic model, the rectangular-shaped area between adjacent principal points and extending half way into each sidelap area. (see SOD 16 & 17)

National Ocean Service (NOS) – NOS is a Line Office of NOAA. Disks inscribed with this NOS name were set from about 1983 to the present, generally for third-order surveys and as tidal bench marks.

National Ocean Survey (NOS) – National Ocean Survey is the older name for the National Ocean Service, NOAA. Disks inscribed with this NOS name were set from about 1970 to about December, 1982 when the name was changed, generally for third-order surveys and as tidal bench marks.

North American Datum of 1927 (NAD 27) - The former official datum for the United States established by the U.S. Coast & Geodetic Survey (predecessor to NGS). The origin is located at station MEADES RANCH in Kansas. Based on the Clarke spheroid of 1866, the geodetic position of triangulation station MEADES RANCH and azimuth from that station to station WALDO are as follows: Latitude of MEADES RANCH: 39° 13' 25.686"N; Longitude of MEADES RANCH: 98° 32' 30.506"W Azimuth to WALDO: 75° 28' 09.64" The geoidal height at MEADES RANCH is assumed to be zero. Replaced by NAD 83. (see SOD 13)

North American Datum of 1983 (NAD 83) - The modern geodetic datum for North America, established by the National Geodetic Survey, NOAA. NAD 83 removed network distortions present in NAD 27 and changed the origin to the center of mass of the Earth. It is the functional equivalent of the World Geodetic System (WGS 84). NAD 83 is based on the Geodetic Reference System of 1980 (GRS 80) ellipsoid, which fits the size and shape of the earth more closely. A national readjustment was completed in 2007 and named NAD 83(NSRS 2007). This readjustment, using all available GPS data archived in the NGS database, also allows for the computation of local and network accuracies for each mark. (see SOD 10 and 13)

North American Vertical Datum of 1988 (NAVD 88) - The modern vertical datum for North America produced by the National Geodetic Survey, NOAA. It is a minimally-constrained adjustment of Canadian, Mexican, and U.S. leveling observations holding fixed the height of the primary tidal benchmark at Father Point/Rimouski, Quebec, Canada. The difference between NAVD 88 and NGVD 29 varies depending on one's location in the United States.

office review - The office function involving a series of quality control checks in the office compilation phase of a project. Office review involves on-line reviews of stereographic model/base manuscript relationship, photo-interpretation results, drafting and cartographic feature symbol quality, and review of draft narratives or completed forms relating to the project. This is a collaboration of effort by the cartographer and lead cartographer.

omega (ω) -In the exterior orientation of a photograph, the rotation about the x-axis.

On-line Positioning User Service (OPUS) – OPUS is NGS' on-line GPS data processingservice that provides GPS users easier access to the NSRS. OPUS allows users to submit their GPS data files to NGS, where the data will be processed to determine a position using NGS computers and software. Each data file that is submitted will be processed with respect to 3 CORS sites. The sites selected may not be the nearest to the user's site but are selected by distance, number of observations, site stability, etc. The position for the user's data will be reported back via email in both ITRF and NAD 83 coordinates as well as UTM, USNG and State Plane Coordinates (SPC) northing and easting. Several versions of OPUS exist or are being developed including: OPUS Static (S), OPUS Rapid Static (RS), OPUS-Data Base (DB), OPUS Projects, and OPUS GIS.

orbit - The path of a body or particle under the influence of a gravitational or other force. For example, the orbit of a celestial body or satellite is its path relative to another body around which it revolves. (see SOD 7)

orthophoto - A photographic copy, prepared from a perspective photograph, in which the displacements of images due to tilt and relief have been removed.(see SOD 7)

parallax - In photography, the apparent displacement of the position of an object in relation to a reference point due to a change in the point of observation. In stereo photogrammetry, the absolute stereoscopic parallax of a point is the algebraic difference of the distances of the two images from their respective photograph nadirs, measured in a horizontal plane and parallel to the air base. (see SOD 2 & 7)

pass points - In photogrammetry, a point whose horizontal and/or vertical position is determined from measurements on photographs using photogrammetric methods for use in the orientation of other photographs. (see SOD 2)

perspective center - The point of origin or termination of bundles of perspective rays.(see SOD 2)

phi (Φ)- In the exterior orientation of a camera, the rotation about the y-axis.

photogrammetric survey - A survey based on the correlation and extraction of data from ground and/or aerial photographs. At NOS, this type of survey is often complemented by limited field survey operations; i.e., field evaluation surveys, item investigations, and/or ground control surveys. The graphic representation of survey data is generally recorded in the form of a map manuscript or suite of map manuscripts.

photogrammetry - The art, science, and technology of obtaining reliable measurements and information through processes of recording, measuring, and interpreting images and patterns of electromagnetic radiant energy and other phenomena. (see SOD 2)

photograph - A general term applying to either a positive or negative exposed on light sensitized material by use of a camera. Also the print made photographically from the negative or positive. The photograph may be exposed or printed, using one of these types of emulsion: panchromatic, negative or positive color, infrared color, or infrared black and white.

photographic model - see “stereomodel”.

photography - The art, science, and process of producing images on sensitized material through the action of light. The term photography is sometimes incorrectly used in place of photographs; however, the distinction between the process and the product is a valuable one and should be observed.

pier - A pier is a long, narrow structure extending into the water approximately perpendicular to a shore to provide a berthing place for vessels, to serve as a promenade, etc.

pile - A long, heavy timber or section of steel, concrete, etc., forced into the earth to serve as a support, as for a pier, or to resist lateral pressure. (see SOD 5)

piling - A group of piles set in a row. As opposed to a group of piles banded together into a circle, called a dolphin. (see SOD 5)

pitch, of airplane - The rotation of an aircraft about the horizontal axis which is perpendicular to the longitudinal centerline of the aircraft, and which causes a nose-up or nose-down situation. See also “roll” and “yaw”. (see SOD 2)

pixel - A picture element, smallest unit of information in a grid cell map or scanner image. Abbreviated from "picture element;" the smallest part of a picture (image). (see SOD 7)

planimetry - Applies to the horizontal placement of all natural and man-made features that are graphically represented on a map or chart. This excludes portrayals of relief in measurable form and all annotations.

polygon - A closed, plane figure that encloses an area. (see SOD 8)

polynomial - An arithmetic expression composed by summing multiples of powers of some variable.

P(x) = sum a_i x^in for in = 0 .. N

The multipliers, a_i, are known as "coefficients" and N, the highest power of x with a non-zero coefficient, is known as the "degree" of the polynomial. If N=0 then P(x) is constant, if N=1, P(x) is linear in x. N=2 gives a "quadratic" and N=3, a "cubic".

principal point -The foot of the perpendicular to the photo plane through the perspective center.(see SOD 7)

Product Standards (PS) - The minimum levels of Quality Measure with which the product is passable. It is generally a function of user requirements/values, technical capabilities, and costs to produce.

production cycle - The series of activities, organized into units referred to as phases, which take place during the life cycle of a mapping project. The major phases of the production cycle are planning, field operations, photographic operations, source data evaluation, aerotriangulation, analog or digital data extraction (compilation), approval, registration, and data dissemination.

Project Completion Report (PCR) - The assembly of all official project instructions, reports and listings specified as being necessary to establish a sufficient reference for a coastal mapping project and supersedes the former requirement for a descriptive report for each map within a project.

pushbroom - A scanner in which all scanning parts are fixed and scanning is accomplished by the forward motion of the scanner; A sensor made up of a linear detector array of CCDs (Charge Coupled Device) that obtains data in the platform's direction of motion (azimuth or along-track dimension). The sensor's instantaneous field of view extends the length of the swath width. (19)

quadrangle - A four-sided figure, bounded by parallels of latitude and meridians of longitude, used as an area unit in mapping. The dimensions are not necessarily the same in both directions. The map of such an area is termed quadrangle map; sometimes shortened to quad.

quality - The totality of features and characteristics of a product or service that bear on its ability to satisfy given needs.

Quality Assurance (QA) –

1. A continuing evaluation of the QC process. It is not a double check on each product, but rather a "check on the checkers." QA techniques often employ a statistical sampling method to examine just enough of the products to determine that the QC system is effective. QA is not intended to catch all the mistakes, but only to determine if the rateof mistakes that pass through the QC system is within the acceptable limits established by management. Any problem identified by the QA process should result in corrective action in the QC process. Since QA evaluates part of the production system, e.g. QC, it

must be organizationally separate from the production manger in order to ensure objectivity.

2. All those planned or systematic actions necessary to provide adequate confidence that a product or service will satisfy given needs.

Quality Control (QC) –

1. A routine inspection to ensure that the product conforms with certain minimum standards and specifications that have been established by management. QC is usually performed at the work site by supervisors or by designated inspectors. Products that fail to meet minimum standards are reprocessed or destroyed.

2. The operational techniques and the activities which sustain a quality of product or service that will satisfy given needs; also the use of such techniques and activities.

Quality Evaluation (QE) - The overall system of activities whose purpose is to provide assurance that the quality control activities are being done effectively. It involves a continuing evaluation of performance of the production system and the quality of the products produced. Auditing is one QE technique.

Quality Measure (QM) - A quantitative measure of the features and characteristics of a product or service. The general term used for accuracy, skill score, number of errors, clarity, or other appropriate measures of goodness. In general, QM is not a function of any specific use.

quality program - The documented plans for implementing the quality system. The term quality program refers to the "total quality program" whereas the term "quality assurance program" and "quality control program" refer to the programs associated with the functions of quality assurance and quality control, respectively.

quality, relative - The degree of excellence of a product or service. The word quality is often used by the layman in a relative sense that does not include many of the quantitative attributes of quality such as the economic aspect of given needs.

quality system - The collective plans, activities and events that are provided to ensure that a product, process, or service will satisfy given needs. The quality system encompasses all of the elements of quality assurance and quality control.

quay - A quay is a structure approximately parallel to the shoreline, accommodating ships on one side only, and usually of solid construction. A wharf is similar to a quay, but with open construction.

radar -RAdio Detection And Ranging equipment that determines the distance and usually the direction of objects by transmission and return of electromagnetic energy. (see SOD 7)

RADARSAT – RADARSAT-1 and -2 are Canadian Earth observation satellites developed to monitor the environment. RADARSAT-1 had a planned lifetime of five years when launched in 1995, but has lasted much longer. RADARSAT-2 was launched in December, 2007. They are equipped with a Synthetic Aperture Radar (SAR). The SAR is a powerful microwave instrument that can transmit and receive signals through clouds, haze, smoke, and darkness, and obtain high quality images of the Earth in all weather at any time. RADARSAT SAR has the unique ability to shape and steer its radar beam over a 500 kilometer range. The beam width can be varied from a swath of 35 kilometers to 500 kilometers with resolutions from 10 meters to 100 meters respectively. Incidence angles range from less than 20 degrees to more than 50 degrees.

ramp - A sloping structure that can either be used as a landing place at variable water levels, for small vessels, landing ships, or a ferry boat; or for hauling a cradle carrying a vessel.

range of tide - The difference in height between consecutive high and low waters. The mean range is the difference in height between mean high water and mean low water. The great diurnal range or diurnal range is the difference in height between mean higher high and lower low water.

raster data - A matrix of measurements ordered by layers, columns and rows with each cell in the matrix being implicitly addressable by its coordinates (x, y). (see SOD 14)

ratio print - A print in which the scale has been changed from that of the transparency by projection printing. The term enlarged photographic print is encouraged over "ratio print".

Real Time Kinematic (RTK) - **Real Time Kinematic** (RTK) satellite navigation is a technique used in surveying based on the use of carrier phase measurements of GNSS signals where a single reference station provides real-time corrections to a few centimeters of accuracy.

Real Time Network (RTN) – A RTN is a collection of permanently mounted **GNSS** receivers that operate 24/7 collecting data from GNSS satellites and communicating data corrections that are interpolated to the site of authorized network users. These updates enable the users to determine positions with their GNSS receiver at longer distances much more accurately than without the Network.

rectification - The process of projecting a tilted or oblique photograph onto a horizontal reference plane. (see SOD 7)

reef - A rocky or coral elevation dangerous to surface navigation which may or may not uncover at the sounding datum. A rocky reef is always detached from the shore, a "ledge" is connected to the shore. A coral reef may or may not be connected with the shore. (see SOD 4)

Reference Mark (RM) - A survey mark of permanent character close to a survey station, to which it is related by an accurately measured distance and azimuth. For a triangulation station, reference marks are generally pre-stamped survey disks, usually within 30 meters (one tape length) of the triangulation station. Standard procedure was to set two reference marks, numbered clockwise from north, with the next consecutive reference number used if an earlier number was destroyed.

reference station - A tide or current station for which independent daily predictions are given in the Tide Tables and "Tidal Current Tables," and from which corresponding predictions are obtained for subordinate stations by means of differences and ratios. The term tide reference station records refers to the documentation and tabulation generated by the appropriate authority within NOS for each reference station.

reformatting - Adding, deleting, or rearranging data fields within a digital record usually done by software. Reformatting frequently includes a form of filtering.

registration (final products) - A series of record keeping and documentation actions that prepare the approved map manuscript, descriptive documentation (descriptive reports and/or project completion report), source data, and other supporting documents and records for permanent storage. Registration is considered complete when the Photogrammetry Branch Support Section has entered all appropriate registration information in the "Permanent Registration Log Book" and the registration copy of the final map manuscript and approved accompanying descriptive documentation have been sent to the NOS vault, and a receipt has been received. Support documents and data are sent to the Physical Sciences Support Section of the Aeronautical Charting Division for subsequent transmittal to the Federal Records Center (National Archives).

relief (mapping) - Inequalities in the elevations of terrain. Similar inequalities of the sea bed or other bodies of water are called submarine relief.

remote sensing - The measurement or acquisition of information of some property of an object or phenomenon by a recording device that is not in physical or intimate contact with the object or phenomenon under study. It is sometimes restricted to the practice of data collection in the wavelengths from ultraviolet to radio regions. (see SOD 7)

resolution (quality) - The minimum difference between two independently measured or computed values which can be reliably distinguished by the measurement or analytical method being considered or used.

roam - The process of moving across a display so that different areas of the image appear on the display screen.

rock - Rocks are classified as bare, awash, or submerged. A submerged rock is potentially the most dangerous natural hazard to navigation. Rocks with tops near the MLLW tidal datum are of particular importance in establishing offshore boundaries. A bare rock (islet) is an extremely important positional reference for the mariner since it can be seen at all tide stages. Chart symbology for rocks of different heights varies, see Chart No. 1, Section K 1-17, a-h.

roll, of aircraft - The rotation of an aircraft about its longitudinal axis causing a wing-up or wing-down situation. See also "pitch" and "yaw". (see SOD 2)

rubber sheeting - The application of a nonlinear rectification; adjusting the coordinates of points in a dataset by stretching, shrinking, etc. to match a few known points.

scale - Relationship existing between a distance on a map, chart, or photograph, and the corresponding distance on Earth. Scale may be expressed as a ratio, 1:24,000; a representative fraction, 1/24,000; or an equivalence, 1 inch = 2,000 feet.

scanner - A device that examines an area or region point by point in a continuous systematic manner, repeatedly sweeping across until the entire area or region is covered. (see SOD 14)

sea level - Height of the surface of the sea at any time.

sea wall - A structure separating land and water areas, primarily designed to prevent erosion and other damage due to wave action. See also "bulkhead" in Attachment F.

secondary control tide station - A tide station at which continuous observations have been made over a minimum period of 1 year but less than 19 years. The series is reduced by comparison with simultaneous observations from a primary control tide station. This station provides for a 365-day harmonic analysis including the seasonal fluctuations of sea level.

semidiurnal - Having a period or cycle of approximately one-half of a tidal day. The predominant type of tide throughout the world is semidiurnal, with two high waters and two low waters each tidal day. The tidal current is said to be semidiurnal when there are two flood and two ebb periods each day.

sensor - A technical means to extend man's natural senses. Also a sensing device or equipment which detects and records in the form of imagery, the energy reflected or emitted by environmental areas, features, objects, and events, including natural and cultural features and physical phenomena, as well as man-made features, objects and activities.(see SOD 7)

server - Hardware and software on a computer in a network that makes resources and/or services available to the other computers on the network.

shoreline - The intersection of the land, including man-made waterfront structures, with the water surface. The shoreline depicted on NOS maps and charts represents the line of contact between the land and a selected water elevation. In areas affected by tidal fluctuations, this line of contact is the mean high water line. In confined coastal water of diminished tidal influence, the mean water level line may be used. In non-tidal waters, the line represents the land/water interface at the time of survey. In areas where the land is obscured by marsh grass, cypress or similar marine vegetation, the actual shoreline can not be accurately represented. Instead, the outer limit line of the vegetation area is delineated (where it would appear to the mariner as the shoreline) and is referred to as the apparent shoreline. The seaward limits of kelp, low grass in water, and other low-lying vegetation normally do not constitute an apparent shoreline. The approximate shoreline is shown on larger scale charts by a dashed line delimiting the gold tint. This is used to show that the coast has been inadequately surveyed.

shoreline maps - A special purpose map manuscript prepared to provide data required for nautical charting operations and serves as a base map for various NOS products; e.g. nautical charts, hydrographic surveys, coastal zone maps, and shoreline movement studies. Coverage is limited to a relatively narrow zone along the shoreline. The cartographic representation of features shown includes the shoreline, alongshore natural and manmade features and selected physical and cultural features inland from the shoreline. Shoreline maps primarily comprise the "T" and "TP" series of NOS maps and provide the graphic representation and correlation of information that has originated from field and photogrammetric survey operations.

softcopy photogrammetry - Photogrammetry using digital images that are stored, viewed, and processed on computers. The digital images may be scanned from photographs or captured by a digital camera. Also called digital photogrammetry.

softcopy workstation - The computer system (hardware and software) used in softcopy or digital photogrammetry. Also called digital photogrammetric workstation.

solar day - The period of the rotation of the Earth with respect to the Sun. The mean solar day is the time of the rotation with respect to the mean Sun. The solar day commencing at midnight is called a civil or calendar day, but if the day is reckoned from noon it is known as an astronomical day because of its former use in astronomical calculations.

spatial resolution - A measurement of the smallest detail which can be distinguished by a sensor system under specific conditions (see SOD 7)

standard deviation - The plus and minus points of inflection of a probability curve. Calculated by taking the square root of the sum of the squares of the residuals divided by n - 1. (see SOD 15)

standard time - Time based on the transit of the Sun over a certain specified meridian, called the time meridian, and adopted for use over a considerable area. With a few exceptions, standard time is based upon some meridian which differs by a multiple of 15° from the meridian of Greenwich. The United States first adopted standard time in 1883 on the initiative of the American Railway Association, and at noon on November 18 of that year the telegraphic time signals from the Naval Observatory at Washington were changed to this system.

state plane coordinate system - The plane-rectangular coordinate systems established by the U.S. Coast and Geodetic Survey, one for each state of the union, for use in defining positions of geodetic stations in terms of place-rectangular (X and Y) coordinates. Each state is covered by one or more zones, over each of which is placed a grid imposed upon a conformal map projection. The relationship between the grid and the map projection is established by mathematical analysis. Zones of limited east-west dimension and indefinite north-south extent have the transverse Mercator map projection as the base for the state coordinate system; while zones for which the above order of magnitude is reversed use the Lambert conformal conic map projection with two standard parallels. See: http://www.ngs.noaa.gov/PUBS_LIB/ManualNOSNGS5.pdf .

station - A definite point on the Earth whose location has been determined by surveying methods. It may or may not be marked on the ground. A station usually is defined by the addition of a term which describes its origin or purpose, such as "triangulation station". Usually marked on the ground by a monument of special construction, or by a natural or artificial structure. See also "mark" and "monument".

stereomodel - The three-dimensional model formed by the intersecting rays of an overlapping pair of photographs. (see SOD 2)

stereoscopy - The science and art that deals with the use of binocular vision for observation of a pair of overlapping photographs. (see SOD 2)

stereo pair - Two photographs taken from different positions with sufficient overlap of detail to make possible stereoscopic examination of an object or an area common to both. Also called stereoscopic pair. (see SOD 7)

strip of photographs - A series of overlapping aerial photographs taken along a single flight line. (see SOD 2)

subordinate tide station –

1. A tide station from which a relatively short series of observations is reduced by comparison with simultaneous observations from a tide station with a relatively long series of observations.

2. A station listed in the Tide tables from which predictions are to be obtained by means of differences and ratios applied to the full predictions at a reference station.

superimposition - The placing of an image or map over the top of one or more other images or maps with corresponding locations aligned. Also called Image Registration.

survey - The orderly process of determining data relating to the physical characteristics of the

Earth. The list of orderly processes which can be properly termed surveys is long; it may be divided into classes according to type of data obtained, the methods and instruments used, and the purposes to be served.

survey, geodetic - A survey in which account is taken of the figure and size of the Earth. Geodetic surveys are usually prescribed where the areas or distances involved are so great that results of desired accuracy and precision can be obtained only by the processes of geodetic surveying.

survey, photogrammetric - A survey utilizing either ground photographs or aerial photographs.

Synthetic Aperture Radar (SAR) - A radar in which a synthetically long apparent or effective aperture is constructed by integrating multiple returns from the same ground cell, taking advantage of the Doppler effect to produce a phase history film or tape that my be optically or digitally processed to reproduce an image. Signal processing uses magnitude and phase of the received signals over successive pulses from elements of a synthetic aperture to create an image. (see SOD 7 & 14)

target - The distinctive marking or instrumentation of a ground point to aid in its identification on a photograph. In photogrammetry, target designates a material marking so arranged and placed on the ground so as to form a distinctive pattern over a geodetic or other control-point marker, on a property corner or above an underground facility or feature. A target is also the image pattern on aerial photographs of the actual marks placed on the ground prior to photography.

tertiary tide station - A tide station at which continuous observations have been made over a minimum period of 30 days but less than 1 year. The series is reduced by comparison with simultaneous observations from a secondary control tide station. This station provides for a 29-day harmonic analysis.

tidal day - Same as lunar day.

tidal wave - A shallow water wave caused by the gravitational interactions between the Sun, Moon and Earth. Essentially, high water is the crest of a tidal wave and low water, the trough. Tidal current is the horizontal component of the particulate motion, while tide is manifested by the vertical component. The observed tide and tidal current can be considered the result of the combination of several tidal waves, each of which may vary from nearly pure progressive to nearly pure standing and with differing periods, heights, phase relationships, and direction.

tide - The periodic rise and fall of the water resulting from gravitational interactions between the Sun, Moon, and Earth. The vertical component of the particulate motion of a tidal wave. Although the accompanying horizontal movement of the water is part of the same phenomenon, it is preferable to designate this motion as tidal current.

tide gauge - An instrument for measuring the rise and fall of the tide. Some examples of gauge types are automatic tide gauge, bubbler tide gauge, electric tape gauge, pressure gauge, acoustic, and tide staff.

tide observation records - The records of tidal cycle observation during coastal mapping project field operations; generally conducted to coordinate photography at predetermined stages of tide. Tide observation records should not be confused with tide reference station records.

tide staff - A tide gauge consisting of a vertical graduated staff from which the height of the tide can be read directly. It is called a fixed staff when secured in place so that it can not be easily removed. A portable staff is one that is designed for removal from the water when not in use. For such a staff a fixed point is provided. The support has a metal stop secured to it so that the staff will always have the same elevation when installed for use.

tide station - The geographic location at which tidal observations are conducted. Also, the facilities used to make tidal observations. These may include a tide house, tide gauge, tide staff, tidal bench marks, and communication devices. See: http://oceanservice.noaa.gov/education/kits/tides/tides09_monitor.html .

tide station reference records - The records of tidal cycle observations conducted at a tide or current station for which independent daily predictions are given in the "Tide Tables" and "Tide Current Tables", and from which corresponding predictions are obtained for numerous other places.

Tide Tables - Tables which give daily predictions of the times and heights of high and low waters. These predictions are usually supplemented by tidal differences and constants through which additional predictions can be obtained for numerous other places.

tidelands - The zone between the mean high water and mean low water lines. It is identical with intertidal zone when the type of tide is semidiurnal or diurnal. Also commonly known as "shore" or "beach."

tie points - Image points identified on photographs in the overlap area between two or more adjacent strips of photography and serving to tie the individual strips of photographs into a single flight unit, or block. (see SOD 7)

time, kinds - Time is measured by the rotation of the Earth with respect to some point in the celestial sphere and may be designated as sidereal, solar, or lunar, according to whether the measurement is taken in reference to the vernal equinox, the Sun, or the Moon. Solar time may be apparent or mean, according to whether the reference is to the actual Sun or the mean Sun. Mean solar time may be local or standard, according to whether it is based upon the transit of the Sun over the local meridian or a selected meridian adopted as a standard over a considerable area. Greenwich time is standard time based upon the meridian of Greenwich. In civil time the day

commences at midnight, while in astronomical time, as used prior to 1925, the beginning of the day was reckoned from noon of the civil day of the same date. The name universal time is now applied to Greenwich mean civil time.
topography - Features of the surface of the Earth considered collectively as to form. A single feature (such as a mountain or valley) is called a topographic feature. Topography is subdivided into hypsography (relief features), hydrography (water and drainage features), and culture (manmade features).

T-Sheet (map) - The term "T-Sheet" refers to compilation manuscripts resulting from planetable and photogrammetric surveys conducted by the Coast Survey, Coast and Geodetic Survey, ESSA, and National Ocean Survey (NOS) during the period 1834 to 1980. These surveys are recorded graphically in the form of a map manuscript. The "T" series products include topographic, planimetric, shoreline, and special-purpose map manuscripts. The preferred term is "T series map" and the discontinuance of the term "T-Sheet" is encouraged.

TP-Sheet (map) - The term "TP-Sheet" refers to a series of map manuscripts produced by ESSA, the National Ocean Survey, and National Ocean Service after 1968. Although the majority are shoreline maps, the "TP" series of products also includes topographic, planimetric, and other special-purpose map manuscripts. These maps provide the graphic representation of photogrammetric survey data. In special survey projects, such as shoreline/photobathymetry surveys, the shoreline map may consist of the base map and one or more overlays. The overlays are considered part of the map and will be registered with the shoreline map. The preferred term is "TP series map" and the discontinuance of the term "TP-Sheet" in encouraged.

transverse Mercator projection - A map projection of the cylindrical type, being in principle equivalent to the regular Mercator map projection turned (transversed) 90º in azimuth. The central meridian is represented by a straight line, corresponding to the line which represents the equator on the regular Mercator map projection. Neither the geographic meridian, except the central meridian, nor the geodetic parallels, except for the equator (if shown) are represented by straight lines. It is a conformal projection and is the base used in the state plane coordinate system for the grids of those zones whose greater dimension is in a north and south direction. The transverse Mercator projection, originally devised by Lambert, is used for large-scale mapping throughout the world (in Europe it is sometimes called the Gauss-Kruger projection).

traverse - A method of surveying in which the lengths and directions of lines between points on the earth are obtained by or from field measurements and used in determining positions of the points. A survey traverse may determine the relative positions of the points which it connects in series, and if tied to control stations on an adopted datum, the positions may be referred to that datum. Survey traverses are classified and identified in a variety of ways: according to methods used, as an astronomical traverse, according to quality of results, as a first-order traverse; according to purpose served, as a geographical-exploration traverse; and according to form, as a closed traverse.

Triangulated Irregular Network (TIN) - A terrain model created from continuously connected triangles derived from the Delauney algorithm. The vertices of the triangles form irregularly spaced elevation posts. Unlike a grid, the TIN allows extra information to be displayed in areas of complex relief without displaying dense or redundant data gathered in areas of simple relief.

triangulation - A method of surveying in which the points whose locations are to be determined, together with a suitable number (at least two) of points of known location, are connected in such a way as to form the vertices of a network of triangles. The angles in the network are measured and the lengths of the sides are either measured or calculated from known points and lengths.

United States Coast & Geodetic Survey (USC&GS) - see "Coast and Geodetic Survey".

United States National Grid (USNG) - USNG is an alpha-numeric point reference system that has been overlaid on the Universal Transverse Mercator (UTM) numerical grid. Every modest size home in a discrete area can be described using 8-digits (e.g., 1234 5678). By adding a two-letter prefix (e.g., XX 1234 5678), the location is identified regionally (state-wide). This alpha-numeric designator can be used today with many consumer GPS receivers costing less than $100.

United States National Map Accuracy Standards - Specifications promulgated by the U.S. Office of Management and Budget to govern accuracy of topographic and other maps produced by Federal agencies.

Universal Time (UT) - Same as Greenwich Mean Time (GMT).

Universal Transverse Mercator (UTM) - A military grid system based on the transverse Mercator projection, applied to maps of the Earth's surface extending to 84E N and 80E S latitudes, with 60 identical zones, each 6E in longitude wide. (12)

uplands - Land above the mean high water line (shoreline) and subject to private ownership, as distinguished from tidelands, the ownership of which is prima facie in the state but also subject to divestment under state statutes.

upper limit of navigability - The character of a river will, at some point along its length, change from navigable to non-navigable. Very often that point will be at a major fall or rapids, or other place where there is a marked decrease in the navigable capacity of the river. The upper limit will therefore often be the same point traditionally recognized as the head of navigation, but may, under some tests, be at some point yet farther upstream.

variance - The square of the standard deviation. (see SOD 9)

variation (of compass) - Difference between true north as determined by the Earth's axis of rotation and magnetic north as determined by the Earth's magnetism. Variation is designated as east or positive when the magnetic needle is deflected to the east of true north, and as west or negative, when the deflection is to the west of true north. Also called magnetic declination.

vector - A directed line segment, with magnitude and direction commonly represented by the coordinates for the pair of end points. A quantity possessing both magnitude and direction. (see SOD 7)

vector data - Geometrical data such as points, lines, and polygons. The representation of spatial features by explicitly recording their geospatial co-ordinates and their attributes using points, lines, and polygons. Raster data is an alternative representation technique to vector data. (see SOD 8 & 14)

way point - The vertexes of a flying route. The end points of aerial photographic flight lines.(see SOD 8)

wharf - A wharf is a structure approximately parallel to the shoreline, accommodating ships on one side only, and usually of open pile construction. A quay is similar to a wharf, but with solid construction.

World Geodetic System of 1984 (WGS 84) - A set of quantities, developed by the U.S. Department of Defense for determining geometric and physical geodetic relationships on a global scale, based on a geocentric origin and the Geodetic Reference System 1980. Used for GPS. (see SOD 9)

wreck - The ruined remains of a vessel which has been rendered useless, usually by violent action, as by the action of the sea and weather on a stranded or sunken vessel. Charted wrecks are of two kinds: stranded wreck, where any portion of the hull is above the chart datum; and sunken wreck, where the hull is below the chart datum or where the masts only are visible.

yaw, of airplane - The rotation of an aircraft about its vertical axis so as to cause the aircraft's centerline to deviate from the flight line. See also "roll" and "pitch". (see SOD 2)

y parallax - The difference between the perpendicular distances of the two images of a point from the vertical plane containing the air base. The existence of y parallax is an indication of tilt in either or both photographs and/or a difference in the flying height. Y parallax interferes with stereo viewing, measurement, etc. (see SOD 2)

Notice – all items highlighted are changes from previous versions of this SOW

Sources of Definitions (SOD)

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8. **SOCET SET User's Manual**, Version 5.4.1, October 2007, Appendix A - Glossary

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12. **ESRI GIS Dictionary** - http://support.esri.com/index.cfm?fa=knowledgebase.gisDictionary.gateway

13. **American Practical Navigator**, by N. Bowditch, NIMA, U.S. Department of Defense, Glossary, 1995, (on-line: http://msi.nga.mil/NGAPortal/MSI.portal?_nfpb=true&_pageLabel=msi_portal_page_62&pubCo de=0002

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15. **Surveying Measurements and their Analysis**, R.B. Buckner, 1983.

16. **Elements of Photogrammetry**, Paul R. Wolf, McGraw-Hill, Boston, Ma., 1983, p 419.

17. **Photogrammetry**, 2nd Ed., Francis H. Moffitt, International Textbook Co., Scranton Pa., 1967, p 337.

18. **Hydrographic Dictionary**, Special Publication 32, Fifth Ed., International Hydrographic Organization, 1994. (Now available on-line inter-actively at: http://www.iho-ohi.net/cgi-bin/cms/search.cgi?link=static&DATA=&search=dictionary

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21. **Wikipedia.**

22. **USACE Coastal Engineering Manual** Appendix A – Glossary of Coastal Terminology. http://140.194.76.129/publications/eng-manuals/ and scroll down.

Notice – all items highlighted are changes from previous versions of this SOW

ATTACHMENT N

SURVEY DISK

DIAGRAMS

REMOVED

TO
SCOPE OF WORK FOR SHORELINE
MAPPING UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC
SURVEY NATIONAL OCEAN
SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Notice – all items highlighted are changes from previous versions of this SOW

January 2018

ATTACHMENT O
GROUND PHOTO CONTROL

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

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ATTACHMENT O: GROUND PHOTO CONTROL

1.INTRODUCTION - Ground photo control is used to help establish scale, azimuth, and a coordinate system. For photography, pre-marked photo panels or photo identified control points may be used. Obtain property owner permission before any work. Blue-booking (entering data into NGS' data entry format) is not required for check points, ground photo control points, or for temporary survey points. If permanent survey marks are set, then Blue-Booking including digital descriptions in NGS format are required, see 2.3, below, and Attachment P.

1.1. CHECK POINTS - For shoreline mapping projects under this Scope Of Work (SOW) using film or digital cameras, at least four check points are required. These points shall have horizontal and vertical positions. In Alaska and other areas outside the continental United States where NAVD 88 bench marks are not available, the Project Instructions may require Global Positioning System (GPS) ties to tidal bench marks within the project area. The check points shall be approximately evenly spaced in the project area and shall be positioned using specifications listed below. On large projects, use at least one check point for every four strips, and at least one near each corner of a block. **These four, or more, check points shall not be used in the aerotriangulation computations, but rather serve as an independent check of the photogrammetric solution.** The contractor shall compare the ground positions of the check points to the results derived from the aerotriangulation solution and shall report these results to NGS in table form in the Report. Note, it is recommended that at each of the four locations, multiple points be located.

1.2. GROUND CONTROL - The Contractor may propose additional ground control to be used in the aerotriangulation. The Contractor shall determine an adequate number and distribution of ground control points. A description of the plan and the number, type and spacing of these points shall be included in the Technical Proposal. See also SOW, Section 6.2; Section 2.3 below, and MANUAL OF PHOTOGRAMMETRY (MOP), Fifth Edition, 2004.

1.3. AIRBORNE KINEMATIC GPS (KGPS) USED - All remotely sensed imagery (including color and infrared) for the Coastal Mapping Program (CMP) shall be positioned using airborne Kinematic GPS (KGPS) with dual-frequency, carrier-phase measurements. The use of an Inertial Measurement Unit (IMU) is recommended but not required. The Contractor shall use at least four check points (Section 1.1, above) and may use additional ground control (Section 1.2, above). See also MOP, Fifth Edition, pages 1112-1113.

1.4. GROUND CONTROL ONLY USED - For projects using ground control exclusively, the amount and distribution of the required photo control will depend on the project size, shape, and number of models, (for general guidelines, see MOP, Fifth Edition, pages 1111-1112. These projects performed with no airborne KGPS, shall have at least the following photo control: a point at the beginning and end of each strip, a point every five photos along a single strip, points near the corners of a block, a point every seven photos around the perimeter of a block, and additional vertical points in the interior of the block. In addition, at least four check points are required as described in Section 1.1 above. Additional requirements for airport control may be specified in the Project Instructions.

1.5 NGS FORMS – The required forms and photographs are listed in Attachment Q, Horizontal Control Forms.

2. CONTROL RECOVERY - All surveys shall be tied to the National Spatial Reference System (NSRS) using at least two points (Continuously Operating Reference Stations (CORS) and/or survey marks). The specified datums are the North American Datum of 1983 (NAD 83) and the North American Vertical Datum of 1988 (NAVD 88). See Attachment AG for guidance on recovering existing survey marks.

2.1. CONTINUOUSLY OPERATING REFERENCE STATION (CORS) TIES - NGS recommends that all surveys be tied to the NSRS by using the CORS system. No recovery is required for CORS. See the CORS map on the NGS www site at: https://www.ngs.noaa.gov/CORS/ . Note, National CORS and Cooperative CORS have now been combined into NGS CORS.

2.2 SURVEY MARK TIES – If CORS are not used, the next priority is to tie to stations with published coordinates derived from the most-recent national adjustment of NAD83. (https://www.ngs.noaa.gov/web/surveys/NA2011/). If the NSRS tie is done through other NSRS survey marks, the marks shall be at least second-order horizontal and third-order vertical. For all non-CORS stations recovered, NGS on-line or NGS format digital recovery notes are required. NSRS survey marks may be found in the NGS database at: https://www.ngs.noaa.gov/datasheets.

2.3 MARK DESCRIPTIONS AND MARK RECOVERY -

A. Mark Descriptions - If a new, permanent survey mark is set, a digital description in NGS format using NGS software WINDESC is required, see Attachment S. If a temporary survey mark (iron pin, PK nail, etc.) is set, complete NOAA Form 76-82, “Control Station Identification”. Digital photographs are required in both cases, two for temporary points and three photos for permanent marks. See Section 8 below, and Attachment R.

