SARASOTA COUNTY
"Dedicated to Quality Service"

Sarasota County Government

GPS Procedures Guideline

SCGIS
GIS Solutions that
Improve Government Services

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. Overview

This document was designed to be used by Sarasota County Government. It was created to assist project managers in understanding what techniques and considerations should be taken into account during GPS data collection. In order to help project managers choose a suitable GPS technique, some GPS techniques will be reviewed and the pros and cons of each method will be weighed to determine how they can affect the overall performance of a project. The document is organized as follows:

?? **Section 2: Methods of GPS Data Collection.** This section presents applicable GPS techniques and discusses accuracy considerations and equipment concerns for each technique.

?? **Section 3: Considerations Affecting Data Accuracy**. This section discusses the necessity of a control network, control sampling, data redundancy, quality assurance/quality control (QA/QC) procedures, and data organization.

?? **Section 4: Field Procedures**. This section provides the methods and approach necessary for field data collection. This includes logistical concerns, control observations, and daily production logs.

?? **Section 5: Office Procedures**. This section presents how to bring field data into the office. This includes downloading it from field computers; checking and preserving the data; and office guidelines for editing, review, and final formatting.

2. GPS Data Collection Methods

2.1 GPS Techniques

Three GPS survey techniques are discussed in this section:

?? Autonomous GPS

?? Real-Time Differential GPS (RTD)

?? Real-Time Kinematic GPS (RTK)

2.1.1 Autonomous GPS

Autonomous GPS survey techniques simply record the position of a person who is using a GPS receiver. The position that the GPS receiver captures is accurate within +/- 20 meters, so it is only useful for navigation purposes.

To obtain GPS positions that are suitable for survey or mapping grade purposes, a positional correction is needed to supplement the autonomous GPS position. One GPS receiver is used as a base station and is positioned over a known control monument. Knowing the actual position of that receiver, the error in the autonomous GPS position can be calculated. A more accurate position can be obtained by either post-processing the GPS data in the office, or by broadcasting the data through a radio link to a roving GPS receiver. By broadcasting the corrections, the roving receiver can view accurate data real-time.

2.1.2 Real-Time Differential (RTD) GPS

Real-time differential (RTD) GPS is a survey technique that uses either a government-established base station that broadcasts corrections or a subscription to a private satellite service must be obtained.

In the state of Florida, the US Coast Guard's navigation beacons are typically used since the entire state is covered by a number of beacons. In coastal lands and inland states where the US Coast Guard's beacons aren't available, a subscription to a private service is required.

Figure 1. RTD GPS

The antenna that is used in the RTD equipment combines the GPS antenna and a differential correction antenna in a single housing. This allows the users to have a convenient, lightweight GPS package that fits inside of a small backpack. The Coast Guard and private satellite subscription services offer mapping-grade horizontal positions that are typically +/- 3 feet. Accurate vertical data is not available when using RTD methods.

2.1.3 Real-Time Kinematic (RTK) GPS

Real-Time Kinematic (RTK) GPS is similar to RTD in that a base station broadcasts positional corrections to a roving GPS receiver. The primary differences are that the base receiver is established by the user, and the range, or distance, of the corrections is much more limited. In order for the user to use the RTK technique, the user must establish a base station, a rover and a communication link between them. Unlike RTD, where a user simply operates a roving receiver and receives corrections automatically, additional equipment, personnel and training are required to ensure that the RTK technique will be successful. The rewards for using this technique, however, are greater horizontal accuracy and accurate elevations can be obtained. The accuracies obtained are typically +/- 0.20 feet horizontal and vertical.

