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Interim Guidance for Developing Global Positioning System Data Collection Standard Operating Procedures and Quality Assurance Project Plans

RESEARCH AND DEVELOPMENT

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Interim Guidance for Developing Global Positioning System Data Collection Standard Operating Procedures and Quality Assurance Project Plans

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Project Lead

George M. Brilis, Chair
Geospatial Quality Council

U.S. Environmental Protection Agency
Office of Research and Development
National Exposure Research Laboratory
Environmental Sciences Division
P.O. Box 93478
Las Vegas, NV 89193-3478

U.S. Environmental Protection Agency
Office of Research and Development
Washington, DC 20460

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Authorship and Contributors

Primary Author

Noel Kohl, Region 5

Contributing Authors

George M. Brilis, EPA, ORD

Carrie Middleton, EPA, NEIC

Rollin Strohman, California Polytechnic University

Nita Tallent-Halsell, EPA, ORD

Contributing Editors

Tyrone R. Smith, county of San Bernardino, CA

Lynne Petterson, EPA, ORD

Jeffrey C. Worthington, EPA, OEI

Reviewed and Edited by

Andrew Lowe,

Field Data Collection Subgroup

EPA GIS Work Group

Peer Reviewers

Kevin Kirby
EPA, OEI

David Hansen
Bureau of Reclamation

John G. Lyon
EPA, ORD

Richard Egg
Texas State Soil & Water
Conservation Board

John T. Lin
EPA, ORD

Jerry Johnston
EPA, OEI

Table of Contents

Table of Contents (Cont.)

Table of Contents (Cont.)

Section 3 GPS Quality Assurance Project Plan (QAPP) Template

Acknowledgments

The geospatial community appreciates the tremendous contribution of the primary author, Mr. Noel Kohl, EPA Region 5. The U.S. Global Positioning System (GPS) is gaining increasing importance as geospatial science and technology are further developed and seamlessly integrated into not only environmental applications, but in our daily lives. This guidance is a landmark on the path to harmonized GPS data collection activities for environmental applications.

It is noteworthy that in creating the core of this document, Mr. Kohl referenced previous products of the EPA Geospatial Quality Council. This is a positive reflection of the dedication, efforts, and forward-thinking of the individuals who have contributed to the efforts of the EPA Geospatial Quality Council.

Manuscript reviewers provide the critical function of peer review. Their comments, suggestions, and recommendations for this document are greatly appreciated.

Background

Since its formation in 1998, the U.S. EPA Geospatial Quality Council (GQC) developed products that provide Quality Assurance (QA) guidance for the development, use, and products of geospatial activities and research. At least two GQC's products became the foundation for EPA geospatial data policy. These include:

- EPA *Guidance for Geospatial Data Quality Assurance Project Plans (Peer Review Draft)*, EPA/600/R-01/062, and
- *Global Positioning Systems: Technical Implementation Guidance, (GPS-TIG)* Revision 2.0, July 2006, EPA/600/R-03/001.

As demonstrated, the GQC can be credited for establishing the foundation of QA in EPA geospatial activities.

With a QA foundation in place, the GQC now focuses on improving administrative efficiency. The approach being taken is to develop Standard Operating Procedures (SOPs) that can be tailored and adapted by organizational entities in the EPA and its extended partners. The administrative benefits of developing these SOPs include, at a minimum:

- Reduction of time scientists spend writing a full Quality Assurance Project Plan (QAPP)
- Approach taken by the various organizational entities in the EPA is, at the core, harmonized. This adds the value of increased confidence and interoperability in each other's products.

On February 27, 2004, the Office of Environmental Information (OEI)/Office of Information Collection (OIC) distributed the GPS-TIG to the EPA. The release memo states:

> "This document also provides guidance for the development of consistent Standard Operating Procedures for the collection of locational data. The ultimate vision is to have universally comparable locational data by collecting GPS data in a consistent manner."

Mr. Kohl used that guidance to develop an exemplary Region 5 SOP and QAPP template. The Region 5 documents serve as the core of this GQC product.

Introduction

Purpose and Intended Audience

The United States Environmental Protection Agency (U.S. EPA, hereinafter referred to as the "Agency" or the "EPA" for the purposes of this document) Geospatial Quality Council developed this document to harmonize the process of collecting, editing, and exporting spatial data of known quality using the Global Positioning System (GPS). Each organizational entity may adopt this document as the core of their Standard Operation Procedures (SOP) manual on GPS data collection procedures.

The intended audience for this document includes U.S. EPA staff, contractors, and grantees who will be:

1. Participating in GPS survey planning,
2. Conducting a GPS survey,
3. Maintaining and lending GPS equipment, and
4. Processing data sets collected in the field and converting them to various file formats for use in a Geographic Information System (GIS) data base.

This document may also serve as a reference guide for Agency staff who will be using GPS equipment and the individual(s) responsible for the maintenance of this equipment. Training on the proper use of the GPS equipment may be required of Agency staff, contractors, and grantees prior to its use. Training will be provided either by Agency staff or through vendor contracts.

This document does not attempt to detail the specific functions of the various receivers because the rapid advancements in GPS technology would necessitate constant, diligent updates to this document. The mention of trade names or commercial products does not constitute endorsement or recommendation for use.

Four important points must be understood by the readers and users of this document:

1. The level of effort and detail should be based on a common sense, "graded approach" that establishes QA and quality control QC requirements commensurate with the importance of the work, the available resources, and the unique needs of the organization.
2. Because this guidance is intended to be a living document, recommendations to include technology that is currently being developed, and new technology that has not yet become an integral part of the EPA's toolbox, were not included in the document. When the new technology has become an integral part of the EPA's geospatial repertoire, this document will be updated by its custodian (OEI).
3. This document is not intended to "micromanage" the GPS community; therefore, only "suggestions" to define limits were included. In addition, attempts were made to keep the document "user-friendly" by keeping the volume of the document to a minimum.
4. Users should check the appropriate references for the latest updates prior to the initiation of work.

Document Structure & Use

This document is divided into three sections. When initially used while targeting a specific project, implementation of the guidance contained herein will result in an organizational entity creating:

- A Standard Operating Procedure (SOP),
- A GPS Quality Assurance Project Plan (QAPP) for the targeted project, and
- A GPS Quality Assurance Project Plan (QAPP) Template that is tailored for the organizational entity to create additional GPS QAPPs.

Section 1

Standard Operating Procedure for Global Positioning System Data Collection

This SOP may be tailored, and then adopted by each organizational entity after wordsmithing and obtaining signatures for approval. The SOP is consistent with the EPA *Guidance for Preparing Standard Operating Procedures,* EPA/600/B-07/001, April 2007. When revising this section for their use, each organizational entity should ensure that the "document control notation" in the upper right-hand corner accurately reflects the organization's information. When finalized and approved, the SOP should be distributed throughout the organizational entity. This section also introduces the concept of QA Categories to facilitate implementation of the graded approach.