B. Mark Recovery - For NSRS survey marks recovered, the NGS on-line recovery method may be used (see: https://www.ngs.noaa.gov/cgi-bin/recvy_entry_www.prl), unless Ground Surveys under Attachment P are also being conducted in which case NGS software WINDESC shall be used. For the on-line recovery system, complete all required fields and enter recovery information in the text box at the bottom of the form. Note, this on-line system does not allow entry of new station descriptions nor photographs at this time. Include in the Ground Control Report a list of all marks recovered using this on-line system, and a printout of each recovery note and include photos. Recoveries may also be made using NGS software WINDESC. Digital photographs are required in both cases, see Attachment R.

2.4 CARE OF RECOVERY - Recovery of survey marks shall be done with the utmost care to provide accurate information. See Attachment AG for additional guidance. The description of an existing station shall be carefully evaluated and checked with ground details, and the distances and directions to reference marks should be checked. This will help ensure that the mark found is in fact the station being searched for and not a replacement station, a reference mark, an azimuth mark, or a nearby mark set by another agency with the same or similar name. The stamping and the agency name must agree exactly with the datasheet from the NGS database.

2.5 NGS DATASHEETS - Datasheets can be downloaded from the NGS WWW site at: https://www.ngs.noaa.gov/datasheets by using the Interactive Map or various methods of searching found under "Search By". For example using "Radial Search", enter the approximate latitude and longitude, scroll down to "Horizontal Order-2 or better", and then click on "Submit Query". GPS connections may also be made to PACS ("PAC and/or SAC"), which are located at many airports. See sample in Attachment Q. Data sheets for CORS may be found "using CORS site ID(s)", with full information on CORS found at https://www.ngs.noaa.gov/CORS/. Datasheets should be downloaded at the beginning of each project to ensure that the most recent data is available.

2.6 SURVEY DISKS - NGS and its parent organization NOS and its predecessor organization USC&GS have used many different letter castings on disks. Note, the letters cast or stamped into a disk generally include the agency name and the type of disk (reference mark, azimuth mark, etc.), and are produced during the manufacture of the disk. These letters are different from the designation (name) and year stamped by the surveyor when the mark is set. The name and date on the mark's datasheet must agree exactly with the information stamped on the disk to confirm that the correct mark is being used. In addition, all survey records must use this same exact name and date. Disk stampings shall not be altered at any time.

2.7 INTERSECTION STATIONS - Intersection stations such as smoke stacks, tanks, water towers, navigational aids, church spires, and radio masts may be used to establish an azimuth, but must have an azimuth check since they are subject to erroneous recovery. Such structures are sometimes demolished and rebuilt close to, but not in exactly the same location, or structures of similar appearance may exist in the same vicinity. The recovery of such stations should be verified not only by visiting the station site but also by questioning local officials.

3. SURVEY METHODS - Either conventional or GPS surveying techniques may be used.

3.1 CONVENTIONAL SURVEY POSITIONING TECHNIQUES - If conventional techniques are used, survey methods utilizing leveling, traverse, triangulation, and/or trilateration may be used to position photo panels or to perform photo identification. Surveys should result in horizontal accuracies of 0.1 meters, and vertical accuracies of 0.2 meters, or better. All surveys shall have an observational check including closing position and closing azimuth checks for horizontal surveys and an elevation check for vertical surveys. In addition, all survey records shall be checked.

3.2 GPS SURVEY POSITIONING TECHNIQUES - GPS techniques, such as static GPS, kinematic GPS, or Real Time (RT) GPS, which result in horizontal accuracies of 0.1 meter (vertical 0.2 meter) or better may be used to position photo panels and/or for photo identification. If Real Time methods are planned, consult https://www.ngs.noaa.gov/PUBS_LIB/UserGuidelinesForSingleBaseRealTimeGNSSPositioningv.3.1APR2014-1.pdf. Each new point should be occupied at least twice, independently, and for the length of time necessary to meet the accuracy requirements. Static positioning should be done by ties to CORS. **Weather data is not required**, and weather (meteorological) data is not available at CORS.

3.3 CONNECTIONS TO NSRS - Both horizontal and vertical surveys shall be connected to the NSRS. Connections should be made to at least three horizontal control stations in the NSRS and at least two vertical stations in the NSRS (NGS recommends using CORS as the highest priority for horizontal control and marks with published NAVD 88 orthometric heights as vertical control). Panels may be constructed directly over third-order or better, NSRS stations. Priority should be given to stations with published NAVD 88 orthometric heights as well as geodetic coordinates derived from the most-recent national adjustment of NAD 83. (Currently, the latest national adjustment of NAD 83 is NAD 83(2011) in the conterminous US and Alaska, NAD 83(PA2011) in the Pacific, and NAD 83(MA11) in the Marianas.)

3.4 TRIPODS - Fixed height tripods are recommended. Tripods with multiple height settings should be set to the highest position. All tripods shall be tested for stability, plumb alignment (straightness of center pole), and height verification at the beginning and end of the project. All tripods shall be examined for stability with each use. Ensure that hinges, clamps, and feet are secure and in good repair. Also, check, and adjust if necessary, the position of the bubble in the circular vial.

4. PENCIL RUBBINGS - The contractor shall capture a pencil rubbing of a marks' stamping (disk or logo cap) each time the mark is occupied for observations. Use the form found at: https://www.ngs.noaa.gov/surveys/forms/pencilrub.pdf, and in Attachment Q. When not

feasible to make the required rubbing, a sketch of the mark shall be substituted, accurately recording all markings. Photographs are not required at each occupation.

5. PRE-MARKED PHOTO CONTROL POINTS – When photo control panels (or targets) are used, the Contractor shall mark them with a temporary point such as an iron pin or PK type nail. Photo control points should have the following characteristics: be in the required location on the photograph, allow positive identification of the image point, and provide good measurement characteristics of the image point. Of these, location is the over-riding factor. The photographic images of the control panels must have sufficient quality for positive identification without excessive bleeding or blending with the background allowing repeat readings to at least 1/3 of a pixel on a softcopy work station. Panels may be installed directly over third-order or better, NGS NSRS stations, and also over newly positioned temporary marks accurate to 0.1 meter, or better, relative to the NSRS.

A triangular or square panel should be centered directly over the photo control point, with locating "wings" placed perpendicular to each side of the center panel. See Annex A, "Specifications for Premarking Control Stations" for recommended panel shapes and sizes. Modifications to the wings may be made as required by local circumstances. Wings may be placed further from the panel than the preferred distances listed on the diagram, but may not be located closer. A wing or wings may be deleted if the panel can be positively identified and the location of the panel precludes the placement of all wings. The identification and positioning of a nearby photo identifiable point is recommended in all cases and such a point shall be established when fewer than two wings can be placed at the panel. See also the Manual Of Photogrammetry, Fifth Edition, 2004, Sections 15.1.2.6, 15.1.3.2, and page 1114 for a target designed for softcopy photogrammetry.

6. PHOTO IDENTIFICATION POINTS – When Photograph IDentified (Photo ID) points are used, they should be temporarily marked, if possible. For Photo ID points, the Contractor shall search for features that can be seen and identified in the aerial photographs. The points identified shall be on a feature minimally elevated from the ground, if possible, such as a lone boulder along a shoreline. A point with high contrast such as the intersection of two sidewalks, an intersection of two highway paint stripes, or similar is ideal. Extreme care must be exercised to ensure that the point can be positively identified on a photo-pair, that the point is well defined allowing positive identification and exact pointing, and that the point has not changed since the date of the photography. An example of an excellent point would be the intersection of a sidewalk and a driveway. An example of a poor point would be the center of a dirt drive that has poorly defined edges.

7. CONTROL STATION FORM **- Control Station Identification (CSI) (NOAA Form 76-53) shall be completed for each check point, and ground control point, whether they be photo panel or photo ID points**. See Attachment Q for sample forms (blank and filled-in), and sample

ground control photos. All modifications to the standard panel must be depicted on the CSI form. In cases where the target panels have a high probability of vandalism, it is recommended that two nearby photo identifiable objects be positioned for redundancy.

8. PHOTOGRAPHS AND MAPS - **While at the site, three digital photographs shall be taken of each permanent mark, and two photographs shall be taken of each check point and ground control point used**. Photographs are only required during one visit to a mark.

TABLE OF DIGITAL PHOTOGRAPH REQUIREMENTS

	Permanent Marks	Check Points, Ground Control Points
Close-Up	V, Stamping legible	not required
Eye-Level	V, Mark & vicinity	H, vicinity
Eye-Level	H, show obstruction(s)	H, vicinity

V = vertical camera line-of-sight H = horizontal camera line-of-sight

For horizontal photos, show the mark in the foreground (with tripod in place, if possible) and the nearest obstruction or feature, such as trees, roads, bridges, telephone poles and buildings in the background. See Attachment R for detailed specifications. For photographs of check points and ground control points, the two horizontal views shall show the photo point from two different angles, with the tripod in place, if possible. Check points, ground control points, and temporary survey points all require the same formats for photo captions and photo file names. These are explained in Attachment R, Sections 3 and 4. Note, file names for photographs of all three of these type points shall begin with "RE". For these three type points, leave the "PID" field blank and the "Station Type" field blank.

Place a legible sign in each photo (except the close-up) showing the name of the panel or point (may use a white board and heavy marker). Captions on the photograph are no longer required.

In addition, the location of each check point and ground control point, and survey mark used shall be plotted on a large scale nautical chart of the area. See Attachment Q.

9. DATA PROCESSING - Survey ties using CORS data could be processed using the On-line Positioning User Service – Static (OPUS-S), Rapid Static (OPUS-RS), or Projects. See https://www.ngs.noaa.gov/OPUS/ for more details. Submit copies of OPUS results and comments on the results in the Ground Control Report.

9.1 OPUS - OPUS-S and OPUS-RS allow users to submit their GPS data files to NGS, where the data will be processed to determine a position using NGS computers and software. For OPUS-S, each data file that is submitted will be processed with respect to three CORS sites, and files will go through a more stringent geometric requirement for OPUS-RS. The sites selected may not be the nearest to the user's site but are selected by distance, number of observations, site stability, etc. The position for the user's data will be reported back via email in both International GNSS Service (IGS) Reference Frame and NAD 83 coordinates as well as Universal Transverse Mercator (UTM), U.S. National Grid (USNG) and State Plane Coordinates (SPC) northing and easting. Make sure the Rapid Orbits are available (usually after one work day) before uploading data to OPUS. OPUS-S processes data files of 2-48 hours in duration while OPUS-RS processes data files of 15 min - 2 hours.

OPUS-S SESSIONS – Sessions as short as two hours can be successfully processed in OPUS-S, but should typically use 90% or more of the observations, althought this may not be true during periods of more accurate results are achieved by processing sessions that are at least four hours in duration. Users should check the quality indicators ofan OPUS-S solution. A good OPUS run atmospheric or ionospheric disturbance. OPUS should have fixed at least 50% of the ambiguities, 70% preferred. The Peak-to-Peak errors should not exceed the required accuracy levels for horizontal (0.1m) and (0.2m) vertical.

See detailed OPUS-S analysis information at: https://www.ngs.noaa.gov/OPUS/about.jsp

Results obtained with OPUS-S may be improved by resubmitting data when a better ephemeris is available or by carefully selecting the CORS that OPUS uses.

Two sessions are recommended.

9.2 OPUS-RS - OPUS-RS is a version of OPUS designed to obtain geodetic quality positioning results from user data sets as short as 15 minutes to 2 hours. To do this, OPUS-RS uses an entirely different internal processing program than OPUS-S. Most of the external interface is the same as the original OPUS-S. Most of the information and explanations offered for the original OPUS-S also apply to OPUS-RS. OPUS-RS works best when the rover position is surrounded by CORS. This is not the case along the coast lines, so the solution is somewhat weaker. A minimum of two independent GPS sessions should be used to position all points.

Before using OPUS-RS, review the on-line information, including:

Using OPUS-RS -https://www.ngs.noaa.gov/OPUS/

OPUS-RS map–https://www.ngs.noaa.gov/OPUSI/Plots/Gmap/OPUSRS_sigmap.shtml

OPUS - Best Practices reference document for both OPUS-S and OPUS-RS, see https://www.ngs.noaa.gov/web/science_edu/presentations_archive/files/weston-soler-opusbestpractices.pdf

If OPUS-S or OPUS-RS is used, a separate least squares adjustment is not required.

9.3 OTHER OPUS VERSIONS - Any updates in this SOW's OPUS requirements will be included in the Project Instructions. NGS is currently developing new versions of OPUS and OPUS-Projects.

9.4 REAL TIME NETWORKS (RTN) – Check points and ground control points may be positioned using RTN if the following criteria are met. The RTN must be tied to the NSRS (should be tied through at least three stations) and at least one calibration shall be performed and reported. This calibration shall include positioning a point in the project with both RTN and OPUS. The positional comparison must be well within the accuracies stated in Section 3.1.
For additional information on RTN see
https://www.ngs.noaa.gov/PUBS_LIB/UserGuidelinesForSingleBaseRealTimeGNSSPositioningv.3.1APR2014-1.pdf

9.5 PROCESSING NON-CORS DATA - Non-CORS survey data shall be processed using standard techniques, including adjustment. All raw and processed data shall be submitted with formats and file naming conventions explained. The software used for data processing shall be pre-approved by NGS, but NGS software PAGES, ADJUST, etc. are not required to be used.

10. QUALITY CONTROL - The Contractor shall prepare and use a written Quality Control Plan, with a section on Photo Control. The Plan shall be supplied to NGS at the beginning of the project as part of their Technical Proposal. The section shall include all phases of this work. NGS requires that all manually collected data be checked (e.g. Heights of Instruments (HI)) and recommends that all manually recorded and manually computer entered data be checked.

11. GROUND CONTROL REPORT – Paper and PDF copies of the report are required. The Report shall include a discussion of:

- Project Identifier and location,
- Purpose,
- Names of firm(s) and individuals performing work,
- Methodologies used (OPUS, stop-and-go GPS, etc.), including length and number of GPS sessions,
- Equipment used (including model and serial numbers),
- Software used (including name and versions),
- Data processing,
- Data, raw and processed,
- Data formats and file naming convention,
- Final coordinates of all control, including whether point is panel or photo ID,
- NOAA Form 76-53, "Control Station Identification", for each photo control point,
- Recovery Notes for survey marks used, (submit on-line and digital),
- A listing of all stations recovered using NGS' On-line "Mark Recovery Form,"
- Whether or not any data was submitted in "Blue-Book" format,
- Photographs of points surveyed, digital copies,
- Unusual circumstances,

- Equipment malfunctions,
- A brief analysis of all results,
- A statement as to whether or not the work meets the SOW and Project Instructions requirements, including accuracy,
- Recommendations,
- The NGS Visibility Obstruction Diagram" and the NGS "GPS Station Observation Log" may be used but are not required.

Any work not meeting specifications must be fully discussed in the report, including dates of prior communication with NGS, and justification.

If Ground Surveys under Attachment P were also performed, submit one combined report.

Notice – all items highlighted are changes from previous versions of this SOW

December 2017

ATTACHMENT P
GROUND SURVEYS

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
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ATTACHMENT P: GROUNDSURVEYS

1. INTRODUCTION

Ground surveys may be required to extend control into a project area and thereby ensure connection to the National Spatial Reference System (NSRS). However, in most shoreline mapping projects, ground surveys under this Attachment P will not be required because suitable accuracies (i.e., 0.1 m horizontally and 0.2 m vertically) can be achieved following the ground photo control connections given in Attachment O. In the case that higher accuracies are desired for establishing control, then campaign-style ground surveys as specified below are required. Blue-booking (entering data into National Geodetic Survey (NGS) data entry format), or submitting data into the On-line Positioning User Service - Static (OPUS-S), OPUS –Rapid Static (OPUS-RS), OPUS-Data Base (OPUS-DB), or OPUS – Projects, is required for Ground Surveys, see the Project Instructions for further requirements.

1.1. CHECK POINTS - The four or more check points required by the Scope of Work (SOW) are described in Attachment O, Section 1.1 should be connected to any Ground Surveys performed.

1.2. GROUND PHOTO CONTROL - Ground photo control surveyed for this project are described in Attachment O, Section 1.2, and should be connected to any Ground Surveys performed.

1.3. AIRBORNE KINEMATIC GLOBAL POSITIONING SYSTEM (KGPS) USED - See Attachment O, Section 1.3 for requirements for airborne KGPS.

1.4. NGS FORMS – The required forms and photographs are listed in Attachment Q, Introduction.

2. CONTROL RECOVERY

All surveys shall be tied to the National Spatial Reference System (NSRS) using at least two points: CORS and/or survey marks. The specified datums are the North American Datum 1983 (NAD 83) and the North American Vertical Datum 1988 (NAVD 88).

2.1. CORS TIES - NGS recommends that all surveys be tied to the NSRS by using the CORS system. If a CORS is used, no recovery is required for the CORS. See the CORS map on the NGS www page at: https://www.ngs.noaa.gov/CORS/

2.2. SURVEY MARK TIES – If CORS are not used, the next priority for tie stations are those included in the NAD 83(YYYY) National Adjustment https://www.ngs.noaa.gov/web/surveys/NA2011/ If the NSRS tie is done through other survey marks, the marks shall be at least second-order horizontal and third-order vertical, and digital recovery notes are required. NSRS survey marks may be found in the NGS database at:

https://www.ngs.noaa.gov/datasheets/.

2.3. MARK DESCRIPTIONS AND MARK RECOVERY

A. MARK DESCRIPTIONS – For all new marks set and for all marks used that were not previously in the NGS database, the Contractor shall write a digital description in NGS format using NGS software WinDesc, see Attachment S. Digital photographs are required, see Attachment R.

B. MARK RECOVERY – For all NSRS marks recovered while performing Ground Surveys, the contractor shall write a digital recovery note using NGS software WinDesc. The NGS on-line recovery method may not be used. See Attachment AG for guidance on recovering marks. Digital photographs are required, see Attachment R.

Submit a copy of all descriptions and recovery notes with the Ground Control Report.

2.4. CARE OF RECOVERY - Recovery of survey marks shall be done with the utmost care to provide accurate information. The description of an existing station shall be carefully evaluated and checked with ground details, and the distances and directions to reference marks should be checked. This will help ensure that the mark found is in fact the station being searched for and not a replacement station, a reference mark, an azimuth mark, or a nearby mark set by another agency with the same or similar name. The stamping and the agency name must agree exactly with the datasheet from the NGS database.

2.5. NGS DATASHEETS – Datasheets can be downloaded from the NGS WWW site at: https://www.ngs.noaa.gov/datasheets, by using the Interactive Map or various methods of searching found under "Search By". For example using "Radial Search", enter the approximate latitude and longitude, scroll down to "Horizontal Order-2 or better", and then click on "Submit Query". GPS connections may also be made to PACS ("PAC and/or SAC"), which are located at many airports. See sample in Attachment Q. Data sheets for CORS may be found "using CORS site ID(s)", with full information on CORS found at https://www.ngs.noaa.gov/CORS/. Datasheets should be downloaded at the beginning of each project to ensure that the most recent data is available.

2.6. MARK SETTING – The importance of setting quality monuments cannot be over emphasized. Monuments that are properly located and set can provide decades of valuable use for surveying operations. Proper attention and workmanship must be given to all the steps in the process including the basic tasks of hole digging, rod driving, concrete mixing and pouring, and finishing the monument. The only physical evidence remaining after a survey has been completed are the monuments; therefore, permanency and neatness of the monument and the surrounding area are of utmost importance.

After existing marks have been recovered and proposed sites for new marks determined, the Contractor shall obtain permission from the property owner before beginning mark setting. The Contractor shall also inquire about underground utilities and future construction that might affect mark longevity. “MISS UTILITY” type services should be contacted before driving rod or digging, this may be required by state or local regulation.

All new permanent survey marks shall be set to NGS specifications for type, length, material, stability, stamping, driving, etc. outlined in Attachments T, U, V, W, AG, and NGS publication “Geodetic Bench Marks”, on-line at: https://www.ngs.noaa.gov/PUBS_LIB/GeodeticBMs/ .

Witness posts should be set unless the property owner objects, the post cannot be driven, or the mark should not be made easily visible because of a high risk of vandalism. Witness Posts are usually not set on airports. Witness posts set shall contain the standard NGS witness post logo

2.7 SURVEY DISKS - NGS and its parent organization NOS and its predecessor organization USC&GS have used many different letter castings on disks. Note, the letters cast or stamped into a disk generally include the agency name and the type of disk (reference mark, azimuth mark, etc.), and are produced during the manufacture of the disk. These letters are different from the designation (name) and year stamped by the surveyor when the mark is set. Confirm that all the information stamped on the disk agrees with the NGS Datasheet. Disk stampings shall not be altered at any time.

2.8. INTERSECTION STATIONS - Intersection stations such as smoke stacks, tanks, water towers, navigational aids, and radio masts may be used to establish an azimuth, but must have an azimuth check since they are subject to erroneous recovery. Such structures may be demolished and rebuilt close to, but not in exactly the same location, or structures of similar appearance may exist in the same vicinity. The recovery of such stations should be verified not only by visiting the station site but also by questioning local officials.

3. SURVEY METHODS

Either conventional or GPS surveying techniques may be used to connect the surveys to the NSRS.

3.1. CONVENTIONAL SURVEY POSITIONING TECHNIQUES - If conventional techniques are used, survey methods utilizing leveling, traverse, triangulation, and/or trilateration may be used. Surveys should result in horizontal accuracies of 0.05 meters, and vertical accuracies of 0.1 meters, or better. All surveys shall have an observational check including closing position and closing azimuth checks for horizontal surveys and an elevation check for vertical surveys. In addition, all survey records shall be checked.

3.2. GPS SURVEY POSITIONING TECHNIQUES - If GPS techniques are used, static GPS techniques with dual frequency GPS receivers shall be used. Each new point shall be occupied twice. All surveys should be connected to the NSRS via connections to CORS (horizontal control) and marks with published NAVD 88 orthometric heights (vertical control). NGS recommends observing two independent sessions at a minimum of 2 hours in duration (4 hours recommended) per mark, collecting data at 15 second epochs, and using a 15 degree elevation mask.

3.3. CONNECTIONS TO NSRS – Both horizontal and vertical surveys shall be connected to the NSRS. For horizontal control, three connections should be made to the following in order of priority: NGS CORS, survey stations included in NAD 83 (YYYY), and second-order, or better, horizontal stations. For vertical control, connections shall also be made to two NGS bench marks, within 50 miles, if possible.

For additional information on geodetic quality GPS observations see the COMET educational videos at https://www.ngs.noaa.gov/corbin/class_description/NGS_Video_Library.shtml

Weather data is not required, and weather (meteorological) data is not available for CORS.

3.4 FINDING CORS – CORS may be found by visiting https://www.ngs.noaa.gov/CORS/ .

3.5 FINDING NAD 83 (YYYY) STATIONS – Visit the NGS web page at: https://www.ngs.noaa.gov/datasheets/ .

3.6. FINDING SECOND-ORDER OR BETTER STATIONS - NSRS second-order or better stations may be found in the NGS database by visiting https://www.ngs.noaa.gov/datasheets/, then clicking on "Radial Search". Enter the approximate latitude and longitude, scroll down to "Horizontal Order-2 or better", and then click on "Submit Query". GPS connections may also be made to PACS ("PAC and/or SAC"), which are located at many airports. Conduct a similar search for vertical control points.

3.7. GPS TIES TO TIDAL BENCH MARKS – A GPS tie to a tidal bench mark should consist of two, independent sessions, each at least 2 hours in duration (four hours or more recommended). See additional specifications in Section 3.2 above.

3.8 TRIPODS - Fixed height tripods shall be used. Tripods with multiple height settings should be set to the highest position. All tripods shall be tested for stability, plumb alignment (straightness of center pole), and heights verification at the beginning and end of the tripiods shall be examined for stability with each use. Ensure that hinges, clams, and feet are secure and in good repair. Also, check, and adjust if necessary, the position of the bubble in the circular vial.

4. VISIBILITY OBSTRUCTION DIAGRAMS AND MARK RUBBINGS

4.1 VISIBILITY OBSTRUCTION DIAGRAMS - These diagrams shall be prepared for each station to depict any trees, buildings, mountains, wires, or other obstructions which may interfere with the GPS line-of-sight satellite signals. These diagrams are useful during processing to explain signal losses, multipath, or radio-interference. To fill out or check this form, use a magnetic compass to measure bearings and an inclinometer to measure vertical angles to obstructions. Sketch the surrounding obstructions as seen from the antenna viewpoint. The diagram depicts a "fish-eye" or "bubble" view of the sky over the antenna. The edges of the circle are the horizon, and the center of the circle is zenith. The NGS "Visibility Diagram" is available in Attachment Q, and a digital version at: https://www.ngs.noaa.gov/surveys/forms/

4.2 . PENCIL RUBBINGS - The contractor shall capture a pencil rubbing of a marks' stamping (disk or logo cap) each time the mark is occupied for observations. Use the form found at: https://www.ngs.noaa.gov/surveys/forms/pencilrub.pdf, and in Attachment Q. When not feasible to make the required rubbing, a sketch of the mark shall be substituted, accurately recording all markings. Photographs are not required at each occupation.

5. GPS OBSERVATION LOGS

GPS Logs shall be used to record all equipment, activities, and other metadata associated with a GPS observing session. Please be very careful and thorough when filling out this form. GPS receivers and antennas must be uniquely identified by manufacturer, model names and numbers, and complete serial numbers. The antenna setup and height measurements must be explicitly described, using sketches and photographs if possible. All height measurements shall be checked. Any non-standard conditions shall be noted and explained. To ensure that all entries are correct, have another person check all data on the log and sign the bottom of the form as "Checked by" with their full name. The NGS "GPS Station Observation Log" is available in Attachment Q and the digital version at:
https://www.ngs.noaa.gov/RSD/forms/obslog.pdf or https://www.ngs.noaa.gov/surveys/forms/
. See Attachment Q for form requirements, sample forms (blank and filled-in), and sample ground photographs.

6. CONTROL STATION FORM

Control Station Identification (CSI) (NOAA Form 76-53) is not required.

7. PHOTOGRAPHS AND MAPS

While at the site, three digital photographs shall be taken of each permanent mark, and two photographs shall be taken of each panel, and/or photo identifiable point used. Refer to https://www.ngs.noaa.gov/web/surveys/photo_submissions for recommendations.

TABLE OF DIGITAL PHOTOGRAPH REQUIREMENTS

	Permanent Marks	Photo Control Points
Close-Up	V, Stamping legible	not required
Eye-Level	V, Mark & vicinity	H, vicinity
Eye-Level	H, show obstruction(s)	H, vicinity

V = vertical camera line-of-sight H = horizontal camera line-of-sight

For horizontal view photos, show the mark in the foreground (with tripod in place, if possible) and the nearest obstruction or feature, such as trees, roads, bridges, telephone poles and buildings in the background. See Attachment R for detailed specifications.

For photographs of photo control points, the two horizontal views shall show the photo point from two different angles, with the tripod in place, if possible. Photo and file naming conventions are not required for photo points.

Place a legible sign in each photo (except the close-up) showing the name of the mark (may use a white board and heavy marker). Captions on the photograph are no longer required.

In addition, the location of each panel, photo identifiable point, and survey mark used shall be marked on a large scale nautical chart of the area. See Attachment Q for samples of both.

8. DATA PROCESSING

All survey data shall be processed using standard techniques, including adjustment, and submitted in "Blue Book" format. See NGS guidelines for processing and adjusting static GPS survey campaigns at: https://www.ngs.noaa.gov/PC_PROD/ADJUST/adjustment_guidelines.pdf . All raw and processed data shall be submitted with formats and file naming conventions explained. The software used for baseline processing shall be pre-approved by NGS, and NGS software ADJUST must be used for adjusting the survey network by least squares and for preparing the results for Blue Booking.

Survey ties using CORS data may be processed using the On-line Positioning User Service (OPUS), see: https://www.ngs.noaa.gov/OPUS/ as a check prior to performing an adjustment. The OPUS-S www site states that at least two hours of data is required for standard OPUS. Make sure the Rapid Orbits (see: https://igscb.jpl.nasa.gov/components/prods_cb.html) are available (usually one work day) before uploading data to OPUS. OPUS-RS may also be used as a data quality check prior to adjustment. See Section 3 above for definitions.

9. QUALITY CONTROL

The Contractor shall prepare and use a written Quality Control Plan with a section on Ground Control. The Plan shall be supplied to NGS at the beginning of the project as part of the Technical Proposal. The plan shall include all phases of this work. NGS requires that all manually collected data be checked (e.g. Heights of Instruments (HI)) and requires that all manually recorded and manually computer entered data be checked.

10. GROUND CONTROL REPORT

Submit a digital copy of the Report in PDF format.

The Report shall include a discussion of:

- Project Identifier and location,
- Purpose,
- Name of firm(s) and individuals performing work,
- Methodologies used (static GPS, etc.),
- Equipment used (including model and serial numbers),
- Software used (including name and versions),
- Data processing,
- Data, raw and processed,
- Data formats and file naming convention,
- WINDESC format Descriptions and Recovery Note copies,
- "Blue-Book" required files (see Attachment P, Annex A)
- photographs of points surveyed, digital copies,
- Paragraph summarizing analysis of results,
- Unusual circumstances,
- Equipment malfunctions,
- A statement as to whether or not the work meets the SOW and Project Instruction requirements and accuracies, and Recommendations,
- NGS Visibility Obstruction Diagrams,
- NGS "GPS Station Observation Log".

Any work not meeting specifications must be fully discussed in the Report, including dates of prior communication with NGS, and justification.

Notice – all items highlighted are changes from previous versions of this SOW

ANNEX A - PROJECT SUBMISSION CHECKLIST - GPS PROJECTS

Project Title:_________________________________Accession Number:_
____ Submitting
Agency:_______________________________________Observing Agency:_
____ Receiver Type:_
____

PACKAGE CONTENTS

Project Report and Attachments **Required For**

( ) Ground Control Report All Projects
( ) Approved Reconnaissance and Project Sketch All Projects
( ) Project Instructions or Contract Specifications All Projects
( ) Final Station List All Projects
( ) Station Visibility Diagrams All Projects
( ) Final Observing Schedule All Projects
( ) Observation Logs All Projects
( ) Equipment Failure Logs NGS Projects
( ) Loop Misclosures Optional
( ) Free Adjustment with Analysis All Projects
( ) Constrained Horizontal Adjustment with Accuracies All
Projects **( )** Constrained Vertical Adjustment (NAVD 88 Heights)
All
Projects ( ) Meteorological Instrument Comparison Logs If
Specified
( ) Photographs of Views from Stations If Specified
( ) Photographs or Rubbings of Station Marks All
Projects ( ) CHKOBS Output (Validation program-B-file) All
Projects ( ) OBSDES Output (Validation program-B/D-files) All
Projects
( ) OBSCHK Output (Validation program-B/G-files) All
Projects ( ) Windesc Check Output (Validation program-D-file) All
Projects

Digitized Data Files ( ) Diskettes ( ) Other:______________________

( ) Raw Phase Data (R-files) All Projects
( ) Base Line Vectors (G-file) All
Projects ( ) Project and Station Occupation Data (Final B-file) All
Projects ( ) Descriptions or Recovery Notes (D-file) All
Projects
( ) Terrestrial Horizontal Observations (T-file) If Applicable
( ) Differential Leveling Observations (L-file) If Applicable

Comments - Enter on the reverse side of this form.

Org Code **Name** **Date**

Received by: ____
Reviewed by: ____

Notice – all items highlighted are changes from previous versions of this SOW

December 2017

ATTACHMENT Q
HORIZONTAL CONTROL FORMS

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

ATTACHMENT Q - HORIZONTAL CONTROL FORMS

For information explaining which forms are required, see the Table, "Requirements for Coastal Mapping Projects" on Q – Page 4.

Q1. Use program WinDesc to create digital descriptions in National Geodetic Survey (NGS) format. WinDesc print outs descriptions in a format very similar to an NGS Datasheet from the NGS database, see Q19 below. The WinDesc printout contains the following statement warning that is not an official Datasheet, "Warning – This is a preliminary description not yet in the NGS data base." To download WinDesc, go to:
http://www.ngs.noaa.gov/PC_PROD/pc_prod.shtml#WinDesc .

Q2. "Mark Recovery Entry" form on NGS WWW site (blank)
Q3. "Mark Recovery Entry" form on NGS WWW site (filled in sample)
For entries on-line, see: https://www.ngs.noaa.gov/cgi-bin/recvy_entry_www.prl. This recovery method is recommended for non-"Blue Book" projects.

Q4. "NGS Station Description/Recovery Form" (Short paper version, 2p), (blank)
Q5. "NGS Station Description/Recovery Form" (Short paper version, 2p), (filled-in sample) For on-line versions (blank and filled-in) see: https://www.ngs.noaa.gov/RSD/forms/recovery.pdf .
This form is good to use in the field, but is not required.

Q6. "NGS - GPS Observation Log" (Info. at time of GPS observations, 2p), (blank)
Q7. "NGS - GPS Observation Log" (Info. at time of GPS observations, 2p), (filled-in sample) For on-line versions (blank and filled-in) see: https://www.ngs.noaa.gov/RSD/forms/obslog.pdf .

Q8. "NGS Visibility Obstruction Diagram" (GPS satellite visibility, 1p), (blank)
Q9. "NGS Visibility Obstruction Diagram" (GPS satellite visibility, 1p), (filled-in sample) For on-line versions (blank and filled-in) see: https://www.ngs.noaa.gov/surveys/forms/visibility.pdf . The alternate form, "Station Location Sketch and Visibility Diagram" may be used instead.

Q10. "Station Pencil Rubbing Form" (blank)
Q11. "Station Pencil Rubbing Form" (filled-in sample)
For on-line versions (blank and filled-in) see:
https://www.ngs.noaa.gov/surveys/forms/pencilrub.pdf .

Q12. "Station Location Sketch and Visibility Diagram" (New), (blank)
Q13. "Station Location Sketch and Visibility Diagram" (New), (filled in sample)
For on-line versions (blank and filled-in) see:
https://www.ngs.noaa.gov/surveys/forms/visibility2.pdf.
This form (three windows + page 2) may be used to replace the "Visibility Diagram," the "Pencil Rubbing," and the "Station Description/Recovery" forms.

Q14. "Control Station Identification" (NOAA Form 76-53; 1 page, blank); Use this form to describe photo panels, photo ID points, and other temporary points.

Q15. "Control Station Identification" (NF 76-53; 1 page, filled-in
This form is not available on-line, but is included in digital version of SOW.

Q16. Digital Photographs-Close-Up - Samples of the three required digital photographs of permanent marks, see Attachment R for additional details.

Q17. Sample photographs of good quality photo control points.

Q18. Sample project area map showing flight lines, survey points, and approximate photo panel locations.

Q19. NGS Data Sheet printout of survey station (Sample output from NGS database, 2p)
To search for a data sheet, see: https://www.ngs.noaa.gov/datasheets/.

Notes:
The www sites listed above contains PDF versions of the forms which may be printed out or completed on-line.

Acronyms:
GPS – Global Positioning System
WWW – World Wide Web
PDF – Portable Document Format

Notice – all items highlighted are changes from previous versions of this SOW

FORM REQUIREMENTS FOR COASTAL MAPPING PROJECTS

REQUIRED TYPE SURVEY	WINDESC (Station Desc. in NGS format	NGS WWW ON-LINE REC FORM Q2-3	STATION DESC/ RECOVERY FORM FORM Q4-5	NGS GPS OBSERVA LOG FORM Q6-7	VISIBILITY DIAGRAM FORM Q8-9	PENCIL RUBBING Q10-11	CONTROL STATION ID. (NF 76-53) Q14-15	3 DIGITAL PHOTOS Q16	2 DIGITAL HORIZONTAL PHOTOS Q17	PROJECT AREA MAP Q18
NEW GROUND BASE STATION (MK SET)	YES	-----	RECOM.	YES	YES	AT EACH OBSERVA	-----	YES	-----	YES
NEW GROUND BASE STATION (TEMP PT)	-----	-----	-----	YES	YES	AT EACH OBSERV	YES	-----	YES	YES
GROUND BASE STA. (EXISTING MARK)	-----	YES	RECOM.	YES	YES	AT EACH OBSERVA	-----	YES	-----	YES
CHECK POINT	-----	-----	-----	RECOM.	RECOM.	AT EACH OBSERVA	YES	-----	YES	YES
PHOTO CONTROL PT	-----	-----	-----	RECOM.	RECOM.	AT EACH OBSERVA	YES	-----	YES	YES
GROUND SURVEY PT (BLUE-BOOK PROJECT)	YES	-----	RECOM.	YES	YES	AT EACH OBSERVA	-----	YES	-----	YES

Notes:
1. All NSRS stations found will be recovered using WINDESC (for Blue-Book projects), or using the NGS on-Line "Mark Recovery Entry" system.
2. Forms Q12 and Q13, the new "Station Location Sketch and Visibility Diagram" form (three windows + page 2) may be used to replace the "Visibility Diagram", the "Pencil Rubbing", and the "Station Description/Recovery" forms.
3. See Attachment R for digital photograph requirements.