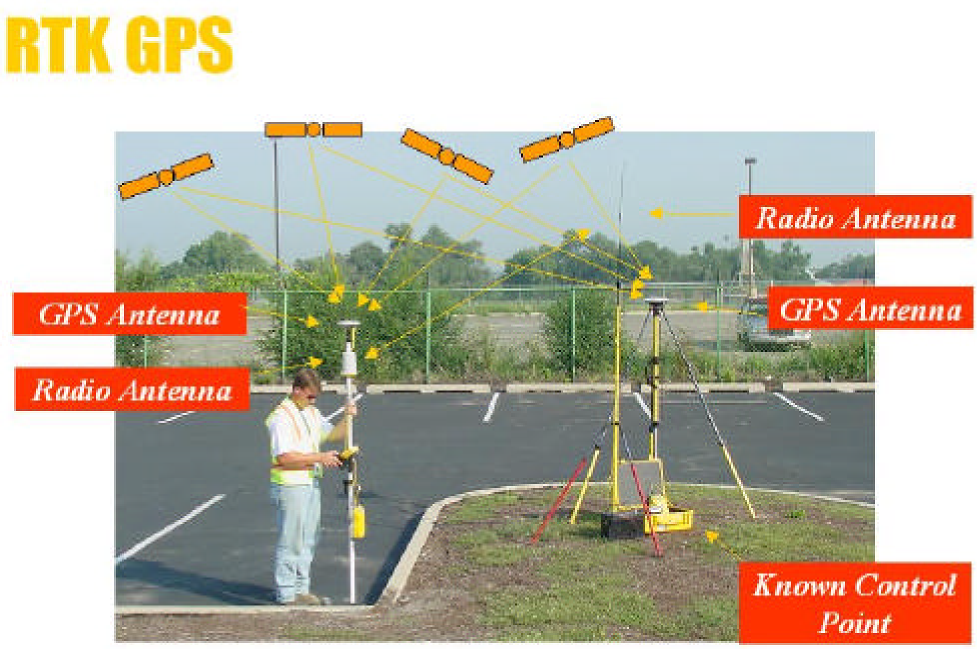

Figure 2. RTK GPS

2.2 LEVEL OF ACCURACY

Before choosing a GPS technique, the accuracy needs of the project need to be analyzed. Factors that are considered during this analysis include:

?? What is the purpose of the resulting data?

?? Will the data be used for multiple purposes?

?? What are the horizontal and vertical requirements of the project?

The answers to these questions will determine whether to use the RTK or RTD techniques. The benefits of increased accuracy from the RTK techniques must be balanced with the increased costs and time requirements. RTK surveys are more time consuming and logistically more complex than the RTD techniques. Additionally, RTK surveys require more resources and equipment. However, RTK techniques provide accurate horizontal and vertical data that can be used for multiple applications.

2.3 EQUIPMENT/HARDWARE CONCERNS

There are certain hardware or equipment requirements that greatly increase the quality and production of GPS data collection. Some requirements are technique-specific and greatly affect the planning and approach to the data collection. Depending on the GPS technique deemed necessary for the project, additional preparation, equipment and personnel may be required.

2.3.2 Power Sources and Power Issues

With large data collection projects, power sources and battery life are large concerns. Power issues can cause lost production and down time. An adequate number of batteries are necessary to supply enough power for daily field collection. If the number of field crews are working concurrently, an ample supply of batteries need to be purchased and a means of charging them on a daily basis needs to be established.

If a system of replenishing power sources is not in place and followed aggressively, field data collection will come to a halt. This will adversely affect delivery schedules and project costs.

2.3.3 Cables

GPS positioning techniques require numerous cables to connect the equipment to peripherals and power. While GPS equipment is made to be rugged, the cables that connect the equipment cannot withstand some of the same conditions that the equipment is subjected to.

If the cables are not properly prepared, they can be the weakest part of the data collection process. Stocking and providing spare cables is essential in maintaining production and avoiding downtime. Each GPS field crew should have access to a replacement cable for each type of cable being used in the GPS equipment set up. This ensures that a field crew does not lose production due to a faulty cable.

2.3.4 RTD– Beacon Coverage/Satellite Subscription

If data is collected with RTD techniques, a differential correction service must be available. If no public differential correction service is available, then a subscription to a private service must be arranged. Throughout the entire state of Florida, the US Coast Guard beacon is available.

2.3.5 RTK - Base Station Requirement

If data is to be collected using the RTK technique, additional equipment and personnel are required. Because the RTK technique requires the user to broadcast corrections to the roving GPS receiver, a base station must be established and either secured or manned for protection. The RTK technique also requires significantly more equipment than the RTD method. In addition to the roving GPS receiver, a base GPS receiver, GPS antenna, radio modem with amplifier and radio antenna are required. Also, a significant supply of power is required to power the base GPS receiver, radio modem and amplifier for a full day's production. Usually, a deep cycle 12-volt marine or tractor battery is used. All of these requirements factor into the extra costs associated with the RTK technique.

3. Considerations That Affect Data Accuracy and Integrity

For large data collection projects, the volume of data can quickly become overwhelming. Certain steps must be taken in order to ensure the accuracy or quality of the data. Otherwise, the project manager may have a volume of data that is inaccurate and meaningless.

Steps that are required to ensure relevant and accurate data include

?? Having a reliable control network

?? Control sampling on a daily basis

?? Repeat observations, office QA/QC

?? Consistent data organization.

3.1 Control Network

Having a reliable network of horizontal and vertical control points is essential in making certain GPS positions collected are correct. The magnitude, densification and accuracy of this network depends in part on which GPS technique is chosen. For the RTD method, the network only needs to consist of horizontal control points and needs to be large enough to cover the limits of the project. But for the RTK method, the network not only needs to cover the project limits but also needs to be dense enough to allow for a control point every few miles and each control point needs to contain horizontal and vertical data. In some instances, existing networks may have to be supplemented to meet the needs of the particular project.