In the EPA, GPS is most frequently used for surveys. Therefore, this focus of this SOP is for GPS surveys. However, it can be edited by the user for the purposes of processing and reporting GPS data sets.

Section 2

GPS Quality Assurance Project Plan (QAPP) Requirements

This section, and the QAPP template in the next section, is a derivative of EPA *Guidance for Geospatial Data Quality Assurance Project Plans (QA/G-5G)*, March 2003. It was condensed and tailored to address GPS data collection activities. This section also contains a table of examples where the graded approach can be applied. A section has been added on Enforcement Considerations, including chain-of-custody. In addition, QA Categories are further defined.

The user should refer to the EPA *Guidance for Geospatial Data Quality Assurance Project Plans (QA/G-5G)*, March 2003, for definitions, more detailed guidance, clarifications, etc.

Section 3

GPS Quality Assurance Project Plan (QAPP) Template

The template in this section was designed to facilitate writing a GPS QAPP. The template was designed for point data collections which are the most common surveys. Surveys to collect polygon or line data would require additional modifications in the template. Text in blue font should be replaced with appropriate text in regular font.

Section 1

Standard Operating Procedure for Global Positioning System Data Collection

Table of Contents

U.S. Environmental Protection Agency
Geospatial Quality Council

DRAFT

STANDARD OPERATING PROCEDURE	
Title: **GLOBAL POSITIONING SYSTEM (GPS) DATA COLLECTION**	
Effective Date:	Number:
Author Date:	
Author (Source &/or Steward)	
Name: **Organization:** **Date:**	
Editor	
Name: Title:	
Approval	
Name: Title: Signature: Date:	
Concurrence[1]	
Name: Title: Signature: Date:	

[1]Optional – typically used by project officers for review by QA Manager

Global Positioning System (GPS)
Standard Operating Procedures

1. Purpose

This SOP provides basic steps to guide the process of collecting, editing, and reporting accurate spatial data using Global Positioning System (GPS) technology. The intended audience of this document includes all personnel involved in planning and conducting GPS surveys, as well as processing and reporting GPS data sets. This SOP is not intended as a detailed user manual for specific brands of GPS receivers, operating systems or software applications.

2. Background

The U.S. Global Positioning System is based on the Navigation Satellite Time and Ranging (NAVSTAR) system operated by the Department of Defense (DOD). The system was initiated in 1977 with the launch of the first constellation of satellites orbiting approximately 12,500 miles above Earth. There are at least four satellites in each of six fixed orbiting planes. This constellation provides GPS users with four to eight visible satellite signals at all times from any point on Earth. Its initial use was intended for highly accurate, all-weather, instantaneous positioning capabilities for the U.S. military and its allies. GPS is now freely available to the public; however, accuracy may be attenuated for national security purposes. The decreasing cost of GPS receivers combined with increasingly accurate operation has allowed this technology to become EPA's method of choice for the acquisition of spatial data. There are similar systems in operation or under development in other countries. Russia has a similar system (GLONASS) http://www.glonass-ianc.rsa.ru/pls/htmldb/f?p=202:1:8312220156118373539 and Europe is working on building a system (GALILEO) http://ec.europa.eu/dgs/energy_transport/galileo/index_en.htm. Receivers that will handle all three have the label Global Navigation Satellite System (GNSS) http://igscb.jpl.nasa.gov/faqs.html#id2839478

3. Planning and Implementing a GPS Survey

The following sections outline the basic steps involved in systematic planning and conducting a GPS survey. In order to complete a successful GPS survey, several steps must be taken prior to using the receiver in the field. These steps will apply to the use of any of the various GPS receivers.

Organizations are encouraged to ensure that personnel are cross-trained to perform GPS coordination activities. Alternatively, an organization may consider appointing and training interested staff members to serve as GPS coordinators. Most of the steps in the pre-survey and post-survey process will be conducted in conjunction with, or entirely by, the GPS coordinator. Equipment may be on loan to those employees who have been trained on the use of the GPS receiver. Those who require training or feel that retraining is necessary must notify the GPS coordinator well in advance of a proposed GPS survey so arrangements can be made for training.

a. **Pre-Survey Planning**. The Field Team Leader should develop the following planning items in cooperation with the GPS coordinator.

(1) Define Objectives of the Survey

It is important to initially establish the ultimate objectives of a GPS survey, including Data Quality Objectives (DQOs). Recognition of these objectives early in the project planning process will help to focus the rest of the planning phase. The accuracy requirements for the positional data must be defined and should be consistent with available program guidance on positional accuracy (See EPA *National Geospatial Data Policy*). In the absence of published program guidance on positional accuracy tiers to meet specific program needs, the following Interim Quality Categories provide benchmarks for establishing quality controls based on the intended use. Data collections for Category I use would dictate more stringent quality controls and potentially higher accuracies than Category IV use. See Section 2 "GPS QA Project Plan Requirements" for additional background on Interim Quality Categories.

Category I: For enforcement, litigation, direct support of rules & regulations, projects of national significance and highly influential scientific assessment

Category II: Development of rules & regulations and influential scientific information

Category III: Validation, general applications and feasibility studies

Category IV: Screening, exploratory and pure knowledge

From the discussion above, some distinct survey objectives may include:
- Registration of remotely sensed photography or imagery with ground control locations to support enforcement actions.
- Evaluation of locational data quality of existing data to validate survey maps, and
- Collection of new data following precise coordinates in a monitoring plan to support rule development.

NOTE: On a case-by-case basis, the user should consider the impact of various factors when determining the appropriate QA Category. These factors include, but may not be limited to:
- National Geospatial Data Policy (NGDP) Accuracy Tiers
- Dwell Time
- Number of Monuments, etc.
  QA categorization of Dilution of Precision (DOP) is provided as a suggestion/example below – section (7) Equipment Testing and Logistics.

(2) Define Project Area

This step is designed to establish the overall project area and define the limits of the survey. Maps and/or aerial photos should be utilized extensively to familiarize the crew with the area prior to the actual field work. For identifying the study area and surrounding environment, 7.5-minute topographic maps are ideal. For locating particular sites by address, a local street map will be required. A complete understanding of the transportation network in the project area will also enable the field crew to maximize the effectiveness of their field time. Much of this information may already be available in digital form and may be used directly in conjunction with GPS site planning as well as validating the capture of the GPS locations.

