



Survey Report

USGS CONTRACT: G16PC00029
CONTRACTOR: Merrick-Surdex JV
TASK ORDER NUMBER: G17PD00237
TASK NAME: MO_Saint_Louis Lidar Project

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TOTAL AWARD: \$147,656.59 (Fixed Price)

CONTRACTOR PROJECT MANAGER:
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CONTRACTOR JOB NUMBER: 2700110

3.0 Survey Accuracy

The final product was to meet USGS QL2 accuracy specifications of an RMSE \leq 10 cm. From this requirement a RMSE for the survey can be developed. Based upon the current ASPRS Positional Accuracy Standards for Digital Geospatial Data the survey accuracy would need to be at a minimum $\frac{1}{4}$ the product RMSE. Therefore, the survey design specification is for an RMSE of 2.5 cm.

4.0 Coordinate Systems

The final horizontal coordinates were derived in NAD83 (2011). The orthometric heights were derived relative to NAVD88 with Geoid12B being utilized for the conversion from ellipsoid height. The survey values were projected into UTM 15 coordinates. The unit of measure was meters.

5.0 Survey Design

A survey plan was developed to select photo identifiable points from Google earth imagery and perform VRS GPS surveys of each selected point. The survey plan is provided in the image below. To validate and calibrate the VRS survey values NGS monuments within the project area were also planned into the survey. The survey plan incorporated calibration points for the LiDAR and Quality Checking points as Non-Vegetated Vertical Accuracy (NVA) and Vegetated Vertical Accuracy (VVA) points.

