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STATE OF MICHIGAN
DEPARTMENT OF LICENSING AND REGULATORY AFFAIRS
BUREAU OF CONSTRUCTION CODES
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MCS 83 Coordinate Reporting

The information contained herein will provide the Office of Land Survey and Remonumentation (OLSR) with the data necessary for efficient processing of the Survey and Remonumentation Grant Program grant applications, contract approvals, start-up funding, work progress reports, completion reports, data filing, and payments for services.

State plane coordinates submitted shall be accompanied by the following in order to provide OLSR and the county surveyors/representatives with a thorough reference to the data submitted and ensure that the work and checks performed are in compliance with the Remonumentation Program.

- Table of Contents
- Detailed report to explain the work completed and processes and procedures used

All documentation should be submitted in a bound and tabbed file for straightforward reference and understanding, e.g., three-ring binder. If coordinates are submitted without the requested report, OLSR will not commence a review until the county provides the necessary information.

If any coordinates submitted do not satisfy the minimum standards of the remonumentation program, the county will receive a letter outlining the deficiencies and the additional information considered necessary. Payment will not be made until the work is completed according to the requirements Remonumentation Program.

The information requested herein is required per:

- State Survey and Remonumentation Act, 1990 PA 345, MCL 54.261-279
- Michigan Coordinate Systems, 1964 PA 9, MCL 54.231-239
- Corner Recordation Act, 1970 PA 74, MCL 54.201-210d
- County Plan
- Annual Grant Agreement
- FGCS Standards and Specifications for Geodetic Control Networks (Yellow Book)
- FGCS Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative Positioning Techniques (Brown Book)
- Minimum Specification Model for Rapid Global Positioning System Observations (Rapid GPS)
- GLO Survey and Instructions
- 1973 Manual of Instructions for the Survey of Public Lands of the United States – BLM Technical Bulletin 6
- Administrative Rules for Professional Surveyors
- Other documents, standards, etc., deemed appropriate by OLSR

MCS 83 Coordinate Reporting

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County of _____

Section	Data Format Required	
	Hard Copy	**Electronic File**
1. Narrative Report	Yes	Yes
2. Certification	Yes	Yes
3. Submitted Coordinate Data	No	Yes, Comma Delimited File
4. Independent Measurement Checks	No	Yes
5. Set-up / Observation Coordinate Checks	No	Yes
6. Coordinate Checks for Adjacent Networks	No	Yes
7. NGS Coordinate Checks	No	Yes
8. Data Sheets	No	Yes
9. Least Squares Adjustment	No	Yes
a. Project Assumptions/Adjustment Settings	No	Yes
b. Fixed Stations	No	Yes
c. Unadjusted observations	No	Yes
d. Adjustment Statistical Summary	No	Yes
e. Adjusted coordinates	No	Yes
f. Scale Factors	No	Yes
g. Adjusted observations and residuals	No	Yes
h. Error Propagation		
- Standard Deviations	No	Yes
- Error Ellipses	No	Yes
i. Network Sketch	No	No

This information encompass both the standard FGCS Model and the Rapid GPS Model for establishing coordinates in conjunction with the Remonumentation Program. Since many of the processes, procedures and deliverables are similar between the two standards OLSR combined both into a single guidance document. Where there is a dramatic difference, in the requirements of the two models, the document provides an explanation as it relates to the FGCS Model and then highlights the differences specified in the Rapid GPS Model.

Please note that the "Rapid Model" or "Rapid GPS" refers to the *Minimum Specifications Model for Rapid Global Positioning Systems Observations*, as outlined by this office. This model shall only be used by those counties that have amended their county plan to include this specification model. For the county plan to be amended the requested amendments must be accepted and approved by the county commissioners and submitted to this office for review and approval.

1. Narrative Report:

The narrative report should be a comprehensive document that summarizes the entirety of the survey, discussing specifics relating to both the field and the office, and is supported by the data. The report shall be separated by contract year, contract surveyor, and least squares adjustment.