(3) Determine Observation Window and Schedule of Operations

This step involves determining the precise window of satellite availability and scheduling accordingly. With approximately 31 GPS satellites and 9 GLONASS satellites available for use, satellite links generally are restricted for very short periods of time (usually less than 40 minutes in a continuous block of time and less than 1 hour during a 12-hour time period) during the day, in open environments. However, in cities with many nearby tall buildings, GPS signals may be difficult to receive. Updated satellite configuration and orbit information can be accessed via the Internet. "Trimble Planning Software" from Trimble Navigation is an easy-to-use software program which provides information critical to the various components of planning a GPS survey: satellite availability, elevations, azimuths, and Geometric Dilution of Precision (GDOP) calculations. However, there are many other easy to use software programs to assist users in updating. Some sites may be specifically designed for desktop, laptop, or handheld devices. Site sources and URLs may change frequently, therefore, users are encouraged to find the best site for their hardware and purpose, and ensure that the source of update is recorded in a notebook. For differential corrections against a base station, the rover must "see" the same satellites as the base. Accuracy is heavily dependent upon the amount of observation time and number of observations taken at each point. It is generally agreed that observation time can be reduced by increasing the quality of observation, i.e., observing a maximum number of satellites during viewing periods.

NOTE: "Trimble Planning Software" [2.74 (.zip file)] can be downloaded from http://www.trimble.com/planningsoftware_ts.asp

Download and install "Installation Program for Planning" software. Download the GPS-satellite almanac from Trimble GPS Data Resources.

If you are in an area with obstructions, select File-Station and click obstacles to enter the elevation and azimuth to define the obstruction. You should then be able to display the DOP relating to that location to better plan your survey. If you are occupying multiple stations at the same time, use File – Multistation in addition to defining the information for each station.

(4) Establish Control Configuration

For high accuracy work, generally sub-meter range, known control points and/or benchmarks should be located for both horizontal and vertical control. This is usually accomplished by researching the records of various federal, state, and local agencies such as the National Geodetic Survey (NGS) or the state geodetic survey. It is advisable to have, if possible, at least two control points each for both vertical and horizontal positions so that there is a double check for all control locations. Vertical accuracy is typically half of the horizontal accuracy. Any additional control points may be done by using centimeter GPS. NGS benchmark information can be obtained at http://www.ngs.noaa.gov.

NOTE: When high accuracy readings, such as sub-meter range, are required for a project, such as a Category I, the user must have substantial technical know-how, perhaps high-end GPS hardware and definitely advance preparation. For the Category I project types, users may consider contracting for professional land surveyor services. Data obtained by non-certified personnel may be inadmissible in litigation. Project Officers are encouraged to contact their local Office of General Council for consultation regarding concerns of admissibility.

It is important that the reference datum within which the monument is located be defined. For horizontal coordinates, the North American Datum of 1927 (NAD 27) or the newer Datum of 1983 (NAD 83) will be specified. For vertical control coordinates, the National Geodetic Vertical Datum of 1929 (NGVD 29) or the new North American Vertical Datum of 1988 (NAVD 88) will be referenced. If the NGS has redefined the benchmark coordinates to correspond to the newer datums, coordinates will be available for both datums. In translating GPS elevations to vertical elevations, the geoid used should be identified. http://www.esri.com/news/arcuser/0703/geoid1of3.html; http://www.ngs.noaa.gov/GEOID/

(5) Select Survey Locations

Obtain a list of the facilities or features targeted for data collection. One suggested approach is to organize the site lists alphabetically by city and alphabetically by street name within each city as well as by zip code. This approach will facilitate initial route planning to visit each survey location and serve as a master list. If possible, plot the general location on a field map and highlight a local street map to serve as a general navigation aid. Similarly, project personnel should also plot potential base stations to serve as control points on a 7.5-minute topographic map and local street map. The survey points/areas should have continuous and direct line-of-site to the path of the satellites in the sky.

If the survey point to be obtained is located on private property, care should be taken to pursue appropriate notification and access protocol. This includes preparation of a letter of introduction and formal contact with the property owner/manager.

(6) Coordinate Pre-Survey Plans

The Field Team Leader should contact the GPS Coordinator to identify and discuss the following items prior the GPS survey:

- **Objectives**. Objectives of the survey, particularly Data Quality Objectives since DQOs will highlight required data accuracies (sub-meter, 1-5 meters) and in turn, dictate the type of equipment needed.
- **Identification**. Identification of the numbers of features to be mapped and time allotted for the survey.
- **Availability**. The availability of the GPS equipment for the required dates.
- **Features**. What features will be mapped, sample point location identification, and how they should be represented (points, lines, areas).
- **Checklist**. A checklist of each feature to be mapped so that none will be overlooked in the field.
- **Site Maps**. Site maps for determining survey location with the identification features to be mapped and mapping sequence.
- **Reconnaissance.** Determine the presence of any obstructions to satellite signals such as buildings or tree canopies.
- **Data Format and Storage**. Data capture requirements and data format to facilitate post-processing at the conclusion of the survey.

(7) Equipment Testing and Logistics

Action items for equipment testing and logistics include determination of equipment availability (laptop PDA, GPS units, and transport vehicle), checking equipment for necessary repair and maintenance (batteries charged in PDA and GPS unit, laptop or PDA loaded with necessary software and map data), and ensuring that the receiver is functioning properly. Operation manuals provided by the vendor should be referenced to complete system checks on the equipment.

Modern GPS units contain many settings that can serve as quality checks during data acquisition. For instance, a minimum number of visible satellites can be specified for data acquisition. The unit will provide a warning signal if less than the minimum specified are available. Four satellites in view are the minimum required, but additional satellites can provide the receiver with stronger signals to select from and perhaps better geometry for calculation. GPS receivers can also calculate a DOP value for horizontal (HDOP), for time (TDOP) and general position (PDOP). Position Dilution of Precision (PDOP) is most often referenced with lower values leading to more accurate measures. PDOP values of 6 or less are generally acceptable and limits on PDOP can be programmed into the unit or software that interfaces with the receiver. See table titled DOP Values in Relation to Data Quality Categories below:

NOTE: The Quality Categories in the following table are *suggested.* Project impact or other factors may supersede the information in the table.

DOP Values in Relation to Quality Categories

DOP Value	Rating	Description	Suggested for Quality Category
1	Ideal	Highest possible confidence level.	I
2 - 3	Excellent	Meets all but most demanding needs.	I or II
4 - 6	Good	Appropriate for most needs.	II, III, or IV
7 - 8	Moderate	For less demanding uses. Positional measurements could be used for calculations, but the fix quality could still be improved. A more open view of the sky is recommended.	IV
9 - 20	Fair	Low confidence level. Positional measurements should be discarded or used only to indicate a very rough estimate of the current location.	Not recommended
> 20	Poor	Very low confidence level. Measurements are inaccurate by as much as half a football field and should be discarded.	Not recommended

Once the equipment is tested, the team can collect and pack the field survey equipment. In addition to the above items, experienced crews carry everything from a compass and tape measure to manuals, almanac printouts and first aid packs.