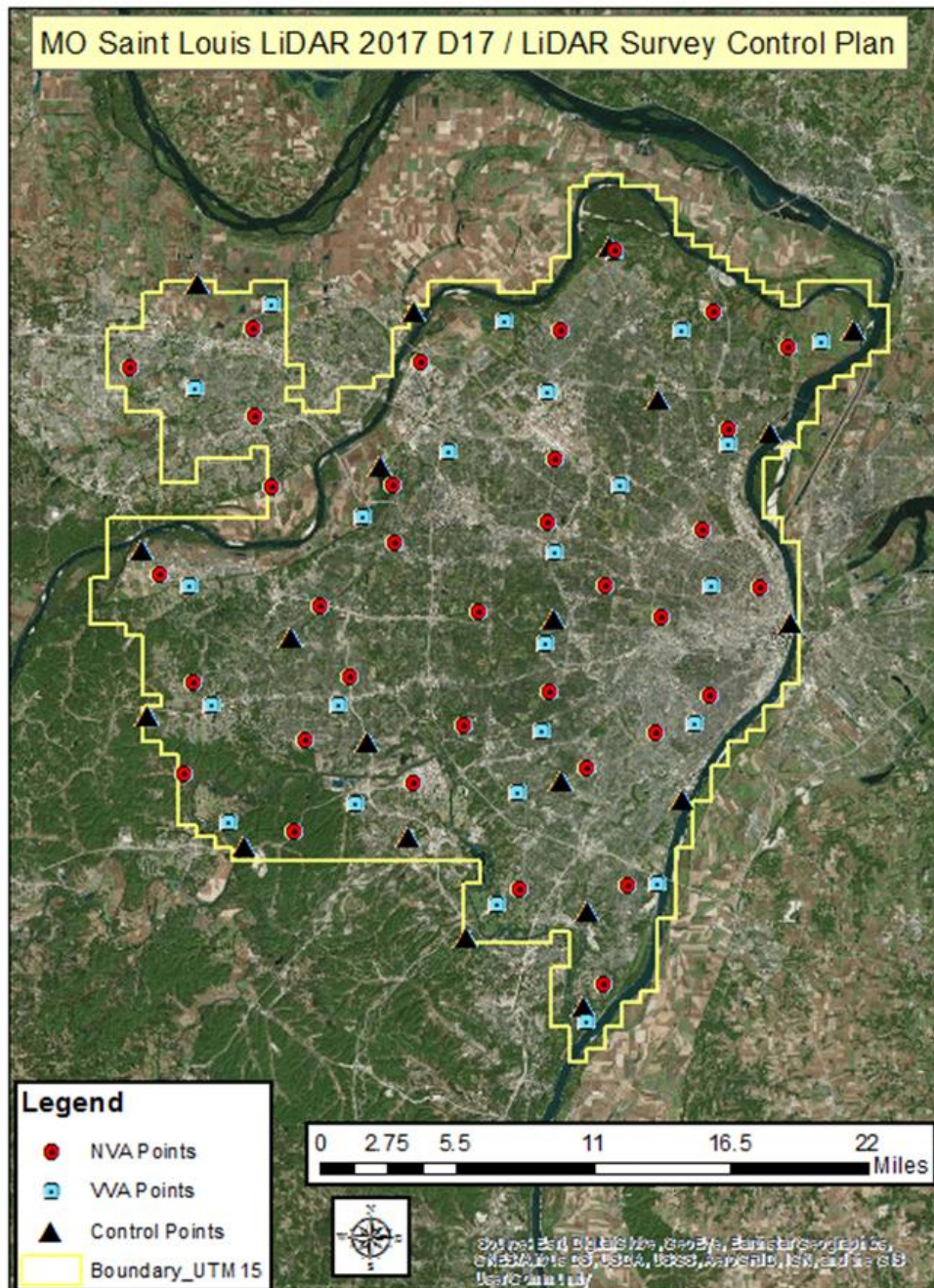


Figure 2: Control Survey Design

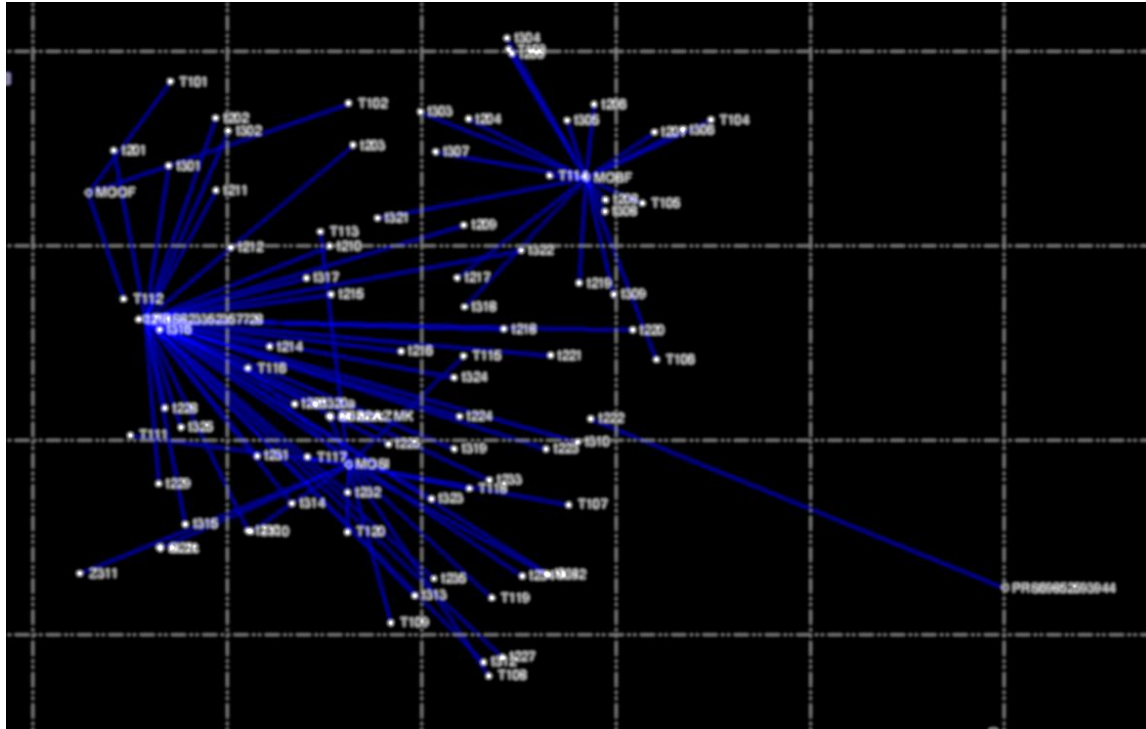


Figure 4: TBC Vector Network

8.0 Survey Accuracy

The survey vectors were evaluated for accuracy at the completion of the calibration process in TBC. The resultant 95% accuracy of the vectors is 2.0 cm in X and Y and 2.9 cm in height. When converted to an RMSE, the height accuracy of the survey is estimated to be ≤ 1.47 cm. This value is within the limiting value of 2.5 cm in height. Therefore, the survey is within the accuracy limits for this mapping project.

Respectfully submitted,

Steve Kasten CP, PLS
October 27, 2017

Appendix A

LiDAR Calibration Survey Points

Project number: 2700110
Horizontal Datum: NAD83 (2011)
Horizontal Zone: UTM 15 N
Horizontal Units: meter
Vertical Datum: NAVD83(2011) GEOID12B(CONUS)
Vertical Units: meter

id	e	n	elev
T101	706432.203	4300873.419	131.871
T102	720446.096	4299533.761	134.133
T103	732865.723	4304114.916	182.616
T104	748885.259	4299034.537	128.464
T105	743695.212	4292339.155	128.398
T106	745146.440	4280118.543	139.007
T107	738576.227	4268546.596	129.323
T108	732666.883	4254966.395	133.599
T109	724883.202	4258928.872	172.789
T110	713720.449	4265790.721	210.396
T111	704045.583	4273053.568	241.578
T112	703240.696	4283723.202	142.496
T113	718526.668	4289428.512	137.169
T114	736367.988	4294302.818	171.777
T115	730002.752	4279984.498	166.882
T116	713130.626	4278568.642	173.154
T117	717988.746	4271738.185	180.584
T118	730740.699	4269610.011	169.164
T119	732735.640	4261089.968	146.809
T120	721272.246	4265931.847	165.462

Appendix B

LiDAR Survey QC Points

Project number: 2700110 QC Points
Horizontal Datum: NAD83 (2011)
Horizontal Zone: UTM 15
Horizontal Units: meters
Vertical Datum: NAVD83(2011) GEOID12B(CONUS)
Vertical Units: meters
id e n elev

