

**FINAL REPORT**  
**Volume I**  
**Colorado Department of Transportation**  
**Interstate 70 East Viaduct**  
Horizontal and Vertical Control Survey Report for Aerial Mapping

CDOT Project Number  
19631



ATKINS Project Number  
100036335

**ATKINS**

Atkins, North America, Inc.  
*Geomatics Division*  
4601 DTC Blvd., #700, Denver, Colorado 80237

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Professional Land Surveyor in Responsible Charge

Eric Christianson, PLS No. 37077



## Volume I

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## 1. INTRODUCTION

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This report describes the ground control survey, performed by Atkins North America, Inc. (Atkins) for the aerial mapping for the design of the Colorado's Department of Transportation (CDOT) I-70 East Viaduct Project (Project Number 19631) in Denver, Colorado. Atkins was contracted to establish horizontal and vertical aerial mapping ground control points, to a CDOT Accuracy Specification of Order B, i.e., relative accuracy of 0.13 foot at the 95 percent level of confidence, at specific locations indicated by the aerial mapping company, Bohannon Huston, Inc. (BHI). Fifty-five (55) ground control points and twenty-one (21) newly established check points were set and surveyed throughout the proposed I-70 corridor from I-25 (at the interchange with I-70 East) to Quebec Street.

The current survey consisted of performing differential Global Positioning System (GPS) survey techniques to densify the mapping control in the project area from nearby CDOT project control.

This report documents the following:

- A description of the project datum;
- A description of problems and issues encountered on the project;
- A description of the differential GPS survey;
- A description of the differential leveling to complement the GPS derived vertical control;
- A description of the data reductions and combined least squares adjustment required to obtain adjusted coordinates, i.e., Universal Transverse Mercator – Zone 13 North (UTM13N), and elevations, i.e., North American Vertical Datum of 1988 (NAVD88);
- Transformation from adjusted coordinates to Project Specific Coordinates (PSC);
- Conclusions and listings of final horizontal coordinates on both UTM13N and on the Project Specific Coordinates (PSC), and elevations on NAVD88; and
- Appendices containing, station data sheets for all newly established ground control points, and printouts of the combined least squares adjustment.

### 1.1 Duration/Time Period

The survey was performed on September 15<sup>th</sup> and September 26<sup>th</sup> through October 7<sup>th</sup>, 2013. Additional GPS was observed October 22<sup>nd</sup> 2013.

Differential GPS observations were performed between September 27<sup>th</sup> through October 3<sup>rd</sup>, 2013. Additional GPS was observed on October 7<sup>th</sup> and October 22<sup>nd</sup>, 2013.

Precise leveling was performed on certain days between September 15<sup>th</sup> through October 10<sup>th</sup>, 2013.

## 1.2 Problems and Issues Encountered During Survey

There were no significant issues encountered during the survey..

## 1.3 Point of Contact

Questions regarding the technical aspects of this report should be addressed to:

**Eric Christianson, PLS**  
Survey Manager, National Geomatics Division

### ATKINS

2270 Corporate Circle, Suite 200, Henderson, NV 89074  
Tel: (702) 263-7275, ext 4513115  
Fax: (702) 263-7200  
Email: [eric.christianson@atkinsglobal.com](mailto:eric.christianson@atkinsglobal.com)

or

**Peter W. DeKrom, MScE.**  
Geodetic Engineer & Manager of Tunnel Surveying,  
National Geomatics Division

### ATKINS

4601 DTC Blvd., #700, Denver, Colorado 80237  
Tel: +1 (303) 221-7275 x4988001  
Fax: +1 (303) 221-6348  
Cell: +1 (719) 213 4130 |  
Email: [peter.dekrom@atkinsglobal.com](mailto:peter.dekrom@atkinsglobal.com) |

## 2. PROJECT DATUM

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The project was referenced to a 'localized' coordinate system known as Project Specific Coordinates (PSC) which are based off of Universal Transverse Mercator Zone 13 North [UTM13N]. The transformation from UTM13 to Project Specific Coordinates can be found in the following document:

- **Colorado Department of Transportation, Region 6.** Land Survey Control Diagram, Title Sheet, Project Number NH 0361-070, Project Location: SH-119/US Route 36/Interstate 70, Project Code 14133, Sheet 3.01, Dated 09-27-2012.

The transformation can be summarized in the equation below:

$$PSC (northing) = [(UTM \cdot 1.0006504025) - 14000000], \text{ and}$$
$$PSC (easting) = [(UTM \cdot 1.0006504025) - 1000000].$$

The elevations are referenced to the North American Vertical Datum of 1988 (NAVD88).

Atkins performed all GPS processing and adjustments on the North American Datum of 1983, re-adjustment of 1992 [NAD83(1992)] horizontal datum and North American Vertical Datum of 1988 [NAVD88] as explained in Section 6.0 of this final report.

### 3. RECONNAISSANCE, MONUMENTATION AND DESIGNATION

A field reconnaissance was performed on existing control to ensure it has GPS intervisibility. The existing Colorado Department of Transportation (CDOT) survey control recovered and used in the GPS Survey consisted of the following control points:

- ARGO - Horizontal/Vertical Control Point located in the north-west corner of the project;
- B394 - Horizontal/Vertical Control Point located in the center of the project;
- 166A - Horizontal/Vertical Control Point located in the western of the project;
- ELLIS – Vertical control point located on the western portion of the project; and
- D394 - Vertical control point located on the eastern portion of the project.

In addition Atkins field personnel set newly-established control at the required locations for the aerial targets. All newly-established control points consisted of two (2) inch aluminum washers set in concrete or asphalt or 2 inch aluminum caps set on rebar flush to the ground.

In the field, the newly established control points were designated with an alpha-numeric point designation, with a prefix BHI (i.e., Bohannon Huston, Inc.), representing the aerial mapping company responsible for the mapping, and a numeric designation from 001 through 056. Therefore each newly established control point was designated as BHI\_001 through BHI\_056. It should be noted that there was no BHI\_029.

In addition, there were twenty-one (21) control points included in the network that were to be used as ‘checks’ on the aerial triangulation solution for mapping purposes. These control points were designated BHI\_057 through BHI\_077. However, it should be noted that the check points were renamed after the the completion of the field survey. The renamed check points are shown below:

<i>Revised Station Point ID</i>	<i>Original Station Point ID</i>
BHI_057	CHECK_101A
BHI_058	CHECK_102
BHI_059	CHECK_103
BHI_060	CHECK_104
BHI_061	CHECK_105
BHI_062	CHECK_106
BHI_063	CHECK_107
BHI_064	CHECK_108
BHI_065	CHECK_109
BHI_066	CHECK_1010
BHI_067	CHECK_1011
BHI_068	CHECK_1012
BHI_069	CHECK_1013
BHI_070	CHECK_1014
BHI_071	CHECK_1014A
BHI_072	CHECK_1015
BHI_073	CHECK_1016
BHI_074	CHECK_1017
BHI_075	CHECK_1018
BHI_076	CHECK_1019A
BHI_077	CHECK_1020

A description of each monument is listed in Appendix A with the final coordinates and elevations.

For final deliverable the alpha portion of the point name was eliminated from the control point identification, (i.e., BHI\_001 became 001).

## **4. FIELD OBSERVATIONS OF GPS NETWORK**

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Atkins field personnel employed four (4) Trimble Navigation™ R8 dual frequency P-code geodetic receivers capable of collecting GPS and GLONASS data. The GPS surface control network was established by relative differential Global Positioning System (GPS) survey techniques and common data between localized control points were observed.

During the survey, high precision rotatable optical plummets were used for the centering on all points to minimize the effect of optical misalignment. Static dual frequency surveying techniques were used for measuring all baseline vectors. Instrument heights were measured at least twice, in meters and feet, and compared prior to leaving the station.

GPS sessions were typically 20 to 120 minutes in length depending on the length of the observed baseline, and data were collected at a logging interval of five seconds (0.2 Hz). Only quasi-independent baseline solutions were adopted during this survey.

The GPS network is shown in Appendix B.

## **5. VERTICAL CONTROL NETWORK (LEVELING)**

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Atkins field personnel performed precision leveling to validate and densify vertical control throughout the project area. A Trimble Navigation's DiNi 22 digital level was used in which double run leveling section were observed between project control points and newly-established control points.

The average section closure was 0.006' with no section exceeding 0.01'.

## **6. GPS PROCESSING, MINIMALLY CONSTRAINED ADJUSTMENT AND FULLY CONSTRAINED ADJUSTMENT**

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### **6.1 Preliminary GPS Processing**

The Atkins field manager performed preliminary GPS vector processing on a daily basis using Trimble Navigation's Business Center (TBC) version 3.10. TBC accommodates the NGS antenna models, precise orbits and allows for GPS baselines to be processed with different tropospheric models. The GPS data was processed on the day after the observations to allow the use of IGS ultra-rapid orbits. All vectors were processed to ensure that integer-cycle ambiguity resolution was achieved.

### **6.2 Final GPS Processing**

Upon completion of the acquisition of the field survey, final processing of the GPS data was performed once again using TBC version 3.10. The same vectors that were processed in the preliminary GPS processing, however they were reprocessed with the IGS precise ephemerides. The precise ephemerides were obtained from the Scripps Orbit and Permanent Array Center (SOPAC) and were downloaded from the following website <http://sopac.ucsd.edu>.

In addition to the local survey baseline observed in the field, additional baselines were processed from the certain project control points to nearby Continuously Operating Reference Stations (CORS) (i.e., AMC2, CTMC, DSRC, and ZDV1).

Once again, all vectors were processed to ensure that integer-cycle ambiguity resolution were achieved. It should also be noted that TBC accommodates the NGS antenna models, precise orbits and allows for GPS baselines to be processed with different antenna types between the CORS and R8 receivers.

The final GPS network consisted of 852 baseline vector components (284 baselines). It should be noted that additional baseline vectors were incorporated into the GPS network for aerial mapping which included baseline vectors for establishing control for terrestrial scanning. The purpose of this is to ensure that all aspects of the survey are adjusted simultaneously allowing all observations to contribute statistically towards the final adjustment and results.

### 6.3 Minimally Constrained Adjustment

A minimally constrained least squares adjustment was performed using Microsearch Geolab software (version 2001.9.20.0), which was used successfully by Atkins on a variety of geodetic projects including those requiring NGS Blue Book reporting. Prior to a fully constrained least squares adjustment, a minimally constrained adjustment was performed to ensure the CDOT's accuracy requirements are achieved (relative accuracy of connecting baseline vectors of 0.13 foot at the 95 percent level of confidence) and that there is a 'reasonable fit' of the existing project control prior to the constrained adjustment (Section 6.4).

The minimally constrained adjustment was performed holding the published North American Datum of 1983, re-adjustment of 1992 [NAD83(1992)] geodetic latitude, longitude and ellipsoidal height of CDOT control point, ARGO. The published geodetic coordinates were obtained from the CDOT design plans as mentioned in Section 2.0 of this report. The minimally constrained adjustment incorporated the GEOID model GEOID12A to obtain orthometric elevations from the adjusted GPS-derived ellipsoidal heights. It should be noted that the published elevations were derived by GEOID99 ellipsoidal elevations. The discrepancy between using GEOID99 versus GEOID12A geoidal undulations resulted in an insignificant difference in adjusted elevations. (< 1cm). It was determined appropriate to use the latest geoidal model (i.e., GEOID12A) to ensure the most rigorous derived elevations are used.

In the resulting adjustment, the estimated variance factor of 1.04 passed the  $\chi^2$ -test at the 95% level of confidence indicating appropriate *a priori* estimates of the accuracy of the GPS observations were used in the adjustments. A review of the 95% relative confidence regions (ellipses) reveals that the relative network accuracy surpasses the accuracy requirements for CDOT Order B surveys requirements of 0.13' at the 95% level of confidence and actually surpasses the requirements for CDOT Order A requirements (0.07' at the 95% level of confidence).

The largest relative accuracy confidence ellipse from the minimally constrained adjustment was determined to be 0.03' at the 95% level of confidence. Results of the relative accuracies can be seen in Volume II, Appendix D.

Comparison of the adjusted coordinates and elevations from the minimally constrained adjustment are compared to the published values. Results are shown below:

Point ID	Atkins			Published			Difference		
	N	E	H	N	E	H	ΔN	ΔE	ΔH
<b>Horizontal Control (Published obtained from "Land Survey Control Diagram Tabulation Sheet NH 0361-070)</b>									
ARGO	14448277.492	1645608.807	5146.37	14448277.492	1645608.807	5146.37	0.000	0.000	0.00
B394	14446532.642	1657100.219	5261.86	14446532.626	1657100.225	5261.82	0.016	-0.006	0.04
DSRC	14523718.023	1567308.321	-	14523717.987	1567308.282	-	0.036	0.039	-
ZDV1	14594962.736	1604888.587	-	14594962.745	1604888.568	-	-0.009	0.019	-
<b>Vertical Control (Published obtained from "Land Survey Control Diagram Tabulation Sheet NH 0361-070)</b>									
D394	14445984.760	1667592.925	5275.29	14445984.734	1667592.906	5275.23	0.026	0.019	0.06
ELLIS	14444053.110	1646061.467	5162.46	14444053.070	1646061.505	5162.41	0.040	-0.038	0.05

Results of the minimally constrained adjustment indicate a good fit, horizontally and vertically, of the control from the published CDOT values. This will indicate that there should be no issues when fully constraining to the project control.

The Geolab output of the minimally constrained adjustment can be viewed in Volume II, Appendix E.

## 6.4 Constrained Least Squares Adjustment

A least squares adjustment was performed on the GPS using Geolab 2001 constraining to the published geodetic coordinates ( $\Phi, \lambda$ ) in NAD83(1992) of the project control points and the NAVD88 elevations. The project control points consisted of the CGPS Stations, AMC2, CTMC, DSRC, and ZDV1. The network was also horizontal constrained to CDOT control points ARGO, B394, and 166A. The least squares adjustment was vertically constrained to the NAVD88 elevation of ELLIS, D394, ARGO, B394 and 166A.

All of the GPS vectors and leveling observations were combined in a single unified adjustment incorporating GEOID12A.

In the resulting adjustment, the estimated variance factor ( $\sigma_0^2 = 1.01$ ) ensures that the weighting of the observations are realistic. In addition, no residuals ( $\nu$ ) or standardized residuals ( $\bar{\nu} = \nu/\sigma$ ) were flagged for possible rejection.

The least squares adjustment note the residuals and weighting of the observations. The accuracies at the 95 percent level of confidence of the points are also given. The least squares adjustment can be viewed in Volume II, Appendix F of the report.

The final results of the least squares adjustment yielded final coordinates on the NAD83(1992) datum, Universal Transverse Mercator, Zone 13 North [UTM13N], and elevations on NAVD88 vertical datum.

## 6.5 Transformation to Project Specific System

The adjusted horizontal values in UTM13N, from the combined least squares were then transformed to the Project Specific Coordinates as indicated in Section 2.0. The horizontal values were transformed as follows:

$$PSC \text{ (northing)} = [(UTM \cdot 1.0006504025) - 14000000], \text{ and}$$

$$PSC \text{ (easting)} = [(UTM \cdot 1.0006504025) - 1000000].$$

## 7. FINAL RESULTS AND DELIVERABLES

The final coordinates of the control points are presented in U.S. survey feet in Appendix A on the NAD83 (1992) datum. Horizontal values are presented in the Universal Transverse

Mercator Zone 13 mapping plane, as well as the Project Specific Coordinates. Elevations are presented on the NAVD88 vertical datum in U.S. survey feet.