Notice – all items highlighted are changes from previous versions of this SOW

December 2017

ATTACHMENT R
REQUIREMENTS FOR DIGITAL PHOTOGRAPHS OF SURVEY CONTROL

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

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ATTACHMENT R - REQUIREMENTS FOR DIGITAL PHOTOGRAPHS OF SURVEY CONTROL — PAGE

ATTACHMENT R: REQUIREMENTS FOR DIGITAL PHOTOGRAPHS OF SURVEY CONTROL

1.PURPOSE - This document describes digital photographic standards for images of survey marks that will be stored in the National Geodetic Survey (NGS) database and for other reconnaissance photographs (including photo ground control). Since many of these images will be in the NGS database and available to the public, the photograph subject matter (survey equipment, personnel, background, etc.) shall be in good taste and professional in nature.

Digital photographs are useful for station (mark) reconnaissance, mark recovery, mark stability assessment, quality control, and as an aid during data processing and data verification. Some projects may require digital photographs during more than one stage of the project. The photographs stored in the NGS database will be accessible to future users. The table below summarizes the required photographs. Detailed descriptions of the photographs follow.

2.SURVEY MARK PHOTOGRAPHS - This section states the requirements for digital photographs of new and existing survey marks. For overall guidance, see: https://www.ngs.noaa.gov/web/surveys/photo_submissions/. For the requirements for reconnaissance photographs, including photo control points, runways, etc., see Section 3, below.

Take all photographs during daylight hours.

Take all photos of the same point consecutively, (photo #1, #2, then #3) so that they are all stored together in the camera's memory. This should help avoid misidentifying photos later.

2.1 NUMBER OF SURVEY MARK PHOTOGRAPHS - At least three digital photographs are required for each permanent mark recovered or described. This means marks for which a written, NGS format, digital description or recovery note was prepared. The three photographs are described as numbers: (1) extreme close-up, (2) eye-level (5-6 feet distant), and (3) horizontal view (approx. 10-30 feet distant). All three photographs require correct file names. Photographs type #2 and #3 also require a **small, temporary sign** in the photograph. Use a small sign with large, clear letters (e.g. white board with dark marker). Ensure that the sign is legible in the photograph and that it does not cover any portion of the mark, the monument, or any important feature. Have a tripod in place over the mark for photo #3, if possible.

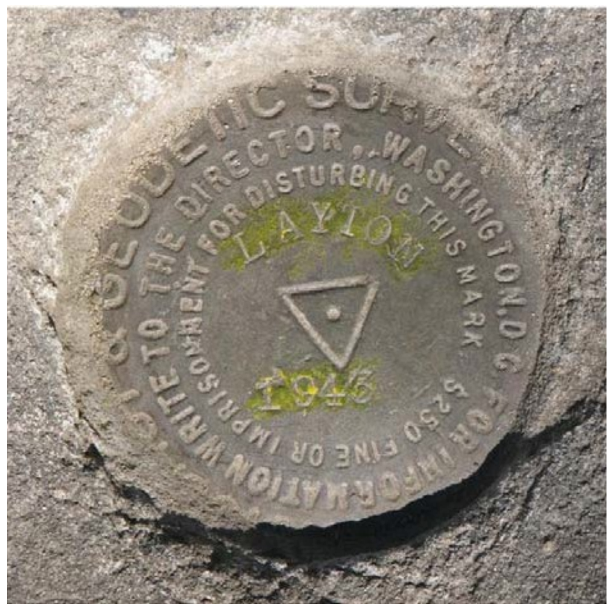
REQUIRED PHOTOGRAPHS

All Permanent Marks Recovered and/or Described
1. Close-up (Taken Vertically; so stamping is clear and legible)
2. Eye level (Taken Vertically; shows mark and area)
3. Horizontal view(s), mark in foreground, feature(s) in background

Take sufficient photographs to describe the stamping, appearance, condition, and location of the mark and points of potential interest including visibility obstructions, buildings, trees, roads, runways, taxiways, or other dangers, and any special set-up requirements, etc. Alter the orientation of the photographs as necessary to include this information in as few photographs as possible. For example, for a tall obstruction, rotate the camera 90 degrees so that the longer axis of the image is vertical. Capture the full heights (including tops) of nearby obstructions, if possible. If a station already has acceptable photographs in the NGS database, additional photographs are not required, unless changes have occurred or more than one year has passed. An “acceptable photograph” is defined as an image that meets the requirements of this document, is of good visual quality, and that no changes have taken place that a new photograph would help clarify.

2.2 CAPTION - A caption on each photograph is no longer required. If the camera allows, include the date and time on the image.

2.3 DESCRIPTION OF PHOTOGRAPHS:



A. CLOSE-UP (#1) - For permanent survey marks, the first photograph (type #1) will be a close-up, taken vertically. It will be oriented downward to show the survey mark from directly above with the disk or logo cap nearly filling the image. The tripod shall not be in place when this photograph is captured. Remove any dirt, debris, water, or snow to show the complete disk. Avoid shadow lines crossing the disk. If it has a logo cap, the logo cap should be open. The intent of this photograph is to **clearly show the mark, its condition, and all stamping on the mark or logo cap so that it is clearly legible**. Use extra care to ensure that the stamping is clear. Suggestions: set the camera to its highest quality and resolution modes; rub a yellow crayon across the stamping to highlight the letters, or use a white house-hold powder for highlighting; set the camera to “macro” mode, if available; consider the minimum focusing distance of the camera (take test photographs to determine the minimum focusing distance and consult the camera owner’s manual) ; and, if a flash is used, hold the camera above and off to the side so that the flash does not create a bright spot in the middle of the disk’s image, due to the reflection of the flash. Note, medium quality and resolution camera modes may be used for photographs other than the close-ups. If additional close-up photographs are required, number these close-ups as 1A, 1B, etc.

B. EYE-LEVEL (#2) - For permanent survey marks, this photograph (type #2) will be oriented vertically downward from eye level to show the monument from directly above and cover an area about 1 meter in radius, all around the mark. The tripod shall not be in place when this photograph is captured. Remove any dirt, debris, water, or snow from the mark to show the disk and the setting. If it is a concrete monument, clear off debris to the edge of the monument. If it has a logo cap, the logo cap should be open. **Include a small, temporary sign in this photograph with the station designation (name) printed so it is clearly visible in the photograph.** The intent of this photograph is to show the general condition of the mark and the immediate surrounding area, especially any condition that would be a threat to the stability of the mark. If additional photographs are required, number these eye-level photos as 2A, 2B, etc.

C. HORIZONTAL VIEW(S) (#3) - For permanent survey marks, take at least one additional, daylight photograph oriented near horizontal (type #3) and show the mark, with tripod and antenna (if possible), in the foreground, and the mark's identifying surroundings and any significant obstructions or possible sources of multi-path in the background. Show the top of nearby obstructions, if possible. Consider rotating the camera 90 degrees to use the long axis of the image to capture entire obstructions. **Place a temporary sign in this photograph with the station designation (name) and the direction the camera is pointing, both printed so they are clearly visible in the photograph.** If additional photographs are taken, ideally move around the mark to locations which are 90 degrees apart (preferably cardinal directions). Name these photographs number 3XX, where the "XX" is the cardinal direction the camera is pointing, for example, 3N or 3NE.

3.RECONNAISSANCE PHOTOGRAPHS - Some, none, or all of the digital images described in this section may be required on a given project; refer to the Project Instructions. Each of these photographs requires a legible sign and the correct file name. **The file names for all of these photographs shall begin with "RE" to indicate REconnaissance.**

Required Item	Contents	Description
Sign in Photo	Name & Direction (unless vertical photo)	Place a sign in this photograph with the station designation (name) and the direction the camera is pointing, both printed so they are clearly visible in the photograph.
Digital Caption	No longer required	
Photo File Name	RE-PID*-Name-Number-Date.jpg	See Section 4.4 below

*PID = Permanent Identifier

All of the images required by this section shall be designated as reconnaissance (recon) with the letters "RE" at the beginning of their file names. Generally these recon images will not be loaded in the NGS data base but may be required for use during planning, review, etc. Note, in these specifications, **"RE" stands for "REconnaissance"** and "R" stands for "Right" runway.

See the Project Instructions to determine which, if any, of the following are required:

3.1 PROPOSED LOCATIONS FOR MARKS - Take two photographs of each proposed permanent mark location. These should be two #3 (3A and 3B) photographs. Include a tripod, stake, sign, or other device showing the proposed mark location.

3.2 RUNWAY END PHOTOGRAPHS - For airport projects, take at least three photographs at the end of each runway (including thresholds and stopways), as follows:

- Eye-Level (photo type #1) - photo from directly above the mark, showing about 1 meter in diameter,
- Approach (photo type #3) - photo showing tripod over mark in foreground and approach in background
- Across runway (photo type #3) - photo taken from the side of the runway looking across the end of the runway, with a tripod or arrow indicating the end point; include any features used to identify the runway end.

3.3 NAVIGATION AIDS (NAVAIDS) - Take photos (type #3) of all NAVAIDS surveyed. Show the survey tripod in place to indicate the exact point surveyed, or if positioned remotely, add arrows and labels to the photograph indicating the horizontal and/or vertical point(s) surveyed.

3.4 DEPTH OF HOLE PHOTOGRAPHS - Take at least one photograph showing the hole dug or drilled for a concrete or rod mark. Place a measuring device (e.g., tape measure or level rod) in the hole, clearly showing the depth of the hole and clearing showing the readings on the tape or rod. Also show the measurement of the diameter of the hole, and show the belled-out bottom portion of the hole.

3.5 PHOTOGRAMMETRIC CONTROL POINTS AND CHECK POINTS (Paneled and photo identified) - **Take two #3 type photographs** (3A and 3B) of all photogrammetric control points clearly showing the point. This requirement includes both ground control points and ground check points. These photos may be used later as an aid in identifying the point on the aerial photographs. Show the mark in the foreground and the nearest identifiable feature in the background. The two photographs should be taken from two different directions, ideally 90 degrees apart (such as from the East and the South). Indicate the location of the survey point in the photograph. It may be helpful to have the survey tripod in the photograph.

3.6 OTHER REQUIRED PHOTOGRAPHS - as may be required by other instructions.

4. GENERAL:

a. IMAGE SIZE - Each image should be about 800 by 1000 pixels when submitted.

b. FILE SIZE - Maximum file size for each image is 500 KiloBytes (KB), typical file size should be about 50 – 100 KB.

c. IMAGE FORMAT - Store the digital photographs in JPEG format, approximately 50% reduction.

d. PHOTOGRAPH FILE NAME - Use the following file naming convention: “RE” (for reconnaissance photographs only), dash, the PID, dash, the station designation, dash, the photo type number (1, 1A, 2, 3N, or 3NE, etc.), dash, date, dot, jpg. For new marks, there is no PID. Use a maximum of 30 alpha-numeric characters to the left of the dot.

Sample File Names

For new stations:	SMITH-3-date.jpg
For existing stations:	AB1234-JONES-1-date.jpg
For recon/photo control photos:	RE-MILLER-3N-date.jpg
For runway end point:	RE-LAX_CL_END_RWY_12R-3-date.jpg

For the runway end point example, “RE” = reconnaissance, dash, LAX = Location Identifier (LID), dash, “CL END RWY 12R” = runway end point designator (CL = centerline, END = end, RWY = runway, 12 = runway number, and R = right (or C = center, or L = left), dash, "3" = photo number, and date. Note, "_" (underscores) used to fill blanks. Note, in these specifications, "RE" stands for "reconnaissance" and "R" stands for "right" runway (used if there is a parallel set of runways). Also, the LID may be four characters rather than just three.

The format for the date is: "yyyymmdd", all numeric.

5. STORAGE MEDIUM - Submit all digital photos for permanent marks (3 photo sets) together on their own archival quality Digital Video Disk (DVD), **not on the same medium with other types of data**. Label this disk with the Project name, number, and the words "Database Photos", and use a DVD safe pen. Submit all RE photos on a separate DVD, also labeled. Do not apply paper labels to DVDs. For airport work, submit all photos for a given airport in a subdirectory named for that airport.

*Acronyms:
CBN - Cooperative Base Network
CORS - Continuously Operating Reference Station (Global Positioning System receiver)
DVD – Digital Video Disk
FBN - Federal Base Network
JPEG (or .jpg) – Joint Photographic Experts Group
KB - KiloByte
LID – Location IDentifier (for airports)
NAVAIDS – NAVigation AIDs
PACS - Primary Airport Control Station
PID – Permanent IDentifier (for NGS control stations)
RE - REconnaissance
SACS - Secondary Airport Control Station
= Number

ANNEX 1
INFORMATION SHEET FOR TAKING PHOTOGRAPHS OF SURVEY MARKS

EQUIPMENT REQUIRED:
CAMERA (WITH MEMORY CHIP, OR FILM FOR LATER SCANNING)
STIFF BRUSH TO CLEAN OFF MARK AND CLEAN LETTERING
SMALL SHOVEL OR SCRAPER TO DIG OUT AND/OR CLEAN OFF MARK
YELLOW CONSTRUCTION CRAYON, OR WHITE HOUSE-HOLD POWDER (BABY POWDER, CORN STARCH, ETC.)
WHITE BOARD WITH DARK MARKER
WEED WACKER (OR OTHER CUTTING DEVICE) TO CUT BACK GRASS AND WEEDS
COMPASS TO DETERMINE DIRECTIONS
MAP
MARK DESCRIPTION
MEASURING TAPE
GPS RECEIVER
SCREW DRIVER (TO OPEN LOGO CAPS AND TO HOLD END OF TAPE)
TILE PROBE
SCIENTIFIC CALCULATOR
TRIPOD

PHOTO #1 - CLOSE-UP:
- SET CAMERA TOHIGH RESOLUTION,
- SET CAMERA TO MACRO MODE (IF AVAILABLE),
- DETERMINE CAMERA'S MINIMUM FOCUS DISTANCE,
- SET DATE AND TIME INTO CAMERA, IF POSSIBLE,
- THOROUGHLY CLEAN OFF TOP OF MARK (INCL. LOGO CAP, CONCRETE, ETC.),
- THOROUGHLY CLEAN LETTERING (DISK OR LOGO CAP),
- CUT BACK GRASS AND WEEDS, AS REQUIRED,
- REMOVE SURVEY TRIPOD,
- OPEN LOGO CAP,
- RUB YELLOW CRAYON (OR WHITE, HOUSE-HOLD POWDER) ACROSS STAMPING,
- ORIENT CAMERA VERTICALLY, AT APPROX. MINIMUM FOCUS DISTANCE,
- COMPOSE TO INCLUDE ENTIRE DISK, OR TOP OF ROD AND LOGO CAP STAMPING,
- EXPOSE PHOTOGRAPH IN MID-AM OR MID-PM, IF POSSIBLE, TO OBTAIN GOOD LIGHTING OF THE STAMPING,
- AVOID SHADOWS ACROSS THE MARK,
- NOTE, IF FLASH IS REQUIRED, MOVE CAMERA SLIGHTLY OFF CENTER TO MINIMIZE REFLECTION,
- EXPOSE PHOTOGRAPH.

PHOTO #2 - EYE LEVEL
- SET CAMERA TO NORMAL RESOLUTION,
- SET CAMERA TO NORMAL MODE (NOT MACRO),
- SET DATE AND TIME INTO CAMERA (IF AVAILABLE),
- IF NOT ALREADY DONE, CLEAN OFF MARK AND STAMPING,
- CUT BACK GRASS AND WEEDS, AS REQUIRED,
- REMOVE SURVEY TRIPOD,

- WRITE STATION NAME, IN LARGE LETTERS, ON SIGN AND PLACE NEAR (NOT ON) MARK,
-OPEN LOGO CAP,
- ORIENT CAMERA VERTICALLY AT EYE LEVEL,
- COMPOSE WITH ENTIRE MONUMENT AND AREA AROUND MARK APPROX. 1 METER IN RADIUS,
-EXPOSE PHOTOGRAPH.

PHOTO #3 - HORIZONTAL VIEW(S)
- SET CAMERA TO NORMAL RESOLUTION,
- SET CAMERA TO NORMAL MODE (NOT MACRO),
- SET DATE AND TIME INTO CAMERA (IF AVAILABLE),
- IF NOT ALREADY DONE, CLEAN OFF MARK AND STAMPING,
- CUT BACK GRASS AND WEEDS, AS REQUIRED,
- SET-UP SURVEY TRIPOD OVER MARK,
- WRITE STATION NAME AND CAMERA DIRECTION, IN LARGE LETTERS, ON SIGN AND PLACE NEAR (NOT ON) MARK,
- CLOSE LOGO CAP,
- ORIENT CAMERA HORIZONTALLY AT EYE LEVEL,
- COMPOSE TO INCLUDE MARK, ANY IDENTIFYING SURROUNDINGS, AND ANY OBSTRUCTIONS OR POSSIBLE SOURCES OF MULTI-PATH,
- EXPOSE PHOTOGRAPH(S), AS REQUIRED.

Notice – all items highlighted are changes from previous versions of this SOW

December 2017

ATTACHMENT S
WRITING STATIONDESCRIPTIONS AND RECOVERY NOTES

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

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ATTACHMENT S: WRITING STATION DESCRIPTIONS AND RECOVERY NOTES

Descriptions are one of the end products of surveying, along with the positions and the survey marks themselves. All three shall be of highest quality. The descriptions must be complete, accurate and in standardized format if the station is to be reliably and easily recovered for use in the future. Descriptions shall be in the standard National Geodetic Survey (NGS) format of three paragraphs as described in Section 2 "Description Format".

1.GENERAL

1.1 DEFINITION OF DESCRIPTION VS. RECOVERY NOTE

A. A *description* details the location of a new survey mark, or one not previously in the NGS digital database.
B. A *recovery note* is an update and/or refinement to a description already in the NGS digital database, written upon a return visit to a survey mark.

1.2 LEVELS OF COMPLEXITY OF RECOVERY NOTES

A. No Changes - If an existing station's digital description is complete, accurate, and meets Blue-Book requirements, the station may be recovered with a brief recovery note, such as "RECOVERED AS DESCRIBED".

B. Minor Changes - If minor changes or additions to the description are required, they may be added after the above phrase, such as "RECOVERED AS DESCRIBED, EXCEPT A NEW WOODEN FENCE IS NOW 3 METERS NORTH OF THE STATION". See typical cases listed in Section 1.5 A.

C. Major Changes - Where major changes have occurred, major inaccuracies are found, or where required information is missing (in any portion of the description), a complete three-paragraph recovery note, with the same format as a new description, is required. If a measurement discrepancy is found, state that the new distance was verified, for example, by taping in both English units and metric units or by two separate measurements by two different people. See typical cases in Section 1.5 B.

D. Exemption - If a recovery note has been written for the station within one year and no changes have taken place, a new recovery note is not required. Note, this may cause an error message in the description checking software, which may be ignored.

1.3 SOFTWARE

1.3 SOFTWARE - Descriptions and Recovery notes must be properly encoded into a D-file by using software WinDesc. For WinDesc information see: https://www.ngs.noaa.gov/PC_PROD/pc_prod.shtml#WinDesc, use the latest version available. Also refer to the NGS Web site: https://www.ngs.noaa.gov/FGCS/BlueBook/ Annex P (Geodetic Control Descriptive Data), for information. Note: WinDesc may be used for both new Descriptions and for Recovery Notes.

For projects that have no new marks and are not being "Blue-Booked", the NGS on-line recovery method may be used to submit Recovery Notes; see: https://www.ngs.noaa.gov/cgi-bin/recvy_entry_www.prl. Submit paper copies for any recovery notes submitted on-line.

1.4 CHECKING - Descriptions shall be written by one person and checked by another. Recovery notes shall also be checked. For example, a mark setter can draft a description immediately after setting the mark, and an observer can check the description during observations. For existing marks, the reconnaissance person can draft the recovery note and the observer can check it. Descriptions and Recovery Notes should be written while at the station or immediately after visiting a station so that all details are fresh in the writer's mind.

1.5 TYPICAL RECOVERY NOTE CASES

A. A brief, one or two sentence Recovery Note is adequate:

i. When the mark is found and the description is completely accurate, sample: ("RECOVERED AS DESCRIBED"),
ii. When the mark is found and there are one or two minor changes, ("RECOVERED AS DESCRIBED EXCEPT A NEW WOODEN FENCE IS NOW 3 METERS NORTH OF THE STATION"),
iii. When the mark is not found, ("MARK NOT FOUND AFTER 3 PERSON-HOUR SEARCH"),
iv. When the mark is not found and presumed destroyed, ("MARK NOT FOUND AND PRESUMED DESTROYED. CONSTRUCTION FOREMAN STATES THAT THE MARK WAS DESTROYED YESTERDAY"),
v. When the mark is found destroyed, ("THE MARK IS DESTROYED AND THE DISK HAS BEEN SENT TO NGS" or "THE MARK IS DESTROYED AND ITS PHOTOGRAPH HAS BEEN SENT TO NGS"). Note, for a station to be considered destroyed by NGS, the disk or photograph showing the destroyed mark must be received by NGS. Otherwise, report the station as "NOT FOUND".

B. A complete, new, three-paragraph Description/Recovery Note is required:

i. When a new, permanent mark is set,
ii. When an existing mark does not have a Permanent Identifier (PID),
iii. When an existing mark does not have an National Spatial Reference System (NSRS) digital description (i.e., description is not in the NGS database),
iv. When an existing mark has only a brief description not meeting the three-paragraph requirement (many bench marks have only short, one-paragraph descriptions),
v. When an existing mark's description is no longer accurate or complete.

2. DESCRIPTION FORMAT

The original U.S. Coast & Geodetic Survey (USC&GS) Special Publication No. 247, MANUAL OF GEODETIC TRIANGULATION, page 116, states, "A description must be clear, concise, and complete. It should enable one to go with certainty to the immediate vicinity of the mark, and by the measured distances to reference points and the description of the character of the mark, it should inform the searcher of the exact location of the mark and make its identification certain. It should include only essential details of a permanent character." NGS still follows these guidelines, so that a person with a minimal background in surveying and no local geographic or historical knowledge can easily find the mark by logically following the text of the description.

2.1 FIRST PARAGRAPH - The **first paragraph** is the *description of locality.* This part of the description begins by referring to the airline distance and direction (cardinal or inter-cardinal point of the compass) from the **three** nearest well-known mapped geographic feature(s), usually the nearest cities or towns. Use three references equally spaced around the horizon, if possible. **In writing the Description, always progress from the farthest to the nearest reference point**. Distances in this part of the description shall be in kilometers (followed by miles), or meters (followed by feet), all distances to one decimal place. Detailed measurements which appear elsewhere in the description should not be repeated in this paragraph. Points of the compass should be fully spelled out. Do not use bearings or azimuths. State the name, address, and phone number of public sector property owners (however, phone numbers of private property owners are NOT included). State any advance notice and security access requirements for reaching the station. Also state any unusual transportation methods that may be required to reach the station.

Sample first paragraph:

> "STATION IS LOCATED ABOUT 12.9 KM (8.0 MILES) SOUTHWEST OF EASTON, ABOUT 6.4 KM (4.0 MILES) NORTHWEST OF CAMBRIDGE, AND ABOUT 3.6 KM (2.2 MILES) EAST OF SMITHVILLE ON PROPERTY OWNED BY MR. H.P. LAYTON, AND KNOWN AS OLD GOVERNOR JACKSONS ESTATE."

2.2 SECOND PARAGRAPH - The **second paragraph** contains the *directions **to reach** the station.* This section is one of the most useful parts of a description. It usually enables a stranger to go directly to a station without a delay due to a detailed study of maps or of making local inquiries. It is a route description which should start from a definite point, such as (a) the nearest intersection of named or numbered **main** highways (ideally Interstate and U.S. highways, or at least those which are shown on commonly used road maps), and approximately where that intersection is, or (b) some definite and well-known geographical feature (e.g. main post office or county courthouse) and give its name and general location. Odometer distances shall be given to tenths of kilometers (followed by tenths of miles). For roads with names and numbers, give both in the first occurrence.

A. The format for the first leg of the "To Reach" is:
  - i. FROM THE MAIN POST OFFICE IN DOWNTOWN SMITHVILLE, or FROM THE INTERSECTION OF INTERSTATE XX AND STATE HIGHWAY YY, ABOUT 4.8 KM (3 MILES) NORTH OF SMITHVILLE;
  - ii. GO A DIRECTION (north, northeast, northerly, northeasterly, etc.);
  - iii. ON A ROAD (name and number of road or highway);
  - iv. FOR A DISTANCE (km followed by miles in parentheses);
  - v. TO SOMETHING (intersection, or fork in road, or T-road left or T-road right).

B. The format for additional legs, as needed:

i. TURN LEFT OR RIGHT, OR TAKE RIGHT OR LEFT FORK, OR CONTINUE STRAIGHT AHEAD;
ii. GO A DIRECTION (north, northeast, northerly, northeasterly, etc.),
iii. ON ROAD (name or number of road or highway);
iv. FOR A DISTANCE (km followed by miles in parentheses);
v. TO SOMETHING (intersection, or fork in road, or side-road left or right, or station on left or right).

Repeat Section B as required.

All five parts of each leg shall be included in each "To Reach".

Sample:

"TO REACH THE STATION FROM THE INTERSECTION OF INTERSTATE 300 AND MAIN STREET (STATE HIGHWAY 101) IN JONESVILLE, GO EASTERLY ON HIGHWAY 101 FOR 3.7 KM (2.3 MILES) TO AN INTERSECTION. TURN RIGHT AND GO SOUTH ON MILLER ROAD FOR 5.1 KM (3.2 MILES) TO A SIDE-ROAD RIGHT. CONTINUE SOUTH ON MILLER ROAD FOR 6.6 KM (4.1 MILES) TO AN INTERSECTION. TURN LEFT AND GO EASTERLY ON SMITH ROAD FOR 2.4 KM (1.5 MILES) TO STATION ON THE LEFT IN THE FENCE LINE."

Use the word "EAST" if the road goes due east and "EASTERLY" if the road wanders in a general easterly direction. Use intermediate references, such as the "side-road right" off Miller Road above, if the distance in a leg becomes longer than about 5 miles. The place at the end of truck travel should be mentioned. If walking is required, note the approximate time required for packing. If travel to the station is by boat, the place of landing should be stated.

2.3 THIRD PARAGRAPH - The **third paragraph** provides *details of the mark and reference measurements*. A new, Third Paragraph shall contain the following information, unless the same information has already been entered into a special field in the WinDesc software.

(A) The station mark type;
(B) How the mark is stamped;
(C) How the mark is set;
(D) Reference measurements;
(E) Hand-held GPS observations;
(F) Primary Airport Control Station (PACS) or Secondary Airport Control Station (SACS) designation, if appropriate.

Older descriptions will usually be in this format:

SECTION	EXAMPLE
(A) - What the mark is:	THE MARK IS AN NGS HORIZONTAL DISK, or A USC&GS TRIANGULATION DISK, or A STAINLESS STEEL ROD, or A CHISELED "X", ETC.),
(B) - How the mark is stamped (in dashes):	STAMPED --JONES 1952--.
(C) - How and in what the mark is set:	THE MARK IS SET IN A DRILL HOLE IN BEDROCK, or SET IN A SQUARE CONCRETE MONUMENT, or IS A ROD DRIVEN TO REFUSAL, ETC. A GREASE-FILLED SLEEVE ONE M LONG WAS INSTALLED.

Specify whether the rod was driven to refusal or whether it met the slow driving rate (this is specified in Attachment V, Section 4.0 as 60 seconds per foot or 90 feet). It shall also state the length of rod driven. Also state if a grease-filled sleeve was installed and its length. For a rod mark, the diameter of the stainless steel rod and the diameter of the PVC pipe with the aluminum cap should be in English units, and the length of the plastic sleeve should be given in metric units only.

- State if the mark projects above the ground, is flush, or is recessed and the amount, (for a rod mark state the above for both the rod and the logo cap):	MARK PROJECTS 15 CM (5 IN), OR MARK IS FLUSH WITH THE GROUND, OR MARK IS RECESSED 20 CM (8 IN); OR LOGO CAP IS FLUSH WITH THE GROUND AND TOP OF ROD IS 10 CM (3.9 IN) BELOW THE TOP OF THE LOGO CAP,
- State the depth of the monument, if known	CONCRETE MONUMENT, 1.2 M (4FT) DEEP, OR, ROD DRIVEN TO REFUSAL AT 15 M (49 FT)
(D) - State reference distances and directions from three or more permanent objects in the mark's immediate vicinity (farthest to nearest), and equally spaced around the horizon:	IT IS 20.7 M (67.9 FT) SOUTHWEST OF POWER POLE #2345, 15.2 M (49.9 FT) WEST OF THE WEST EDGE OF HIGHWAY 134, AND 3.4 M (11.1 FT) NORTH OF A CHAIN-LINK FENCELINE.

Examples of objects used as references: existing reference marks, witness posts, center lines of roads, edges of roads, edges of runways, ditches, power or telephone poles, and buildings. Start with the farthest distance. Horizontal distances should be used. If slope distances were measured, that fact should be stated in the paragraph. Specify whether the reference distance was from the center or the edge of the reference object, and specify which edge, like "north edge". The distances shall be in meters (followed by English measurement units in parentheses, except as noted in (C) above), and the directions shall be cardinal and inter-cardinal directions, fully spelled out, such as "NORTH", "NORTHEAST", or "NORTH-NORTHEAST". Magnetic bearings from the reference objects are recommended to assist in future recoveries.

(E) Provide a handheld GPS position for all new and recovered marks, and for all proposed mark locations. Include the position and the accuracy code of HH1 or HH2, depending on the type of receiver used. HH1 stands for Hand-Held accuracy code 1 (differentially corrected, hand-held GPS), and HH2 stands for Hand-Held accuracy code 2 (stand-alone, hand-held GPS), as follows:

Accuracy code 1 (HH1) = ± 1-3 meters
Accuracy code 2 (HH2) = ± 10 meters

GPS Data Formats:

CODE	LATITUDE	LONGITUDE	SECOND PLACES
HH1	NDDMMSS.ss	WDDDMMSS.ss	(2 places of seconds)
HH2	NDDMMSS.s	WDDDMMSS.s	(1 place of seconds)

Use "N" or "S" for latitude and "W" or "E" for longitude. Use three digits for the degrees of longitude, adding one or two leading zeros if required.

(F) If the station is a Primary or Secondary Airport Control Station mark, the third paragraph shall end with the appropriate designation of Primary or Secondary Airport Control Station):

THIS STATION IS DESIGNATED AS A PRIMARY AIRPORT CONTROL STATION.

Sample for a rod mark:
"THE STATION IS THE TOP-CENTER OF A 9/16 INCH STAINLESS STEEL ROD DRIVEN TO REFUSAL AT A DEPTH OF 18M. THE LOGO CAP IS STAMPED --SMITH 2003--. THE LOGO CAP IS MOUNTED ON A 5 IN DIAMETER PVC PIPE. A ONE METER LONG GREASE-FILLED SLEEVE WAS INSTALLED. LOGO CAP IS FLUSH WITH THE GROUND AND TOP OF ROD IS 10 CM (3.9 IN) BELOW THE TOP OF THE LOGO CAP. THE MARK IS 32.4 METERS (101.74 FEET) NORTHEAST OF NORTHEAST CORNER OF THE HOUSE, 16.62 METERS (54.5 FEET) NORTH OF WATER PUMP ALONGSIDE OF HEDGE AROUND OLD FLOWER GARDEN, AND 4 METERS (12.96 FEET) NORTH OF NORTHEAST CORNER OF HIGH HEDGE ENCLOSING OLD FLOWER GARDEN. THE HH1 GPS IS: N304050.2, W1201020.4."

Sample for a concrete monument:
"THE STATION IS AN NGS HORIZONTAL CONTROL DISK, STAMPED --JONES 2003-- SET IN A ROUND CONCRETE MONUMENT 1.2 M (4 FT) DEEP AND 0.3 M (12 IN) IN

DIAMETER. IT IS SET FLUSH WITH THE GROUND. IT IS 32.4 METERS (101.74 FEET) NORTHEAST OF NORTHEAST CORNER OF THE HOUSE, 16.62 METERS (54.5 FEET) NORTH OF WATER PUMP ALONGSIDE OF HEDGE AROUND OLD FLOWER GARDEN, AND 4 METERS (12.96 FEET) NORTH OF NORTHEAST CORNER OF HIGH HEDGE ENCLOSING OLD FLOWER GARDEN. THE HH1 GPS IS: N304050.2, W1201020.4."

3. IMPORTANT POINTS REGARDING DESCRIPTIONS

3.1 NAMES - Use the station designation (name) and PID, exactly as listed in the NGS database, in all survey records. Do not add dates, agency acronyms, or other information to the name, nor the stamping. Do not use abbreviations of the name. Note, frequently the stamping and the official station designation are not the same. For example, stampings include the year set, but designations generally do not.

3.2 TERMINOLOGY - Correct NGS survey terminology shall be used in all station descriptions and reports (see GEODETIC GLOSSARY, NGS, 1986).

3.3 DISTANCES - All measurements are assumed to be horizontal unless labeled "slope". Distances measured from a line (e.g., the center-line of a road or a fence line) are assumed to be measured perpendicular to that line. The origin of measurements at the junction of two roads is assumed to be the intersection of center-lines of both roads. Measurements are assumed to be from the center of an object (i.e. power pole) unless stated otherwise.

3.4 REPAIR - Any work done to repair a mark shall be described completely in the updated recovery note. Note: a repair strengthens the mark but must not change its position, elevation, or orientation. For example, adding concrete or epoxy around a disk where some is missing is a repair.

3.5 REFERENCE MARK NAMES - Note, reference marks are abbreviated "RM x" in descriptions, but on "Reference Mark" disks they are stamped "NO. X". Also, some reference marks and some azimuth marks have their own PID.

3.6 METRIC CONVERSION - Use the U.S. Survey Foot conversion, in which 3.2808333333 feet equals one meter.

3.7 ABBREVIATIONS – KM = kilometer, M = Meter, CM = centimeter, and NM = nautical mile, MI = mile, FT = feet, IN = inch.

3.8 GPS OBSERVATIONS - Remember to enter "Y" into the satellite usage code field in the *Header Record* if the mark is suitable for survey-grade GPS observations.

December 2017

ATTACHMENT T
SETTINGCONCRETE MARKS

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

This attachment remains unchanged from previous SOW Version 14A. Please see:
https://www.ngs.noaa.gov/ContractingOpportunities/CMPSOWV14A_FINAL.pdf
if this work is required

Notice – all items highlighted are changes from previous versions of this SOW

December 2017

ATTACHMENT U
SETTING A SURVEY DISK IN OR NEAR BEDROCK OR LARGE STRUCTURES

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC
SURVEY NATIONAL OCEAN
SERVICE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OFCOMMERCE

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if this work is required

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December 2017

ATTACHMENT V
SETTING AN NGS 3D MONUMENT

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC
SURVEY NATIONAL OCEAN
SERVICE
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December 2017

ATTACHMENT W
STATION SITE SELECTION GUIDE

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
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ATTACHMENT W: STATION SELECTION GUIDELINES

1. SELECTION PRIORITIES

Station selection shall be based on the following priorities, which are given in the order of highest priority first. Within each priority category, preference should be given to selection of appropriate older stations having a known history of prior stability as indicated by previous observations.

1.1 STATIONS

A. Existing A- or B-order station, where possible,

B. Primary Airport Control Stations (PACS),

C. Existing National Spatial Reference System (NSRS) station, prioritizing stability and quality.

D. Existing NSRS station with elevation, higher accuracy classification being preferred,

E. Existing NSRS station with first- or second-order horizontal coordinates, higher accuracy classification being preferred,

F. New station or existing station not in NSRS, suitable for GPS observations, set in bedrock,

G. New station or existing station not in NSRS, suitable for GPS observations, established by setting a 3D monument,

H. New stations or existing station not in NSRS, suitable for GPS observations, established by setting lesser stability mark, such as standard concrete mark.

2. STATION SPACING

Station spacing is project dependent. See project instructions.

3. MONUMENTATION AND STATION ENVIRONMENT

The following is a list of considerations for each station. The intent is to ensure that station monuments will be locally stable and remain usable indefinitely. Each of these considerations is important.

3.1 CONSIDERATIONS

A. Adequate GPS satellite visibility (unrestricted at 15 degrees and higher above the horizon). Minor obstructions may be acceptable, but must be depicted on the Visibility Obstruction Diagram.

B. Accessible by vehicle (two-wheel drive preferred),

C. Stability; bedrock mark being most preferred. (See Section 4.0 below.),

D. Permanency,

E. Ease of recovery,

F. Avoid known multi-path sources,

G. Appropriate geographic location and spacing,

H. Location allows efficient use by surveying community,

I. Accessible by public. (See Section 5.0 below.),

J. No known potential conflict with future development,

K. Open area for possible aerial-photo paneling,

L. Avoid electronic interference where possible.

4. STABILITY

Station monument stability is often difficult to assess in the field with limited resources. For existing NSRS station monumentation, the NGS database contains stability qualifiers which were assigned for the majority of marks when they were set.
Quality Codes are as follows:

4.1 QUALITY CODE A - most reliable; are expected to hold a precise elevation. Examples: rock outcrops; rock ledges; rock cuts; bedrock; massive structures with deep foundations; large structures with foundations on bedrock; or sleeved deep settings (10 ft or more) with galvanized steel pipe or galvanized steel, stainless steel, or aluminum rods.

4.2 QUALITY CODE B - will probably hold a precise elevation. Examples: unsleeved deep settings (10 ft or more) with galvanized steel pipe or galvanized steel, stainless steel, or aluminum rods; massive structures other than those listed under Quality Code A; massive retaining walls; abutments and piers of large bridges or tunnels; unspecified rods or pipe in a sleeve less than 10 ft; or sleeved copper-clad steel rods.

