

## Optimizing accuracy with MobileMapper Pro

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### A. RECORDING ROVER DATA

There are seven basic rules for recording MobileMapper Pro rover data that can be post-processed to sub-meter accuracy:

1. All features must be logged while the receiver is continuously tracking at least 5 satellites with a PDOP less than 4 *for at least 20 minutes*.
2. Allow the receiver to have full “view” of the sky *the entire time a job is open, not just when a feature is open*.
  - a. While you do not need a survey-grade external antenna for sub-meter accuracy, using one will yield better accuracy.
  - b. If you are not using an external antenna, keep the MobileMapper Pro receiver *vertical* the entire time a job is open.
  - c. If you are not using an external antenna, keep the MobileMapper Pro receiver *at eye level* the entire time a job is open.
3. Keep the receiver (or external antenna) stationary for 5-10 seconds before opening any point feature.
4. Average all point features for at least 30 seconds.
5. Use a one-second logging interval and move as steadily as possible while recording line and area features.
6. If you are using SBAS corrections, allow the MobileMapper Pro receiver to track at least one SBAS satellite for four minutes before logging data.
7. After opening a job for post-processing wait at least 10 seconds before logging the first feature. Do not close the job until 10 seconds after recording the last feature.

#### Explanations:

1. *All features must be logged while the receiver is continuously tracking at least 5 satellites with a PDOP less than 4 for at least 20 minutes.*

When you record features for post-processing, the MobileMapper Pro receiver actually logs two types of files:

- MMJ files with feature descriptions and real-time positions
- GPS measurement files.

MobileMapper Office’s differential correction utility post-processes just the GPS measurement files and requires 20 minutes of continuously recorded GPS measurements to allow differential correction to submeter accuracy. The newly post-processed positions then overwrite the real-time positions contained in the MMJ file. *Any number of features recorded during a 20-minute period of continuous satellite lock is post-processable to sub-meter accuracy.*

In addition to this 20 minute rule, there are three other requirements:

- The receiver must be tracking at least 5 satellites in common with the base station receiver
- The PDOP must be less than 4

- Any point feature recorded during the 20 minute period must be average for at least 30 seconds

If you do not maintain satellite lock for more than 20 minutes, you will still be able to post-process your data but accuracy can be degraded. If the period of continuous lock is less than 5 minutes, the real-time positions recorded in the receiver may be more accurate than the post-processed positions. If you cannot maintain lock for more than 2-3 minutes, it is possible that MobileMapper Office will not be able to post-process the data at all. Any feature that could not be post-processed will continue to be displayed by MobileMapper Office with its real-time position.

2. *Allow the receiver to have full “view” of the sky.*

There are three ways to achieve this:

- a. While you do not need a survey-grade external antenna for sub-meter accuracy, using one will yield better accuracy.  
Survey-grade antennas such as the one used by the Magellan ProMark3 are built to higher specifications enabling them to pick up GPS signals more reliably and will less distortion. Some tests have shown that when using a ProMark3 antenna, the MobileMapper Pro yielded accuracy less than 50 cm as opposed to less than 100 cm with the MobileMapper Pro’s internal antenna. Note: the magnetically mounted external antenna sold as an option for MobileMapper Pro is for real-time use only in vehicles when the MobileMapper Pro cannot be positioned in the vehicle with a clear view of see the sky. Accuracy with the internal antenna in an open area is better than with the magnetically mounted antenna.
- b. If you are not using an external antenna, keep the MobileMapper Pro receiver *vertical* the entire time a job is open, not just when you are logging data to a feature. The internal antenna element is more sensitive to GPS signals and rejects multipath more effectively when it is vertical. It still works when horizontal, but not as well. There is a separate tech note on this topic.
- c. If you are not using an external antenna, keep the MobileMapper Pro receiver *at eye level* the entire time a job is open, not just when a feature is open.  
When you hold the receiver at eye level, your head and body do not block the internal antenna’s view of the sky. It still works when at chest level, but not as well. There is a separate tech note on this topic.

3. *Keep the receiver (or external antenna) stationary for 5-10 seconds before opening any point feature.*

The MobileMapper Pro receiver is equipped with a velocity filter that improves the accuracy of line and area features by averaging the receiver’s velocity over a small number of epochs. To ensure that the receiver turns off the filter and recognizes that the receiver is now stationary over a point, remain stationary for 5-10 seconds before opening a point feature.

4. *Average all point features for at least 30 seconds.*

The longer you average positions recorded for point features, the greater the accuracy. The improvement in accuracy diminishes over time. MobileMapper Pro has been

tested to provide submeter accuracy for 30-second occupations. Accuracy continues to improve with time – especially if you continue to record after a GPS constellation change (one or more satellites set and one or more rise). But after 2-3 minutes, you get little improvement. An exception to this rule is when you must record data under tree canopy sufficiently dense to break satellite lock when you move from one feature to another. If you need submeter accuracy for points under dense tree canopy, you should record at least 20 minutes of data at each point.

5. *Use a one-second logging interval while moving as steadily as possible while recording line and area features.*

The velocity filter enhances accuracy for line and area features. For this reason, we recommend recording line and area features at a one-second logging interval and moving at a steady speed to optimize accuracy. Conversely, we do *not* recommend that you record a line or area feature by occupying corners and averaging for 30 or more seconds each. For line and area features, a steady velocity works better than averaging at corners.