In addition to the final coordinates and elevations, final deliverables presented with this report include the following:

- Hard copy of the report;
- Digital copy of the report;
- Digital copies of the DataSheets of the Aerial Mapping Control;
- Level Notes; and
- NGS Data Sheets.

**APPENDIX A**  
**Final Coordinates and Elevations**

### I-70 East Viaduct Photo Control and Check Control Points

CDOT PROJECT NUMBER: 19631

Horizontal Datum: NAD83(1992)

Vertical Datum: NAVD88

Mapping Zone: UTM 13 and Project Specific System

Units: US Survey Feet

Point ID	UTM 13		Project		Ortho	$\sigma E$	$\sigma H$	Description	
	N	E	N	E	Ht	$\sigma N$	$\sigma E$	$\sigma H$	
<b>Aerial Targets</b>									
1	14444858.4926	1642864.8102	454253.4538	643933.3323	5170.02	0.01	0.01	0.02	2" diam. washer/mag nail, stamped BHI No 01
2	14446151.5236	1642957.8116	455547.3258	644026.3943	5184.29	0.01	0.01	0.02	2" diam. alum. Disk, stamped BHI No 02
3	14447261.3717	1642770.0314	456657.8958	643838.4919	5195.17	0.01	0.01	0.02	2" diam. alum. Disk, stamped BHI No 03
4	14447300.7356	1645697.6984	456697.2852	646768.0631	5147.44	0.01	0.01	0.01	2" diam. washer/mag nail, stamped BHI No 04
5	14446030.9344	1645730.2782	455426.6581	646800.6640	5151.16	0.01	0.01	0.01	2" diam. washer/mag nail, stamped BHI No 05
6	14444832.9087	1646227.5507	454227.8532	647298.2600	5154.51	0.01	0.01	0.01	2" diam. alum. Disk, stamped BHI No 06
7	14446032.7477	1644293.8354	455428.4726	645363.2869	5149.93	0.01	0.01	0.02	2" diam. washer/mag nail, stamped BHI No 07
8	14443788.4161	1647956.8083	452167.6551	649028.6423	5198.65	0.01	0.01	0.02	2" diam. washer/mag nail, stamped BHI No 08
9	14443844.7439	1647005.4607	453182.6813	648076.6759	5189.97	0.01	0.01	0.02	2" diam. washer/mag nail, stamped BHI No 09
10	14446245.3079	1649066.8595	453239.0458	650139.4155	5198.10	0.02	0.01	0.02	2" diam. washer/mag nail, stamped BHI No 010
11	14444955.0292	1648164.1983	454350.0532	650569.8273	5188.36	0.01	0.01	0.01	2" diam. washer/mag nail, stamped BHI No 011
12	144446093.7654	1647295.0804	455489.5300	649236.1672	5188.33	0.01	0.01	0.02	2" diam. washer/mag nail, stamped BHI No 012
13	14447334.9302	1648855.8248	456731.5021	648366.4840	5159.60	0.01	0.01	0.01	2" diam. washer/mag nail, stamped BHI No 013
14	14446084.2816	1651836.1533	455480.0400	649928.2435	5182.74	0.01	0.01	0.02	2" diam. washer/mag nail, stamped BHI No 014
15	14444876.0432	1651843.7856	454271.0158	652910.5105	5188.11	0.01	0.01	0.01	2" diam. washer/mag nail, stamped BHI No 015
16	14444836.3718	1653300.0004	454231.3186	652918.1477	5200.28	0.01	0.01	0.01	2" diam. washer/mag nail, stamped BHI No 016
17	14444817.3576	1650049.0185	454212.2920	654375.3096	5208.95	0.01	0.01	0.01	2" diam. washer/mag nail, stamped BHI No 017
18	14447335.7093	1651877.4076	456732.2817	651122.2133	5197.51	0.01	0.01	0.02	2" diam. alum. Disk, stamped BHI No 018
19	14447390.0324	1654690.3651	456786.6401	652951.7915	5185.06	0.01	0.01	0.01	2" diam. washer/mag nail, stamped BHI No 019
20	14446093.8968	1653301.0750	455489.6615	655766.5786	5208.23	0.01	0.01	0.01	2" diam. washer/mag nail, stamped BHI No 020
21	14446032.5733	1654854.0691	455428.2981	654376.3849	5207.22	0.01	0.01	0.03	2" diam. washer/mag nail, stamped BHI No 021
22	14446003.6023	1657038.4706	455399.3083	655930.3890	5210.91	0.01	0.01	0.01	2" diam. washer/mag nail, stamped BHI No 022
23	14444825.9377	1657038.4740	454220.8777	658116.2113	5262.36	0.01	0.01	0.01	2" diam. alum. disk, stamped BHI No 023
24	14444702.4850	1659920.4676	454097.3447	658116.2147	5272.28	0.01	0.01	0.01	2" diam. washer/mag nail, stamped BHI No 024
25	14444767.9385	1654845.5722	454162.8408	661000.0828	5260.81	0.01	0.01	0.02	2" diam. washer/mag nail, stamped BHI No 025
26				655921.8867	5223.88	0.01	0.01	0.02	2" diam. washer/mag nail, stamped BHI No 026

### I-70 East Viaduct Photo Control and Check Control Points

CDOT PROJECT NUMBER: 19631  
 Horizontal Datum: NAD83(1992)  
 Vertical Datum: NAVD88  
 Mapping Zone: UTM 13 and Project Specific System  
 Units: US Survey Feet

Point ID	UTM 13			Project			Ortho Ht	σN	σE	σH	Description
	N	E	N	E	Ht						

**Aerial Targets**

27	14447259.6719	1657029.1569	456656.1948	658106.8915	5232.19	0.01	0.01	0.01	0.01	0.01	2" diam. alum. disk, stamped BHI No 027
28	14447160.1149	1659827.6571	456556.5731	660907.2119	5242.99	0.01	0.01	0.01	0.01	0.02	2" diam. alum. disk, stamped BHI No 028
30	14445965.8641	1659612.1601	455361.5455	660691.5747	5253.71	0.01	0.01	0.01	0.01	0.02	2" diam. washer/mag nail, stamped BHI No 030
31	14445881.5902	1662211.3399	455277.2168	663292.4450	5251.92	0.01	0.01	0.01	0.01	0.02	2" diam. washer/mag nail, stamped BHI No 031
32	14444744.7095	1662223.3033	454139.5967	663304.4162	5270.07	0.01	0.01	0.01	0.01	0.02	2" diam. washer/mag nail, stamped BHI No 032
33	14444693.2257	1664958.4399	454088.0795	666041.3317	5281.82	0.01	0.01	0.01	0.01	0.02	2" diam. alum. disk, stamped BHI No 033
34	14445957.4443	1660927.5037	455353.1203	662007.7739	5253.19	0.01	0.01	0.01	0.01	0.02	2" diam. washer/mag nail, stamped BHI No 034
35	14447242.4541	1662250.8583	456638.9659	663331.9891	5249.36	0.01	0.01	0.01	0.01	0.02	2" diam. washer/mag nail, stamped BHI No 035
36	14447191.6217	1665980.5799	456588.1004	667064.1366	5222.45	0.01	0.01	0.01	0.01	0.02	2" diam. washer/mag nail, stamped BHI No 036
37	14445875.8378	1663788.4540	455271.4607	664870.5849	5273.26	0.01	0.01	0.01	0.01	0.02	2" diam. washer/mag nail, stamped BHI No 037
38	14445909.7521	1666041.4461	455305.3971	667125.0424	5272.68	0.01	0.01	0.01	0.01	0.02	2" diam. washer/mag nail, stamped BHI No 038
39	14445921.8085	1668266.3038	455317.4613	669351.3471	5257.23	0.02	0.01	0.01	0.01	0.01	2" diam. alum. disk, stamped BHI No 039
40	14444861.4395	1668234.4469	454256.4026	669319.4695	5267.31	0.02	0.01	0.01	0.01	0.02	2" diam. washer/mag nail, stamped BHI No 040
41	14444724.0910	1666210.0280	454118.9648	667293.7340	5278.09	0.01	0.01	0.01	0.01	0.02	2" diam. washer/mag nail, stamped BHI No 041
42	14447131.8043	1668192.5258	456528.2441	669277.5211	5231.96	0.02	0.01	0.01	0.01	0.01	2" diam. washer/mag nail, stamped BHI No 042
43	14450930.4869	1649207.2484	460329.3973	650279.8956	5142.03	0.01	0.01	0.01	0.01	0.01	2" diam. alum. disk, stamped BHI No 043
44	14449965.0163	1649191.1465	459363.2988	650263.7833	5146.42	0.01	0.01	0.01	0.01	0.01	2" diam. washer/mag nail, stamped BHI No 044
45	14447951.2681	1648852.3837	457348.2408	649924.8002	5169.91	0.01	0.01	0.01	0.01	0.01	2" diam. washer/mag nail, stamped BHI No 045
46	14450625.4855	1653972.0100	460024.1976	655047.7562	5170.37	0.01	0.01	0.01	0.01	0.02	2" diam. washer/mag nail, stamped BHI No 046
47	14449974.6429	1654005.3827	459372.9316	655081.1507	5175.99	0.02	0.01	0.01	0.01	0.02	2" diam. washer/mag nail, stamped BHI No 047
48	14448702.2206	1653310.9464	458099.6818	654386.2627	5179.40	0.01	0.01	0.01	0.01	0.01	2" diam. washer/mag nail, stamped BHI No 048
49	14450020.2154	1651863.8130	459418.5338	652938.1881	5172.69	0.01	0.01	0.01	0.01	0.01	2" diam. washer/mag nail, stamped BHI No 049
50	14448531.0630	1650380.2648	457928.4129	651453.6750	5181.43	0.01	0.01	0.01	0.01	0.01	2" diam. washer/mag nail, stamped BHI No 050
51	14445182.0627	1652496.7386	460681.2018	653571.5253	5158.18	0.01	0.01	0.01	0.01	0.02	2" diam. washer/mag nail, stamped BHI No 051
52	14447340.2200	1653306.0987	456736.7954	654381.4119	5185.26	0.01	0.01	0.01	0.01	0.01	2" diam. washer/mag nail, stamped BHI No 052
53	14448683.8925	1651859.9710	458081.3418	652934.3436	5180.32	0.01	0.01	0.01	0.01	0.01	2" diam. washer/mag nail, stamped BHI No 053
54	14444182.1892	1647758.8526	453576.7106	648830.5579	5188.07	0.01	0.01	0.01	0.01	0.02	2" diam. washer/mag nail, stamped BHI No 054

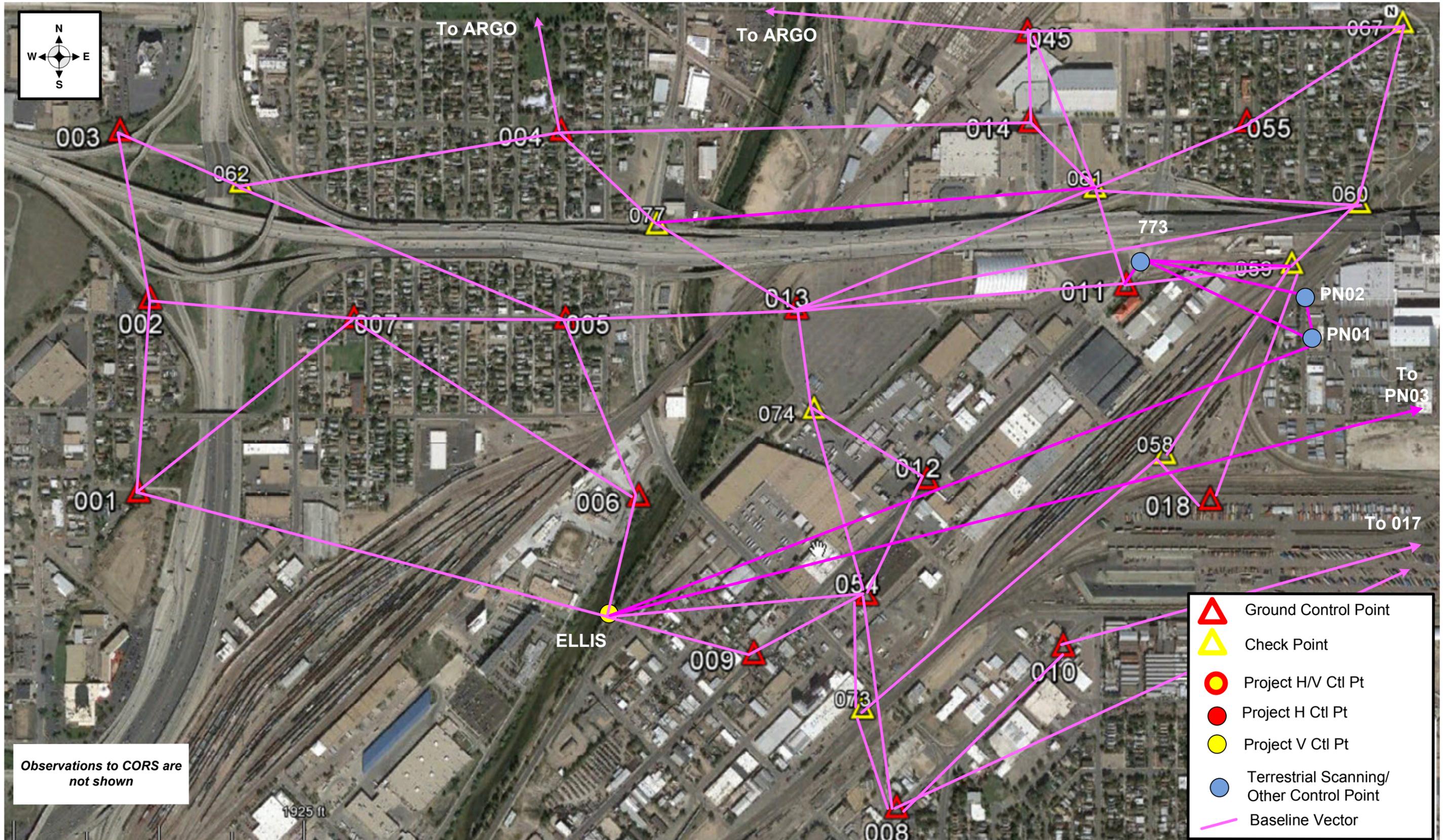
**I-70 East Viaduct Photo Control and Check Control Points**