t201	702146.143	4295340.413	164.503
t202	710051.803	4298095.539	129.691
t203	720882.407	4296285.034	134.988
t204	729898.449	4298587.767	169.802
t205	733168.686	4303784.496	170.744
t206	739710.252	4299995.589	153.740
t207	744494.391	4297949.577	145.023
t208	740810.371	4292544.893	140.219
t209	729748.804	4290259.399	176.020
t210	719262.530	4288328.750	136.037
t211	710248.255	4292452.171	190.365
t212	711545.081	4287994.177	140.249
t213	704450.995	4282157.351	140.482
t214	714790.063	4280313.722	155.363
t215	719502.110	4284542.168	169.006
t216	725100.537	4280235.203	179.243
t217	729334.097	4286108.258	182.595
t218	733121.225	4282191.547	171.545
t219	738923.417	4285954.098	154.587
t220	743205.618	4282401.006	139.836
t221	736830.010	4280220.039	156.628
t222	740127.929	4275337.835	170.027
t223	736687.665	4272877.379	148.883
t224	729839.144	4275243.011	150.884
t225	724304.240	4272919.456	191.057
t226	716863.036	4275861.541	173.258
t227	733717.655	4256448.258	168.886
t228	706720.170	4275265.606	209.874
t229	706374.652	4269334.759	136.485
t230	713490.443	4265832.215	213.372
t231	714044.680	4271711.613	159.046
t232	721209.744	4269041.671	134.932
t233	732307.441	4270315.851	189.775
t234	735084.915	4262848.804	154.556
t235	728164.880	4262484.334	161.719
t301	706469.918	4294280.038	162.511
t302	711069.979	4297121.538	157.601
t303	726118.103	4299047.459	132.932
t304	732744.098	4304989.876	201.712
t305	737629.109	4298681.583	182.319
t306	746701.055	4298220.403	127.431
t307	727389.452	4295940.213	173.304
t308	740794.386	4291625.013	135.807
t309	741662.031	4285130.867	154.885
t310	739144.743	4273487.877	137.880
t311	737017.361	4263114.947	129.645

t312	732249.155	4256044.213	128.353
t313	726703.461	4261115.650	148.430
t314	716865.571	4268072.503	127.400
t315	708544.950	4266214.508	146.044
t316	706122.807	4281412.763	165.931
t317	717516.048	4285773.514	138.074
t318	729968.218	4283837.469	170.059
t319	729479.720	4272687.735	190.492
t320	718491.992	4275905.100	154.807
t321	722977.981	4290618.145	164.578
t322	734311.990	4288397.991	179.505
t323	727796.112	4268725.152	199.583
t324	729311.711	4278288.022	155.447
t325	708011.920	4273794.163	195.412
z311	700379.298	4262128.646	141.112

