



Procedures for Georeferencing Inventory Field Sample Plots Using GPS Technology



**Resources Inventory Branch
Ministry of Forests
722 Johnson Street
Victoria, B.C. V8W 9C2**

March 31, 1998

Notes

This document is a simplified version of the previously published document “MoF Standard Procedures for Georeferencing Field Sample Plots Using GPS Technology” (hereinafter called the Procedures). It is a “how-to-do” procedure manual designed specifically for the inventory audit and Vegetation Resources Inventory (VRI) GPS programs. For complete detail standards, procedures, terms and acronyms, the reader must consult the Procedures.

For the purpose of this document, the following terms are often used:

1. Field data collector: The person responsible for GPS data collection.
2. Data processor: The person responsible for processing the GPS data. It will be the Ministry of Forests, Resources Inventory staff, or designated contract person..

A target accuracy (i.e. maximum positioning error) is set at 10 meters horizontal and 15 meters vertical at the 95 percent confidence level for georeferencing inventory sample plots using GPS. Coupling with other error sources, such as mapping error (about 20 meters), and compass/chain traversing error (about 20 to 30 meters), the final location error, i.e. distance between the actual plot location and the intended map location, could be 40 meters which could be used as a threshold value for acceptance/rejection of sampling data.

This document is divided into the sections shown below.

1. GPS Field Data Collection Procedures
2. GPS Data Processing and Presentation
3. The Check List for GPS Project Management
4. Trimble GeoExplorer Operation Procedures
5. Standard Form for Submitting GPS Field Data

For any questions, suggestions, and comments concerning the GPS data collection, please contact the Inventory Technical Applications Section, Resource Inventory Branch at the following address:

Xiaoping Yuan, Ph.D., R.P.F.
PO Box 9516, 722 Johnson St.
Victoria, B.C. V8W 9C2
Telephone:(250) 953-3626, Fax. (250) 387-5999
E-mail: xiaoping.yuan@gems9.gov.bc.ca

Section 1 GPS Field Data Collection Procedures

The following is an overview of the procedures to collect GPS data

Point Feature

The tie point and at least one plot center pin for each sample plot are the point features that shall be measured for their locations using GPS. The tie point must be clearly identifiable from both the map or photo and from the ground. If it is not possible, any significant nearby land marks such as road intersections, creek junctions, etc. shall be measured with GPS as substitute GPS tie points.

Observation

GPS observations shall be attempted immediately when arriving at the point features. If positioning is difficult, proceed other work and attempt again. Every effort must be made to collect the data, however if data cannot be collected due to problems in receiving the signal this will be acceptable. Data collector must record all necessary information (crew id, sample id, point type, approximate time of measurements, etc.) and document the possible reasons if GPS data is not collected.

Offset

GPS data must be collected directly over the point feature to be surveyed wherever possible. If it is not possible, an offset position shall be surveyed with GPS. The offset distance and azimuth **from the GPS antenna to the point feature to be surveyed must be measured** with a sighting compass and nylon tape. The maximum offset distance allowed is 50 m (horizontal). Any offset distance over 25 m must have the compass azimuth observed both forward and backward (with the averaged forward azimuth being recorded). The offset information (forward azimuth, slope distance and vertical angle) is to be recorded on the field cards comment section in the following format:

GPS offset :Slope dist: 12.4m @ 030^o, vertical angle + 8^o

Bearings must be accurate to 2 degrees, and distances to 1 meter.

File Names

The name for each point feature GPS data file must be in the following format:

ABBCD

Where	A	Project Description: TFL number (e.g. 99) or TSA number (e.g. 08)
	BB	Sample number (e.g. 23)
	C	Sample type descriptor V = Volume Age or I = Immature
	D	Location Type Descriptor T= Tie Point, or Number 1 to 9 = plot number

Note that default file name convention for Trimble GPS receivers is also acceptable.

- A separate “**GPS field summary card**” must be completed for a each sample where GPS data was collected. The card (compass note card) should contain the following minimum information: **file name (from above), offset information (if collected) and comments. The cruise tally card (comments section) should note if GPS data is collected.**

Measurement

Each point feature must be observed with a GPS receiver for no less than 300 seconds with at least 200 position fixes (at 1 second logging interval) during that period. If satellite tracking is difficult, it shall be a minimum 150 seconds with at least 50 position fixes.

GPS Equipment

The data collector must ensure that all the field GPS equipment is properly maintained and operational (e.g. batteries are charged; receiver space is cleared; configuration is correctly done; etc.). The data collector must ensure that GPS data is downloaded properly each day, and storage and back-up of the data are done before erasing it from the receivers. In most situations contractors will require a portable laptop computer and an adequate power source.

GPS Data Collection Parameters

The following GPS data collection parameters must be configured.