4.3 QUALITY CODE C - may hold precise elevation, but subject to ground movement. Examples: metal rods with base plates less than 10 ft deep; concrete posts (3 ft or more deep); unspecified rods or pipe more than 10 ft deep; large boulders; retaining walls for culverts or small bridges; footings or foundation walls of small to medium-size structures; or foundations such as landings, platforms, or steps. See Section 4.5, below.

4.4 QUALITY CODE D - of questionable stability. Examples: generally, objects of unknown character; shallow set rods or pipe (less than 10 ft); light structures; pavements such as street, curbs, or aprons; piles and poles such as spikes in utility poles; masses of concrete; or concrete posts less than 3 ft deep.

4.5 QUALITY CODE C EXCEPTION - when selecting FBN stations, only Quality Codes A and B are recommended. However, concrete posts may be selected with a C stability if the mark is deemed stable from review of historical re-leveling, soil type, and frost depth. Final selection is subjective, and is based on local knowledge of soil and frost heave, plus knowledge of how well the mark has held its horizontal and vertical positions over the years.

5. ACCESSIBILITY

Accessible public property should be utilized where feasible. If the station is located on private property, permission must be obtained from the land owner for station accessibility. Include the name, address, and, if public ownership, the telephone number of the responsible party. Do not include telephone numbers of private property owners.

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December 2017

ATTACHMENT X
BENCH MARK TIES

TO
SCOPE OF WORK FOR SHORELINE MAPPING
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NATIONAL GEODETIC
SURVEY NATIONAL OCEAN
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For guidance to make optical or digital leveling ties, use the observational procedures in the on-line document "Bench Mark Reset Procedures", dated September 2010, https://www.ngs.noaa.gov/PUBS_LIB/Benchmark_4_1_2011.pdf

Notice – all items highlighted are changes from previous versions of this SOW

December 2017

ATTACHMENT Y

Light Detection and Ranging (LIDAR), Digital Camera Imagery and Shoreline Requirements

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
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1. LIST OF ACRONYMS

ASPRS...American Society of Photogrammetry and Remote Sensing

CMP……………………………………………………………………Coastal Mapping Program

CO ....Contracting Officer

COR.. Contracting Officer's Representative

CORS………………………………………………………Continuously Operating Reference Stations

DEM………………………… ....………………………………Digital Elevation Model

FGDC .... Federal Geographic Data Committee

GSD……………………………………………...…………………………Ground Sample Distance

IWG-OCM…………………………………Interagency Working Group on Ocean and Coastal Mapping

JALBTCX……………………………....Joint Airborne Lidar Bathymetry Technical Center of Expertise

LIDAR..Light Detection and Ranging

MHW…………………………………………………………………………Mean High Water

MLLW……………………………………………………………………Mean Lower Low Water

NAD .... North American Datum

NIR……………………………………………………………………………...Near-Infrared

NGS……………………………………………………………………..National Geodetic Survey

NAVD ....North American Vertical Datum

NOAA .... National Oceanic and Atmospheric Administration

NOS……………………………………………………………………..National Ocean Service

NPS…………………………………………………………….……… .Nominal Pulse Spacing

NSRS………………………………………………………….…National Spatial Reference System

NSSDA..National Standard for Spatial Data Accuracy

NVA……………………………………………………………..Non-vegetated Vertical Accuracy

OCM……………………………………………………………… Office of Coastal Management

POC……………………………………………………...………………………Point of Contact

QA .... Quality Assurance

QC .... Quality Control

RGB.. Red, Green, and Blue

RMSE .... Root Mean Square Error

RSD.. Remote Sensing Division

SOW .... Scope of Work

TOMIS.. Task Order Management and Information System

USACE.. United States Army Corps of Engineers

USGS.. United States Geological Survey

UTC.. Universal Coordinated Time

VVA.. Vegetated Vertical Accuracy

2. OVERVIEW - The National Geodetic Survey (NGS) Remote Sensing Division (RSD) Coastal Mapping Program (CMP) requires the collection of airborne topographic/bathymetric lidar and digital camera imagery data to enable accurate and consistent measurement of the national shoreline. The shoreline is defined as the land water interface at a specific tidal datum. Topographic/bathymetric lidar is employed as an accurate, efficient way to collect data for generation of a DEM, which is in turn used to extract vectors for generating the tidal datum shoreline of interest. The CMP works to provide a regularly-updated and consistent national shoreline to define America's marine territorial limits and manage coastal resources. This shoreline is applied to National Oceanic and Atmospheric Administration (NOAA) nautical charts and is considered authoritative when determining the official shoreline for the United States.

This attachment defines requirements for lidar data acquisition and processing to support the CMP, for accurate and consistent shoreline. However, NGS recognizes there are many other uses to this data to support additional mapping, charting, geodesy services, marine debris surveys, and for other purposes in coastal states. In addition, NOAA participates with the Interagency Working Group on Ocean and Coastal Mapping (IWG-OCM) and the Committee on Marine Transportation Safety to develop common standards for airborne coastal mapping and charting data and products. These standards were developed in conjunction with the Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX) partner agencies (U.S. Army Corps of Engineers (USACE), U.S. Naval Oceanographic Office (NAVO), and the U.S. Geological Survey (USGS).

The following conventions have been adopted for this document. The term "shall" means that compliance is required. The term "should" implies that compliance is not required, but is strongly recommended. All times shall be recorded in Universal Coordinated Time (UTC).

3. TOPOGRAPHIC/BATHYMETRIC LIDAR DATA COLLECTION AND PROCESSING

3.1 PROJECT AREA - Topographic/Bathymetric lidar shall be collected within the specified area detailed in the provided project boundary shapefile. A lidar sensor capable of collecting both topographic and bathymetric data concurrently shall be utilized. Shapefiles shall be provided to indicate the limits of the boundaries to be surveyed.

3.2 SENSOR REQUIREMENTS - In the requested survey areas, bathymetric lidar data are required from the water's edge seaward from the land/water interface, to the specified extent as detailed in the provided project boundary shapefile or to laser extinction, whichever comes first. For shoreline mapping and modeling uses, it is particularly important to have good bathymetric data in the very shallow (0-4 m) areas. For this reason, the lidar systems, software, and processing procedures shall enable measurement of bathymetry in this very shallow region. The sensor used for this mapping shall have an operational measurement depth range equal to or greater than a 1.5 secchi depth. Sensors with segmented beams, shall also comply with these specifications.

3.3 COLLECTION TIME - The lidar can be collected day or night.

3.4 IMAGERY COLLECTION - The contractor is encouraged to collect imagery concurrently with the bathymetric lidar to assist in editing, although not required as a deliverable.

3.5 ALTITUDE - It is recommended to fly at an altitude as low as possible (within the eye safety parameters established by the sensor manufacturer and applicable regulations), so as to maximize bathymetric returns. A nominal density of 2 points per square meter shall be met, to support the gridding of a 1 meter GSD DEM. The bathymetric or submerged topographic portion of the lidar collect shall be planned for a nominal density for 2 points per square meter, although it is understood that this density may not be met due to certain environmental conditions that cannot be controlled.

3.6 POINT CLOUD - The spatial distribution of geometrically usable points is expected to be uniform. Although it is understood that lidar instruments do not produce regularly gridded points, collections should be planned and executed to produce a first-return point cloud that approaches a regular lattice of points, rather than a collection of widely spaced high density profiles of the terrain.

3.7 CONDITIONS - NOAA's overarching objective is to obtain clean, seamless (i.e., free of gaps or discontinuities) topographic-bathymetric data across the intertidal zone and shallow nearshore zone. With this overarching objective in mind, the following decision tree shall be used for determining when to collect shoreline flight lines:

> A. Optimal environmental conditions: If the mission crew encounters` optimal environmental conditions for nearshore topo-bathy mapping (defined here to mean exceptional water clarity relative to typical conditions in project site, as well as low wind and wave conditions in the surf and nearshore zones) at any time during the project, then the flight lines shall be flown immediately, to take advantage of the optimal conditions, without concern for stage of tide. If these optimal conditions yield clean, seamless topographic and bathymetric data, free of voids in the intertidal zone and near shore submerged topography, then it may be unnecessary to conduct repeat passes for that flight line; however, this shall be verified with the COR. A repeat pass is recommended to assist in filling in voids due to waves and white water.
>
> B. All other conditions: In the absence of optimal environmental conditions, the shoreline flightlines shall be tide coordinated to ensure the highest probability of achieving clean, seamless topo-bathy coverage across the intertidal and shallow nearshore zones. This typically requires flying each shoreline flight line twice: once within 20% of the Mean Range of tide around MLLW and once within 30% of the Mean Range of tide around MHW, as well as during favorable water clarity conditions. The Mean Range of tide is defined as the difference in height between mean high water and mean low water. If the contractor wishes to propose an alternate method for achieving the overarching objective (clean, seamless data across the intertidal and shallow nearshore zones) for a particular area, the proposed method shall be discussed with the COR and NGS, and the COR's approval granted, before proceeding.

3.8 PRIORITY - NGS recognizes the uncertainty for bathymetric lidar success along many areas of the coast. The Contractor has complete flexibility to determine the priority, location and schedule of data collection for mapping production, provided the schedule defined in Section 18 is achieved. Contractor has the right to demobilize and remobilize at any time, provided the schedule defined in Section 18 is achieved and the resulting mapping activities are communicated with the Point of Contact (POC) for Contract Issues.

3.9 WATER CLARITY - A major consideration in bathy lidar acquisition is water clarity, as high turbidity can hinder or preclude lidar acquisition in many areas of the U.S. Acquisition contractors are responsible for monitoring water clarity conditions in the project sites and determining suitable times for acquisition. Second, as water clarity in a region can vary on time scales from minutes to hours, seasons, and longer, it is important to continually assess local weather events (e.g., rain or winds that can cause sediment re-suspension), tides, currents, and other factors that can affect the probability of success of bathy lidar acquisition.

In areas where water conditions are deemed unsuitable for lidar collection, conditions shall be monitored in attempt to seize any opportunity to collect valid data. Some locations may require acquisition opportunities at a significantly different time period to investigate different conditions. Subsequent efforts shall be made to collect valid data, at the discretion of the Contractor. The contractor shall communicate results with the Point of Contact (POC) for Contract Issues.

The bathymetric lidar requirement may be eliminated from a task order in areas where persistent turbidity or weather conditions prohibit successful bathymetric lidar data collection. In instances where requirements are eliminated, the task for this area will be utilized to cover other NGS requirements.

In areas where bathymetry requirements are eliminated, the topographic data portion shall be collected in accordance with the specifications stated herein, as well as the flight line that intersects the shoreline with specification adhered to as stated in section 3.7.b.

3.10 QUALITY LEVEL - Bathymetric lidar points shall meet a vertical RMSE of $QL2_b$ specified in the Draft National Coastal Mapping Strategy 1.0 Document. Table 1 below documents this specification. Typical projects do not require IHO feature detection standards to be met, as stated in IHO S-44 TVU standards for Order 1b surveys. However, any seafloor features (e.g., wrecks or submerged rocks) identified in the data are of interest to NOAA, shall not be removed.

The form of the vertical accuracy specifications given in the table is taken from the International Hydrographic Organization S-44 standard:

$$\pm\sqrt{a^2 + (b \times d)^2}$$

where:

a	represents that portion of the uncertainty that does not vary with depth
b	is a coefficient which represents that portion of the uncertainty that varies with depth
d	is the water depth

b x d represents that portion of the uncertainty that varies with depth

Vertical positions of subaerial (i.e., topographic) points shall meet the 10 cm accuracy class standard for elevation data as specified in the APSRS Positional Accuracy Standards for Digital Geospatial Data Edition, 1, Version 1.0 – November, 2014. Testing and reporting of vertical accuracies shall follow the procedures for the Non-vegetated Vertical Accuracy (NVA) at the 95% confidence level in all non-vegetated land cover categories combined and reports the Vegetated Vertical Accuracy (VVA) at the 95th percentile in all vegetated land cover categories combined stated in the Standard. A copy of this specification may be found at: http://www.asprs.org/a/society/committees/standards/ASPRS_Positional_Accuracy_Standards_Edition1_Version100_November2014.pdf .

Table 1. Quality level definitions for bathymetric lidar. These definitions are applicable for areas submerged at the time of survey.

Bathy Lidar Quality Level	**Source**	**Vertical accuracy coefficients a,b as in** $\pm\sqrt{a^2 + (b \times d)^2}$	**Nominal Pulse Spacing (m)**	**Point Density (pt/m²)**	**Example Applications**
$QL0_B$	Bathymetric Lidar	0.25, 0.0075	≤0.7	≥2.0	Detailed site surveys requiring the highest accuracy and highest resolution seafloor definition; dredging and inshore engineering surveys; high-resolution surveys of ports and harbors
$QL1_B$	Bathymetric Lidar	0.25, 0.0075	≤2.0	≥0.25	
$QL2_B$	Bathymetric Lidar	0.30, 0.0130	≤0.7	≥2.0	Charting surveys; regional sediment management General bathymetric mapping; coastal science and management applications Change analysis; deepwater surveys, environmental analysis
$QL3_B$	Bathymetric Lidar	0.30, 0.0130	≤20	≥0.25	
$QL4_B$	Bathymetric Lidar	0.50, 0.0130	≤5.0	≥0.04	Recon/planning; all general applications not requiring higher resolution and accuracy

3.11 HORIZONTAL POSITIONS - Horizontal positions shall be accurate to 1.0m (RMSE)

3.12 HORIZONTAL DATUMS - All positions shall be tied to the NSRS via processing with respect to the NGS-managed Continuously Operating Reference Stations (CORS) network, and referenced to NAD83(2011)epoch:2010. The appropriate UTM coordinate system and zone as designated in the tiling scheme provided shall be used. This datum and coordinate system must be used throughout the survey project for everything that has a position or for which a position is to be determined. Those documents used for comparisons, such as charts, junctional surveys, and prior surveys, must be referenced or converted to NAD 83. In addition, all software used on a survey must contain the correct datum parameters.

3.13 VERTICAL DATUM - All positions shall be tied to the NSRS via processing with respect to the NGS managed Continuously Operating Reference Stations (CORS) network, and referenced to NAD83(2011)epoch:2010 ellipsoidal heights in meters.

3.14 FLIGHT LINES - For QA/QC purposes, one cross line is required every 30 kilometers. In areas of the coast where natural or artificial barriers prevent aircraft operations, the cross line(s) shall be collected at the nearest possible location to the required interval, but no closer than 8 kilometers to an adjacent planned cross line.

A. Flight lines shall have a minimum of 20% planned sidelap with adjacent flight lines.

B. In areas where valid bathymetry data are obtained, topographic data should be collected such that the resulting bathymetric and topographic lidar data may be merged later with no discontinuity. Prudence should be exercised by the Contractor to ensure the final bathymetry and topographic data submitted are in agreement with one another.

C. Data gaps due to aircraft motion or building shadows shall be re-flown to fill the voids.

D. The Contractor shall make reasonable "best efforts" to fill voids due to white water and breaking waves near the land-water interface.

E. If airspace restrictions are anticipated or known, the Contractor shall coordinate with the NGS for any needed assistance in obtaining clearance(s). If clearance cannot be obtained, survey requirements within these areas shall be eliminated and the task order shall be modified in similar manner as presented in Section 3.9.

3.15 INTENSITY VALUES - are required for each return. The values shall be recorded in the .las files in their native radiometric resolution.
Atmospheric conditions shall be cloud and fog-free between the aircraft and ground during all collection operations. Ground conditions shall be snow free.

3.16 LAST DAY OF COLLECTION - The following conditions exist to define the "last day of collection" for metadata and attribution purposes.

A. All lidar data have been collected along the shoreline of the given region.
B. The last day on which the production data were collected within a tile shall be the "last day of collection."

4. DIGITAL CAMERA IMAGERY DATA COLLECTION AND PROCESSING IN CONJUNCTION WITH LIDAR COLLECTION

The following section has been modified from Attachment Z. Unless otherwise stated below, all other specifications should be adhered to unless discussed with the COR and NGS, and the COR's approval granted, before proceeding.

4.1 SENSOR - The sensor shall be a geometrically stable and calibrated frame system suitable to use for high-accuracy photogrammetric mapping.

4.2 IMAGERY - RGB/NIR images should be collected in a manner to provide stereo coverage of the area detailed in the provided project boundary shapefile. Any imagery collected, outside of the ground swath defined, shall not be deleted. Since the imagery will likely be collected at a higher altitude, covering a larger swath than the project boundary, all imagery of the frame falling outside of the project boundary shall be processed and shall not be clipped to the project boundary.

4.3 SIDELAP – Adjacent images shall have a minimum sidelap of 30% of the mean image width.

4.4 ENDLAP – Consecutive images in a flight line shall have a minimum endlap of 60% of the mean image width.

4.5 GROUND SAMPLE DISTANCE - RGB/NIR images should be collected in a manner to produce a resulting ortho-mosaic with a 30cm Ground Sample Distance (GSD).

4.6 WEATHER - Digital imaging shall not be conducted when clouds or cloud shadow obscure the land-water interface or features of navigational significance in the scene. The land-water interface shall not be obscured by snow, ice, smoke, haze, etc. Storm systems and events (e.g. hurricanes, northeasters, and frontal boundaries) that may cause an increase in water levels, tidal heights, and wave activity shall be avoided.

4.7 TIME OF DAY - Time of day for digital camera imagery is determined by the sun angle which shall not be less than 25 degrees above the horizon at the time of exposure. If imagery is collected between the months of November and February, the sun angle requirement shall not be less the 20 degrees.

4.8 PRIORITY - Collection of the lidar data is the first priority of this task order and should not be precluded by meeting the RGB/NIR Imagery collection parameters above. The RGB/NIR imagery shall be collected within one month of the lidar collection and within 25% of the Mean Range of tide around MLLW. The temporal period may be relaxed in certain circumstances based on prior approval from the Point of Contact (POC) for Contract Issues.

4.9 HORIZONTAL POSITIONS - Horizontal positions shall be accurate to ≤ 0.60 meters ($RMSE_x$ and $RMSE_y$)

4.10 HORIZONTAL DATUM - All positions will be tied to the NSRS via processing with respect to the NGS managed Continuously Operating Reference Stations (CORS) network, and referenced to NAD83(2011)epoch:2010. The appropriate UTM coordinate system and zone as designated in the tiling scheme provided shall be used. This datum and coordinate system must be used throughout the survey project for everything that has a position or for which a position is to be determined. Those documents used for comparisons, such as charts, junctional surveys, and prior surveys, must be referenced or converted to NAD 83. In addition, all software used on a survey must contain the correct datum parameters.

4.11 AEROTRIANGULATION – Aerotriangulation is required in accordance to Attachment I.

4.12 LAST DAY OF COLLECTION - The following conditions exist to define the "last day of collection" for metadata and attribution purposes.

A. All digital camera imagery data have been collected along the shoreline of the given region.
B. The last day on which the production data were collected within a tile shall be the "last day of collection."

5. TOPOGRAPHIC/BATHYMETRIC LIDAR POINT COLOUD CLEANING, CLASSIFICATION, AND MERGING

5.1 PURPOSE – Cleaning, classification, and merging the collected topographic and bathymetric data acquired along the designated project boundaries is required. An integrated topographic-bathymetric point cloud dataset is an important component in understanding the land-sea interface and effectively adapting to sea level rise, mitigating impacts from natural hazards, storm surges, and flooding, as well as preserving the integrity of coastal habitats and resources.

5.2 CLEANING - The topographic and bathymetric point clouds shall be cleaned so that all outliers in the raw data are classified to the appropriate LAS classification scheme as detailed in Appendix 1. Outliers include obvious noise or clutter in the data such as returns from birds or atmospheric particles, or due to electronic noise; however be careful to not reclassify real features, such as offshore rocks, as class 7. In the LAS file, no points shall be permanently removed; rather they should be assigned to the appropriate class.

5.3 CLASSIFICATION - The LAS point cloud shall be bare earth processed for the topographic portion of the data set, with the classification scheme stated in Appendix 1 utilized at a minimum. Jetties and Groins exposed above the water line shall be classified as bare earth. All points representative of submerged topography below a water surface shall be classified as bathymetric point (e.g., seafloor or riverbed).

Point classification is to be consistent across the entire project. Noticeable variations in the character, texture, or quality of the classification between tiles, swaths, lifts, or other non-natural divisions will be cause for rejection of the entire deliverable.

5.4 MERGING - Topographic and bathymetric lidar data shall be merged to form a single LAS point cloud. The merged LAS elevation data set shall be from the lidar project data available along the entire designated project boundary

5.5 HORIZONTAL DATUM - All positions shall be tied to the NSRS via processing with respect to the NGS managed Continuously Operating Reference Stations (CORS) network, and referenced to NAD83(2011)epoch:2010. The appropriate UTM coordinate system and zone as designated in the tiling scheme provided shall be used. This datum and coordinate system shall be used throughout the survey project for everything that has a position or for which a position is to be determined. Those documents used for comparisons, such as charts, junctional surveys, and prior surveys, shall be referenced or converted to NAD 83. In addition, all software used on a survey must contain the correct datum parameters.

5.6 VERTICAL DATUM - All positions shall be tied to the NSRS via processing with respect to the NGS managed Continuously Operating Reference Stations (CORS) network, and referenced to NAD83(2011)epoch:2010 ellipsoidal heights in meters.

5.7 LAST DAY OF COLLECTION - The following conditions exist to define the "last day of collection for metadata and attribution purposes.

A. All lidar data have been collected along the shoreline of the given region.
B. The last day on which the production data were collected within these tiles shall be the "last day of collection."

6. TOPOGRAPHIC/BATHYMETRIC MERGED DEM CREATION

The contractor shall provide a consistent resolution merged DEM data set from high quality elevation data acquired along the entire project area. The contractor shall prepare a detailed work plan defining their process for performing the data merge and where and how they intend to fill in the data voids, and use of breaklines. The contractor shall also provide a confidence layer (SD of all ground or bathymetric points located within a 1 meter cell size). The contractor shall provide a data void layer showing all areas within the AOI where there is no data.

6.1 ISSUES TO CONSIDER -

A. Data gaps
B. Interpolation on points/DEMs
C. Synthetic points
D. Smoothing vs Best Fit
E. Generation of and use of breaklines
F Size of water bodies, rivers to consider

The contractor shall propose a DEM development plan and submit to the COR and NGS, and the COR's approval granted, before proceeding.

6.2 SPECIFICATIONS - The following specifications shall be utilized for the topographic/bathymetric merged DEM:

A. ERDAS Imagine format (with pyramid layers computed internally within the IMG file)
B. Projection: Majority - UTM zone
C. Horizontal datum: NAD83(2011)epoch:2010
D. Vertical datum: NAVD88 (based on utilizing the most recent NGS GEOID available)
E. Resolution: 1 meter
F. Units: Meters
G. Tile layout: Each of these tiles shall cover an areal extent of approximately 5 km X 5km.
H. One FGDC compliant metadata file, in xml format, is required per image file.

7. QUALITY ASSURANCE - The contractor shall perform quality assurance on the final lidar topo/bathy merge LAS products, and provide an independent Quality Assurance report on the qualitative and quantitative quality of the final products as defined in Section 9.

7.1 QUALITY ASSURANCE REPORT - The following quality control measure items will be calculated, documented and provided within the Quality Assurance Report.

A. Bathymetric Portion of lidar Data

1. Qualitative Assessment: The contractor should employ a qualitative methodology to assess the quality of the data. The process should look for any anomalies in the data, classification errors, assure there are no obvious bias or elevation shifts between flight lines at the edges, and there are no scan pattern issues or geometric artifacts present in the data.
2. Overlapping lines and datasets shall be compared to each other and to cross lines and the differences calculated.
3. Elevations shall also be verified through comparison with ground truth data as described below.
4. All systematic errors shall be identified and eliminated and remaining errors should have an approximately zero-mean Normal distribution (defined here as abs(μ) < 0.05 m, and abs(skewness) < 1.0), and shall meet a vertical RMSE of $QL2_b$ specified in the Draft National Coastal Mapping Strategy 1.0 Document..

B. Topographic portion of lidar Data

1. Qualitative Assessment: The contractor should employ an interpretive based methodology to assess the quality of the data. The process should look for any anomalies in the data, classification errors, assure there are no obvious bias or

elevation shifts between flight lines at the edges, and there are no scan pattern issues or artifacts present in the data.
2. Overlapping lines and datasets shall be compared to each other and the differences computed.
3. The relative accuracy requirements listed below shall be calculated and meet the 10 cm accuracy class standard for elevation data as specified in the APSRS Positional Accuracy Standards for Digital Geospatial Data Edition, 1, Version 1.0 – November, 2014.

a. Within-Swath hard Surface Repeatability (Max Diff): 6 cm
b. Swath-to-Swath Non-Veg Terrain (RMSEDz): 8 cm
c. Swath-to-Swath Non-Veg Terrain (Max Diff): 16 cm

4. Elevations shall also be verified through comparison with ground truth data as described below.
5.. All systematic errors shall be identified and eliminated and remaining errors should have an approximately zero-mean Normal distribution (defined here as abs(μ) < 0.05 m, and abs(skewness) < 1.0), and shall meet the 10 cm accuracy class standard for elevation data as specified in the APSRS Positional Accuracy Standards for Digital Geospatial Data Edition, 1, Version 1.0 – November, 2014. Testing and reporting of vertical accuracies shall follow the procedures for the Non-vegetated Vertical Accuracy (NVA) at the 95% confidence level in all non-vegetated land cover categories combined and reports the Vegetated Vertical Accuracy (VVA) at the 95th percentile in all vegetated land cover categories combined stated in the Standard. A copy of this specification may be found at: http://www.asprs.org/a/society/committees/standards/ASPRS_Positional_Accuracy_Standards_Edition1_Version100_November2014.pdf .
6. The Quality Assurance report shall provide evaluation results of the point cloud accuracy for bare- earth and low grass and at least two other main categories of ground cover in the study area. For example, these additional categories could be:

a. High grass and crops (hay fields, corn fields, wheat fields);
b. Brush lands and low trees (chaparrals, mesquite, mangrove swamps);
c. Fully covered by trees (hardwoods, evergreens, mixed forests); and
d. Urban areas (high, dense manmade structures)

7. The contractor may further subdivide and expand the above definitions to better accommodate the predominant vegetation and land cover types in the survey area. The contractor will evenly distribute sample points throughout each category area being evaluated and not group the sample points in a small subarea.

7.2 CHECK POINTS/GROUND TRUTH - The below has been modified from Attachment Z, Sections 16.5 and 16.6, and Attachment O

For each acquisition region, the contractor shall follow the guidance of recommended number of checkpoints to be used for vertical accuracy testing of elevation datasets and for horizontal accuracy testing of digital orthoimagery data sets from the APSRS Positional Accuracy Standards for Digital Geospatial Data Edition, 1, Version 1.0 – November, 2014. The contractor shall follow the guidance of recommended number of checkpoints based on project area for NVA and VVA. Checkpoints shall be distributed generally proportionally among the various land cover types in the project. The contractor shall propose a checkpoint acquisition plan for the project area to the COR and NGS, and the COR's approval granted, before proceeding. All raw data, notes and logs shall be provided along with the processed results of each area.

A. Lidar

1. The contractor shall provide check points, "discrete areas of ground truth" within the designated region of interest to assist in the interrogation of the bathymetric data set.

2. The contractor shall provide check points, "discrete areas of ground truth" for the ground cover categories specified in sections 9.b.v-viii, within the designated region of interest to assist in the interrogation of the topographic data set.

3. Spot elevations to determine the accuracy of the overall dataset should be selected on flat terrain, or on uniformly sloping terrain for 5 meters in all directions from each checkpoint. Whereas flat terrain is preferable, this is not always possible. Whenever possible, terrain slope should not be steeper than a 10 percent grade and should avoid vertical artifacts or abrupt changes in elevation because horizontal errors will unduly influence the vertical RMSE calculations.

4. The checkpoints shall be collected within a temporal period, close enough to the acquisition of data, which minimizes geomorphic change that can occur between the lidar and checkpoints.

5. Horizontal Datum - All positions shall be tied to the NSRS via processing with respect to the NGS managed Continuously Operating Reference Stations (CORS) network, and referenced to NAD83(2011)epoch:2010. The appropriate UTM coordinate system and zone as designated in the tiling scheme provided shall be used.

6. Vertical Control Datum - All positions will be tied to the NSRS via processing with respect to the NGS managed Continuously Operating Reference Stations (CORS) network, and referenced to NAD83(2011)epoch:2010 ellipsoidal heights in meters.

7. The accuracy of the check points should be at a minimum, based on the ASPRS standards, at least three times better than the accuracy of the lidar they are being used to test. Documentation of all control used shall be provided in the Quality Assurance report.

B. Imagery:

1. The contractor shall provide horizontal check points at "well-defined points" within the designated region of interest to assist in the interrogation of the imagery data set.

2. The contractor shall provide horizontal check points at "well-defined points" that represents a feature for which the horizontal position can be measured to a high degree of accuracy and position with respect to the geodetic datum.

3. For testing orthoimagery, well-defined points shall not be selected on features elevated with respect to the elevation model used to rectify the imagery.

4. The checkpoints shall be collected within a temporal period, close enough to the acquisition of data, which minimizes change that can occur between the imagery and checkpoints.

5. Horizontal Datum - All positions shall be tied to the NSRS via processing with respect to the NGS managed Continuously Operating Reference Stations (CORS) network, and referenced to NAD83(2011)epoch:2010. The appropriate UTM coordinate system and zone as designated in the tiling scheme provided shall be used.

The accuracy of the check points should be at a minimum, based on the ASPRS standards, at least three times better than the accuracy of the lidar they are being used to test. Documentation of all control used shall be provided in the Quality Assurance report.

8. RECORDS AND METADATA - The contractor shall document all delivered data and data products (including options if exercised) according to Executive Order 12906 (http://www.fgdc.gov/policyandplanning/executive_order/) for the whole of the project in one metadata product. Specifically, the contractor shall deliver for all data and data products, metadata records which detail all flight lines, flight dates and times, datums, transformations, reprojections, resampling algorithms, processing steps, field records, positional accuracy, and any other pertinent information. The metadata records shall conform to the Content Standards for Digital Geospatial Metadata (FGDC-STD-001-1998) as published on May 1, 2000, by the Federal Geographic Data Committee (FGDC) or to any format that supersedes it as determined by the FGDC (http://www.fgdc.gov/metadata/csdgm/). Profiles and extensions to the standard that have been endorsed by the FGDC shall be used if they are applicable to the data or data products. The metadata records shall contain any and all elements, including those that are considered optional, wherever applicable to the data or data product. The metadata record shall contain sufficient detail to ensure the data or data product can be fully understood for future use and for posterity. The metadata records shall be delivered free of errors in both content and format as determined by the metadata parser (mp) program developed by the United States Geological Survey or an equivalent. The metadata records will be subject to review and approval prior to final acceptance by the Government.

9. DELIVERABLES

9.1 PROPERTY OF DATA - All original data, from the instant of acquisition, and other deliverables required through this contract including final data, are and shall remain the property of the United States Government. This includes data collection outside the project area. These items include the contractor-furnished materials.

9.2 PROVIDED BY THE GOVERNMENT **-** The government will provide to the Contractor:

A. A project boundary in a shapefile detailing the region for acquisition of data.

B. Small scale maps showing the coastline and/or coastal ports to be acquired. Tide coordination time windows for data acquisition, if needed.

C. Rejected Data – If data are rejected by NGS, NGS will send sample data upon request showing the problem areas.

9.3 LIST OF DELIVERABLES - This section contains the complete list of deliverables associated with this project, subject to change. All submitted plans shall be of sufficient detail so that the Government can verify that the contractor has a thorough understanding of the requirements of this SOW. The contractor shall also complete the attached spreadsheet with a percentage of the overall task order that each deliverable represents and the proposed due date for each deliverable. This data will be used to track performance and for approval of invoices. The contractor may propose additional deliverables/ milestones in their technical proposal if they determine they are required. All deliverables, including monthly reports, shall be submitted using OCM's Task Order Management and Information System (TOMIS). The following project deliverables are required.

A. Work Plan – in some instances, the technical proposal may be accepted as the work plan. The work plan should include but is not limited to; potential base station locations, horizontal and vertical accuracy of the base stations, projected maximum baseline length for airborne trajectories, prior calibration reports, process to perform daily calibration checks, flight acquisition etc. The plan shall be in Microsoft Word format and shall include the major milestones and deliverables shown in Gantt chart format.

B. Flight line map and plan of lidar and imagery collecting aircraft. Shapefiles files identifying lidar and imagery acquisition flight lines.

C. Check Point/Ground Truth Plan – including detailed discussion of the number and distribution of checkpoints to be used for vertical accuracy testing of elevation data sets and for horizontal accuracy testing of digital orthoimagery data sets, acquisition strategy and associated uncertainties of checkpoints in Microsoft Word format.

D. Quality Control Plan – including detailed discussion of accuracy assessment methods/plan or other means of proving contract specifications have been met in Microsoft Word format.

E. DEM Development Plan – including detailed discussion of their work plan defining their process for performing the data merge for a consistent resolution DEM, how they intend to fill in the data voids, creation of the confidence layer in Microsoft Word format.

F. Project schedule to include dates for all deliverables.

G. Daily situational reports (sitreps) as an email correspondence. Only required during acquisition phase.

H. A Pilot area of at least 10 km^2 including LAS, imagery, DEMs, shoreline (lines and points) and metadata are required.

I. The raw data shall include, but not be limited to, digital copies of all electronic and paper files generated in the course of the survey, flight sheets, field data collection sheets, raw airborne and ground GPS data, Ground Truth data, GPS processing projects, processed GPS data, project tracking files, raw airborne lidar data, flight plans in GIS or manufacturer format, processed lidar data in manufacturer directory structure and format, crossline dataand an unclassified LAS 1.2 point cloud.

J. Final Products shall include:

1. Data coverage images of the lidar (Lidar data coverage images will be delivered prior to delivery of elevation data.)
2. Cleaned, classified, and merged point clouds in a LAS 1.2 format
3. Lidar point cloud metadata
4. Topographic/Bathymetric DEM
5. Topographic/Bathymetric DEM metadata
6. GeoTiff RGB/NIR Ortho-mosaic imagery
7. GeoTiff RGB/NIR Ortho-mosaic imagery metadata
8. RGB/NIR Stereo Imagery - Uncompressed Developed Images (*.tif)
9. RGB/NIR Stereo Imagery metadata
10. Exterior Orientation (EO) Files (*.txt)
11. Ground Control Report for Imagery
12. Ground Control Report for lidar
13. Ground Control Shapefile for Imagery
14. Ground Control Shapefile for lidar
15. Lidar Boresight and Calibration Report and Files
16. Camera Boresight Calibration Report and Files
17. Camera Calibration Report (Terrestrial Calibrations - Bench calibrations that have the computed distortion values)
18. Flight Line Maps for lidar
19. Flight Line Maps for Imagery
20. Shapefiles identifying imagery acquisition flight lines.
21. Shapefiles identifying lidar acquisition flight lines.
22. Shapefiles depicting exposure stations of acquired imagery
23. Electronic Exposure Data (EED) File
24. Tabulation of Aerial Photography
25. Photographic Flight Reports
26. Lidar Flight Reports
27. Airborne Positioning and Orientation Report (APOR)

28. Aerotriangulation Report (95% CC computed)
29. Feature attributed shoreline shapefiles
30. Shoreline metadata
31. Chart Evaluation Files (CEF)
32. Project Completion Report (PCR)
33. Quality Assurance Report
34. Final Report of Survey.

All deliverables will be provided on external USB 3.0 capable hard drives that will become the property of the government.

K. All valid data collected during production flight lines shall be processed and used to generate the final products. This includes data that is collected outside of the project specified coastal swath that the scope specifies.

L. Additional information for each of the following products is found in Appendix 1

1. Lidar Data Coverage
2. Cleaned, Classified and Merged Topographic/Bathymetric Point Cloud Data in LAS 1.2 format
3. Topographic/Bathymetric DEM
4. RGB/NIR Ortho-mosaic Imagery
5. RGB/NIR Stereo Imagery
6. Aerotriangulation Report
7. Feature Attributed Shoreline Shapefiles and associated deliverable files
8. Metadata
9. EED File
10. Tabulation of Aerial Photography
11. Photographic Flight Reports
12. Airborne Positioning and Orientation Report (APOR)
13. Quality Assurance Report:
14. Final Report of Survey

9.4 – PRODUCT DELIVERY SCHEDULE - During project acquisitions, a daily sitrep as an email correspondence shall be provided by the contractor detailing the day's acquisition activities, location, and mission status.

The data coverage product files will be delivered to POC no later than 14 days from the last day of data acquisition. Please see the Data Coverage section for details of this product.

10. LIDAR DATA COVERAGE

One file will be produced per project area that shows areas where valid data were collected. The file will be an elevation raster in GeoTiff format with 5m pixel resolution.

The Horizontal Datum shall be positioned to the NSRS via processing with respect to the NGS managed Continuously Operating Reference Stations (CORS) network, and referenced to NAD83(2011)epoch:2010. The appropriate UTM coordinate system and zone as designated in the tiling scheme provided shall be used.

