Appendix E
Application: Photogrammetric Mapping Control Surveys of Nine Mile Run (Pittsburgh District)

The following report of a photo control survey was submitted by TERRASURV, a contractor to the Pittsburgh District. It summarizes GPS observations performed to establish control for a photogrammetric mapping project.

REPORT OF SURVEY
NINE MILE RUN
PITTSBURGH, PA

INTRODUCTION

TERRASURV was requested to perform a geodetic control survey covering a portion of the Nine Mile Run watershed in Pittsburgh, Allegheny County, Pennsylvania. The purpose of the survey was to provide control values (photo identities) for use in photogrammetric mapping of an area around Nine Mile Run between the Monongahela River to the south and Forbes Avenue to the North.

In addition, three pairs of intervisible monuments were to be established for use in future survey work in the project area. This phase of the project was observed and adjusted separately from the photo control.

The work was performed as a subcontractor to GRW, Inc. (client) who was contracted by the Pittsburgh District of the US Army Corps of Engineers (contracting agency).

CONTROL

The contracting agency requested that the horizontal component of the control be referenced to the North American Datum of 1983, 1986 adjustment (NAD 1983 1986), and that the vertical component of the control be referenced to the National Geodetic Vertical Datum of 1929 (NGVD 1929).

The horizontal control consisted of two National Spatial Reference System (NSRS) stations located along the Monongahela River. Station **7002** (PID# KX2402) is a City of Pittsburgh City Line disk in a monument box at the now abandoned Amoco Refinery, on the left bank of the Monongahela River at river mile 5.75, just west of the mouth of Streets Run and the Glenwood Bridge. Station **L/D 2 M 6** (PID# KX2396) is a USACE survey disk on the right bank land wall at Lock and Dam 2, at the lower lock gates. Both of these stations were part of the USACE Monongahela River GPS network done in 1989. They are first order horizontal and second order class I vertical control.

The vertical control consisted of the two stations used for horizontal control, and station **IVY** (PID# KX1251). This is a USACE harbor line monument located along the rail line on the right bank of the river, approximately 165 m upstream of the upstream edge of the railroad bridge over Nine Mile Run, in the Duck Hollow section of Pittsburgh. This station has a vertical accuracy of first order class I.

In 1988, a Second-Order level run was made starting at **3041** (PID# KX1478) and **3042** (PID# KX1479), both of which are first order class II benchmarks. This level line, run with a Wild NA-2 with micrometer

and Inver rods, ran along the perimeter of this project, and ended at **IVY**. The line closed +0.000 m, and was computed on the NGVD 1929 datum. Several elevations determined in the 1988 run were used in the current project. Ties were made at the following stations: 00028I, 00028K, 00028N, and 00028U.

In addition to the requested datums, horizontal positions were also computed on the North American Datum of 1927 (NAD 1927), utilizing the USACE river control, and on the North American Datum of 1986, 1996 adjustment (NAD 1983 1996), utilizing the Continuously Operating Reference Station (CORS) PIT1. The elevations were computed on the North American Vertical Datum of 1988 (NAVD 1988) as well.

PHOTO CONTROL STATIONS

The locations of the photo identities were selected by GRW. The following is a list of the photo control points:

name	GPSID	description
101	00028A	C/L sidewalk @ west end of street
102	00028B	NW corner of walk at end
103	00028C	NW edge of street @ c/l narrow sidewalk
104	00028D	NW corner of drive @ S edge of street
105H1	00028E ECC	base of pole
105H2	00028E ECC	Post
105H3	00028E ECC	Milepost
105V1	00028E ECC	C/L tracks opposite signal box
105V2	00028E ECC	C/L tracks opposite milepost
106	00028F	SW corner of drive
107	00028G	SW corner of drive @ N edge of road
108H	00028H ECC	base of pole
109	00028I	NW corner of pavement
110H	00028J ECC	base of lone tree
110V1	00028J ECC	C/L road opposite tree
110V2	00028J ECC	C/L road X C/L trail
111	00028K	center of CB grate on N side of street
112	00028L	NW corner of pavement
113H	00028M ECC	Base of northernmost goal post
114	00028N	edge of pavement at end of stop bar
115	00028O	C/L sidewalk X C/L sidewalk
116	00028P	NW corner of sidewalk intersection
117	00028Q	C/L manhole
118	00028R	N edge of sidewalk @ C/L sidewalk
119	00028S	NW corner of sidewalk @ N edge of drive
120	00028T	NE corner of parking pavement
121	00028U	C/L manhole
122	00028V	center of CB grate on N side of street

Note that additional identities were selected at several of the stations (105 & 110). At 105, the pole selected was located on a steep bank, and therefore additional horizontal and vertical identities were surveyed along the railroad tracks. At 110, additional vertical identities (coordinated) were surveyed.

The short eccentrics at 108 and 113 were done with a compass (corrected for declination) and tape. The longer offsets at 110 and 105 were done using a Zeiss S10 total station, utilizing distant intersection stations for orientation.

MONUMENTS

Three monument pairs were established in locations that would be useful for conventional surveying. The following is a description of these stations:

00028AA: located at the fishing area at the bottom of Old Browns Hill Road, in the Duck Hollow Section of the City of Pittsburgh, on the right bank of the Monongahela River. It is a disk on a concrete structure, 15.25 m SW of a triangular metal structure near the SE corner of the parking area, 0.67 m landward of the river wall. Intervisible with 00028AB. "DUCK HOLLOW"

00028AB: located on an access bridge to an old water intake station at the former USX Homestead Works in Homestead, in what is now a new development, behind the Eat N Park headquarters building (under construction), on the left bank of the Monongahela River. The disk is 15.81 m N of the NE corner of the building, 0.805 m north (riverward) of the south end of the access bridge, and 0.545 m E of the E face of the W curb of the bridge. Intervisible with 00028AA. "EAT N PARK"

00028AC: To reach, take Beechwood Boulevard east from Browns Hill Road to the entrance to Rosemont (new subdivision). Travel to the end of the cul-de-sac, and walk out to the edge of the hill, past the air monitor station. The station is a disk in a concrete monument in the cleared area around the edge of the hill, 10.464 m from three punch marks in a fence corner post at the air monitor station, and 0.5 m back from the edge. Intervisible with 00028AD. "ROSEMONT"