3.1.1 System of Check Points with the RTD Method

The control network with the RTD method requires only horizontal points that serve as checkpoints during data collection. The network with RTD does not need to be overly dense. Instead, the network should be expansive enough to ensure that checkpoints exist throughout the project limits.

3.1.2 Network of Base Stations with the RTK Method

For the RTK method, the control network should consist of control points with known horizontal and vertical coordinates. And unlike the RTD method, this network needs to be much more accurate. This network serves as a system of checkpoints and as a network of base stations from which positional corrections will be broadcast.

The network must be expansive and dense enough to make sure that the correction broadcasts cover the entire project area. This may be a large cost addition because control networks may need to be established or existing networks may need to be supplemented.

3.2 FIELD QA/QC OBSERVATIONS

Field observations are necessary to verify the accuracy of the equipment and the procedures that are used for the data collection. This is accomplished by taking observations on existing control points in the network and then by obtaining repeat observations on features throughout the project. These techniques allow for a confirmation of accuracy of the data that is being collected. By obtaining redundant observations, the precision of the data can be verified.

3.2.1 Control Observations

With a control network in place, it is imperative that each field crew, each day, verifies control points during their data collection. Each data file that is submitted must have observations on the control network. This typically means that a field crew will position two or three control points per data file. Each control point is positioned three times with new GPS initializations between each measurement. This ensures proper results in case of a bad observation. Office personnel can then analyze, document, and confirm the validity of the GPS positions in each data file that is submitted to the database.

3.2.2 Redundancy

A good practice, along with control checks, is to take repeat measurements on features throughout the project. This practice confirms data consistency from day to day and from data file to data file.

Each data file should contain repeat measurements on data in another data file or from another field crew. The idea is to "overlap" the data files so that office personnel can document and confirm accurate, consistent data collection throughout the project.

3.3 GPS ERRORS AND SETTINGS

The scope of this document does not include an in-depth review of GPS and how it works. However, this section presents some important factors concerning GPS errors and settings so that a project manager can be aware of and understand any potential errors. Much GPS information can be obtained from the Internet and through books and professional magazines. Equipment vendors also have information readily available. Additionally, project managers must ensure that GPS users are properly trained with the equipment.

3.3.1 GPS Errors

There are a number of errors associated with GPS. Most of these errors are accounted for in the equipment or in the GPS vendor's software. The most prominent error that the GPS user will experience is multipath. Multipath is a range delay in the GPS signal and is the result of the reflection of that signal. This error occurs when part of the signal from the GPS satellite reaches the receiver after reflecting from the ground, a building, or another object. One or more of these signals can then interfere with the signal that reaches the receiver directly from the satellite.

There are to ways to avoid multipath errors.

?? The GPS user must be aware of and avoid any structures that are near the antenna (such as traffic signs, large trucks, and buildings) and use a GPS antenna ground plane whenever possible.

?? The GPS user must set a cutoff or mask angle for the GPS signal. This is done using the GPS software settings and will be discussed in the next section.

Other factors that cause GPS errors:

?? Overhead obstructions: Tree cover and tall buildings limit the amount of open sky visible to the GPS antenna. This will decrease the amount of data the antenna is receiving from the satellites.

?? Antenna measurements: The correct antenna height is crucial for accurate GPS data. Errors in height measurements, plumbness (making sure the antenna is truly vertical) and centering (making sure the antenna is centered over the feature being positioned) will cause GPS measurements to be inaccurate.

3.3.2 GPS Settings

All vendors' software packages have an option to adjust the GPS receiver settings. The project manager should follow the manufacturer's guidelines, or the client's guidelines if they are provided. Sarasota County Government GPS Settings and Accuracy Guidelines are included in this document in Appendix B.

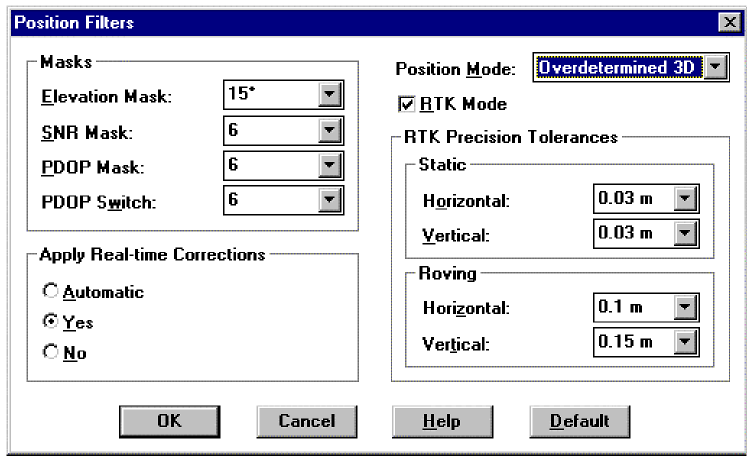

Figure 3. Position Filter Settings

Usually, the settings have default values that are identical to the manufacturer's recommended settings. Settings that GPS users must be aware of are:

?? The minimum number of satellites

?? PDOP settings

?? SNR values

?? Position filers

?? The carrier phase settings

?? The logging settings (minimum number of epochs and required precision)

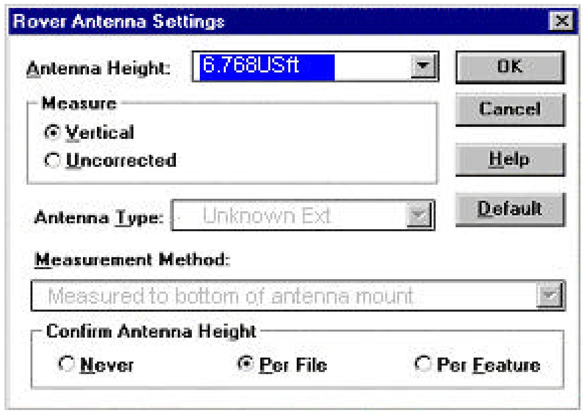

Figure 4. Antenna Settings

For display purposes and for real-time position information, GPS users should properly set the display coordinate system. Also, if the RTK method is being used and elevations are being measured, users must be aware of the antenna height settings. If the antenna height is not set properly, every position collected with the GPS will have an incorrect elevation.

3.4 Data Organization

Raw data that is downloaded from the field must be downloaded to the same location on a computer or network, and the data must be frequently backed up. Before the data is run through QA/QC procedures, it should be copied and placed onto the office technician's computer.

After the QA/QC procedures have been run on a dataset, the dataset should be copied back to the server. However, it must be in a different location than the original raw field data.

Aggressively following these procedures is valuable and necessary for successful data collection.

3.5 QA/QC Process

Quality assurance and quality control steps begin while the data is being collected in the field and continue after the data has been downloaded to the office computer.

The data is checked for completeness pertaining to the volume of data and the attribution of the data. Accuracy is checked and verified.

Field and office personnel share QA/QC steps. Steps between the field and office personnel often overlap so that there is a built-in double-check of the QA/QC procedures. Following is the recommended three-step approach.

3.5.1 Field QA/QC

An important component of field QA/QC procedures is to develop a Field Procedures Manual so that each GPS user and crew member performs the data collection in the same way. This manual should include the requirement to use a data dictionary and it should also define standard pick lists to ensure uniform feature attribution. The manual should also include the GPS software settings that are required so that all GPS users follow the same settings.

Additionally, providing the field crews with the means of charting their production is essential. Frequently, the features being collected have original source documentation, or there may be geographic maps of the area in which the features reside. It can be beneficial to provide these maps to the field crews so that they can mark the features that have been located. This can prevent costly return trips to collect features that were originally overlooked.

3.5.2 Initial Office QA/QC

Data accuracy and completeness must be verified and documented after the data is downloaded to the office computer.

The procedures that field crews practice provide office personnel with assurances and checks to validate the data. After download, the data must be scanned and compared to the source documents for completion and attribution. Office personnel must also check and compare the control point observations and the repeat observations. If any concerns or questions arise, field crews may have to return to the project site to investigate or pick up missing features. After data is confirmed, complete, and accurate, these check sheets must be documented and saved in the project files.

3.5.3 Final Office QA/QC

The last step in office QA/QC procedures is to export, adjust, format, and package the data for final delivery. A final export of the checked data is to place it into a spreadsheet. The data is adjusted to remove control observations and repeat points. The data is formatted to remove inconsistent entries, corrected comments for spelling, abbreviations, and punctuations. After the data is clean and uniform, it is exported to a text file for insertion into the GIS.

4. Field Procedures

The approach for field data collection follows a typical path, no matter the size or scope of a project. Before the actual data collection can begin, a good amount of preparation must happen. The background files for the field computer must be created, the control network needs to be in place, and the features and subsequent attribution must be established.

Throughout the data collection process, procedures should be in place to document field activities and to establish a consistent data transfer process.

4.1 Field Crew Preparation

4.1.1 Background Files

In order for field crews to begin data collection, any useful maps or source documentation available, needs to be organized and copied. Planimetric files that contain basic parcel and right-of-way information are good examples of maps that can aid in navigation and field QA/QC. Providing the crews with these maps will allow them to chart their production, ensuring that there will be no gaps in the data collection coverage. Many data collectors can store waypoints, coordinates of a feature or position that the user may want to navigate to. These coordinates can be used to help with navigating to control or repeat points.

