

# MISSOURI DEPARTMENT OF TRANSPORTATION

## Design Division



## HEIGHT MODERNIZATION CONTROL SURVEY

NAD83 (2011) ADJUSTMENT

PROJECT REPORT FOR

Project Name: MOCH HEIGHT MODERNIZATION  
NGS Tracking Number: 9572

### LOCATION:

Missouri Department of Transportation's maintenance facility located in Mississippi County on County Road (CR) 325, 0.49 km (0.3 mi) south of the intersection of US Hwy 62 and CR 325.

Report Date:

January 2022

Conducted For:	MODT
Conducted By:	MODT
Adjusted By:	MODT

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# 1 Introduction

This geodetic control survey was performed to establish a GPS-Derived Orthometric Heights on NOAA's CORS Site, MOCH. It was distinguished by use of redundant, interconnected, permanently monumented control points to be incorporated into the National Spatial Reference System (NSRS). This survey was performed to a far more rigorous accuracy and quality assurance standards than those for general surveying, engineering, or topographic mapping purposes.<sup>1</sup>

Point of contact

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# 2 Project Attributes

Horizontal Datum: North American Datum of 1983 (2011) epoch 2010.00

Vertical Datum: North American Vertical Datum 1988

Geoid Model Used: Geoid 18

Number of new stations: 0 stations not yet in the NGS IDB

Number of existing stations: 3 stations with PIDs in the NGS IDB

Numbers of CORS station: 6 stations were tied to this project

Specific station details are provided in Section 2.2.

Latitude/Longitude of the project boundaries as defines by WinDesc, excluding the CORS

		Project Limits			
		Minumum		Maximum:	
Latitude:	<input type="text" value="365505"/>	<input type="text" value="N"/>	<input type="text" value="370139"/>	<input type="text" value="N"/>	<input type="text" value=""/>
Longitude:	<input type="text" value="0891317"/>	<input type="text" value="W"/>	<input type="text" value="0892211"/>	<input type="text" value="W"/>	<input type="text" value=""/>
Elevation:	<input type="text" value="103.571"/>	<input type="button" value="Compute"/>			

<sup>1</sup> The introductory paragraph was largely composed of information found in the FGDC, Geospatial Positioning Accuracy Standards Part 2: Standards for Geodetic Networks, 1998. Available at, <https://www.fgdc.gov/standards/projects/accuracy/part2/chapter2>

## 2.1 Agency and Purpose

This survey was conducted by the Missouri Department of Transportation's Design Division (agency code MODT) in support of the department's real-time network.

## 2.2 Project Chronology and Field Work

### Initial Project Request

The initial project request was submitted to and approved by the National Geodetic Survey on November 12, 2021.

### Reconnaissance and Mark-Setting

Reconnaissance for this project was completed by MODOT field personnel in the fall of 2021. The following table detail the marks used in this project.

Existing Marks Recovered for this Project			
SSA	SSN	PID	DESIGNATION
B278	1001	HB1239	B 278
D278	1002	GD1266	D 278
W277	1003	GD1247	W 277

### Field Observations

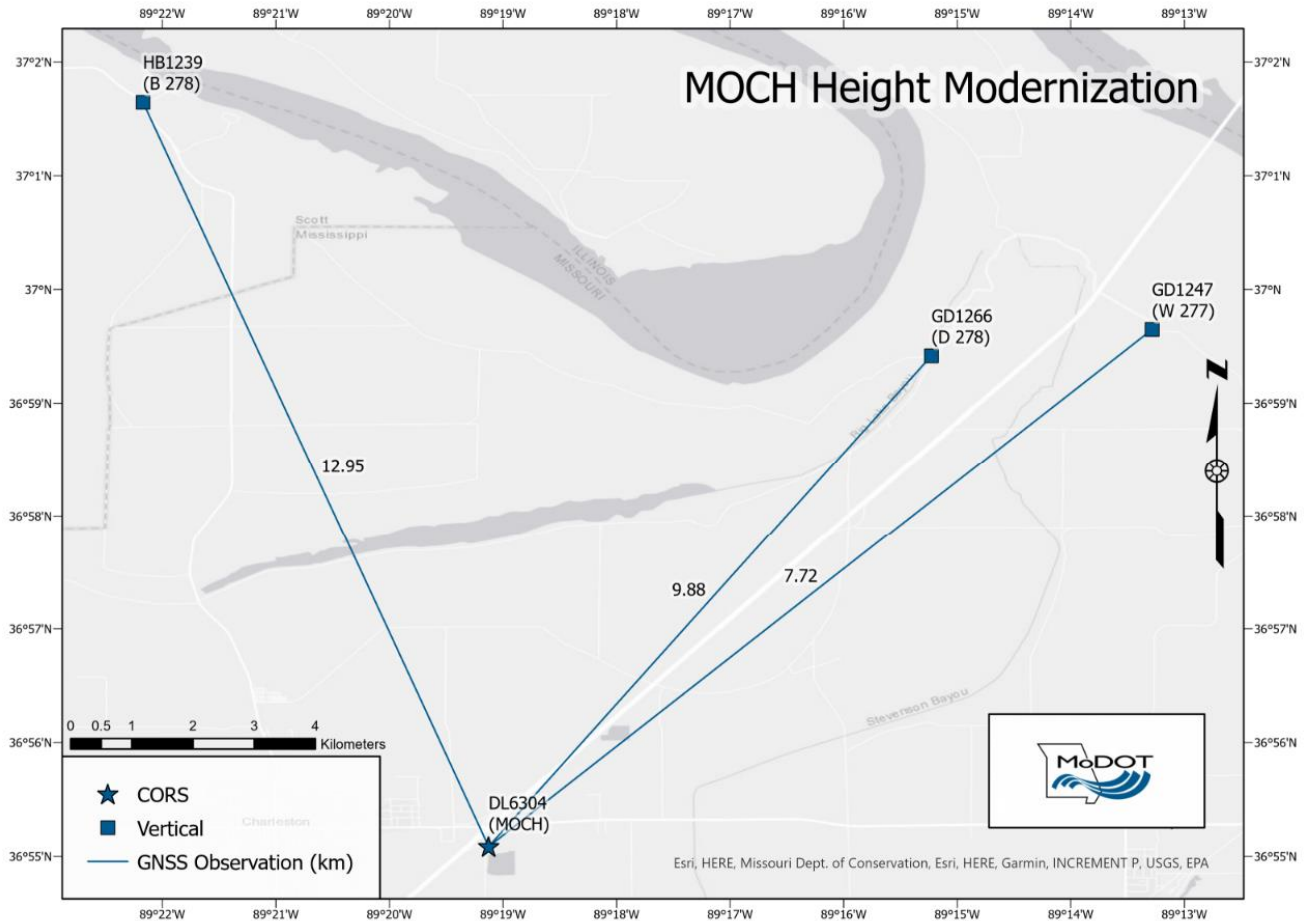
GNSS observations were conducted by MoDOT between November 08, 2021 and November 15, 2021 under the supervision of Jim Copeland. The observations were collected according to the specifications detailed in section 4.3 of this report which included only the GPS constellation, a collection interval of 1 second, at a 10° mask angle.