00028AD: located in a clearing off of Commercial Street, now reachable only from Whipple Street in Swissvale due to a road closure. There is a boarded up construction trailer to the SE, and the station is near the guardrail. The station is a disk in a concrete monument, 7.085 from a PK in a utility pole, and 10.472 m from a punch mark in the top of a guardrail post. Intervisible with 00028AC. "COMMERCIAL"

00028AE: located on a traffic island between Forbes Avenue and Beechwood Boulevard, near the entrance to Homewood Cemetery. The station is an existing disk cemented in the concrete island, stamped 226 AZIMUTH MON VALLEY EXP. Intervisible with 00028AF. "BEECHWOOD"

00028AF: located on the back wall of a catch basin on the north side of Forbes Avenue, near a small gas utility building. The disk is 0.52 m east of the east edge of the building extended, 5.57 m from the corner, 0.119 m north of the south face of curb on the north side of Forbes, also 2.88 m south of the south face of a stone wall. Intervisible with 00028AE. "FORBES"

Four of the six stations have additional backsight objects. A steel standpipe (WTVENT) located atop a hill near the Monongahela Cemetery, straddling the Braddock and Braddock Hills boundary was intersected from EAT N PARK, DUCK HOLLOW, and ROSEMONT. The point sighted was the small vent rising from the center of the roof of the tank. A barrel like object (HAZELMICRO) atop a radio tower just west of Calvary Cemetery in the Glenwood section of the City of Pittsburgh was intersected from ROSEMONT and DUCK HOLLOW. Both of these intersection stations were previously coordinated during an electronic traverse along the Monongahela River for sounding control. Station

BEECHWOOD is an existing azimuth mark set in 1988 during mapping of the proposed Monongahela Valley Expressway. The main station MV226 was tied by angle and distance measurements. All of these additional measurements were included in the adjustment, as were the EDM and zenith distances between the stations of each monument pair. [Sketches of these stations are included in Appendix A--withdrawn.]

GPS OBSERVATIONS

The project was observed in two phases. The photo control was done on days 099 and 101 of 2000. The following is a summary of the station occupations:

Day 099 (three receivers):

Station	Filename	UTC Start	UTC End	Duration
00028C	97570990.DAT	12:38:00	13:00:45	23 min
00028B	17690990.DAT	12:44:00	13:00:30	17 min
00028A	99810990.DAT	12:51:00	13:22:15	31 min
00028G	97570991.DAT	13:12:15	13:59:15	47 min
00028D	17690990.DAT	13:13:00	13:22:00	9 min
00028H	17690990.DAT	13:41:00	14:00:00	19 min
00028I	99810991.DAT	13:42:00	14:53:30	72 min
00028V	17690990.DAT	14:19:30	15:30:00	71 min
00028J	97570992.DAT	14:24:30	14:45:15	21 min
00028K	97570993.DAT	15:10:30	15:30:15	20 min
00028R	99810992.DAT	15:13:15	16:08:00	55 min
00028Q	97570994.DAT	15:39:45	16:07:30	28 min
00028S	17690990.DAT	15:47:30	16:46:15	59 min
00028T	97570995.DAT	16:16:45	16:46:15	30 min
00028U	99810993.DAT	16:29:45	17:15:00	45 min
00028O	17690991.DAT	16:58:15	17:14:15	16 min
00028O	17690992.DAT	18:17:30	18:47:00	30 min
00028N	9757099B.DAT	18:20:00	18:47:00	27 min
00028F	99810994.DAT	18:27:00	18:47:15	20 min
00028T	9757099C.DAT	18:55:45	19:32:15	37 min
00028P	17690992.DAT	19:05:00	19:32:15	27 min
00028M	99810995.DAT	19:16:00	20:30:15	74 min
00028H	17690992.DAT	19:41:15	20:30:00	49 min
00028L	9757099D.DAT	19:55:15	20:30:30	35 min
00028F	99810996.DAT	20:51:15	21:28:30	37 min
00028C	17690992.DAT	20:55:15	21:46:00	51 min
00028E	9757099E.DAT	21:11:00	21:28:15	17 min
KX1251	9957099F.DAT	21:36:45	21:46:00	9 min

Day 101 (two receivers):

Station	Filename	UTC Start	UTC End	Duration
00028N	97571010.DAT	11:47:00	12:14:30	28 min
KX2396	99811011.DAT	13:43:45	18:30:15	287 min
KX1251	97571011.DAT	14:08:30	14:26:45	18 min
KX2402	97571012.DAT	18:06:45	19:34:30	88 min
00028R	99811010.DAT	18:54:00	19:08:15	14 min

The monument control was done on day 228 using two receivers:

Station	Filename	UTC Start	UTC End	Duration
KX1251	99812280.DAT	17:00:00	17:37:30	38 min
00028AA	97572280.DAT	17:00:30	18:31:30	91 min
00028AB	99812281.DAT	17:48:30	18:05:00	17 min
00028AC	99812282.DAT	18:16:30	18:31:00	15 min
00028AD	99812283.DAT	18:50:00	19:52:15	62 min
00028AC	97572281.DAT	18:51:30	19:20:00	29 min
00028AB	97572282.DAT	19:36:00	19:53:45	18 min
00028AC	97572283.DAT	20:06:15	20:35:00	29 min
00028AE	99812284.DAT	20:08:15	21:29:45	82 min
00028AF	97572284.DAT	20:55:30	22:15:30	80 min
00028AD	99812285.DAT	21:51:00	22:17:15	26 min

No equipment or other problems were encountered during the observations.