(8) Prepare the Quality Assurance Project Plan

Upon conclusion of the planning and coordination in items (1) through (7), the Field Team Leader will be in position to develop the QA Project Plan. Requirements for the preparation of the QA Project Plan are stated in *EPA Requirements for Quality Assurance Project Plans*, EPA QA/R2, March 2001 (Reissued May 2006). Additional guidance for developing a Geospatial QA Project Plan is found in Section 2.

b. Survey Execution. The actual GPS survey consists of:

(1) Establishing a Schedule of Operations

This step involves determining the window of satellite configuration availability and scheduling the GPS sessions. The schedule is dependent on the size of the crew, the level of accuracy desired, and the logistics of setup and travel between control points. Maximum data quality and collection efficiency can be obtained by arranging data collection periods to coincide with periods of 3-D or better satellite visibility.

(2) Pre-Survey: The Day Before

Plan to arrive at the field site the day before the survey. Charge all batteries, make note if GPS unit(s) can be charged through the automobile. Many GPS collection systems utilize a battery system which requires either 8-hour or overnight charging. Review the travel routes to survey sites and base stations, if required, and coordinate with local personnel. Review use of unfamiliar equipment and understanding of procedures.

(3) Pre-data Collection: Establishing a Base Control Station(s)

The type of survey will dictate if any base control stations in the field are required. If required and the location(s) is not secure or if the data collection period is particularly long, part of the survey crew may be required to remain at the site. Logistical considerations will need to be scheduled, i.e., shut down periods for downloading files, changing battery packs, and when to terminate collection. Once a setup at a base station begins, the GPS units will need to be initialized. Depending upon the location and familiarity with equipment, this activity can take anywhere from a few minutes to a couple of hours.

(4) Data Collection: Performing the GPS Survey

The crew must warm up, check, and program the receiver for proper operation. Most vendors currently recommend collecting fixes for discrete point data for a period of 3-5 minutes, at 1- or 2-second intervals. Vendor documentation should be consulted for the recommended time on station and sample interval to obtain the most accurate results.

Depending on the unit being utilized, sufficient battery power must be available. For high accuracy work, the receiving antenna should be leveled on a tripod and centered exactly over the control point location. Log sheets containing critical information on position, weather, timing, height of instrument, and local coordinates must be maintained. Once the session is completed, the receiving equipment must be disassembled and stored. The log and tape files should then be documented and saved. If the survey to be performed will span numerous days, it is likely that the data will be transferred from the GPS to a laptop PC with some regularity. Data from the base station as well as the roving unit will need to be collected with equal frequency.

c. Data Assessment, Processing and Validation. Post-processing should be conducted after returning from the field. Tools for post-processing are more easily used and controlled in an office environment. The common steps in post-processing are transferring the data from the field to office workstations, conducting the initial stages of processing, computation of the solutions for critical factors, data conversion for use in a GIS, and the final documentation and reporting. Each of these stages is discussed in detail below. Data assessment and validation should integrate in each stage.

(1) Data Transfer

There are currently two common methods of collecting data in the field: using a GPS unit with a data logger or using a GPS unit attached to a laptop/notebook/PDA computer. With the latter method some users subsequently perform all processing directly on the same device. More commonly, data are transferred into a computer. This consists of reading the raw data from the GPS unit into a structured data base for processing. As with any computer data, backup copies should be made immediately. Validation should consist of reviewing the contents of the data logger or computer file against the survey plan and field notes to ensure that the data transfer has occurred properly and that file and directory names are adequate to link the data to specific field operations or features.

(2) Data Assessment and Initial Processing

The electronic GPS data stream may not be immediately useable. It normally consists of satellite navigation messages, phase measurements, user input field data and other information that must be transferred to various files for processing before computations can be accomplished. Depending upon the hardware and software vendor, many of these operations are transparent to the user.

In some instances, depending on the type of maintenance and upgrades that are going on to the NAVSTAR constellation at the time of the survey, utilization of the actual ephemeris rather than the ephemeris projected prior to the survey date may improve solution accuracy. Actual ephemerides are available 2 weeks after a given survey date.

In the data screening and editing, there are at least three considerations that might be taken in editing. Outlier position data can be removed from a data file. This editing should be guided by establishing an absolute deviation threshold, using the mean coordinate as a reference. The threshold criteria might be varied to determine the sensitivity of the solutions to this editing. Data points collected immediately after a break in the data stream, such as in the event of masking, should be edited out because these positions will be less reliable.

The majority of processing operations are typically performed “automatically” by the application software. Occasionally, the scientist (or operator) may need to override automatic computer operations. In these instances, scientist (or operator) should document the judgments made and identify the manual operations in the appropriate notebook.

(3) Computation

This component uses the preprocessed data to compute the network of sites and give a full solution showing geographical coordinates (latitude, longitude and ellipsoidal height), distances of the vectors between each pair of sites in the network, and several assessments of accuracy of the various transformations and residuals of critical computations. This is usually accomplished by the vendor post-processing software and may be transparent to the user.

(4) Data Conversion to GIS

Data conversion is accomplished by use of data export utilities provided by the GPS vendor. These utilities should accompany the data processing software packaged with the GPS equipment. Example formats are: ArcView, ArcGIS, dBase, ASCII, MapInfo, AutoCAD, etc. Before exporting, ensure that the correct coordinate system and datums are chosen. The default coordinate system should be the Geographic Coordinate System which provides unprojected latitude/longitude values. The default datum is NAD83 for horizontal coordinates and NAVD88 for vertical coordinates. Note that GPS units initially capture data using the WGS84 horizontal datum but can be usually converted to the NAD83 datum during the data export process. Care should be taken in reporting the proper datum upon completion of the conversion process.

(5) Metadata Documentation and Reporting

The documentation requirements for spatial data are established in the Agency's *Geospatial Metadata Technical Specification v. 1.0*, November 2007. This data specification draws elements from both the EPA Geospatial Data Policy and the Federal Geographic Data Committee's (FGDC) Content Standard for Digital Geospatial Metadata, and identifies metadata elements that EPA views as essential in properly documenting geospatial metadata.