### Adjustment

The NAD83(2011) adjustment was processed and adjusted in January 2022.

### 3 Location

Missouri Department of Transportation’s maintenance facility located in Mississippi County on County Road (CR) 325, 0.49 km (0.3 mi) south of the intersection of US Hwy 62 and CR 325.



### 4 Project Specifications

The following project specifications describe the instructions under which this survey was planned, observed, and processed. See Appendix B for a table captured from OPUS Projects that illustrates the sessions and number of observations associated with each mark.

## 4.1 Accuracy Standards<sup>2</sup>

This GNSS survey conforms to the FGCC standards for first-order GPS surveys according to the Geometric Geodetic Accuracy Standards and Specifications for using GPS Relative Positioning Techniques, version 5.0 with corrections, August 1, 1989, FGCC.

Network design, field observations, and processing standards conformed to the specifications found in Guidelines for Establishing GPS-Derived Ellipsoid Heights (Standards: 2cm and 5cm), NOAA Technical Memorandum NOS NGS 58 and Guidelines for Establishing GPS-Derived Orthometric Heights, NOAA Technical Memorandum NOS NGS 59 whenever possible.

This geodetic network survey was performed to meet automated data recording, submittal, project review, and least squares adjustment requirements established by the Federal Geodetic Control Subcommittee (FGCS).

The network accuracies<sup>3</sup>, expressed at two sigma ( $2\sigma$ ), were the result of the final constrained adjustment described in section 9.2 of this report and represent the certainty of position by a single point coordinate. It provides a means to directly compare the accuracy of coordinate values obtained in this survey with those obtained by other methods for the same point.

SSN	PID	DESIGNATION	SD_N (cm)	SD_E (cm)	SD_h (cm)
0001	DL7695	HCES	0.08	0.19	0.33
0002	DM4672	MODX	0.14	0.15	0.35
0004	DR7391	MOPT	0.13	0.13	0.39
0007	DN6083	MOHT	0.04	0.07	0.17
1001	HB1239	B 278	0.17	0.16	0.52
1002	GD1266	D 278	0.17	0.16	0.52
1003	GD1247	W 277	0.17	00.16	0.53
1004	DM4118	MOCH	0.06	0.08	0.26

<sup>2</sup> Information found in this section was primarily composed of statements and concepts found in the FGDC, Geospatial Positioning Accuracy Standards Part 2: Standards for Geodetic Networks, 1998. Available at, <https://www.fgdc.gov/standards/projects/accuracy/part2/chapter2>

<sup>3</sup> The network accuracy of a control point is a value that represents the uncertainty in the coordinates of the control point with respect to the geodetic datum at the 95-percent confidence level. For NSRS network accuracy classification, the datum is considered to be best expressed by the geodetic values at the Continuously Operating Reference Stations (CORS) supported by NGS.

## 4.2 Planning

This Height Modernization Survey conforms to the specifications found in Guidelines for Establishing GPS-Derived Ellipsoid Heights (Standards: 2cm and 5cm), NOAA Technical Memorandum NOS NGS 58 and Guidelines for Establishing GPS-Derived Orthometric Heights, NOAA Technical Memorandum NOS NGS 59.

## 4.3 Fieldwork

### Monumentation

No new monuments were set as a part of the scope for this project.

### Observations

The observation guidelines under which this survey was conducted were a combination of NOS 58, OPUS Projects processing requirements, and MoDOT specifications. They included:

#### Equipment:

- Equipment must be well maintained and properly calibrated.
- Uniform receivers and antennas are required for all observations. That is to say, the same manufacturer and model of equipment must be used for all observations.
- Receivers must collect dual-frequency GPS(L1/L2) full-wavelength carrier observables.
- Only antennas with calibrations accepted by the National Geodetic Survey (NGS) may be used. See <http://www.ngs.noaa.gov/ANTCAL/> for a list of accepted antennas.
- Fixed height tripods will be required.