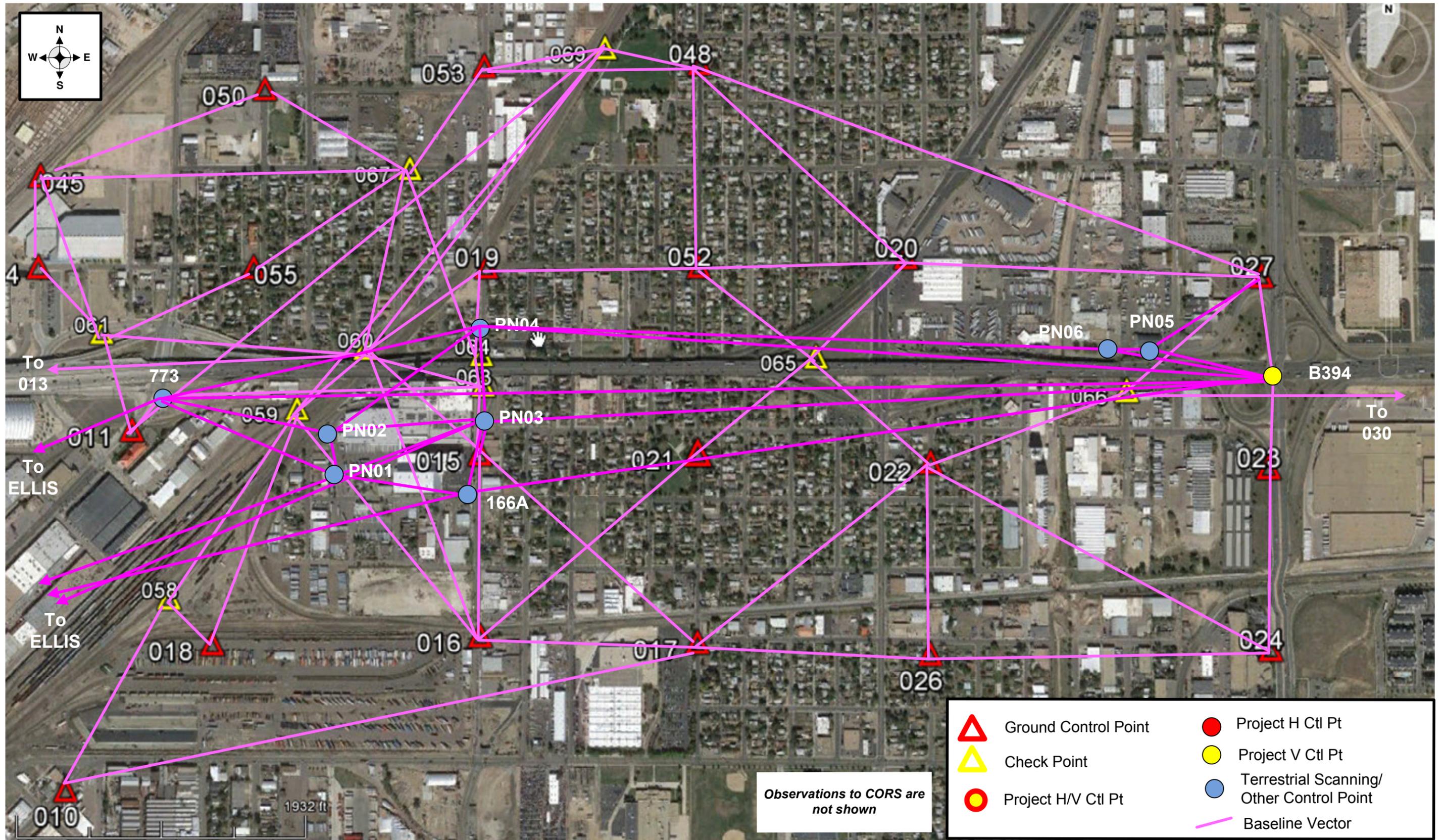
CDOT PROJECT NUMBER: 19631  
 Horizontal Datum: NAD83(1992)  
 Vertical Datum: NAVD88  
 Mapping Zone: UTM 13 and Project Specific System  
 Units: US Survey Feet

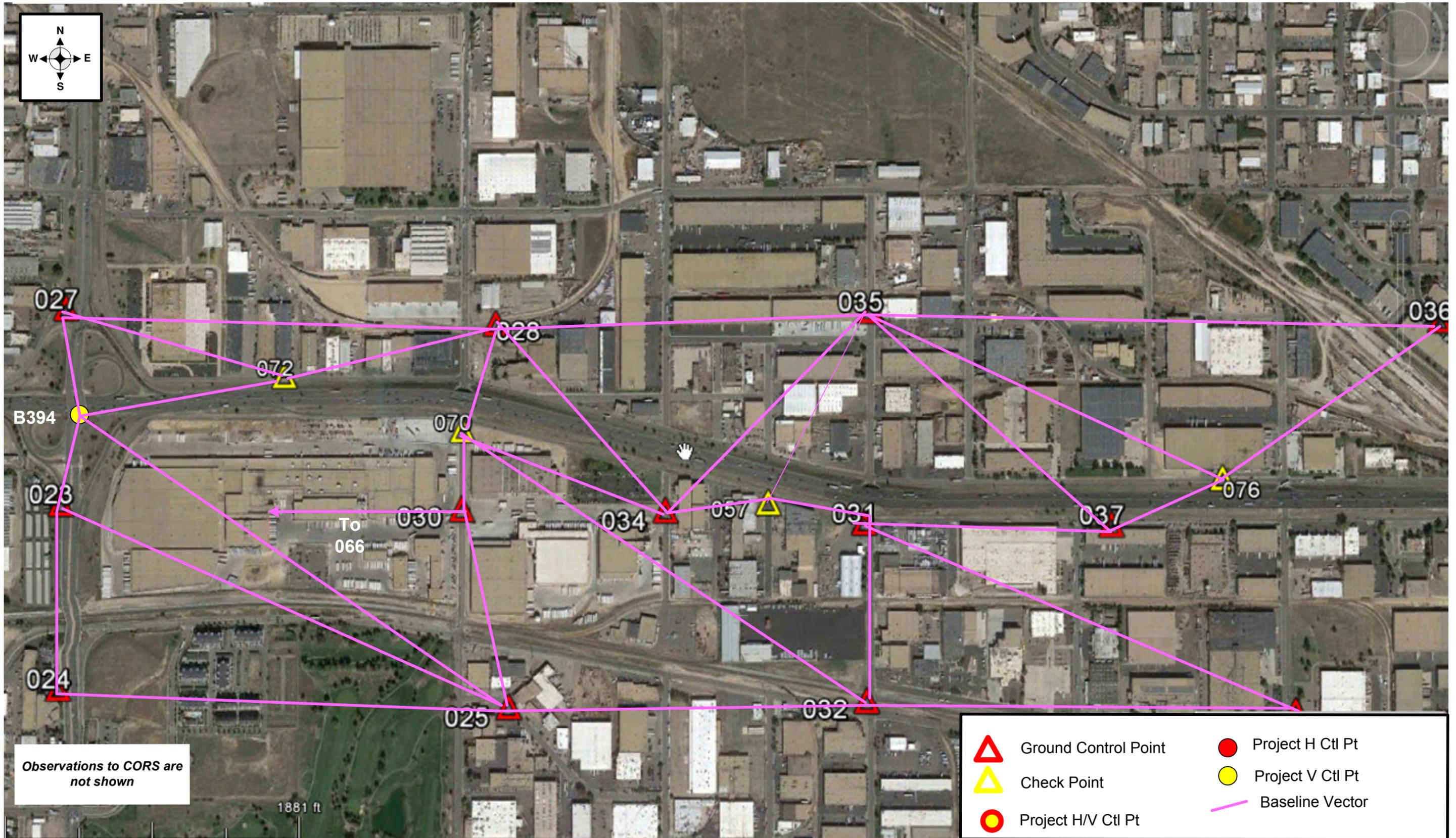
Point ID	UTM 13			Project			Ortho	σ			Description	
	N	E	N	E	Ht		σE	σN	σH			
<b>Aerial Targets</b>												
55	14447333.1229	1650309.2967	456729.6936	651382.6608	5182.64	0.01	0.01	0.02	0.02	2" diam. washer/mag nail, stamped BHI No 055		
56	14449721.9691	1650166.6079	459120.0935	651239.8791	5154.46	0.01	0.01	0.01	0.01	2" diam. washer/mag nail, stamped BHI No 056		
<b>Check Points</b>												
57	14446011.3180	1661590.8549	455407.0290	662671.5565	5252.40	0.01	0.01	0.02	0.02	2" diam. washer/mag nail		
58	14445122.2476	1649751.5691	454517.3803	650824.5704	5190.97	0.01	0.01	0.02	0.02	2" diam. alum. Disk		
59	14446387.2603	1650606.5533	455783.2158	651680.1107	5186.57	0.01	0.01	0.01	0.01	2" diam. alum. Disk		
60	14446789.9231	1651061.9249	456186.1405	652135.7784	5186.50	0.01	0.01	0.01	0.01	2" diam. washer/mag nail		
61	14446894.4342	1649290.1831	456290.7196	650362.8843	5184.36	0.01	0.01	0.01	0.01	2" diam. washer/mag nail		
62	14446936.2243	1643540.4819	456332.5368	644609.4435	5162.93	0.01	0.01	0.02	0.02	2" diam. alum. Disk		
63	14446544.5014	1651858.4780	455940.5592	652932.8496	5185.66	0.01	0.01	0.01	0.01	2" diam. washer/mag nail		
64	14446747.8541	1652477.1803	456144.0441	653551.9544	5187.31	0.02	0.01	0.03	0.03	2" diam. washer/mag nail		
65	14446728.2541	1654089.2608	456124.4314	655165.0833	5203.94	0.01	0.01	0.01	0.01	2" diam. alum. Disk		
66	14446505.4401	1656129.3748	455901.4725	657206.5242	5233.03	0.01	0.01	0.01	0.01	2" diam. washer/mag nail		
67	14447996.8019	1651359.2433	457393.8043	652433.2902	5181.15	0.01	0.01	0.01	0.01	2" diam. washer/mag nail		
68	14450625.8969	1653537.8735	460024.6092	654613.3375	5172.08	0.01	0.01	0.02	0.02	2" diam. washer/mag nail		
69	14448805.5160	1652673.6693	458203.0443	653748.5711	5181.31	0.01	0.01	0.02	0.02	2" diam. alum. Disk		
70	14446473.5244	1659614.1738	455869.5360	660693.5898	5250.06	0.01	0.01	0.02	0.02	2" diam. washer/mag nail		
71	14446246.8577	1667101.2415	455642.7219	668185.5271	5268.83	0.02	0.01	0.01	0.01	2" diam. alum. Disk		
72	14446823.8023	1658448.5405	456220.0417	659527.1983	5235.78	0.01	0.01	0.01	0.01	2" diam. washer/mag nail		
73	14443429.4803	1647731.0076	452823.5120	648802.6947	5192.75	0.01	0.01	0.02	0.02	2" diam. washer/mag nail		
74	14445419.5760	1647410.1914	454814.9021	648481.6698	5171.99	0.01	0.01	0.02	0.02	2" diam. washer/mag nail		
75	14450400.7768	1649178.2316	459799.3427	650250.8600	5143.33	0.01	0.01	0.02	0.02	2" diam. washer/mag nail		
76	14446171.6264	1664502.5027	455567.4416	665585.0980	5271.94	0.01	0.01	0.02	0.02	2" diam. alum. Disk		
77	14446666.1331	1646349.3178	456062.2700	647420.1063	5149.06	0.02	0.02	0.01	0.01	2" diam. washer/mag nail		

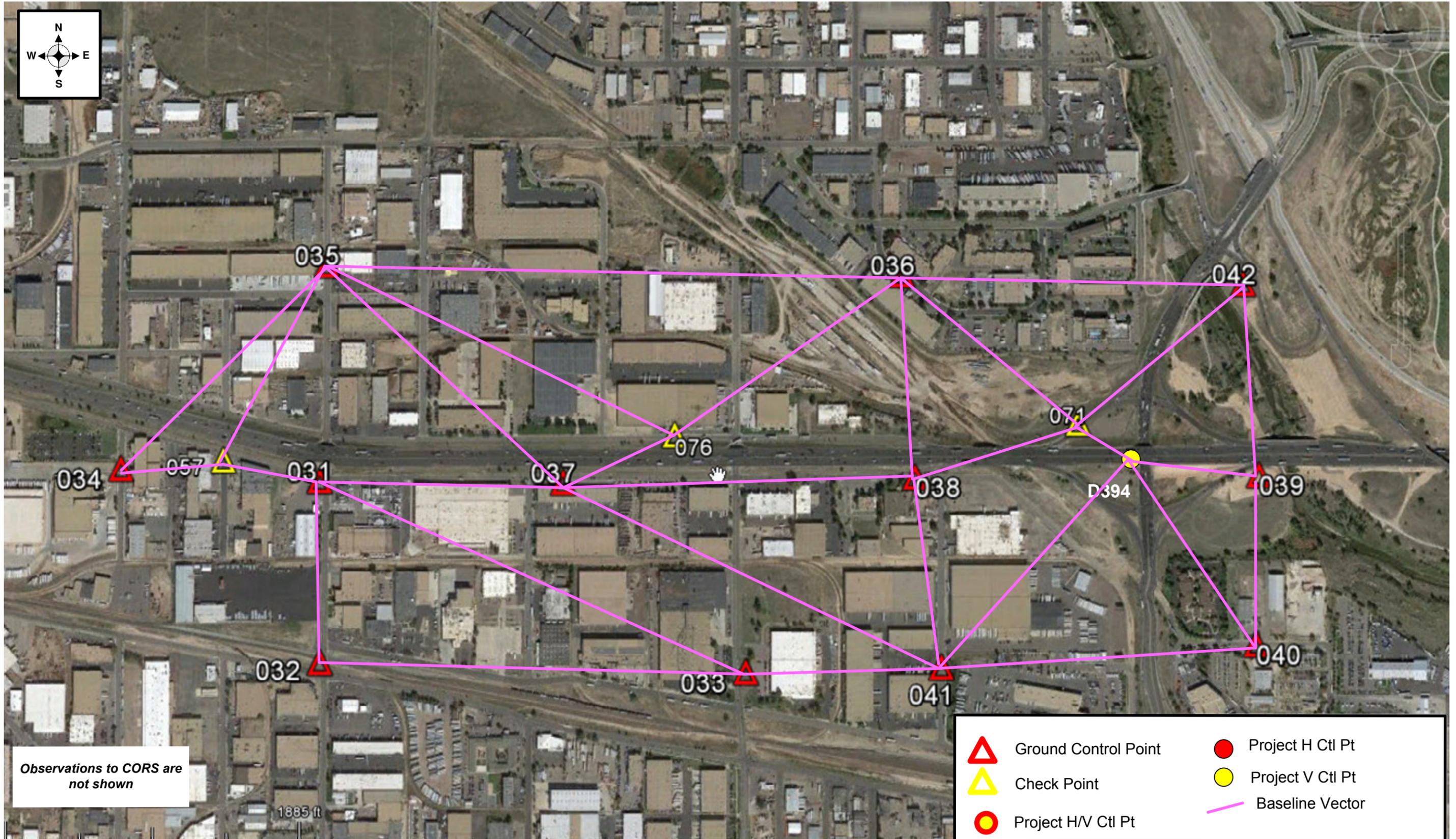
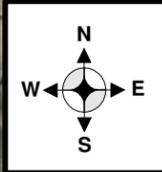
# **APPENDIX B**