GPS DATA PROCESSING

The GPS data was downloaded to a PC and processed using the GPSurvey WAVE processor, version 2.35. The single baseline method was used. Most of the baselines in the network independent (i.e. non-trivial), but several of the "trivial" baselines from day 099 were included. These lines are not totally non-trivial, due to differing start and stop times. The broadcast ephemeris was used. The following is a summary of the baseline processing for the photo control network:

FILENAME	FROM	TO	DATE	TIME	DUR	RATIO	VAR	RMS	LENGTH
00063958	00028A	00028B	04/08/00	12:51	10	14.81	4.25	0.006	625 m
00063962	00028A	00028C	04/08/00	12:51	10	12.00	8.68	0.009	788 m
00063966	00028B	00028C	04/08/00	12:44	17	67.14	6.89	0.008	613 m
00064010	00028C	00028E	04/08/00	21:11	17	9.66	17.56	0.016	611 m
00064014	00028C	00028F	04/08/00	20:55	33	13.75	6.57	0.008	914 m
00064006	00028C	KX1251	04/08/00	21:36	9	75.64	2.37	0.005	59 m
00063954	00028D	00028A	04/08/00	13:13	9	10.92	4.34	0.007	867 m
00064018	00028F	00028E	04/08/00	21:11	17	10.08	13.62	0.015	539 m
00063946	00028G	00028A	04/08/00	13:12	10	10.01	4.24	0.006	1319 m
00063950	00028G	00028D	04/08/00	13:13	9	18.94	2.56	0.005	588 m
00063942	00028H	00028G	04/08/00	13:41	18	20.14	16.93	0.017	721 m
00063998	00028H	00028L	04/08/00	19:55	35	3.86	38.11	0.023	975 m
00063886	00028I	00028G	04/08/00	13:42	17	13.30	2.64	0.005	852 m
00063894	00028I	00028H	04/08/00	13:42	18	20.62	18.28	0.017	744 m
00063882	00028I	00028J	04/08/00	14:24	21	22.80	1.96	0.005	610 m
00063890	00028I	00028V	04/08/00	14:19	34	11.85	3.79	0.006	1051 m
00063898	00028J	00028V	04/08/00	14:24	21	10.24	6.23	0.008	819 m
00063910	00028K	00028R	04/08/00	15:13	17	10.86	3.53	0.006	463 m
00063990	00028M	00028H	04/08/00	19:41	49	10.68	23.96	0.018	704 m
00063982	00028M	00028L	04/08/00	19:55	35	3.66	18.00	0.014	562 m
00063994	00028M	00028P	04/08/00	19:16	16	9.06	9.01	0.009	578 m
00063986	00028M	00028T	04/08/00	19:16	16	15.06	2.33	0.006	912 m
00063978	00028N	00028F	04/08/00	18:27	20	12.02	8.98	0.011	555 m
00063970	**00028O**	**00028F**	**04/08/00**	**18:27**	**20**	**1.71**	**71.39**	**0.025**	**1092 m**
00063974	**00028O**	**00028N**	**04/08/00**	**18:20**	**27**	**1.89**	**112.63**	**0.031**	**537 m**
00064046	00028O	00028N	04/10/00	11:49	26	12.28	7.56	0.009	537 m
00064002	00028P	00028T	04/08/00	19:05	27	4.49	6.83	0.009	454 m
00063922	00028Q	00028S	04/08/00	15:47	20	5.08	12.44	0.011	589 m
00063914	00028R	00028Q	04/08/00	15:39	28	11.11	6.65	0.009	893 m
00063918	00028R	00028S	04/08/00	15:47	21	5.84	9.99	0.011	1087 m
00063930	00028S	00028T	04/08/00	16:16	30	4.05	9.48	0.010	460 m
00063926	00028S	00028U	04/08/00	16:29	17	3.41	11.93	0.012	1096 m
00063934	00028T	00028U	04/08/00	16:29	17	11.03	3.22	0.006	671 m
00063938	00028U	00028O	04/08/00	16:58	16	12.41	5.29	0.008	593 m
00063906	00028V	00028K	04/08/00	15:10	20	8.45	6.59	0.009	708 m
00063902	00028V	00028R	04/08/00	15:13	17	11.21	5.10	0.007	1159 m
00064038	KX2396	KX1251	04/10/00	14:08	18	9.14	1.79	0.014	5247 m
00064034	KX2396	KX2402	04/10/00	18:06	24	14.36	1.19	0.011	6692 m
00064042	KX2402	00028R	04/10/00	18:54	14	11.33	2.15	0.016	6177 m

The two baselines denoted above in **bold** type were rejected.

The data from the CORS station PIT1 was obtained and processed using the data from day 099. The following summarizes these results:

00063870	**pit1**	**00028A**	**04/08/00**	**12:51**	**31**	**8.97**	**5.17**	**0.027**	**24515 m**
00063846	**pit1**	**00028C**	**04/08/00**	**20:55**	**51**	**25.94**	**1.56**	**0.015**	**23730 m**
00063830	pit1	00028F	04/08/00	20:51	37	13.56	2.48	0.016	22824 m
00063866	**pit1**	**00028G**	**04/08/00**	**13:12**	**47**	**4.97**	**5.15**	**0.024**	**23316 m**
00063850	pit1	00028H	04/08/00	19:41	49	6.99	4.86	0.025	22598 m
00063862	pit1	00028I	04/08/00	13:42	72	4.72	1.19	0.012	22788 m
00063834	**pit1**	**00028L**	**04/08/00**	**19:55**	**35**	***********	**21.97**	**0.049**	**21633 m**
00063838	pit1	00028M	04/08/00	19:16	74	7.70	3.44	0.021	21971 m
00063858	pit1	00028R	04/08/00	15:13	55	29.63	0.99	0.010	20781 m
00063874	pit1	00028S	04/08/00	15:47	59	1.74	8.12	0.031	20915 m
00063842	pit1	00028T	04/08/00	18:55	37	27.28	0.95	0.010	21302 m
00063854	pit1	00028U	04/08/00	16:29	45	10.26	2.13	0.017	21633 m
00063878	pit1	00028V	04/08/00	14:19	71	7.79	2.00	0.016	21795 m

Of the thirteen baselines processed from PIT1, four (in **bold** type) were rejected. The other nine were included in the adjustment.

The monument network was observed on day 228. The following is a summary of these results:

FILENAME	FROM	TO	DATE	TIME	DUR	RATIO	VAR	RMS	LENGTH
00087929	00028AA	00028AC	08/15/00	18:16	15	14.96	5.14	0.007	929 m
00087945	00028AE	00028AC	08/15/00	20:08	27	7.09	11.19	0.012	1721 m
00087925	00028AA	00028AB	08/15/00	17:48	17	17.34	16.50	0.013	356 m
00087941	00028AF	00028AD	08/15/00	21:51	25	6.90	11.71	0.012	1506 m
00087921	00028AA	KX1251	08/15/00	17:00	37	15.39	5.83	0.007	265 m
00087957	00028AD	00028AB	08/15/00	19:36	16	13.38	3.20	0.007	1459 m
00087937	00028AE	00028AF	08/15/00	20:55	34	3.18	18.07	0.016	379 m
00087953	00028AD	00028AC	08/15/00	18:51	29	21.29	1.91	0.005	728 m
00087933	pit1	00028AE	08/15/00	20:08	82	6.62	2.57	0.017	22116 m
00087949	pit1	00028AD	08/15/00	18:50	62	13.09	1.86	0.015	22533 m
00087917	pit1	00028AA	08/15/00	17:00	91	12.65	2.63	0.019	23976 m

All of these results were acceptable.