#### Procedures:

- The antenna's north reference point (NRP) shall be aligned oriented toward the true north direction as defined by NGS. See <http://www.ngs.noaa.gov/ANTCAL/FAQ.xhtml#faq5> for additional details.
- The antenna must remain unmoved throughout the observing session.
- Only GPS observables will be processed.

- Elevation cut-off or mask angle shall not be set greater than 10°.
- Recording rates, or epochs, shall be set to 15 seconds or less.
- Data shall be collected as static observations.
- The assigned and provided station SSA and SSN shall be used as the station identification for any field inputs prior to the commencement of the observation.
- A record of deviations from these instructions will be maintained and submitted to MoDOT at the conclusion of the project

Session Parameters:

- Data will be collected in sessions. A minimum of three receivers will be required for every session. Each session will require a minimum of 5.0 hours of simultaneous observation (i.e., when all receivers are recording at the same time) and a minimum of 4.0 hours of individual observation (a specific receiver on a specific mark). If one surveyor is operating multiple receivers it is understood that there will be staggered start/stop times.
- One field surveyor may operate up to three receivers per session.
- Each station will be observed a minimum of three times. The observations associated with any one mark should be taken on different days. The time of at least one redundant observation must be different than the other two.
  - 1st observation of mark ONE taken on day 001, session A
  - 2nd observation of mark ONE taken on day 002, session A
  - 3rd observation of mark ONE taken on day 003, session A
- Sessions will be scheduled so that marks are observed in line, that is to say, connected to their nearest neighbor in the session with alternate sessions overlapping previous sessions to tie the project together.
- Field log sheets (format provided by MoDOT) will be required for each observation/occupation.
  - NGS mark designation will be used.
  - Cross out any incorrect entries and replace with the appropriate correction as one would do with traditional survey field notations.



- Fixed height metric unit to the Antenna Reference Point (ARP) will be used as shown in this illustration from Volume I – Global Navigation Satellite System Control, Chapter 4, page 4-19, available at, [http://www.ngs.noaa.gov/FGCS/BlueBook/pdf/Chapter%204%204\\_24\\_15.pdf](http://www.ngs.noaa.gov/FGCS/BlueBook/pdf/Chapter%204%204_24_15.pdf)
- ARP height will be recorded in meters.
- Record comments about potential issues such as inclement weather or potential obstructions nearby.

Available resources in terms of manpower, equipment, and time may result in slight deviations regarding the session attributes. See Appendix B for a table captured from OPUS Projects that illustrate the sessions and number of observations associated with each mark.

#### 4.4 Vector Processing

OPUS Projects was used as the baseline processor for this project. The following guidelines provided by Missouri's State Advisor, Brian Ward along with the National Geodetic Survey's Horizontal Branch recommended that the following preferences be set for processing. The recommendations were applied to this survey.

##### Network Design

- Session networks included both short (CORS within 100km) and long (IGS exceeding 500km) baseline lengths
- Baselines were defined by selecting one CORS station per session as a hub
- Each rover<sup>4</sup> connected directly to the hub station
- All hub stations were present in all project sessions where data was available
- No distances to hub stations exceeded 100km

##### Preferences, Constraints, and Tropospheric Modeling

- See Appendix C for a copy of the OPUS Projects Preference settings
- Precise ephemeris was used
- The normal constraints option was selected
- User was selected as the Network Design
- Piecewise Linear was selected as the Tropo Model option with a Tropo Interval of 7200 seconds

- Elevation cutoff, 15 degrees

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<sup>4</sup> In this report, rover is defined as an autonomous receiver used to observe a passive mark

## 5 Conditions Affecting Progress

### 5.1 Weather

The field surveyors reported no thunderstorms during the scheduled observation period.

### 5.2 Instrumentation Failures

The field surveyors reported no issues with the instrumentation.

### 5.3 Deviations from Instructions

There were no reported deviations from instructions.

## 6 CORS and CORS Accuracies

Six CORS were included in the project. They were:

SSA	PID	DESIGNATION
MOCH	DM4118	MODOT CHARLESTON CORS ARP
MODX	DM4672	MODOT DEXTER CORS ARP
MOHT	DN6083	MODOT HAYTI CORS ARP
HCES	DL7695	HILLCREST ELEMENT CORS ARP
MOPT	DR7393	MODOT PATTON CORS ARP
MOTK	DP4105	MODOT TARKIO CORS ARP

MoDOT CORS MOTK located in Tarkio, Missouri was included in every session for proper tropospheric modeling.

CORS data were automatically referenced in OPUS Projects. Copies of the CORS data were not included with this submittal. Published accuracies were available for MOCH, MODX HCES, MOHT and MOTK. Although MOTK had published accuracies, the station was not constrained in this project. Short-term accuracies were used for all other CORS. See Appendix A, of this report, for screen captures of the accuracies.

## 7 Instrumentation

Passive mark instrumentation used on this job:

Manufacturer	Integrated Receiver/Antenna Model Type	NGS Antenna Model Designation	Serial Number	Firmware Version
Topcon	GR3	TPSGR3 NONE	444-0812	4.0 p7
Topcon	GR3	TPSGR3 NONE	444-0814	4.0 p7
Topcon	GR3	TPSGR3 NONE	442-0256	4.0 p7

CORS instrumentation used on this job:

	CORS SSA	Manufacturer	Type	Serial Number
Receiver Info	MOCH	Trimble	NETR9	5504R50139
	MODX	Trimble	ALLOY	5921R40223
	MOHT	Trimble	NETR9	5502R50089
	HCES	Septentrio	SEPT POLARX5	3046496
	MOPT	Trimble	ALLOY	6103R40202
	MOTK	Trimble	NETR5	4816K55307
Antenna Info	MOCH	Trimble	TRM57971.00 NONE	30972990
	MODX	Trimble	TRM115000.00 NONE	1551017004
	MOHT	Trimble	TRM57971.00 NONE	1440912561
	HCES	Septentrio	SEPPOLANT_X_MF NONE	14417
	MOPT	Trimble	TRM57971.00 NONE	5000117465
	MOTK	Trimble	TRM57971.00 NONE	30895646

## 8 Data Processing

GNSS data was collected directly to the receivers. The files were downloaded from each receiver using a USB data transfer cable onto a network server share before ultimately uploading to OPUS Projects.