Parameter	Value	Comment
GDOP	< 10.0	use only if HDOP or PDOP not available in rover unit
PDOP	< 8.0	use only if HDOP not available in rover unit
HDOP	< 5.0	use of HDOP preferred over PDOP
Elevation angle	> 15	satellite elevation tracking angle (degrees)
Positioning modes	3D	no 2D positioning acceptable
Logging interval	1 sec.	maximum allowable is 5 sec under certain conditions
Signal strength	default	minimum threshold to be set at manufacturer's default value (or higher)
Dynamics	lowest	set to lowest value available
Static averaging	200	minimum observation time is 300 seconds with at least 200 position fixes during that period, or 150 seconds with at least 50 position fixes under difficult satellite tracking conditions

Section 2 GPS Data Processing and Presentation

GPS Reference Station

Only the GPS reference stations that are validated and approved by the MoF are used for GPS differential corrections. The distance between the GPS reference stations and field receivers must be within 500 km. These reference stations must have a capability of archiving data for no less than 30 days and a data logging interval at no slower than 5 seconds. **MoF RIB staff will ensure that reference stations are activated in the sample areas and for the times the field crews will be collecting the data. Regional Staff must ensure that RIB staff are notified of when contractors will be in the field collecting data.**

GPS Data Processing

The regional contract officer must ensure that GPS data is provided to the data processor by clearly informing the data collectors the data transmission methods. It is especially important to provide the first several samples in order to ensure that data collection is being performed correctly. **The data collectors shall forward the original raw data or original receiver downloaded data (via e-mail attachment or ftp, if not possible, send 3.5 inch disk packaged for overnight courier) to the data processor for differential correction.** . The data processor will notify the data collectors and MoF contractor officers if there are any problems with the data. Mapping of GPS locations will be conducted by RIB after all samples have been supplied for compilation and analysis.

Data Archiving

The data collectors must make a back-up and archive of all the raw data (directly downloaded from the receiver) for a time period specified by the MoF contract officer. All these files must be in the manufacture's proprietary or RINEX format.

The data collectors must submit, at the end of projects, to the MoF Regional contract officer the following deliverables:

- All data files for each point feature surveyed in the original manufacture's proprietary or RINEX format on a 3.5 inch disk.
- All field notes and field cards with information regarding GPS files

Section 3 The Check List for GPS Project Management

The following check list is provided to ensure the successful capture of GPS data.

Responsibilities

RIB

- Develop and maintain standards, procedures, and guidelines for GPS data collection and processing
- Develop and oversee the contract with the GPS data processor
- Provide a summary report at the end of projects for Audit and VRI programs
- Advise and recommend Audit and VRI on improvement use of GPS
- Map all GPS sample plot positions
- Provide technical support to the contractor and Regional staff as required.

Region

- Check the contractors hardware and software, etc. are appropriate.
- Provide training to the contractor on the use of GPS, with assistance from RIB.
- Receive and inspect the project deliverables and forward to RIB for review.

Data Collector (Contractor)

- Provide (rent/purchase) an appropriate GPS data collection unit and provide adequate data backup (laptop PC)
- Familiarize staff with its operation
- Ensure that all staff on the project attend the regional training session.
- Collect GPS data
- Provide digital GPS data to contract officer
- Provide hardcopy summary of GPS data collection information.

Data Processor (Contractor)

- Check the availability of the GPS reference stations within the project area (e.g. if it is validated; if operating continuously during the scheduled time of the project; if its receiver/ parameters/data format, etc. are appropriate; and cover the costs)
- Ensure that GPS reference stations are turned on and order the reference data.
- Ensure that the data processor receives uncorrected digital GPS data from the data collectors, performs differential correction, and reports back to the data collectors and MoF Region coordinators any problems associated with the data
- Archive all field raw data (including GPS, maps, field cards, notes, etc.) and reference station data
- Map the GPS coordinates
- Provide a summary report for each audit and VRI project at the completion
- Provide technical support to the data collectors and MoF Regional staff as required.

Section 4 Trimble GeoExplorer Operation Procedures

This section is designed for the inventory audit and VRI programs for use of Trimble GeoExplorer GPS receivers.

