



DEPARTMENT OF THE ARMY
GALVESTON DISTRICT, CORPS OF ENGINEERS
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CESWG-RD

MEMORANDUM FOR All Regulatory Personnel and the Regulated Public

SUBJECT: SWG-Standard Operating Procedures; Recording and Submitting Jurisdictional Delineations Using Global Positioning Systems (GPS) and Geographic Information Systems (GIS) Tools and Technologies

1. General: The purpose of this document is to provide a set of Standard Operating Procedures (SOP) and requirements for addressing the use of GPS equipment for surveying jurisdictional delineations pursuant to Section 10 of the Rivers and Harbors Act and 404 of the Clean Water Act within the Galveston District (District). Use of this SOP is required by all who use GPS/GIS data for the purposes of obtaining a Department of the Army permit or jurisdictional determination, as well as all Regulatory personnel. U.S. Army Corps of Engineers Regulatory Guidance Letter 05-02 requires documentation sufficient to allow a reasonably accurate replication of the delineation at a future date. District Policy Statement 98-01 defines reasonably accurate as within two-meters. Significant advances in GPS technology allow the recording of differential GPS positions to sub-meter accuracy and is now the industry standard. This SOP will supersede the previous: Recording Jurisdictional Delineations Using Global Positioning Systems (GPS), dated October 2003. The District will retain discretion concerning modifications or adjustment to the spatial accuracy standard on a project to project basis. Applicants and/or landowners seeking assistance from the District in surveying their property for waters of the United States should call the Regulatory Hotline at 409-766-3869

2. Resources: The following information outlines documents referenced and used in the development of this SOP. These resources also provide additional guidance and procedures for preparing and conducting jurisdictional delineations.

- Corps of Engineers Wetlands Delineation Manual, January 1987.
- Atlantic and Gulf Coastal Plains Region Supplement (Version 2.0), November 2010.
- Great Plains Region Supplement, March 2010.
- SWG SOP: Recording Jurisdictional Delineations Using Global Positioning Systems (GPS), October 2003.
- Regulatory Guidance Letter (RGL) 05-02– Expiration of Geographic Jurisdictional Determinations of Water of the United States, June 2005.
- District Policy Statement 98-01 – Recording Wetland Delineations, June 1998.
- District Policy Statement – Electronic Distribution of Documents, July 2013.

3. Reevaluation: The District will review this SOP at least every two (2) years to determine whether changes are required to achieve its purpose. This SOP may be modified or amended at any time.

4. Organization of SOP: This SOP is divided into two sections: Data Collection and Data Submission. Each section will outline the required parameters when using GPS/GIS during delineations. A glossary of terms used in this SOP is also attached.

- I. Data Collection: This section outlines the required parameters when using GPS equipment to collect data while performing a delineation.
 - a. Written documentation of the specific type of GPS equipment used must be provided.
 - b. If multiple GPS units are used on a project, a unique prefix (letter) must be assigned to each unit, which will ensure that downloaded files for each unit contain a unique identifier within the filename.
 - c. Spatial data must be recorded and submitted as NAD 1983 Decimal Degrees with a degree of precision six digits past the decimal point.
 - d. Data must be processed to ensure positional accuracy throughout the duration of GPS data collection using either real-time or post-processing data correction.
 - i. Real-Time Data Correction.
 1. Real-Time Data correction must use a known benchmark or monument as a waypoint during the entirety of the GPS data collection.
 2. Once the benchmark or monument has been identified, the procedure for ensuring positional accuracy requires two readings/collections from the established waypoint: one at the start and one at end of each field day when GPS data collection occurs.
 3. This procedure applies to each GPS unit used for field collection that day.
 - ii. Post-Processing Data Correction: If real-time data correction is not used, post-processing differential correction must be completed and documented to ensure positional accuracy.
 - e. Instances when GPS field data collection are not optimal and will compromise data quality and accuracy, contact the District to determine the appropriate course of action in order to remain compliant.