The reporting of spatial information and metadata is addressed in EPA's *National Geospatial Data Policy* and EPA's *Geospatial Metadata Technical Specification, Management*, Version 1.0, November 2, 2007. A Metadata Editor Tool has been developed by EPA to simplify the documentation process. The aforementioned documents and tools are available for download from EPA's GeoData Gateway at http://geogateway.epa.gov. Other tools are under development such as the GeoToolkit to facilitate reporting geospatial data to EPA via EPA's Central Data Exchange (CDX). Spatial data submitted to the Exchange will be loaded into EPA's Locational Reference Table for use by EPA, EPA partners and the public. Access restrictions can be specified in the metadata.

4. References

FGDC-STD-001-1998, *Content Standard for Digital Geospatial Metadata*, Federal Geographic Data Committee, June 1998.

FGDC-STD-007.1-1998, *Geospatial Positioning Accuracy Standards Part 1: Reporting Methodology*, Federal Geographic Data Committee, June 1998.

EPA *Latitude Longitude Data Standard,* Standard Number EX000017.2, January 6, 2006. http://www.epa.gov/edr/LatLongStandard_08112006.pdf

EPA, *National Geospatial Data Policy*, Office of Environmental Information, August 2005. http://www.epa.gov/irmpoli8/ciopolicy/2121.pdf

EPA, *Geospatial Metadata Technical Specification v. 1.0*, November 2, 2007. http://geodata.epa.gov/docs/EPA_Geospatial_Metadata_Technical_Specification_v1_11_2_2007.pdf

EPA, *Guidance for Geospatial Data Quality Assurance Project Plans (QA/G-5G)*, March 2003 http://www.epa.gov/nerlesd1/gqc/pdf/g5g-final.pdf

EPA, *Global Positioning Systems – Technical Implementation Guidance,* Revision 2, Office of Environmental Information, October 2006. http://www.epa.gov/oei/pdf/GPS-TIG.pdf

Attachments: Attachment 1, GPS Pre-Survey Checklist

Attachment 1
GPS Pre-Survey Checklist

Pre-Survey Checklist

______ Obtain List of Facilities
______ Obtain Current GPS-Satellite Almanac
______ Call Coast Guard to Verify Satellite Availability
______ Obtain Control Points from NGS or Local Source
______ Obtain 7.5-min. Topographic Maps
______ Obtain Local Street Maps
______ Prepare Letter of Introduction
______ Collect and Pack Field Equipment

Field Equipment

______ GPS Equipment
______ Laptop or Other Field Computer
______ 7.5-min. Maps
______ Aerial Photo if Available
______ Camera [Digital cameras that can synchronize the images with the latitude / longitude field data are recommended]
______ Film [or Memory Stick]
______ Compass
______ Tape Measure
______ Binoculars
______ Field Forms
______ Clip Board
______ Calculator
______ GPS Hardware/Software Manuals
______ Mini Tape Recorder
______ Hard Copy of GPS-Satellite Almanac
______ Rain Gear
______ Two-way Radio Communication (i.e., CB, cellular phone, etc.)

Last Minute Checks

______ Charge Batteries
______ Verify GPS-Satellite Almanac
______ Target Travel Route

In the Field Checks

______ Find Base Stations
______ Initialize Equipment
______ Begin Collecting Data

Section 2

GPS Quality Assurance Project Plan (QAPP) Requirements

Table of Contents

1. **Purpose:** This Quality Assurance Project Plan (QAPP) Template is designed to provide an outline for typical Global Positioning System (GPS) data acquisition operations in a field environment. It is intended for use as guidance by those who plan and carry out GPS data acquisition projects on behalf of the EPA. The GPS QAPP Template as presented below may be tailored to match the particular requirements of approved Quality Management Plans (QMPs). Tailored templates may then be used repeatedly to provide quality management planning for similar GPS data collections.

2. **Background:**

a. EPA QA Policy

The root QA document, from which other QA documents applicable to the collection and disposition of GPS data are based, is EPA Order 5360.1 A2 (2000), *Policy and Program Requirements for the Mandatory Agency-wide Quality System*, and EPA Manual 5360 A1 (2000), *EPA Quality Manual for Environmental Programs*. These documents cover environmental data,[2] including any field or laboratory measurements or information that describes location and information compiled from other sources, such as data bases (e.g., georeferenced data) or the literature (maps), under their requirements. Three of the applicable requirements are:

- The use of a systematic planning approach to develop acceptance or performance criteria for all work covered by the EPA Order. See Section 3.3.8 of the EPA Quality Manual for Environmental Programs, and Section 3 of this SOP;

- The approval of Quality Assurance Project Plans (QAPPs), or equivalent documents defined by a division or office QMP, for all applicable projects and tasks involving environmental data with review and approval having been made by the EPA QA Manager (or authorized representative defined in the QMP); see Chapter 5 of the EPA Quality Manual for Environmental Programs; and

- Assessment of existing data, when used to support Agency decisions or other secondary purposes, to verify that they are of sufficient quantity and adequate quality for their intended use.

b. EPA QA/QC Requirements and Guidelines. Key documents for use in developing spatial QAPPs include *EPA Requirements for Quality Assurance Project Plans (QA/R-5),* March 2001 (reissued May 2006), and the *Guidance for Geospatial Data Quality Assurance Project Plans (QA/G-5G)*, March 2003. The latter document is a useful guideline devoted to the technical aspects of GPS field measurements and forms much of the basis for this attachment.

c. Uniform Federal Policy for QA Project Plans. The Uniform Federal Policy for QA Project Plans (UFP-QAPP) is a consensus policy voluntarily adopted by the sponsoring federal agencies. It is used primarily for the evaluation of federal facilities and will be phased into EPA operations over time. This attachment does not specifically address the content or structure of the UFP-QAPPs,

[2]Environmental data – any measurements or information that describes environmental processes, location, or conditions, ecological or health effects and consequences or the performance of environmental technology. For EPA, environmental data included information collected directly from measurements, produced from models, and compiled from other sources such as data bases or the literature.

although is noted that the UFP-QAPPs contain the same four major groups discussed below. See URL http://www.epa.gov/fedfac/documents/qualityassurance.htm for additional documentation.