The Vertical Datum should be positioned to the NSRS via processing with respect to the NGS managed Continuously Operating Reference Stations (CORS) network, and referenced to NAD83(2011)epoch:2010 ellipsoidal heights in meters.

The base naming convention for these files will be "YYYY_ XXXXXXe_YYYYYYYn_lascoverage"; box numbering is provided in the tiling shapefile.

One FGDC compliant metadata file, in xml format, is required per data type.

11. LAS FILES

All project swaths, returns, and collected points, fully calibrated, adjusted to ground, and classified, by tiles. Project swaths exclude calibration swaths and other swaths not used, or intended to be used, in product generation. LAS files should be delivered in LAS 1.2 format.

The Horizontal Datum should be positioned to the NSRS via processing with respect to the NGS managed Continuously Operating Reference Stations (CORS) network, and referenced to NAD83(2011)epoch:2010. The appropriate UTM coordinate system and zone as designated in the tiling scheme provided shall be used.

The Vertical Datum should be positioned to the NSRS via processing with respect to the NGS managed Continuously Operating Reference Stations (CORS) network, and referenced to NAD83(2011)epoch:2010 ellipsoidal heights in meters.

All returns shall be delivered (including vegetation, buildings, etc) with the exception of obvious error points. The LAS file public header block shall include all required fields according to the September 2008 LAS1.2 specification. The LAS file shall also include the mandatory GeoKey DirectoryTag variable length header. See the LAS v1.2 Specification for additional information. The Point Source ID field must be filled out for each record matching an ESRI shapefile vector format file of the flight lines. The start and stop date/times for each flightline will also be included in the shapefile. Point families (multiple return "children" of a single "parent" pulse) shall be maintained intact through all processing before tiling. Multiple returns from a given pulse will be stored in sequential (collected) order. Each point in the LAS file shall also include the return number, number of returns from the pulse, time, scan angle, and intensity values (native radiometric resolution).

The Point Data Record Format 3 shall be used. The topographic points shall be bare earth processed with the following classification scheme utilized at a minimum. All points representative of submerged topography below a water surface shall be classified as bathymetric point (e.g., seafloor or riverbed).

Classification Value	Meaning
1	Processed, but unclassified
2	Bare-earth ground
7	Noise (low or high; manually identified)
25	Water Column (No Bottom Found)
26	Bathymetric point (e.g., seafloor or riverbed; also known as submerged topography)
27	Water surface (sea/river/lake surface from bathymetric or topographic-bathymetric lidar; distinct from Point Class 9, which is used in topographic-only lidar and only designates "water," not "water surface")
28	Derived water surface (synthetic water surface location used in computing refraction at water surface)
29	Submerged object, not otherwise specified (e.g., wreck, rock, submerged piling)
30	International Hydrographic Organization (IHO) S-57 object, not otherwise specified
31	Denotes bathymetric bottom temporal changes from varying lifts, not utilized in bathymetric point class

All waveform data shall be delivered in the PulseWaves format capable of being read or written by the open-source PulseWaves Tools. More information can be found at http://pulsewaves.org.

Tiled delivery, without overlap, using the Project Tiling Scheme. The base naming convention for these files will be "YYYY_XXXXXXe_YYYYYYYn_las"; box numbering is provided in the tiling shapefile. Tiles shall be 500 meters X 500 meters.

GPS times are to be recorded as Adjusted GPS Time, at a precision sufficient to allow unique timestamps for each return. Adjusted GPS Time is defined to be Standard (or satellite) GPS time minus 1*109. See the LAS Specification for more detail.

One FGDC compliant metadata file, in xml format, is required per data type.

12. RGB/NIR ORTHO-MOSAIC IMAGERY

The following requirements have been modified from those in Attachment AL.

One Geo Tiff ortho-mosaic is required for each tile and will contain all images collected within the tile that show land mass or fixed features in the water, such as jetties, breakwaters, etc. Areas containing no imagery will have a transparent background.

The base naming convention for these files will be "YYYY_XXXXXXe_YYYYYYYn_orthomosaic". Each tile shall be 3 km X 3 km, with no gaps or overlap. These files shall be provided in GeoTIFF format and the Horizontal Datum should be positioned to the NSRS via processing with respect to to the NGS managed Continuously Operating Reference Stations (CORS) network, and referenced to NAD83(2011)epoch:2010. The appropriate UTM coordinate system and zone as designated in the tiling scheme provided shall be used.

One FGDC compliant metadata file, in xml format, is required per image file.

13. RGB/NIR STEREO IMAGERY

Stereo Imagery will be delivered in a format capable of loading into BAE's SocetSet or GXP software products. The following deliverables shall be included in the RGB/NIR Stereo Imagery package:

- Uncompressed Developed Images (*.tif),
- Exterior Orientation (EO) Files (*.txt)
  - The EO file shall contain at a minimum the following fields:
    - ID, [Image ID needs to be renamed according to the CMP naming convention (ex. 120001_99999)].
    - Time (GPS Seconds of the Week),
    - Latitude(signed Decimal Degrees),
    - Longitude (signed Decimal Degrees),
    - UTM Easting (meters),
    - UTM Northing (meters),
    - Orthometric Height (meters, utilizing the latest NGS GEOID model),
    - Omega (degrees),
    - Phi (degrees),
    - Kappa (degrees),
    - UTM Easting Standard Deviation (meters),
    - Northing Standard Deviation (meters),
    - Height Standard Deviation (meters),
    - Omega Standard Deviation (degrees),
    - Phi Standard Deviation (meters),
    - Kappa Standard Deviation (degrees).
- Terrestrial Calibration Files (*.pdf)

- Boresite Calibration Files (*.html or *.pdf)
- Project Metadata (*.xml)
- AIRBORNE POSITIONING AND ORIENTATION REPORT - The Report shall include at least the following paragraphs:
  – Introduction,
  – Positioning
    – Image Collection
    – Static Processing
    – Kinematic Processing
    – Data Sets
  – Orientation
    – Data Collection
    – Data Processing
    – Data Sets
  – Final Results.

  A. INTRODUCTION – Provide an overview of the project and the final processed data sets and list the data sets in table form with the following columns: Dataset ID, Date of Acquisition, Projects covered by the data set, and Description/Flight Line(s) Identification.

  B. POSITIONING – Discuss the methodology, the hardware and software used (including models, serial numbers, and versions), the CORS station(s) used, a general description of the data sets, flight lines, dates and times of sessions, the processing (including the type of solution–float, fixed, ion–free, etc.), and the results (discussion of the coordinates and accuracy). Submit a description of the data sets, and the raw and processed data. If the NGS OPUS website was used to process the static data, the Contractor shall provide a copy of the OPUS report. If a known station was used from the NGS database, the Contractor shall identify the station by name and permanent identifier (PID), and provide the published coordinates used in the kinematic position step. If multiple base stations were used, provide processing details, coordinates, and accuracy for all stations.

  C. ORIENTATION – Discuss the factors listed above for Positioning.

  D. FINAL RESULTS – Describe any unusual circumstances or rejected data, and comment on the quality of the data.

13.1 METADATA - Complete metadata will be provided for each of these products. Only one metadata record is needed for each respective deliverable product, i.e., LAS and DEM files. The metadata will be in xml format. Draft version of the metadata will be provided to NOAA for review prior to final data submittal. An example of the minimum content that shall be included is provided as a supplement to this SOW.

13.2 ELECTRONIC EXPOSURE DATA (EED) FILE - The contractor will need to supply one (1) CSV file per lift. The field Format is absolutely critical because this is the file that is imported into, and populates, the FIF. With respect to the verbiage in Attachment Z, section 18.7,the CSV format should be considered the "latest version of the NGS EED file format for digital imagery". See Attachment H.

13.3 AIRBORNE POSITIONING AND ORIENTATION REPORT (APOR) - Refer to Attachment Z, section 16.

13.4 TABULATION OF AERIAL PHOTOGRAPHY - Refer to ANNEX 7A – SAMPLE, TABULATION OF AERIAL PHOTOGRAPHY in Attachment C - of Version 14A Scope of Work for Shoreline Mapping under the NOAA Coastal Mapping Program, for an example of the Tabulation of collected imagery.

13.5 PHOTOGRAPHIC FLIGHT REPORTS - Please see attachment Z, Section 18.6

13.6 QUALITY ASSURANCE REPORT - The Quality Assurance Report shall detail the qualitative and quantitative (absolute, within swath, and between swath) assessment of the cleaned, classified, and merged topographic/bathymetric point cloud deliverable, topographic/bathymetric DEMs, and Ortho-mosaic Imagery.

13.7 FINAL REPORT OF SURVEY -

Report will include, at a minimum:

- Area Surveyed
- Survey Purpose
- Data Acquisition and Processing
    - Equipment used to perform this work, including hardware models and serial numbers, calibration reports, software names and versions (include aircraft, lidar, digital imaging system, and trajectory positioning info), and information on the equipment utilized to determine aircraft to sensor offsets.
        - Data Acquisition Hardware and Software
        - Processing Software
    - Quality Control
        - Survey Methods and Procedures
    - Data Processing Methods and Procedures
        - Field Processing
        - Workflow Overview
        - Trajectory Processing
        - Lidar Processing
        - Lidar Editing
        - Product Creation
        - Imagery Processing
        - Additional Quality Checks (discussion of data quality procedures)
        - Discussion of each deliverable included and a list of delivered files,
        -
    - Corrections to measurements
        - Lidar System Offsets and Calibrations

        - Imagery System Offsets and Calibrations
        - Motion Corrections
        - Environmental Parameters/Processing Settings
        - Vertical Datum Conversions
    - Uncertainty (Accuracy check reports)
- Vertical and Horizontal Control (GPS logs and photos of control points)
- List of problems encountered and any deviations from this SOW, and any recommendation for changes to this SOW for future work.

Notice – all items highlighted are changes from previous versions of this SOW

December 2017

ATTACHMENT Z
Digital Aerial Camera Usage & Data Processing

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPINGPROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETICSURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Notice – all items highlighted are changes from previous versions of this SOW

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ATTACHMENT Z: DIGITAL AERIAL CAMERA USAGE & DATA PROCESSING

Notice – all items highlighted are changes from previous versions of this SOW

ATTACHMENT Z: DIGITAL IMAGERY REQUIREMENTS

1. INTRODUCTION

These Coastal Aerial Film Photography Requirements include specifications for aerial film photography and associated data to support the National Oceanic and Atmospheric Administration's (NOAA) Coastal Mapping Program (CMP). In addition, Project Instructions (PI) will provide project specific information. The CMP is administered by the National Geodetic Survey (NGS), National Ocean Service (NOS), NOAA.

2. SCOPE

This document contains specifications for metric quality, tide-coordinated, Global Positioning System (GPS) controlled, digital imagery over the shoreline, including planning, acquisition, data processing, controlling quality, calibrating equipment, and constructing reports. The scope of the project will be fully described in the PI and may include additional phases of shoreline mapping work.

The following conventions have been adopted for this document. The term "shall" means that compliance is required. The term "should" implies that compliance is not required, but is recommended. All times shall be recorded in Coordinated Universal Time (UTC). Any request to deviate from this Scope of Work shall be submitted in advance in writing for possible approval by the National Geodetic Survey (NGS). Throughout this document where "GPS" is mentioned, Global Navigation Satellite Systems (GNSS) may be substituted.

Projects may also include: aerial imagery of disaster areas, and other special case aerial imagery tasks.

3. PROJECT PARAMETERS

3.1. PROJECT LIMITS - Projects can be along any portion of the U.S. shoreline, including U.S. possessions in the Caribbean and the Pacific, or other areas of interest. Individual project limits will be defined in the PI and may be outlined on government provided project diagram. If Contractor planning of photo coverage is required, that coverage shall be planned to include all shoreline within the project area, all land within 2,000 feet of that shoreline, and all seaward rocks and/or obstructions on the existing nautical chart of the project area.

4. COMPLIANCE REQUIREMENTS

4.1. PROJECT INSTRUCTIONS PRECEDENCE - The PI will take precedence over the Scope of Work (SOW) since the PI provide detailed and often unique information about each project.

4.2. TERMS - The following conventions have been adopted. The term "shall" means that compliance is required. The term "should" implies that compliance is not required, but is strongly recommended.

4.3. MODIFICATION - Requests to exceed or deviate from the SOW or the PI will be considered if written justification is provided in advance to the Contracting Officer (CO) and the Contracting Officer's Representative (COR). No deviation is permitted until written approval is received from the CO. All requests for modification to the SOW and/or the PI shall be submitted by the Contractor in writing to the CO prior to the due date on the Task Order and as soon as a possible need for modification is identified. Send a copy of the request to the NGS points of contact (including the COR). If the Contractor anticipates not meeting a required deadline, the Contractor shall request, in writing, an extension from the CO. Provide a copy of the extension request to the COR. Extensions may be granted if extenuating circumstances exist.

4.4. UNUSUAL CIRCUMSTANCES - The Contractor shall notify the COR of any unusual circumstances that occur during the performance of the project which might affect the deliverables or their quality, and especially of any deviation from the SOW, or the PI.

4.5. ORIGINAL DATA - Observation logs and other records generated during this project are legal records which will be archived. It is very important that these logs be original, legible, neat, clear, and fully completed in indelible black ink. Original data shall be saved, unmodified, whether in hand written or computer recorded form and shall be marked "ORIGINAL DATA". In the original records (paper or digital), nothing is ever erased or obliterated. All available spaces on the recording forms should be completed. If a space on a form does not apply, then enter "N.A.' for "Not Applicable". If a mistake is made on a form, draw a single line through the mistake and write the correction above or to the side. If space is too limited to permit a field correction, restart with a new log sheet. However, do not recopy the form in the office in order to make a "clean" copy. An explanatory note should be made for all corrections to the original recorded figures. It is essential that all recorded figures be neat and legible. All editing of computer recorded data shall be done on a copy of the original. Always submit the unmodified version of the data.

4.6. DATA BACKUP - The Contractor shall back-up all data and take whatever steps necessary to ensure the safety of all data, especially original, raw data. The Contractor shall save all data back-ups until after NGS has accepted all data for that Task Order. The contractor shall sanitize all equipment following NIST Special Publications 800-88 Guidelines for Media Sanitization, http://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-88r1.pdf, that stored data utilized during this project.

4.7. GOVERNMENTAL RULES AND REGULATIONS - The Contractor shall ensure that they comply with applicable regulations of government agencies, including the:

- Federal Aviation Administration (FAA), https://www.faa.gov/regulations_policies/
- US Coast Guard (USCG), https://www.navcen.uscg.gov/?pageName=navRuleChanges

- Environmental Protection Agency (EPA), https://www.epa.gov/laws-regulations
- Occupation Safety & Health Admin. (OSHA), https://www.osha.gov/html/compliance.html
- National Park Service (NPS), https://www.nps.gov/aboutus/lawsandpolicies.htm
- Homeland Security, https://www.dhs.gov/
- Surface Transportation Board, https://www.stb.gov/stb/index.html

and other federal, tribal, state, commonwealth, and local governmental rules and regulations. The Contractor shall be responsible for identifying, obtaining, completing, and submitting applications, forms, and permits, and obtaining approval of all necessary permits for work performed under this contract.

4.8. WEEKLY STATUS REPORTS - The Contractor shall submit Weekly Status Reports via the Task Order Management and Information System (TOMIS) every Monday by 2:00 PM Eastern Time, from the date of a Task Order award until the work is complete and accepted by NGS, see Attachment G for details. Also include any unusual circumstances, deviations from the SOW the PI, equipment malfunctions, and/or any disturbance of the camera. A Weekly Status Report is required even if no progress has been made.

5. REFERENCE SYSTEMS

5.1. GEODETIC STANDARDS FOR IMAGE PROCESSING

- HORIZONTAL CONTROL - The horizontal datum is the North American Datum 1983 (NAD 83, 2011) Epoch: 2010;

- VERTICAL REFERENCE - The vertical datum is the North American Vertical Datum of 1988 (NAVD 88). In Alaska and other areas outside the continental United States where NAVD 88 bench marks are not available, the Contractor may be required to make Global Positioning System (GPS) ties to tidal bench marks within the project area;

- SHORELINE REFERENCE –
  - MEAN LOWER LOW WTER (MLLW),
  - MEAN HIGH WATER (MHW);

- NATIONAL SPATIAL REFERENCE SYSTEM (NSRS) – All positioning shall be tied to the NSRS https://www.ngs.noaa.gov/INFO/OnePagers/NSRSOnePager.pdf

- GEOID MODEL - The geoid model to be used in converting GPS-derived ellipsoid heights to NAVD 88 orthometric heights is GEOID12B or the most current version. For GEOIDinformation see: https://www.ngs.noaa.gov/GEOID/

- The contractor shall record all processing steps and software used including version number;

- The contractor shall use either the rapid or precise IGS orbit ephemeris for GPS processing.

6. REFERENCES AND GLOSSARIES

- Obtaining Nautical Chart Products - https://www.nauticalcharts.noaa.gov/staff/chartspubs.html
- "NOAA Chart #1" (Chart symbols, abbreviations, and terms) at: https://www.nauticalcharts.noaa.gov/mcd/chartno1.htm
- Dates of Latest Editions of charts: https://www.nauticalcharts.noaa.gov/mcd/dole.htm
- NOAA CHART CATALOG - The NOAA catalog shows chart coverage and lists nautical chart dealers, see: https://www.nauticalcharts.noaa.gov/catalog/index.html
- NOAA NGS WWW Site: https://www.ngs.noaa.gov/
- "U.S. Coast Guard Light List" available on-line at: https://www.navcen.uscg.gov/?pageName=lightLists
- Glossaries in Attachments F and M,
- Manual Of Photogrammetry (MOP), Fifth Edition, 2004,
- Manual of Color Aerial Photography, First Edition, 1968,
- Water Level Station Specifications and Deliverables for Shoreline Mapping Projects, May 2009, at: https://tidesandcurrents.noaa.gov/publications/Water_Level_Station_Specifications_and_Deliverables_for_Shoreline_Mapping_Projects,_Updated_May_2009.pdf
- Note, this document is an update of Chapter 4 of the Hydrographic Specifications and Deliverables and is now the primary CO-OPS reference for shoreline mapping. https://nauticalcharts.noaa.gov/hsd/specs/HSSD_2017.pdf

7. DATA FORMAT STANDARDS

7.1. The format of the digital imagery deliverables shall be uncompressed TIFF images;

7.2. The media for the deliverables shall be DVD, portable hard drive, or secure SFTP server, depending on feasibility of data transfer and the amount of data. Contractor shall maintain a copy of the data until NGS acknowledges receipt.

8. GOVERNMENT FURNISHED INFORMATION

8.1. PROPERTY OF DATA – All original data and imagery, from the instant of acquisition, and other deliverables required through this contract including final images, are and shall remain the property of the United States Government. This includes image collection outside the project area.

8.2. DATA - The government will provide to the Contractor:

8.3. PROJECT INSTRUCTIONS – Project Instructions are a separate document providing specific project information, containing any unique project requirements, and may have the following attachments:

- Project Diagrams with project limits marked and showing the shoreline to be compiled highlighted. Compilation limits, if different from the 2000 foot requirement; and, as required, limits of tide-coordination areas, if different from compilation limits;
- Digital Files with the above information;
- Tidal zoning diagram; Tidal Constituent And Residual Interpolation (TCARI) data, TCARI memo;
- Tidal zoning memo;
- Waypoint file;

8.4. ADDITIONAL INSTRUCTIONS - Instructions regarding tidal coordination, ground control, and any other project specific requirements;

8.5. PROJECT IDENTIFIER - The “Project Identifier,” an eleven character alpha-numeric Identifier (ID) unique to each project (i.e. FL1701-CM-C).

Note, the Contractor is responsible for procuring new editions of nautical charts, as required, to ensure that they are using the latest edition of all nautical charts. A link to the listing of the latest editions is listed above.

9. DIGITAL AERIAL CAMERA USAGE & DATA PROCESSING

9.1. QUALITY CONTROL

9.1.1. GENERAL - The Contractor shall check all data to ensure that it is complete, reliable, and accurate. Note, accuracy requirements may be in the PI. The Contractor’s personnel shall become thoroughly familiar with the SOW; the PI; the definitions of terms; and the material covered in the other references and publications, as required. See Section 6 for a list of References.

9.1.2. QUALITY CONTROL PLAN - The Contractor shall have the responsibility for the overall quality of the Project. The Contractor shall submit a written Quality Control Plan (QCP) as part of their Technical Proposal, prior to beginning work. It shall include checking at least the following:

- Manually recorded data;
- Data manually entered into a computer system;
- All digital data output formats;
- Data at various points in the over-all process;
- All Deliverables (including documents , data, reports, etc.) submitted.

9.1.3. The Contractor shall also describe how data shall be backed up and how it shall be ensured that original data are not modified, see Section 18, Deliverables and Section 4, Compliance Requirements.

9.1.4. A summary of how the steps of the QCP were met shall be included in the Photo Final Report.

9.2. IMAGERY TESTING AND STANDARDS

9.2.1. DIGITAL IMAGERY TEST – The Contractor shall acquire and deliver images over a section of coastline and/or coastal ports which is similar to the contract work. The test data set shall include all bands used for imagery collection. NGS will review this imagery test as soon as possible and notify the Contractor of the results of the review. The Contractor shall not proceed with continued imagery collection until it has received approval from NGS. If NGS rejects the imagery test, a repeat test shall be required.

9.2.2. REJECTED IMAGERY – If images are rejected by NGS (for reasons that may include, but are not limited to: flooding, smoke, snow, over-exposure, cloud cover, distortion, sun angle), NGS will send sample images upon request showing the problem areas.

10. EQUIPMENT AND MATERIAL

10.1. DIGITAL IMAGING AND POSITIONING SYSTEM

10.1.1. SPECIFICATIONS

- The sensor shall be a geometrically stable and calibrated system suitable to use for high-accuracy photogrammetric mapping;

- The sensor shall be of a high enough resolution and have a large enough Field of View (FOV) to provide the required Ground Sample Distance (GSD) and stereo coverage of a ground swath defined in the Project Instructions;

- Calibration: Aerial Sensors/Camera(s) used to collect project imagery shall have current U.S. Geological Survey (USGS) certification, or in the case of digital sensors a current USGS digital aerial sensor type certification;

- The sensor shall meet the requirements of the Inter-agency Digital Imagery Working Group (IADIWG);

- The sensor shall not produce bright object edge artifacts;

- The sensor shall acquire blue (B), green (G), red (R), and near infrared (NIR) spectral bands. To provide sharp contrast between land and water, it is critical that the NIR passband start at a wavelength greater than 740 nm (ideally, around 800 nm or higher). For example, a well-suited sensor might have a NIR passband of 800-1000 nm with high transmittance inside this band, and very low transmittance below 800 nm. (It is perfectly acceptable for the passband to extend further into the NIR on the high wavelength end.) The justification for this requirement is explained in Parrish et al. (2005). If an optical bandpass filter is used to satisfy the above requirement, this filter must be accounted for in the camera calibration so that the sensor's geometric accuracy is not adversely affected by the use of the filter.

- Reference:

  - Parrish, C.E.; Sault, M.; White, S.A., and Sellars, J., 2005. Empirical Analysis of Aerial Camera Filters for Shoreline Mapping, Proceedings of the ASPRS Annual Conference, unpaginated CD-ROM

10.1.2. MAINTENANCE – The Contractor shall supply certification to NGS before the project is commenced to prove that preventive maintenance and system calibration have been satisfactorily completed for the digital sensor.

10.1.3. CALIBRATION – See sections 10.1.1 and 12.

10.1.4. IMAGE ACQUISITION – The digital imaging system shall be able to acquire the following bands: red, green, blue, and black-and-white IR. The IR shall be a separate image and the IR shall meet the accuracy and resolution requirements without pan-sharpening. The raw image is defined as the data that is retrieved from the sensor system before any conversion to processed format. If any radiometric image enhancement is performed on the raw images following image collection, the raw images must be submitted along with enhanced images. All use of contrast, brightness, and other radiometric image enhancements shall be discussed in the final report.

10.1.5. MALFUNCTIONS – All digital imaging system malfunctions shall be recorded and NGS notified. A malfunction is defined as a failure anywhere in the digital sensor that causes an interruption to the normal operation of the unit. Also, any malfunctions of the GPS or Inertial Measurement Unit (IMU) collection systems shall be recorded and reported directly to NGS.

10.1.6. INERTIAL MEASUREMENT UNIT - If an IMU is employed in the digital imaging system, the IMU shall be capable of determining the absolute orientation (roll, pitch, and yaw) and meet or exceed the following performance specifications:

  - Post-processed accuracy in roll and pitch: 20";

- Post-processed accuracy in heading: 30".

10.1.7. GLOBAL POSITIONING SYSTEM - Carrier-phase L1 and L2 airborne kinematic GPS shall be acquired and used along with IMU measurements (if IMU is used) in processing trajectories. The performance specification for post-processed positioning solution accuracy shall be no worse than 30cm relative to the National Spatial Reference System (NSRS).

10.1.8. The GPS antenna shall be a Federal Aviation Administration (FAA)-approved antenna (following appropriate safety and structural air-worthiness considerations) suitable for geodetic quality carrier-phase L1 and L2 reception and installed in accordance with FAA airframe modification requirements. Antenna should be located in a location near the camera to minimize lever arm lengths, and also in a location to provide optimal GPS signal quality and continuous reception in an appropriate, unobstructed location on the plane.

11. AIRCRAFT REQUIREMENTS

11.1. PLATFORM TYPE – All equipment shall be connected, attached, mounted and secured to the aircraft airframe in a manner to provide a safe environment for the crew. The type of aircraft and the aircraft tail number used shall be stated on the digital sensor Flight Log and all aircraft and airframe modifications used in the performance of this Project shall be maintained and operated in accordance with all regulations required by the Federal Aviation Administration. Any inspections or maintenance of the aircraft for performance of this Project which results in missed data collection shall not be considered as an excusable cause for delay. The Contractor shall ensure that the aircraft has a proven service ceiling, with operating load (fuel, crew, sensor, and other required equipment), of not less than the highest altitude required to acquire the data.

11.2. PORT OPENING – The design of the port opening(s) in the aircraft shall be such that the field of view is unobstructed when a sensor is mounted with all its parts above the outer structure. The field of view shall, so far as is practicable, be shielded from air turbulence and from any outward flows, such as exhaust gases, oil, etc.

11.3. OPTICAL FLAT – NGS recommends that an optical flat not be used. If an optical flat is used, the physical characteristics of the window (such as size, thickness, smoothness, flatness, parallelism, glass quality, and optical transmissivity) shall be reported to NGS prior to use. The optical flat shall meet the following specifications:

- Optical quality;
- Mounted in material eliminating mechanical stress to the window;
- Free of blemishes, dirt, significant scratches, etc;
- Shall not degrade the resolution or the accuracy of the camera.

Any optical flat should meet the American Society of Photogrammetry and Remote Sensing Aerial Photography Standards, 1995, which states, “If an aircraft camera has a port glass it shall be preferably 50mm thick but not less than 37mm thick. The surface finish shall be 80/50 or better. Glass material shall be polished crown, group category M. Mil Specs Mil-W-1366F (ASG) October 1975, C-1 optical quality or better."

12. SYSTEM CALIBRATION

12.1. The digital imaging system shall be calibrated and a calibration report submitted. Any incomplete reports shall be cause for rejection of the data. Calibration reports for each digital imaging system used shall be supplied to NGS at the beginning of each project and again if the system is removed and remounted during the project. The contractor shall follow the manufacturer's specifications for appropriate calibration and recalibration.

12.2. The calibration reports shall cover each of the following topics:

- SYSTEM CALIBRATION – System calibration shall address geometric performance. Parameters to be tested include calibrated focal length, lens distortion parameters, and principal point location. Also, any radiometric calibration parameters and files shall be provided to NGS. Some of these procedures and parameters may be unique to a manufacturer since hardware varies from manufacturer to manufacturer. The IMU-to- camera alignment shall be checked. Also, updated IMU misalignment angles shall be provided as evaluated.

- BORESIGHT CALIBRATION VALUES – The boresight calibration is the determination of relative orientation between camera and IMU reference frames. If IMU georeferencing will be used, boresight calibration shall be performed according to manufacturer specifications for each project or any time the camera or IMU is mounted or removed. The contractor shall supply NGS with a boresight calibration report indicating the method used in boresighting and the final values

- DETERMINATION OF OFFSETS – The sensor-to-GPS-antenna offset vector components ("lever arm") shall be measured. The offset vector shall be determined with an absolute accuracy (1Σ) of 1.0 cm or better in each component. By convention, this vector is measured from the incident nodal point of the camera lens to the GPS antenna phase center in the coordinate system of the camera. The offset vector components shall be re-determined each time the sensor or aircraft GPS antenna is moved or repositioned in any way.

13. MISSION PLANNING AND CLEARANCES

13.1. MISSION PLANNING

13.1.1. COVERAGE AND PARAMETERS – Projects can be along any portion of the U.S. shoreline, including U.S. possessions in the Caribbean and the Pacific, or other areas of interest. Individual project limits will be defined in the PI and may be outlined on government provided project diagram. If Contractor planning of photo coverage is required, that coverage shall be planned to include all shoreline within the project area, all land within 2,000 feet of that shoreline, and all seaward rocks and/or obstructions on the existing nautical chart of the project area. The NGS may supply shapefiles illustrating the flight lines to be used for a project. The Contractor shall check this flight line data and the associated waypoint files to ensure adequate coverage for mapping and aerotriangulation (AT), including coverage of offshore rocks and islands. The Contractor shall notify NGS immediately of any problems found with the flight lines. When supplied, the Contractor shall use the NGS flight lines to acquire the required imagery. Individual project limits will be defined in the PI and may be outlined on government provided project diagram. On the other hand, the Contractor may be required to plan flight lines in the project area and ensure complete coverage of the area. Flight lines shall cover the project area with the fewest flight lines practicable, at the acquisition altitude specified in the project instructions. Flight lines shall be designed to an altitude that produces a 0.6 meter Ground Sample Distance (GSD) with the Contractor's digital camera. Other mission planning parameters may include, but are not limited to: endlap, sidelap, flying speed, crab, tilt, tide coordination, PDOP , and aircraft bank angle.

13.1.2. PRIORITY – Project priority, if any, will be defined in the PI.

13.1.3. GROUND SAMPLE DISTANCE – The GSD is an area on the ground represented by each pixel in a digital image, typically 60 cm (0.6 meter) for a shoreline mapping project.

13.1.4. ENDLAP - Consecutive images in a flight line shall have a minimum endlap of 60% of the mean image width if the camera mount provides correction for crab, otherwise 70%. This section does not apply to push broom sensors.

13.1.5. SIDELAP – Adjacent images shall have a minimum sidelap of 30% of the mean image width if the camera mount provides correction for crab, otherwise 40%.

13.1.6. FLYING SPEED – The camera manufacturer's recommendation should be followed for flying speed. Flying speed shall be limited to keep image smear below 15%. The maximum speed over ground for push broom sensors shall not exceed the manufacturer's guidelines.

13.1.7. CRAB - While collecting digital imagery, the camera shall be compensated for crab of the aircraft, with a resultant error not exceeding +/- five (5) degrees, as measured from the average line of flight, and the differential between any two successive exposures shall not exceed +/- five (5) degrees.

13.1.8. TILT - While collecting digital imagery, tilt (departure from the vertical) of the camera shall not exceed +/- five (5) degrees for any photographic frame. The average tilt for the entire project shall not exceed +/- one (1) degree.

13.1.9. TIDE COORDINATION – Coordination of imagery acquisition with specific stages of tide may be required. See Attachment J for tide coordination requirements.

13.1.10. PDOP/VDOP - PODP/VDOP shall be < 3.

13.1.11. AIRCRAFT BANK ANGLE – The aircraft bank angle shall not exceed 15°.

13.1.12.FLIGHT CLEARANCES - The Contractor shall comply with all required Federal

Aviation Administration Regulations, including obtaining all required clearances.

13.2. ACCURACY OF IMAGE MENSURATION - General guidance on HORIZONTAL accuracy at a 95% confidence level for well defined points.

- Harbors, ports, channels, etc. 1 meter
- Approach areas to ports 3 meters
- Open coastal areas 5 meters

14. WEATHER CONDITIONS AND TIME OF YEAR

14.1. WEATHER - No clouds or cloud shadows shall appear on the photographs. High, thin overcast clouds will be permitted above the flying altitude if it does not cause ground mottling or a discernable reduction in light levels and/or ground object shadows. Digital imaging shall not be conducted when clouds or cloud shadows appear in the scene or if the land-water interface is obscured by snow, ice, etc. Storm systems and events (e.g. hurricanes, northeasters, and frontal boundaries) that may cause an increase in water levels, tidal heights, and wave activity shall be avoided.

14.2. TREE LEAVES - Leaf-off condition is not required but is preferred. Trees along a shoreline can obscure the shoreline if care is not taken in planning.

14.3. WELL-DEFINED IMAGES - Imagery collection shall be undertaken only when the land- water interface can be well-defined. Imagery shall not be attempted where the ground is obscured by clouds, haze, smoke, smog, dust, snow, sleet, rain, etc. Also, imagery shall not be conducted when the ground, and especially land-water interface, is covered by water (flood), snow, or ice.

14.4. VISIBILITY - The minimum visibility at the time of exposure is eight (8) miles. Imagery shall not be collected when a haze is present. Visibility is determined by looking at objects on the ground toward the sun. The distance at which the detail of ground objects is clearly defined is the visibility. If the visibility is satisfactory, details of ground objects shall be clearly defined at the edge of the view through the drift sight (assuming the system makes use of a drift sight which may not be the case for some automated digital systems).

14.5. TIME OF DAY - Time of day is determined by the sun angle which shall not be less than 25 degrees above the horizon at the time of exposure. The Project Instructions may require a larger sun angle for certain projects. Ideally, the sun angle should be between 30 and 45 degrees for shoreline photography. Photography should be collected while the sun is over the water so that any shadows created by elevated objects will point inland and will not obscure the shoreline.

14.6. SUN SPOTS - The size and number of hot spots (no sun shadow points) and “sun spots” (bright, sun reflectance areas) on the water and shoreline shall be kept to a minimum and eliminated if possible because these bright spots can obscure important features. During flight planning, flight line directions and times should be arranged to preclude the occurrence of these spots in critical areas of the photographs (especially shoreline and near shoreline areas).

14.7. SUN ANGLES - Sun angles for a given day can be determined from a "Solar Altitude Diagram" or from appropriate computer software. For on-line sun angle solutions, see the U.S. Naval Observatory's WWW site: http://aa.usno.navy.mil/data/docs/AltAz.php

14.8. CLEAR DAY MAP – Refer to: https://www.climate.gov/maps-data & https://graphical.weather.gov/sectors/conus.php?element=Sky

14.9. TIME OF YEAR - Consideration of the season should be taken into account when trying to image the ground surface. Project Instructions may discuss seasonal fluctuations in sandy beach dynamics. Beach profiles and morphology can significantly vary in response from the energy presented upon the system in relation to the sequencing and fluctuations of weather events and patterns.

15. TIDE COORDINATION

15.1. IMAGE COLLECTION TIDE CONDITIONS - Image collection may need to be at tide- coordinated stages depending on the required tide stage defined by the Project Instructions. Imagery shall not be collected during strong onshore winds, high waves or other anomalous weather conditions, see (National Data Buoy Center: http://www.ndbc.noaa.gov/, and the National Climatic Data Center: https://www.ncdc.noaa.gov/ .

15.2. WINDOWS

15.2.1. NGS-SUPPLIED – The government may supply image acquisition time/tide windows for each coastal area to be mapped, or the contractor may be tasked with window determination. These "windows" cover an extended range of possible flying dates. These time/tide windows will be determined by NGS initially to help ensure that all data meet the NGS tolerances for tide-coordinated image acquisition. If tide windows for additional dates are required, contact NGS.

15.2.2. CONTRACTOR-DETERMINED – If required by the Project Instructions, the Contractor shall determine predicted acquisition time/tide windows (data acquisition times for tide coordination) for Mean High Water (MHW) and/or Mean Lower Low Water (MLLW). Note, MHW is the mean of 18.6 years of high water and is not the high water level for any given day, except by coincidence. The same holds true for MLLW time/tide windows. The Project Instructions may also require the Contractor to install and/or monitor tide gauges in the project areas for either real-time or post-flight tidal height comparisons, and also to process tidal data.

15.3. REQUIREMENTS - The Contractor shall acquire imagery within the given time/tide windows as required and shall produce a table showing the times of the time/tide windows and the times of the data acquisition. Be sure to take into account time zones, daylight savings time and to use Coordinated Universal Time (UTC).

16. POSITIONING AND ORIENTATION

16.1. GPS COLLECTION

16.1.1. All imagery shall be positioned using kinematic GPS having dual frequency receivers and oriented with an inertial navigation system;

16.1.2. All kinematic GPS (KGPS) solutions should use differential, ionosphere-free, carrier-phase combinations with phase ambiguities resolved to their integer values;

16.1.3. Aircraft trajectories shall be processed using carrier-phase GPS. Dual L1 and L2 frequency receivers and one-second, or faster, collection shall be used in the aircraft.