Appendix C

NGS Monuments Utilized in Survey

The NGS Data Sheet

See file [dsdata.pdf](#) for more information about the datasheet.

```
PROGRAM = datasheet95, VERSION = 8.12.3
1 National Geodetic Survey, Retrieval Date = OCTOBER 27, 2017
AA8662 *****
AA8662 FBN - This is a Federal Base Network Control Station.
AA8662 DESIGNATION - SL 21
AA8662 PID - AA8662
AA8662 STATE/COUNTY- MO/ST LOUIS
AA8662 COUNTRY - US
AA8662 USGS QUAD - EUREKA (1993)
AA8662
AA8662 *CURRENT SURVEY CONTROL
AA8662
AA8662* NAD 83(2011) POSITION- 38 30 10.88992(N) 090 37 49.71256(W) ADJUSTED
AA8662* NAD 83(2011) ELLIP HT- 110.318 (meters) (06/27/12) ADJUSTED
AA8662* NAD 83(2011) EPOCH - 2010.00
AA8662* NAVD 88 ORTHO HEIGHT - 141.249 (meters) 463.41 (feet) ADJUSTED
AA8662
AA8662 GEOID HEIGHT - -30.923 (meters) GEOID12B
AA8662 NAD 83(2011) X - -54,995.680 (meters) COMP
AA8662 NAD 83(2011) Y - -4,997,644.042 (meters) COMP
AA8662 NAD 83(2011) Z - 3,949,360.861 (meters) COMP
AA8662 LAPLACE CORR - -0.04 (seconds) DEFLEC12B
AA8662 DYNAMIC HEIGHT - 141.157 (meters) 463.11 (feet) COMP
AA8662 MODELED GRAVITY - 979,976.6 (mgal) NAVD 88
AA8662
AA8662 VERT ORDER - SECOND CLASS II
AA8662
AA8662 Network accuracy estimates per FGDC Geospatial Positioning Accuracy
AA8662 Standards:
AA8662 FGDC (95% conf, cm) Standard deviation (cm) CorrNE
AA8662 Horiz Ellip SD_N SD_E SD_h (unitless)
AA8662 -----
AA8662 NETWORK 0.41 0.90 0.19 0.14 0.46 0.03504874
AA8662 -----
AA8662 Click here for local accuracies and other accuracy information.
AA8662
AA8662
AA8662.The horizontal coordinates were established by GPS observations
AA8662.and adjusted by the National Geodetic Survey in June 2012.
AA8662
AA8662.NAD 83(2011) refers to NAD 83 coordinates where the reference frame has
AA8662.been affixed to the stable North American tectonic plate. See
AA8662.NA2011 for more information.
AA8662
AA8662.The horizontal coordinates are valid at the epoch date displayed above
AA8662.which is a decimal equivalence of Year/Month/Day.
AA8662
AA8662.The orthometric height was determined by differential leveling and
AA8662.adjusted by the NATIONAL GEODETIC SURVEY
AA8662.in March 1998.
AA8662
AA8662.Significant digits in the geoid height do not necessarily reflect accuracy.
AA8662.GEOID12B height accuracy estimate available here.
AA8662
AA8662.The X, Y, and Z were computed from the position and the ellipsoidal ht.
AA8662
AA8662.The Laplace correction was computed from DEFLEC12B derived deflections.
AA8662
AA8662.The ellipsoidal height was determined by GPS observations
AA8662.and is referenced to NAD 83.
AA8662
AA8662.The dynamic height is computed by dividing the NAVD 88
AA8662.geopotential number by the normal gravity value computed on the
AA8662.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
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AA8662.degrees latitude (g = 980.6199 gals.).

AA8662

AA8662.The modeled gravity was interpolated from observed gravity values.

AA8662

AA8662. The following values were computed from the NAD 83(2011) position.

AA8662

AA8662;	North	East	Units	Scale	Factor	Converg.
AA8662;SPC MO E	- 296,272.971	238,619.475	MT	0.99993493	-0 04 52.4	
AA8662;UTM 15	- 4,264,289.825	706,622.216	MT	1.00012578	+1 28 32.5	
AA8662!	- Elev Factor	x Scale Factor	=	Combined Factor		
AA8662!SPC MO E	- 0.99998269	x 0.99993493	=	0.99991762		
AA8662!UTM 15	- 0.99998269	x 1.00012578	=	1.00010847		

AA8662

AA8662_U.S. NATIONAL GRID SPATIAL ADDRESS: 15SYC0662264289(NAD 83)

AA8662

SUPERSEDED SURVEY CONTROL

AA8662

AA8662	NAD 83(2007)-	38 30 10.89002(N)	090 37 49.71325(W)	AD(2002.00)	0
AA8662	ELLIP H (02/10/07)	110.343 (m)		GP(2002.00)	
AA8662	ELLIP H (02/11/04)	110.310 (m)		GP()	4 1
AA8662	NAD 83(1997)-	38 30 10.88991(N)	090 37 49.71406(W)	AD()	B
AA8662	ELLIP H (03/31/98)	110.359 (m)		GP()	3 1
AA8662	NAD 83(1986)-	38 30 10.90631(N)	090 37 49.71250(W)	AD()	1
AA8662	NAVD 88	141.25 (m)	463.4 (f)	LEVELING	3
AA8662	NAVD 88	141.23 (m)	463.4 (f)	LEVELING	3

AA8662

AA8662.Superseded values are not recommended for survey control.

AA8662

AA8662.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.

AA8662.See file [dsdata.pdf](#) to determine how the superseded data were derived.

AA8662

AA8662_MARKER: DD = SURVEY DISK

AA8662_SETTING: 7 = SET IN TOP OF CONCRETE MONUMENT

AA8662_STAMPING: SL 21 1990

AA8662_MARK LOGO: MODNR

AA8662_PROJECTION: FLUSH

AA8662_MAGNETIC: N = NO MAGNETIC MATERIAL

AA8662_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO

AA8662+STABILITY: SURFACE MOTION

AA8662_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR

AA8662+SATELLITE: SATELLITE OBSERVATIONS - October 07, 2009

AA8662

AA8662	HISTORY	- Date	Condition	Report By
AA8662	HISTORY	- 1990	MONUMENTED	MODNR