3. Spatial QA Project Plan Considerations:

a. Components of a QA Project Plan

- **Group A. Project Management.** The elements in this group address the basic area of project management, including the project history and objectives, roles and responsibilities of the participants, etc. These elements ensure that the project has a defined goal, that the participants understand the goal and the approach to be used, and that the planning outputs have been documented. Group A elements include:

  A1 Title and Approval Sheet
  A2 Table of Contents
  A3 Distribution List
  A4 Project/Task Organization
  A5 Problem Definition/Background
  A6 Project/Task Description
  A7 Data Quality Objectives and Criteria
  A8 Special Training/Certification
  A9 Documents and Records

- **Group B. Data Generation and Acquisition.** The elements in this group address all aspects of project design and implementation. Implementation of these elements ensures that appropriate methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are employed and are properly documented. Group B elements include:

  B1 Collection Process/Field Survey Design
  B2 Data Collection Methods
  B3 Data Handling and Custody
  B4 Analytical Methods
  B5 Quality Control
  B6 Instrument/Equipment Testing, Inspection, and Maintenance
  B7 Instrument/Equipment Calibration and Frequency
  B8 Inspection/Acceptance for Supplies and Consumables
  B9 Nondirect Measurements/Secondary Data Use
  B10 Data Management

- **Group C. Assessment and Oversight.** The elements in this group address the activities for assessing the effectiveness of project implementation and associated QA and QC activities. The purpose of assessment is to ensure that the QA Project Plan is implemented as prescribed. Group C elements consist of:

  C1 Assessments and Response Actions
  C2 Reports to Management

- **Group D. Data Validation and Usability.** The elements in this group address the QA activities that occur after the data collection or generation phase of the project is completed.

Implementation of these elements ensures that the data conform to the specified criteria, thus achieving the project objectives. Group D elements consist of:

D1 Data Review, Verification, and Validation
D2 Verification and Validation Methods
D3 Reconciliation with User Requirements

b. Graded Approach. The "graded" approach to developing QA Project Plans increases efficiency in that QA Project Plan elements are planned to be commensurate with the scope, magnitude, or importance of the project itself. Simple, straightforward data collection tasks would require simple, straightforward QA Project Plans and plan elements.

The EPA Quality Staff has left the use of the graded approach to the discretion of those implementing it. To facilitate the application of the graded approach, the use of QA Categories is recommended. The following definitions were developed from existing QA Category definitions being used in various parts of the EPA Office of Research and Development.

Examples of Graded QA Project Plan Elements			
QAPP Element	**Description**	**Simple QA Project Plan**	**Complex QA Project Plan**
A.3.c	Sat. Observation Window	Not Calculated	Calculated
A.3.d	Control Configuration	Use DOP Settings	Differential Correction
A.5.a	Data Quality Objectives	$\geq$ 10 Meters	< 10 Meters
A.5.b	Receiver Performance	PDOP $\leq$ 6	PDOP $\leq$ 4
A.5.c	Statistical Quality Control	Based on Method	Based on Testing
B.1.b	Sampling Locations	Single Location	Multiple Locations
B.2	Sampling Methods	Standard Operations	Tailored Operations
B.5	Quality Control	Standard QC Checks	Extended QC Checks

Category I: For Enforcement, Litigation, Direct Support of Rules & Regulations, Projects of National Significance, and Highly Influential Scientific Assessment

The results from Category I activities may directly and/or immediately support specific Agency rule-making, enforcement, regulatory, or policy decisions. This category may also include research of significant national interest, such as tasks that might be monitored by the Administrator. It may also include technology transfer projects for which the data and/or the research by which the data were obtained may be critical to the award of a patent or other important commercial or legal decision. Category I tasks require the most detailed and rigorous QA and QC activities to ensure both legal and scientific defensibility, and will likely require chain-of-custody. This means that the data quality objectives (DQOs) and data quality assessments, if required for the project, must be specific (or quantitative) and that the extensive quality documentation must include all key measurements. This category includes projects that fit the Office of Management and Budget (OMB) peer review definition of "highly influential scientific assessment."

NOTE: Project Officers are encouraged to contact their local Office of General Council during the planning stage of the project.

Category II: Development of Rules & Regulations, and Influential Scientific Information

Category II activities are of high programmatic relevance that, in conjunction with other ongoing or planned studies, is expected to provide complementary support of Agency rule-making, regulatory, or policy decisions. Chain-of-custody may be required for some projects in this category; however, good recordkeeping practices always apply. For example, projects providing data measurement technology effectiveness that may be used by a Program Office, but that were not intended for use in enforcement. The rigorous standards of Category 1 are not necessarily needed or appropriate, although thorough quality documentation must be described and developed over the course of the project.

Category III: Validation, General Applications, and Feasibility Studies

Category III activities provide demonstration or proof of concept projects. Category III activities include method validation studies. Chain-of-custody may not be required for this category; however, good recordkeeping practices always apply. Small pilot studies, methods development (sampling or analytical), process engineering evaluations, etc., that fall into this category require flexible approaches; considerable latitude is allowed with respect to the format. Quality documentation initially must be described, but may be changed and further developed over the course of the project.

Category IV: Screening, Exploratory, and Pure Knowledge

Category IV activities are basic, exploratory, conceptual projects to study basic phenomena or issues. This includes the characterization of naturally occurring mechanisms.

c. Generic vs. Project-Specific QA Project Plans. QA Project Plans can be either generic or project specific. Generic QA Project Plans are typically used for simple data collections that rely on logistically simple, repetitive field methods, the same equipment, post-processing techniques and straightforward data verification and validation methods. As an example, the establishment of field base stations for GPS differential corrections increases the complexity and would dictate a project-specific QA Project Plan. Because generic QAPPs are used repetitively, they are typically approved periodically rather than project by project. SOPs used to support the generic QAPP should be attached to the QAPP.

d. Enforcement Considerations. For GPS surveys where data may be presented as evidence during legal proceedings, certain recordkeeping procedures are necessary in order to protect the integrity of the data as evidence. The recorded information must be sufficient to recall and describe observations and measurements made as well as document the life cycle of the data that is used in final products such as reports or court exhibits. Records must be identifiable and secured in a manner such that they can be retrieved. Records can include information recorded in logbooks, checklists, electronic media, data bases, and digital documents. Important information contained in records include: who conducted the GPS survey, data post-processing, and data management; chronological information related to the data regarding creation, processing, use, and archival; methods used in collecting, processing, distributing, and archiving the data; who had access to the data throughout the life cycle of the data; and where the original data and records reside.

Chain-of-custody procedures apply when the record of transfer and receipt of samples, data, documents, or other evidence is required. Chain-of-custody is a record of accountability that clearly identifies the personnel directly in contact with the evidence. The chain-of-custody procedures vary for each organization; however, it is important that the procedures are followed in order to maintain the integrity of the evidence. Examples of situations where chain-of-custody procedures apply to GPS data include activities related to criminal investigations, confidential business information (CBI), attorney-client privileged information, grand jury rule 6(e) information, and national security information (NSI). Refer to the appropriate evidence management procedure for your organization for specific requirements on the handling and custody of GPS data and derived products.

4. QA Project Plans – Quality Management Plans – GPS Template

- **Division and Office Quality Management Plans.** All EPA organizations should have developed their own tailored Quality Management Plan (QMP). The QMPs may describe the organization's approach to quality management and identify many of the specifics about timing, reporting, resources and approvals. Therefore, in developing QA Project Plans based on the following template or other guidance, the author should be completely familiar with the QMP for their division and incorporate the division or office policies where appropriate.