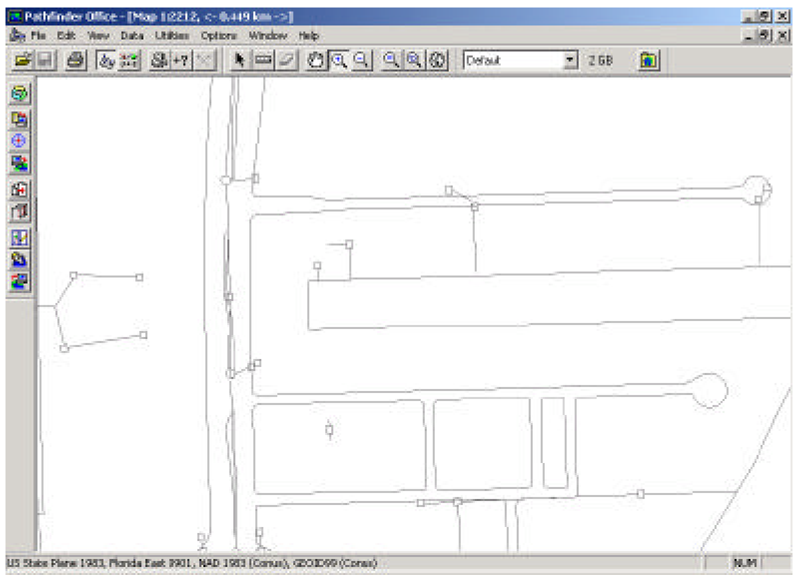

Figure 5. Planimetric Background File

4.1.2 Control Network

Section 3.1, Control Network discusses the importance of a control network for the data collection process. If an existing network is being used for the project, field crews need to recover the control points in the network as well as determine whether the network covers the entire limits of the project site. Control points must be suitable for GPS. If the control points within the network are to be used as base stations for an RTK survey, these points must be in a suitable location to setup the GPS equipment.

Oftentimes, existing control points are located within rights-of-way, bridge abutments, or under a tree canopy. These locations do not accommodate the GPS equipment necessary for a base station. It may be necessary to supplement an existing network by adding control points or adding elevations to existing horizontal control points. And for some projects, a new network may need to be created. A sufficient amount of time must be planned for to set new control points, reference the points, prepare location sketches, and to position the points. A report should be prepared that lists the final coordinates of the control points within the network and it should include the location sketches, descriptions on how to reach the control points, the adjustment results, and statements referring to the network accuracy.

4.1.3 Feature and Attribution Lists

Table 1. Features and Attributes Defined in Data Dictionary

Water Features						
Attribute	**Fire Hydrant**	**Hydrant Valve**	**Water Valve**	**Air Release Manhole**	**Well**	**Monitoring Well**
Inventory Class	??	??	??	??	??	??
New	??	??	??	??	??	??
Notes	??	??	??	??	??	??
ID	??	?	?	?	?	?
FH Type	??	?	?	?	?	?
Sewer Features						
		Air Release Manhole				
Inventory Class	??	??	??	??	?	?
New Location	??	??	??	??	?	?
Notes	??	??	??	??	?	?
ID	?	?	?	??	?	?
Storm Features						
Attribute	**Inlet**	**Storm Manhole**	**Outfall**			
Inventory Class	??	??	??	?	?	?
New	??	??	??	?	?	?
Notes	??	??	??	?	?	?
Inlet Type	??	?	?	?	?	?
Flag	??	??	??	?	?	?
Other Features						
Attribute	**Control Stations**	**Repeat Points**	**Other**			
Inventory Class	??	??	??	?	?	?
ID	??	?	?	?	?	?
Notes	?	??	??	?	?	?
Feature Type	?	??	?	?	?	?

When a data collection project begins, some questions that a project manager must address are:

?? What features are to be located?

?? What feature attributes are to be recorded?

When the field crews know what to collect, the data collection software can be used to create a data dictionary. A data dictionary provides the field crews with a pre-defined feature list and partially automates the data collection process. When a feature is positioned, a menu opens and provides a list of the attributes that are to be collected. Typically, attribute lists are pull-down menus that show all possible choices for the attribute values. After the attributes have been populated, the feature is saved to the collection file.

4.2 DATA COLLECTION PROCEDURES

An important early step of the data collection process is to produce a Field Procedures Manual. This manual is essential to establish a logical and consistent approach to data collection. It serves as instructions for the field personnel for QA/QC procedures, informs them of the features to locate, notifies them of the specific location on a feature in which to take the GPS position, and provides them with instructions to setup and maintain the GPS equipment and GPS settings.

4.2.1 Base Station Procedures (RTK Only)

The RTK survey method requires a base station to broadcast real-time corrections to the roving GPS receiver. Setting up and verifying the base station settings are the first procedures that the field crews follow. Once the base station is setup, field-crew members verify the settings in the base GPS receiver and enter the coordinates for the base control point. The control point that is used and the coordinates that are entered into the base receiver should be documented in the daily field log.

