



Environmental Analysis Program

Pomona College
Biogeochemistry Laboratory

SOP-F006

GPS and Site Navigation

Standard Operating Procedure

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Author(s)	Marc Los Huertos
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Organization	EA Program, Pomona College

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Table of contents

1 Purpose	1
2 Scope	2
3 Responsibilities	2
4 Definitions	2
5 Safety and Hazards	3
5.1 Required PPE	3
5.2 Emergency Procedures	3
6 Equipment and Materials	3
7 Procedure	4
7.1 Pre-Field Setup	4
7.2 Recording Waypoints in the Field	4
7.3 Waypoint Naming Convention	4
7.4 Navigating to Existing Waypoints	5
7.5 Post-Field Data Management	5
8 Quality Control	5
9 References	5
10 Related SOPs	6
11 Training Record	6

1. Purpose

This SOP describes standardized procedures for recording geographic coordinates, navigating to field sites, and managing waypoint data. Accurate and consistent location data are essential for linking field observations to spatial analyses, returning to the same sampling points across seasons, and sharing site information among researchers. This SOP covers handheld GPS receivers, smartphone GPS applications, and post-field data management (U.S. Forest Service, 2012).

2. Scope

- **Applies to:** All EA Program field activities that require geographic coordinates, including sample collection, transect establishment, monitoring well location, equipment installation, and site reconnaissance
- **Does not apply to:** High-precision survey-grade GNSS work (sub-centimeter accuracy); drone-based georeferencing (see [SOP-F630](#)); GIS post-processing and spatial analysis (see future SOP-L804)
- **Location:** All EA Program field sites

3. Responsibilities

Role	Responsibility
PI / Field Lead	Approve coordinate system and datum for each project
Trained Personnel	Record waypoints per this SOP, upload data after fieldwork
New Students	Complete training before independent use

4. Definitions

- **Datum:** A mathematical model of the Earth's surface used as the reference for geographic coordinates; the EA Program default is **WGS 84** (World Geodetic System 1984), the datum used by consumer GPS and Google Maps; NAD 83 is nearly identical for most field purposes but must be specified explicitly if used (U.S. Forest Service, 2012).
- **Decimal degrees (DD):** A coordinate format expressing latitude and longitude as a single decimal number (e.g., 34.0975 N, 117.7125 W); the EA Program default format; preferred for data entry in spreadsheets and GIS.
- **GNSS (Global Navigation Satellite System):** The general term for satellite-based positioning systems; includes the US GPS, Russian GLONASS, European Galileo, and Chinese BeiDou constellations; modern receivers use multiple constellations simultaneously to improve accuracy.
- **GPS (Global Positioning System):** The US-operated GNSS constellation of 31+ satellites; provides horizontal accuracy of 3–5 m under open sky with a modern consumer receiver (U.S. Forest Service, 2012).
- **GPX file:** A standard XML-based file format for exchanging GPS waypoints, tracks, and routes between devices and software; the preferred export format for EA Program waypoints.
- **HDOP (Horizontal Dilution of Precision):** A dimensionless number indicating GPS positional uncertainty due to satellite geometry; values below 2 indicate excellent geometry; values above 5 indicate poor geometry and reduced accuracy (U.S. Forest Service, 2012).
- **Offline map:** A map tile set downloaded to a smartphone or device before the field visit, enabling navigation without cellular data; required for EA Program field sites with unreliable coverage.
- **UTM (Universal Transverse Mercator):** A projected coordinate system that divides the world into 60 zones and expresses positions in meters east (easting) and north (northing) of a zone origin; useful for measuring distances directly but requires specifying the UTM zone.

- **Waypoint:** A named, saved geographic location stored in a GPS receiver or smartphone app; defined by coordinates (latitude, longitude, and optionally elevation), a name, and often a description or icon.
- **WGS 84 (World Geodetic System 1984):** The global coordinate datum used by GPS satellites, Google Maps, and most modern consumer GPS devices; the EA Program default (U.S. Forest Service, 2012).

5. Safety and Hazards



Hazards

- **Physical:** Navigating to remote waypoints may involve uneven terrain, dense vegetation, or stream crossings. Do not fixate on the GPS screen while walking.
- **Environmental:** Reliance on GPS in areas with poor satellite coverage (dense canopy, steep canyons) can lead to navigation errors. Always carry a paper map or site sketch as a backup.

5.1. Required PPE

- ☐ Closed-toed shoes or field boots
- ☐ Sun protection (hat, sunscreen)

5.2. Emergency Procedures

Refer to [SOP-F001 Field Safety](#). If lost or disoriented, stop moving, note your last known coordinates, and contact the field lead by phone or walkie-talkie.

