

Geodetic Survey Monument Monitoring Requirements

The Monroe County Monumentation Law of 2019 requires subdivision and other survey based mapping to be tied into the Monroe County Monument Network. Geodetic monuments are utilized to tie subdivisions and surveys to a permanent physical monument and to establish horizontal positioning to the New York State Plane Coordinate System and vertical datum for subdivisions and surveys. There is a long history of this practice in Monroe County. While the monuments serve the purpose of coordinating and tying subdivisions and surveys they also have significant survey retracement value. The preservation of the historical position of the monuments is necessary for survey retracement purposes in order to perpetuate the position in a way that allows reproduction of surveys that were tied to the monuments.

Under the requirements of the Monroe County Monumentation Law of 2019, when a County geodetic monument is in close proximity to proposed construction the County of Monroe requires the following GPS/GNSS and conventional Theodolite or Total Station terrestrial (TPS) survey procedures to be followed to perpetuate the existing position and to monitor the position of the monument to detect whether disturbance occurred that destabilized or disturbed the monument and whether the disturbance constitutes destruction. The County of Monroe requires measurements to be taken under the direction of and certified by a licensed land surveyor before and after construction.

A survey monument will be considered disturbed and destroyed that has been:

- Moved equal to or in excess of 0.02', in either the horizontal or vertical direction.
- Rendered inaccessible.
- Broken.
- Disturbed to a point that the survey monument position is no longer fixed or stable.
- Removed from the ground for any reason.

GEODETIC MONUMENT GPS/GNSS POSITIONING REQUIREMENTS

Prior to commencement of construction activity the General Contractor shall have the monument positioned utilizing GPS/GNSS survey techniques according to the following procedures.

The horizontal datum shall be NAD 83 (2011), New York State Plane Coordinate System, Western Zone and the vertical datum shall be NAVD 88.

The NAD 83 (2011) geodetic position of the monument shall be determined by employing GPS/GNSS survey techniques.

GPS/GNSS surveys shall be static surveys performed by 15 minute minimum occupations with separate observations under differing satellite configurations. Adjustment shall be completed by a minimally constrained least squares adjustment. From the least squares adjustment the maximum allowable Network Horizontal Positional Accuracy (at two sigma, 95% confidence level) shall not exceed 0.02.

If site conditions at the monument location compromise the quality of direct GPS/GNSS observation of the monument position, conventional Theodolite or Total Station terrestrial (TPS) survey techniques shall be employed to position the monument from nearby locations that provide quality GPS/GNSS observation conditions. The alternate locations providing quality GPS/GNSS observation conditions shall be measured between and to the geodetic monument being positioned by fully traversing through all points, forming a closed loop traverse with an occupation of each point by the Theodolite or Total Station.

Conventional Theodolite or Total Station terrestrial (TPS) surveys shall be performed with either an Electronic Distance Measuring Instrument (EDM) (rated with an internal uncertainty of no more than 0.003 m and scale of no more than 2 parts-per-million (ppm)). The EDM distance measurements shall be corrected for both temperature and pressure as necessary. The angulation shall be performed with a directional theodolite or total station that has an internal least count of no more than 2 seconds. A minimum of two positions on the circle (both direct and reverse) and an EDM distance shall be taken along with each angle measurement. Any of the individual angles shall differ from the mean of all angles by no more than 5 seconds and individual distances shall differ from the mean of all distances by no more than 0.01 feet and 2 parts per million (ppm).

LEAST SQUARES ADJUSTMENT OF DATA

Adjustment of the combined GPS/GNSS survey data, Conventional Theodolite or Total Station terrestrial (TPS) survey data shall be completed by a single minimally constrained least squares adjustment of the combined data. From the least squares adjustment the maximum allowable Network Horizontal Positional Accuracy (at two sigma, 95% confidence level) shall not exceed 0.02 feet or a precision of 1 part in 50,000 parts (1:50,000).