## **Network Diagram**





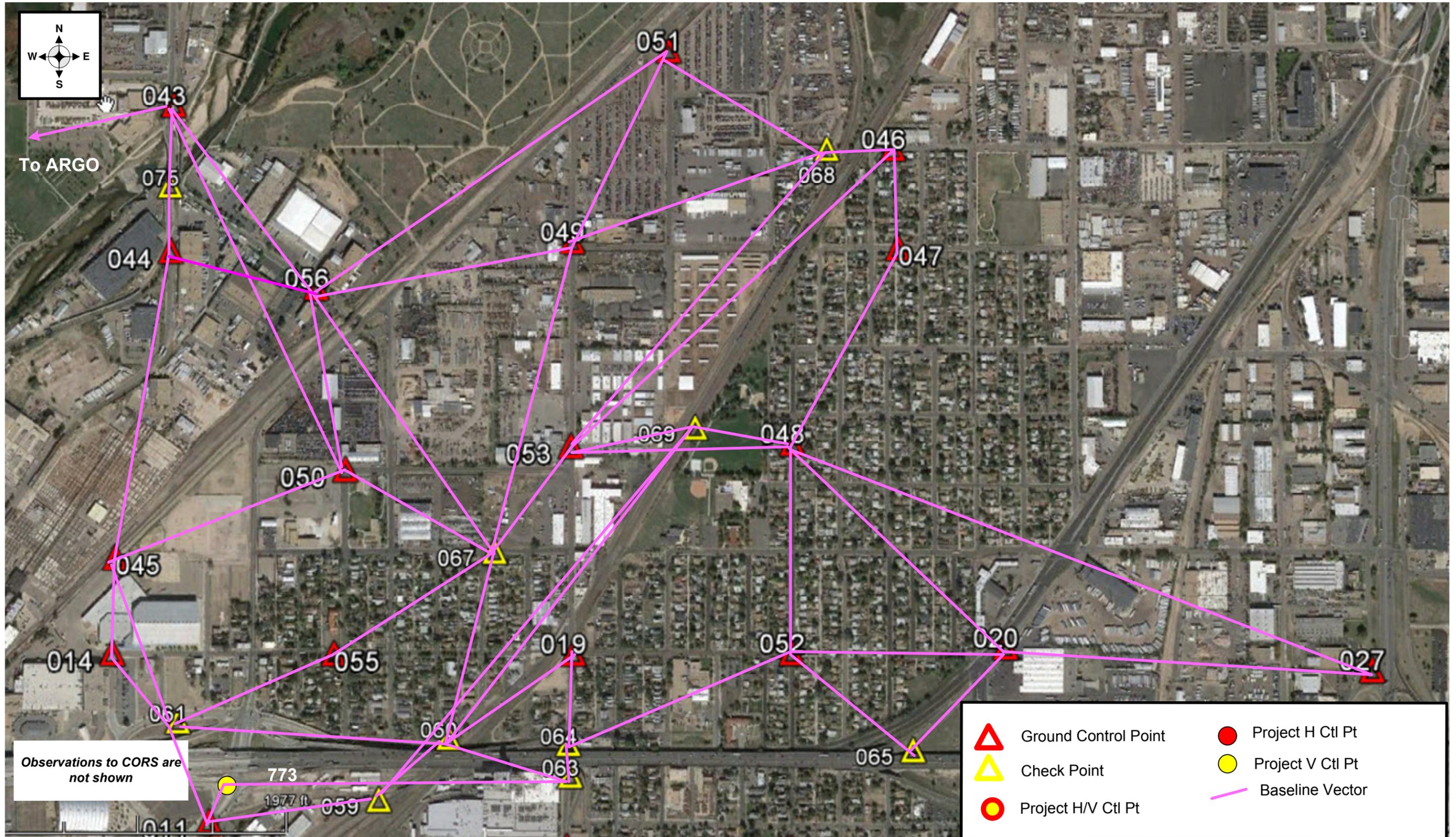




Observations to CORS are not shown

1885 ft

	Ground Control Point		Project H Ctl Pt
	Check Point		Project V Ctl Pt
	Project H/V Ctl Pt		Baseline Vector



**APPENDIX C**  
**Data Sheets of Ground**  
**Control Points**







# I-70 East Viaduct

## CDOT Project Number 19631

### STATION LOCATION and DATASHEET



**Control Point:** 04 **Stamping:** BHI\_04

**Project Coordinates [NAD83(1992) NAVD88]**

Point ID	UTM 13		Project		Ortho Ht
	N	E	N	E	
04	14447300.74	1645697.70	456697.29	646768.06	5147.44

Control adjusted using Geolab 2001 3-D Adjustment package constrained to project control points

Control surveyed by differential GPS to CDOT Class B Accuracy (relative accuracy of 0.13 ft at 95 percent level of confidence).

*Units in U.S. Survey Feet*

Point ID	Latitude [° ' " ]	Longitude [° ' " ]	Ellip Ht [meters]
04	N 39 46 54.684104	W 104 58 52.328220	1551.78

**Looking north-west**



**Monument Type: MAG NAIL and 2" DIAMETER WASHER SET FLUSH IN PAVEMENT**  
**Set By: Atkins North America, Inc. (September 24th, 2013)**

































# I-70 East Viaduct

## CDOT Project Number 19631

### STATION LOCATION and DATASHEET



**Control Point:** 020 **Stamping** BHI\_020

**Project Coordinates [NAD83(1992) NAVD88]**

Point ID	UTM 13		Project		Ortho
	N	E	N	E	Ht
020	14447390.03	1654690.37	456786.64	655766.58	5208.23

Control adjusted using Geolab 2001 3-D Adjustment package constrained to project control points

Control surveyed by differential GPS to CDOT Class B Accuracy (relative accuracy of 0.13 ft at 95 percent level of confidence).

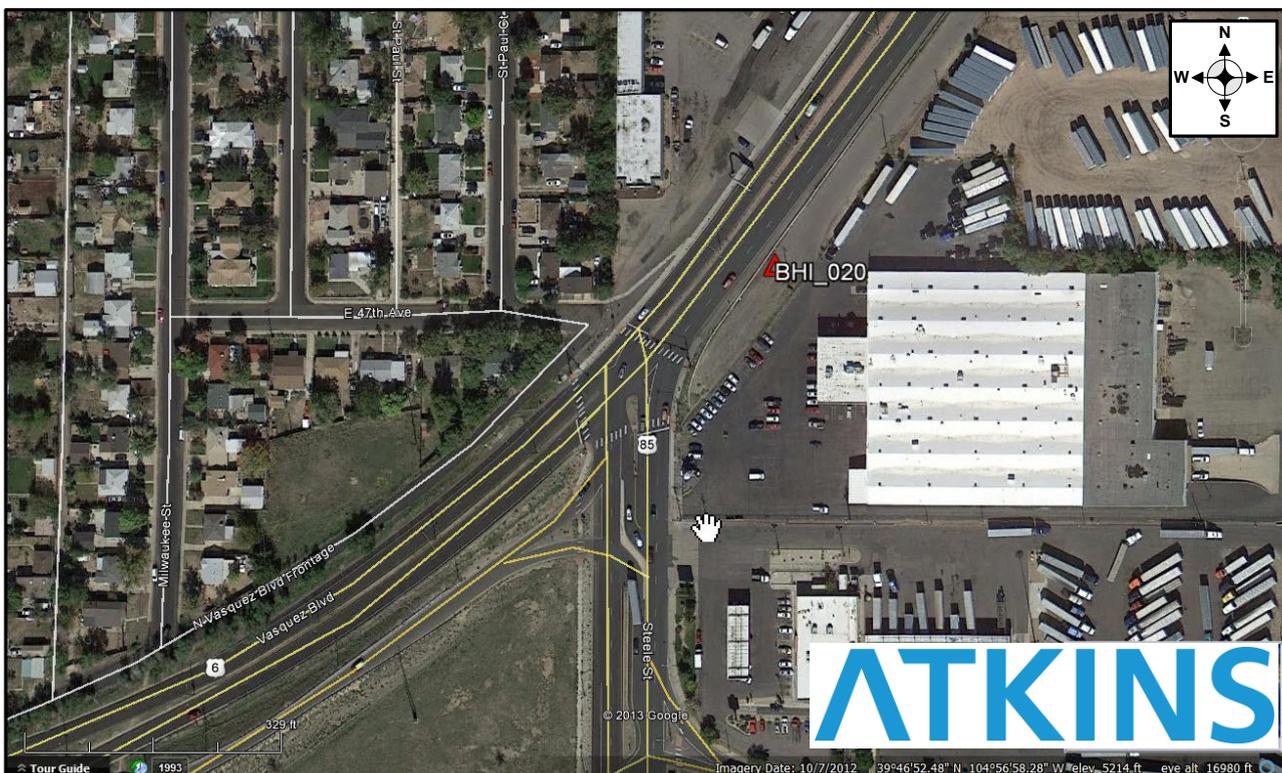
*Units in U.S. Survey Feet*

Point ID	Latitude [° ' " ]	Longitude [° ' " ]	Ellip Ht [meters]
020	N 39 46 55.532396	W104 56 57.094482	1570.18



**Monument Type: MAG NAIL and 2" DIAMETER WASHER SET FLUSH IN PAVEMENT**

**Set By: Atkins North America, Inc. (September 24th, 2013)**



















# I-70 East Viaduct

## CDOT Project Number 19631

### STATION LOCATION and DATASHEET



**Control Point:** 030 **Designation** BHI\_030

**Project Coordinates [NAD83(1992) NAVD88]**

Point ID	UTM 13		Project		Ortho Ht
	N	E	N	E	
030	14445965.86	1659612.16	455361.55	660691.57	5253.71

Control adjusted using Geolab 2001 3-D Adjustment package constrained to project control points

Control surveyed by differential GPS to CDOT Class B Accuracy (relative accuracy of 0.13 ft at 95 percent level of confidence).

*Units in U.S. Survey Feet*

Point ID	Latitude [° ' " ]	Longitude [° ' " ]	Ellip Ht [meters]
030	N 39 46 41.419751	W 104 55 54.039753	1583.98

**Looking north**



**Monument Type: MAG NAIL and 2" DIAMETER WASHER SET FLUSH IN PAVEMENT**

**Set By: Atkins North America, Inc. (September 24th, 2013)**













# I-70 East Viaduct

## CDOT Project Number 19631

### STATION LOCATION and DATASHEET



**Control Point:** 037 **Stamping:** BHI\_037

**Project Coordinates [NAD83(1992) NAVD88]**

Point ID	UTM 13		Project		Ortho
	N	E	N	E	Ht
037	14445875.84	1663788.45	455271.46	664870.58	5273.26

Control adjusted using Geolab 2001 3-D Adjustment package constrained to project control points

Control surveyed by differential GPS to CDOT Class B Accuracy (relative accuracy of 0.13 ft at 95 percent level of confidence).

*Units in U.S. Survey Feet*

Point ID	Latitude [° ' " ]	Longitude [° ' " ]	Ellip Ht [meters]
037	N 39 46 40.494762	W 104 55 0.528193	1589.89

**Looking south**



**Monument Type: MAG NAIL and 2" DIAMETER WASHER SET FLUSH IN PAVEMENT**

**Set By: Atkins North America, Inc. (September 24th, 2013)**

















# I-70 East Viaduct

## CDOT Project Number 19631

### STATION LOCATION and DATASHEET



**Control Point:** 045 **Stamping:** BHI\_045

**Project Coordinates [NAD83(1992) NAVD88]**

Point ID	UTM 13		Project		Ortho Ht
	N	E	N	E	
045	14447951.27	1648852.38	457348.24	649924.80	5169.91

Units in U.S. Survey Feet

Point ID	Latitude [° ' " ]	Longitude [° ' " ]	Ellip Ht [meters]
045	N 39 47 1.107198	W 104 58 11.900910	1558.58

Control adjusted using Geolab 2001 3-D Adjustment package constrained to project control points

Control surveyed by differential GPS to CDOT Class B Accuracy (relative accuracy of 0.13 ft at 95 percent level of confidence).

Looking north-east



**Monument Type: MAG NAIL and 2" DIAMETER WASHER SET FLUSH IN PAVEMENT**

**Set By: Atkins North America, Inc. (September 24th, 2013)**





# I-70 East Viaduct

## CDOT Project Number 19631

### STATION LOCATION and DATASHEET



**Control Point:** 047 **Stamping:** BHI\_047

**Project Coordinates [NAD83(1992) NAVD88]**

Point ID	UTM 13		Project		Ortho Ht
	N	E	N	E	
047	14449974.64	1654005.38	459372.93	655081.15	5175.99

Control adjusted using Geolab 2001 3-D Adjustment package constrained to project control points

Control surveyed by differential GPS to CDOT Class B Accuracy (relative accuracy of 0.13 ft at 95 percent level of confidence).

Units in U.S. Survey Feet

Point ID	Latitude [° ' " ]	Longitude [° ' " ]	Ellip Ht [meters]
047	N 39 47 21.089310	W 104 57 5.854062	1560.35

Looking east



**Monument Type: MAG NAIL and 2" DIAMETER WASHER SET FLUSH IN PAVEMENT**

**Set By: Atkins North America, Inc. (September 24th, 2013)**



# I-70 East Viaduct

## CDOT Project Number 19631

### STATION LOCATION and DATASHEET



**Control Point:** 048 **Stamping:** BHI\_048

**Project Coordinates [NAD83(1992) NAVD88]**

Point ID	UTM 13		Project		Ortho Ht
	N	E	N	E	
048	14448702.22	1653310.95	458099.68	654386.26	5179.40

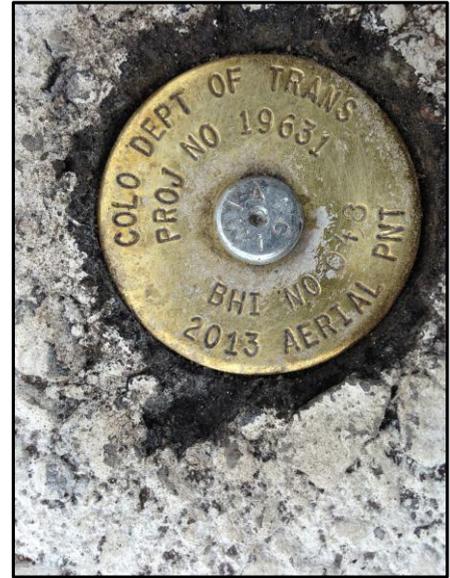
Control adjusted using Geolab 2001 3-D Adjustment package constrained to project control points

Control surveyed by differential GPS to CDOT Class B Accuracy (relative accuracy of 0.13 ft at 95 percent level of confidence).