LEAST SQUARES ADJUSTMENTS

GEOLAB was used to perform all of the various adjustments. No scaling of the *a priori* baseline statistics was done. Geoid heights were interpolated for each station using the GEOID99 model. Station errors (HI and centering) of 0.005 m were input for the GPS observations.

The first adjustment was a free adjustment of the GPS only portion of the photo control network (i.e. no traverse or eccentric observations). A map of this network is shown in figure 1. Station **7002** was held fixed in all three dimensions (NAD 1983 1986 latitude and longitude, NGVD 1929 orthometric height). The estimated variance factor was 1.18. The plot in figure 2 shows the horizontal and vertical residuals versus baseline length for this adjustment. The misclosures at the other control stations were as follows:

Station Name	Azimuth	Distance	Δ Height
00028I			+0.009 m
00028K			+0.036 m
00028N			+0.019 m
00028U			+0.002 m
KX1251			+0.001 m
KX2396	319ø	0.037 m	+0.011 m

As can be seen, the misclosures are all within the expected range. The output from this adjustment is included in appendix B.

The next adjustment added the traverse and eccentric information to the network, vertically constrained the four new stations with elevations, and constrained in all three dimensions the two existing NSRS stations, **7002** and **L/D 2 M 6**. This adjustment had an estimated variance factor of 1.70. The output from this adjustment is included in appendix C. The coordinates from this adjustment were provided to the client to be used as photo control for aerotriangulation.

The monument network was surveyed as a network with a tie to **IVY** and **PIT1**. The coordinate for **IVY** resulting from the photo control network was constrained in a free adjustment. The network is shown in figure 3. This adjustment had an estimated variance factor of 1.31. A level tie from BEECHWOOD to a nearby TBM from the 1988 survey had a vertical misclosure of 0.008 m. A subsequent adjustment was performed that constrained **IVY** in all three dimensions, and BEECHWOOD (00028AE) vertically. This adjustment had an estimated variance factor of 1.27. This adjustment supplied the coordinates for the monuments, and the output is included in appendix D. The plot in figure 4 shows the horizontal and vertical residuals versus baseline length for this adjustment.

Although not requested by the contracting agency, adjustments were also performed on the NAD 1983 1992 horizontal datum and NAVD 1988 vertical datum, as well as the NAD 1927 horizontal datum.

A free adjustment was run holding the NAD 1983 1996 coordinates of PIT1 fixed, as well as the GPS derived NAVD 1988 orthometric height of PIT1. This adjustment included all of the GPS observations from both the photo control network and the monument network, as well as the traverse observations and eccentric measurements. The estimated variance factor was 1.14. The misclosure at the other control stations were as follows:

Station	Azimuth	Distance	Δ Height
KX1251			+0.018 m
KX2396	51ø	0.102 m	+0.021 m
KX2402	51ø	0.108 m	+0.007 m

The vertical misclosures are excellent. The horizontal misclosures show a bias of approximately 10 cm. This is common in Pennsylvania, and results from the poor ties between the HARN/CORS network and the existing NSRS network. Although the two Monongahela River GPS Network stations were established using GPS, they were controlled by triangulation stations. The ties between the existing triangulation network and the HARN/CORS are very sparse. Because of this, these two stations were not constrained horizontally in the subsequent constrained adjustment.

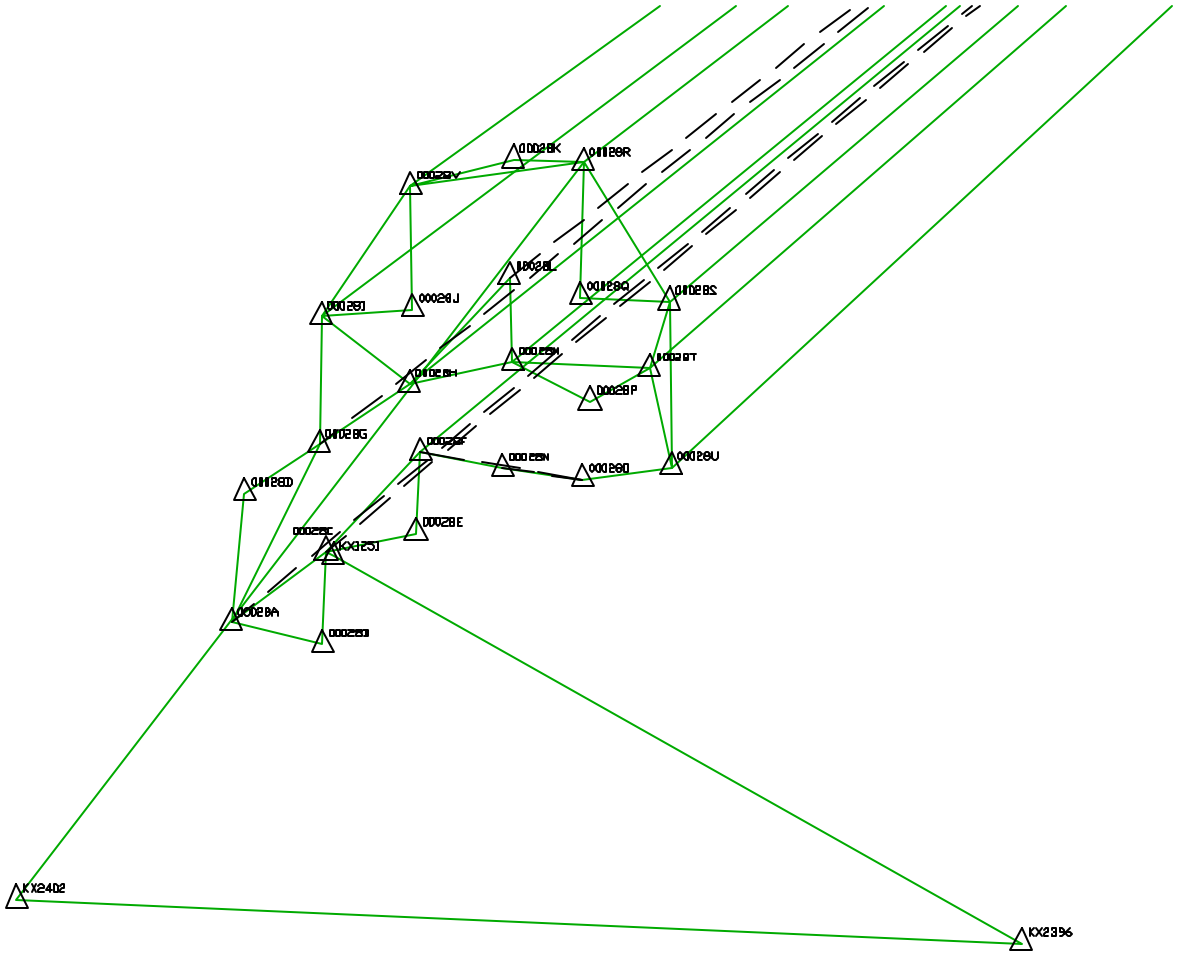
A constrained NAD 1983 1992/NAVD 1988 adjustment was done that held PIT1 fixed in all three dimensions, and KX1251, KX2396, and KX2402 fixed vertically. The coordinates from this adjustment are listed below.