GEODETIC MONUMENT ORTHOMETRIC HEIGHT REQUIREMENTS

If the geodetic monument has a record published orthometric height the monument shall be elevated in accordance with one of following procedures.

Where existing geodetic monuments on NAVD 88 vertical datum are within reasonable proximity, the orthometric height, shall be established by employing conventional terrestrial differential leveling techniques and shall close within $0.033 \text{ feet} * \text{SQRT}(s)$ where s is equal to the length of the level run in miles.

Where there are no existing geodetic monuments on NAVD 88 vertical datum within reasonable proximity the orthometric height shall be derived from the GPS/GNSS survey of the direct observation of the monument. Where the geodetic monument position has been determined from nearby locations that provide quality GPS/GNSS observation conditions, the orthometric height shall be determined by employing conventional terrestrial differential leveling techniques from the location that achieved the highest quality GPS/GNSS least squares adjustment orthometric elevation. The orthometric height of the nearby GPS/GNSS location utilized shall have a vertical uncertainty relative to the geodetic monument of no more than 0.006 feet.

GEODETIC MONUMENT POSITIONING & HEIGHT REPORTING REQUIREMENTS

The General Contractor shall submit copies of a report certified, signed and sealed by the Licensed Land Surveyor to the Monroe County Surveyors Office for review and acceptance by the Monroe County Surveyors Office. The report shall contain the following and follow the format of an example report

provided by the County Surveyors Office:

- A summary of survey field operations and least squares adjustment.
- GPS/GNSS post processing report when performed.
- GPS/GNSS OPUS Extended report when utilized.
- If TPS survey techniques are employed, provide an angle sets report (Rounds Report, Direct-Reverse Report), record of field notes, reduction of field data and raw data file.
- Least squares adjustment report with a final adjusted grid coordinate listing.
- Differential leveling summary report.

GEODETTIC MONUMENT MONITORING REQUIREMENTS

Prior to commencement of construction activity and upon completion of construction activity the General Contractor shall secure survey tie information to all geodetic monuments shown on the project plans of the job site that are to be protected. The tie information shall be acquired utilizing conventional Theodolite or Total Station terrestrial (TPS) survey techniques only, without employing GPS/GNSS survey techniques, by angle and distance to points that are identifiable, permanent, substantial, not subject to being disturbed during the construction period, and no more than 100 feet from the geodetic monument being tied down. Distance ties may be made with either an electronic Distance Measuring Instrument (EDM) (rated with an internal uncertainty of no more than 0.003 m and scale of no more than 2 parts-per-million (ppm)) or a surveyor's tape that has been checked against a standard tape traceable to the national standard of reference. The distance measurements shall be corrected for both temperature and pressure as necessary. The angulation shall be performed with a directional theodolite or total station that has an internal least count of no more than 2 seconds. A minimum of two positions on the circle (both direct and reverse) and an EDM distance shall be taken along with each angle measurement. Any of the individual angles shall differ from the mean of all angles by no more than 5 seconds and distances by no more than 0.01 feet and 2 parts per million (ppm).

The contractor's surveyor shall also reference the geodetic monument to a minimum of three vertical tie points that are identifiable, permanent, substantial, not subject to being disturbed during the construction period, and no more than 250 feet from the point being tied down. The reference elevations on the vertical tie points shall have a vertical uncertainty relative to the geodetic monument of no more than 0.006 feet.

The General Contractor shall submit copies of a report certified, signed and sealed by the Professional Land Surveyor to the Monroe County Surveyors Office for review and acceptance by the Monroe County Surveyors Office. The report shall be submitted prior to the start of construction and resubmitted upon completion of construction. The report shall contain the following and follow the format of an example report provided by the County Surveyors Office:

- Pre and post construction survey measurements to tie points and summary of horizontal and vertical pre and post construction measurement differences.
- Angle sets report (Direct-Reverse Report, Rounds Report), record of field notes and raw data file.