Units in U.S. Survey Feet

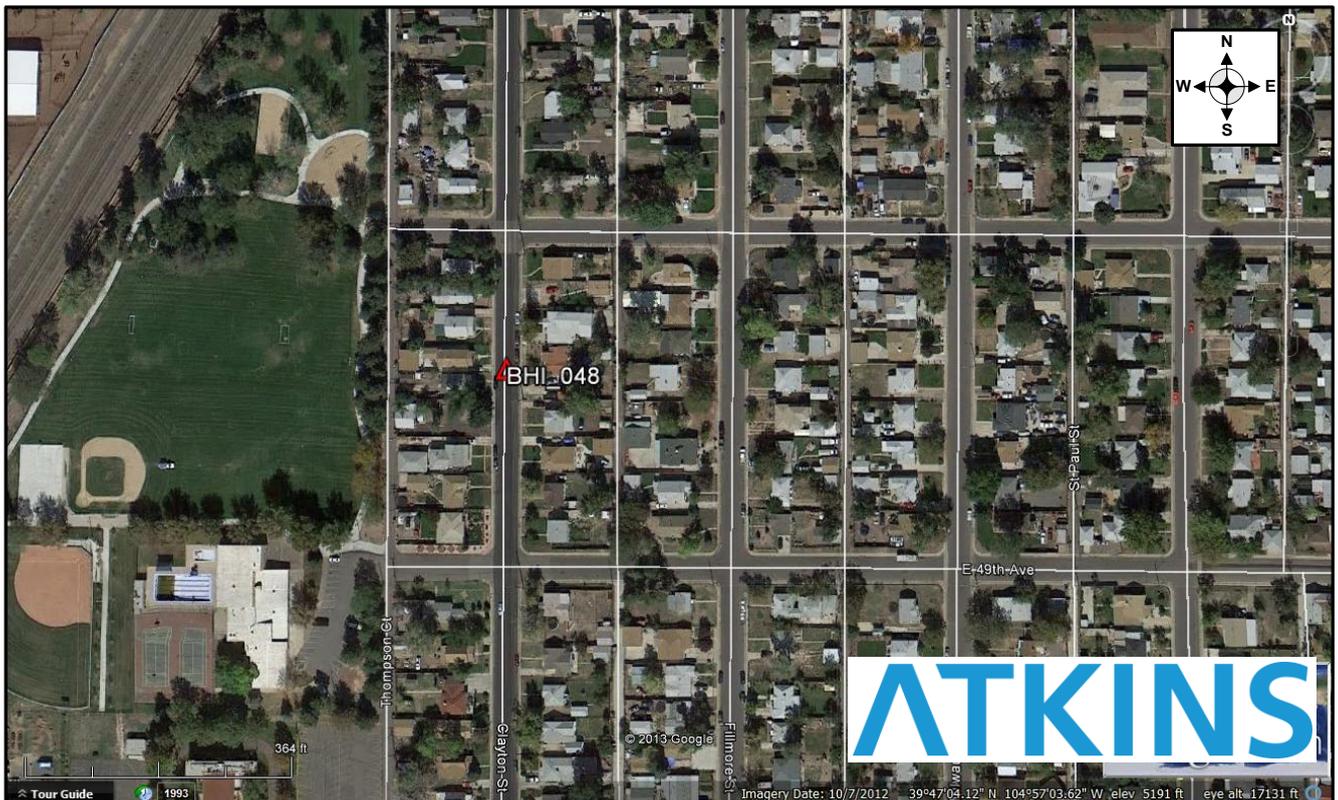
Point ID	Latitude [° ' " ]	Longitude [° ' " ]	Ellip Ht [meters]
048	N 39 47 8.512923	W 104 57 14.761955	1561.41

Looking north



**Monument Type: MAG NAIL and 2" DIAMETER WASHER SET IN FLUSH IN PAVEMENT**

**Set By: Atkins North America, Inc. (September 24th, 2013)**



# I-70 East Viaduct

## CDOT Project Number 19631

### STATION LOCATION and DATASHEET



**Control Point:** 049 **Stamping:** BHI\_049

**Project Coordinates [NAD83(1992) NAVD88]**

Point ID	UTM 13		Project		Ortho Ht
	N	E	N	E	
049	14450020.22	1651863.81	459418.53	652938.19	5172.69

Control adjusted using Geolab 2001 3-D Adjustment package constrained to project control points

*Units in U.S. Survey Feet*

Point ID	Latitude [° ' " ]	Longitude [° ' " ]	Ellip Ht [meters]
049	N 39 47 21.550409	W 104 57 33.299037	1559.38

Control surveyed by differential GPS to CDOT Class B Accuracy (relative accuracy of 0.13 ft at 95 percent level of confidence).

**Looking north-east**



**Monument Type: MAG NAIL and 2" DIAMETER WASHER SET FLUSH IN PAVEMENT**

**Set By: Atkins North America, Inc. (September 24th, 2013)**



# I-70 East Viaduct

## CDOT Project Number 19631

### STATION LOCATION and DATASHEET



**Control Point:** 050 **Stamping:** BHI\_050

**Project Coordinates [NAD83(1992) NAVD88]**

Point ID	UTM 13		Project		Ortho Ht
	N	E	N	E	
050	14448531.06	1650380.26	457928.41	651453.67	5181.43

Control adjusted using Geolab 2001 3-D Adjustment package constrained to project control points

Units in U.S. Survey Feet

Point ID	Latitude [° ' " ]	Longitude [° ' " ]	Ellip Ht [meters]
50	N 39 47 6.833911	W 104 57 52.319012	1562.07

Control surveyed by differential GPS to CDOT Class B Accuracy (relative accuracy of 0.13 ft at 95 percent level of confidence).



**Monument Type: MAG NAIL and 2" DIAMETER WASHER SET FLUSH IN PAVEMENT**

**Set By: Atkins North America, Inc. (September 24th, 2013)**















**APPENDIX D**  
**Level Notes**









PT#	+	I-70 HI	-	ELEV	ADJ. ELEV
TP6	4.037	92.879	5.141	87.738	
TP7	4.589	92.327	5.332	5186.995	
TP8	5.018	92.013	6.338	85.675	
BM 165A	6.165	91.840	6.254	5185.586	5185.577
TP9	6.272	91.858	7.856	89.002	
TP10	4.389	93.391	5.011	88.380	
BM 166A ✓ IN	6.158	94.538	5.078	5189.460	

Loop 2 (CONT.)	09-15-13			DW, YS 55°, RAIN
	DESC			
	RE-SHOT ON 103			
	RE-SHOT ON 101			
	BM 165A - CCD BR. CAP, SE TOP OF CURB YORK/46TH AVE NAVD '88: 5185.56 (+0.17)			
	BM 166A ✓ IN: +0.010 (RECORD = 5189.45 PG. 2) 39 TURNS			

Pt #	+	HI	-	ELEV	ADJ. ELEV
BM PNOZ	5.697	5192.804		5187.107	
310	5.385	92.634	5.555	5187.249	
333	5.031	92.677	4.988	5187.646	
334	5.244	92.747	5.174	5187.503	
313	5.406	92.457	5.696	5187.051	
335	5.031	92.330	5.158	5187.299	
336	5.682	92.479	5.533	5186.797	
332	5.321	91.666	6.134	5186.345	
311	5.513	91.729	5.450	5186.216	
312	5.409	91.864	5.274	5186.455	
314	5.651	92.344	5.171	5186.693	
315	5.392	92.495	5.241	5187.103	
316	5.299	92.450	5.344	5187.151	
309	5.608	92.913	5.145	5187.305	
BM PNOZ $\checkmark$ IN			5.803	5187.110	

LOOP 3

09-16-13

DW, YS  
68°, FAIR

DESC  
BM PNOZ - REBAR/CAP (PG. 2)

BM PNOZ  $\checkmark$  IN = +0.003 (SEE ABOVE)









I-70

PT #	+	HI	-	ELEV	ADJ. ELEV
TBM 124				5203.608	
	6.285	5209.893			
125			5.162	5204.731	
	4.451	09.182			
TP1			5.003	5204.179	
	5.611	09.790			
128			3.975	5205.815	
	3.952	09.767			
127			6.019	5203.748	
	7.001	10.749			
129			5.982	5204.767	
	4.299	09.066			
CHECK - 109			5.110	5203.956	
	7.131	11.087			
130			6.301	5204.786	
	6.457	11.243			
131			5.944	5205.299	
	6.217	11.516			
132			6.116	5205.400	
	6.573	11.973			
133			5.806	5206.167	
	5.522	11.689			
134			4.807	5206.882	
	5.582	12.464			
135			6.035	5206.429	
	6.079	12.508			
136			6.415	5206.093	
	6.488	12.581			
137			5.885	5206.696	
	5.954	12.650			
138			5.720	5206.930	
	6.045	12.975			
139			5.468	5207.507	

LOOP 6

09-28-13

DW, YS  
42°, COLD

DESC

TBM 124 - SET MAG NAIL FOR SCANNER PT. (PG. 4)

\* NOTE \* PT. 126 BECAME LOOSE AND NOT A PART OF THE LEVEL LOOP

CHECK - 109





I-70

Pt. #	+	HI	-	ELEV	ADJ. ELEV
BM P104				5185.382	
CHECK - 107	5.919	5191.301	5.633	5185.668	5185.671
BM P104 $\checkmark$ IN	5.601	5189.269	5.892	5185.377	
Pt. #	+	HI	-	ELEV	ADJ. ELEV
BM 166A		5194.049		5189.45	
BMI - 015	4.599		5.926	5188.123	
BM 166A $\checkmark$ IN	5.918	5194.041	4.591	5189.45	

LOOP 7

09-28-13

DW. YS  
60° FAIR

DESC	
BM P104 - SPIKE YORK ST (PG. 3)	
CHECK - 107	
BM P104 $\checkmark$ IN = -0.005 (SEE ABOVE) 2 TURNS	
LOOP 8	
DESC	
BM 166A - 2" BR. CAP (PG. 2)	
BMI - 015	
BM 166A $\checkmark$ IN = 0.000 (SEE ABOVE) 2 TURNS	

I-70

PT. #	+	HI	-	ELEV	ADJ ELEV
BM B 394				5261.82	
	4.965	5266.785			
TP 1			4.404	5262.381	
	4.980	5267.361			
BHI - 023			4.990	5262.371	5262.366
	9.844	5272.215			
TP 2			1.156	5271.059	
	12.485	5283.544			
TP 3			1.577	5281.967	
	5.442	5287.409			
TP 4			8.850	5278.559	
	3.991	5282.550			
BHI - 024			10.252	5272.298	5272.290
	10.236	5282.534			
TP 5			3.974	5278.560	
	8.788	5287.348			
TP 6			5.382	5281.966	
	1.406	5283.372			
TP 7			12.307	5271.065	
	0.748	5271.813			
BHI - 023(2)			9.435	5262.378	
	5.059	5267.437			
TP 8			4.964	5262.473	
	4.945	5267.418			
BM B 394 $\sqrt{IN}$			5.582	5261.836	

Loop 9

09-28-13

DW, YS  
600, FAIR

15

	DESC
BM B 394 - NGS STANDARD DISC IN CONC. ON COLORADO BRIDGE STAMPED "B 394 1983" (PUBLISHED ADJ. '88.)	
BHI - 023	
BHI - 024	
BM B 394 $\sqrt{IN} = + 0.016$ (SEE ABOVE) 12 TURNS	

I - 70					
PT. #	+	HI	-	ELEV	ADJ. EL
TBM 117	4.363	5200.883		5196.520	
TP 1	1.417	5193.132	9.168	5191.715	
BHI 052	7.833	5193.104	7.861	5185.271	5185.270
TP 2	9.141	5200.857	1.388	5191.716	
TBM 117 $\checkmark$ IN			4.334	5196.523	
PT #	+	HI	-	ELEV	ADJ. ELEV
BH PNO4	5.439	5190.821		5185.382	
TP 1	5.157	5190.466	5.512	5185.309	
BHI 019	5.377	5190.457	5.386	5185.080	5185.079
TP 2	5.447	5190.758	5.146	5185.311	
BH PNO4 $\checkmark$ IN			5.373	5185.385	

LOOP 10	09-28-13	DW, YS 60°, FAIR
DESC		
TBM 117 ADJ EL PG. 4	SCANNER PT	
BHI 052		
TBM 117 $\checkmark$ IN = +0.003 (SEE ABOVE) 4 TURNS		
LOOP 11	DESC	
BH PNO4 - SPIKE YORK ST (PG. 3)		
BHI 019		
BH PNO4 $\checkmark$ IN = +0.003 (SEE ABOVE) 4 TURNS		







I - 70					
Pt. #	+	HI	-	ELEV	ADJ. EL
BM D 394	4.026	5279.250		5275.23	
TP 1	2.773	76.291	5.738	5273.518	
TP 2	2.323	70.700	7.914	5268.377	
TP 3	2.298	65.152	7.846	5262.854	
BHI_039	7.884	65.123	7.913	5257.239	
TP 4	7.527	70.380	2.270	5262.853	
TP 5	8.032	76.405	2.007	5268.373	
TP 6	5.578	79.095	2.888	5273.517	
BM D 394 $\checkmark$ IN			3.865	5275.23	

Loop 13	09-30-13				DW, YS 73% FAIR
					DESC
BM D 394 - NGS STANDARD DISC IN CONC. ON QUEBEC BRIDGE STAMPED					
"D 394 1983" (PUBLISHED ADJ. '88')					
BHI_039					
BM D 394 $\checkmark$ IN = 0.000 (RECORD: 5275.23) PUBLISHED NAVD '88					
8 TURNS					

PT. #	+	HI	-	ELEV	ADJ. ELEV
BM D 394		I - 70			
	6.737	5281.967		5275.23	
TP 1	4.141	83.478	2.630	5279.337	
TP 2			11.030	5272.448	
CHECK - 1014	2.870	75.318			
	0.125	68.967	6.476	5268.842	5268.841
TP 3	0.048	57.445	11.570	5257.397	
TP 4			9.123	5248.322	
TP 5	2.928	51.250	9.773	5241.477	
TP 6	1.315	42.792	1.764	5241.028	
TP 7	7.095	48.123	10.803	5237.320	
BHI - 042	4.937	42.257	10.274	5231.983	5231.980
	10.245	42.228			
TP 8			4.908	5237.320	
TP 9	10.780	48.100	7.075	5241.025	
TP 10	2.055	43.080	1.600	5241.480	
TP 11	9.388	50.868	3.764	5247.104	
TP 12	12.411	59.515	4.222	5255.293	
TP 13	12.925	68.218			
		77.900	2.811	5265.407	
BM D 394 / IN	12.493		2.664	5275.236	

Loop 14	09-28-13	DESC	DWYS
			73°, FAIR
BM D 394 -	NGS PT. (PG. 20)	PUBLISHED NAVD '88	
CHECK - 1014			
BHI - 042			
BM D 394 / IN	+0.006	RECORD = 5275.23 (SEE ABOVE)	
	16 TURNS		

I - 70

PT #	+	HI	-	ELEV	ADJ. ELEV
BM 325				5186.201	
CHECK - 104	5.259	5191.460		5186.920	
381	4.624	5191.144	4.940	5185.888	
382	4.215	90.103	5.256	5185.168	
383	5.302	90.470	4.935	5185.003	
384	5.269	90.272	5.467	5184.086	
BM 353 ✓ IN	6.581	90.667	6.186	5183.532	
			7.135		
PT #	+	HI	-	ELEV	ADJ. ELEV
BM PNO4				5185.382	
402	6.742	5192.124		5187.149	
403	4.966	92.115	4.975	5186.626	
404	5.177	91.803	5.489	5186.913	
TP-1	5.170	92.083	4.890	5186.909	
409	4.970	91.879	5.174	5187.347	
			4.532		

LOOP 15

10-03-13

DW, YS  
78°, FAIR

DESC
BM 325 - SET MAG NAIL FOR SCANNER PT. (PG. 8)
CHECK - 104
BM 353 ✓ IN = +0.002 (RECORD = 5183.530 SEE PG. 18) 6 TURNS
LOOP 16
PNO4 - SPIKE, YORK ST (PG. 3)
TP-1 (UNIDENTIFIED SCANNER PT)

I - 70

Pt #	+	HI	-	ELEV	ADJ. ELEV
408	5.026	5192.373	5.119	5187.254	
407	5.187	92.441	4.174	5188.267	
	3.762	92.029			
406			4.649	5187.380	
405	4.845	92.225	4.951	5187.274	
B.M. PNo4 ✓	4.801	92.075	6.698	5185.377	

LOOP 16 (CONT.)