The report should list the points positioned, identified by Town – Range and Code, specify the total number of corners positioned, the total number of new corners/coordinates established, and the total number of common corners/coordinates established. The report should also identify if "points of convenience" were used during the course of the survey, how many were established and the purpose they served. (For the purpose of the Remonumentation Program "point of convenience" refers to any position established that is not a corner position, i.e., traverse points, base stations, local control points, etc.)

The report should provide an explanation of the mission planning and field procedures employed in the completion of the survey. It should specifically identify the classification of the survey standard and procedures used to complete the survey. It should also highlight the classification of the survey standard and procedures used when alternate methodologies were employed and describe how they were implemented. **Please Note:** The minimum classification requirements are: Conventional Survey – Third-Order Class 1; GPS – Group C Order 3, or Rapid GPS (depending on County Plan).

The report should describe the approach to data collection and identify the minimum procedural specifications established for the survey. Procedural specifications should be identified for each methodology and classification employed during the course of the survey. Some of the specifications that should be considered and discussed include; number of satellites simultaneously tracked and observed, data sampling/collection interval, observation time, Dilution of Precision (DOP), elevation mask, conventional positioning (angles and distances measured,) etc.

The report should specifically identify points that were observed under canopy or where significant natural signal obstructions were prevalent. Additionally, a narrative describing the site conditions and problems with or changes to typical point observation / data collection techniques should be provided.

The report should include a statement certifying equipment calibrations were completed, e.g. bubble checks on rods, tripods, etc. The certification should include the date of the calibration and the names of the individuals completing the calibrations. The equipment used to complete the survey should also be identified by manufacturer, model number and serial number for each receiver and antenna. The names of the equipment operators and the dates they completed observations should also be provided.

The report should include a narrative description of the approach to data processing. It should highlight and discuss the procedures followed and the software used for completing the least squares adjustment. A detailed analysis of the least squares adjustment and the final coordinate data should be provided. The project assumptions and adjustment settings should be discussed. The fixed and partially fixed (weighted) stations used should be identified with explanations given. Discussion of the final adjustment statistics, residuals, covariant terms, and error propagation should also be provided and include the identification of adjusted observations where the statistical analysis reports errors or relative accuracies that are outside the standards and discuss how they were resolved.

The report should also include the identification of the MCS zone the coordinates are based on, the current realization (adjustment year), either CORS96 or NSRS2007, of the NAD 83 held for the network adjustment, the vertical datum and height used in the adjustment, the designation and PID for control stations held fixed or otherwise utilized including a description of the stations purpose.

Naming conventions used in the survey whether for corners, points of convenience, townships or other uses should also be provided and explained.

Other information regarding the survey deemed significant.

2. Certification:

MCS 83 Surveyor's Certification: the OLSR provided certification signed, sealed and dated by the contracting surveyor.

3. Submitted Coordinate Data:

Upload data file: provided as a comma-delimited file on CD. **Please Note**: Since the filing data is being requested via disc, the county does not need to enter any data into the online system; OLSR will upload the data using this file. See the document titled MCS 83 Data Uploads from Counties (Rev. 7-2-2009) for the required data fields and format.

NOTE: Standard Deviation: 1.96 times 1-sigma or greater must be the number reported for the state to publish coordinates and demonstrate that the desired accuracy has been achieved. By definition, the standard deviation is equivalent to 1-sigma, which represents a probability at the 68.3 percent confidence level. The Michigan Coordinate Systems, 1964 PA 9, MCL 54.231-239, requires a standard deviation for the northing coordinate and the easting coordinate be stated for each coordinate pair intended to be placed on public record. Contractually, the grant agreement requires the standard deviation be expressed at the 95 percent confidence level, which equates to 1.96-sigma.