## 8.1 Software Used

Vector processing was completed using OPUS Projects 4.0.1 solution software page5 (2008.25).

The network adjustment was completed using NGS Adjust Suite software version 6.4.3.

## 8.2 Vector Processing and Analysis

All observations were uploaded to OPUS Projects through OPUS Static. OPUS Projects automatically grouped the data into sessions based on simultaneous occupation time. The OPUS Projects sessions matched the observed sessions as reported.

The independent solutions were reviewed to identify the best possible CORS hubs for each session. This information was compared against the processing requirement that the local CORS be within 100km of the project mark. That analysis resulted in the selection of five local CORS which were used to process the project.

The single most prevalent CORS in each session was selected as an initial hub. This resulted in a preliminary G file which was used in a preliminary adjustment to identify poorly fitting vectors by examining the vector residuals. The sessions with individual marks having high residuals were reprocessed in OPUS Projects using a different hub. Those marks were then reviewed individually using the OPUS Projects, Processing Results Plots to identify the best fitting solutions in the northing, easting, and upping components. A guideline for allowable variation in northing and easting was approximately 0.02m horizontally and in the upping approximately 0.04m vertically. Outlying solutions were excluded as possible hub solutions for the final G file.

The final CORS selection is shown in the table below. Session hubs are labeled.

Session	MOPT	HCES	MODX	MOCH	MOHT	MOTK
313A	X	X	X	HUB	X	X
314A	X	X	X	HUB	X	N/A
319A	X	X	X	HUB	X	N/A

### Loop Closures

OPUS Projects does not compute a loop closure. No loop analysis was completed for this project.

### COMPVECS Analysis

Comparable vector analysis, as recommended by NOS 58, was not computed for this project. The OPUS Projects network design utilizes the CORS hub method where all session marks are connected to one hub. This did not allow for a nearest station comparable vector analysis in the upping.

## 9 Network Adjustment

Normal MoDOT file naming conventions were adhered to and NGS adjustment procedures were followed.

### 9.1 Minimum Constrained Horizontal Adjustment

MOCH CORS ARP (DM4118) was constrained in all three dimensions. The sigma scale factors were 0.856 horizontally and 0.386 vertically. These scale factors are typical of adjustments processed using OPUS Projects. For that reason, the sigma scale factors were accepted.

PREPLT2 was run and analyzed for residuals exceeding the recommend guidelines of 0.02m horizontally and 0.04m vertically. There were no issues.

A coordinate comparison was computed to evaluate the differences between published control and the positions computed in the free adjustment. There were no issues. The results were shown in the table below (units in meters).

SSN	DESIGNATION	HORIZ. DIFF	H. AZIMUTH	VERT. DIFF
0001	Hillcrest Element CORS BPA	0.013	69 42 29	0.005
0002	MODOT Dexter CORS ARP	0.007	82 10 56	0.025
0004	MOPT Patton CORS GRP	0.001	0 17 47	0.031
0007	MODOT Hayti CORS ARP	0.007	45 27 23	0.010
1004	MODOT Charleston CORS ARP	Fixed	Fixed	Fixed

## 9.2 Constrained Horizontal Adjustment

The sigma scale factors from the free adjustment B file were applied to the constraining A file's VS record. All published coordinates were constrained as shown:

PID	SSN	DESIGNATION	LATITUDE (N)	LONGITUDE (W)	ELLIP. (m)
DR7695	0001	Hillcrest Element CORS BRP	36 19 57.35353	089 10 18.33419	79.140
DM4672	0002	MODOT Dexter CORS ARP	36 48 24.82023	089 58 42.95873	89.104
DR7393	0004	MOPT Patton CORS GRP	37 31 27.91539	090 00 47.19032	194.772
DN6083	0007	MODOT Hayti CORS ARP	36 14 37.95240	089 43 41.85530	56.880
DM4118	1004	MODOT Charleston CORS ARP	36 55 05.22457	089 19 07.58651	71.325

The adjustment results were:

DEGREES OF FREEDOM = 60

VARIANCE SUM = 71.0

STD.DEV.OF UNIT WEIGHT = 1.087

VARIANCE OF UNIT WEIGHT = 1.18

PREPLT2 was run and analyzed for excessive vector residuals which may have indicated a coordinate conflict. None was found. All published positions should be constrained.

The constrained station shifts found in the Adjust output file were reviewed and tabulated below (units in meters). There were no concerns.

LAT.	LONG.	HORIZ.	ELLIP.	SSN	DESIGNATION
0.003	0.008	0.008	0.010	0001	Hillcrest Element CORS BRP
0.000	0.003	0.004	0.019	0002	MODOT Dexter CORS ARP
0.001	0.003	0.003	0.008	0004	MOPT Patton CORS GRP
0.004	0.001	0.004	-0.004	0007	MODOT Hayti CORS ARP
-0.001	-0.003	0.004	0.006	1004	MODOT Charleston CORS ARP

### 9.3 Free Vertical Adjustment

The horizontally constrained output B file was run through INTG using GEOID 18 to add the geoid separation to the \*86\* records. This B file was the input B file for the vertically free adjustment. The same sigma scale factors (VS record) from the horizontal free adjustment were added to the vertical free A file.