10-03-13

DW, YS  
78° FAIR

DESC
B.M. PNo4 ✓ INE - 0.005 (RECORD = 5185.382 SEE PG. 3) 10 TURNS

PT. #	+	HI	-	ELEV	ADJ. ELEV
TBM BHL-09	6.558	5191.637		5185.079	
TP 1	3.642	88.009	7.270	84.367	
TP 2	4.479	86.374	6.114	81.895	
CHECK_1011	5.207	86.370	5.211	5181.163	5181.162
TP 3	3.986	85.811	4.475	81.895	
TP 4	5.232	85.394	5.719	80.162	
BHL-053	4.688	85.027	5.055	5180.339	5180.337
TP 5	4.169	84.122	5.074	79.953	
TP 6	4.135	80.801	7.456	76.666	
TP 7	4.865	78.675	6.991	73.810	
BHL-049	0.107	72.813	5.969	5172.706	5172.703
TP 8	2.200	66.041	8.972	63.841	
TP 9	4.210	64.270	5.981	60.060	
TP 10	8.569	69.051	3.788	60.482	
TP 11	10.027	76.873	2.205	66.846	
TP 12	5.709	5179.706	2.876	73.997	

LOOP 17	10-04-13	DESC	DWYS
TBM BHL-019 (PG. 16, LOOP 11)			78°, FAIR
CHECK_1011			
BHL-053			
	10-04-13		
BHL-049	10-09-13		

PT #	+	I-70 HI	-	ELEV	ADJ EL
TP 13	5.321	80.738	4.289	5175.417	
TP 14	6.670	69.177	12.231	68.507	
TP 15	2.166	61.131	10.212	58.965	
BHI-056	4.347	58.831	6.647	5154.484	5154.479
TP 16	5.004	57.378	6.457	52.374	
TP 17	1.814	51.035	8.157	49.221	
TP 18	6.061	49.149	7.947	43.088	
BHI-044	2.808	49.253	2.704	5146.445	5146.439
TP 19	5.107	48.454	5.906	43.347	
TP 20	4.734	47.306	5.882	42.972	
BHI-043	6.001	48.055	5.252	5142.054	5142.047
BM CC&D	4.969	48.179	4.845	5143.210	5143.203
BM CC&D	4.768	48.513	4.374	5143.805	5143.798
TP 21	7.048	50.400	5.221	43.352	
TP 22	8.517	57.144	1.773	48.627	
TP 23	6.218	58.949	4.413	52.731	

LOOP 17 (CONT.)	10-09-13	DESC			DW,YS 65°, FAIR
BHI-056					
BHI-044					
BHI-043					
BM-CC&D 2" BR. CAP, FHEC GPS 133, 1993, LS 28668, NW COR. BRIDGE FRANKLIN					(PUBLISHED: 5143.190)
BM-CC&D BR. CAP IN CONC, SE COR FRANKLIN BRIDGE, N. OF RACE CT.					(PUBLISHED: 5143.78)



PT #	+	I-70 HI	-	ELEV	ADJ. EL
BM ARGO				5146.37	
TP 1	4.275	5150.645	4.784	45.861	
TP 2	4.976	50.837	4.919	45.918	
BHI_04	6.007	51.925	4.486	5147.439	5147.437
TP 3	5.665	53.104	5.566	47.538	
	5.865	53.403			
TP 4			4.477	48.926	
CHECK_1020	5.447	54.373	5.308	5149.065	5149.061
TP 5	5.595	54.660	3.002	51.658	
TP 6	5.805	57.463	6.345	51.118	
TP 7	4.977	56.095	5.218	50.877	
	5.263	56.140			
BHI_05			4.965	5151.175	5151.168
TP 8	4.544	55.719	4.902	50.817	
TP 9	4.989	55.806	7.398	48.408	
TP 10	5.816	54.224	4.130	50.094	
TP 11	12.858	62.952	3.087	59.865	
	2.102	62.027			
BHI_06			7.504	5154.523	5154.513

LOOP 18	10-07-13	DESC.	DW, YS 68°, FAIR
BM ARGO	NGS PUBLISHED NAVD '88	ADJUSTED	
BHI_04			
CHECK_1020			
BHI_05			
BHI_06			



PT. #	+	HI	-	ELEV	ADJ. EL
BM B 394		I - 70 5265.863		5261.82	
TP 1	4.043		6.053	59.810	
TP 2	2.141	61.951	11.233	50.718	
TP 3	0.814	51.532	8.185	43.347	
TP 4	0.869	44.216	6.977	37.239	
TP 5	4.939	42.178	5.481	36.697	
TP 6	4.906	41.603	4.792	36.811	
CHECK_1015	4.804	41.615	5.788	5235.827	5235.826
TP 7	7.941	43.768	1.435	42.333	
TP 8	9.687	52.020	4.592	47.428	
TP 9	7.112	54.540	5.733	48.807	
TP 10	1.132	49.939	6.110	43.829	
BHI_028	5.318	49.147	6.124	5243.023	5243.021
TP 11	6.090	49.113	5.282	43.831	
TP 12	6.611	50.442	1.685	48.757	
TP 13	5.893	54.650	5.087	49.563	

LOOP 19	DATE	DESC	DW, YS
	10-09-13		71°, FAIR
BM B 394		NGS STANDARD DISC IN CONC. ON COLORADO BRIDGE (PUBLISHED '88 DATUM)	
CHECK_1015			
BHI_028			

I - 70					
PT. #	+	HI	-	ELEV	ADJ. ELEV
TP 14	6.574	5256.137	4.339	51.798	
BHI_030	5.848	57.646	3.934	5253.712	5253.709
	3.926	57.638			
TP 15			5.838	51.800	
	4.567	56.367			
BM 445			6.342	5250.025	5250.021
	6.306	56.331			
TP 16			5.692	50.639	
	4.932	55.571			
TP 17			6.700	48.871	
	4.904	53.775			
TP 18			3.608	50.167	
	7.364	57.531			
BHI_034			4.296	5253.235	5253.230
	4.238	57.473			
TP 19			5.739	51.734	
	5.970	57.704			
TP 20			5.622	52.082	
	5.470	57.552			
CHECK_10 14			5.131	5252.421	5252.416
	5.502	57.923			
TP 21			8.083	49.840	
	5.675	55.515			
BHI_031			3.588	5251.927	5251.921
	5.961	57.888			
BM 268A			5.090	5252.798	5252.792
	7.800	60.598			
TP 22			5.998	54.600	
	8.926	63.526			
TP 23			0.880	62.646	

LOOP 19 (CONT.)	10-09-13 / 10-10-13	DW, YS
DESC		71°, FAIR
BHI_030		
BM 445 - CCD BR. CAP IN TOP OF CURB, SE COR. DAHLIA & STAPLETON DR. SO PUBLISHED RECORD: 5250.02 (+.001)		
10-10-13		
BHI_034		
CHECK 10_14		
BHI_031		
BM 268A - CCD BR. CAP IN TOP OF CURB, SE COR. HOLLY & STAPLETON PUBLISHED RECORD: 5252.78 (+.012)		



**APPENDIX E**  
**NGS Data Sheets**

# The NGS Data Sheet

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

```

PROGRAM = datasheet95, VERSION = 8.4
1      National Geodetic Survey,  Retrieval Date = APRIL 29, 2014
DJ8223 *****
DJ8223 DESIGNATION - ELLIS
DJ8223 PID - DJ8223
DJ8223 STATE/COUNTY- CO/DENVER
DJ8223 COUNTRY - US
DJ8223 USGS QUAD - COMMERCE CITY (1994)
DJ8223
DJ8223 *CURRENT SURVEY CONTROL
DJ8223
DJ8223* NAD 83(1986) POSITION- 39 46 22. (N) 104 58 49. (W) SCALED
DJ8223* NAVD 88 ORTHO HEIGHT - 1573.509 (meters) 5162.42 (feet) ADJUSTED
DJ8223
DJ8223 GEOID HEIGHT - -17.18 (meters) GEOID12A
DJ8223 DYNAMIC HEIGHT - 1572.018 (meters) 5157.53 (feet) COMP
DJ8223 MODELED GRAVITY - 979,623.9 (mgal) NAVD 88
DJ8223
DJ8223 VERT ORDER - SECOND CLASS I
DJ8223
DJ8223.The horizontal coordinates were scaled from a topographic map and have
DJ8223.an estimated accuracy of +/- 6 seconds.
DJ8223.
DJ8223.The orthometric height was determined by differential leveling and
DJ8223.adjusted by the NATIONAL GEODETIC SURVEY
DJ8223.in June 2009.
DJ8223
DJ8223.No vertical observational check was made to the station.
DJ8223
DJ8223.The dynamic height is computed by dividing the NAVD 88
DJ8223.geopotential number by the normal gravity value computed on the
DJ8223.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
DJ8223.degrees latitude (g = 980.6199 gals.).
DJ8223
DJ8223.The modeled gravity was interpolated from observed gravity values.
DJ8223
DJ8223; North East Units Estimated Accuracy
DJ8223;SPC CO C - 520,230. 958,930. MT (+/- 180 meters Scaled)
DJ8223
DJ8223 SUPERSEDED SURVEY CONTROL
DJ8223
DJ8223.No superseded survey control is available for this station.
DJ8223
DJ8223_U.S. NATIONAL GRID SPATIAL ADDRESS: 13SEE016025(NAD 83)
DJ8223
DJ8223_MARKER: DV = VERTICAL CONTROL DISK
DJ8223_SETTING: 32 = SET IN A RETAINING WALL OR CONCRETE LEDGE
DJ8223_SP_SET: HEADWALL
DJ8223_STAMPING: VCM ELLIS 2000
DJ8223_MARK LOGO: NGS
DJ8223_MAGNETIC: N = NO MAGNETIC MATERIAL
DJ8223_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
DJ8223+STABILITY: SURFACE MOTION
DJ8223_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR

```

DJ8223+SATELLITE: SATELLITE OBSERVATIONS - December 09, 2002

DJ8223

DJ8223	HISTORY	- Date	Condition	Report By
DJ8223	HISTORY	- 2000	MONUMENTED	CO0600
DJ8223	HISTORY	- 20021209	GOOD	CODOT

DJ8223

DJ8223

STATION DESCRIPTION

DJ8223

DJ8223'DESCRIBED BY COLORADO DEPARTMENT OF TRANSPORTATION 2002

DJ8223'THE STATION IS LOCATED IN DENVER, IN THE SOUTHEAST 1/4 OF SECTION 22,

DJ8223'T 3 S, R 68 W, 0.5 MI (0.8 KM) SOUTH OF THE INTERCHANGE OF I-70 AND

DJ8223'WASHINGTON STREET, IN CITY OF DENVER RIGHT-OF-WAY.

DJ8223'

DJ8223'TO REACH THE STATION FROM THE INTERCHANGE OF I-70 AND WASHINGTON

DJ8223'STREET IN THE CITY OF DENVER GO SOUTH AND THEN SOUTHEAST ON WASHINGTON

DJ8223'STREET FOR 0.3 MI (0.48 KM) TO ARKINS COURT, TURN RIGHT, GO SOUTHWEST

DJ8223'ON ARKINS COURT FOR 0.15 MI (0.24 KM) TO 36TH STREET AND A GRAVEL

DJ8223'PARKING AREA AND THE STATION ON THE RIGHT.

DJ8223'

DJ8223'THE STATION IS A STANDARD NGS DISK STAMPED--VCM ELLIS 2000--SET 3.8 FT

DJ8223'(609.6 M) ABOVE THE GROUND INTO THE TOP OF A 3.5 X 19-FOOT MORTARED

DJ8223'SANDSTONE HEADWALL ABOVE AN ARCHED PIPE OPENING FOR STORM DRAINAGE

DJ8223'INTO THE SOUTH PLATTE RIVER,

DJ8223'

DJ8223'6 FT (1.8 M) SOUTHWEST FROM THE NORTHEAST END OF THE HEADWALL, 12.5 FT

DJ8223'(3.8 M) NORTHEAST OF THE SOUTHWEST END OF THE HEADWALL, 73 FT (22.3 M)

DJ8223'NORTHWEST FROM A METRO SEWER MANHOLE NEAR THE INTERSECTION OF THE

DJ8223'CENTERLINES OF 36TH STREET AND ARKINS COURT.

\*\*\* retrieval complete.