After the base station is up and running, each field crew sets up their rover packs and turn on the power to verify that they are receiving corrections. Additionally, it is recommended that field crews set a checkpoint near the base station to serve as a final check. This final check is to verify that the base is operating and outputting correctly. By following these procedures, it is unlikely that crews will have to return to the base station because of improper setup.

4.2.2 Control Observations

Each field crew should observe horizontal and vertical control points in each data file. These observations serve as another check to ensure the base station has been set up properly and that the real time corrections received by the roving unit are accurate. Typically, field crews will pick up control points at the beginning and end of a data collection session.

4.2.3 Data Collection

Data collection can begin once the data dictionary is created. The delivery schedule and the size of the project generally determine the process of data collection. Usually, data is organized in square mile segments that are arranged according to the sections in the Public Land Survey System (PLSS). For large projects, multiple deliveries of groups of sections are usually established. Data collection should proceed so that there are no data gaps in each of the sections. This is important when dealing with multiple field crews. Clear communication needs to occur between crews to prevent data gaps in the collection coverage areas. A delivery area is not designated as complete until the office QA/QC is performed. Crews may be sent to the field after the office QA/QC to locate stray features that were not collected.

4.2.4 Repeat Observations

Field crews should observe repeat observations on features that were previously positioned throughout the data collection effort. This provides redundancy in the data collection effort so that office personnel have data for statistical analysis. Office personnel use the redundant data to determine whether measurements are consistent. Field crews should look for features that were positioned in a different data file as well as features that were positioned by different field crews if multiple crews are working on the project. Often, the features that are along the perimeters of each of the square mile sections will be collected twice to guarantee complete coverage and also to provide repeat data for office QA/QC.

4.3 DOWNLOADING/DOCUMENTING/EQUIPMENT CHECK-IN

4.3.1 Downloading Data

Transferring data from the field computers to the office network or computers is a critical step in the data collection process. Numerous people are involved from start to finish. When there is the possibility of more than one person being involved in downloading data, procedures need to be in place to control the data file management. Consistency is the key to good file management. Steps such as the following enable confidence in file management:

?? Downloading to the same folder location

?? Managing directory structures consistently

?? Preserving and backing up the unedited raw data files

?? Verifying file transfers before removing data from the field computers

Deleting a file from the field computer before it has been transferred is one of the costliest errors that can happen during the data transfer process. Downloading field data is just the first step in a much larger process of data management.

4.3.2 Daily Field Logs

A powerful tool in the process of maintaining smooth data collection is a daily field log. This log should include:

?? The date of field activity

?? The number of crews

?? The names of the files that were logged

?? The areas that were worked

?? Base station information

?? Notes and comments

A simple daily listing of the files can be helpful. But adding pertinent information such as the technical details of the base GPS receiver setup can prove invaluable if questions are raised concerning the data accuracy.

4.3.3 Check-in Equipment/Prepare for Tomorrow

When data collection is ended for the day, it is important for the field crews to organize their equipment and assign responsibilities to individual crews members to account for equipment, check that batteries are being charged, and to check that faulty cables or GPS equipment are replaced. If a methodical approach to the equipment check is not established, a production loss can occur because of a lack of preparation.

5. Office Procedures

Before data collection beings, office procedures are necessary to prepare the project for data collection. Additionally, crews must be provided with the tools to complete the project.

After data has been collected in the field, it is transferred to the office and becomes the responsibility of the office personnel. When the data is transferred to the office, it must be protected, checked, and preserved. This is a critical stage in the data collection process, especially for large data collection efforts. Office procedures that edit or modify the field collected data, run the greatest risk of corrupting or further more, deleting that data. Steps must be put in place to make sure that raw field data is preserved and isolated from final data that is prepared for delivery to the GIS.

5.1 Office Preparation Procedures for Data Collection

To start data collection, office personnel will determine what features are to be collected and the attribution to obtain. Then, a data dictionary is created with pick lists to standardize data collection.

A daily almanac should be obtained to determine maximum satellite availability for optimum performance. The RTD Unit can do this internally. The RTD Unit requires equipment software.

Also, a data collection plan must be determined. Office personnel design a delivery schedule and set delivery area designations. These delivery areas must be formalized as all source information is to be organized according to this delivery structure. Office personnel need to prepare field crews by collecting, organizing, and uploading source information as well as navigation and planimetric map files. Hard copies of schedules, delivery areas, and control points should also be provided to the field crews.