All stations had First order, Class I orthometric heights published in the NGSIDB.

A vertical free adjustment was run constraining NGSIDB station B 278 (HB1239) vertically and CORS station MOCH (DN4118) horizontally. A height comparison was made to evaluate the leveled values against the GNSS computed values. The results were shown in the table below.

SSN	Designation	Vert Diff (m)
1001	B 278	Fixed
1002	D 278	0.022
1003	W 277	0.025

### 9.4 Constrained Vertical Adjustment

All published heights determined by Second order, Class I leveling methods or better were constrained. The following table lists the constraints applied and their source.

SSN	PID	Designation	Elevation (m)	Source
1001	HB1239	B 278	103.571	NGSIDB
1002	GD1266	D 278	103.564	NGSIDB
1003	GD1247	W 277	102.475	NGSIDB

The adjustment results were:

DEGREES OF FREEDOM = 50

VARIANCE SUM = 69.0

STD.DEV.OF UNIT WEIGHT = 1.175

VARIANCE OF UNIT WEIGHT = 1.38

There were no concerns with this adjustment. Only station MOCH was positioned vertically in this survey.



## 10 Comments and Recommendations

OBSCHK, CHKOBS, and OBSDES were run. All checking programs ran without error.

## 11 Supporting Documentation

The following information has been submitted using OPUS Project 4.0.

- Station descriptions – MOCH.des
- Observing Schedule and Field Logs - Observing Schedule\_FieldLogs\_MOCH.pdf

## 12 Certification

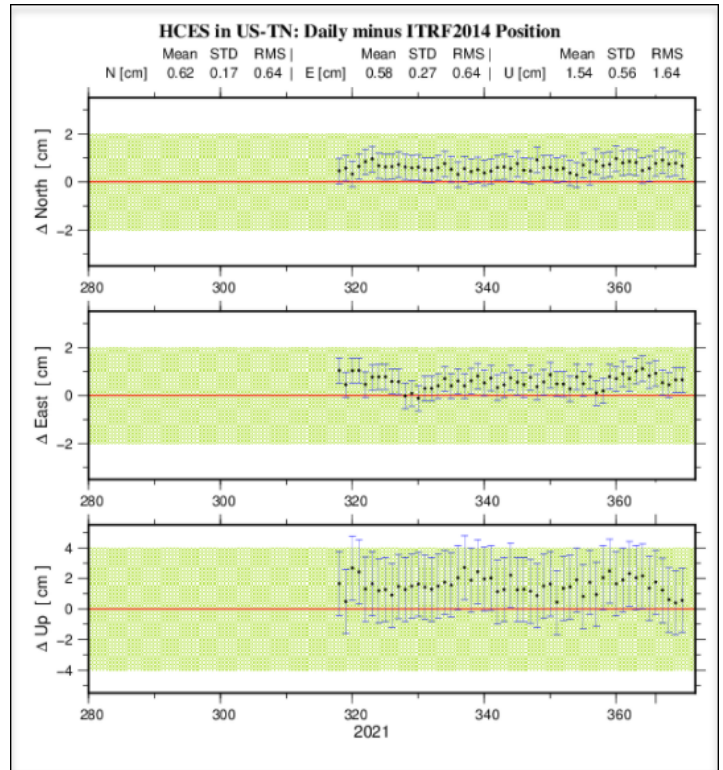
I hereby certify that this report was prepared by me and that all information acquired has been verified and to the greatest extent inaccuracies have been omitted by thorough analysis as well as proper research.

Signature: \_\_\_\_\_

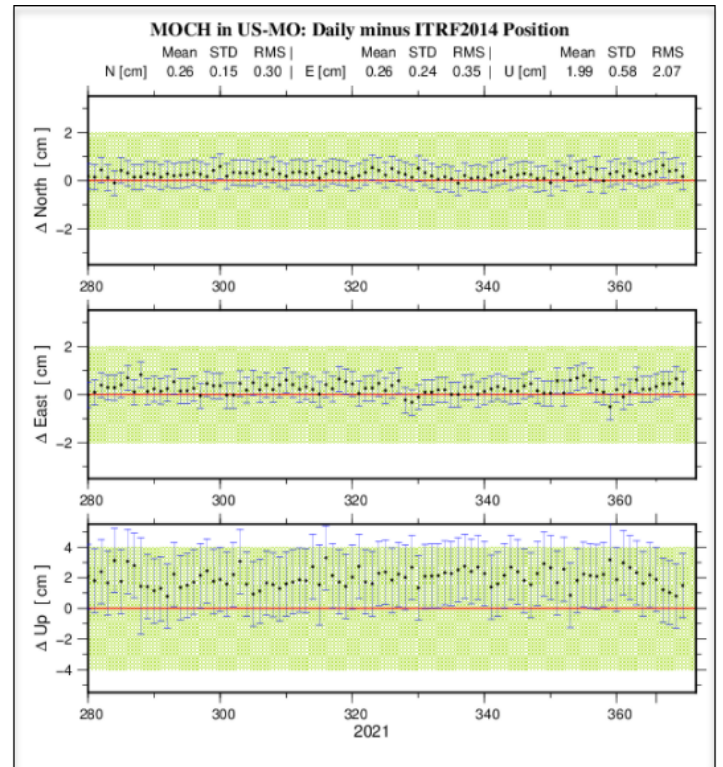
Jim Copeland, PLS  
Land Survey Coordinator

