Standards

For

Positional Accuracy

For Cadastral Surveys

Conducted Using

Global Navigation Satellite Systems (GNSS)

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United States Department of the Interior-Bureau of Land Management

Standards for Positional Accuracy for Cadastral Surveys
Using Global Navigation Satellite Systems (GNSS)

Preface

These "Standards for Positional Accuracy for Cadastral Surveys Conducted Using Global Navigation Satellite Systems (GNSS)" were developed as an update to the positional standards originally defined in the Bureau of Land Management (BLM) Instruction Memorandum (IM) 2001-186. The positional standards outlined in this document were developed jointly between BLM and the United States Department of Agriculture – Forest Service (USFS). The BLM and USFS intend these standards to apply to all boundary surveys conducted by these agencies, surveys performed under Special Instructions issued to other agencies, or their contractors when GNSS technology is used. In addition to the positional standards this document also defines how the survey accuracies should be defined and computed. The positional accuracy standards are harmonious with the *Manual of Survey Instructions (2009)* and previous manuals.

In 2001, when the BLM issued IM 2001-186, the use of GPS technology, especially Real-Time Kinematic (RTK) GPS technology, in conducting cadastral or other boundary surveys was in its infancy. The BLM intended the original IM to be a teaching document on how to use these technologies as well as providing guidance on the accuracies necessary to achieve results comparable to conventional terrestrial surveys. In 2010, the BLM issued updated accuracy standards under IM 2010-094 to update the policy with technology advancements. The USFS did likewise under their official memorandum system on April 6, 2010. **The standards issued in 2010 have not been revised, and remain unchanged here.**

The accuracy reporting requirements contained in this policy are in accordance with accuracy reporting requirements of the Federal Geographic Data Committee's "Geospatial Positioning Accuracy Standards" of July 1997. These standards do not require that agencies perform cadastral surveys to the higher accuracy and methodology requirements of geodetic control surveys. The BLM intends these standards to provide sufficient observational and occupational redundancy to detect blunders and quantitatively demonstrate the achievement of the stated accuracy of a survey.

The positional standards set forth in this document have undergone both internal and external review. The BLM, in coordination with the USFS have addressed comments received, as appropriate, in preparing this final version.

Standards for Positional Accuracy
Using GNSS Technology

The following standards are for Global Navigation Satellite System (GNSS) technology and shall be used to define the minimally acceptable levels of positional accuracy required of a DOI – BLM Cadastral Survey or administrative boundary survey (see Supporting Information, Appendix 1).

<u>Local Accuracy Standards</u>

Semi-major axis 95% error ellipse	Application
Less than 0.025 (m)	Cadastral Project Control
Less than 0.050 (m)	Cadastral Corner Measurements

See items 3 and 4, Supporting Information.

<u>Network Accuracy Standards</u>

Semi-major axis 95% error ellipse	Application
Less than 0.050 (m)	Cadastral Project Control
Less than 0.100 (m)	Cadastral Corner Measurements

See items 5 and 6, Supporting Information.

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Supporting Information

1. The standard is based on the magnitude of the semi-major axis of the 95% confidence level error ellipse.

2. The surveyor should use a least squares adjustment or other multiple baseline data analysis to verify that the required level of positional accuracy has been achieved.

3. The local accuracy of a control point established as part of a static GNSS project control network can be determined by doing a minimally constrained least squares analysis of the network and determining the magnitude of the semi-major axis of the 95% confidence level error ellipse is less than or equal to the values in Table 1.

4. The local accuracy of a Cadastral Corner Measurement can be determined by doing a minimally constrained least squares analysis of the network and determining the magnitude of the semi-major axis of the 95% confidence level error ellipse is less than or equal to the values in Table 1.

5. The network accuracy of a control point established as part of a static GNSS project control network can be determined by doing a fully constrained least squares analysis of the network and determining the magnitude of the semi-major axis of the 95% confidence level error ellipse is less than or equal to the values in Table 2.

6. The network accuracy of a cadastral corner measurement point established by real time kinematic, fast static or kinematic methods which meet the manufacturer's specifications may be further evaluated by doing a fully constrained least squares analysis of the network and determining that the magnitude of the semi-major axis of the 95% confidence level error ellipse is less than or equal to the values in Table 2.

7. The NGS program "OPUS – Static" (http://www.ngs.noaa.gov/OPUS/) returns the maximum peak-to peak separation for each component of the computed position. The surveyor will use the maximum peak-to-peak separation of the computed position to estimate the semi-major axis of the 95% confidence error ellipse for network accuracy determination for these standards.

8. The NGS program "OPUS – RS" (http://www.ngs.noaa.gov/OPUS/) returns the standard deviation for each component of the computed position. The surveyor will calculate two times the largest position component standard deviation to estimate the semi-major axis of the 95% confidence error ellipse for network accuracy determination for these standards.

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Glossary

Cadastral Corner Measurements - The measurements used to define the location of *Public Land Survey System (PLSS)* corners and boundaries. Cadastral Measurements are based on the Cadastral Project Control coordinates or direct ties to the National Spatial Reference System (NSRS).

Cadastral Project Control – A network or series of the GPS/GNSS of control points that are tied to the NSRS, which is created to control all subsequent GPS Cadastral Measurements. The Project Control is adjusted independently of other cadastral measurements

Fully Constrained Least Squares Adjustment - For the purpose of this document a least squares adjustment performed by holding the horizontal coordinates of all control points and a minimum of one vertical control coordinate fixed and allowing all other points to be adjusted.

Local Accuracy - A value that represents the uncertainty at the 95% confidence level in the coordinates of a measured point relative to the coordinates of other directly connected and adjacent points in the survey.

Minimally Constrained Least Squares Adjustment – For the purpose of this document a least squares adjustment performed by holding the coordinates of one control point fixed and allowing all other points to be adjusted.

Network Accuracy – A value that represents the uncertainty in the coordinates of a measured point at the 95% confidence level relative to the NSRS as determined in the survey.

OPUS-RS – An on-line positioning program developed and supported by the National Geodetic Survey (NGS). This program allows the user to submit 15 minutes to 2 hours of GPS data to the NGS. They will then compute and return via email the calculated coordinates of the position.

OPUS-Static - An on-line positioning program developed and supported by the NGS. This program allows the user to submit a minimum of 2 hours of GPS data to the NGS. They will then compute and return via email the calculated coordinates of the position.