5.2 Office Procedure After Data Collection

After data collection begins, office personnel is responsible for:

?? File management

?? Data checks and assurances

?? Preservation of the integrity of the data

5.2.1 File Management

Just as field collection crews have the responsibility to transfer their data consistently, office personnel have to manage that data consistently as well. The data that is downloaded should be left unmodified. Rather, the data should be copied into another directory so that it can be checked and edited (QA/QC). The raw data should reside on a network or specific computer and should be backed up onto a CD regularly. The edited data should reside on a specific computer that will be used to check the data and should be copied to the network frequently. Eventually, the QA/QC data should be backed up onto a CD as well. Keeping two sets of data, edited and unedited, guarantees that none of the original data will be lost due to blunders in QA/QC. The biggest concern is to make sure that there are not multiple versions of QA/QC data. With a large project containing a lot of features, this could lead to a lack of confidence in the delivered data and can serve to disrupt delivery schedules.

5.2.2 Initial QA/QC Process

A primary goal of the initial office QA/QC is to ensure that the data is accurate and complete. The field data is checked for gaps in the coverage area and then it is checked for complete attribution. An attribution check verifies that all attribute entries for each feature have been assigned or populated. Finally, the data is analyzed for accuracy. Repeat positions and control checks are compared to confirm accurate data.

5.2.2.1 Data Completeness

Downloaded data can be checked for completeness by scanning the data for coverage gaps in features collected by comparing the collected data to the original source documents (if applicable) and for gaps in attribution of the features collected.

Downloaded data is generally checked using the GPS vendor's software. You can graphically display the positioned features against the scanned images of the source documents or against planimetric map files. This lets office technicians verify and document the areas in which data collection has been completed. The software should allow the technicians to browse the attribution of each feature and confirm that all attribution has been addressed.

Office personnel then need to determine whether there are any missing features or attribution to obtain or to clean up. Typically, hard copies of the source files and background information are plotted. Office personnel mark these sheets for missing or incomplete features. Then, they instruct the field crews of their assignments for the next day of field collection.

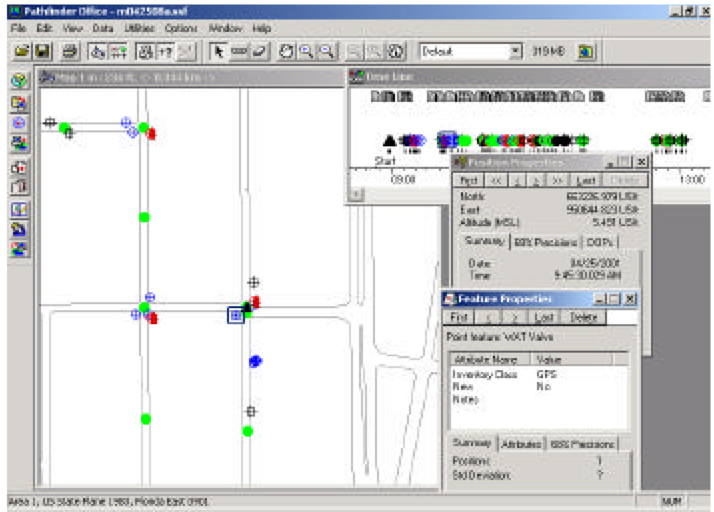

Figure 6. Checking Data for Completeness

5.2.2.2 Data Accuracy

Once the data is checked for completeness, it can now be checked for its accuracy. The control "checks" and "repeat points" can now be examined. Typically, spreadsheet software is utilized to compare the data and to calculate statistical results. The comparisons should be analyzed to make sure the data meets the desired accuracy requirements of the project. Any outliers should be flagged and checked. If there is a pattern of bad data then a field crew needs to be sent to recollect all or a portion of that data to determine the cause of the inaccuracies.

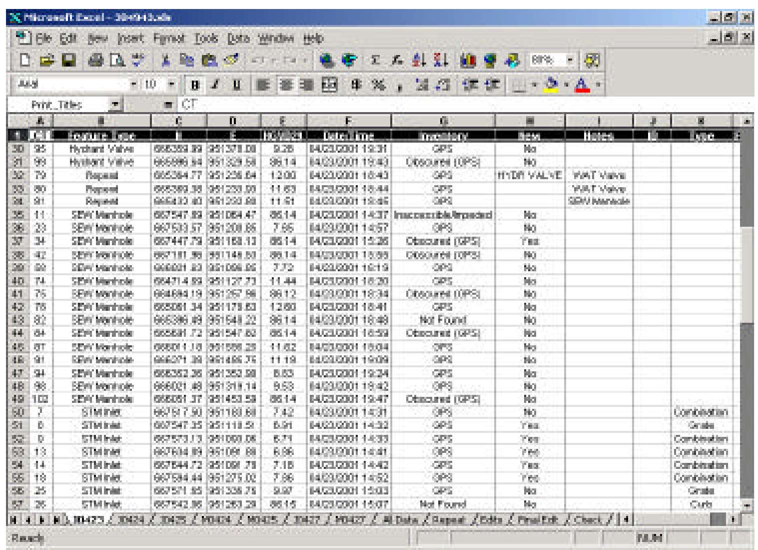

Figure 7. Checking Data Accuracy

After the data is checked for completeness, it is then checked for accuracy.