Elapsed Time = 00:00:08

# The NGS Data Sheet

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

```

PROGRAM = datasheet95, VERSION = 8.4
1      National Geodetic Survey,  Retrieval Date = APRIL 29, 2014
KK1292 *****
KK1292 DESIGNATION - D 394
KK1292 PID - KK1292
KK1292 STATE/COUNTY- CO/DENVER
KK1292 COUNTRY - US
KK1292 USGS QUAD - COMMERCE CITY (1994)
KK1292
KK1292 *CURRENT SURVEY CONTROL
KK1292
KK1292* NAD 83(1986) POSITION- 39 46 41.53 (N) 104 54 11.79 (W) HD_HELD1
KK1292* NAVD 88 ORTHO HEIGHT - 1607.898 (meters) 5275.25 (feet) ADJUSTED
KK1292
KK1292 GEOID HEIGHT - -17.47 (meters) GEOID12A
KK1292 DYNAMIC HEIGHT - 1606.377 (meters) 5270.26 (feet) COMP
KK1292 MODELED GRAVITY - 979,624.6 (mgal) NAVD 88
KK1292
KK1292 VERT ORDER - SECOND CLASS I
KK1292
KK1292.The horizontal coordinates were determined by differentially corrected
KK1292.hand held GPS observations or other comparable positioning techniques
KK1292.and have an estimated accuracy of +/- 3 meters.
KK1292.
KK1292.The orthometric height was determined by differential leveling and
KK1292.adjusted by the NATIONAL GEODETIC SURVEY
KK1292.in June 2009.
KK1292
KK1292.Photographs are available for this station.
KK1292
KK1292.The dynamic height is computed by dividing the NAVD 88
KK1292.geopotential number by the normal gravity value computed on the
KK1292.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
KK1292.degrees latitude (g = 980.6199 gals.).
KK1292
KK1292.The modeled gravity was interpolated from observed gravity values.
KK1292
KK1292;
KK1292;SPC CO C - North East Units Estimated Accuracy
KK1292; 520,871.3 965,522.9 MT (+/- 3 meters HH1 GPS)
KK1292
KK1292 SUPERSEDED SURVEY CONTROL
KK1292
KK1292 NAVD 88 (06/15/91) 1607.892 (m) 5275.23 (f) SUPERSEDED 1 2
KK1292 NGVD 29 (??/??/??) 1607.000 (m) 5272.30 (f) ADJUSTED 1 2
KK1292
KK1292.Superseded values are not recommended for survey control.
KK1292
KK1292.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
KK1292.See file dsdata.txt to determine how the superseded data were derived.
KK1292
KK1292_U.S. NATIONAL GRID SPATIAL ADDRESS: 13SEE0828303144(NAD 83)
KK1292
KK1292_MARKER: DV = VERTICAL CONTROL DISK
KK1292_SETTING: 38 = SET IN THE ABUTMENT OR PIER OF A LARGE BRIDGE

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KK1292\_SP\_SET: ABUTMENT  
 KK1292\_STAMPING: D 394 1983  
 KK1292\_MARK LOGO: NGS  
 KK1292\_MAGNETIC: O = OTHER; SEE DESCRIPTION  
 KK1292\_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL  
 KK1292\_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR  
 KK1292+SATELLITE: SATELLITE OBSERVATIONS - February 11, 2007

KK1292	HISTORY	- Date	Condition	Report By
KK1292	HISTORY	- 1983	MONUMENTED	NGS
KK1292	HISTORY	- 19960626	GOOD	CODOT
KK1292	HISTORY	- 20010303	GOOD	METRSC
KK1292	HISTORY	- 20020710	GOOD	CODOT
KK1292	HISTORY	- 20060721	GOOD	ZYLSTR
KK1292	HISTORY	- 20070211	GOOD	METRSC

KK1292  
 KK1292 STATION DESCRIPTION  
 KK1292

KK1292'DESCRIBED BY NATIONAL GEODETIC SURVEY 1983  
 KK1292'IN DENVER.  
 KK1292'IN DENVER, AT THE INTERSECTION OF INTERSTATE HIGHWAY 70 AND QUEBEC  
 KK1292'STREET, IN TOP OF AND 0.3 METER (1.0 FT) NORTH OF THE SOUTH END OF THE  
 KK1292'EAST CONCRETE ABUTMENT OF THE HIGHWAY OVERPASS OVER THE STREET,  
 KK1292'19.5 METERS (64.0 FT) EAST OF THE CENTER OF THE STREET, AND  
 KK1292'11.8 METERS (38.7 FT) SOUTH OF THE CENTER OF THE EAST BOUND LANES OF  
 KK1292'THE HIGHWAY.  
 KK1292'THE MARK IS 0.3 M ABOVE THE HIGHWAY.

KK1292  
 KK1292 STATION RECOVERY (1996)  
 KK1292

KK1292'RECOVERY NOTE BY COLORADO DEPARTMENT OF TRANSPORTATION 1996 (TA)  
 KK1292'RECOVERED AS DESCRIBED.

KK1292  
 KK1292 STATION RECOVERY (2001)  
 KK1292

KK1292'RECOVERY NOTE BY METROPOLITAN STATE COLLEGE OF DENVER 2001 (HWS)  
 KK1292'RECOVERED IN GOOD CONDITION.

KK1292  
 KK1292 STATION RECOVERY (2002)  
 KK1292

KK1292'RECOVERY NOTE BY COLORADO DEPARTMENT OF TRANSPORTATION 2002 (JTG)  
 KK1292'RECOVERED AS DESCRIBED.

KK1292  
 KK1292 STATION RECOVERY (2006)  
 KK1292

KK1292'RECOVERY NOTE BY ZYLSTRA-BAKER SURVEYING INCORPORATED 2006 (LDV)  
 KK1292'RECOVERED AS DESCRIBED.

KK1292  
 KK1292 STATION RECOVERY (2007)  
 KK1292

KK1292'RECOVERY NOTE BY METROPOLITAN STATE COLLEGE OF DENVER 2007 (HPP)  
 KK1292'RECOVERED AS DESCRIBED

\*\*\* retrieval complete.  
 Elapsed Time = 00:00:08

# The NGS Data Sheet

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

```

PROGRAM = datasheet95, VERSION = 8.4
1      National Geodetic Survey,  Retrieval Date = APRIL 29, 2014
KK1294 *****
KK1294 DESIGNATION - B 394
KK1294 PID - KK1294
KK1294 STATE/COUNTY- CO/DENVER
KK1294 COUNTRY - US
KK1294 USGS QUAD - COMMERCE CITY (1994)
KK1294
KK1294 *CURRENT SURVEY CONTROL
KK1294
KK1294* NAD 83(2011) POSITION- 39 46 47.04099(N) 104 56 26.22144(W) ADJUSTED
KK1294* NAD 83(2011) ELLIP HT- 1586.460 (meters) (06/27/12) ADJUSTED
KK1294* NAD 83(2011) EPOCH - 2010.00
KK1294* NAVD 88 ORTHO HEIGHT - 1603.806 (meters) 5261.82 (feet) ADJUSTED
KK1294
KK1294 NAD 83(2011) X - -1,265,785.140 (meters) COMP
KK1294 NAD 83(2011) Y - -4,743,634.740 (meters) COMP
KK1294 NAD 83(2011) Z - 4,060,235.534 (meters) COMP
KK1294 LAPLACE CORR - -7.36 (seconds) DEFLEC12A
KK1294 GEOID HEIGHT - -17.34 (meters) GEOID12A
KK1294 DYNAMIC HEIGHT - 1602.292 (meters) 5256.85 (feet) COMP
KK1294 MODELED GRAVITY - 979,626.1 (mgal) NAVD 88
KK1294
KK1294 VERT ORDER - FIRST CLASS II
KK1294
KK1294 FGDC Geospatial Positioning Accuracy Standards (95% confidence, cm)
KK1294 Type Horiz Ellip Dist(km)
KK1294 -----
KK1294 NETWORK 0.44 0.82
KK1294 -----
KK1294 MEDIAN LOCAL ACCURACY AND DIST (010 points) 0.53 0.95 6.00
KK1294 -----
KK1294 NOTE: Click here for information on individual local accuracy
KK1294 values and other accuracy information.
KK1294
KK1294
KK1294.The horizontal coordinates were established by GPS observations
KK1294.and adjusted by the National Geodetic Survey in June 2012.
KK1294
KK1294.NAD 83(2011) refers to NAD 83 coordinates where the reference
KK1294.frame has been affixed to the stable North American tectonic plate. See
KK1294.NA2011 for more information.
KK1294
KK1294.The horizontal coordinates are valid at the epoch date displayed above
KK1294.which is a decimal equivalence of Year/Month/Day.
KK1294
KK1294.The orthometric height was determined by differential leveling and
KK1294.adjusted by the NATIONAL GEODETIC SURVEY
KK1294.in June 1991.
KK1294
KK1294.Photographs are available for this station.
KK1294
KK1294.The X, Y, and Z were computed from the position and the ellipsoidal ht.

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KK1294

KK1294.The Laplace correction was computed from DEFLEC12A derived deflections.

KK1294

KK1294.The ellipsoidal height was determined by GPS observations

KK1294.and is referenced to NAD 83.

KK1294

KK1294.The dynamic height is computed by dividing the NAVD 88

KK1294.geopotential number by the normal gravity value computed on the

KK1294.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45

KK1294.degrees latitude (g = 980.6199 gals.).

KK1294

KK1294.The modeled gravity was interpolated from observed gravity values.

KK1294

KK1294. The following values were computed from the NAD 83(2011) position.

KK1294

KK1294;		North	East	Units	Scale	Factor	Converg.
KK1294;SPC CO C	-	521,020.870	962,322.809	MT	1.00000602	+0 21	10.1
KK1294;SPC CO C	-	1,709,382.64	3,157,220.75	sFT	1.00000602	+0 21	10.1
KK1294;UTM 13	-	4,403,311.956	505,085.159	MT	0.99960032	+0 02	16.8
KK1294!	-	Elev Factor	x	Scale Factor	=	Combined Factor	
KK1294!SPC CO C	-	0.99975117	x	1.00000602	=	0.99975719	
KK1294!UTM 13	-	0.99975117	x	0.99960032	=	0.99935159	

KK1294

KK1294

## SUPERSEDED SURVEY CONTROL

KK1294

KK1294	NAD 83(2007)-	39 46 47.04063(N)		104 56 26.22171(W)	AD(2002.00)	1
KK1294	ELLIP H (05/14/09)	1586.515 (m)			GP(2002.00)	4 2
KK1294	NAD 83(2007)-	39 46 47.04133(N)		104 56 26.22217(W)	AD(2002.00)	0
KK1294	ELLIP H (02/10/07)	1586.468 (m)			GP(2002.00)	
KK1294	ELLIP H (12/03/02)	1586.492 (m)			GP( )	4 2
KK1294	NAD 83(1992)-	39 46 47.04085(N)		104 56 26.22144(W)	AD( )	1
KK1294	ELLIP H (05/15/96)	1586.532 (m)			GP( )	3 1
KK1294	NAVD 88 (05/15/96)	1603.81 (m)		5261.8 (f)	LEVELING	3
KK1294	NGVD 29 (??/??/??)	1602.915 (m)		5258.90 (f)	ADJUSTED	1 2

KK1294

KK1294.Superseded values are not recommended for survey control.

KK1294

KK1294.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.

KK1294.[See file dsdata.txt](#) to determine how the superseded data were derived.

KK1294

KK1294\_U.S. NATIONAL GRID SPATIAL ADDRESS: 13SEE0508503311(NAD 83)

KK1294

KK1294\_MARKER: DV = VERTICAL CONTROL DISK

KK1294\_SETTING: 38 = SET IN THE ABUTMENT OR PIER OF A LARGE BRIDGE

KK1294\_SP\_SET: BRIDGE ABUTMENT

KK1294\_STAMPING: B 394 1983

KK1294\_MARK LOGO: NGS

KK1294\_MAGNETIC: O = OTHER; SEE DESCRIPTION

KK1294\_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL

KK1294\_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR

KK1294+SATELLITE: SATELLITE OBSERVATIONS - July 21, 2006

KK1294

KK1294	HISTORY	-	Date	Condition	Report By
KK1294	HISTORY	-	1983	MONUMENTED	NGS
KK1294	HISTORY	-	19950929	GOOD	CHANCE
KK1294	HISTORY	-	19960411	GOOD	MSAM
KK1294	HISTORY	-	20010303	GOOD	METRSC
KK1294	HISTORY	-	20020712	GOOD	CODOT
KK1294	HISTORY	-	20060721	GOOD	ZYLSTR

KK1294

KK1294

## STATION DESCRIPTION

KK1294

KK1294'DESCRIBED BY NATIONAL GEODETIC SURVEY 1983

KK1294'IN DENVER.

KK1294'IN DENVER, AT THE INTERSECTION OF COLORADO BOULEVARD AND INTERSTATE  
KK1294'HIGHWAY 70, IN TOP OF AND 0.6 METER (2.0 FT) WEST OF THE EAST END OF  
KK1294'THE SOUTH CONCRETE ABUTMENT OF THE BOULEVARD OVERPASS OVER THE  
KK1294'HIGHWAY, 22.4 METERS (73.5 FT) SOUTH OF THE CENTER OF THE EAST BOUND  
KK1294'LANES OF THE HIGHWAY, 10.2 METERS (33.5 FT) WEST OF THE CENTER OF THE  
KK1294'NORTH BOUND LANES OF THE BOULEVARD, AND 8.0 METERS (26.2 FT) EAST OF  
KK1294'THE CENTER OF THE SOUTH BOUND LANES OF THE BOULEVARD.  
KK1294'THE MARK IS 0.3 M ABOVE THE BOULEVARD.

KK1294

KK1294 STATION RECOVERY (1995)

KK1294

KK1294'RECOVERY NOTE BY JE CHANCE AND ASSOCIATES 1995 (FND)

KK1294'STATION WAS RECOVERED IN GOOD CONDITION AS DESCRIBED. A NEW  
KK1294'DESCRIPTION FOLLOWS\$THE STATION IS LOCATED IN THE NORTH PART OF THE  
KK1294'CITY OF DENVER AT THE INTERCHANGE OF INTERSTATE HIGHWAY 70 AND  
KK1294'COLORADO BOULEVARD (STATE HIGHWAY 2) , IN THE SOUTH BRIDGE ABUTMENT OF  
KK1294'THE BRIDGE OVER INTERSTATE HIGHWAY 70, ABOUT 4 MI (6.4 KM) NORTHEAST  
KK1294'OF DOWNTOWN DENVER, 2 MI (3.2 KM) SOUTH-SOUTHWEST OF COMMERCE CITY, 6  
KK1294'MI (9.7 KM) WEST-NORTHWEST OF FITZSIMONS ARMY HOSPITAL, IN THE  
KK1294'NORTHEAST 1/4 OF SECTION 24, T 3 S, R 68 W, 6TH P.M.

KK1294'OWNERSHIP--COLORADO DEPARTMENT OF TRANSPORTATION\$THE STATION IS  
KK1294'LOCATED IN THE MEDIAN OF COLORADO BOULEVARD (STATE HIGHWAY 2) , IN THE  
KK1294'TOP OF A CONCRETE ABUTMENT ON THE WEST SIDE OF THE SOUTH END OF THE  
KK1294'BRIDGE OVER INTERSTATE HIGHWAY 70. NOTE--PARK IN THE ASPHALT MEDIAN  
KK1294'TO THE SOUTH OF THE BRIDGE\$THE STATION MARK IS A STANDARD NGS VERTICAL  
KK1294'CONTROL MARK DISK STAMPED --B 394 1983-- SET FLUSH IN THE TOP OF A  
KK1294'CONCRETE BRIDGE ABUTMENT. IT IS 74 FT (22.6 M) SOUTH OF THE CENTER OF  
KK1294'THE EAST BOUND LANES OF INTERSTATE HIGHWAY 70, 26 FT (7.9 M) EAST OF  
KK1294'THE CENTER OF THE SOUTH BOUND LANES OF THE BOULEVARD, 34 FT (10.4 M)  
KK1294'WEST OF THE CENTER OF THE NORTH BOUND LANES OF THE BOULEVARD, 3.5 FT  
KK1294'(1.1 M) EAST OF THE WEST EDGE OF THE ABUTMENT, 10.3 FT (3.1 M) WEST OF  
KK1294'THE EAST EDGE OF THE ABUTMENT, AND 2.2 FT (0.7 M) WEST-NORTHWEST OF A  
KK1294'CARSONITE WITNESS POST\$DESCRIBED BY F.N. DREXEL

KK1294

KK1294 STATION RECOVERY (1996)

KK1294

KK1294'RECOVERY NOTE BY MOUNTAIN SURVEYING AND MAPPING INC 1996 (RSC)

KK1294'RECOVERED AS DESCRIBED.

KK1294

KK1294 STATION RECOVERY (2001)

KK1294

KK1294'RECOVERY NOTE BY METROPOLITAN STATE COLLEGE OF DENVER 2001 (HWS)

KK1294'RECOVERED IN GOOD CONDITION.

KK1294

KK1294 STATION RECOVERY (2002)

KK1294

KK1294'RECOVERY NOTE BY COLORADO DEPARTMENT OF TRANSPORTATION 2002 (JTG)

KK1294'RECOVERED AS DESCRIBED.

KK1294

KK1294 STATION RECOVERY (2006)

KK1294

KK1294'RECOVERY NOTE BY ZYLSTRA-BAKER SURVEYING INCORPORATED 2006 (LDV)

KK1294'RECOVERED AS DESCRIBED.

\*\*\* retrieval complete.