6. Equipment and Materials

Item	Notes
Handheld GPS receiver (Garmin or equivalent)	Check battery level; carry spare batteries (Garmin International, 2019)
Smartphone with GPS app	Avenza Maps, Gaia GPS, or similar app with offline map capability (Avenza Systems, 2024)
Backup paper map or site sketch	Annotated with known landmarks and access roads
Field notebook	For recording waypoint IDs and descriptions
USB cable or Bluetooth adapter	For downloading waypoints to a computer
Spare batteries (AA or rechargeable)	Matched to the GPS unit model

7. Procedure

7.1. Pre-Field Setup

1. Confirm the coordinate system and datum for the project. The EA Program default is **WGS 84, latitude/longitude in decimal degrees** (U.S. Forest Service, 2012). If a project requires UTM or NAD 83, configure the device accordingly and note the setting in the field notebook.
2. On a handheld GPS, verify the datum setting: navigate to Setup > Position Format and confirm WGS 84 (Garmin International, 2019).
3. On a smartphone app, enable offline maps for the study area. Do not rely on cellular data for map tiles in the field (Avenza Systems, 2024).
4. Clear or archive old waypoints from the device so the day's data are easy to identify.
5. Pre-load target waypoints if revisiting known sites. Use the naming convention described in §6.3.

7.2. Recording Waypoints in the Field

1. At the sampling location, hold the GPS receiver at chest height in an open area away from dense canopy, cliff faces, and vehicles.
2. Wait until the GPS reports an accuracy of 5 m or better ($\text{HDOP} < 2$ preferred). If accuracy remains above 5 m after two minutes, record the waypoint and note the reported accuracy in the field notebook (U.S. Forest Service, 2012).
3. Save the waypoint using the naming convention in §6.3.
4. In the field notebook, record:
 - Waypoint name
 - Date and time
 - Coordinates (as displayed on the device)
 - Reported accuracy (HDOP or meters, as available)
 - A brief description (e.g., “upstream riffle, transect 3 start”)
5. If using a smartphone, take a screenshot of the GPS display as a backup record.

7.3. Waypoint Naming Convention

Use the following format: `SITE_TYPE_NN`

- **SITE** = three- or four-letter site abbreviation (e.g., BFS, THW, MRW)
- **TYPE** = two-letter code for the point type (see table below)
- **NN** = sequential two-digit number

Code	Point Type	Example
WQ	Water quality sampling	BFS_WQ_01
SO	Soil sampling	THW_SO_03

Code	Point Type	Example
TR	Transect endpoint	MRW_TR_01
WL	Monitoring well	BFS_WL_02
RF	Reference / benchmark	THW_RF_01
GN	General / other	MRW_GN_05

If a project requires a different convention, document it in the project README and field notebook.

7.4. Navigating to Existing Waypoints

1. Load the target waypoint on the GPS receiver or smartphone app.
2. Use the “Navigate” or “Go To” function. Follow the bearing indicator, checking your surroundings periodically.
3. When the GPS indicates you are within the reported accuracy of the waypoint, look for physical markers (flagging, rebar, painted rocks) to confirm the exact location.
4. If the physical marker cannot be found, record a new waypoint at the location you judge to be correct and note the discrepancy in the field notebook.

7.5. Post-Field Data Management

1. Download waypoints from the GPS receiver to the project computer within 48 hours of returning from the field.
2. Export waypoints as a `.gpx` or `.csv` file and save to the project GitHub repository under `data/gps/`.
3. Use the file naming convention: `YYYY-MM-DD_SiteID_waypoints.gpx`
4. Verify that waypoint names match the field notebook entries. Correct any discrepancies before committing the file.
5. Back up the raw GPS file to the lab shared drive.

8. Quality Control

- Compare GPS coordinates against known benchmarks or previously recorded waypoints when revisiting sites. Discrepancies greater than 10 m should be investigated and noted (U.S. Forest Service, 2012).
- At least once per semester, verify the GPS receiver against a known benchmark (e.g., a USGS survey marker or campus reference point).
- Record the GPS model, serial number, and firmware version in the field notebook at the start of each project.

9. References

- Garmin International (2019)
- Avenza Systems (2024)

- U.S. Forest Service (2012)

Avenza Systems. (2024). *Avenza maps user guide*. <https://support.avenzamaps.com>

Garmin International. (2019). *GPSMAP 66 series owner's manual*. <https://www8.garmin.com/manuals/webhelp/gpsmap66st/EN-US/GUID-BF2E4F90-EB9F-4A7D-A94E-52614D3B9D05-homepage.htm>

U.S. Forest Service. (2012). *Field data collection with GPS: A best practices guide* (Gen. Tech. Rep. RMRS-GTR-289). USDA Forest Service, Rocky Mountain Research Station. <https://www.fs.usda.gov/research/treesearch/43085>

10. Related SOPs

SOP	Title	Relationship
F001	Field Safety	Required prerequisite
F003	Field Notebook Protocols	Waypoint data recorded in notebook
F005	Random Sampling Design	GPS used to navigate to random points

11. Training Record

Before using GPS equipment independently, personnel must:

1. Read this SOP in full
2. Demonstrate proper waypoint recording (datum check, accuracy verification, naming convention) during a supervised field visit
3. Successfully download and export waypoints to the project repository
4. Be signed off by the PI or field lead