A final adjustment held the two Monongahela River GPS network stations fixed horizontally on NAD 1927. The horizontal coordinates from this adjustment are also given below.

SUMMARY

A geodetic control network was established in Allegheny County, Pennsylvania for the purpose of photogrammetric mapping of a portion of the Nine Mile Run watershed. The relative accuracy of the network is first order (10 ppm). The absolute accuracy of the network on NAD 1983 1992/NAVD 1988 is ± 0.03 m, and ± 0.05 m on NAD 1983 1986/NGVD 1929.

Figure 1 - Photo Control network



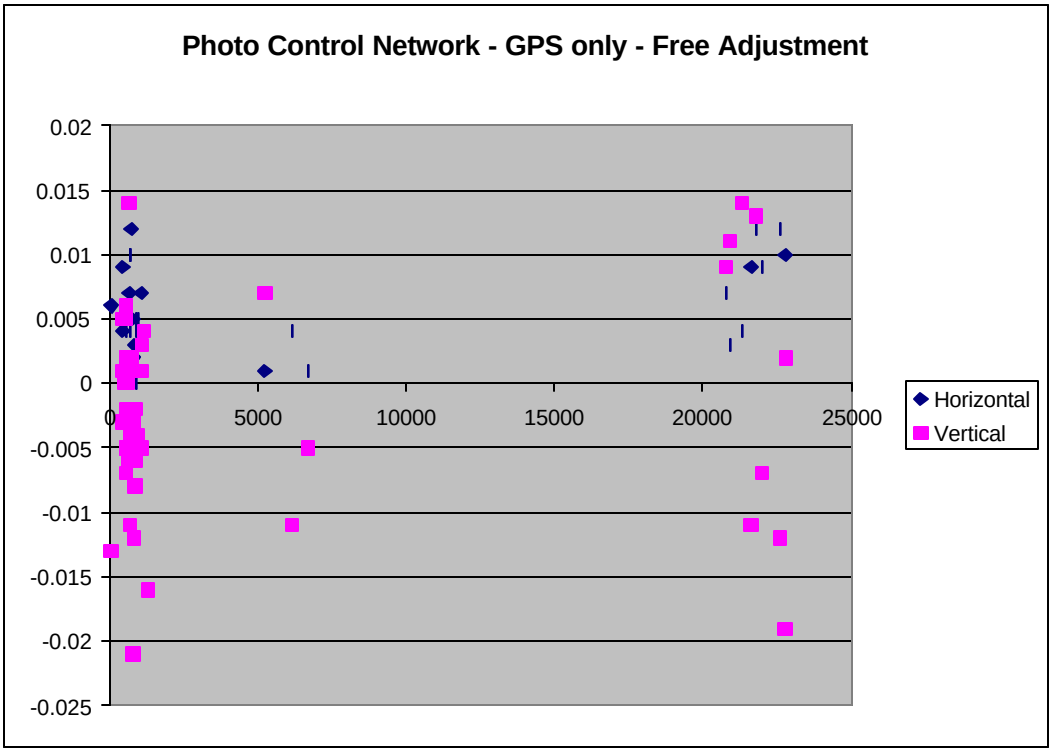


Figure 2 - Free Adjustment Residuals Photo Control Network

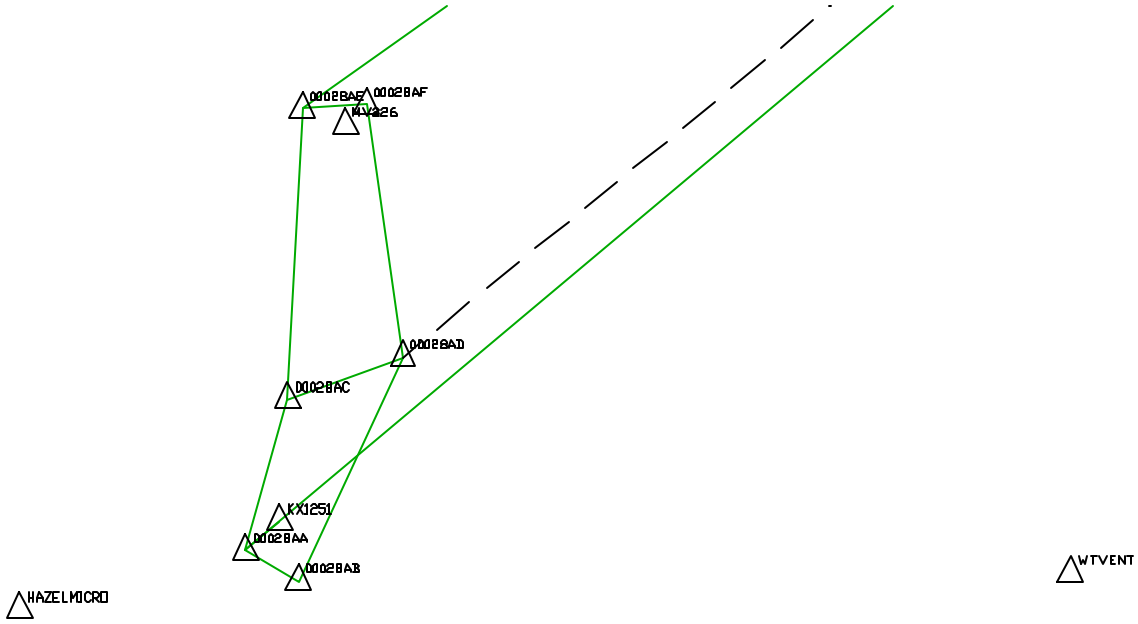


Figure 3 - Monument network

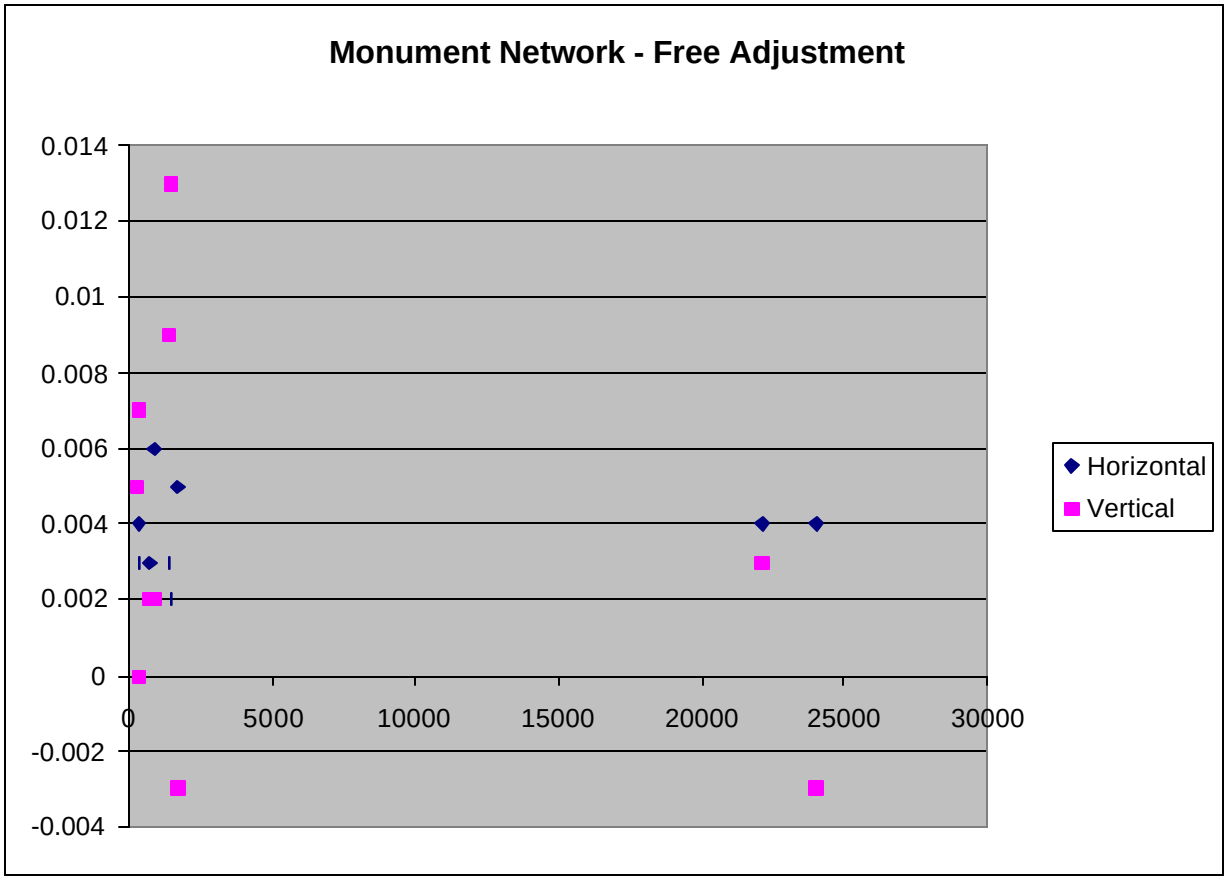


Figure 4 - Free Adjustment Residuals Monument Network

Geographic Coordinates – NAD 1983 1986/NGVD 1929 meters

Station name	DD.MMSSssssss	DD.MMSSssssss	NGVD 29
00028A	+40.244373915	-79.551903928	279.471
00028B	+40.243892060	-79.545337681	226.404
00028C	+40.245877823	-79.545212383	226.078
00028D	+40.251161627	-79.551470183	314.363
00028E	+40.250258950	-79.542669843	229.274
00028F	+40.251994846	-79.542509201	272.652
00028G	+40.252182038	-79.545361428	313.808
00028H	+40.253459240	-79.542806129	266.139
00028I	+40.254941105	-79.545272706	345.491
00028J	+40.255069893	-79.542692187	335.031
00028K	+40.262266917	-79.535783977	287.435
00028L	+40.255732751	-79.535935253	244.717
00028M	+40.253912794	-79.535880664	234.322