Elapsed Time = 00:00:03

# The NGS Data Sheet

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

```

PROGRAM = datasheet95, VERSION = 8.4
1      National Geodetic Survey,  Retrieval Date = APRIL 29, 2014
AE5245 *****
AE5245 DESIGNATION -  ARGO
AE5245 PID          -  AE5245
AE5245 STATE/COUNTY-  CO/DENVER
AE5245 COUNTRY      -  US
AE5245 USGS QUAD    -  COMMERCE CITY (1994)
AE5245
AE5245                                *CURRENT SURVEY CONTROL
AE5245
AE5245* NAD 83(2011) POSITION- 39 47 04.34135(N) 104 58 53.46476(W) ADJUSTED
AE5245* NAD 83(2011) ELLIP HT- 1551.505 (meters) (06/27/12) ADJUSTED
AE5245* NAD 83(2011) EPOCH   - 2010.00
AE5245* NAVD 88 ORTHO HEIGHT - 1568.617 (meters) 5146.37 (feet) ADJUSTED
AE5245
AE5245 NAD 83(2011) X - -1,269,075.863 (meters) COMP
AE5245 NAD 83(2011) Y - -4,742,374.100 (meters) COMP
AE5245 NAD 83(2011) Z - 4,060,623.312 (meters) COMP
AE5245 LAPLACE CORR - -8.91 (seconds) DEFLEC12A
AE5245 GEOID HEIGHT - -17.18 (meters) GEOID12A
AE5245 DYNAMIC HEIGHT - 1567.135 (meters) 5141.51 (feet) COMP
AE5245 MODELED GRAVITY - 979,627.5 (mgal) NAVD 88
AE5245
AE5245 VERT ORDER - SECOND CLASS I
AE5245
AE5245 FGDC Geospatial Positioning Accuracy Standards (95% confidence, cm)
AE5245 Type Horiz Ellip Dist(km)
AE5245 -----
AE5245 NETWORK 0.83 1.61
AE5245 -----
AE5245 MEDIAN LOCAL ACCURACY AND DIST (003 points) 0.79 1.49 4.91
AE5245 -----
AE5245 NOTE: Click here for information on individual local accuracy
AE5245 values and other accuracy information.
AE5245
AE5245
AE5245.The horizontal coordinates were established by GPS observations
AE5245.and adjusted by the National Geodetic Survey in June 2012.
AE5245
AE5245.NAD 83(2011) refers to NAD 83 coordinates where the reference
AE5245.frame has been affixed to the stable North American tectonic plate. See
AE5245.NA2011 for more information.
AE5245
AE5245.The horizontal coordinates are valid at the epoch date displayed above
AE5245.which is a decimal equivalence of Year/Month/Day.
AE5245
AE5245.The orthometric height was determined by differential leveling and
AE5245.adjusted by the NATIONAL GEODETIC SURVEY
AE5245.in June 2009.
AE5245
AE5245.The X, Y, and Z were computed from the position and the ellipsoidal ht.
AE5245
AE5245.The Laplace correction was computed from DEFLEC12A derived deflections.

```

AE5245

AE5245.The ellipsoidal height was determined by GPS observations

AE5245.and is referenced to NAD 83.

AE5245

AE5245.The dynamic height is computed by dividing the NAVD 88

AE5245.geopotential number by the normal gravity value computed on the

AE5245.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45

AE5245.degrees latitude (g = 980.6199 gals.).

AE5245

AE5245.The modeled gravity was interpolated from observed gravity values.

AE5245

AE5245. The following values were computed from the NAD 83(2011) position.

AE5245

AE5245;	North	East	Units	Scale Factor	Converg.
AE5245;SPC CO C	- 521,533.652	958,815.920	MT	1.00000702	+0 19 37.2
AE5245;SPC CO C	- 1,711,064.99	3,145,715.23	sFT	1.00000702	+0 19 37.2
AE5245;UTM 13	- 4,403,843.793	501,582.566	MT	0.99960003	+0 00 42.6

AE5245!

AE5245!	Elev Factor	x	Scale Factor	=	Combined Factor
AE5245!SPC CO C	- 0.99975666	x	1.00000702	=	0.99976367
AE5245!UTM 13	- 0.99975666	x	0.99960003	=	0.99935678

AE5245

AE5245

## SUPERSEDED SURVEY CONTROL

AE5245

AE5245	NAD 83(2007)-	39 47 04.34164(N)	104 58 53.46551(W)	AD(2002.00)	0
AE5245	ELLIP H (02/10/07)	1551.516 (m)		GP(2002.00)	
AE5245	ELLIP H (12/03/02)	1551.531 (m)		GP( )	4 2
AE5245	NAD 83(1992)-	39 47 04.34115(N)	104 58 53.46470(W)	AD( )	1
AE5245	ELLIP H (01/12/98)	1551.572 (m)		GP( )	4 1
AE5245	NAVD 88 (01/12/98)	1568.7 (m)	GEOID96 model used	GPS OBS	

AE5245

AE5245.Superseded values are not recommended for survey control.

AE5245

AE5245.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.

AE5245.[See file dsdata.txt](#) to determine how the superseded data were derived.

AE5245

AE5245\_U.S. NATIONAL GRID SPATIAL ADDRESS: 13SEE0158203843(NAD 83)

AE5245

AE5245\_MARKER: F = FLANGE-ENCASED ROD

AE5245\_SETTING: 59 = STAINLESS STEEL ROD IN SLEEVE (10 FT.+)

AE5245\_STAMPING: ARGO 1995

AE5245\_MARK LOGO: NGS

AE5245\_PROJECTION: FLUSH

AE5245\_MAGNETIC: I = MARKER IS A STEEL ROD

AE5245\_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL

AE5245\_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR

AE5245+SATELLITE: SATELLITE OBSERVATIONS - October 05, 2007

AE5245\_ROD/PIPE-DEPTH: 6.4 meters

AE5245\_SLEEVE-DEPTH : 0.9 meters

AE5245

AE5245 HISTORY - Date Condition Report By

AE5245 HISTORY - 1995 MONUMENTED NGS

AE5245 HISTORY - 20020716 GOOD CODOT

AE5245 HISTORY - 20040609 GOOD CO0600

AE5245 HISTORY - 20060909 GOOD METRSC

AE5245 HISTORY - 20071005 GOOD MSCD

AE5245

AE5245

## STATION DESCRIPTION

AE5245

AE5245'DESCRIBED BY NATIONAL GEODETIC SURVEY 1995 (RSC)

AE5245'THE STATION IS LOCATED ABOUT 0.7 MI (1.1 KM) NORTHWEST OF THE DENVER

AE5245'COLISEUM, 0.5 MI (0.8 KM) NORTHEAST OF THE INTERSTATE HIGHWAY 70 AND

AE5245'INTERSTATE HIGHWAY 25 INTERCHANGE, 0.35 MI (0.56 KM) WEST OF THE SOUTH

AE5245'PLATTE RIVER AND IN THE SECTION OF DENVER CALLED GLOBEVILLE, IN THE  
AE5245'SOUTHEAST 1/4 OF SECTION 15, T 3 S, R 68 W. OWNERSHIP--CITY AND  
AE5245'COUNTY OF DENVER PARKS AND RECREATION DEPARTMENT, 303-964-2500 TO  
AE5245'REACH THE STATION FROM THE INTERSECTION OF INTERSTATE HIGHWAY 70 EXIT  
AE5245'274 (FROM EASTBOUND LANES) OR EXIT 275 A (FROM WESTBOUND LANES) AND  
AE5245'WASHINGTON STREET, GO NORTH ON WASHINGTON STREET FOR 0.25 MI (0.40 KM)  
AE5245'TO EAST 48TH AVENUE. TURN LEFT, WEST, FOR 0.15 MI (0.24 KM) TO THE  
AE5245'INTERSECTION OF PENNSYLVANIA STREET AND ARGO PARK. THE STATION IS IN  
AE5245'THE NORTHSIDE OF A LARGE OPEN GRASSY AREA JUST SOUTH OF AN ELEVATED  
AE5245'RAILROAD TRACK SPUR THE MARK IS A PUNCH HOLE, TOP CENTER ON A 6.4 M  
AE5245'(21.0 FT) LONG STAINLESS STEEL ROD DRIVEN TO REFUSAL, ENCASED IN A 0.9  
AE5245'M (3.0 FT) LONG GREASED 1-INCH PVC PIPE, ENCLOSED IN A 5-INCH PVC PIPE  
AE5245'WITH LOGO LID, SURROUNDED BY A CONCRETE COLLAR FLUSH WITH THE GROUND.  
AE5245'IT IS 84.5 M (277.2 FT) NORTH-NORTHWEST OF THE NORTHWEST EDGE OF  
AE5245'ASPHALT AT THE CORNER OF EAST 48TH AVENUE AND PENNSYLVANIA STREET,  
AE5245'42.4 M (139.1 FT) NORTHEAST OF THE EASTERN MOST METAL LIGHT POLE FOR  
AE5245'THE BALL PARK, 30.6 M (100.4 FT) EAST-SOUTHEAST OF A FENCE CORNER FOR  
AE5245'THE BALL PARK, 18.1 M (59.4 FT) SOUTH OF THE SOUTHERN RAIL OF A SPUR  
AE5245'TRACK, 9.4 M (30.8 FT) SOUTH OF A WITNESS POST AND THE NORTHERN EDGE  
AE5245'OF GRASS.

AE5245

AE5245

STATION RECOVERY (2002)

AE5245

AE5245'RECOVERY NOTE BY COLORADO DEPARTMENT OF TRANSPORTATION 2002 (JTG)

AE5245'RECOVERED AS DESCRIBED.

AE5245

AE5245

STATION RECOVERY (2004)

AE5245

AE5245'RECOVERY NOTE BY CITY AND COUNTY OF DENVER COLORADO 2004 (RTE)

AE5245'RECOVERED IN GOOD CONDITION.

AE5245

AE5245

STATION RECOVERY (2006)

AE5245

AE5245'RECOVERY NOTE BY METROPOLITAN STATE COLLEGE OF DENVER 2006

AE5245'LOCATION TO REACH, DESCRIPTION AND TIES ARE STILL ACCURATE. CONDITION

AE5245'OF BM IS GOOD

AE5245

AE5245

STATION RECOVERY (2007)

AE5245

AE5245'RECOVERY NOTE BY METROPOLITAN STATE COLLEGE-DENVER 2007 (HPP)

AE5245'RECOVERED AS DESCRIBED

\*\*\* retrieval complete.

Elapsed Time = 00:00:02

# The NGS Data Sheet

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

```

PROGRAM = datasheet95, VERSION = 8.4
1      National Geodetic Survey,  Retrieval Date = APRIL 29, 2014
DJ8149 *****
DJ8149 DESIGNATION - 166 A
DJ8149 PID - DJ8149
DJ8149 STATE/COUNTY- CO/DENVER
DJ8149 COUNTRY - US
DJ8149 USGS QUAD - COMMERCE CITY (1994)
DJ8149
DJ8149 *CURRENT SURVEY CONTROL
DJ8149
DJ8149* NAD 83(1986) POSITION- 39 46 39. (N) 104 57 34. (W) SCALED
DJ8149* NAVD 88 ORTHO HEIGHT - 1581.748 (meters) 5189.45 (feet) ADJUSTED
DJ8149
DJ8149 GEOID HEIGHT - -17.26 (meters) GEOID12A
DJ8149 DYNAMIC HEIGHT - 1580.253 (meters) 5184.55 (feet) COMP
DJ8149 MODELED GRAVITY - 979,626.0 (mgal) NAVD 88
DJ8149
DJ8149 VERT ORDER - SECOND CLASS I
DJ8149
DJ8149.The horizontal coordinates were scaled from a topographic map and have
DJ8149.an estimated accuracy of +/- 6 seconds.
DJ8149.
DJ8149.The orthometric height was determined by differential leveling and
DJ8149.adjusted by the NATIONAL GEODETIC SURVEY
DJ8149.in June 2009.
DJ8149
DJ8149.The dynamic height is computed by dividing the NAVD 88
DJ8149.geopotential number by the normal gravity value computed on the
DJ8149.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
DJ8149.degrees latitude (g = 980.6199 gals.).
DJ8149
DJ8149.The modeled gravity was interpolated from observed gravity values.
DJ8149
DJ8149; North East Units Estimated Accuracy
DJ8149;SPC CO C - 520,760. 960,710. MT (+/- 180 meters Scaled)
DJ8149
DJ8149 SUPERSEDED SURVEY CONTROL
DJ8149
DJ8149.No superseded survey control is available for this station.
DJ8149
DJ8149_U.S. NATIONAL GRID SPATIAL ADDRESS: 13SEE034030(NAD 83)
DJ8149
DJ8149_MARKER: DD = SURVEY DISK
DJ8149_SETTING: 31 = SET IN A PAVEMENT SUCH AS STREET, SIDEWALK, CURB, ETC.
DJ8149_SP_SET: CURB
DJ8149_STAMPING: DENVER CITY ENGINEERS BM 166A 1990
DJ8149_MARK LOGO: CO0600
DJ8149_MAGNETIC: N = NO MAGNETIC MATERIAL
DJ8149_STABILITY: D = MARK OF QUESTIONABLE OR UNKNOWN STABILITY
DJ8149_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
DJ8149+SATELLITE: SATELLITE OBSERVATIONS - 2002
DJ8149
DJ8149 HISTORY - Date Condition Report By

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DJ8149 HISTORY - 1990 MONUMENTED CO0600  
DJ8149 HISTORY - 2002 GOOD CODOT

DJ8149

DJ8149

DJ8149

STATION DESCRIPTION

DJ8149

DJ8149'DESCRIBED BY COLORADO DEPARTMENT OF TRANSPORTATION 2002

DJ8149'THE STATION IS LOCATED IN DENVER, IN THE NORTHWEST 1/4 OF SECTION 24,

DJ8149'T 3 S, R 68 W, 1.0 MI (1.61 KM) EAST OF THE INTERCHANGE OF I-70 AND

DJ8149'WASHINGTON STREET, IN CITY OF DENVER RIGHT-OF-WAY.

DJ8149'

DJ8149'TO REACH THE STATION FROM THE INTERCHANGE OF I-70 AND WASHINGTON

DJ8149'STREET IN THE CITY OF DENVER GO EAST ON I-70 FOR 1.0 MI (1.61 KM) TO

DJ8149'THE EXIT FOR YORK STREET, EXIT RIGHT, CURVING FROM SOUTHEAST TO

DJ8149'SOUTHWEST, TURN LEFT, GO SOUTH, ON YORK STREET FOR 1 BLOCK TO 44TH

DJ8149'AVENUE AND THE STATION ON THE LEFT.

DJ8149'

DJ8149'THE STATION IS A 2 BRASS DISK STAMPED--DENVER CITY ENGINEERS BM 166A

DJ8149'1990--SET INTO THE TOP OF THE CURB AT THE SOUTHWEST CORNER OF A STORM

DJ8149'INLET IN THE SOUTHEAST CORNER OF THE INTERSECTION OF EAST 44TH AVENUE

DJ8149'AND YORK STREET,

DJ8149'

DJ8149'21 FT (6.4 M) SOUTH FROM THE CENTERLINE OF 44TH AVENUE, 17 FT (5.2 M)

DJ8149'EAST FROM THE CENTERLINE OF YORK STREET, 14 FT (4.3 M) NORTHWEST FROM

DJ8149'THE CORNER OF A CHAIN-LINK FENCE, 8 FT (2.4 M) NORTH OF THE STREET

DJ8149'SIGN FOR THE INTERSECTION.

\*\*\* retrieval complete.

Elapsed Time = 00:00:04