AA8662	HISTORY	- 19970131	GOOD	NGS
AA8662	HISTORY	- 19970224	GOOD	NGS
AA8662	HISTORY	- 19970624	GOOD	NGS
AA8662	HISTORY	- 20010529	GOOD	WOOLPT
AA8662	HISTORY	- 20030502	GOOD	WOOLPT
AA8662	HISTORY	- 20030724	GOOD	MODNR
AA8662	HISTORY	- 20030804	GOOD	MODNR
AA8662	HISTORY	- 20050316	GOOD	MODNR
AA8662	HISTORY	- 20050908	GOOD	INDIV
AA8662	HISTORY	- 20091007	GOOD	INDIV

AA8662

STATION DESCRIPTION

AA8662

AA8662'DESCRIBED BY MO DEPT OF NAT RES 1990

AA8662'STATION, AZIMUTH MARKS AND REFERENCE TIES STATION SL-21, 1990 IS
AA8662'LOCATED ON THE SOUTH R/W OF THE UNION PACIFIC RAILROAD IN THE TOWN OF
AA8662'EUREKA, MO IT IS 23.06 FT (7.03 M) SOUTH OF THE SOUTH RAIL OF THE
AA8662'SOUTH TRACK, 82.13 FT (25.03 M) SW OF A PK NAIL IN THE WEST SIDE OF A
AA8662'POWER POLE ON THE SOUTH SIDE OF WEST 1ST STREET, 25.4 FT (7.7 M) WEST
AA8662'OF THE EXTENDED CENTER LINE OF A BARRICADED CROSSING ON THE SOUTH SIDE
AA8662'OF WEST MAIN ST., 96.82 FT (29.51 M) NNW OF THE NE EDGE OF THE
AA8662'BARRICADE SUPPORT GIRDER, 42.5 FT (13.0 M) NORTH OF THE WEST MAIN ST
AA8662'PAVEMENT, 79.75 FT (24.31 M) NORTH OF A PK NAIL IN THE EAST SIDE OF A
AA8662'TELEPHONE POLE AND 2 FT (0.6 M) EAST OF A WITNESS POST SL-21A, 1990 IS
AA8662'0.55 MILES (0.89 KM) WEST ON THE SOUTH R/W OF THE UNION PACIFIC. IT
AA8662'IS 23.60 FT (7.19 M) SOUTH OF THE SOUTH RAIL OF THE SOUTH TRACK, 87.37

AA8662'FT (26.63 M) SW OF A PK NAIL IN THE WEST SIDE OF A POWER POLE, 80.99
AA8662'FT (24.69 M) SW OF A (1) IN THE SW ANCHOR BOLT OF A SIGNAL BASE ON THE
AA8662'NORTH SIDE OF THE TRACKS, 53.79 FT (16.40 M) SW OF A (X) IN THE SW
AA8662'ANCHOR BOLT OF A SIGNAL BASE ON THE SOUTH SIDE OF THE TRACKS, 26 FT
AA8662'WEST OF THE CENTER LINE OF AN ACCESS DRIVE FROM WEST MAIN ST., 37 FT
AA8662'NORTH OF THE WEST MAIN PAVEMENT AND 2 FT (0.6 M) EAST OF A WITNESS
AA8662'POST STATION AND AZIMUTH MARK TO REACH TO REACH SL-21, 1990 FROM THE
AA8662'INTERSECTION OF WEST MAIN ST AND CENTRAL IN EUREKA, MO (WEST MAIN IS
AA8662'THE STREET BETWEEN THE BURLINGTON-NORTHERN AND UNION PACIFIC RAILROAD
AA8662'R/W S), GO WEST ON WEST MAIN ABOUT 700 FT TO A BARRICADED CROSSING OF
AA8662'THE BURLINGTON-NORTHERN RAILROAD ON LEFT AND THE STATION ON RIGHT
AA8662'(NORTH) SIDE AND ON THE SOUTH R/W OF THE UNION PACIFIC AS DESCRIBED.
AA8662'TO REACH SL-21A, 1990 FROM THE STATION CONTINUE WEST ON WEST MAIN
AA8662'STREET FOR 0.55 MILES (0.89 KM) TO THE AZIMUTH MARK ON THE RIGHT
AA8662'(NORTH) AS DESCRIBED. DATE OF REPORT 06-06-1995

AA8662

AA8662

STATION RECOVERY (1997)

AA8662

AA8662'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1997 (CSM)
AA8662'THE STATION IS LOCATED NEAR THE SOUTH SIDE OF EUREKA, MO., ALONG THE
AA8662'NORTH SIDE OF WEST MAIN STREET, BETWEEN THE BURLINGTON-NORTHERN AND
AA8662'UNION PACIFIC RAILROADS, ON THE SOUTH SIDE OF A TRACK ROAD ON THE
AA8662'SOUTH SIDE OF THE NORTH SET OF TRACKS. OWNERSHIP--UNION PACIFIC
AA8662'RAILROAD. NOTE--THIS STATION IS A (FBN/CBN STATION) . TO REACH THE
AA8662'STATION FROM THE INTERSECTION OF WEST MAIN STREET AND CENTRAL IN
AA8662'EUREKA, (WEST MAIN IS THE STREET BETWEEN THE 2 RAILROAD RIGHT-OF-WAYS)
AA8662', GO WEST, ABOUT 0.21 KM (0.15 MI) TO A BARRICADED CROSSING OF THE
AA8662'BURLINGTON-NORTHERN RAILROAD ON THE LEFT AND THE STATION ON THE RIGHT,
AA8662'(NORTH SIDE) , ON THE SOUTH RIGHT-OF-WAY OF THE UNION PACIFIC
AA8662'RAILROAD. STATION IS 24.3 M (79.7 FT) WEST-SOUTHWEST OF A RAILROAD
AA8662'SWITCH POLE, 16.4 M (53.8 FT) NORTH OF THE WEST MAIN STREET CENTER,
AA8662'15.0 M (49.2 FT) EAST OF A 4-FOOT SQUARE CONCRETE BOX CULVERT RUNNING
AA8662'UNDER THE TRACKS, 8.3 M (27.2 FT) NORTH-NORTHEAST OF A 24-INCH ROUND
AA8662'METAL MANHOLE COVER CENTER, 7.3 M (24.0 FT) SOUTH OF THE TRACKS SOUTH
AA8662'RAIL, 0.6 M (2.0 FT) EAST OF A WITNESS POST, AND THE MONUMENT IS ABOUT
AA8662'0.4 M (1.3 FT) BELOW THE TRACKS AND FLUSH WITH THE GROUND SURFACE. BY
AA8662'R.G. HAYES

AA8662

AA8662

STATION RECOVERY (1997)

AA8662

AA8662'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1997 (CSM)
AA8662'THE STATION IS LOCATED NEAR THE SOUTH SIDE OF EUREKA, MO., ALONG THE
AA8662'NORTH SIDE OF WEST MAIN STREET, BETWEEN THE BURLINGTON-NORTHERN AND
AA8662'UNION PACIFIC RAILROADS, ON THE SOUTH SIDE OF A TRACK ROAD ON THE
AA8662'SOUTH SIDE OF THE NORTH SET OF TRACKS. OWNERSHIP--UNION PACIFIC
AA8662'RAILROAD. TO REACH THE STATION FROM THE INTERSECTION OF WEST MAIN
AA8662'STREET AND CENTRAL IN EUREKA, (WEST MAIN IS THE STREET BETWEEN THE 2
AA8662'RAILROAD RIGHT-OF-WAYS) , GO WEST, ABOUT 0.21 KM (0.15 MI) TO A
AA8662'BARRICADED CROSSING OF THE BURLINGTON-NORTHERN RAILROAD ON THE LEFT
AA8662'AND THE STATION ON THE RIGHT (NORTH SIDE) , ON THE SOUTH RIGHT-OF-WAY
AA8662'OF THE UNION PACIFIC RAILROAD. THE STATION IS AN ALUMINUM DNR
