

GPS Field Protocol:

What you need to know when using a GPS unit for fieldwork

Global Positioning Systems (GPS) is a common way to collect location data for agricultural, urban, and natural resources. It is made up of a constellation of 24 satellites used for civilian GPS, which accurately determine your location (X, Y, Z) in any weather, day or night, anywhere on Earth. A GPS unit uses four or more satellites to triangulate your position on Earth. For this reason, you need four or more satellites! GPS satellite signals travel by line of sight, and will pass through clouds, glass, & plastic, but NOT through most solid objects, such as buildings & mountains.

Your GPS accuracy depends on:

The type of GPS unit you have

If you have a handheld GPS unit (e.g. Garmin), the highest attainable horizontal accuracy is about 3 m. More accurate units like Trimble's GeoXH, will give you accuracy of < 3 m, sometimes sub-meter accuracy under good conditions or with additional antennas. More expensive units are not *always* the most accurate – many have reported that Garmin handhelds give better accuracy under heavy canopy than do more advanced Trimble units.

Recommendation: buy the most affordable (and dependable) GPS that best suits your accuracy requirements!

Number of satellites visible to your receiver

Buildings, terrain, or sometimes even dense foliage can block signal reception, causing position errors or possibly no position reading at all. Also, signal multipath might happen if a signal from a satellite is reflected off objects such as tall buildings or large rock surfaces before it reaches the receiver. This increases the travel time of the signal, causing errors.

Recommendation: The more satellites, the better – but you must have four or more before you record a point! If you cannot get four or more, wait a few minutes for the satellites to move/adjust, or move to an area with better reception and make note of distance and direction moved from the desired point.

Strength of satellite signals

While many GPS units do not give you a measurement of satellite signal strength, you can get an idea of it by viewing the satellite screen on most GPS units, which depicts signal strength with bar graphs for each visibly satellite.

Recommendation: The stronger the signals, the better – just make sure you have four or more satellite signals before you record a point!

Geometric positioning of the satellites in the sky

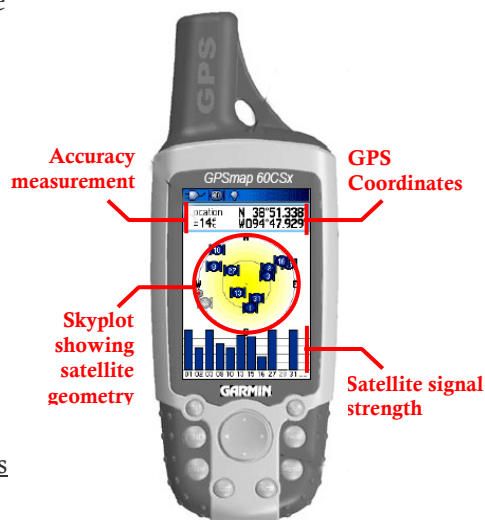
Ideal satellite geometry exists when the satellites are located at wide angles relative to each other in the sky, which improves triangulation and thus reduces error. While Trimble units give a measurement for satellite geometry ("PDOP," "HDOP," or "GDOP"), handheld units do not give a measurement for it – it is a good idea to be aware that accuracy will improve when satellites are distributed in different areas of the sky.

Recommendation: Aim for the satellites to be widely distributed across the skyplot on your GPS unit.

Differential correction procedures

Wide-Area Augmentation System (WAAS) is available on many GPS units (see "Handheld GPS Buyer's Guide" for more info), and on all Trimble receivers. WAAS can improve GPS accuracy to within 2 m for compatible handheld GPS units, and to less than 1 m with Trimble units. However, it's only available in North America, and you need an unobstructed view of the southern horizon, so it's ideal for open land (such as open agricultural crops) and marine applications. You know you are receiving WAAS signal if you are receiving signals from satellites with ID numbers 31 or higher (in the skyplot). Differential GPS (DGPS) is available for Trimble units (and for PDAs with ArcPad and GPS Correct software) and can improve accuracy to about 1 cm.