16.1.4. All KGPS shall use at least two ground stations. The Ground GPS Base Stations shall be accurately tied to the NSRS (stations in the NGS database); shall be positioned to 0.1 meter accuracy, or better; shall be within or near the project area; and shall be within 100 kilometers of the entire project area. Additional ground GPS stations may be required. NGS recommends that CORS (Continually Operating Reference Stations) be used as ground stations. The Ground GPS Base Stations should be positioned on opposite sides of the operating area. The Ground GPS Base Stations shall be positioned, or the flight path arranged, so that during flight operations the aircraft will pass within 10 kilometers to each ground station at least once. CORS data collected at a data rate of 1-second is preferred if available, but data from 5-second, 10-second, or 15-second CORS stations may be used, when interpolated to a 1-second rate, using NGS approved interpolation software. CORS stations with a 30-second (or longer) data rate shall not be used as GPS base stations.

16.1.5. The maximum GPS baseline shall not exceed 100 kilometers at any time during flight. Regardless of aircraft flight time, GPS ground station data shall be collected for at least four hours;

16.1.6. Ground station data shall be submitted to OPUS (Online Positioning User System – http://www.ngs.noaa.gov/OPUS/) for positioning in the NSRS. Observe and submit two sessions for new points and one session for existing survey points.

16.2. GPS SOLUTION PROCESSING

16.2.1. The Contractor shall collect, process, and submit the ground and airborne GPS data, both raw data and final processed data;

16.2.2. Differential KGPS solutions for the aircraft shall be obtained independently using each ground station;

16.2.3. These independent KGPS solutions shall be compared to display their differences in the north-south, east-west, and vertical components during the operational portions of the flights;

16.2.4. The RMS of these differences shall not exceed 5cm in the horizontal and 10cm in the vertical;

16.2.5. The KGPS solutions shall model the tropospheric delay using average surface meteorological values at the ground stations collected near the midpoint of operations;

16.2.6. The final KGPS solution will be an average of the separate ground station solutions.

16.3. GROUND-BASED GPS RECEIVER HARDWARE AND OPERATIONS

16.3.1. ANTENNA - The Ground GPS Base Station receivers shall be equipped with antenna models that have been calibrated by NGS. A choke-ring antenna to minimize multipath is preferred but not required.

16.3.2. The antenna height shall be accurately measured.

16.3.3. MARK – The ground-based receiver shall be set up over a known (or to-be-determined) marked base station and shall run continuously during the mission. If a known base station is used, it must be in the NGS database and hence part of the National Spatial Reference System (NSRS). NGS recommends the use of CORS as Ground GPS Base Stations.

16.3.4. The Ground GPS Base Stations should preferably be located on opposite sides of the project area, and no closer than 50 kilometers to each other

16.3.5. OBSERVATIONS – The position of an existing mark shall be checked by processing one GPS session and comparing the computed position with the NGS published position. A new mark shall be referenced to the NSRS by tying to the NGS CORS. If the distance to the nearest reference receiver is less than 100 kilometers, observe at least two independent sessions, each 2 hours long. If the distance to the nearest NGS CORS is greater than 100 kilometers, observe at least two sessions, each 4 hours long. Make a separate tripod set-up and height measurement for each session. Take care in the accurate recording of the height of the antenna both before and after the flight. Record all heights, equipment serial numbers, etc. on the NGS forms: Visibility Obstruction Diagram and GPS Observation Log. For a listing of these and other forms on the NGS www site see: https://www.ngs.noaa.gov/surveys/forms/. Also, static observations should be processed using the NGS On-Line Positioning User Service (OPUS) found at: https://www.ngs.noaa.gov/OPUS/ . Observations to establish a new, permanent mark shall be submitted in NGS "Blue Book" format https://www.ngs.noaa.gov/FGCS/BlueBook/

16.3.6. RECOVERY – For an existing NSRS station, write a digital recovery note using the NGS on-line recovery note method at: https://www.ngs.noaa.gov/GPSonBM/Recover.shtml or https://www.ngs.noaa.gov/cgi-bin/recvy_entry_www.prl. For new stations, write digital descriptions using WinDesc, found at: https://www.ngs.noaa.gov/PC_PROD/pc_prod.shtml. See description format in Attachment S. For a new, temporary mark write a brief description adequate to recover the station. Take three photographs of the base station (photographs of the CORS station are not required). See Attachment R.

16.4. AIRCRAFT GPS RECEIVER

16.4.1. GPS OBSERVATIONS – The aircraft's GPS receiver shall be able to collect carrier phase observations and record, at least, once per second, from a minimum of four satellites (five or more preferred) at both the aircraft and the ground GPS receivers, for off-line processing. All data shall be collected with a Position Dilution of Precision (PDOP) of less than 3 at a minimum elevation mask angle of 10 degrees. After the post–processing, the GPS observation and ephemeris files are used to determine a flight path trajectory.

16.4.2. GPS LOCK – The aircraft shall maintain GPS satellite lock throughout the entire flight mission. If it appears that lock has been lost, attempt to reacquire lock by flying within 10km of a Ground GPS Base Station or CORS. Report these instances, procedures used, and any other unusual occurrences.

16.4.3. AIRBORNE POSITIONING AND ORIENTATION REPORT - The Report shall include at least the following paragraphs:

- Introduction,
- Positioning
    - Image Collection
    - Static Processing
    - Processing
    - Data Sets
- Orientation
    - Data Collection
    - Data Processing
    - Data Sets
- Final Results.

16.4.4. INTRODUCTION – Provide an overview of the project and the final processed data sets and list the data sets in table form with the following columns: Dataset ID, Date of Acquisition, Projects covered by the data set, and Description/Flight Line(s) Identification.

16.4.5. POSITIONING – Discuss the methodology, the hardware and software used (including models, serial numbers, and versions), the CORS station(s) used, a general description of the data sets, flight lines, dates and times of sessions, the processing (including the type of solution–float, fixed, ion–free, etc.), and the results (discussion of the coordinates and accuracy). Submit a description of the data sets, and the raw and processed data. If the NGS OPUS website was used to process the static data, the Contractor shall provide a copy of the OPUS report. If a known station was used from the NGS database, the Contractor shall identify the station by name and permanent identifier (PID), and provide the published coordinates used in the kinematic position step. If multiple base stations were used, provide processing details, coordinates, and accuracy for all stations.

16.4.6. ORIENTATION – Discuss the factors listed above for Positioning.

16.4.7. FINAL RESULTS – Describe any unusual circumstances or rejected data, and comment on the quality of the data.

16.5. GROUND CHECK POINTS - Four or more Check Points are required, see: Attachment O for requirements.

16.6. GROUND PHOTO CONTROL - Ground photo control may be required by the PI, and may be proposed by the Contractor. See Attachment O for requirements

16.7. DATA LABELING

16.7.1. All DVDs shall be labeled with the project name, collection date(s), Contractor name, and disk contents. Digital imagery DVDs shall be able to be easily matched with the corresponding flight log.

17. DATA SHIPMENT AND PROCESSING

17.1. SHIPMENT - The Contractor shall ship final deliverables directly to NGS. Copies of the Flight Log and the raw navigation files may be made and used by the Contractor to produce and check the final deliverables. Raw digital images shall be sent on different DVDs or hard disks from all other data. See Main Text, Section 10, "TOMIS", for full requirements on shipped deliverables.

17.2. NGS NOTIFICATION – The same day as shipping, the Contractor shall notify NGS of the data shipment's contents and date of shipment by submitting the information via the Task Order Management and Information System (TOMIS).

17.3. DELIVERY DATE - All deliverables shall be received by NGS, as specified, no later than the date in the Project Instructions.

18. DELIVERABLES

18.1. LABOR, EQUIPMENT AND SUPPLIES – The Contractor shall provide all labor, equipment (including aircraft and digital imaging system), supplies and material to produce and deliver products as required under this document.

18.2. DIGITAL IMAGE COLLECTION SURVEY PLAN – Prior to data acquisition, submit a proposed Digital Image Collection Survey Plan which specifies the data collection parameters to be used and contains a shapefile of the flight lines and the project coverage area, including flying height and speed over ground, focal length, ground space distance, sidelap, and endlap. The Project Instructions supplied by NGS will define the project area(s) and may define the flight lines, ground sample distance, endlap, sidelap, and other requirements. See Section 13. NGS will review the proposed mission planning reports, normally within five business days, and will respond in writing with approval and/or comments. The Final Report shall contain shapefiles showing the flight lines and boundaries of imagery actually collected.

18.3. DIGITAL IMAGERY TEST – The Contractor shall acquire and deliver images over a section of coastline and/or coastal ports which are similar to the contract work. The test data set shall include all bands used for imagery collection. See section 9.2 and Project Instructions.

18.4. RAW IMAGES – Submit the raw images on separate media from other deliverables.

18.5. DIGITAL IMAGERY PRODUCTS – Required products may include radiometrically enhanced images, ortho-rectified images and mosaics. The Project Instructions will specify which additional products, if any, are required.

18.6. FLIGHT REPORTS – Submit the completed, original Digital Camera Acquisition Log with the data, and a copy to NGS via TOMIS. For a sample Log see Annex 1. (Use the latest version of NGS' Log for digital imagery.

18.7. ELECTRONIC EXPOSURE DATA (EED) FILE – Complete and submit. Use the latest version of NGS' EED file format for digital imagery.

18.8. AIRBORNE POSITIONING AND ORIENTATION – The Contractor shall submit the original, raw GPS and IMU data files and processed trajectory files to NGS via TOMIS, along with the raw data points and final products. If IMU geo-referencing is employed, submit the exterior orientation file with the EO parameters. See sections 10 and 16.

18.9. GPS POINTS – Submit an organized list of all GPS points used for the project as Ground GPS Base Stations, ground control points, and check points. Indicate which points are existing ground control and which stations are newly positioned relative to the NSRS. See Project Instructions and Section 16. Also indicate which are pre-marked and which are photo-identified points.

18.10. TABULATION OF AERIAL PHOTOGRAPHY – Supply table(s) showing the actual times of acquisition flights and the tide coordination time "windows". Explain any discrepancies.

18.11. CALIBRATION REPORTS – The calibration reports shall contain, at a minimum, the following information:

18.12. The date the calibration was performed;

18.13. The name of the person, company, or organization responsible for performing the calibration;

18.14. The methods used to perform the calibration;

18.15. The final calibration parameters or corrections, including any bore-sight calibration values, determined through the calibration procedures.

18.16. SENSOR MAINTENANCE – Provide maintenance history before completing project directly to NGS of the sensor to be used for acquiring images. See Section 10.1.2.

18.17. SENSOR PORT WINDOW – Report the physical characteristics of any port window used to NGS. See Section 4.4 B.

18.18. DATA SHIPMENT REPORTING – The Contractor shall submit Deliverables via TOMIS. Mark "COPY" at the top of the digital copy of the Flight Log. This shall be done the same day the data is shipped. See Section 17

18.19. UNUSUAL CIRCUMSTANCES – The Contractor shall also notify NGS of any unusual circumstances that occur during the performance of this project which might affect the deliverables or their quality and especially of any deviation from this project. This may be included in the weekly status report required below, unless urgent.

18.20. WEEKLY STATUS REPORTS – The Contractor shall submit project weekly status reports to NGS via TOMIS These reports are due at NGS by 2:00 p.m. EST each Monday, from the date of a Task Order award until the work is complete and accepted by NGS.. These reports shall include a summary of completed data acquisition, with dates completed; data shipped, and dates; and any unusual circumstances, equipment malfunctions, and/or any disturbance of the sensor. A weekly status report is required even if no progress has been made. See the format in Attachment G.

18.21. FINAL REPORT - The Contractor shall supply to NGS a Final Report incorporating all of the information in this Deliverables section including, at least, the sections suggested below:

18.22. Work performed under this contract, discuss each deliverable including: the maximum range from the base station, standard deviation and residuals in GPS trajectories, and an explanation of the DVD labeling;

18.23. Equipment used to perform this work, including hardware models and serial numbers, calibration reports, and software names and versions (include aircraft and digital imaging system info);

18.24. Flight line shapefiles, and project coverage area;

18.25. Discussion of data quality including quality assurance (QA)/quality control (QC) procedures;

18.26. Ground Control Report, including a station list in table format;

18.27. Airborne navigation and kinematic GPS Report;

18.28. Weather, solar altitude, and time of year;

18.29. Tide Coordination Report and Table;

18.30. Any unusual circumstances or problems, including equipment malfunctions (including those already reported);

18.31. Any deviations from this Digital Imaging SOW, including those already reported;

18.32. Any recommendations for changes in the Digital Imaging SOW for future work.

19. REVIEW

19.1. Images and other deliverables not meeting these specifications may be rejected.

20. POINTS OF CONTACT

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COR
National Geodetic Survey
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Mike Espey, Chief, Applications Br.
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301-713-4573
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21. GLOSSARY

- CMP - Coastal Mapping Program
- CORS - Continuously Operating Reference Stations
- DVD – Digital Video Disc
- FOV - Field of View
- FTP – File Transfer Protocol
- GPS - Global Positioning System
- GSD - Ground Sample Distance
- IMU - Inertial Measurement Unit
- MHW - Mean High Water
- MLLW - Mean Lower Low Water
- NGS - National Geodetic Survey
- NOAA - National Oceanic and Atmospheric Administration
- NSRS - National Spatial Reference System
- OPUS - Online Positioning User System
- PACS - Primary Airport Control Station
- SACS - Secondary Airport Control Station
- SOW - Scope of Work
- TIFF – Tagged Image File Format
- UTC - Coordinated Universal Time

ANNEX 1: SUMMARY OF DIGITAL CAMERA IMAGERY ACQUISITION REQUIREMENTS

DIGITAL IMAGERY TEST - The contractor shall acquire and deliver images over a section of coastline and/or coastal ports which are similar to the contract work site.

GEODETIC REFERENCES - NAD 83, NAVD 88, and GEOID 03 (or latest version).

DATA FORMAT - TIFF

QUALITY CONTROL - Plan required.

SYSTEM - The sensor shall be geometrically stable and shall be calibrated. It shall also have sufficiently high resolution and have a large enough Field of View to provide the required Ground Sample Distance and stereo coverage. The system shall have had routine maintenance.

IMAGE COLLECTION - The digital imaging system shall acquire visible and/or infrared, or color infrared imagery depending on the project.

INERTIAL MEASUREMENT UNIT - If an IMU is employed it shall meet:
Post-processed accuracy in roll and pitch: 20"
Post-processed accuracy in heading: 30"

POSITIONING - Carrier-phase L1 and L2 airborne kinematic GPS shall be acquired and used in producing trajectories. Positions shall be not be worse than 30 cm relative to the NSRS.

MISSION PLANNING PARAMETERS - Typical photogrammetric parameters (flying height, overlap, crab, etc.) shall be used, except those required to be modified for the particular sensor.

WEATHER CONDITIONS - No clouds or cloud shadows. Data shall be collected only when well-defined images can be obtained. In addition to no clouds, imagery shall not be attempted when the ground is obscured by haze, smoke, smog, dust, or falling: snow, sleet, rain, etc. In addition, imagery shall not be collected when the land-water interface is obscured by snow, ice, flooding, etc.

VISIBILITY - Minimum is 8 miles.

SUN ANGLE - Minimum sun angle is 30 degrees. Sun spots should be avoided.

TIDE COORDINATION - May be required. The contractor may be required to compute tidal acquisition time windows, install and monitor tide gauges (including setting tidal bench marks and leveling), analyze and process tidal data, and monitor water levels, local weather, and off-shore weather conditions.

REPORTS - Produce reports, such as Photographic Flight Report, Electronic Exposure Data File, and Photo Final Report.

DELIVERABLES - Submit raw and processed data, raw and processed imagery, and reports explaining the data.

More detailed technical specifications will be included with the Project Instructions for individual projects.

Digital Camera Acquisition Log

NOAA/ NOS/ NGS Remote Sensing Division Silver Spring, MD 20910	Aircraft		Pilot	
	Tail Number		Co-Pilot	
	Date		Operator	
	Camera		Lens	

	Project	Flight Line	Start Frame	Stop Frame	Hdg	AGL (ft)	PDOP	Clouds	Remarks
			Start Time	Stop Time	Speed		SVs	Vis.	
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									

Notice – all items highlighted are changes from previous versions of this SOW

ATTACHMENT AA

HYPERSPECTRAL

SENSOR USAGE AND

DATA PROCESSING

REMOVED

TO
SCOPE OF WORK FOR SHORELINE
MAPPING UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Notice – all items highlighted are changes from previous versions of this SOW

ATTACHMENT AB

INTERFEROMETRIC

SYNTHETIC APERTURE

RADAR (IFSAR)

REMOVED

TO
SCOPE OF WORK FOR SHORELINE
MAPPING UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
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U.S. DEPARTMENT OF COMMERCE

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December 2017

ATTACHMENT AC
TRANSMITTAL LETTER

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
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ATTACHMENT AC - TRANSMITTAL LETTER

1. TOMIS
The Task Order Management Information System (TOMIS) has replaced Transmittal Letters (TL) for most shipments.

1.1 DELIVERABLES SUBMITTED THROUGH TOMIS - Contractor Deliverables that are submitted through TOMIS do not require a TL.

1.2 DELIVERABLES SUBMITTED OUTSIDE TOMIS – For Contractor Deliverables that cannot be submitted through TOMIS, such as: files larger than 10 Mega Bytes (MB), paper copies of Deliverables, large charts, hard drives, etc., the Contractor shall make a TOMIS entry for them, and shall prepare a TL and include it in the shipment.

1.3 NOAA ACKNOWLEDGEMENT - NOAA will acknowledge receipt of all Deliverables (digital and paper; including those submitted through TOMIS and those submitted outside TOMIS) using TOMIS.

1.4 NOAA SHIPPED ITEMS - TOMIS does not handle items that NOAA ships to Contractors. NOAA will include TL with items shipped to Contractors. Contractors shall verify that the shipment is complete (or note any discrepancies), sign and date the TL, and FAX or email the TL back to NOAA.

See also Attachment AI, TOMIS INSTRUCTIONS.

Notice – all items highlighted are changes from previous versions of this SOW

ATTACHMENT AD

TECHNICAL PROPOSAL

CONTENTS

REMOVED

TO
SCOPE OF WORK FOR SHORELINE
MAPPING UNDER THE
NOAA COASTAL MAPPING PROGRAM

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NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
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Notice – all items highlighted are changes from previous versions of this SOW

August 2017

ATTACHMENT AE

CHART EVALUATION FILE

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
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U.S. DEPARTMENT OF COMMERCE

TABLE OF CONTENTS

ATTACHMENT AE: CHART EVALUATION FILE

1. CREATING THE CHART EVALUATION FILE

The purpose of the Chart Evaluation File (CEF) is to document navigational hazards, landmarks, and certain other notable coastal features portrayed on NOAA nautical chart products that are gone, or whose geographic position appears to have changed significantly from current chart portrayal, or whose existence cannot be confirmed photogrammetrically. For each Coastal Mapping Program (CMP) project, the contractor shall provide one CEF in Esri's shapefile format (2D polygon) as a final deliverable product to NGS.

1.1 COORDINATE SYSTEM AND DATUM

The CEF shall utilize a geographic coordinate system (GCS) with units expressed in decimal degrees, referenced to the North American Datum of 1983 (NAD 83). Within Esri's ArcGIS® Desktop GIS software, the projection shall be specified as "GCS_North_American_1983."

1.2 SHAPEFILE NAMING CONVENTION

The shapefile will be named "LLYYNNA-TT-S_CEF" where:

LL – two character abbreviation for state/territory (OH = Ohio, PR = Puerto Rico, etc.)
YY – two digit year identifier (16 = 2016, 17 = 2017, etc.)
NN – two digit sequence # (e.g. 01 = 1st project planned in state/territory that year)
A – one character sequential subproject designation *if applicable* (A, B, C, etc.)
TT – two character project type (CM = conventional mapping, TB = topobathy, etc.)
S – one character identifier for acquisition source (N = NOAA, C = contractor, etc.)

The "LLYYNNA-TT-S" project ID will be supplied by the government.

1.3 SHAPEFILE ATTRIBUTE TABLE STRUCTURE

Shapefile attribute fields to be included upon creation of the CEF consist of the following:

Attribute_Label: Id
- Data type: Long integer
- Precision (or width, the number of digits): 6
- Definition: Unique sequential feature identifier. (This field is automatically created by Esri's ArcGIS software when a shapefile is created, but the values must be calculated manually.) Values for this field shall be > 0.

Attribute_Label: IMG_SOURCE
- Data type: Text
- Width: 32

- Definition: Describes the source of imagery. Use “Aerial/camera” for aerial imagery, where camera = camera type (e.g. DSS, DMC, etc.), and for satellite imagery enter the name of the sensor (e.g. WorldView-2).

Attribute_Label: IMG_DATE
- Data type: Text
- Width: 8
- Definition: Date of source imagery (YYYYMMDD) for the feature.

Attribute_Label: LAT_DD
- Data type: Double
- Precision: 12
- Scale (the number of decimal places): 8
- Definition: Latitude of the polygon centroid in decimal degrees, with positive values in the northern hemisphere, negative values in the southern hemisphere.

Attribute_Label: LON_DD
- Data type: Double
- Precision: 12
- Scale: 8
- Definition: Longitude of the polygon centroid in decimal degrees, with positive values in the eastern hemisphere and negative values in the western hemisphere.

Attribute_Label: FEATURE
- Data type: Integer (short is preferred, long is acceptable)
- Precision: 5 – 9 (range)
- Definition: Cartographic feature code number from the ‘Coastal Cartographic Object Attribute Source Table’ (C-COAST) attribution scheme.
- Domain: 1 – 212 (See Attachment E for the assigned numbers associated with each C-COAST class/attribute combination.)

Attribute_Label: ATTRIBUTE
- Data type: Text
- Width: 66
- Definition: Concatenation of the C-COAST feature class and attribute.
- Domain: (See Attachment E for a complete list of C-COAST feature classes and attributes.)

Attribute_Label: S57_CODE
- Data type: Text
- Width: 50
- Definition: The International Hydrographic Organization (IHO) S-57 translation of the C-COAST feature attribution.
- Domain: (See Attachment E for the designated S-57 translations for C-COAST class/attribute combinations.)

Attribute_Label: CHG_NOTE
- Data type: Text
- Width: 75
- Definition: Description of discrepancies found between imagery and current editions of the NOAA nautical charts, or a notation that the position/existence of specific features portrayed on NOAA charts could not be confirmed. Examples of appropriately filled CHG_NOTE fields are shown below:

CHG_NOTE	ENC_vs_RAS	VERIFIABLE	PRIORITY	RSD_REC	RSD_NOTE
Charted piers (2) are gone		YES	LOW	REMOVE	Disprove subm ruins
Charted piers (3) are gone		YES	LOW	REMOVE	Disprove subm ruins
Charted islands are gone		YES	LOW	REMOVE	Disprove subm hazards
Charted pier is gone		YES	LOW	REMOVE	Disprove subm ruins
Charted wreck is not visible		DOUBTFUL	MEDIUM	MAINTAIN	
Charted wreck is not visible		DOUBTFUL	LOW	MAINTAIN	
Charted wreck is not visible		DOUBTFUL	MEDIUM	MAINTAIN	
OVHD CAB not visible, cannot confirm existence with imagery		DOUBTFUL	MEDIUM	MAINTAIN	
OVHD CAB not visible, cannot confirm existence with imagery		DOUBTFUL	LOW	MAINTAIN	
Charted tank landmark is gone		YES	LOW	REMOVE	
Charted buildings (3) and stacks (3) are gone		YES	LOW	REMOVE	
Charted tanks (3) are gone		YES	LOW	REMOVE	
OVHD CAB not visible, cannot confirm existence with imagery		DOUBTFUL	MEDIUM	MAINTAIN	

Attribute_Label: ENC_vs_RAS
- Data type: Text
- Width: 8
- Definition: Disagreements in feature portrayal between current edition NOAA nautical charts and the NOAA Electronic Navigational Chart (NOAA ENC®) suite are flagged with "CONFLICT." Contractors should only populate this field IF instructed to do so in the Project Instructions.

Attribute_Label: VERIFIABLE
- Data type: Text
- Width: 8
- Definition: Degree of confidence in the ability to verify the position or existence of the feature in the imagery. Answers question, *should the feature be visible?* (Takes into account all factors including imagery quality, depth of feature, etc.)
- Domain: YES – The feature should be visible in the imagery.
  DOUBTFUL – It is doubtful the feature would be visible.
  NO – The feature should not be visible.

Attribute_Label: PRIORITY
- Data type: Text
- Width: 8
- Definition: Relative importance of the feature to surface navigation.
- Domain: LOW – Feature of little or no importance to surface navigation.
  MEDIUM – Feature of significant importance to navigation.
  HIGH – Feature of critical importance to navigation.

  Note: It is *general practice* to assign the majority of CEF items a LOW priority while restricting HIGH priority to exceptional items.

Attribute_Label: RSD_REC
- Data type: Text
- Width: 8
- Definition: Recommendation to NOAA nautical chart compilers regarding feature in question.
- Domain: ADD – New feature to be added to NOAA chart.
  REMOVE – Feature should be removed from chart.
  MOVE – Charted position is incorrect or has changed, and should be updated or re-evaluated.
  RESHAPE – Shape or alignment of the feature should be changed on the chart.
  MAINTAIN – No change in chart depiction is recommended at this time. Further investigation is required in order to verify the feature's existence or position.

Attribute_Label: RSD_NOTE
- Data type: Text
- Width: 50
- Definition: Description of unresolved issues of importance in the geographic cell (GC), documenting items for further investigation by NOAA hydrographic personnel. A common case when this field would be populated is to flag the possible presence of submerged ruins where a charted pier is recommended to be removed (e.g. "Disprove subm ruins").

Attribute_Label: ENC_NOTE
- Data type: Text
- Width: 75
- Definition: A description of an unresolved issue in the corresponding NOAA ENC file, to be populated by the ENC compiler. The contractor shall not populate this field.

Attribute_Label: FIELD_NOTE
- Data type: Text
- Width: 220
- Definition: A description of field findings, to be populated by NOAA field personnel. The contractor shall not populate this field.

Attribute_Label: FIELD_REC
- Data type: Text
- Width: 75
- Definition: A recommendation to the chart compiler from the NOAA field personnel. The contractor shall not populate this field.

Attribute_Label: CARTO_REC
- Data type: Text
- Width: 75
- Definition: A recommendation to the chart compiler from a cartographer assigned to the NOAA field verification office. The contractor shall not populate this field.

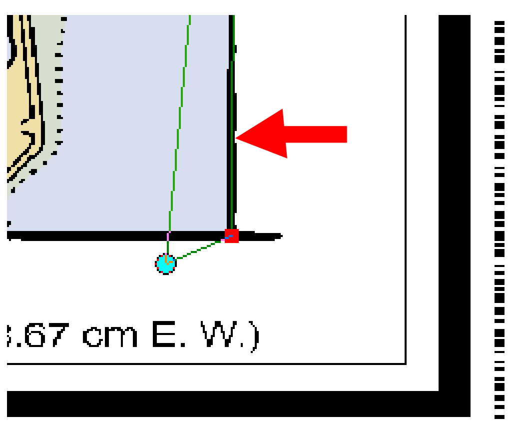
Attribute_Label: DATASRC_ID
- Data type: Text
- Width: 20
- Definition: Unique identifier assigned by the NOAA Office of Coast Survey. The contractor shall not populate this field.

2. POPULATING THE CHART EVALUATION FILE

The CEF shall consist of two categories of polygon features: those that delineate the geographic extents of the NOAA charts used as references, and those that refer to individual features whose charted positions are no longer valid or could not be verified.

2.1 CHART EXTENT POLYGONS

A polygon shall be digitized around the perimeter of each NOAA Raster Navigational Chart (RNC®) used for chart comparison purposes. The chart outline in the CEF shall represent the edge of the geographic area covered by each chart, excluding chart margins (see below).

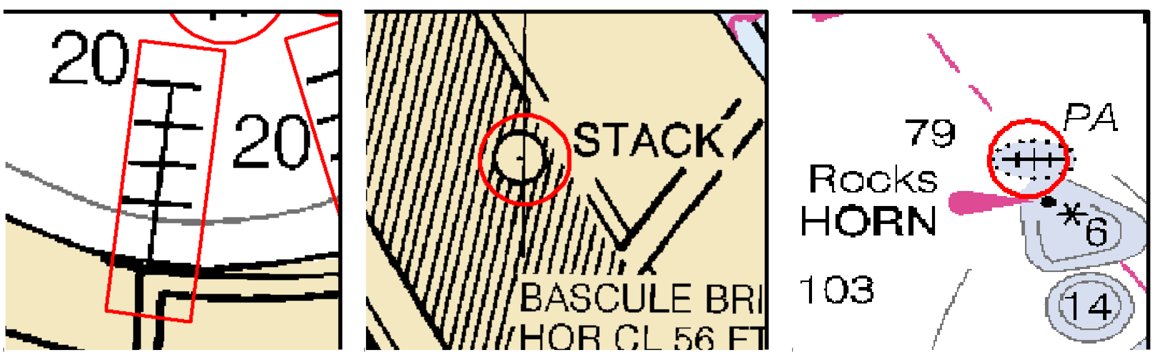


For each RNC polygon in the CEF, the chart edition information shall be entered into the CHG_NOTE attribute field. This information shall include the RNC identifier, edition number and date, and scale. All other attribute fields (except the "Id" field) should be left blank by the contractor. See the example below for proper chart representation in a CEF:

CHG_NOTE	ENC_vs_RAS	VERIFIABLE	PRIORITY	RSD_REC	RSD_NOTE
RNC 14927_1, 26th Ed., Dec. 2016, Scale 1:60,000					
RNC 14926_31, 13th Ed., Dec. 2016, Scale 1:60,000					
RNC 14928_1, 23rd Ed., Sep. 2011, Scale 1:15,000					
RNC 14926_6, 13th Ed., Dec. 2016, Scale 1:15,000					
RNC 14926_11, 13th Ed., Dec. 2016, Scale 1:10,000					
RNC 14926_1, 13th Ed., Dec. 2016, Scale 1:10,000					
RNC 14926_2, 13th Ed., Dec. 2016, Scale 1:10,000					
RNC 14926_3, 13th Ed., Dec. 2016, Scale 1:10,000					
RNC 14926_4, 13th Ed., Dec. 2016, Scale 1:10,000					

2.2 UNVERIFIED OR CHANGED FEATURE POLYGONS

Each charted hazard, landmark, or coastal feature (e.g. pier) in the project area which is gone, has moved significantly from its charted location, or whose position or existence cannot be verified with the project imagery shall be identified in the CEF by enclosing the chart symbol with a polygon (see examples below, in red) and attributing appropriately. Feature polygons shall be compact and cartographically pleasing in appearance. There must be no uncertainty regarding which charted feature is indicated by the feature polygon.



The following attribute fields are required to be populated for **each** CEF feature polygon:

Id
IMG_SOURCE
IMG_DATE
LAT_DD
LON_DD
FEATURE
ATTRIBUTE
S57_CODE
CHG_NOTE
VERIFIABLE
PRIORITY
RSD_REC

Additionally, the RSD_NOTE field should **only** be populated when appropriate.

2.3 GUIDANCE ON FEATURE INCLUSION/EXCLUSION

Charted features which shall be **included** in a CEF are principally those with direct impact to surface navigation which can reasonably be expected to be visible in photographic surveys. Some examples are:

- Mooring structures of significant size (e.g. piers, platforms, dolphins)
- Structures posing a barrier to navigation (e.g. breakwaters, jetties, bridges, groins, training walls)
- Port/harbor facilities (e.g. drydocks, marine railways, ramps)
- Hazards which pose a threat to navigation (e.g. dangerous rocks/reefs, overhead cables, wrecks, bare ruins/obstructions)
- Features which serve as a means of orientation to mariners (e.g. buildings, tanks, silos, lakes/ponds, etc. located immediately adjacent to the shore, charted landmarks)
- Small charted islands which are gone

The charted features listed below shall be **excluded** from a CEF:

- Aids to navigation (both fixed and floating)
- Submerged features (e.g. ruins, dols/piles, obstructions, *non-dangerous* wrecks and rocks, sewers, cribs)
- Transportation features (roads, railways, helipads, etc.) located far from shore
- Snags
- Submerged areas/features portrayed in magenta on NOAA charts

The following charted features **may be included** in a CEF, and *if* so, should be done sparingly. Inclusion depends on factors such as quality of source data (e.g. imagery), perceived impact to mariner, and location of the charted feature relative to important navigational waterways:

- Minor piles/posts, stakes
- Features charted as covers/uncovers
- General changes to shoreline/nearshore areas perceived to be critical to navigation

Notice – all items highlighted are changes from previous versions of this SOW

July 2005

ATTACHMENT AF
SUN ANGLE NOMOGRAMS
(AND SUN REFLECTIONS)
FROM
MANUAL OF COLOR AERIAL PHOTOGRAPHY
AMERICAN SOCIETY OF PHOTOGRAMMETRY
1968

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
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U.S. DEPRATMENT OF COMMERCE

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by E. A. FLEMING

Introduction

FORE KOWLEDGE of rhe time durin which Lhe un will be above a pecifi d a l t i t ude i n integral part of p la n-nin a photographic flight. The aerial photorrrapher mu t have ome mean of readily determining thi- information in advance in rder to know at what time in t.he mornin photo raphy can be comm nc d and at what time in rhe afternoon it mu be ended. The e Lime ,,-ill vary with he date, the latitude of the project area and the rcquiremenL of the co n tra t.

1n addition to onsiderinrr minimum o!ar altitudes, there i ometirne a need to con icier maximum per rni siblc olar alt it ude when plannin a photo raphic fligh L. The fore ter i oncemed with th entry of th "hot spot., in Lo th rea of the pho ro o-ra ph and Ll1e hydro raphcr i con- rerned \Yith the un'. refl ction from ,Yater su rfaces ; both phenomena are a ociated with high olar al ti l udcs .

The nomogram given n the [o llo,, ·ino- pa e provid th air - urv ey photographer with a imple o-ra phi' a l oluLi n to Lhe problem in a form Jle xi ble nough to me ta vari ty o(r quiremenl anywh re in the world.

Each nomoo-ram i- ba-ed on the projection of th solar ray through th arnera station lo the point at which it intersect the earth. The locus of thi anti- olar point, a- th sun's altitude and azi111ulh chancre, form the un<la-menLal curve of Lhe nomogram. ince the un'- altiLude i not only a funclion r he ti, ,e or dL y, but al O of the time of year and Lhe lati Lud , it i nece ary to use a nomogram appropriate to th latitude of the project area and lo elect on that nomo ra m the curve for th date at which photo - raphy i to be taken.

2.2.2 To determine the length of the photographic day

To determine the lencr-th of Lhe photographic day, el ct the nomogram for th latitud clo-e t to that of the proj ct area, inte r pola t i ng if nece sary. If t he req ui remen t of the contract permit photography to tart at a solar altitude of *10°*, the point at whi h the time cale inter e t the date on th 20° re ive the tart and fmi h of the photo - graphic day. 1·or example, using the nomogram iUu trated in Fig u re 2.2.1, it can b seen tha on :\la 1 (or A uo-u *t* 1") at -4o Latitude the photographic day would tart at 06-O and end a r 1710 Joe 1 solar time.

The length of the photographic day for higher olar alti-tudes may ue determined imilarly by drawing the appro-priate olar alt;tude arc and readin time iatercepr on chi arc. Thu in the above example, the photographi day for 30° minimum a l t it ude would be from oro to 1616.

The times det r m in d from lh nornogram are convened Lo Gre nwich lean Tim or Landard Tim accordin to th !ongi tud, of the projcc L area.

G.:\LT. = olar ti me -:- — local longitude / 1 - ——

1, here \re t !on ·tudc i '·plus" and ea lono--iLude i ·'minu ." T ble for the com·er ion of Ion itude Lo timr, Figure *2 .1 . 2 ,* and the rel a t ion hip of :,'orth American tandard Time Loni! to G.:d.T. are iven with th no mogr am ·.

2.2.3 How to determine the "hot spot"

The "hot spot" or ·'110 hadow point" in photo!raph appears a bright area lacking in detail imm diately ur-rounding the an Li-solar point. It i particularly notic abl over fore ccd areas and pre ent problem in for try interprelation. Therefore, i L may be de irable to avoid it oc u rre nce within the area of the photograph, or alterna-tively. to ensure full - tereo copic coverage of the area afferted by adju ting the end -la p or the icle-lap.

The locu of th "hot spOL" aero the fi ld of view, a the day progresse-. can b d Lermin d b, ccnterin a transparent template representing the field of view of th camera at point ' P' of Lhe nomogram. lf the template is ori nted to co rr espond to the flight d irect ion- nor th bein con idered as the up\\'ard direction of the noon !in th time of mry and exit of the ·'hot pot" can be read at th point whe r th date line cut the templat area. Tem-pla e izes for ,1·ide-a ngle (-1 3 mm.) and upe r-w id e angle (mm .) lens with 23 cm. forma are iven in Fi ure 2.2.3. Template ior u e with camera of other focal

Notice – all items highlighted are changes from previous versions of this SOW

Jen lhs a nd format can l>e d ra \·I II to the ,ale of these nomogran1s using the re la ti on hip:

templale size = $\frac{\text{format ize}}{\text{focal length}}$ X 19 mm.