# Appendix A – CORS Accuracies

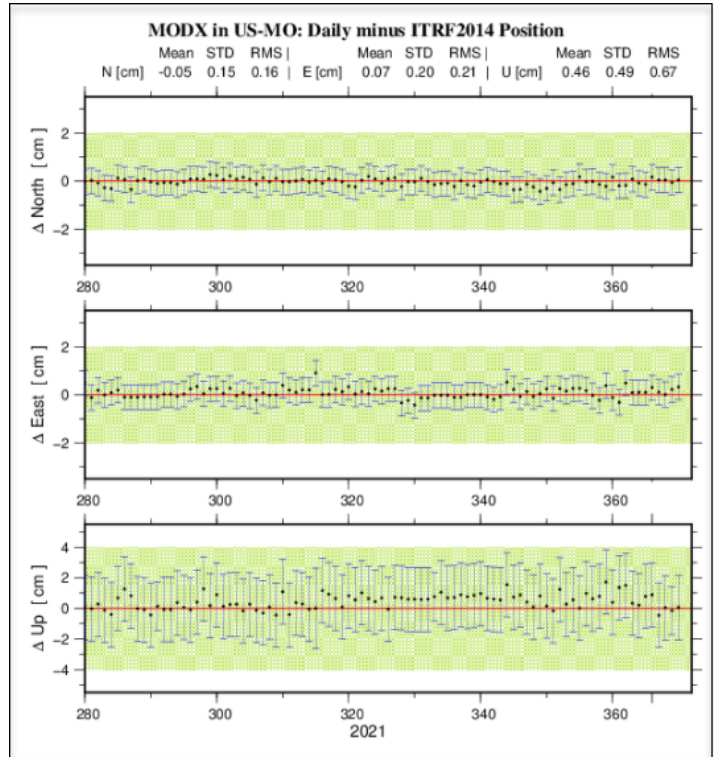
## HILLCREST ELEMENT CORS ARP, DL7695



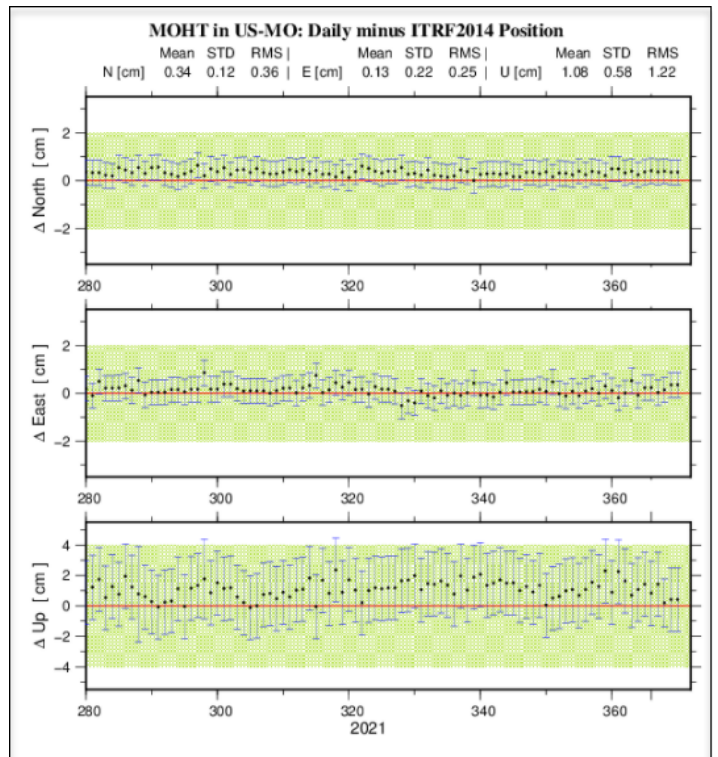
## MODOT CHARLESTON CORS ARP, DM4118



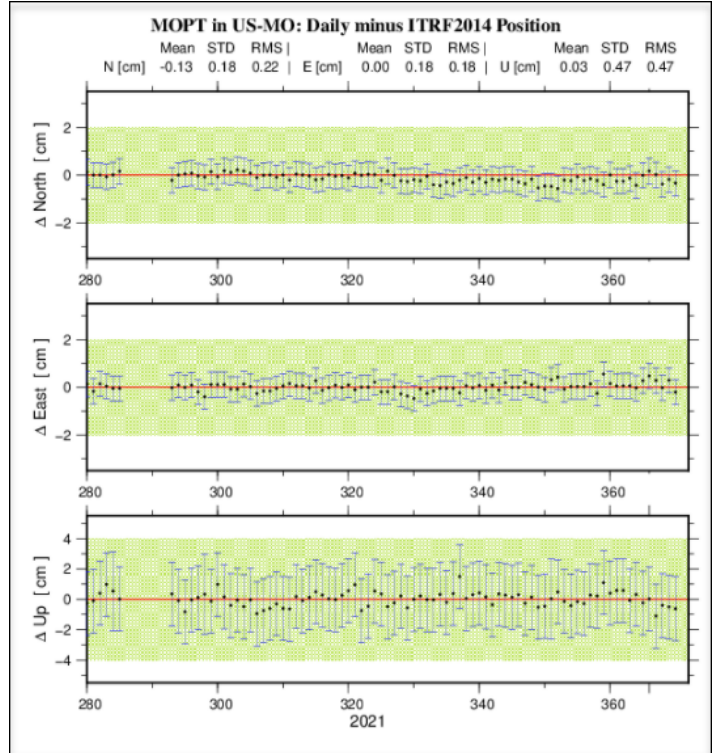
MODOT DEXTER CORS ARP, DM4672



MODOT HAYTI CORS ARP, DN6083



MODOT MOPT CORS ARP, DR7391



## Appendix B – Mark Observations by Session

Stations were identified by their assigned SSA and listed across the top of the table. The table contains three stations, increasing in alphabetical order left to right. In addition, table lists every Julian day/Session along the left-hand column increasing from top to bottom.