Recommendation: Only enable WAAS if you have an open view of the southern horizon – if you have WAAS enabled without a clear view, your accuracy will be reduced because the GPS unit is constantly trying to find the WAAS satellites. As for DGPS, use it if you have access to DGPS correction (either real-time or post-processed), and you want sub-meter accuracy.



What format should I use to collect GPS data?

The most important things about collecting GPS are to be consistent and to document your data. That way, data can be easily used with other data with minimal adjustments, and people who use your data in the future (including you) can know exactly what format (projection and datum) you used to collect the data. If you do not document your data, it is possible that it will be unusable in the future!

All geographic data has a projection and a datum:

- **Projection** is how the 3D earth is mapped on a 2D surface, like a map on paper or your computer screen. GPS units call it the “Position Format” or “Coordinate System.”
- **Datum** is the mathematical model that fits the earth to an ellipsoid. Most GPS units call it the “Datum” or “Map Datum.”

Recommendations:

- Use the projection: UTM (stands for Universal Transverse Mercator)
- Use the datum: NAD 83 (stands for North American Datum 1983)
- Using other projections (like Latitude-Longitude or Stateplane) and other datum (like WGS 84) is **okay** – just be sure you record whatever projection and datum you used!
- If you decide to use Latitude-Longitude, try to collect in decimal-degrees (hddd.dddd°) as the Position Format.

GPS Accuracy:

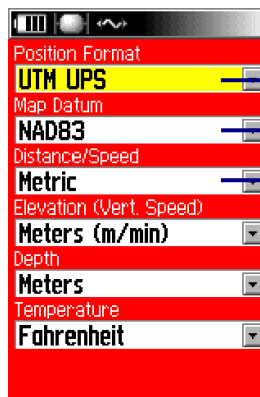
- Accuracy is how close you are to the real-world location. It is also called the offset or the error. On most handheld units, accuracy is represented by a “error buffer,” e.g. $\pm 14\text{ft}$ or $\pm 11\text{m}$.
- Your GPS accuracy depends on many things; see other side.
- When we talk about accuracy, usually we mean horizontal accuracy. There is also vertical accuracy, which is how close you are to the real-world elevation at a given location. Vertical accuracy is usually somewhat inaccurate with handheld GPS unit (10-200m), while it is more accurate with more advanced Trimble units (<5m). For sub-meter vertical accuracy, survey-grade GPS equipment is required.

Things to Remember:

1. Be consistent with what projection and datum you use to collect data.
2. When in doubt, or if starting a new project, use UTM projection with NAD 83 datum.
3. Only record a point if you have 4 or more satellites.
4. Record accuracies on your field sheet since you can't always transfer these digitally.

How do I set my GPS projection & datum?

All GPS units have a Setup menu, where you can set the projection and datum. Check the GPS unit's manual for detailed instructions. Below is a screenshot from Garmin's Setup | Units menu:



Set the projection here.
For UTM, set to UTM UPS.
For Lat/Long, set to hddd.dddd°.

Set the datum here.
For NAD 83 or WGS 84..

Set the distance units here,
either meters or feet. If you
use UTM, use meters as the
units.

Recording GPS Information

- **UTM:**
 - » Easting (e.g. 0525690)
 - » Northing (e.g. 4286289)
 - » Accuracy (e.g. $\pm 11\text{m}$)
- **Latitude, Longitude:**
 - » Latitude (e.g. 37.867242) with 5-6 decimals
 - » Longitude (e.g. 122.300746) with 5-6 decimals
 - » Accuracy (e.g. $\pm 11\text{m}$)
- **Backup**
It is always a good idea to record GPS coordinates and any other data on paper/notebook in the field if possible, just in case of data loss after accidental damage. (Damage is less common with rugged units, such as Garmin handhelds or the Trimble Recon.)

If you do record GPS coordinates, write both the X (Easting or Latitude), the Y (Northing or Longitude), and the accuracy, e.g. $\pm 11\text{m}$.