For the ea·t-,\e ·L orientation of the Le111plate indicated in Fi •ure 2.2.1, the "hot pot"' would fall ·wit hin he photo area bet\\een 0()40 and 14.20 on :\la: 1. lt can al ob s en that the area affected by the "hot pot"' could be cov reel stereo copicall_ if th flight !in to lhe north had 20 - 2" % sid -lap \\·it h the line under consideration. If the li ne- of photo raphy \\ e re oriented north- outh then an end-lap of at lea t -6- i S'lc wou ld be req uir ed to en ur stereo copic covera••e of the affected area. H mapping a ,Yell a interpretation were involved then a choice of 0o/c

:\ORTH i\:\ I ER! C..\ . TJME ZOXE.

:'\e1·ifoun dland .	td. Time = Gl\IT - 3h. 30m
Atlantic	td. Time=Gl\[T- --l-h
Eastern	td. Time=Gi\lT- Sh
Central	td. Time = C, vIT - 6h
:.\fo untain	td. Time=GMT- ih
Pacific	. td. Time = Gl\dT - h
Yukon	td. Time=G?-lT- 9h
.\ las ka n	t d. T ime = G:\1T - 10h

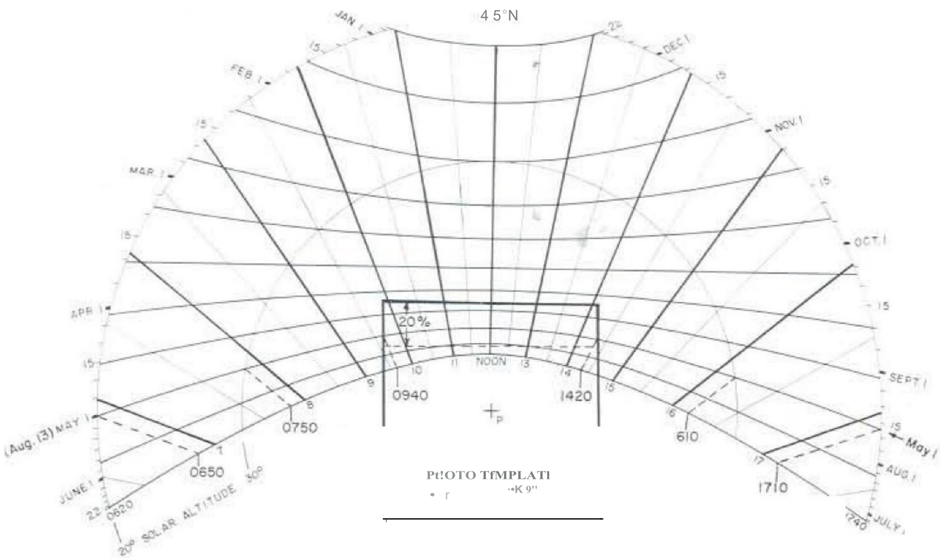


FIGURE 2.2. 1- Deter mina tion of the length of the photo gra phic day and the position of the " hot-spot".

■	h m	■	h m	•	h m
0	0 0	60	4 0	120	8 0
1	0 4	61	4 4	121	8 4
2	0 8	62	4 8	122	8 8
3	0 12	63	4 12	123	8 12
4	016	64	4 16	124	8 16
5	0 20	65	4 20	125	8 20
6	0 24	66	4 24	126	I! 24
7	0 28	67	4 28	127	8 28
8	0 32	68	4 32	128	8 32
9	0 36	69	4 36	129	8 36
10	0 40	70	4 40	130	8 40
11	0 44	71	4 44	131	8 44
12	0 d8	72	4 48	132	8 48
13	0 52	73	4 52	133	8 52
14	0 56	74	4 56	134	8 56
15	1 0	75	5 0	135	9 0
16	1 4	76	5 4	136	9 4
17	1 8	ii	5 8	137	9 8
18	1 12	78	5 12	138	9 12
19	1 16	79	5 16	139	9 16
20	1 20	80	5 20	140	9 20
21	1 24	81	5 24	141	9 24
22	1 28	82	5 28	142	9 28
23	1 32	83	5 32	143	9 32
24	1 36	84	5 36	144	9 36
25	1 40	85	S 40	145	9 40
26	1 44	86	5 44	146	9 44
27	1 4-8	87	5 48	14 /	9 48
28	1 52	88	5 52	148	9 52
29	1 56	89	5 56	149	9 56
30	2 0	90	6 0	150	10 0
31	2 4	91	6 4	151	10 4-
32	2 8	92	6 8	152	10 8
33	2 12	93	6 12	153	10 12
34	2 16	94	6 16	154	10 16
35	2 20	95	6 20	155	10 20
36	2 24	96	6 24	156	10 24
37	2 28	97	6 28	157	10 28
38	2 32	98	6 32	158	10 32
39	2 36	99	6 36	159	10 36
40	2 40	100	6 40	160	10 40
41	2 44	101	6 44	161	10 44
42	2 4-8	102	6 48	162	10 48
43	2 52	103	6 52	163	10 52
44	2 56	104	6 56	1	10 56
45	3 0	105	7 0	165	11 0
46	3 4	106	7 4	166	11 4
47	3 8	107	7 8	167	11 8
48	3 12	108	7 12	168	11 12
49	3 16	109	7 16	169	11 16
50	3 20	110	7 20	170	11 20
51	3 24	111	7 24	171	11 24
52	3 28	112	7 28	1 72	11 28
53	3 32	113	7 32	173	11 32
54	3 36	114	7 36	174	1 I 36
55	3 40	115	7 40	175	11 40
56	3 44	116	7 44	176	11 44
57	3 48	117	7 48	177	II 48
58	3 52	118	7 52	1 78	11 52
59	3 56	119	7 56	179	11 55
60	4 0	120	8 0	180	12 0

FrGURE *2.1.1- Con* ersion of Longitude to Time.

end-lap would pcrmi t al tern ate pictures to be discarded for the mapping operation.

2.2.4 4 How to determine the sun's reflection

Whcr waler are ar being photo raphed for hydro- graphic ur\'ey the reflection of the un' ima e into the camera len can - riou ly dimini h the amount of r cord d detail in th area of r fl c ion.

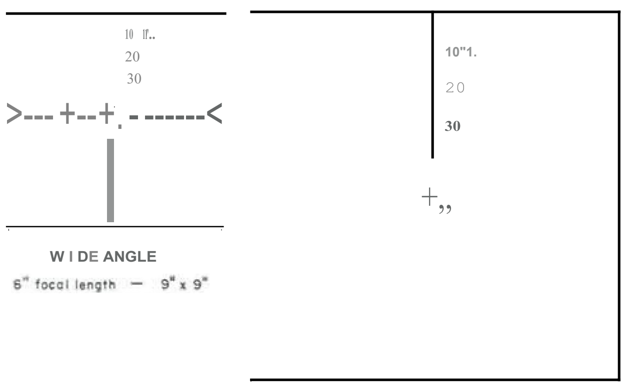
The Lime of ntry of the center of thi reflec tio n into the area of the photograph can be de ter m ined in the ame ma n ne r a. for the "hot pot" with the exception that i-L po 1t1on i iven by letting the u p\\"a rd d.irection of the noon line repre enl outh.

The ize of th area affected by reflect io n will vary depending on the rou hne of the wa te r and the ob- liquity of the sun' ray . tudie by the -. . ·oa t and eodetic urvev have indicated that the un pot may ran e in ize from I 1 '*l* to *l* inche in ca l m , \·a te r to a lar e a 7 inc-he· in rou h wa te r on a 9- by 9-inch photo- graph taken with a 6-inch l n . ·nder the -e conditiow reflection will occur well into the area of the photocrraph even though the center of the _un'- reflection may fall out ide the field of vie,\·.

The template ill u trated in Figure 2.2.4 can be dra" non tran parent mat ria l and u ed to indicate the maximum area of the photograph that may be affected b -olar reflections. Point.-\ of this em plate i plac don the nomo- ram ac the tim and date of the proposed photography and line AB is orien led to inter ect point P. The araduation on _.\-B corresponding to ihe solar altitude at poinl .--\ ,\·ill indicate th cncnl of th reflecLion under the \\"Or t ondition .

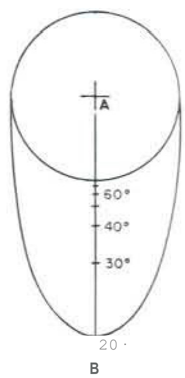
For example. if photography ,\ ere to be taken on :.Iay 22 at 0°)l or t h latitude at ahout 10 .-\. I. local olar time, the e.·tent of the olar reflection from water area could he

(Text continu on pa e 1.!)



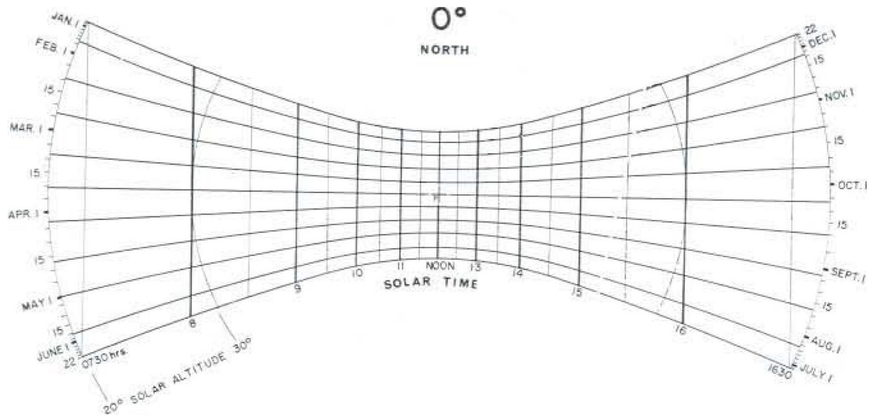
PHOTOGRAPHIC TEMPLATES

FIGURE 2.2."-PhoLOgraphic Templa te-.



SUN-SPOT TEMPLATE

F11;,v1m 2.2 ...1-- un-spot Template.


0°
NORTH
JAN. I
FEB. I
15
MAR. I
15
APR. I
15
MAY I
15
JUNE I
22
0730 hrs.
20° SOLAR ALTITUDE 30°
8
9
10
11
NOON
13
14
15
16
SOLAR TIME
22
DEC. I
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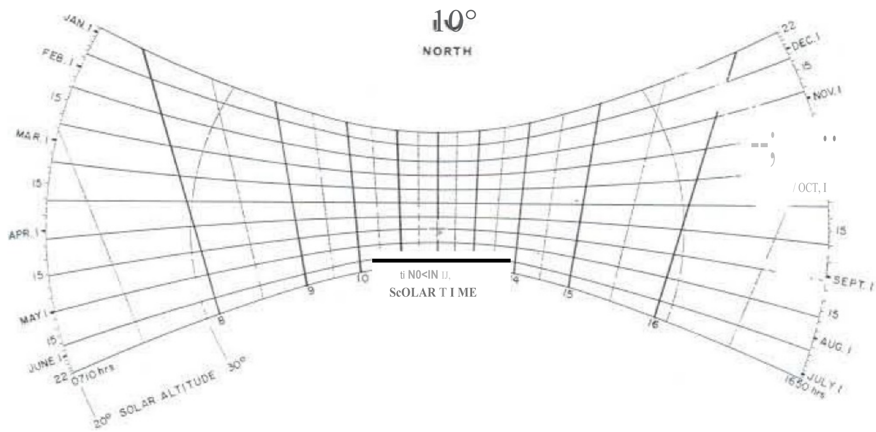
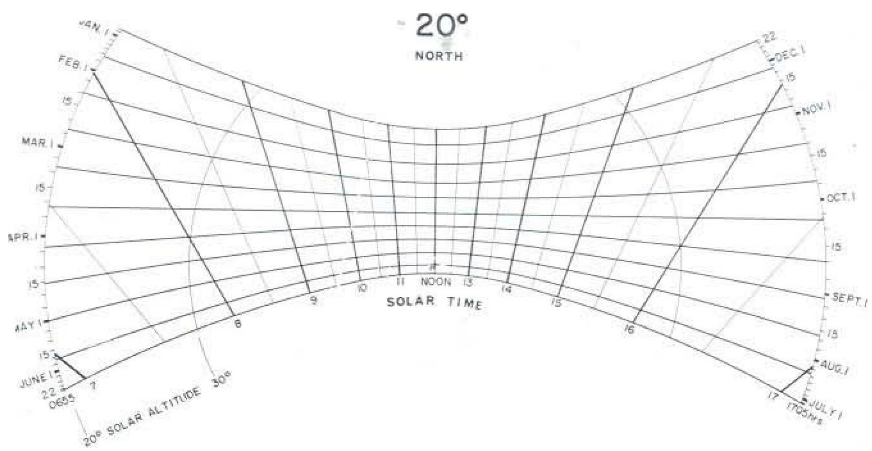
NOV. I
15
OCT. I
15
SEPT. I
15
AUG. I
JULY I
1630


10°
NORTH
JAN. I
FEB. I
15
MAR. I
15
APR. I
15
MAY I
15
JUNE I
22
0710 hrs
20° SOLAR ALTITUDE 30°
8
9
10
NOON
14
15
16
SOLAR TIME
22
DEC. I
15
NOV. I
OCT. I
15
SEPT. I
15
AUG. I
JULY I
1650 hrs


20°
NORTH
JAN. I
FEB. I
15
MAR. I
15
APR. I
15
MAY I
15
JUNE I
22
0655
7
20° SOLAR ALTITUDE 30°
8
9
10
11
NOON
13
14
15
16
17
SOLAR TIME
22
DEC. I
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NOV. I
15
OCT. I
15
SEPT. I
15
AUG. I
JULY I
1705 hrs

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F ! Gt ' KE 2.2.i - olar Altitude :-.:omogrnms.

70

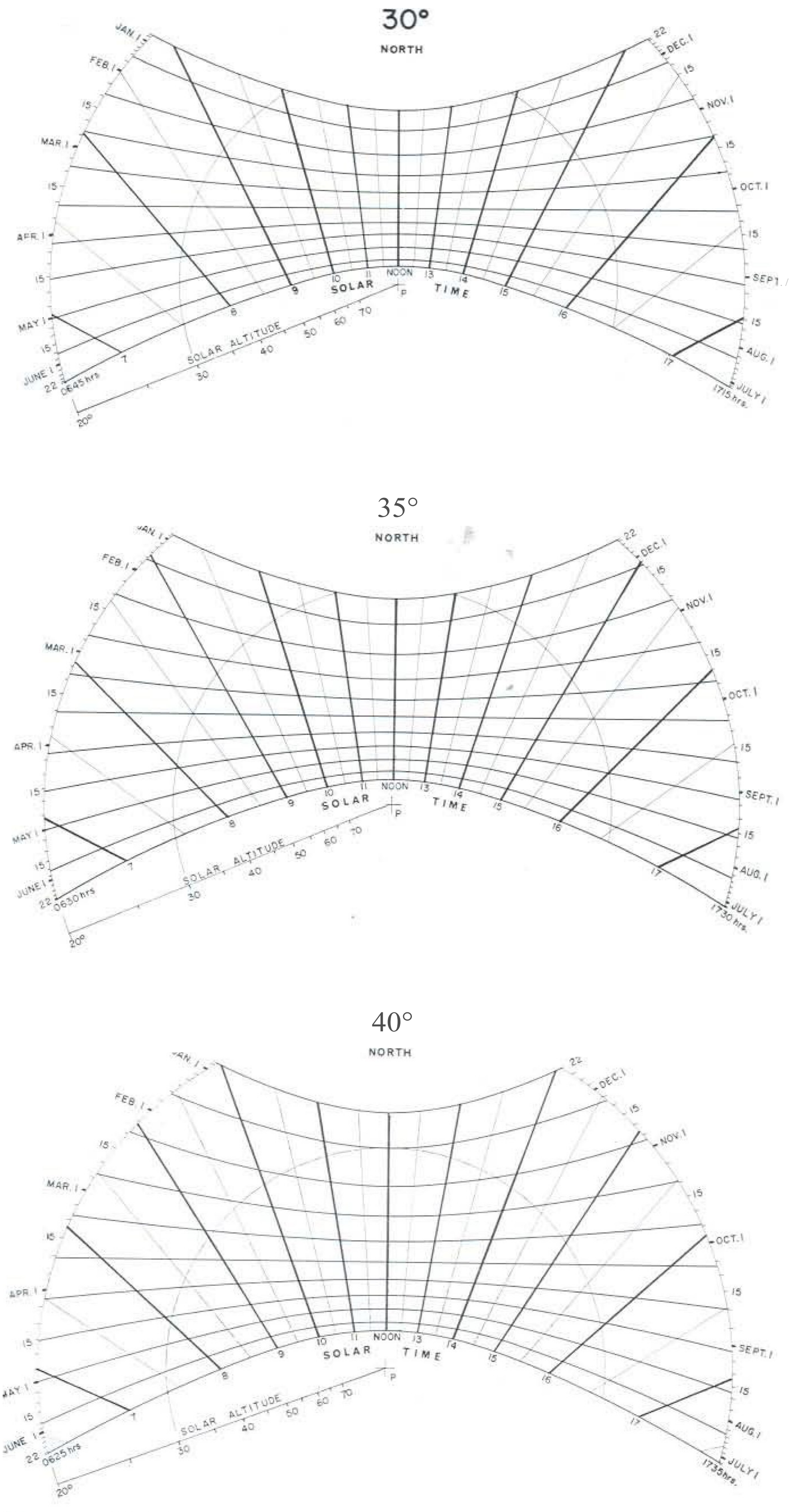

FIGURE 2.2.8–Solar Altitude Nomograms.

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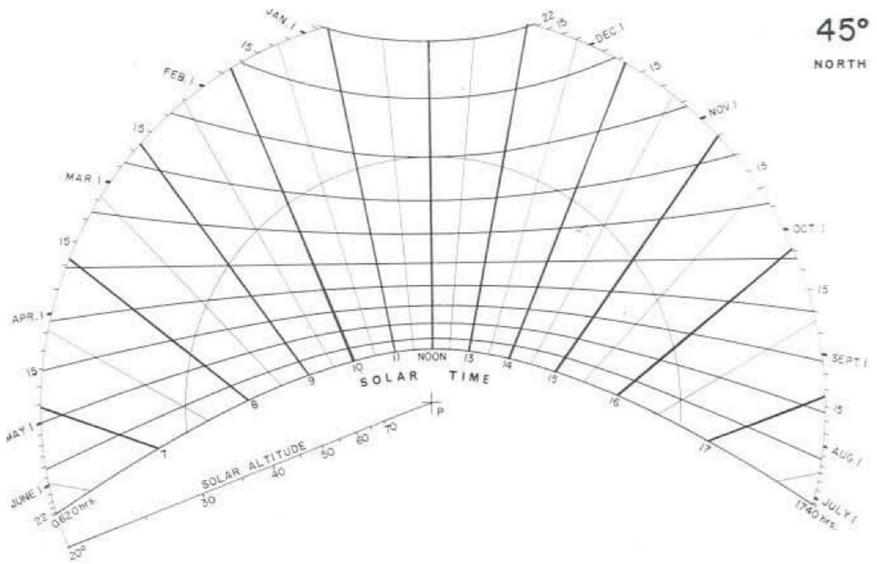
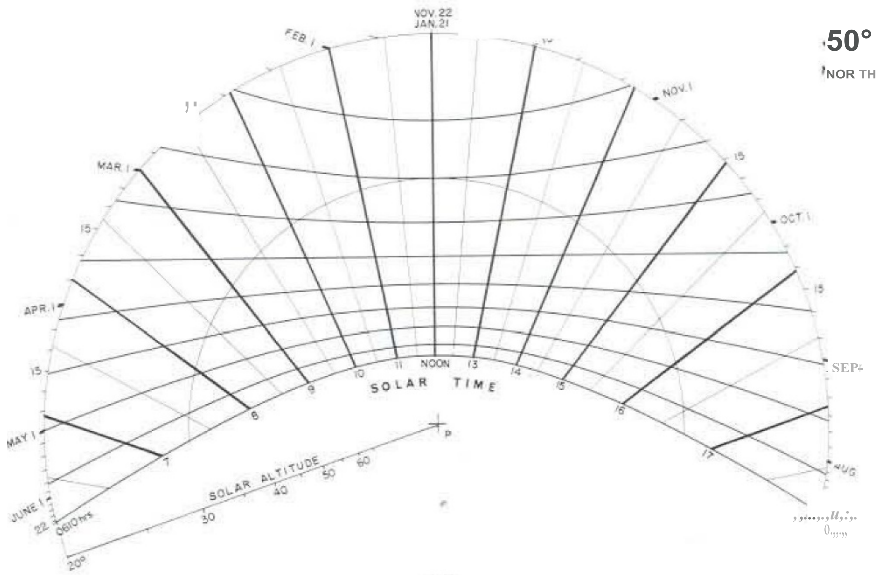




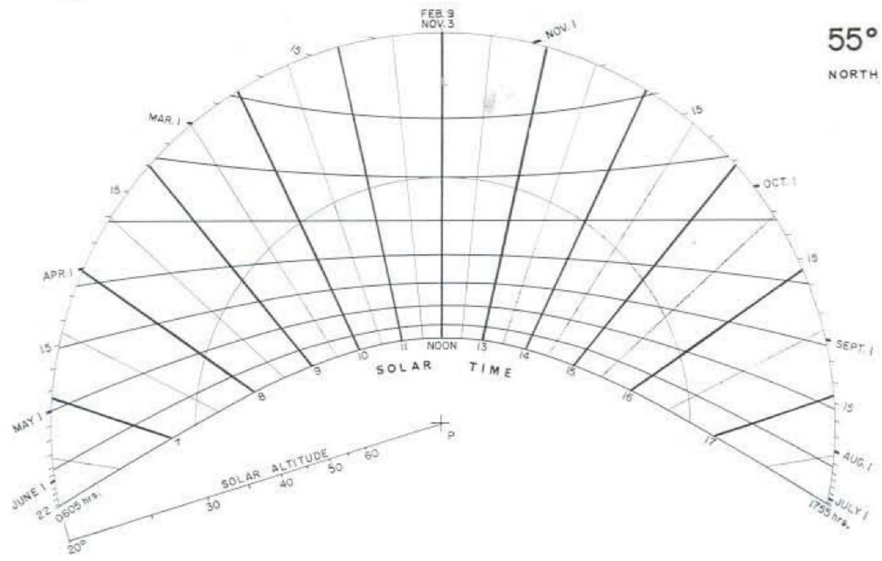
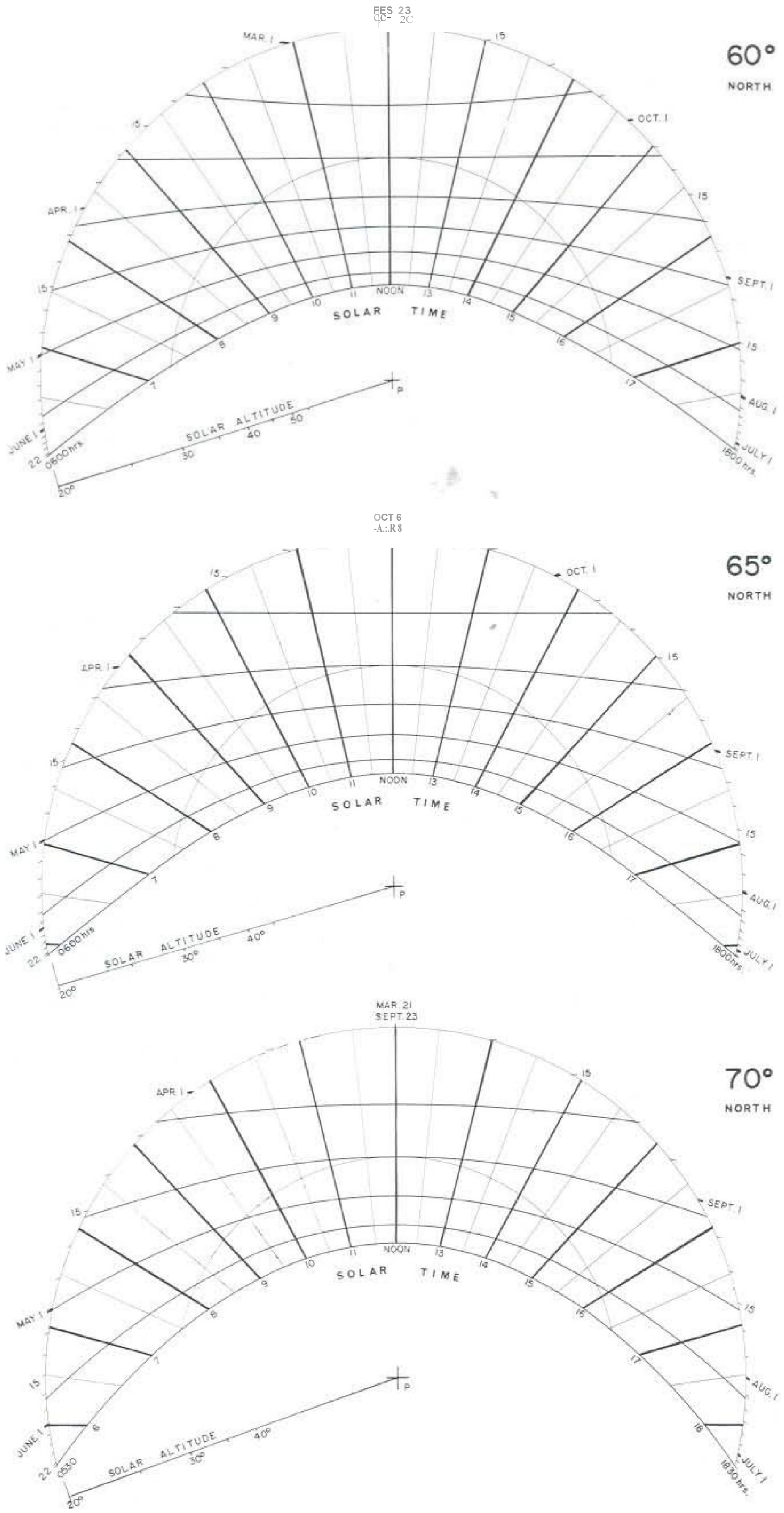


FIGURE 2.2.9- Solar Altitude Nomogram



FIGLRE 2.2. 10- olar .-\ltitude Xomograms.

•

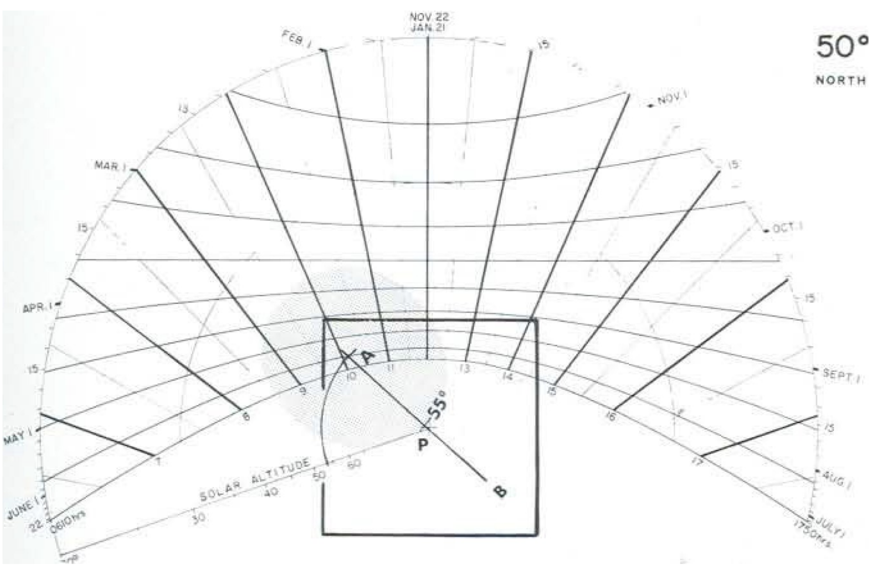
Notice

predicted as shown in Figur 2.2.5. An ar , centered at P, through the solar alli rude scale shows lhaL th solar altitude at 10 A."\L on :\Iay 22 i alma t 55°. The un- pot template i th er efo re rounded off at - .- o on the A-B ca le an d , when po i ion d, ho" · that in r U""h wa er condition the entire outh-ea t quadrant of the picture may be sun- truck. Fi ure 2.2.6 how a wide angle photogra ph taken at the time and date of the example, but with ometbing le than rou b water condition . Al o illu trated in thi photo rapb i the '·hot po t" " ·h ic h o cur diametrically oppo ite the center of the u n '. pecu!ar reflection and the ame di tance from the pri nc i p al point.

Using Lhi m thod, 11 1 possibl to plan photographic flights so as to avoid Lhe occurr nee of th reflection ·wit hin the photographic area or, alternatively, to ens u re that it i covered tereo copica ll y b y eith rend- or ide-lap.

2.2.5 Southern latitudes

For use of the nomogram in outhern latitude add i..x month to the date cale o that December 22 become June 22. J a nu a ry be ome July, etc. outh would b at the top of the pag for the "hot spot" determination a nd no r t h would be at the top of the parre for the " un pot" determination.



FtGVRF 2.1.--Locating the extent of the un' reflection froITI waler surface.

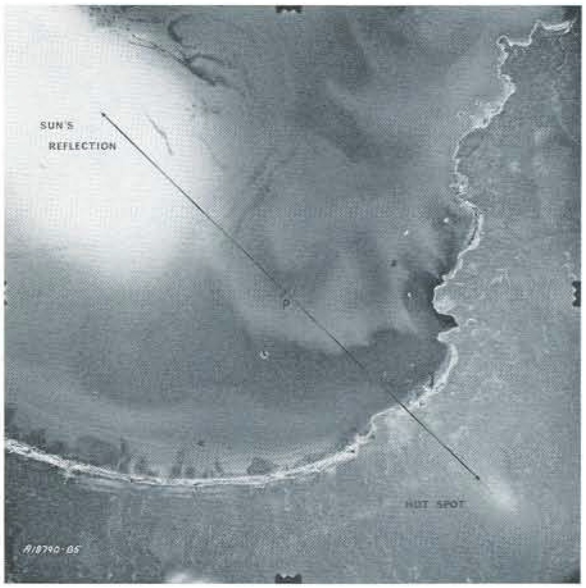


FIGURE 2.2. \Vide- ngle photograph showing lhe sun' re- flection and the hot-spoL

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Notice – all items highlighted are changes from previous versions of this SOW

SEMt OURATION OF SOLAR ALTITUDE ABOVE 20°, 30°

7

6

5

4

3

2

maximum altitude
June 22= 33 1/2°

5 10 15 20 25 APRIL 5 10 15 20 25 MAY 5 10 1!5 20 2!5 JUNE 5 10 1!5 20 25 JULY !5 10 1!5 20 2!5 AUGUST !5 10 SEPT

F I GLTK£ .!.2.11 - , 0° *Varth Lnti tude.-* ."ince neit her the "hot spo L" nor the " un spot"', i. of $erious significance at Lhis latitude the form of the graph ha been changed to give only the hour of photographic light before :rnd after local solar 110011. *90° _\"(lr/h Lutitutde.-The* ·olar alti- tude i· abo\·e *10°* for 1-! hours a day from .\ la y 21 lo Jul 2-t

75

Notice – all items highlighted are changes from previous versions of this SOW

December 2017

ATTACHMENT AG

MARK RECOVERY INSTRUCTIONS

TO

SCOPE OF WORK FOR SHORELINE MAPPING

UNDER THE

NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION

NATIONAL GEODETIC SURVEY

NATIONAL OCEAN SERVICE

NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION

U.S. DEPARTMENT OF COMMERCE

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ATTACHMENT AG - MARK RECOVERY INSTRUCTIONS

1.DATASHEET - Obtain and study the mark's most recent datasheet (description), including all recovery notes, and highlight key points (such as: the number of reference marks, the distance from the edge of a road, etc.) and any flag any discrepancies found. U.S. Coast & Geodetic Survey (USC&GS) and National Geodetic Survey (NGS) marks and some others are included in the NGS database at: https://www.ngs.noaa.gov/datasheets/. For an explanation of the NGS datasheet format, see: https://www.ngs.noaa.gov/DATASHEET/dsdata.pdf. Also, recent recoveries and photos of many marks can be found on the Geocaching.com web site. Note, the Geocaching web site is not a government web site and is not maintained by NGS. Visiting the Geocaching site will direct the user off the NGS web site.

2.DATABASE SEARCH - Perform a NGS database search for other nearby survey marks using the NGS Data Explorer: https://www.ngs.noaa.gov/datasheets/, or performing a radial search at: https://www.ngs.noaa.gov/cgi-bin/ds_radius.prl. This information may be helpful in finding the intended mark and may help avoid confusion between marks at the site.

Alternate method, this with graphics; download program DSWORLD from: https://www.ngs.noaa.gov/PC_PROD/PARTNERS/index.shtml, and then click on "Stations", select your area of interest, the type of mark and the mark stability. The program will plot the marks in the selected area on a Google Earth background, with different symbols for different types of marks. This program provides a link to the station's Datasheet in the NGS database, a link to the on-line NGS Mark Recovery Entry page, and driving directions. This software allows the submission of: ".gpx" files of station positions, individual positions of stations, and photographs of stations.

Second alternate method, also with graphics; go to: http://benchmarks.scaredycatfilms.com/index.php, and click on the U.S. State of interest. Then scroll and zoom as necessary to display the area of interest. Markers of various colors and with various letters representing the type and condition of the mark will show the location of all the NGS database marks within the selected area. Various backgrounds are available. By clicking on one of the markers, links are provided to NGS data sheets, and to recent photographs and recovery notes on the Geocaching web site.

Note, the two alternate methods above are not maintained by NGS. Both methods will direct the user off the NGS web site.

3.MAPS - Obtain maps, aerial imagery and/or satellite imagery of the area (paper or digital).

4.COMPUTE POSITIONS - Recommend computing the positions of Reference Marks (RMs) and any other nearby marks, and consider computing the distances between RMs and any other marks. The "box score" on the datasheet lists the directions and distances to RMs and any other nearby marks, and the "Forward" on-line software at: https://www.ngs.noaa.gov/TOOLS/Inv_Fwd/Inv_Fwd.html can be used to do the computation. Also, the "Inverse" software can be used to compute the distance between known points. Be careful to use the same distance units for all computations. Consider converting all distances to the same units for ease of use in the field. It is also helpful to convert true bearings to magnetic bearings to save time and work in the field.

5. PLOT - Recommend plotting all marks on the map and/or imagery at a scale to show surrounding features. Check features in the imagery against the facts stated in the description (near a road, on a hill top, etc.), and then attempt to resolve any discrepancies and contradictions.

6. EQUIPMENT - Gather recovery equipment including: mark description, map, magnetic compass, 100 – 300 ft tape, shovel, long screwdriver (to hold one end of tape; and open logo caps over rod marks), whisk broom, camera, Global Positioning System receiver (GPSr), scientific calculator, and, optionally, tile probe, metal detector, lopper, vegetable brush, survey flagging, distance wheel. Also, a yellow crayon or white powder (baby powder, corn starch, etc.) can improve the photos by highlighting the stampings.

7. TRAVEL - To travel to the mark the original way, travel to the beginning of the description's "To Reach" and follow the "To Reach" using the vehicle's odometer, and left and right turns as listed in the description. Otherwise, enter the position into the GPSr and follow the GPSr's directions (making sure to use the North American Datum of 1983 (NAD 83) or the World Geodetic System of 1984 (WGS 84) datum).

8. PERMISSION - Request property owner permission as necessary.

9. COMPLETE TRAVEL - Continue travel to the immediate vicinity of the mark and do a visual search for:
9.1. REFERENCE OBJECTS - Reference objects mentioned in the description (edge of roads, bridges, buildings, fence-lines, telephone poles, etc.),
9.2. WITNESS POSTS – Wooden, metal, or plastic posts with or without signs,
9.3 REMAINS - Remains from previous occupations (wood, wire, slight depression, etc.)
9.4 SURVEY MARKS – Disks, marks in stone, etc.

10. FIND - Use distances, angles, and other information from the description to narrow the search, (e.g., the distance from a road or fence, witness post, reference mark, etc., the type of mark: concrete monument, disk in bedrock, etc.). If not found, review the datasheet for additional clues.

11. MEASURE - Once some of the objects and/or marks are found, use a magnetic compass to determine the approximate directions and measure the distances by pacing or taping from the witness post, Reference Marks (RM), and other reference objects. Mark the arc of each distance and intersect the distance arcs, as required. Use any vertical information provided, such as distance above or below road or railroad track. When using a magnetic compass be sure to correct for the magnetic declination (difference between true north and magnetic north). The value can be obtained from: https://www.ngdc.noaa.gov/geomag/declination.shtml. If the main station is found first, use a compass, and pacing or taping to locate the RMs. If an RM is found first, use the direction of the RM's arrow and the distance stated on the Datasheet to help find the main station. Also, the "Back Azimuth" from the "Forward" computation for that RM will provide the azimuth from the RM back to the Triangulation Station.

12. GPS - Remember when searching using GPS that most vertical control points have only scaled positions with a 6 arc-second error tolerance (about 600 ft); the description may get you much closer to the mark than a GPSr with the scaled coordinates. Combine GPS results with other clues. Most horizontal control points have coordinates that are much better than a hand-held GPS receiver (GPSr). A hand-held GPSr may only be accurate to 6-8 meters, perhaps 1-2 meters if equipped with the Wide Area Augmentation System (WAAS) and if the WAAS signal is available. Thick trees are a definite challenge for a GPSr. The Wide Area Augmentation System is operated by the Federal Aviation Administration (FAA.)