An “X” indicates an observation of a mark. By intersecting the Julian day in the row with an “X” with the SSA in the column one can easily identify when a mark was observed and by tallying the “X” values in a particular column one can identify how many observations of a mark were taken.

**Table 1**

Session	Station SSA						
	B278	D278	W277				
313A	X	X	X				
314A	X	X	X				
319A	X	X	X				

# Appendix C – OPUS Projects Preferences and Network Design

## MOCH HEIGHT MODERNIZATION Preferences

? ↺ Save Changes and Close ✕

Project Title, ID and Keywords	Data & Solution Quality Thresholds	Data Processing Defaults	Session Definition	Mark Co-location Definition
<b>NGS Tracking ID, Data Code, Organization and Title</b> An NGS tracking ID, data code, your organization's name and a project title are required. These were defined when a tracking ID was added when the project was created or when using the "Add NGS Project Tracking ID" control. The values cannot be modified and are repeated here as a convenience.				
NGS Tracking ID: 9572 Data Code: AA Organization: MISSOURI DEPARTMENT OF TRANSPORTATION Project Title: MOCH HEIGHT MODERNIZATION				
<b>Project ID and Keywords</b> A project ID and keywords are required. The ID and keywords have the following restrictions: <ul style="list-style-type: none"> <li>The project ID <u>must be</u> unique to your project.</li> <li>The ID and keywords are <u>not</u> case sensitive.</li> <li>The ID and keywords can <u>not</u> contain more than eight characters.</li> <li>The ID and keywords can <u>only</u> contain letters, numbers, the dash and underscore characters.</li> </ul>				
Project ID: <input type="text" value="moch"/> Confirm: <input type="text" value="moch"/> Manager Keyword: <input type="text" value="moch"/> Confirm: <input type="text" value="moch"/> Session Keyword: <input type="text" value="moch"/> Confirm: <input type="text" value="moch"/>				
<b>CC Manager Emails</b> Copies of emails created by and sent to you from the project can be sent to others automatically. <a href="#">Privacy Act Statement</a>				
CC Manager Emails To: <input type="text"/>				
<input type="button" value="Add To CC List"/> <input type="text"/>				
<input type="button" value="Remove From CC List"/> <input type="button" value="--- NONE ---"/>				



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## MOCH HEIGHT MODERNIZATION Preferences




? ↺ Save Changes and Close ✕

Project Title, ID and Keywords	Data & Solution Quality Thresholds	Data Processing Defaults	Session Definition	Mark Co-location Definition
Thresholds are used to highlight solution results that do not meet the quality preferences for your project.				
Precise Ephemeris: <input type="button" value="Best Available"/>				
Minimum ARP Height (m): <input type="text" value="0.000"/>				
Maximum ARP Height (m): <input type="text" value="3.000"/>				
Minimum Observations Used (%): <input type="text" value="80.0"/>				
Minimum Ambiguities Fixed (%): <input type="text" value="80.0"/>				
Maximum Solution RMS (m): <input type="text" value="0.025"/>				
Maximum Height Uncertainty (m): <input type="text" value="0.040"/>				
Maximum Latitude Uncertainty (m): <input type="text" value="0.020"/>				
Maximum Longitude Uncertainty (m): <input type="text" value="0.020"/>				



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## MOCH HEIGHT MODERNIZATION Preferences




  [Save Changes and Close](#) 

Project Title, ID and Keywords	Data & Solution Quality Thresholds	Data Processing Defaults	Session Definition	Mark Co-location Definition
<p>Data processing defaults are project-wide, but they can still be changed on a case-by-case basis during processing setup.</p> <p>Output Ref Frame: <input type="text" value="LET OPUS CHOOSE"/></p> <p>Output Geoid Model: <input type="text" value="LET OPUS CHOOSE"/></p> <p>GNSS: <input type="text" value="G (GPS-only)"/></p> <p>Tropo Model: <input type="text" value="Piecewise Linear"/></p> <p>Tropo Interval (s): <input type="text" value="7200"/></p> <p>Elevation Cutoff (deg): <input type="text" value="15.0"/></p> <p>Constraint Weights: <input type="radio"/> LOOSE <input checked="" type="radio"/> NORMAL <input type="radio"/> TIGHT</p>				

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## MOCH HEIGHT MODERNIZATION Preferences




  [Save Changes and Close](#) 

Project Title, ID and Keywords	Data & Solution Quality Thresholds	Data Processing Defaults	Session Definition	Mark Co-location Definition
<p>A data file is assigned to a session based upon its overlaps in time with other files. These parameters control how much overlap is required for a file to be assigned to a session.</p> <p>Changing these values after any processing has been completed may invalidate those processing results. You must delete all existing session processing and network adjustment results to access these preferences.</p> <p>Minimum Data Duration (s): <input type="text" value="1800"/></p> <p>Minimum Session Overlap Multiplier: <input type="text" value="0.5"/></p>				