00028N	+40.251625186	-79.540203241	276.056
00028O	+40.251371439	-79.533948213	269.077
00028P	+40.253038314	-79.533713726	260.288
00028Q	+40.255286358	-79.533933278	274.932
00028R	+40.262180888	-79.533823209	277.638
00028S	+40.255164744	-79.531439207	278.031
00028T	+40.253742651	-79.532020712	265.289
00028U	+40.251612166	-79.531451814	284.970
00028V	+40.261721597	-79.542700963	305.088
105H1	+40.250285773	-79.542675087	231.017
105H2	+40.250294316	-79.542491782	228.181
105H3	+40.250231666	-79.542982566	228.664
105V1	+40.250283909	-79.542478089	229.083
105V2	+40.250217640	-79.542979675	229.565
108H	+40.253460079	-79.542807586	266.139
110H	+40.255111069	-79.542734712	335.930
110V1	+40.255089174	-79.542728131	335.547
110V2	+40.255091557	-79.542710634	335.478
113H	+40.253911904	-79.535881363	234.322
KX1251	+40.245775546	-79.545001015	228.411
KX2396	+40.233266491	-79.513732815	223.342
KX2402	+40.234468037	-79.562064720	222.229
PIT1	+40.330373303	-79.415003350	387.967
WM TANK	+40.220215201	-79.552106762	
00028AA	+40.245218145	-79.545853741	222.236
00028AB	+40.244629080	-79.544553760	227.315
00028AC	+40.252095183	-79.544753173	307.386
00028AD	+40.252889612	-79.541862393	236.118
00028AE	+40.261662630	-79.544304435	319.725
00028AF	+40.261723257	-79.542698290	305.243
HAZELMICRO	+40.244148128	-79.555545080	
MV226	+40.261346816	-79.543230087	329.615
TBM	+40.252128376	-79.544885781	307.083
WTVENT	+40.244605636	-79.513177261	

PA South Zone State Plane Coordinates – NAD 1983 1986 US Survey FT.