- **Use of the GPS QAPP Template.** The following template was designed for point data collections which are the most common surveys. Surveys to collect polygon or line data would require additional modifications in the template. Text in blue font should be replaced with appropriate text in regular font.

Enclosure GPS QAPP Template

Section 3

GPS Quality Assurance Project Plan (QAPP) Template

Template Source:

This template was derived from EPA *Guidance for Geospatial Data Quality Assurance Plans*, EPA QA/G-5g, March 2003 [EPA/240/R-03/003] and tailored for point data collections which are the most common surveys. Surveys to collect polygon or line data would require additional modifications in the template.

Please refer to EPA QA/G-5g for definitions, more detailed guidance, clarifications, etc.

Template Use:

Text in blue font should be replaced with appropriate text in regular font. Each organization should also modify the document control notation located in the upper right-hand corner.

GPS QUALITY ASSURANCE PROJECT PLAN

[Title of QAPP Here]

Division: ____________________________

Branch: ____________________________

Section: ____________________________

Creation Date: [Date original QAPP finalized]

Revision #: [Number of revision]

Date Revised: [Date of last revision]

Review Cycle: [Applicable to generic QAPPs]

Project Summary: [Provide a brief 1 or 2 sentence summary]

APPROVALS

______________________________	_______________
Lead Author(s) of the QAPP, Title Office Name	Date
______________________________	_______________
Program Office Approving Official	Date

This QA Project Plan is consistent with EPA requirements.

______________________________	_______________
Quality Assurance Manager	Date

[Title of QAPP Here]

TABLE OF CONTENTS

Section

[Title of QAPP Here]

A. Project Management

1. Project Distribution List

_______________, QA Manager
_______________, Project Manager
_______________, QAPP Writer / Field Team Leader
_______________, GPS Coordinator
_______________, GPS Operator
_______________, GIS Coordinator

2. Project/Task Organization

The following individuals and organizations will participate in the project. Their specific roles and responsibilities are listed in the table below. The Approving Official exercises supervision over the Project Manager and QAPP Writer. The QA Manager is independent of the Approving Official, Project Manager, and QAPP Writer. The QA Manager ensures that QA Project Plan is consistent with USEPA requirements.

Name	Organization	Role
		Approving Official
		QA Manager
		QAAP Writer
		Maintains QAPP Documents
		Project Manager
		GPS Coordinator
		Field Team Leader
		GPS Operator
		Data User

3. Problem Definition/Background (See SOP, Section 1, 3a. Pre-Survey Planning)

a. Objectives of the Survey. (State the Objectives of the Survey)

b. Project Area. (Attach Overview Map and describe Project Area)

c. Observation Window and Schedule of Operations. (State overall schedule)

d. Control Configuration. (Applicable for high accuracy collections)

4. Project/Task Description

Task	Output	Outcome	Schedule
Example Tasks Follow	Edit & Add as Appropriate		
Develop Pre-Survey Plan	Pre-Survey Plan	Understand the Survey Parameters	5 Days
Develop QA Project Plan	Approved QA Project Plan	Quality Assured Project Implementation	3 Days
Coordinate Pre-Survey Plans	Meetings and Survey Planning Products	Identification and resolution of issues	3 Days
Equipment Testing & Quality Checks	Log of Testing & Quality Checks	Calibrated & Tested Equipment per OEM Manual	2 Days
Safety Briefing for Field Crew	Safety Checklist	Understand Risks and Proper Safety Measures	2 Hours
Move to Field Location	Travel Logs	Safe Arrival at Field Survey Site	Variable
Data Collection	Field & Data Logs	GPS Data Backed up on Laptop Computers	Variable
Move to Home Location	Travel Logs	Safe Arrival at Home Location	Variable
Data Assessment & Processing	Data in GIS Electronic Format	Quality Assured Data in Proper Format	2 Days
Data Documentation	Metadata Record in Proper Format	Data Documented per EPA Guidelines	4 Hours
Internal Data Review	Approval Record	Approved Locational Data for Distribution	Variable
Publish GPS Data to Locational Reference Table (LRT)	Transaction Record for Data Submission	Data Forwarded to LRT for Secondary Data Users	2 Hours
Develop Final Project Report	Approved Final Project Report	Document & Understand Project Results	Variable

5. Quality Objectives and Survey Measurement Performance Criteria

a. Data Quality Objectives. The GPS survey will utilize the [Brand, Model] receiver in the GPS Code, Standard Position Mode to obtain facility latitude/longitude values within 10 meters of true locations at the 95% confidence level. This level of accuracy is consistent with Tier 3 described in the EPA National Geospatial Data Policy.

b. Receiver Performance Criteria. The [Brand, Model] will be set to capture data provided that at least four satellites are in view and the Position Dilution of Precision (PDOP) value remains at 6 or below. The receiver will be set to provide audible or visual warnings when the quality settings are exceeded. Sample interval and time on station will be consistent with [Brand, Model] Manual recommendations. Generally, this will require 3 minutes on each station sampling at 2-second intervals.

c. Statistical Quality Control Check. Post-processing the GPS data will be accomplished using the vendor's software package operating on a local workstation. The higher end software package will perform statistical analyses on the point data downloaded from the GPS receiver. For 10-meter data accuracy, any data points with a standard deviation of 3 meters or more will be a basis to exclude that data point from the collection. Ideally, the standard deviation for 10-meter accuracy data should be 1 meter or less at the 95% confidence level.

6. Training/Certification

a. Training. In addition to field safety training, the GPS Operator must complete a general GPS course, become familiar with the receiver's Operation Manual, and test the receiver under real operating conditions for familiarity with all receiver settings, options and operations prior to actual field use.

b. Certification. Not applicable.

7. Documentation and Records

Documentation consists of the outputs described in section A.4 above. The GPS Coordinator is responsible for development of the metadata documentation. The Project Manager is responsible for developing the Final Project Report which will reference the planning and performance documents. The documents will be maintained and managed per EPA Records Management Guidelines. The QA Manager will maintain a copy of the approved QA Project Plan and any amendments.

B. Measurement Data Acquisition

1. Sampling Process Design

a. General. Discuss the overall approach to the data acquisition survey in terms of the purpose of the survey, the number of locations to visit, the operational area (refer to map to discuss operational area), equipment, timing and team composition.

b. Sampling Locations. Discuss the sampling locations in detail concerning the measurement sites (e.g., Main Entrance, Receiving Dock, Sub-Facility), need for access clearance if appropriate, and control points if applicable. Establish a data dictionary and a list of site attributes to be collected. Identify any checklists.