13. CHECK DESCRIPTION - For all marks found, check the description elements such as: (1) the name of the agency cast into the disk or logo cap, (2) the type of disk (RM, Azimuth Mark, etc.) cast into the disk, (3) the exact name and date stamped, and (4) the type of setting (bedrock, concrete, etc.). Check all information on the survey disk against what is stated on the Datasheet. Avoid false recoveries. Also avoid false "destroyed" notices. Do not report a mark as destroyed unless you are sending the disk itself or its photo showing it destroyed, to NGS. Note, and ideally resolve, any discrepancies. In the Recovery Note, list significant changes and discrepancies.

14. GROUND CHECK - For all marks found, visually check them to see if they appear disturbed. Then check them by taping the distances between the marks and any other usable references, and compare them to published and computed values. Note the direction (to at least the nearest 45 degrees--NE, NW, etc.) from the main Triangulation Station to each RM. Note any significant differences from what is on the datasheet. A good check on distance measurements is to first tape in metric units, then tape in English units, and then to use a calculator to convert and compare. There are 3.280833333 U.S. Survey Feet in one meter.

15. PHOTOS - Clean the marks off completely and photograph the marks. Ensure adequate and even lighting. Close-up photos should be in sharp focus, and clearly and legibly show ALL the information cast into, and stamped onto, the disks. Also take photo(s) showing the surrounding area and including the mark. See Attachment R for more specifications.

16. TIPS

16.1. INFORMATION - Ask local residents for information, and permission, as necessary.

16.2. LIKELY LOCATION - Once close to the triangulation station, go to the location where you would set a mark, where it would make sense (highest point, point with best view, exposed bedrock, etc.).

16.3. SKY VISIBILITY - Marks originally positioned with GPS can be anywhere with good access and good sky visibility.

16.4. REFERENCE MARKS - RMs are usually within 30 meters of the Triangulation Station, about the same elevation when possible, numbered clockwise from north, and about 90 degrees apart (around the Triangulation Station).

16.5. OLDER BENCH MARKS - Older Bench Marks (vertical control points) are usually along a road or railroad, often set in a rock outcrop or bridge abutment. Newer, rod-type marks may be near the right-of-way fence along a road.

16.6. REMAINS - There may be signs of a previous survey, like old wooden boards or wire. In the Western U.S. some intact 4-foot wooden stands have been found that are many years old.

16.7. DATUM - Ensure that the coordinates, map, and imagery are on the same datum (use NAD 83).

16.8. AZIMUTH MARK - From the Description, determine if the Azimuth Mark is along the route to the main mark, and while enroute to the main station, watch for the mark and a possible Witness Post.

16.9. METAL DETECTOR - If the marks are still not found, consider using a metal detector and/or steel tile probe (long rod with handle).

16.10. CONSTRUCTION CHANGES - Also consider construction in the area which may have destroyed the mark, or at least changed its setting considerably. Also consider that roads are sometimes rerouted and the mark may be adjacent to the old roadbed and some distance from the new road.

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ATTACHMENT AH

NGS

REQUIREMENTS

FOR TIDE GUAGE

STATIONS

REMOVED

TO
SCOPE OF WORK FOR SHORELINE
MAPPING UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING
DIVISION NATIONAL
GEODETIC SURVEY
NATIONAL OCEAN
SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

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December 2017

ATTACHMENT AI
TASK ORDER MANAGEMENT AND INFORMATION SYSTEM (TOMIS) INSTRUCTIONS

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

ATTACHMENT AI: TASK ORDER MANAGEMENT AND INFORMATION SYSTEM (TOMIS) INSTRUCTIONS

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ATTACHMENT AI: TASK ORDER MANAGEMENT AND INFORMATION SYSTEM (TOMIS) INSTRUCTIONS

1. INTRODUCTION - The web-based Task Order Management and Information System (TOMIS) is designed to help manage geospatial services contracts for the National Ocean Service. TOMIS allows Government Officials to track the status of Deliverables, Task Orders, and Contracts. TOMIS sends Officials emails when the status of Deliverables changes. TOMIS allows Government Contractors to submit and track Deliverables, as well as monitor Deliverables that are upcoming or delinquent. E-mail notifications remind Contractors and government officials when actions are required. Contractors will be evaluated on their performance at the completion of all Task Orders. The TOMIS system is located at: https://secure.csc.noaa.gov/TOMIS/index2.jsp .

2. SUBMITTING DELIVERABLES - The Contractor shall submit all Task Order Deliverables (size and type permitting) and Weekly Status Reports to NGS using the TOMIS system. All Weekly Status Reports shall be submitted directly to TOMIS by 2:00 pm Eastern Standard Time every Monday. All Deliverables smaller than 10 Mega Bytes (MB) in size shall be submitted to TOMIS as an attachment. Larger files may be compressed and then submitted to TOMIS. If the Deliverable is still too large, or hardcopy, DVD, etc. the Contractor shall submit an entry to TOMIS expressly stating what the Deliverable is and how the Deliverable is being delivered, i.e. via FedEx, FTP, etc. The Contractor shall submit the data shipment report to TOMIS the same day that the hard copy Deliverable is sent and ensure that the Deliverable name in TOMIS and the Deliverable name on the item are the same. Use a Transmittal Letter (TL) for all shipments outside of TOMIS. Once the Deliverable is received by NGS, NGS will mark it as received in TOMIS and TOMIS will send an e-mail to the Contractor confirming receipt of the Deliverable.

All Deliverables shall be submitted by the Prime Contractor to NGS via TOMIS, not from a Sub-Contractor, except for film which a Sub-Contractor may ship directly to NGS' film processing Contractor. This shipment to the Prime Contractor enables the Prime Contractor to check all data prior to shipment to NOAA. The Prime Contractor shall enter into TOMIS that the film has been shipped to NGS' film processing Contractor.

3. NGS SHIPMENTS - TOMIS does not currently support items that NGS ships to the Contractors, so TL shall continue to be used for this. The Contractor shall inventory the items upon receipt, sign the TL, and FAX it back to NGS. The TL will list all items sent, each individually. See Attachment AC for details and an example.

4. TOMIS SPREADSHEET - The Contractors shall complete a Deliverable Tracking Spreadsheet in TOMIS format, and submit it with their Technical Proposal, see attached sample. This shall be submitted as part of the Technical Proposal and NGS will use it to add the project to TOMIS. The spreadsheet will be used as a tool for tracking and for determining payment based on the percentage of the project completed. The due dates for all Deliverables on the

TOMIS Spreadsheet shall be on or before the final project due date in the Project Instructions. After its receipt by NGS, the spreadsheet will be reviewed and approved by the Contracting Officer's Representative (COR) before being entered into TOMIS. The Contractor shall ensure that the list of Deliverables on the spreadsheet includes, at least, the list of Deliverables in the SOW and Project Instructions. The format of the spreadsheet must be exactly as provided or TOMIS will not accept it. The Contractor shall complete the columns headed: Deliverables, "% of Task Order" and "Due Date". Comments may be added in the fourth column. The "% of Task Order" value must be a realistic portion of the overall project. Invoices may be submitted monthly (or at longer intervals) and shall be based on the work complete. The last 10% of payment shall be assigned to the shipment of the Government Supplied Materials back to the government.

5. PAYMENT - The Government will not pay an invoice until the percent of work invoiced has actually been completed and accepted by NGS. The last 10% will be approved for payment once all Deliverables have been received and approved by NGS.

6. DUE DATES - The Contractor will be held accountable to the dates that are placed in the spreadsheet. If the Contractor determines that they will not be able to meet a due date, it is their responsibility to request and justify an extension prior to the due date.

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December 2017

ATTACHMENT AK
REPORT OF GOVERNMENT PROPERTY IN POSSESSION OF CONTRACTOR

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

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ATTACHMENT AK - REPORT OF GOVERNMENT PROPERTY IN POSSESSION OF CONTRACTOR

1. INTRODUCTION – The "Report of Government Property in Possession of Contractor" is a document required to be confirmed, signed, and returned to NGS by the contractor when possession of Federal Government property occurs. No Government IT equipment will be provided to the contractor at any time.

2. RECEIPT OF PROPERTY

2.1 PROCEDURES – Included in any shipment of Government property from NGS to the contractor will be the document "Report of Government Property in Possession of Contractor". Upon receipt of the Government property, the contractor shall check to confirm the items described on the form are included in the shipment and sign the document. At time of shipment, NGS will add a deliverable field for the applicable project within the Task Order Management Information System (TOMIS) titled "Government Property Report". Once verification of the property has taken place and the document signed, the contractor shall submit that document through the associated deliverable field within TOMIS.

2.2 DISCREPANCIES – In the case of a discrepancy being discovered between the Government property and the associated description of the property on the report, the contractor shall notify the COR within three (3) days of receipt.

2.3 EXCLUSIONS – Film products ordered from the NGS film processing contract laboratory and paper products are exempt from this requirement.

2.4 YEARLY REQUIREMENT – Should the contractor maintain possession of the property for more than one (1) year, the contractor shall submit an additional completed document through TOMIS on the anniversary date of receipt. NGS will have created this provisionary TOMIS deliverable slot at the time the contractor originally received the property. This yearly requirement remains in effect for the duration of time the property is in possession of the contractor.

2.5 DOCUMENT LOCATION – Along with the version that will accompany any shipment of Government property to the contractor, this document can be located online, see: http://www.osec.doc.gov/ofm/OAP/PPMTD/Documents/PPM_TD_Forms/CD-281.pdf

3.0 RETURN OF PROPERTY – At the conclusion of the project, or any time at the Government's request, the contractor shall return the property to the COR in the same condition as it was received.

3.1 PROCEDURES – At the time the contractor receives the Government property, NGS will also add a deliverable slot in TOMIS for a Transmittal Letter for each item of property. When the contractor ships each item of property back to the COR, the contractor shall submit a copy of the Transmittal Letter to this slot. Upon receipt and inspection of the property, NGS will accept the Transmittal Letter deliverable, verifying return of the Government property.

3.2 PROPERTY CONDITION – The contractor is responsible for the property being returned in the same condition as it was at time of receipt, less normal wear and tear. The contractor is responsible for proper shipment of the property during return. All damages, repairs, and replacement of the property from time of contractor receipt to time of COR acknowledgment of its return are the contractor's responsibility.

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December 2017

ATTACHMENT AL
ORTHOPHOTOGRAPHY REQUIREMENTS

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

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ATTACHMENT AL: ORTHOPHOTOGRAPHY REQUIREMENTS

ORTHOPHOTOGRAPHY

1. GENERAL – The contractor shall provide natural color orthorectified mosaic digital images (hereafter referred to as "orthos" or "orthomosaics") using all the color imagery that was included in the aerotriangulation for the original acquisition/compilation project, including any partial (or incomplete) tiles. The non-image area of partial tiles shall be black (RGB=0,0,0). Along the edges of the photo coverage the contractor should attempt to include as much of the actual image data as practical in the orthomosaic, without including any non-image data (fiducial marks, etc.) The same digital scan files of the color photography for use in performing shoreline compilation shall be used to produce the orthos. Orthos shall not be created using the infrared (IR) imagery that was acquired for this project.

2. AEROTRIANGULATION – If an acceptable aerotriangulation (AT) of the project photography has already been completed in order to support feature compilation, this same AT solution shall be used for the orthorectification of the imagery. If the project requirements include multiple sets of imagery (Color, Mean High Water-IR, Mean Lower Low Water-IR) then the AT should include all sets of imagery adjusted together. It is important for the georeferencing to be consistent in both the orthos and the compiled features. If the contractor should wish to begin ortho production prior to all imagery being collected and a combined AT solution being accepted, the contractor shall request approval for this change from NGS in writing. If all of the color imagery has been collected NGS may approve the request. If this is approved the AT may be performed using only the complete set of color images and the results used to produce the orthos. Furthermore, when the IR imagery is subsequently collected, and additional AT is performed, the contractor shall hold the previously adjusted images in the color block fixed, and points measured from this block shall be used to control the IR images, as a means of tying all sets of imagery together. The color images shall not be readjusted.

3. DIGITAL ELEVATION MODEL – A "bare earth" Digital Elevation Model (DEM) shall be used in the production of the orthos to correct for terrain displacements. The contractor shall use the most current version of a United States Geologic Survey (USGS) 10-meter DEM, if available. If not, the contractor shall use another equivalent DEM of the same or better spatial resolution. If no DEM coverage is available, the contractor shall create a 10 meter resolution DEM from the original color stereo imagery that is of equivalent quality or better than a standard USGS 10- meter DEM. The contractor shall include in their Technical Proposal which DEM they propose to use.

4. DIGITAL ORTHORECTIFIED MOSAIC IMAGES – The orthomosaic images shall meet the following requirements:

   4.1 The orthomosaic images shall have a nominal spatial resolution of one (1) meter.

4.2 The orthomosaic image files shall be in 8-bit Georeferenced Tagged Image File Format (GeoTIFF) format with embedded pyramid layers.

4.3 The orthomosaic shall be divided into tiles. Each tile shall represent a ground distance of 2.5 km by 2.5 km. There shall be a ten meter buffer (overlap) around all four edges of the tile.

4.4 The orthomosaic shall be color and tone balanced to provide a consistent and uniform image quality. The final product shall maintain as much of the original color and appearance as practical.

4.5 As stated above, the orthos shall include correction for terrain displacement, but they shall not be corrected for building lean or for other displacements caused by structures elevated above the land.

4.6 When mosaicking the images, the placement of seam lines shall be chosen to minimize specular reflections and extreme tonal variations in adjacent image areas. Seam lines should go around, and avoid cutting through, elevated structures in the images, especially those structures (such as bridges) that cross over navigable water. The ortho images shall not contain any non- image data, such as artifacts, fiducial marks, film titling, or frame borders.

5. COORDINATE SYSTEM – The final digital ortho image files shall be projected in the Universal Transverse Mercator (UTM) coordinate system, in meters, and referenced to the North American Datum of 1983 (NAD 83). Should the project extend beyond a single UTM zone, all image tiles shall use the coordinate system of the zone that contains the majority of the project.

6. HORIZONTAL ACCURACY – The horizontal accuracy of points tested in the final orthos shall be five meters or better at the 95% confidence level.

7. TILE FILE NAMING – Tiles shall be named using the UTM easting and northing coordinate (rounded to the nearest meter) of the upper left corner of the upper left pixel of the 2.5 x 2.5 km tile (not the buffer pixel coordinate). The tile image files shall conform to the following naming convention:

CZZeEEEEEEnNNNNNNN.tif

where:

C = refers to the images being color negative images

ZZ = UTM zone

e = start of easting

EEEEEE = easting coordinate

n = start of northing

NNNNNNN = northing coordinate

Example: C17e560000n6627500.tif

8. PREPRODUCTION SAMPLE – The contractor shall submit a single, color and tone balanced, orthorectified sample image as soon as possible after initiation of this phase, for Government review. The sample shall be in GeoTIFF format, UTM (NAD 83) coordinates. NGS will make every attempt to evaluate and approve or disapprove the sample with comments no later than 3 business days after receipt. Additional sample images may be submitted for review if approved by the COR.

9. ORTHOMOSAIC TILE INDEX – The contractor shall submit an index of the orthomosaic tiles in the form of polygon shapefiles that delineate the area of each tile, not including the buffer zone around each. The shapefiles for the index shall use NAD 83 geographic coordinates.

10. ORTHOMOSAIC METADATA – Prior to the start of work the Government will furnish to the contractor a text (.txt) file containing a template which will define the Federal Geographic Data Committee (FGDC) compliant metadata elements required. The contractor shall create an FGDC compliant metadata file using the Government provided template for each orthomosaic tile generated.

11. ORTHOMOSAIC REPORT – The contractor shall submit a report describing the work performed to produce the orthos. This report shall include at least the following information:

11.1 A summary of the aerotriangulation procedures performed, and the quality of the results

11.2 What DEM was used, including its source, date, resolution, and accuracy

11.3 A summary of the processes used to produce the orthos

11.4 A summary of the Quality Control/Quality Assurance (QC/QA) procedures followed to validate the accuracy and quality of the orthos, and the results of that validation.

If the AeroTriangulation (AT), and the accompanying AT Report, have already been completed, then this Orthomosaic Report shall be submitted as a separate document. Otherwise, if the AT Report has not yet been written, the above information may be included as a section in the AT Report called “ORTHOMOSAIC PRODUCTION”.

12. DVD LABELING – Media, Digital Video Disk (DVD), containing the final orthomosaic tiles, index, and report deliverables shall be uniquely labeled with the following identifying elements:

ELEMENT	EXAMPLE
Disk Number	DVD 1 of 1
Company Name (with optional logo)	Acme Company
Project ID	MD1701-CM-C
Brief Description of Contents	Orthomosaic Tiles, Index, Metadata, and Report
Creation Date	February 10, 2017
Coordinate System and Zone	UTM Zone 17

See Main Text, Section 9.4 for further details about the use of DVDs.

13. QUALITY CONTROL – Quality control shall be exercised by the contractor continuously throughout all phases of the project. Procedures shall be established to assure that all contract materials are delivered in accordance with the required level of accuracy and quality. Any products delivered by the contractor which do not meet the minimum requirements described in the SOW and in the sections above may be rejected.

Notice – all items highlighted are changes from previous versions of this SOW

July 25, 2017

ATTACHMENT AM
GRAVITY FOR THE REDEFINITION OF THE AMERICAN VERTICAL DATUM (GRAV-D) GOVERNMENT FURNISHED PROPERTY

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Notice – all items highlighted are changes from previous versions of this SOW

ATTACHMENT AM - GRAVITY FOR THE REDEFINITION OF THE AMERICAN VERTICAL DATUM (GRAV-D) GOVERNMENT FURNISHED PROPERTY

1. GOVERNMENT FURNISHED PROPERTY NOTIFICATION

Government furnished property will be specified within individual task orders.

2. GOVERNMENT FURNISHED PROPERTY AVAILABLE

2.1. Turnkey Airborne Gravimetry System (TAGS) Air III gravity meter, either S-137 or S-161, manufactured by Micro-g LaCoste (http://www.microglacoste.com/tags.php).

A) Quantity – 2 Each

B) Property ID: CD0001723983 and CD0004084915

C) Unit acquisition cost - $800,000 each

D) Size: 71 x 56 x 84 cm, Weight: 140 kg (308 lbs)

E) Equipment will be supplied in an "As is" condition. Gravimeter will come with an aluminum base plate for mounting to seat tracks that can be modified to fit various aircraft.

2.2. Turnkey Airborne Gravimetry System (TAGS) System 7, S-211, manufactured by Micro-g LaCoste (http://www.microglacoste.com/tags-6.php).

A) Quantity – 1

B) Property ID: TBD, in acquisition

C) Unit acquisition cost - $800,000

D) Size: 59 x 53 x 56 cm, Weight: 73 kg (161 lbs)

E) Equipment will be supplied in an "As is" condition. Gravimeter will come with an aluminum base plate for mounting to seat tracks that can be modified to fit various aircraft.

2.3. NovAtel SPAN GNSS Inertial Systems including a SPAN-SE-RT2-G-S-J receiver (http://www.novatel.com/products/span-gnss-inertial-systems/span-receivers/span-enclosures/span-se/) and a Honeywell LASEREF V Micro-IRS SM inertial measurement unit

(https://commerce.honeywell.com/webapp/wcs/stores/servlet/eSystemDisplay?catalogId=10251&storeId=10651&categoryId=14183&langId=-1)

A) Quantity – 2 Each

B) Property ID: CD0001723982 and CD0004084916

C) Unit acquisition cost - $125,000 each

D) Equipment will be supplied in an "As is" condition. The Inertial System is usually mounted to the top of the gravimeter racks.

3. SPECIAL INSTRUCTIONS FOR CONTRACTOR SUPPLIED AIRCRAFT

3.1. The contractor will provide an aircraft that meets the following minimum requirements to utilize GRAV-D Government Furnished Property:

A) Pressurized and capable of operation at 20,000 ft

B) Able to fly at 200-250 kts ground speed

C) Sufficient payload capability to carry the 420 lbs of the GRAV-D instrument suite plus two pilots and an operator

D) Capable of at least 4 hours endurance given the payload

E) Can deliver 700W max of 60 Hz, 110VAC power to the gravity instruments

F) Equipped with an autopilot in good working condition that is capable of maintaining straight and level with minimal variance and is capable of being coupled with the aircraft flight management system (FMS).

G) Equipped with a NovAtel ANT-A72GLA-TW-N antenna, 33 db with TNC connector, or equivalent with antenna feed into the cabin (http://www.novatel.com/products/gnss-antennas/compactgnss-antennas/)

H) Able to accept AC ground power via an extension cord for 24 hours a day, 7 days a week power supplied to the aircraft while parked

I) Equipped with a satellite telephone system that performs and is compatible with the area of operations

Notice – all items highlighted are changes from previous versions of this SOW

December 2017

ATTACHMENT AN

CONTINUALLY UPDATED SHORELINE PRODUCT (CUSP) REQUIREMENTS

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Notice – all items highlighted are changes from previous versions of this SOW

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ATTACHMENT AN: CUSP REQUIREMENTS

1. INTRODUCTION

Consumers of coastal mapping data include federal agencies, state and local organizations, academic institutions, and private companies. This data is commonly used by analysts and decision makers equipped with geographic information systems (GIS) technology to develop coastal community plans, manage resources, study the environment, mitigate hazard events, and more.

In response to these demands, NOAA's Continually Updated Shoreline Product (CUSP) has been developed to provide the most current nationwide, seamless shoreline representation of the United States and its territories to support mapping scales as large as 1:1,000 to a minimum of 1:24,000. CUSP maintains the highest available resolution from all of its sources, which include lidar-derived and image-extracted shoreline data from a variety of sources, including federal and state agencies. Wherever applicable, CUSP will reference a mean high water (MHW) shoreline, usually based on vertical modeling or image interpretation.

2. SHAPEFILE REQUIREMENTS

2.1 GENERAL – The Contractor shall supply one Esri line (polyline) shapefile, consisting only of singlepart features, as the final deliverable product to NOAA. The final CUSP shapefile shall employ only a subset of the attribute types in the Coastal Cartographic Object Attribute Source Table (C-COAST) available for compilation of Geographic Cells (GC). CUSP also contains several additional/modified data fields. Data fields and attributes in CUSP are character and case sensitive. The glossary of terms in C-COAST may be found in Attachment F, and is also available on the web at: https://www.ngs.noaa.gov/RSD/shoredata/c_coast_def.htm

2.2 COORDINATE SYSTEM AND DATUM – The final shapefiles shall be in geographic decimal degrees using double precision and referenced to the North American Datum of 1983 (NAD 83). A projection file (.prj) shall be included in the shapefile which shall conform to the "GCS_North_American_1983" projection used in Esri's ArcGIS software.

2.3 SHAPEFILE NAMING CONVENTION – The name of the shapefile shall include the NOAA-provided Project ID followed by "_CUSP", indicating that it is the full resolution CUSP shoreline product. An example of a CUSP deliverable shapefile name is "NY1407A_CUSP.shp".

2.4 SHAPEFILE ATTRIBUTION – The final CUSP shapefiles shall include the following data fields, *ordered as they are listed below:*

Attribute_Label: SOURCE_ID
- Data type: Text
- Width: 32
- Definition: Source Identification of feature. This is generally the GC ID, if applicable/known, but may also include other contributor ID naming conventions.
- Domain: Free text

Attribute_Label: SRC_DATE
- Data type: Text
- Width: 8
- Definition: Date of source imagery (YYYYMMDD) for the feature
- Domain: 20000101 - Present

Attribute_Label: HOR_ACC
- Data type: Text
- Width: 6
- Definition: Horizontal positional accuracy (meters)
- Domain: Free text

Attribute_Label: INFORM
- Data type: Text
- Width: 50
- Definition: Ancillary Information (e.g. Describing or defining a feature)
- Domain: Free text

Attribute_Label: ATTRIBUTE
- Data type: Text
- Width: 50
- Definition: C-COAST Feature attribute description
- Domain: Breakwater.Bare
  Groin.Bare
  Jetty.Bare
  Man-made.Bulkhead Or Sea Wall
  Man-made.Bulkhead Or Sea Wall.Ruins
  Man-made.Canal.Navigable
  Man-made.Canal.Navigable.Approximate
  Man-made.Canal.Non-navigable
  Man-made.Drydock.Permanent
  Man-made.Lock
  Man-made.Ramp
  Man-made.Rip Rap
  Man-made.Slipway
  Man-made.Wharf Or Quay
  Man-made.Wharf Or Quay.Ruins
  Natural.Apparent.Mangrove Or Cypress
  Natural.Apparent.Marsh Or Swamp

Natural.Glacier
Natural.Great Lake Or Lake Or Pond
Natural.Great Lake Or Lake Or Pond.Approximate
Natural.Mean High Water
Natural.Mean High Water.Approximate
Natural.Mean Water Level
Natural.River Or Stream
Natural.River Or Stream.Approximate
Stream.Perennial
Undetermined
Undetermined.Approximate

Attribute_Label: VER_DATE
Data type: Text
Width: 8
Definition: Date of verification imagery (YYYYMMDD) for the feature
Domain: 20000101 - Present

Attribute_Label: SRC_RESOLU
Data type: Float
Width: 4
Definition: Resolution of source (imagery or grid) in meters used for compiling shoreline
Domain: 0 - 200

Attribute_Label: DATA_SOURC
Data type: Text
Width: 32
Definition: Data Source describing the type of imagery used in compilation
Domain: Aerial Photography, Satellite Imagery, Lidar, IFSAR, SAR, HyperSpectral, Multispectral

Attribute_Label: EX_METH
Data type: Text
Width: 10
Definition: Method used to extract feature from source
Domain: Derived, Mono, Stereo

Attribute_Label: DAT_SET_CR
Data type: Text
Width: 50
Definition: Data Set Credit: organization responsible for providing the original shoreline data
Domain: Free text

Attribute_Label: FIPS_ALPHA

Data type: Text

Width: 2

Definition: Two- letter FIPS State Alpha Code for each State and the District of Columbia. The FIPS State Alpha Code is identical to the two-letter U.S. Postal Service (USPS) abbreviation for each entity. Areas not included in the FIPS State Alpha Code are identified as "99".

Domain: 99, AK, AL, AS, CA, CT, DC, DE, FL, GA, GU, HI, ID, IL, IN, LA, MA, MD, ME, MI, MN, MP, MS, NC, NH, NJ, NY, OH, OR, PA, PR, RI, SC, TX, UM, VA, VI, VT, WA, WI

Attribute_Label: NOAA_Regio

Data type: Text

Width: 32

Definition: NOAA Regional Collaboration. Areas not included in the NOAA Regional Collaboration are identified as "99".

Domain: 99, Alaska, Great Lakes, Gulf of Mexico, North Atlantic, Pacific Islands, Southeast and Caribbean, Western

2.5 MINIMALLY REQUIRED ATTRIBUTES – The Contractor shall populate, at a minimum, the following data fields for every record in the final CUSP shapefile:

SRC_DATE

HOR_ACC

ATTRIBUTE

DATA_SOURC

EXT_METH

DAT_SET_CR

FIPS_ALPHA

Example of an attribute table for final deliverable CUSP shapefile:

CUSP_Sample

FID	Shape *	SOURCE_ID	SRC_DATE	HOR_ACC	INFORM	ATTRIBUTE	VER_DATE	SRC_RESOLU	DATA_SOURC	EX_METH	DAT_SET_CR	FIPS_ALPHA	NOAA_Regio
0	Polyline		20160212	9		Man-made.Ramp	20170531	0.15	Aerial Photography	Mono	NOAA	FL	Gulf of Mexico
1	Polyline		20160212	9		Man-made.Bulkhead Or Sea Wall	20170531	0.15	Aerial Photography	Mono	NOAA	FL	Gulf of Mexico
2	Polyline		20160212	9		Man-made.Bulkhead Or Sea Wall	20170531	0.15	Aerial Photography	Mono	NOAA	FL	Gulf of Mexico
3	Polyline		20160212	9	Dam	Man-made.Bulkhead Or Sea Wall	20170531	0.15	Aerial Photography	Mono	NOAA	FL	Gulf of Mexico
4	Polyline		20160212	9		Man-made.Bulkhead Or Sea Wall	20170531	0.15	Aerial Photography	Mono	NOAA	FL	Gulf of Mexico
5	Polyline		20160212	9		Man-made.Ramp	20170531	0.15	Aerial Photography	Mono	NOAA	FL	Gulf of Mexico
6	Polyline		20160212	9		Man-made.Ramp	20170531	0.15	Aerial Photography	Mono	NOAA	FL	Gulf of Mexico
7	Polyline		20160212	9		Man-made.Bulkhead Or Sea Wall	20170531	0.15	Aerial Photography	Mono	NOAA	FL	Gulf of Mexico
8	Polyline		20160212	9		Man-made.Ramp	20170531	0.15	Aerial Photography	Mono	NOAA	FL	Gulf of Mexico
9	Polyline		20160212	9		Man-made.Bulkhead Or Sea Wall	20170531	0.15	Aerial Photography	Mono	NOAA	FL	Gulf of Mexico
10	Polyline		20160212	9		Man-made.Ramp	20170531	0.15	Aerial Photography	Mono	NOAA	FL	Gulf of Mexico
11	Polyline		20160212	9		Man-made.Ramp	20170531	0.15	Aerial Photography	Mono	NOAA	FL	Gulf of Mexico
12	Polyline		20160212	9		Man-made.Bulkhead Or Sea Wall	20170531	0.15	Aerial Photography	Mono	NOAA	FL	Gulf of Mexico
13	Polyline		20160212	9		Natural.Apparent.Mangrove Or Cypress	20170531	0.15	Aerial Photography	Mono	NOAA	FL	Gulf of Mexico
14	Polyline		20160212	9		Natural.Apparent.Mangrove Or Cypress	20170531	0.15	Aerial Photography	Mono	NOAA	FL	Gulf of Mexico
15	Polyline		20160212	9		Natural.Apparent.Mangrove Or Cypress	20170531	0.15	Aerial Photography	Mono	NOAA	FL	Gulf of Mexico

3. CUSP FEATURE COMPILATION

3.1 COMPILATION CONTENT AND LEVEL OF DETAIL – CUSP consists only of the shoreline and *certain* alongshore features of solid construction (no water passing beneath) which are always bare at high water and therefore essentially also constitute shoreline. The shoreline shall be compiled using any combination of attributes specified in Section 2.4 above. Each compiled shoreline vector shall be classified with the most appropriate attribute type based on the nature of the shoreline at the immediate land-water interface. All alongshore features not included in Section 2.4 above such as piers, bridges, training walls, etc. do not constitute shoreline and shall be ignored.

Shoreline type variations along the shoreline of 2 meters or less may be ignored unless considered to be of particular significance. The compiler should always take great care to measure features in the imagery as precisely as possible.

The use of freely available supplemental image sources is encouraged for interpreting the attribution of features that may not be fully discernable in the provided imagery. Supplemental images may provide a different image perspective to assist in the image interpretation. The additional detail that oblique imagery offers, such as the Coastal Imagery Viewer (https://geodesy.noaa.gov/storm_archive/coastal/viewer/), may be especially helpful for assigning attributes to features that may be obscured by other features above them, such as tree canopy, bridges, etc.

3.2 CONTINUITY AND GENERALIZATION – The shoreline shall be compiled in CUSP as a continuous unbroken line within the extent of source imagery. This line represents the boundary between a land area and a body of water. This concept of shoreline as a boundary is useful, as the line must always represent land on one side and water on the other side. To maintain this topology the shoreline can never split, or fork, into two lines; and two shorelines can never converge into one. A shoreline can only end by closing on itself, as when surrounding an island or lake; or when terminating at the limit of the source data from which it is compiled; or when obscured by clouds, smoke, etc. in source imagery, in which case it should be resumed immediately where no longer obscured. Adjoining lines shall connect exactly, endpoint to endpoint, typically by snapping the endpoints together during compilation. To avoid unnecessarily short features, adjoining shoreline vectors that were compiled with the exact same attribution for all fields should usually be merged together. There shall be no duplicate segments, overlapping segments, dangles, or gaps in the shoreline. Bare groins, breakwaters, and jetties shall in all cases be delineated with an outline around the perimeter of the object (double-line delineation), regardless of width. Since CUSP does not include point features, bare rocks of significant value shall be shown as closed polyline features.

The shoreline of lakes, ponds, or non-tidal streams shall be compiled at the position where the land-water interface would be situated when the water is at the stage that prevails for the greater part of the year (Average Water Elevation). If this level cannot be determined, the shoreline shall be compiled at the visible land-water interface at the date of image source.

With new compilation of features, non-connecting streams should be closed when the width of the upstream/pond becomes less than 5 meters. Streams shall be closed with a V-shape pointing upstream.

Generalization (the simplification of individual line features by removing or thinning vertices) shall not be performed on CUSP for the most part, in order to preserve the spatial resolution of the source data as much as possible. The only exception to the prohibition against generalization is in cases of the grouping of homogeneous objects, principally small/scattered areas of apparent shoreline (marsh, mangrove), which are less than 5 meters in width and length that are approximately 10 meters or less apart from one another.

3.3 EDITING NOAA-PROVIDED SHORELINE VECTORS – A common CUSP production scenario involves the use of contouring algorithms and tide modeling to automatically extract shoreline vectors from NOAA-acquired topographic-bathymetric ("topobathy") lidar. This method for extracting shoreline vectors results in highly detailed, very complex delineations of shorelines. These shoreline contours are extracted as unclassified (un-attributed) vectors, which must be segmented and classified with the appropriate attribute types for inclusion in CUSP. Listed below are the specifications and procedures for contractors to produce the attributed full-resolution CUSP deliverables from the lidar shoreline data that has been provided by NOAA.

1) Contractor will receive un-attributed lidar shoreline vector data from NOAA.
    a. The base for the full-resolution deliverable shall be the lidar shoreline.
    b. NOAA will provide shapefiles in FINAL format (SOW v.15 Att. D, Sec. 3).
2) Contractor shall perform preliminary attribution of lidar shoreline vector data.
    a. The Contractor shall attribute all vector features included in the full-resolution deliverable.
    b. Attribution of full-resolution data is not expected to differ significantly from the attribution of the generalized/edited Final deliverable subsequently produced.
    c. The Contractor shall not include in the full-resolution deliverable any attribute type not listed in Section 2.4 above.
    d. Where necessary, the Contractor shall edit the lidar-derived vector data to properly align vector features to the project imagery. For example, where the lidar placement of a Marsh shoreline vector does not match project imagery, then the Contractor should adjust the Marsh vector to align with the imagery.
    e. The Contractor shall NOT generalize vectors prior to submission of the initial attributed full-resolution deliverable.
3) Contractor shall deliver the attributed full-resolution deliverable for each subproject in the CUSP Shapefile format in Section 2 above.
4) NOAA will review the data in a timely manner and respond with comments to the Contractor requesting any necessary revisions.

Notice – all items highlighted are changes from previous versions of this SOW

January 2018

ATTACHMENT AO

ADDITIONAL REMOTE SENSING TECHNOLOGIES, SERVICES, AND CAPABILITIES

TO
SCOPE OF WORK FOR SHORELINE MAPPING
UNDER THE
NOAA COASTAL MAPPING PROGRAM

REMOTE SENSING DIVISION
NATIONAL GEODETIC SURVEY
NATIONAL OCEAN SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Notice – all items highlighted are changes from previous versions of this SOW

1. SERVICE AND CAPABILITY TYPES - While the NGS relies primarily on digital imagery and light detection and ranging (lidar) to meet its mission there are current and developing technologies that can be utilized and are being developed that need to be evaluated and considered.

The additional services and capabilities required by NGS necessitate firms having end-to-end capabilities for the following:

1.1 DATA ACQUISITION - aerial, satellite, shipboard, and unmanned vehicles; collection methods include, but are not limited to:

A. Lidar (topographic, bathymetric, mobile)

B. Digital multi-spectral

C. Hyper-spectral imaging

D. Satellite imagery

E. Video

F. Acoustic

G. Sediment sampling

1.2 THEMATIC MAPPING – Examples include land use/cover, impervious surfaces, wetland and benthic habitats. The use of supervised and unsupervised classification, and regression tree modeling is included.

1.3 HIGH-RESOLUTION TOPOGRAPHIC/BATHYMETRIC PRODUCT GENERATION

1.4 PHOTOGRAMMETRIC MAPPING AND ORTHOPHOTOGRAPHY PRODUCTION

1.5 SURVEY AND CONTROL SERVICES - Includes the use of ground-based and airborne Global Positioning Systems (GPS) technologies.

1.6 GIS SERVICES

1.7 CADASTRAL MAPPING (terrestrial and marine)

1.8 GEOSPATIAL SERVICES AND TRAINING (remote and onsite)

1.9 SYNTHETIC APERTURE RADAR (SAR) AND INTERFEROMETRIC SYNTHETIC APERTURE RADAR (IfSAR) – Includes data collection and processing, including specialized analysis including IfSAR for subsidence, Digital Elevation Model (DEM) generation, flood mapping, shoreline mapping, etc.

1.10 ANALYSIS AND DOCUMENTAION - Specialized analysis and documentation of current and future geospatial topics of importance to NOAA, NGS, and the Integrated Ocean and Coastal Mapping (IOCM) community.

1.11 MISSION AIRCRAFT SUPPORT - Support NOAA mapping and data collection as needed