A least squares adjustment completed at the 95 percent confidence level may or may not report the standard deviation at 1.96-sigma. For example no matter what confidence level is selected for an adjustment, Star*Net will only report the standard deviation per its definition, 1-sigma. Thus, when submitting the standard deviation for publication through the Remonumentation Program, the Star*Net output data must be multiplied by 1.96 or greater to satisfy the standards outlined in the grant agreement. This may or may not be true of other adjustment programs being used.

The contracting surveyor may report a standard deviation greater than 1.96-sigma within tolerance (.125 feet) where the professional believes that the calculated number may misrepresent the true accuracy of the coordinate pair and the overall survey. 1964 PA 9, MCL 54.231-239 requires that the standard deviation be reported. Thus, other positional errors, including error ellipses, root mean square, and standard errors may not be directly substituted for the standard deviation. These errors are important values, however, and provide a realistic representation of the positional accuracy of the points surveyed. As such, they are imperative for the statistical analysis and may be requested as part of the completion report.

4. Independent Measurement Checks:

The independent checks defined in Article 1.1, Statement of Work, Section A(3)(a)(ii) of the grant agreement correspond to checks made on and involving only the current points and network adjustment. "…independent measurements shall be made, using a different equipment configuration and/or technique from that originally used, between adjacent corners to compare with the final adjusted distance from the least squares adjustment program. These independent measurements shall be performed on a randomly selected minimum of 5 percent of quarter corner-section corner (half mile) or section corner-section corner (full mile) distances originally measured and adjusted."

A minimum of 5 percent of the currently established corners require independent measurement checks. These distance checks must be half mile distances measured between a quarter section corner and a section corner or full mile distances measured between two section corners. These measurements should be made in as direct a manner as site conditions allow.

The specific survey methods to complete this task are not defined, except that they must be "…made, using a different equipment configuration and/or technique from that originally

used." It is expected that the work completed under this category will be completed to an acceptable standard of practice and a description of the processes and procedures employed will be provided.

Distances measured between standard and closing corners do not qualify as check measurements under this subsection; however it is highly recommended that direct distance measurements be observed between all standard and closing corners and used in the network adjustment.

The *Minimum Specifications Model for Rapid Global Positioning Systems Observations* modify these standards and requirements. Section 4a increases the requirement for independent measurements from 5 percent to 10 percent. Section 4b requires "A direct measurement shall be made using conventional methods between adjacent corners that are 100 feet or less apart." These observations must be used in the network adjustment. As direct measurements, they will hold greater weight in the adjustment and provide additional data for fixing the positions of corners that are in close proximity to each other.

Specific information requested to be provided under this section includes:

a. Calculated grid distance from final adjusted coordinates

b. Average combined scale factor for the distance; show individual point combined scale factors used to calculate average

c. Calculated ground distance from final adjusted coordinates and application of average combined scale factor

d. Independent ground distance measurement

e. Difference error between calculated ground distance and independent ground distance measurement

f. Difference expressed as PPM
(Difference error / Calculated ground distance)*1,000,000=PPM

g. Narrative describing the procedures used to establish the independent distance checks and any other significant information regarding these distances and checks.

5. Set-up / Observation Coordinate Checks:

Section 6d of the *Minimum Specification Model for Rapid Global Positioning System Observations* states "Observations should begin and end with check shots to known control." These checks should be completed for each independent set of observations. The reason for this requirement is to verify that the rover unit has a good initialization with the base unit and that accurate data will be collected.

Specific information requested to be provided under this section includes:

a. Coordinate values for each known control point being checked

b. Coordinate values for each observation to known control point (these coordinates should be raw observations, not adjusted)

c. Difference error for each coordinate component between the known coordinate and the check coordinate

d. Narrative describing the procedures used and any other significant information regarding these distances and checks

6. Coordinate Checks for Adjacent Networks:

The adjacent coordinate checks defined in Article 1.1, Statement of Work, Section A(3)(a)(iv) of the grant agreement correspond to the checks made on and involving all coordinate work adjacent to the current project and adjustment area. "For projects where two or more surveyors are working in adjacent contract areas or where separate least square adjustments are made to establish state plane coordinates…" 30 percent of all adjacent coordinates, whether previously or concurrently established, are required to be verified. The 30 percent should be distributed across the entirety of the border and include coordinates within each adjacent network.