2. Sampling and Image Acquisition Methods. Discuss the equipment to be employed, the time on station and sample interval, receiver settings and mode of operation. Discuss the data logs and attribute documentation methods (date recorded, time recorded, and correction status). Identify any checklists. Identify corrective action steps should the receivers fail or malfunction in the field.

3. Sample Handling and Custody. Discuss the method for protecting the data and establishing a verifiable record of collection, post-processing and reporting the data. If supporting an enforcement matter or other sensitive situation, discuss any special recordkeeping provisions that apply in collecting, processing and reporting the data, such as chain-of-custody and computer security.

4. Analytical Methods. The GPS unit samples multiple satellite signals within its line of sight and internally processes the signals using triangulation algorithms to produce latitude/longitude and altitude values for the station under evaluation. The GPS unit is capable of storing the latitude/longitude and altitude values along with other relevant GPS data, including the internal unit settings. Record the GPS make/model information to ensure that triangulation algorithm and other analytical methods can be traced through the manufacturer if necessary.

5. Quality Control. Quality Control will be achieved by assuring that the GPS receiver performance criteria under section A.5 above are met at all times. Statistical checks will be performed on the data during the post-processing phase and the data will be compared to known map coordinates and features using TIGER/Line files, USGS topographic maps, the Tele Atlas data base and other appropriate map sources of known quality.

6. Instrument/Equipment Testing, Inspection, and Maintenance Records. Equipment testing will be accomplished by the GPS Operator prior to, during and after field use. Built-in equipment diagnostics and functionality checks will be utilized in accordance with the operation manuals. Results will be reported in pre-survey, field and post-processing logs. Issues will be documented with the GPS Coordinator or equipment owner.

7. Instrument Calibration and Frequency. GPS receivers cannot be calibrated. However, a number of settings can be changed (maximum PDOP, signal-to-noise ratio, filter coefficient, etc.) which will affect operation of the unit. In general, manufacturer default settings will be employed for optimum data accuracy.

8. Inspection/Acceptance Specifications for Supplies and Consumables. The primary consumables for GPS operations are batteries. During the equipment testing, inspection and maintenance periods, batteries will be examined by the GPS Operator for functionality, charge and compatibility with manufacturer's specifications. Fully charged, backup batteries will be taken to the field for use when recharging is not an option.

9. Nondirect Measurements. The display of survey results will be accomplished by overlaying the collected points on map features of comparable quality. This provides a road network, topographic features and other map elements that can place the collected points in the

context of real-world features. This is an additional quality check, since large deviations from expected locations would cause the data and processing methods to be rechecked. Standards map products of known quality will be used.

10. Data Management

a. Data Dictionary. (Define program-specific terminology)

b. Data Collection Process and Quality Checks. See sections A.5.a and A.5.b above.

c. Data Processing. Post-processing is described in section A.5.c above.

d. Metadata Preparation. Metadata preparation will be accomplished by the GPS Operator upon conclusion of the data processing phase using the EPA, *Geospatial Metadata Technical Specification v. 1.0*, November 2007.

e. Data Acceptance and Documentation Process. The Project Manager will prepare a Data Acceptance Report with an overlay map showing new data collected in the context of standard map features (roads, streams, political boundaries) and forward it to the Approving Official for review and approval. The Project Manager is also responsible for developing the Final Project Report which will reference the planning and performance documents (see Outputs, section A.4 above). The documents will be maintained and managed per EPA Records Management Guidelines. The QA Manager will maintain a copy of the approved QA Project Plan and any amendments. (Option – Data Acceptance may be combined with the Final Project Report to eliminate a separate report)

f. Data Storage, Access and Security. Data storage, access and security will follow the procedures described in EPA National Geospatial Data Policy sections.

C. Assessment/Oversight

In all assessment and oversight issues, the individual(s) making assessments and implementing actions must be identified in the appropriate records.

1. Assessment and Response Actions

Type Assessment	Results	Corrective Action
Project Objectives by Project Manager	Complete / Incomplete / Partial	Redo or Amend Project Objectives
Equipment Testing by GPS Operator	Pass / Fail	Repair or Replace
Data Completeness by Project Manager	Stations Sampled vs. Planned Sampling	Revisit Site or Amend Project Objectives
Data Quality Objectives by GPS Operator	Data Meets / Does Not Meet DQO	Exclude Questionable Data Points
Performance Criteria by GPS Operator	Met / Did Not Meet Performance Criteria	Exclude Questionable Data Points
Statistical Quality Checks by GPS Operator	Met / Did Not Meet Standard Deviation	Exclude Questionable Data Points
Map Overlay Against Known Locations by GPS Operator	Good / Poor Fit Against Known Locations	Recheck Acquisition and Processing Steps

2. Reports to Management

Report	Content	Frequency
Project Status Report by Project Manager	Status of Tasks in Section A.4 above	Bi-Weekly Updates
Data Acceptance Report by the GPS Operator	Data Collection, Quality Check Results and Processing Results	Once Upon Completion
Final Project Report by Project Manager	Summary of Project Accomplishments	Once Upon Completion

D. Data Validation and Usability

1. Data Review, Validation, and Verification Criteria

Data Element	Reviewed By	Validation Criteria
Coordinate Data	Project Manager	Consistent with Sampling Process Design
Coordinate Data	GPS Operator	GPS Mode Matches Field Log & GPS Internal Data
Coordinate Data	GPS Operator	Default Settings Match GPS Internal Data
Coordinate Data	GPS Operator	Standard Deviation below 3 Meters for Acceptance
Coordinate Data	GPS Operator	Good Fit when Data Plotted against Known Locations
Coordinate Data	GPS Operator	Meets National Map Accuracy Standards
Metadata	Project Manager	Meets EPA Guidelines for Metadata Documentation

2. Verification and Validation Methods

Data Element	Validation Method
Coordinate Data	Compare Sampling Process vs. Field Log and Internal GPS Log
Coordinate Data	Compare GPS Planned Mode vs. Field Log and Internal GPS Log
Coordinate Data	Compare Manufacturer Default Settings vs. Internal GPS Log
Coordinate Data	95% of Coordinate Points fall within National Map Accuracy Standards when overlaid on known quality map features of similar accuracy

3. Reconciliation with User Requirements

The GPS Survey results and products will be evaluated against the Data Quality Objectives established and user requirements to determine if any reconciliation is needed. Reconciliation concerning the quality, quantity or usability of the data will be reconciled with the user during the data acceptance process. Types of reconciliation may include reduction in the scope of the project in terms quality or quantity of data produced in meeting partial user requirements.

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