AA8662'GEOGRAPHIC REFERENCE SYSTEM SURVEY MARKER SET IN THE TOP OF A ROUND
AA8662'CONCRETE MONUMENT. IT IS, 24.3 M (79.7 FT) WEST-SOUTHWEST OF A
AA8662'RAILROAD SWITCH POLE, 16.4 M (53.8 FT) NORTH OF THE WEST MAIN STREET
AA8662'CENTER, 15.0 M (49.2 FT) EAST OF A 4-FOOT SQUARE CONCRETE BOX CULVERT
AA8662'RUNNING UNDER THE TRACKS, 8.3 M (27.2 FT) NORTH-NORTHEAST OF A 24-INCH
AA8662'ROUND METAL MANHOLE COVER CENTER, 7.3 M (24.0 FT) SOUTH OF THE TRACKS
AA8662'SOUTH RAIL, 0.6 M (2.0 FT) EAST OF A WITNESS POST, AND THE MONUMENT IS
AA8662'ABOUT 0.4 M (1.3 FT) BELOW THE TRACKS AND FLUSH WITH THE GROUND
AA8662'SURFACE. BY R.G. HAYES.

AA8662

AA8662

STATION RECOVERY (1997)

AA8662

AA8662'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1997 (CSM)
AA8662'RECOVERED AS DESCRIBED.

AA8662

AA8662

STATION RECOVERY (2001)

AA8662

AA8662'RECOVERY NOTE BY WOOLPERT CONSULTANTS 2001 (BJM)
AA8662'RECOVERED AS DESCRIBED.

AA8662'

AA8662'
AA8662'
AA8662
AA8662 STATION RECOVERY (2003)
AA8662
AA8662'RECOVERY NOTE BY WOOLPERT CONSULTANTS 2003 (BJM)
AA8662'STATION WAS RECOVERED AS DESCRIBED AND FOUND IN GOOD CONDITION.
AA8662'
AA8662'
AA8662
AA8662 STATION RECOVERY (2003)
AA8662
AA8662'RECOVERY NOTE BY MO DEPT OF NAT RES 2003 (AAW)
AA8662'RECON BY MODNR AS DESCRIBED.OCCUPIED BY ST LOUIS COUNTY DEPT OF
AA8662'HIGHWAYS AND TRAFFIC FOR FBN PROJECT.
AA8662
AA8662 STATION RECOVERY (2003)
AA8662
AA8662'RECOVERY NOTE BY MO DEPT OF NAT RES 2003 (BDC)
AA8662'RECOVERED IN GOOD CONDITION.
AA8662
AA8662 STATION RECOVERY (2005)
AA8662
AA8662'RECOVERY NOTE BY MO DEPT OF NAT RES 2005 (MJC)
AA8662'RECOVERED AS DESCRIBED. DESCRIPTION AND TO REACH ARE ADEQUATE.
AA8662
AA8662 STATION RECOVERY (2005)
AA8662
AA8662'RECOVERY NOTE BY INDIVIDUAL CONTRIBUTORS 2005 (BB)
AA8662'RECOVERED AS DESCRIBED
AA8662
AA8662 STATION RECOVERY (2009)
AA8662
AA8662'RECOVERY NOTE BY INDIVIDUAL CONTRIBUTORS 2009 (TMB)
AA8662'RECOVERED IN GOOD CONDITION.

*** retrieval complete.
Elapsed Time = 00:00:02

The NGS Data Sheet

See file [dsdata.pdf](#) for more information about the datasheet.

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PROGRAM = datasheet95, VERSION = 8.12.3
1 National Geodetic Survey, Retrieval Date = OCTOBER 27, 2017
*****
DF7515 DESIGNATION - SL 62 AZ MK
DF7515 PID - DF7515
DF7515 STATE/COUNTY- MO/ST LOUIS
DF7515 COUNTRY - US
DF7515 USGS QUAD - KIRKWOOD (1993)
DF7515
DF7515 *CURRENT SURVEY CONTROL
DF7515
DF7515* NAD 83(2011) POSITION- 38 35 45.73140(N) 090 28 39.90083(W) ADJUSTED
DF7515* NAD 83(2011) ELLIP HT- 111.577 (meters) (06/27/12) ADJUSTED
DF7515* NAD 83(2011) EPOCH - 2010.00
DF7515* NAVD 88 ORTHO HEIGHT - 142.694 (meters) 468.16 (feet) ADJUSTED
DF7515
DF7515 GEOID HEIGHT - -31.126 (meters) GEOID12B
DF7515 NAD 83(2011) X - -41,620.324 (meters) COMP
DF7515 NAD 83(2011) Y - -4,991,339.582 (meters) COMP
DF7515 NAD 83(2011) Z - 3,957,436.593 (meters) COMP
DF7515 LAPLACE CORR - 0.73 (seconds) DEFLEC12B
DF7515 DYNAMIC HEIGHT - 142.600 (meters) 467.85 (feet) COMP
DF7515 MODELED GRAVITY - 979,973.0 (mgal) NAVD 88
DF7515
DF7515 VERT ORDER - SECOND CLASS I
DF7515
DF7515 Network accuracy estimates per FGDC Geospatial Positioning Accuracy
DF7515 Standards:
DF7515 FGDC (95% conf, cm) Standard deviation (cm) CorrNE
DF7515 Horiz Ellip SD_N SD_E SD_h (unitless)
DF7515 -----
DF7515 NETWORK 0.75 1.31 0.34 0.26 0.67 -0.01277768
DF7515 -----
DF7515 Click here for local accuracies and other accuracy information.
DF7515
DF7515
DF7515.The horizontal coordinates were established by GPS observations
DF7515.and adjusted by the National Geodetic Survey in June 2012.
DF7515
DF7515.NAD 83(2011) refers to NAD 83 coordinates where the reference frame has
DF7515.been affixed to the stable North American tectonic plate. See
DF7515.NA2011 for more information.
DF7515
DF7515.The horizontal coordinates are valid at the epoch date displayed above
DF7515.which is a decimal equivalence of Year/Month/Day.
DF7515
DF7515.The orthometric height was determined by differential leveling and
DF7515.adjusted by the NATIONAL GEODETIC SURVEY
DF7515.in March 2007.
DF7515
DF7515.No vertical observational check was made to the station.
DF7515
DF7515.Significant digits in the geoid height do not necessarily reflect accuracy.
DF7515.GEOID12B height accuracy estimate available here.
DF7515
DF7515.The X, Y, and Z were computed from the position and the ellipsoidal ht.
DF7515
DF7515.The Laplace correction was computed from DEFLEC12B derived deflections.
DF7515
DF7515.The ellipsoidal height was determined by GPS observations
DF7515.and is referenced to NAD 83.
DF7515
DF7515.The dynamic height is computed by dividing the NAVD 88
DF7515.geopotential number by the normal gravity value computed on the
```

