NJDEP's GPS Receiver Requirements for Spatial Data Collection

The use of Global Positioning System (GPS) technology for accurately and efficiently storing map feature locations and attributes has become a widely accepted method for collecting GIS data. The NJDEP standards for the collection of spatial data using GPS technology demand spatial accuracy to be within ±5 meters. This level of accuracy is routinely achieved if the correct GPS receiver hardware, field data collection, and post data management procedures are employed. The purpose of the document is to provide GPS receiver guidelines for individuals and organizations that are using GPS to capture high quality spatial data that the NJDEP will ultimately use in its GIS for environmental decision making. For additional information, be sure to review the NJDEP GPS Data Collection Standards for GIS Data Development.

GPS Receivers

Depending on the type of GPS receiver used and the procedures followed, GPS can be used to provide location accuracy from a few centimeters to tens of meters. There are basically three classes of GPS receivers. The first are commonly called consumer or recreation grade receivers. This type is not designed for mapping and GIS data collection, but for basic navigation use by boaters, hikers, and the like. Generally, these do not have data collection capabilities beyond the storing of waypoints (points you wish to navigate to) and routes (sets of linked waypoints). With this class of receiver, users can expect determined positions to be accurate to within 15 meters with a 95% confidence under ideal conditions (GPS signals of sufficient strength, and favorable satellite geometry). Under typical field conditions where a user has to contend with tree cover and other obstructions, and with less than favorable geometry however, users can expect the accuracy of determined positions to be much worse, perhaps as high as 50 meters. **Data collected with this type of receiver is inappropriate for NJDEP's GIS as it will not meet NJDEP's ±5 meter accuracy standard.**

The GPS receivers most commonly used for GIS applications are the mapping/GIS or resource grade receivers. These are specifically designed for storing mappable features (coordinates and attributes), and include GPS post processing software. Positions determined by these receivers are generally in the 1 to 5 meter accuracy range after differential correction. These receivers generally produce better results in less GPS friendly environments. They achieve higher accuracy, can operate in real time differential correction mode, and have significant data storage capacity. The processing software includes utilities to enable GPS field data file transfer to a PC, perform post-process differential corrections, allow analysis/edit of data, and enable the export of collected data to a GIS file format. The mapping grade GPS receivers are used for all GIS data collection projects for NJDEP.

The third class of GPS receiver, the geodetic grade or carrier phase based, is designed for applications that require extremely high accuracy. Positions determined by these receivers can be accurate to within less than a centimeter. This type is not typically used

to capture spatial data for NJDEP's GIS since the accuracy requirements of most NJDEP programs are not to this level.

To achieve NJDEP's horizontal accuracy standard of ±5 meters (with a 95% level of confidence), the mapping/GIS type receiver must have the following characteristics:

- The receiver must be operated in a 3D mode. In this mode the receiver requires simultaneous signals (of sufficient strength) from a minimum of four satellites to determine a 3D (latitude, longitude, and elevation) location (a fix). Locations calculated from fixes determined with fewer than 4 satellites are unacceptable.

- The receiver must have the capability to prohibit the collection of GPS data under poor conditions. This is typically accomplished through the setting of collection parameter masks. These masks can prevent the calculation of position fixes during times of poor satellite geometry (PDOP) and signal strength (SNR).

- The receiver must allow the storage of position fixes for features that are being mapped. **Not just waypoints**. When mapping point features, the receiver must be able to store a sample of position fixes (the minimum number depending on receiver manufacturer recommendation) in a computer file structure for the feature.

- The receiver must provide processing software utilities that allow the download of collected data from the receiver to a PC, differential correction of the data, and export of spatial data to GIS or database file formats.

- If the spatial data is not going to be differentially corrected using GPS software utilities, it must be differentially corrected in real time (as it is being stored). This will most often require the use of a "beacon receiver" which is a separate piece of hardware that receives real time correction data (RTCM) that is then transmitted to the GPS receiver. Note that this is different than a correction determined using the Wide Area Augmentation System (WAAS). The WAAS is still under development and its correction signal is not always accessible. If the user operates a GPS receiver along with a beacon receiver, they must make sure that the GPS data is in fact being corrected in real time (i.e., that the differential GPS is working), and that no uncorrected positions are being determined by the receiver.

Issues with Consumer or Recreation Grade GPS for GIS Data Collection

With the elimination of Selective Availability (SA) and the emergence of consumer grade GPS with WAAS correction capability, there is interest in using these products for spatial

data collection for GIS. The low cost of these units, compared to mapping/GIS grade receivers, makes this an appealing option.

Many of the manufacturers of consumer grade GPS receivers with WAAS capabilities claim better than 3-meter accuracy. Under the right conditions this is possible. Unfortunately, normal field surroundings do not always provide the right conditions for the WAAS correction to work. Having the capability to average coordinates over a period of time should improve accuracy, but no guidance is provided to the user for how long the averaging should take place to achieve a desired accuracy. Some of these receivers indicate to the user that the displayed location is accurate to within *x* number of feet, which only seems to make sense if somehow the receiver knew the exact coordinate value of the location that the user was stationed.

The manufacturers do not provide guidelines for users to follow that will enable them to achieve NJDEP's stated level of accuracy with any confidence. There are no GPS receiver settings to enable the receiver to reject weaker signals that reduce accuracy. If signal reception is a problem, these receivers often will determine a location using only 3 satellites, using an estimated elevation value that is often inaccurate.

The inexpensive consumer receivers are designed for a particular niche. They do what they were designed for very well. They determine coordinates, sometimes using tricks if necessary, at the expense of accuracy. This is fine for someone using a receiver to find their way back to a campsite or fishing spot. This is not fine for a user that needs to collect more accurate data that is to be used with other spatially accurate data of the same standard, in environmental analyses using GIS. Finally, users should beware of the term "mapping receivers" as this is often given to consumer grade GPS receivers that provide the capability to load background map data (typically roads, and points of interest) for display. This does not mean the receiver is suitable for spatial data collection for GIS.

Helpful Web Links

GPS
Peter H. Dana, Univ. of CO - **www.colorado.edu/geography/gcraft/notes/gps/gps_f.html**
Samuel J. Wormley - **www.edu-observatory.org/gps/gps.html**

NJDEP GPS Data Collection Standards For GIS Data Development:
http://www.nj.gov/dep/gis/GPSStandards_2011.pdf

Differential GPS and WAAS:
http://www.navcen.uscg.gov/pdf/dgps/dgpsdoc.pdf
www.gpsinformation.net/waasgps.htm

GPS Manufacturers
Ashtech - **www.ashtech.com**
Trimble Navigation Ltd. - **www.trimble.com**
Corvallis MicroTechnology, Inc. - **www.cmtinc.com**