The reason for Section A(3)(a)(iv) of Article 1.1 of the Grant Agreement is to verify that all work (coordinates, network adjustments, etc.) within the greater project area are mathematically related and can be duplicated, within the tolerance specified, under different conditions and different methodology. The outlined process tests the accuracy of both the current network as well as the adjacent networks and verifies that they are associated within the project specifications.

The specific survey methods to complete this task are not defined; however, it is expected that work completed under this category will be completed to an acceptable standard of practice and a description of the processes and procedures employed will be provided.

Specific information requested to be provided under this section includes:

a. Published coordinates for each adjacent point

b. Measured coordinates for each adjacent point

c. Difference error for each coordinate component between the published coordinates and measured coordinates

d. Narrative describing the procedures used and any other significant information regarding these points and checks

7. **NGS Coordinate Checks:**

The FGCS manual *Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative Positioning Techniques*, states that "Direct connections are required: Between ANY adjacent {NGRS and/or new GPS} stations (new or old, GPS or non-GPS) located near or within project area, when spacing is less than (Km)…" and the distance specified for Group C, Order 3 is 3 km. The recovery and maintenance of these points is reimbursable through the program per Section VIII Geodetic Densification and Maintenance Program of the County Plan.

Specific information requested to be provided under this section includes:

a. Published coordinates for each adjacent point

b. Measured coordinates for each adjacent point

c. Difference error for each coordinate component between the published coordinates and measured coordinates

d. Narrative describing the procedures and any other significant information regarding these points and checks

Note: Please contact OLSR for specifics and additional clarification concerning NGS Coordinate Checks.

8. Datasheets:

For all published, second order or better, NGS stations held fixed in the least squares adjustment, please provide copies of published NGS datasheets and recovery information; also note the station as a control station held fixed in the adjustment.

For all published NGS stations not fixed but otherwise used or checked during the survey, please provide copies of published NGS datasheets and recovery information; also note whether the station was used, if so, please describe how the station was used/checked.

For all unpublished control stations held fixed in the least squares adjustment, please provide a report which certifies these control stations in accordance with 1964 PA 9, MCL 54.231-239, Michigan Coordinate Systems, specifically sections 54.235a and 54.236 as outlined in Section VIII Geodetic Densification and Maintenance Program of the County Plan.

The monument requirements and positioning standards for first and second order control stations are outlined in the FGCS manual Standards and Specifications for Geodetic Control Networks (Yellow Book) and FGCS manual Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative Positioning Techniques (Brown

Book). The reporting requirements for NGS control densification and inclusion into the National Geodetic Reference System (NGRS) are defined in FGCS manual Input Formats and Specifications of the National Geodetic Survey Data Base (Blue Book), additional information and standards are available through NGS.

9. Least Squares Adjustment:

A copy of the fully/rigidly constrained least squares adjustment should be provided. The adjustment should be reported and pass at the 95 percent confidence level, processed and reported in international feet. The report should include unadjusted and adjusted observation data, with residuals for the adjusted observations. When possible, the difference error and relative accuracy of the adjusted data should be provided and expressed as parts per million (ppm).

The following is required to be submitted, at a minimum, as part of the adjustment file

a. Project Assumptions/Adjustment Settings
b. Fixed Stations
c. Unadjusted observations
d. Adjustment Statistical Summary
e. Adjusted coordinates
f. Scale Factors
g. Adjusted observations and residuals
h. Error
   - Standard Deviations
   - Error Ellipses
i. Network Sketch