Basic Operation

Trimble GeoExplorer	The geoExplorer is a 6-channel GPS receiver made by Trimble Navigation capable of both displaying an uncorrected coordinate position and storing multiple position fixes for post processing.
Rover Data File	For each point feature to be surveyed, e.g. tie point and plot center, a file shall be created and data stored and a precise coordinate position of this point shall be determined after the differential correction. This data file is typically called rover file.
Major Keys	<p>The ESC key will allow you to back up to the previous screen or it will cancel entered data</p> <p>The DIAMOND key at the center is used to SELECT a menu option and to ACCEPT entered data.</p> <p>The UP and DOWN arrows are used to SCROLL up and down through the menu.</p> <p>The LEFT and RIGHT arrows are used to move the cursor left and right through the menu.</p> <p>The ON/OFF switch is the lower bottom button to turn receiver on and off.</p> <p>The key is used for accepting an entry.</p>
On/Off	Press the ON switch to turn the receiver on, and press the ON and hold it for 5 seconds to turn it off.
Main Menu	<p>Turn the receiver on. Press the ESC key until the menu 'backs up' to the MAIN MENU. Scroll up and down the main menu using the UP and DOWN arrows.</p> <p><i>Note: the receiver will power up to the same menu location that it was on when the power was turned off.</i></p>
GPS Positioning	<p>Press ESC until you reach the MAIN MENU. Scroll using UP and DOWN arrows to the 2. POSITION under the MAIN MENU. Press DIAMOND key to select the 2. POSITION option. Keep the receiver steady for at least more than 3 minutes. If the screen displays a set of coordinates and message GPS POSITION, this indicates that the receiver is receiving data and is able to calculate a position. If the message OLD POSITION is displayed, it indicates that the receiver is not able to determine its current position. If this happens (i.e. the receiver is not determining its position, please refer to the SATELLITE TRACKING.</p> <p><i>Note: the position displayed is not accurate (could be 100 meters off). It must be post corrected with the reference data to get a less than 10 meters accuracy.</i></p>
Recording GPS Positions	Press ESC until you reach the MAIN MENU. Scroll using UP and DOWN arrows to the 1. DATA CAPTURE under the MAIN MENU. Press DIAMOND key to select the 1. DATA CAPTURE option. Scroll to 1. OPEN ROVER FILE using the DIAMOND key to select the option. The name of the rover file is automatically generated and is displayed in the upper left hand corner. This file name must be clearly recorded at this time on to the field card (along with feature

	<p>type, offset if there is any, time, and any other notes). The number on the upper right corner will be showing up and accumulating. It is the number of acceptable points recorded.</p> <p><i>Note: If the number is not changing, there may be problems with satellite tracking and you should refer to the SATELLITE TRACKING section. For configuration of the receiver, refer to the CONFIGURATION section.</i></p>
File Closing	<p>When a suitable number of positions have been collected (i.e. 200 position fixes), select CLOSE FILE using DIAMOND key to close the file for storage.</p> <p><i>Note: You must close the file. Otherwise next time you select DATA CAPTURE and data will add to the old file that you have not closed.</i></p>
Receiver Shut off	<p>Press ON/OFF key and hold it for 5 seconds to turn it off.</p>

Configuration

The configuration of the field GPS receivers must be done by a qualified technical person. Contractors and Regional staff should check with RIB remote sensing staff to ensure the receiver is configured correctly. However, the contractor must verify and check it during the field work.

View Configuration Options Press the **ESC** until you are at the MAIN menu. Scroll to the 6.CONFIGURATION menu using the **UP** and **DOWN** keys and select this menu using the **DIAMOND** key. Scroll to 1. ROVER OPTIONS and select this option with the **DIAMOND** key. Scroll through the PARAMETERS and check each one.

Position mode	Manual 3D
Elevation mask	15
PDOP mask	8
PDOP switch	8
SNR mask	4
Feature log pts	1 sec
Feature log line/arc	5 sec
Feature log min pos	200
Not in feature rate	All
Log DOPS	On
High Accuracy	Off

Parameter Setup Use the **LEFT**, **RIGHT**, **UP**, and **DOWN** keys to move the cursor and change value for each parameter and use the **DIAMOND** key to accept it.

Note: If the values do not match the above specifications, confirm the differences with RIB staff. Do not change them yourself, unless you have received approval.

Section 5 Standard Form for Submitting GPS Field Data

The following is a sample of the standard form for submitting GPS field data to the data processor. This form must be signed by the field data collector and attached to each batch of the data to the data processor.

Crew ID XYZ
Project ID VRI Fraser TSA
Submission Date 5/15
Signature

Sample ID	Map ID	Feature ID	File Name	Date	Time	Offset	Field Card	Comment
Submission Batch #			1					
200	92H083	TP	R050812A	5/8	12:00	5.4m@150 ⁰	Submitted	Tie Point
200	92H083	PC	R050815A	5/8	15:00	None	Submitted	Plot Center
301	92H083	TP	R051010A	5/10	10:00	None	Submitted	Tie Point
301	92H083	PC	R051011A	5/10	11:00	None	Submitted	Plot Center
405	92H083	TP	R051012A	5/10	12:00	10.8@135 ⁰	Submitted	Tie Point
405	92H083	PC	R051013A	5/10	13:00	None	Submitted	Plot Center
4	92H010	TP	R051010A	5/10	10:00	None	Submitted	Tie Point
4	92H010	PC	R051012A	5/10	12:00	None	Submitted	Plot Center
6	92H010	TP	R051209A	5/12	9:00	None	Submitted	Tie Point
6	92H010	PC	R051211A	5/12	11:00	None	Submitted	Plot Center
10	92H010	TP	R051409A	5/14	9:00	35.4@093 ⁰	Submitted	Tie Point
10	92H010	PC	R051411A	5/14	11:00	45.2@010 ⁰	Submitted	Plot Center