- II. Data Submission: This section outlines the required parameters when using GIS technology to analyze and submit delineation data.
- a. Submitted spatial directories and files names must NOT contain non-alpha-numeric characters and/or spaces, with the exception of underscores. A logical naming convention for submitted files must include:
 - i. Project Number;
 - ii. Unique File Name;
 - iii. Date of Acquisition/Creation (YYYYMMDD).
 - b. All submitted spatial data layers must include attribute data for each polygon, line, or data point surveyed and mapped. The table must include the following information for each point surveyed:
 - i. Complete SWG Project Number (when possible);
 - ii. Unique number, name, and/or comment;
 - iii. NAD 1983 Decimal Degrees with a degree of precision six digits past the decimal point;
 - iv. Number of satellites (minimum 4);
 - v. PDOP value of 6 or less;
 - vi. Distances between each consecutively numbered survey point;
 - vii. Date Recorded;
 - viii. Initials of data collector or creator;
 - ix. Receiver Type;
 - x. Correction and/or Accuracy Status.
 - c. GPS and GIS data must be in separate data folders following a logical data structure.
 - d. The wetland survey map(s) must include the following information:
 - i. Standard mapping conventions (e.g. north arrow, scale, legend) and features which facilitate the correlation of map locations with ground features.
 - ii. A vicinity map.
 - iii. The following standard base layers must be included in the submitted map product(s) when applicable and available:
 1. Roads: streets, highways, interstates, etc.;
 2. Hydro: major streams, rivers, creeks, etc.;
 3. Political Boundaries: county, state, etc.;
 4. NWI;
 5. DOQQ Imagery;
 6. DRG;
 7. Lidar and/or DEM;
 8. FEMA NFHL/FIRM (100 year floodplain);
 9. Soils.

- iv. Reference block which identifies the project, surveyors and date.
 - v. Identity, location and size of all aquatic resource limits within the project boundary. Acreage not examined for aquatic resources must be clearly indicated.
 - vi. MHTL, HTL, OHWM, where appropriate.
 - vii. Consecutively numbered delineation boundary points, line segments, control points and sample points (e.g. A-1, A-2, A-3, etc.) delivered in ESRI geodatabase formats.
 - viii. Symbols must be easily and quickly identifiable when displayed in color and black and white.
 - ix. Symbols must be clearly distinguishable between other symbols when displayed in color and black and white.
- e. Metadata is required for all submitted spatial data layers. Minimal requirements include content description, content abstract, source, vintage, accuracy, viewing resolution, condition, projection, responsible party, contact phone number, method of collection, description of attributes, and any other pertinent identifiers or descriptors. The following details must be incorporated within the appropriate metadata fields:
- i. Complete SWG Project Number (when possible);
 - ii. Name of project;
 - iii. Name(s) of data collectors;
 - iv. EHE/EPE or maximum PDOP (using 4 satellites);
 - v. Coordinate system (projection, datum & zone);
 - vi. Type(s) of GPS units used;
 - vii. The range of field collection dates;
 - viii. Name of Base Station used for correction;
 - ix. Name and version of software used for downloading and any corrections;
 - x. Any editing performed on the raw data;
 - xi. Signature block certifying accuracy.
- f. Hardcopy and digital wetland survey maps must be submitted.
- i. Hardcopy submission:
 - 1. At minimum, the hardcopy version must be 8.5 x 11;
 - 2. The District may request paneled hardcopy maps, in a visible scale, if the project encompasses an extensive and complex area;
 - 3. When requested, a large scale, copy of the survey map must also be presented to the District representative for field verification purposes.
 - ii. Digital Submission must include: .pdf(s) of all hardcopy map, geodatabases, and all other appropriate associated data files. Digital data may be transmitted via either:
 - 1. CD-ROM;
 - 2. Email, if attachment size is appropriate;