For the most accurate line and area features, it helps to imagine that drops of water are coming out of the receiver and that where these drops fall on the ground is where the individual positions will appear on the map. If you slip or deviate accidentally from the feature, you can use MobileMapper Office to delete unwanted positions making up line and area features. If your feature library has an attribute called Notes, you can record the time you slipped to help you find the errant positions when you're back in the office. And remember that you can pause a feature if you need to walk around an obstacle. Refer to the MobileMapper Office User Manual (click on Help>User Manual) for information on removing unwanted lines and areas.

If it is unrealistic to restrict the receiver's movement to straight lines and smooth arcs, leave the recording interval for line and area features at the default interval (10 sec). This will remove small deviations that might make the resulting feature positions look erratic on large-scale maps.

6. *If you are using SBAS corrections, allow the MobileMapper Pro receiver to track at least one SBAS satellite for four minutes before logging data*

Most SBAS systems (like WAAS, EGNOS and MSAS) transmit a complete correction message once every four minutes. If you begin logging data before the receiver has a complete message, accuracy can be degraded. Because you only have to track one SBAS satellite to get a complete message and do not have to be tracking any GPS satellites, you might consider turning the receiver on four minutes before arriving at the first location at which you will collect data.

7. *After opening a job for post-processing wait at least 10 seconds before logging the first feature. Do not close the job until 10 seconds after recording the last feature.*

The post-processing software in MobileMapper Office cannot post-process features unless 10 seconds of raw GPS measurements were recorded both before and after the features.

## B. RECORDING REFERENCE STATION DATA

The reference station may use any receiver that records Magellan B- and E-files. These include all Magellan surveying receivers as well as the MobileMapper Pro. You can also use any receiver that can output GPS measurements in RINEX format. There are many public sources of RINEX reference data in North America and Europe, as well as in some other parts of the world. The (US) National Geodetic Survey's CORS site (<http://www.ngs.noaa.gov/CORS/>) is a popular source of free data in the United States. The International GPS Service (<http://igscb.jpl.nasa.gov/>) also provides reference station data worldwide at no charge. In addition, many local governments and agencies record and publish reference station data.

If you want to record your own reference station data for post-processing, you should adhere to the following rules:

1. When setting up your own reference station in the field, make sure you first locate a control point within 100 km of the work area. The closer the reference receiver is to the work area, the better the accuracy will be. After you download the reference data into MobileMapper Office, be sure to click on the Edit Reference Station Properties icon and type in the actual, surveyed coordinates of the control point. If you do not do this, MobileMapper Office's differential correction module will use the average position recorded by the reference receiver. This will almost certainly be less accurate than the surveyed coordinates and any error will be transferred to the rover positions after post-processing.
2. Make sure the coordinates surveyed for the reference station are as accurate as possible. Most CORS sites are surveyed to centimeter accuracy, but some sites have greater errors than others. One site was moved 100 km without public notification. All GPS positions corrected using data from the site were 100 km in error. This very rarely happens, but it does illustrate that one should take care not to blame the rover data for errors when they may come from the misidentification of the reference station's coordinates.
3. Make sure you enter the reference receiver's antenna height above sea level in the Reference Station Properties window. GPS positions are always three-dimensional, even if you only care about the horizontal coordinates. Errors in height can easily add to horizontal errors.
4. Make sure the coordinate system indicated in the Reference Station Properties window is the same as that used for the surveyed coordinates of the control point and that of the rover data. If you only know the reference station coordinates in one coordinate system, first use MobileMapper Office to adjust to this system and then select this system in the Reference Station Properties window.
5. The reference station antenna should be at least two meters off the ground and in a location where it has an open view of the sky. Real post-processing purists will add the antenna's height off the ground to the *orthometric* height (Mean Sea Level elevation) of the reference station's control point. They should then subtract the height that the rover receiver is typically held above the ground. However, people

who adhere to the Eye Level rule for recording rover data can usually assume that the height above the ground of both the reference receiver's antenna and the rover's antenna is roughly the same.

6. You should use a survey-grade antenna for the reference receiver in order to achieve sub-meter accuracy. A Magellan ProMark3 external antenna works very well. The magnetic antenna sold as a MobileMapper Pro accessory is intended for use with a rover receiver that is inside a vehicle and cannot "see" enough satellites to calculate a position. This antenna is not intended for use with reference receivers.
7. If a MobileMapper Pro receiver with internal antenna is used as a reference station, the receiver must be vertical and at least two meters off the ground. Accuracy using reference station data recorded by a MobileMapper Pro and its internal antenna may not be submeter.
8. Record all reference station files for at least 30 minutes. The reference file must be opened at least eight epochs before any rover job is opened and closed at least eight epochs after the last rover job is closed. If you are recording line or area features with a 5-second recording interval, for example, eight epochs will span 40 seconds.
9. The reference receiver must be able to see the satellites seen by any of the rovers. Therefore, the reference receiver must be in an area far from buildings and hills and with a completely open view of the sky. Any satellites not seen by both the reference and the rover will not be used in post-processing.