DF7515.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
DF7515.degrees latitude (g = 980.6199 gals.).
DF7515
DF7515.The modeled gravity was interpolated from observed gravity values.
DF7515
DF7515. The following values were computed from the NAD 83(2011) position.
DF7515
DF7515;
DF7515;SPC MO E - North East Units Scale Factor Converg.
DF7515;UTM 15 - 306,589.371 251,938.200 MT 0.99993338 +0 00 50.0
DF7515;UTM 15 - 4,274,967.069 719,658.367 MT 1.00019422 +1 34 26.7
DF7515
DF7515!
DF7515!SPC MO E - Elev Factor x Scale Factor = Combined Factor
DF7515!UTM 15 - 0.99998249 x 0.99993338 = 0.99991587
DF7515!UTM 15 - 0.99998249 x 1.00019422 = 1.00017671
DF7515
DF7515_U.S. NATIONAL GRID SPATIAL ADDRESS: 15SYC1965874967(NAD 83)
DF7515
DF7515
DF7515 SUPERSEDED SURVEY CONTROL
DF7515
DF7515 NAD 83(2007)- 38 35 45.73143(N) 090 28 39.90149(W) AD(2002.00) 0
DF7515 ELLIP H (02/10/07) 111.603 (m) GP(2002.00)
DF7515 NAD 83(1997)- 38 35 45.73149(N) 090 28 39.90192(W) AD() B
DF7515 ELLIP H (08/29/03) 111.615 (m) GP() 4 2
DF7515 NAVD 88 142.69 (m) 468.1 (f) LEVELING 3
DF7515
DF7515.Superseded values are not recommended for survey control.
DF7515
DF7515.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
DF7515.See file [dsdata.pdf](#) to determine how the superseded data were derived.
DF7515
DF7515_MARKER: DD = SURVEY DISK
DF7515_SETTING: 7 = SET IN TOP OF CONCRETE MONUMENT
DF7515_STAMPING: SL-62 A 1992
DF7515_MARK LOGO: MODNR
DF7515_PROJECTION: FLUSH
DF7515_MAGNETIC: N = NO MAGNETIC MATERIAL
DF7515_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
DF7515+STABILITY: SURFACE MOTION
DF7515_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
DF7515+SATELLITE: SATELLITE OBSERVATIONS - October 30, 2014
DF7515
DF7515 HISTORY - Date Condition Report By
DF7515 HISTORY - 1992 MONUMENTED MODNR
DF7515 HISTORY - 20030502 GOOD WOOLPT
DF7515 HISTORY - 20030718 GOOD WOOLPT
DF7515 HISTORY - 20141030 GOOD DOASLS
DF7515
DF7515
DF7515 STATION DESCRIPTION
DF7515
DF7515'DESCRIBED BY WOOLPERT CONSULTANTS 2003 (BJM)
DF7515'THE STATION IS LOCATED APPROXIMATELY 1.65 MI EAST OF THE CITY OF
DF7515'MANCHESTER, 2.5 MI WEST
DF7515'OF THE CITY OF DES PERES, AND 1.4 MI SOUTH-SOUTHWEST OF THE COMMUNITY
DF7515'OF TOWN AND
DF7515'COUNTRY. IN THE SOUTHEAST QUADRANT OF STATE HIGHWAY 100 (MANCHESTER
DF7515'ROAD) WITH
DF7515'MASON LANE. OWNERSHIP--STATE OF MISSOURI.
DF7515'
DF7515'TO REACH THE STATION FROM THE JUNCTION OF HIGHWAY 100 WITH INTERSTATE
DF7515'HIGHWAY 270, EXIT
DF7515'9, APPROXIMATELY 0.95 MI WEST OF DES PERES, GO WESTERLY 2.2 MI ON
DF7515'HIGHWAY 100 TO THE
DF7515'STATION ON THE LEFT. THE STATION IS AN ALUMINUM MISSOURI DEPARTMENT OF
DF7515'NATURAL
DF7515'RESOURCES GEOGRAPHIC REFERENCE STATION SURVEY MARKER DISK STAMPED
DF7515'--SL-62 A 1992-- SET
DF7515'IN THE TOP OF A 12-INCH DIAMETER CONCRETE MONUMENT AND SET FLUSH WITH
DF7515'THE GROUND.
DF7515'
DF7515'THE STATION IS 29.5 FEET EAST OF THE CENTERLINE OF MASON LANE, 104.7
DF7515'FEET WEST OF A UTILITY