Station name	Northing	Easting
00028A	400435.8779	1363757.9807
00028B	399899.6831	1365730.4180
00028C	401906.1722	1365876.5568
00028D	403247.7692	1364162.7121
00028E	402243.6187	1367851.9233
00028F	403996.6802	1368019.0322
00028G	404240.0212	1365818.4710
00028H	405483.7251	1367825.6717
00028I	407029.5104	1365955.4943
00028J	407110.9705	1367953.5743
00028K	410290.3802	1370280.5208
00028L	407729.5595	1370101.1665
00028M	405887.3896	1370098.5408
00028N	403579.2282	1369792.7885
00028O	403280.1225	1371530.0718
00028P	404961.9994	1371752.3144
00028Q	407240.3361	1371637.8055
00028R	410166.5011	1371793.9987
00028S	407070.5582	1373562.8761
00028T	405642.7933	1373078.4837
00028U	403476.8521	1373466.1279
00028V	409793.7040	1368012.3367
105H1	402270.8526	1367848.5345
105H2	402276.0323	1367990.4748
105H3	402221.9265	1367609.4503
105V1	402265.2456	1368000.8108
105V2	402207.6827	1367611.3381
108H	405484.6017	1367824.5637
110	407153.4294	1367921.7141
110V1	407131.1552	1367926.2594
110V2	407133.2352	1367939.8470
113H	405886.5022	1370097.9778
KX1251	401798.6993	1366037.4568
KX2396	392829.9184	1380730.4457
KX2402	394578.9939	1358845.9242
PIT1	449561.1714	1427433.1207
WM TANK	384093.1350	1363198.9126
00028AA	401250.9819	1365364.2711
00028AB	400630.4221	1366354.8731
00028AC	404140.6297	1366286.5849
00028AD	404889.6479	1368541.2109
00028AE	409764.3684	1366771.4392
00028AF	409795.3329	1368014.4416
HAZELMICRO	400276.8881	1360936.7527
MV226	409424.5584	1367594.0708
TBM	404176.7208	1366184.8803
WTVENT	400244.2779	1381337.4967

Geographic Coordinates – NAD 1983 1992/NAVD 1988 meters

Station name	DD.MMSSssssss	DD.MMSSssssss	NAVD 88	Ellip H
00028A	+40.244373923	-79.551902931	279.315	245.654
00028AA	+40.245218164	-79.545852750	222.103	188.444
00028AB	+40.244629097	-79.544552771	227.185	193.532
00028AC	+40.252095199	-79.544752183	307.258	273.593
00028AD	+40.252889624	-79.541861400	235.994	202.335
00028AE	+40.261662646	-79.544303440	319.598	285.919
00028AF	+40.261723272	-79.542697296	305.118	271.444
00028B	+40.243892070	-79.545336685	226.250	192.598
00028C	+40.245877835	-79.545211390	225.925	192.266
00028D	+40.251161633	-79.551469183	314.206	280.536
00028E	+40.250258960	-79.542668847	229.121	195.468
00028F	+40.251994853	-79.542508202	272.499	238.841
00028G	+40.252182043	-79.545360426	313.649	279.982
00028H	+40.253459242	-79.542805124	265.979	232.316
00028I	+40.254941106	-79.545271700	345.330	311.656
00028J	+40.255069893	-79.542691179	334.873	301.206
00028K	+40.262266913	-79.535782970	287.299	253.633
00028L	+40.255732752	-79.535934247	244.556	210.895
00028M	+40.253912795	-79.535879658	234.160	200.504
00028N	+40.251625191	-79.540202241	275.910	242.260
00028O	+40.251371440	-79.533947208	268.920	235.278
00028P	+40.253038315	-79.533712719	260.126	226.479
00028Q	+40.255286352	-79.533932265	274.775	241.122
00028R	+40.262180880	-79.533822193	277.483	243.823
00028S	+40.255164742	-79.531438197	277.870	244.226
00028T	+40.253742652	-79.532019705	265.127	231.484
00028U	+40.251612168	-79.531450811	284.802	251.168
00028V	+40.261721595	-79.542699953	304.933	271.258
105H1	+40.250285783	-79.542674089	230.864	197.211
105H2	+40.250294319	-79.542490783	228.028	194.375
105H3	+40.250231689	-79.542981571	228.511	194.857
105V1	+40.250283911	-79.542477091	228.930	195.278
105V2	+40.250217662	-79.542978681	229.412	195.758
108H	+40.253460081	-79.542806581	265.979	232.316
110	+40.255111070	-79.542733702	335.772	302.105
110V1	+40.255089174	-79.542727122	335.388	301.721
110V2	+40.255091557	-79.542709625	335.319	301.652
113H	+40.253911906	-79.535880357	234.160	200.504
HAZELMICRO	+40.244148158	-79.555544088		
KX1251	+40.245775573	-79.545000039	228.262	194.604
KX2396	+40.233266541	-79.513731866	223.196	189.625
KX2402	+40.234468007	-79.562063673	222.065	188.411
MV226	+40.261346832	-79.543229093	329.488	295.813
PIT1	+40.330373303	-79.415002340	387.807	354.289
TBM	+40.252128392	-79.544884790	306.955	273.290
WM TANK	+40.220215201	-79.552106762		
WTVENT	+40.244605614	-79.513176210		

PA South Zone State Plane Coordinates – NAD 1983 1992 US Survey FT.

