



Reply to
Attention of:

DEPARTMENT OF THE ARMY
MEMPHIS DISTRICT CORPS OF ENGINEERS
167 NORTH MAINSTREET B-202
MEMPHIS, TENNESSEE 38103-1894

CONFIRMATION OF VERTICAL SURVEY CONTROL IN THE BIRDS POINT-NEW MADRID FLOODWAY Final Report 10/27/2015

Overview

A verification survey of vertical control and main stem gages in the New Madrid, MO, area was started on 20 July 2015. It was to be determined if select vertical control and main stem gages are properly and accurately tied to the National Spatial Reference System (NSRS). In addition the vertical profile of Highway WW was to be evaluated relative to stages on the New Madrid gage. Past flood events were to be researched to determine New Madrid stage vs. WW roadway inundation. A Real Time Kinematic (RTK) profile of the lower fuse plug, using the verified vertical survey control, was to be performed. A project location map is presented in *Appendix A*.

Methodology

Global Position System (GPS) Static survey techniques were used through contract resources to tie existing primary area control to the National Geodetic Survey Continuous Operating Reference Stations (CORS). Multiple sites were available outside the Birds Point-New Madrid Floodway area. Gage reference marks for Cairo, IL; Wickliffe, KY; Hickman, KY and New Madrid, MO gages were included in the reference benchmark ties. Specific control along the Birds Point-New Madrid Frontline and Setback Levees were tied to the NSRS.

Third order vertical digital level runs were conducted from primary gage control to the gage equipment and compared to existing gage zero values.

Using verified benchmark values, a GPS RTK profile survey was conducted along the centerline of Highway WW. The profile data will be maintained as a historical reference for future analyses. Profile data was compared to available data for roadway inundation in past events.

Gage data was analyzed relative to both the North American Vertical Datum of 1988 (NAVD88), as well as, the National Geodetic Vertical Datum of 1929 (NGVD29). Due to the historic nature of these gages, there was an attempt to compare data to datum's that were referenced in the installation of the gages. Few, if any, physical ties remain to benchmarks used to install gages dating back to the 1800's. However, river movement, landscape changes, and many other factors have necessitated gage relocations from time to time. Where possible, gage relocations were addressed.

Results

Multiple 6-hour Static GPS survey sessions were performed on the following gage reference benchmarks:

1. CAIRO GAGE REF 2001 (Cairo gage reference benchmark, National Geodetic Survey Permanent Identifier (NGS PID): DE9679)
2. SG 950.4L (New Wickliffe gage reference USACE benchmark)
3. HICKMAN GAGE REF 2001 (Hickman gage reference benchmark, NGS PID: DE9676)
4. T 274 1976 (New Madrid gage reference benchmark, NGS PID: GD1170)
5. WICKLIFFE 1929 NO. 1 (Old Wickliffe staff gage reference benchmark, NGS PID: GD0563)

Regional NGSCORS data was used during the post processing of the 6-hour Static GPS surveys. This method of post processing served to tie the selected survey control to the NSRS. The following CORS were used for this project:

1. MOCH (NGS PID: DM4118)
2. MODX (NGS PID: DM4672)
3. MOJK (NGS PID: DL6890)
4. MOKE (NGS PID: DL6892)
5. TN49 (NGS PID: DL6306)

The following benchmarks and horizontal control were tied with 1-hour Static GPS survey sessions:

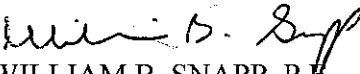
1. A 276 1976 (NGS PID: GD1185)
2. BAYOU 1977 (Horizontal control, NGS PID: GD1570)
3. BAYOU NO 2 1977 (Horizontal control, NGS PID: GD1571)
4. JMA10025-4 2011 (USACE benchmark)
5. JMA10025-6 2011 (USACE benchmark)
6. SJNM PS-1 2009 (USACE benchmark)
7. SJNM PS-2 2009 (USACE benchmark)
8. Y 274 1976 (NGS PID: GD1187)

The New Madrid, Cairo, Wickliffe, and Hickman gages were tied to their respective gage reference benchmarks through electronic level runs. GPS baseline ties are shown at *Appendix B*.

Conclusion

The horizontal plane coordinates are referenced to the North American Datum of 1983 (NAD 83) using the Universal Transverse Mercator (UTM) Projection for Zone 16 in U.S. Survey Feet. Vertical elevations are referenced to the NAVD 88 in U.S. Survey Feet using Geoid12A.