3. AMRDEC. AMRDEC is a Safe Access File Exchange (SAFE) system for securely exchanging large files to a .gov or .mil email address. The maximum upload size of all documents is 2GB. The maximum number of files is 25. The system accepts .zip files. AMRDEC can be accessed online at <https://safe.amrdec.army.mil/safe/>. See District Policy Electronic Distribution of Documents, July 2013 for further details. The District will print the list of documents received for the administrative record.
 - g. An Excel spreadsheet listing each aquatic resource must also be included.
 - i. At minimum, the list must include the location coordinates and acreage of the aquatic resource.
 - ii. Ask the District for the most recent version of the ORM aquatic resources upload sheet.
 - h. When feasible, distances between selected GPS survey points will be measured for accuracy. All errors must be corrected before the map will be verified.
 - i. In cases of complex or controversial projects, we reserve the right to request the seal and signature of a Registered Professional Land Surveyor (RPLS).
 - j. The surveyed jurisdictional boundary may be field verified by a District representative accompanied by the surveyor who prepared the information.
- III. Data Storage: Permanent storage of all submitted GPS/GIS digital data from an applicant will be stored electronically in the District's database. District personnel will place all submitted digital data on the W drive (W:\eGIS\Regulatory) for QA/QC process.
5. Conclusion: District personnel will assess collected and submitted data to ensure consistency with this SOP. The District reserves the right to request additional data and/or information related to submitted data. For further assistance on this SOP, please call the Regulatory Hotline at 409-766-3869.

Kimberly S. Baggette
Kimberly S. Baggette
Chief, Regulatory Division
Galveston District

Date: 4/21/2016

GLOSSARY

Accuracy - The degree of conformance between the estimated or measured position, time, and/or velocity of a GPS receiver and its true time, position, and/or velocity as compared with a constant standard.

Almanac - Data transmitted by a GPS satellite, which include orbit information on all the satellites, clock correction, and atmospheric delay parameters. The almanac is used to facilitate rapid SV acquisition. The orbit information is a subset of the ephemeris data with reduced precision.

Attribute - Tabular information about a specific feature, generally stored in a table and linked to the feature by a unique identifier.

Base Station - GPS files collected continuous from community base stations, local base stations, or Continually Operating Stations (CORS). Gathering base files will require an internet connection and software that dials into a server that houses the base station data collected at the same time of the rover. Data stored on these servers will not be available in real-time, as such, this step is conducted after field collection. Trimble users would use the Differential Correction utility supplied in Pathfinder Office.

Coordinates - The x- and y-values that define a location in a planar or three-dimensional coordinate system.

Differential correction - The merging of rover file data with base map data to correct position errors due to atmospheric interference. Autonomous data (rover) are collected in the field while base data are stored at the stationary base station. The two datasets are loaded into a post-processing software package where corrections are applied. This process will reduce errors in the field collected data (the rover) by correlating and correcting for known errors recorded in the base file that has the same time tag. As distance between the rover and base file increase, there is degradation in post-processed accuracy. In general, a degradation of one part per million (1ppm) occurs as the distance between the base station and rover increases. For example, one millimeter of degradation occurs for every kilometer between base and rover.

Datum (*geodetic datum*) - A mathematical model that is designed to fit a point on the earth's surface to an ellipsoid. Commonly used datums are North American Datum (NAD) 1927, and NAD 1983, modeled to represent the North American continent.

Digitize - To convert the shapes of geographic features from media such as paper maps or raster imagery into vector x, y coordinates.

DEM - Digital Elevation Model. A digital representation of a continuous variable over a two-dimensional surface by a regular array of z values referenced to a common datum.

DOQQ - Digital Orthophoto Quarter Quad. A USGS Aerial Photo product of One-Meter resolution. 3.75' Area; created from the National Aerial Photography Program.

DRG - Digital Raster Graphic. A USGS product, a scanned USGS topographic map.

EHE/EPE - Estimated Horizontal Error (EHE) Estimated Precision Error (EPE). Describes the strength of a satellite configuration on the accuracy of data collected with GPS receivers.

ESRI - Environmental Science Research Institute. Accessible: www.esri.com

Feature - A feature is the spatial location of a physical object, or some event or phenomenon. Features are often referred to as graphic data in a GIS. Examples include a tree (point), road (line), or land parcel (polygon).

FEMA NFHL/FIRM - Federal Emergency Management Agency (FEMA) National Flood Hazard Layer (NFHL) Flood Insurance Rate Map (FIRM). A digital database that contains flood hazard mapping data from FEMA's National Flood Insurance Program. For Regulatory purposes, the 100-year floodplain must be illustrated on appropriate maps.