Station name	Northing	Easting
00028A	400435.8671	1363758.7464
00028AA	401250.9826	1365365.0372
00028AB	400630.4205	1366355.6389
00028AC	404140.6270	1366287.3509
00028AD	404889.6413	1368541.9767
00028AE	409764.3658	1366772.2050
00028AF	409795.3293	1368015.2149
00028B	399899.6742	1365731.1916
00028C	401906.1656	1365877.3226
00028D	403247.7565	1364163.4854
00028E	402243.6098	1367852.6966
00028F	403996.6683	1368019.8055
00028G	404240.0074	1365819.2443
00028H	405483.7083	1367826.4446
00028I	407029.4927	1365956.2673
00028J	407110.9515	1367954.3552
00028K	410290.3575	1370281.2937
00028L	407729.5415	1370101.9473
00028M	405887.3716	1370099.3217
00028N	403579.2145	1369793.5618
00028O	403280.1045	1371530.8526
00028P	404961.9814	1371753.0953
00028Q	407240.3111	1371638.5860
00028R	410166.4742	1371794.7792
00028S	407070.5372	1373563.6566
00028T	405642.7753	1373079.2645
00028U	403476.8357	1373466.9012
00028V	409793.6830	1368013.1175
105H1	402270.8440	1367849.3081
105H2	402276.0166	1367991.2481
105H3	402221.9311	1367610.2164
105V1	402265.2289	1368001.5762
105V2	402207.6864	1367612.1042
108H	405484.5847	1367825.3367
110	407153.4114	1367922.4950
110V1	407131.1362	1367927.0402
110V2	407133.2162	1367940.6278
113H	405886.4854	1370098.7587
HAZELMICRO	400276.8992	1360937.5267
KX1251	401798.7082	1366038.2153
KX2396	392829.9515	1380731.1816
KX2402	394578.9434	1358846.7356
MV226	409424.5558	1367594.8365
PIT1	449561.1540	1427433.8999
TBM	404176.7185	1366185.6464
WM TANK	384093.1350	1363198.9126
WTVENT	400244.2362	1381338.3080

Geographic Coordinates – NAD 1927

Station name	DD.MMSSssssss	DD.MMSSssssss
00028A	+40.244349603	-79.551986513
00028AA	+40.245193860	-79.545936409
00028AB	+40.244604788	-79.544636468
00028AC	+40.252070927	-79.544835873
00028AD	+40.252865366	-79.541945187
00028AE	+40.261638437	-79.544387157
00028AF	+40.261699067	-79.542781066
00028B	+40.243867751	-79.545420358
00028C	+40.245853542	-79.545295081
00028D	+40.251137345	-79.551552780
00028E	+40.250234673	-79.542752613
00028F	+40.251970585	-79.542591969
00028G	+40.252157768	-79.545444089
00028H	+40.253434984	-79.542888866
00028I	+40.254916860	-79.545355361
00028J	+40.255045651	-79.542774919
00028K	+40.262242708	-79.535866797
00028L	+40.255708526	-79.540018090
00028M	+40.253888547	-79.535963495
00028N	+40.251600920	-79.540286074
00028O	+40.251347169	-79.534031107
00028P	+40.253014061	-79.533796623
00028Q	+40.255262116	-79.534016143
00028R	+40.262156675	-79.533906073
00028S	+40.255140513	-79.531522168
00028T	+40.253718409	-79.532103665
00028U	+40.251587902	-79.531534782
00028V	+40.261697382	-79.542783695
105H1	+40.250261496	-79.542757856
105H2	+40.250270033	-79.542574556
105H3	+40.250207401	-79.543065327
105V1	+40.250259625	-79.542560864
105V2	+40.250193374	-79.543062438
108H	+40.253435823	-79.542890323
110	+40.255086827	-79.542817443
110V1	+40.255064931	-79.542810862
110V2	+40.255067315	-79.542793365
113H	+40.253887658	-79.535964195
HAZELMICRO	+40.244123813	-79.555627636
KX1251	+40.245751293	-79.545083789
KX2396	+40.233242234	-79.513816333
KX2402	+40.234443553	-79.562146844
MV226	+40.261322620	-79.543312845
PIT1	+40.330349718	-79.415088725
TBM	+40.252104121	-79.544968476
WM TANK	+40.220190200	-79.552189000
WTVENT	+40.244581371	-79.513261026

PA South Zone State Plane Coordinates – NAD 1927 US Survey FT.

Station name	Northing	Easting
00028A	400405.9895	1395177.4664
00028AA	401221.1024	1396783.7489
00028AB	400600.5429	1397774.3460
00028AC	404110.7278	1397706.0624
00028AD	404859.7368	1399960.6822
00028AE	409734.4341	1398190.9246
00028AF	409765.3976	1399433.9228
00028B	399869.8009	1397149.8958
00028C	401876.2845	1397296.0189
00028D	403217.8625	1395582.2064
00028E	402213.7231	1399271.3860
00028F	403966.7708	1399438.5104
00028G	404210.1046	1397237.9665
00028H	405453.7960	1399245.1626
00028I	406999.5715	1397374.9981
00028J	407081.0273	1399373.0791
00028K	410260.4098	1401700.0258
00028L	407699.6170	1401520.6469
00028M	405857.4556	1401518.0256
00028N	403549.3152	1401212.2607
00028O	403250.2053	1402949.5450
00028P	404932.0703	1403171.7890
00028Q	407210.3798	1403057.3036
00028R	410136.5242	1403213.5064
00028S	407040.6104	1404982.3575
00028T	405612.8600	1404497.9573
00028U	403446.9322	1404885.5930
00028V	409763.7428	1399431.8480
105H1	402240.9570	1399267.9976
105H2	402246.1298	1399409.9415
105H3	402192.0443	1399028.9147
105V1	402235.3425	1399420.2699
105V2	402177.7999	1399030.8025
108H	405454.6723	1399244.0544
110	407123.4853	1399341.2182
110V1	407101.2107	1399345.7638
110V2	407103.2917	1399359.3514
113H	405856.5695	1401517.4626
HAZELMICRO	400247.0088	1392356.1915
KX1251	401768.8424	1397456.8696
KX2396	392800.1691	1412149.6687
KX2402	394549.0396	1390265.6255
MV226	409394.6244	1399013.5473
PIT1	449531.0097	1458852.3085
TBM	404146.8199	1397604.3628
WM TANK	384062.8217	1394618.6122
WTVENT	400214.3974	1412756.5621