The results of this survey matched previously published values for vertical elevations. This survey complied with USACE Comprehensive Evaluation of Project Datum (CEPD), EM1110-1-1005, and EM1110-2-8160 requirements for vertical survey control and gage calibration references. Gage references were surveyed according to techniques and procedures recommended by the NGS. The individual results of the referenced GPS Static survey sessions are contained in *Appendix C*.


WILLIAM B. SNAPP, P.E.
Chief, Geospatial Section
Geotechnical Engineering Branch

Appendix A

CONFIRMATION OF VERTICAL SURVEY CONTROL IN THE BIRDS POINT-NEW MADRID FLOODWAY

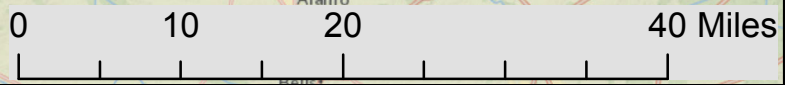
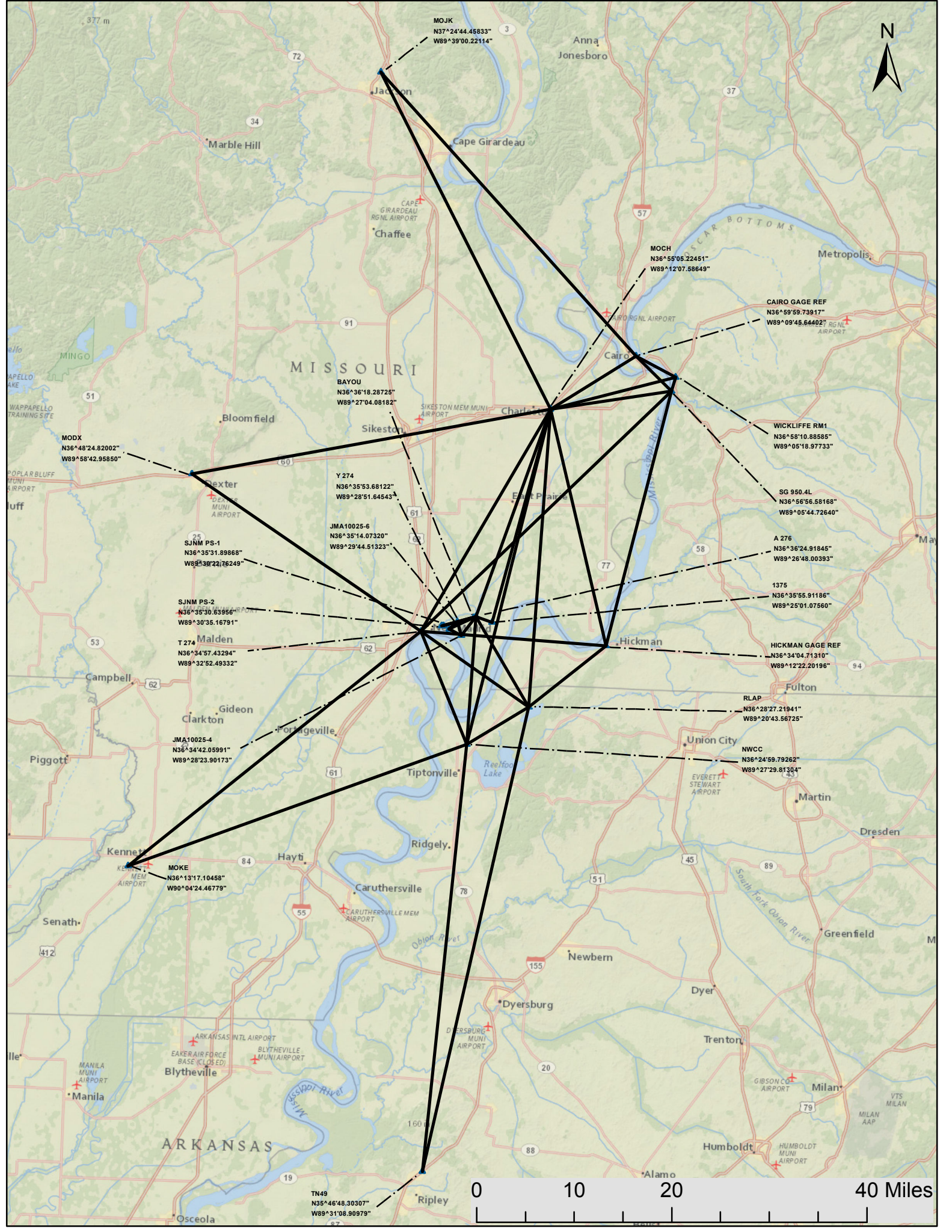