FGDC - The Federal Geographic Data Committee. Accessible: www.fgdc.gov/index.html. A 19 member interagency committee composed of representatives from the Executive Office of the President, Cabinet-level and independent agencies who develop policies, standards, and procedures for organizations to cooperatively produce and share geographic data.

Geodatabase - A geodatabase is a 'container' used to hold a collection of spatial data sets. There are three types of geodatabases: personal, file, and ArcSDE.

Geographic Information System (GIS) - A system designed to capture, store, manipulate, analyze, manage, and present all types of spatial or geographical data.

Global Positioning Systems (GPS) - a constellation of a minimum of twenty-four satellite vehicles orbiting the earth approximately every twelve hours at an approximate pacing of sixty degrees, between 11,000 – 12,000 miles above the surface of the Earth.

HTL - High Tide Line. Further defined: 33 CFR 328.3(c)(7).

Latitude - The angular distance along a meridian north or south of the equator, usually measured in degrees. Lines of latitude are also called parallels.

Lidar (Light Detection and Ranging) - Similar to radar, lidar is an active remote sensing technique. This technique involves the use of pulses of laser light directed toward the ground and measuring the time of pulse return. The return time for each pulse back to the sensor is processed to calculate the variable distances between the sensor and the various surfaces on or above the earth's surface.

Lines - Geographic term related to the scale that describe how a feature is drawn. Lines are linear measures of a feature (such as a line representing a trail).

Longitude - The angular distance, expressed in degrees, minutes, and seconds, of a point of the earth's surface east or west of a prime meridian (usually the Greenwich meridian). All lines of longitude intersect the equator and pass through the North and South Poles.

Mapping Grade - GPS receivers capable of attaining five meters of accuracy or better using differential correction.

Metadata - Information about data. Usually comes in the form of a text or html document with information on the dataset's quality, current projection, attributes, distribution, and citation.

MHTL - Mean High Tide Line. Further defined as mean high water in 33 CFR 329.12.

Multipath - Error which occurs when a GPS signal sent from a satellite vehicle is bounced or redirected by an object, prior to reaching a GPS receiver. Multipath will cause the time it takes a GPS signal sent by a satellite vehicle to reach a GPS receiver to be inflated. This will cause inaccuracies in positions collected.

NAD - North American Datum. Geodetic reference system.

NWI - National Wetland Inventory. Established by the U.S. Fish and Wildlife Service in 1974 to conduct a nationwide inventory of U.S. wetlands to provide its biologists and others with information on the distribution of wetlands to aid in wetland conservation efforts.

NGS - National Geodetic Survey. Accessible: www.ngs.noaa.gov. Contains benchmark and monument data.

OHWM - Ordinary High Water Mark. Further defined: 33 CFR 328.3(c)(6).

ORM - OMBIL (Operations & Maintenance Business Information Link) Regulatory Module. Internal USACE electronic database.

PDOP - Position Dilution of Precision. Describes the strength of a satellite configuration on the accuracy of data collected with GPS receivers.

Points - Geographic term related to the scale that describes how a feature is drawn. Points are single dimensional features (such as a point representing a spring).

Polygons - Geographic term related to the scale that describes how a feature is drawn. Polygons have area associated with the feature (such as a circle representing a parking lot).

Projection - A method of representing the earth's three-dimensional surface as a flat two-dimensional surface. This normally involves a mathematical model that transforms the locations of features on the earth's surface to locations on a two-dimensional surface.

Post processing - Utilizing base station data, GPS software, and data acquired by a GPS receiver in the field to gain an accurate fixed position.

Shapefile - A vector file format for storing the location, shape, and attributes of geographic features. It is stored in a set of related files and contains one feature class.

Standard Base Layers - A data layer in a GIS to which all other layers are geometrically referenced. Acquisition/free download of standard base layers are attainable through multiple state and federal agencies websites such as the Texas Natural Resources Information System at www.tnris.org.

SWG – Southwest Galveston (Galveston District). Used as a prefix in all project numbers.

USGS - United States Geological Survey. Accessible: www.usgs.gov.

Waypoint - A named 3 dimensional position on the earth's surface having both latitude and longitude. Waypoints are assigned to a fixed location in the field so it can be navigated to consistently and accurately through time.