5.2.3 Final QA/QC and Data Integrity

After the data is complete and accurate, it is exported. Then hardcopies are printed. Any edits or modifications should be noted on hardcopy in case questions arise.

Hardcopy of the spreadsheets should be made as well and backed up with the QA/QC data. Passwords should be required to access the spreadsheets to ensure the information is preserved.

Final data should be adjusted, formatted, and printed and immediately backed up.

These office procedures serve to confirm the data's integrity. Field data collection is expensive and vulnerable to handling by office personnel. Keeping the data organized and consistent is the first step to ensuring data integrity. Additionally, office personnel must document all edits, modifications, and analysis results and include those documents in the project files.

APPENDIX A

RTK Base Station Log Sheet

Project Name: ____________________ Julian Day: __________ Job Number: _______-_____-_______

Local Date: _______________

Receiver Number: ____________

Receiver Type: 4000 SSE/SSI, 4700, 4800 Antenna Type: Compact, GR/PL, Micro Centered

Antenna Height: (2.063M) ______

Reference Position

Station Name: ________________

Latitude: ______? ______' __________________ N

Longitude: ______? ______' _________________ W

Ellipsoidal Height: ____________________ M

Crew #1: ____________________ Section:______________ File: ________________

Notes:____

____

____

____

Crew #2: ____________________ Section:______________ File: ________________

Notes:____

____

____

____

____

____

APPENDIX B

Suggested Sarasota County Technical Details

Autonomous GPS

?? Accuracy is better or equal to 30 meters horizontal

?? Applications: General location of features that do not require high accuracy.

?? Training needs: A brief introduction to GPS concepts. No specialized equipment training is needed.

?? Minimum number of satellites: 4

?? Maximum PDOP: 6

?? Recommended PDOP: <4

Mapping Grade (Single Frequency Code Differential) GPS for GIS

?? Accuracy is better or equal to 1 meter horizontal

?? Applications: Accurate collection of features for use in a GIS.

?? Training Needs: An introduction to GPS and GIS concepts. Vendor specific training is needed.

?? Minimum number of satellites: 5

?? Maximum PDOP: 6

?? Recommended PDOP: <4

?? Recommended minimum number of positions per feature:

  ?? Point feature - 30 positions

  ?? Line feature - 2 positions

  ?? Polygon feature - 3 positions

?? Real-Time Status: Always on (log only Real-Time positions)

?? Data Dictionary: Must be completely composed prior to the start of data collection effort. The Data Dictionary should NOT be changed once data collection has begun.

?? Rover file management: Rover files should not be re-opened or added to. Rover files should not span more than 1 day of data collection.

Survey Grade (Dual Frequency Carrier Phase Static & RTK) GPS

?? Accuracy is better or equal to 1 cm horizontal

?? Applications: Surveying

?? Training Needs: A detailed explanation of GPS concepts and processing techniques. Specific training is needed for the type of GPS equipment used.

?? Minimum number of satellites: 5

?? Maximum GDOP: 6

?? Recommended GDOP: <4

?? Maximum CQ: 0.2

?? Recommended CQ: <0.1

?? Recommended Redundant Measurements: 2 with at least 60 minutes difference.

?? Maximum Static Baseline: 20 miles

?? A Florida Registered Professional Survey and Mapper must supervise GPS crew. Follow instructions given in your GPS equipment's Operation Manual.

FDEP SPATIAL DATA ACCURACY LEVELS

Accuracy Level	Accuracy Expectations	Typical Applications	Methods Available
Level 1	+/- 0.01 meters	?? High Accuracy Reference Network ?? Vertical Topography	?? GPS, Integer resolved, carrier processed, differential
Level 2	0.01 to 1.0 meters	?? Ground Control for photo and digital mapping ?? GPS controlled Aerial photos ?? Parcel or Right-of-Way mapping ?? Mapped data in cooperation with local governments ?? Mapping Jurisdictional wetlands	?? GPS, Integer resolved, carrier processed, differential, lower order traverse ?? GPS 3-D code phase real-time and post processed carrier smoothed psuedo-range differential corrections
Level 3	1.1 to 10 meters	?? Point, line, polygon feature delineation ?? 3-D real time navigation GPS (horizontal)	?? GPS 3-D differential code phase
Level 4	11 to 20 meters	?? 1:24,000 DLG ?? 2-D real time navigation GPS ?? 2-D post process GPS routing	?? GPS low quality data, 3-D post processed and real time ?? GPS 2-D post processed and real time differential corrections