0 3 6 Miles



Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2013

Appendix B



MOJK
N37°24'44.46833"
W89°39'00.22114"

MOCH
N36°55'05.22451"
W89°12'07.58649"

CAIRO GAGE REF
N36°59'59.73917"
W89°09'45.64402"

WICKLIFFE RM1
N36°58'10.88585"
W89°05'18.97733"

SG 950.4L
N36°56'56.58168"
W89°05'44.72640"

A 276
N36°38'24.91845"
W89°26'48.00393"

1375
N36°35'55.91186"
W89°25'01.07560"

HICKMAN GAGE REF
N36°34'04.71310"
W89°12'22.20196"

RLAP
N36°28'27.21941"
W89°20'43.56725"

NWCC
N36°24'59.79262"
W89°27'29.81304"

MODX
N36°48'24.82002"
W89°58'42.95850"

SJNM PS-1
N36°35'31.89868"
W89°30'22.76249"

SJNM PS-2
N36°35'30.63956"
W89°30'35.16791"

T 274
N36°34'57.43294"
W89°32'52.49332"

JMA10025-4
N36°34'42.05991"
W89°28'23.90173"

MOKE
N36°13'17.10458"
W90°04'24.46779"

Y 274
N36°35'53.68122"
W89°28'51.64543"

JMA10025-6
N36°35'14.07320"
W89°29'44.51323"

TN49
N36°46'48.30307"
W89°31'08.90979"

Appendix C

Point ID	Northing	Easting	Elevation	Published Elevation	Latitude	Longitude	Constraint	DATUM
	(US survey foot)	(US survey foot)	(US survey foot NAVD88)	(US survey foot NAVD88)				
MOCH	13413032.079	962753.142	326.769	CORS	N36°55'05.22451"	W89°19'07.58649"	(CORS)*LLh	NAD83/2011
MODX	13377897.170	768611.214	385.633	CORS	N36°48'24.82002"	W89°58'42.95850"	(CORS)*LLh	NAD83/2011
MOJK	13595490.676	870947.261	477.069	CORS	N37°24'44.45833"	W89°39'00.22114"	(CORS)*LLh	NAD83/2011
MOKE	13165617.796	734027.929	270.691	CORS	N36°13'17.10458"	W90°04'24.46779"	(CORS)*LLh	NAD83/2011
TN49	13000252.138	893382.936	407.464	CORS	N35°46'48.30307"	W89°31'08.90979"	(CORS)*LLh	NAD83/2011
T 274 1976	13292606.779	892522.877	309.940	309.9	N36°34'57.43294"	W89°32'52.49332"	T 274 1976 (NGS)*LLe	NAD83/2011
BAYOU 1977	13300043.414	921144.959	316.198	See Note 2	N36°36'18.28725"	W89°27'04.08182"	BAYOU 1977 (NGS)*E FROM MEMPHIS GRID	NAD83/2011
Y 274 1976	13297780.483	912311.328	309.087	309.09	N36°35'53.68122"	W89°28'51.64543"	Y 274 1976 (NGS)*E	NAD83/2011
HICKMAN GAGE REF 2001	13284793.976	992729.865	321.584	321.6	N36°34'04.71310"	W89°12'22.20196"	HICKMAN GAGE REF 2001 (MEM GRID)* E FROM MEMPHIS GRID	NAD83/???
WICKLIFFE 1929 NO. 1	13430250.377	1030440.600	416.213	416.2	N36°58'10.88585"	W89°05'18.97733"	WICKLIFFE 1929 NO. 1 (MEM GRID)* E FROM MEMPHIS GRID	NAD83/???
JMA10025-4 2011	13290479.887	914386.934	306.384	306.38	N36°34'42.05991"	W89°28'23.90173"	JMA10025-4 2011* (MEM GRID) *E FROM MEMPHIS GRID	NAD83/???
JMA10025-6 2011	13293887.035	907896.704	304.025	304.1	N36°35'14.07320"	W89°29'44.51323"	JMA10025-6 2011* (MEM GRID) *E FROM MEMPHIS GRID	NAD83/???
SJNM PS-2 2009	13295669.833	903809.755	314.521	314.52	N36°35'30.63956"	W89°30'35.16791"	SJNM PS-2 2009 (RECOVERED TYPE F) *E USCE DATA SHEET	NAD83/???
SJNM PS-1 2009	13295770.742	904824.638	312.887	312.89	N36°35'31.89868"	W89°30'22.76249"	SJNM PS-1 2009 (RECOVERED TYPE F) *E USCE DATA SHEET	NAD83/???
A 276 1976	13300680.522	922472.823	312.284	312.39	N36°36'24.91845"	W89°26'48.00393"	A 276 1976 (NGS)	NAD83/2011
SG 950.4L 1991	13422782.905	1028186.139	326.249	326.08	N36°56'56.58168"	W89°05'44.72640"	SG 950.4L 1991 * (MEM GRID)	NAD83/???
CAIRO GAGE REF 2001	13441740.361	1009054.548	333.044	333.00	N36°59'59.73917"	W89°09'45.64402"	CAIRO GAGE REF 2001 * (MEM GRID)	NAD83/???
1375	13297526.678	931116.288	298.836	Not Available	N36°35'55.91186"	W89°25'01.07560"	1375 (RECOVERED TBM)	NAD83/2011
NWCC	13231489.514	917294.712	309.904	CORS	N36°24'59.79262"	W89°27'29.81304"	NWCC (CORS POSTION UNKNOWN)	NAD83/2011
RLAP	13251636.532	951005.206	288.442	CORS	N36°28'27.21941"	W89°20'43.56725"	RLAP (CORS POSTION UNKNOWN)	NAD83/2011