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## MOCH HEIGHT MODERNIZATION Preferences

  [Save Changes and Close](#) 

Project Title, ID and Keywords	Data & Solution Quality Thresholds	Data Processing Defaults	Session Definition	Mark Co-location Definition
<p>Data files can be associated with marks by using the first four characters of the file name or how closely the positions computed in the OPUS solutions agree.</p> <p>Changing these values after any processing has been completed may invalidate those processing results. You must delete all existing session processing and network adjustment results to access these preferences.</p> <p>Group By: <input type="radio"/> Mark ID <input checked="" type="radio"/> Position</p> <p>Maximum Position Difference (m): <input type="text" value="1.000"/></p>				

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# Session 313-A

MOCH HEIGHT MODERNIZATION
  
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Results From : Session Solution

**Controls**

? ← ↻

Manager's Page

Show File

Send Email

Set up Processing

**LEGEND** MARKS: ● meet preferences ● do not meet preferences ● are not included ● have error  
 CORS: ● meet preferences ● do not meet preferences ● are not included  
 Baselines: —

Map
Satellite

**LEGEND**

**MARKS**

- b278
- d278
- w277

**ADD MARKS**

**CORS**

- hces
- moch
- modx
- moht
- mopt
- motk

**Add/Del CORS**

**Solution Quality Indicators**

MARKS	ANTENNA	HEIGHT (m)	EPH TYPE	OBS (%)	FIXED (%)	RMS (m)	LAT (m)	Lon (m)	HGT (m)
b278	TPSGR3	NONE	2.000	precise	97.8	100.0	0.011	0.001	0.002
d278	TPSGR3	NONE	2.000	precise	97.9	100.0	0.009	0.001	0.002
w277	TPSGR3	NONE	1.998	precise	97.6	100.0	0.010	0.001	0.002
PREFERENCES:				Best Available	≥80.0	≥80.0	≤0.025	≤0.020	≤0.040

**Data Availability**

2021-11-09T14:00:00 GPST to 2021-11-09T20:50:00 GPST in 10 minute cells  
 2021-11-09T00:00:00 GPST to 2021-11-09T23:59:30 GPST time windowing for session 2021-313-A

MARKS	2021-11-09																																						
	14	15	16	17	18	19	20																																
b278	0	9	9	9	A	A	A	9	8	8	8	8	8	8	8	8	8	8	8	B	B	B	9	9	9	9	A	9	9	9	A	A	A	A	9	A	B	0	0
d278	0	0	8	9	9	9	9	8	7	7	7	8	8	8	7	7	7	7	9	8	8	9	8	8	9	9	9	9	A	A	9	9	9	9	9	9	9	9	0
w277	8	9	9	9	A	A	9	8	8	8	8	8	8	8	8	8	B	B	B	9	9	9	9	A	9	9	A	B	A	A	A	9	9	A	B	0	0		

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# Session 319-A

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Search

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Results From : Session Solution

Controls

?
←
↶

Manager's Page
Show File
Send Email
Set up Processing

LEGEND

● MARKS: meet preferences  
 ● do not meet preferences  
 ● are not included  
 ● have error  
● CORS: meet preferences  
 ● do not meet preferences  
 ● are not included  
 Baselines:

Map
Satellite
+   Marks   Marks&CORS   -

LEGEND

● MARKS  
● b278  
● d278  
● w277

CORS

● hces  
● moch  
● modx  
● moht  
● mopt  
● motk

Add MARKS  
Add/Del CORS

Solution Quality Indicators

MARKS	ANTENNA	HEIGHT (m)	EPH TYPE	OBS (%)	FIXED (%)	RMS (m)	LAT (m)	LN (m)	HGT (m)
b278	TPSGR3	NONE	2.000	precise	98.2	100.0	0.011	0.001	0.000
d278	TPSGR3	NONE	2.000	precise	97.1	100.0	0.009	0.001	0.000
w277	TPSGR3	NONE	1.998	precise	97.3	100.0	0.010	0.001	0.000
PREFERENCES:				Best Available	≥80.0	≥80.0	≤0.025	≤0.020	≤0.040

Data Availability

2021-11-15T16:30:00 GPST to 2021-11-15T23:20:00 GPST in 10 minute cells  
 2021-11-15T00:00:00 GPST to 2021-11-15T23:59:30 GPST time windowing for session 2021-319-A

MARKS	2021-11-15						
	16	17	18	19	20	21	22
b278	00	79	88	88	88	99	99
d278	00	00	BB	99	88	99	99
w277	00	00	BB	99	99	99	99

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## Appendix D – WINDESC

All CORS stations were removed from the WINDESC files. WINDESC version 5.03.03 was used. The following data checks were run:

### Photos

Photos are being submitted for every mark. They have been checked and verified as being a correct representation of the marks observed. They are MoDOT's most current photos available and are being submitted to support the mark description process. They may be useful in verifying disk stampings, setting information, or similar attributes that can be confirmed visually. They are not, nor intended to be, a record of occupation.

### Neighbor for all marks

Each mark was evaluated in neighbor using a radius of 400 meters and excluding TBMs. All of the stations being claimed as observed were confirmed.

### Discrep for all PIDs

All discrepancies were reviewed and evaluated to identify and address any significant differences between the mark attributes being submitted and those found in the IDB. None was found.

### Recovery dates for all marks

There were no duplicate recovery dates associated with this project.

### Spell-check all descriptions

Spell-check was run on all descriptions. Corrections were applied where necessary.

### Error file

The error file was evaluated. All errors were corrected. The remaining warnings were determined to be acceptable.