DF7515'POLE, 85.8 FEET NORTHWEST OF THE NORTHWEST CORNER OF A BRICK BUILDING,
DF7515'AND 58.8 FEET
DF7515'NORTHEAST OF A UTILITY POLE.

DF7515

DF7515

STATION RECOVERY (2003)

DF7515

DF7515'RECOVERY NOTE BY WOOLPERT CONSULTANTS 2003 (BJM)

DF7515'THE STATION IS LOCATED APPROXIMATELY 1.65 MI EAST OF THE CITY OF
DF7515'MANCHESTER, 2.5 MI WEST OF THE CITY OF DES PERES, AND 1.4 MI
DF7515'SOUTH-SOUTHWEST OF THE COMMUNITY OF TOWN AND COUNTRY. IN THE
DF7515'SOUTHEAST QUADRANT OF STATE HIGHWAY 100 (MANCHESTER ROAD) WITH MASON
DF7515'LANE. OWNERSHIP--STATE OF MISSOURI. TO REACH THE STATION FROM THE
DF7515'JUNCTION OF HIGHWAY 100 WITH INTERSTATE HIGHWAY 270, EXIT 9,
DF7515'APPROXIMATELY 0.95 MI WEST OF DES PERES, GO WESTERLY 2.2 MI ON
DF7515'HIGHWAY 100 TO THE STATION ON THE LEFT. THE STATION IS AN ALUMINUM
DF7515'MISSOURI DEPARTMENT OF NATURAL RESOURCES GEOGRAPHIC REFERENCE STATION
DF7515'SURVEY MARKER DISK STAMPED --SL-62 A 1992-- SET IN THE TOP OF A
DF7515'12-INCH DIAMETER CONCRETE MONUMENT AND SET FLUSH WITH THE GROUND.
DF7515'THE STATION IS 29.5 FEET EAST OF THE CENTERLINE OF MASON LANE, 104.7
DF7515'FEET WEST OF A UTILITY POLE, 85.8 FEET NORTHWEST OF THE NORTHWEST
DF7515'CORNER OF A BRICK BUILDING, AND 58.8 FEET NORTHEAST OF A UTILITY
DF7515'POLE.

DF7515

DF7515

STATION RECOVERY (2014)

DF7515

DF7515'RECOVERY NOTE BY DEPARTMENT OF AGRICULTURE STAT 2014 (MJC)

DF7515'STATION RECOVERED IN GOOD SHAPE. IT IS 12.5 FEET NE OF A STOP SIGN
DF7515'POST, 2.9 FEET SOUTH OF BACK OF CURB AND 104.7 FEET WEST OF A UTILITY
DF7515'
DF7515'POLE.

*** retrieval complete.

Elapsed Time = 00:00:03

Appendix D

LiDAR Survey Calibration Points Field Photos



t101[1]_tag



t101_tag



t102[1]_tag



t102_tag



t103[1]_tag



t103_tag



t104[1]_tag



t104_tag



t105[1]_tag



t105_tag



t106[1]_tag



t106_tag



t107[1]_tag



t107

Date & Time: Sat Feb 11 10:44:18 CST 2017
Position: +088.93837° 7-090 26304°
Altitude: 460ft
Datum: WGS-84
Azimuth/Bearing: 294° S71/4W 451.6mils (True)
Elevation Angle: -78.4°
Horizon Angle: -87.1°
Zoom: 1X
t107 parking intersection

N 38° 32' 00.15"
W 90° 15' 46.96"

460 ft

t107_tag



t108[1]_tag



t108_tag



t109[1]_tag



t109_tag



t110[1]_tag



t110_tag



t111[1]_tag



t111_tag



t112[1]_tag



t112_tag



t113[1]_tag



t113_tag



t114[1]_tag



t114_tag



t115[1]_tag



t115_tag



t116[1]_tag



t116_tag



t117[1]_tag



t117_tag



t118[1]_tag



t118_tag



t119[1]_tag



t119_tag



t120[1]_tag



t120_tag

Appendix E

LiDAR Survey QC Point Field Photos



T201[1]_tag



T201_tag



T202[1]_tag



T202_tag



T203[1]_tag



T203_tag



T204[1]_tag



T204_tag



T205[1]_tag



T205_tag



T206[1]_tag



T206_tag



T207

N 38° 47' 47.31"
W 90° 11' 04.93"

364 ft

11:37:17 AM
3/30/2017

T207[1]_tag



T207_tag



T208[1]_tag



T208_tag



T209[1]_tag



T209_tag



T210[1]_tag



T210_tag



T211[1]_tag



T211_tag



T212[1]_tag



T212_tag



T213[1]_tag



T213_tag



T214[1]_tag



T214_tag



T215[1]_tag



T215_tag



T216[1]_tag



T216_tag



T217[1]_tag



T217_tag



T218[1]_tag



T218_tag



T219[1]_tag



T219_tag



T220[1]_tag



T220_tag



T221[1]_tag



T221_tag



T222[1]_tag



T222_tag



T223[1]_tag



T223_tag



T224[1]_tag



T224_tag



N 38° 34' 35.14"
W 90° 25' 30.39"

518 ft

10:15:32 AM
4/3/2017

T225[1]_tag



T225_tag



T226[1]_tag



T226_tag



T227[1]_tag



T227_tag



T228[1]_tag



T228_tag



T229[1]_tag



T229_tag



T230[1]_tag



T230_tag



T231[1]_tag



T231_tag



T232[1]_tag



T232_tag



T233[1]_tag



T233_tag



T234[1]_tag



T234_tag



T235[1]_tag



T235_tag



T301[1]_tag



T301_tag



T302[1]_tag



T302_tag



T303[1]_tag



T303_tag



T304[1]_tag



T304_tag



T305[1]_tag



T305[2]_tag



T305[3]_tag



T305_tag



T306[1]_tag



T306_tag



T307[1]_tag



T307_tag



T308[1]_tag



T308_tag



T309[1]_tag



T309_tag



T310[1]_tag



T310_tag



T311[1]_tag



T311_tag



T312[1]_tag



T312_tag



T313[1]_tag



T313_tag



T314[1]_tag



T314_tag



T315[1]_tag



T315_tag



T316[1]_tag



T316_tag



T317[1]_tag



T317[2]_tag



T317[3]_tag



T317_tag



T318[1]_tag



T318_tag



T319[1]_tag



T319_tag



T320[1]_tag



T320_tag



T321[1]_tag



T321_tag



T322[1]_tag



T322_tag



T323[1]_tag



T323_tag



T324[1]_tag



T324_tag



T325[1]_tag



T325_tag