Note 1: The Survey Engineering Report, electronic level report, field books, and raw GPS logs are located at the Memphis District.

Note 2: No vertical order was listed on the NGS data sheet; not to be used for vertical control. Ortho height listed on data sheet was computed from vertical angle and rounded to 0 decimal places.

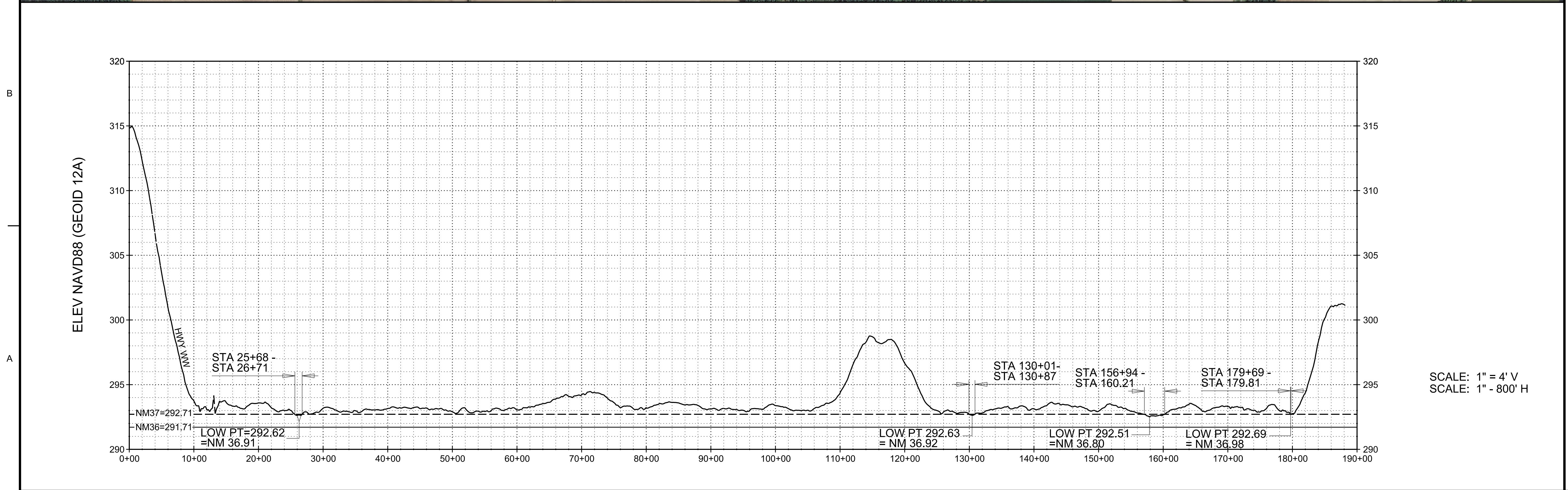
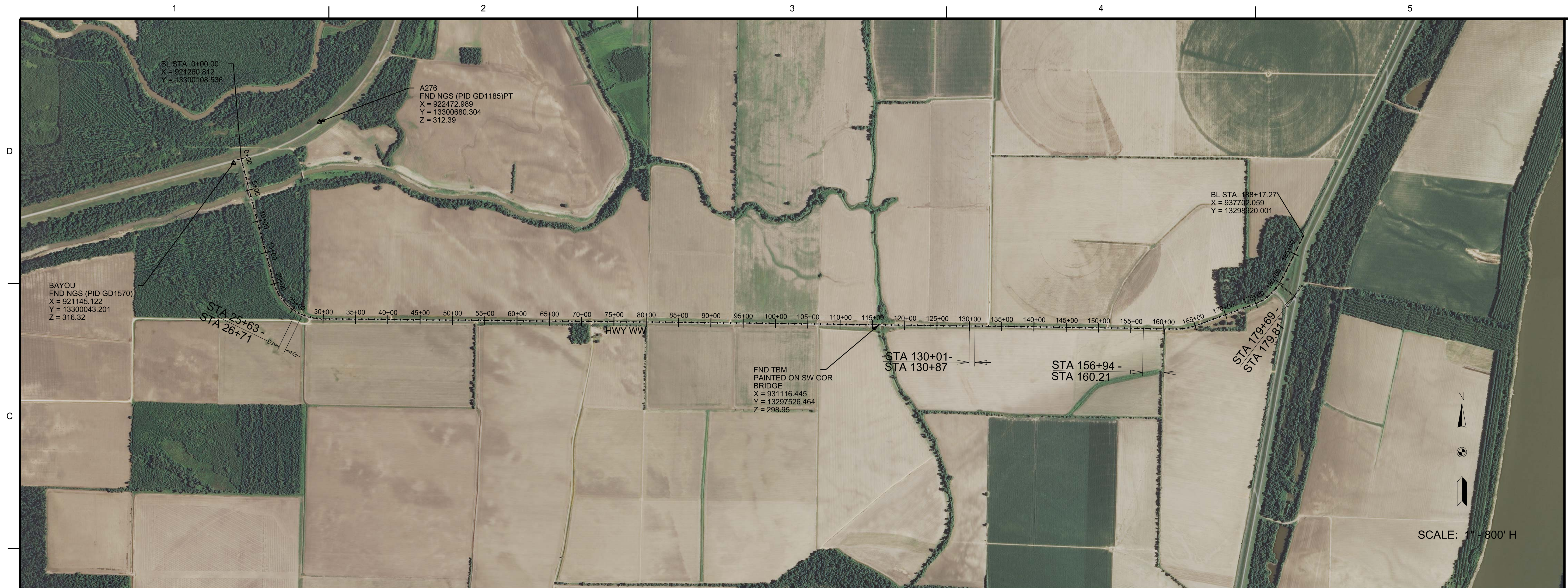
The NAVD 88 height was computed by applying the Vertcon shift value to the NGVD 29 height and rounded to 0 decimal places.

Note 3: Monument "BAYOU 1977" elevation was determined by the Corps of Engineers to be 316.198 US Survey Feet NAVD88.

Note 4: All horizontal and vertical values meet the NGS 58/59 specifications for GPS surveying.

Gage Zero Values

Gage	NGVD 29	NAVD 88
	(US survey foot)	(US survey foot)
Cairo OH111	270.47	269.99
Hickman MS113	264.73	264.47
New Madrid MS115	255.48	255.65



MARK	DESCRIPTION	DATE	APPR.	MARK	DESCRIPTION	DATE	APPR.

DESIGNED BY: JCH	DATE: 07/23	SUBMITTAL NO.:
DRAWN BY: JCH	DATE: 07/23	CONTRACT NO.:
DESIGNED BY: LARRY ANDERTON	DATE: 07/23	CONTRACT NO.:
DRAWN BY: LARRY ANDERTON	DATE: 07/23	CONTRACT NO.:
DESIGNED BY: LARRY ANDERTON	DATE: 07/23	CONTRACT NO.:
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JMA14031 NEW MADRID VERTICAL CONTROL
NEW MADRID, MO

HWY WW PROFILE

Sheet ID