

APPENDIX B

NETWORK ADJUSTMENT REPORT

2003

GEODETIC CONTROL RESTORATION

of

JEFFERSON COUNTY, KENTUCKY

JUNE 2003

Fuller, Mossbarger, Scott & May  
1901 Nelson Miller Parkway  
Louisville, Kentucky 40223-2177



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401 West Main Street, Suite 600  
Louisville, Kentucky 40202



# Network Adjustment Report

**Project : Jtl-0260**

<b>User name</b>	Default	<b>Date &amp; Time</b>	11:27:57 AM 2/24/03
<b>Coordinate System</b>	US State Plane 1983	<b>Zone</b>	Kentucky North 1601
<b>Project Datum</b>	NAD 1983 (Conus)		
<b>Vertical Datum</b>		<b>Geoid Model</b>	GEOID99 (Conus)
<b>Coordinate Units</b>	US survey feet		
<b>Distance Units</b>	US survey feet		
<b>Height Units</b>	US survey feet		

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## Adjustment Style Settings - 95% Confidence Limits

### Residual Tolerances

**To End Iterations** : 0.000033sft  
**Final Convergence Cutoff** : 0.016404sft

### Covariance Display

#### Horizontal

**Propagated Linear Error [E]** : U.S.  
**Constant Term [C]** : 0.00000000sft  
**Scale on Linear Error [S]** : 1.96

#### Three-Dimensional

**Propagated Linear Error [E]** : U.S.  
**Constant Term [C]** : 0.00000000sft  
**Scale on Linear Error [S]** : 1.96

**Elevation Errors were used in the calculations.**

### Adjustment Controls

**Compute Correlations for Geoid** : False  
**Horizontal and Vertical adjustment performed**

## Set-up Errors

### GPS

**Error in Height of Antenna** : 0.000sft

**Centering Error** : 0.000sft

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## Statistical Summary

### Successful Adjustment in 1 iteration(s)

**Network Reference Factor** : 0.99

**Chi Square Test ( $\alpha=95\%$ )** : PASS

**Degrees of Freedom** : 34.00

### GPS Observation Statistics

**Reference Factor** : 1.00

**Redundancy Number (r)** : 33.01

### Individual GPS Observation Statistics

Observation ID	Reference Factor	Redundancy Number
B1	1.26	0.40
B2	0.78	1.86
B3	0.87	1.19
B4	0.90	1.93
B5	0.42	1.32
B6	0.94	2.21
B7	1.39	0.85
B8	1.27	1.93
B9	0.54	2.18
B10	0.07	1.80

B11	2.29	2.23
B12	0.83	1.75
B13	0.47	1.07
B14	0.59	2.23
B15	1.27	2.08
B16	0.93	1.80
B18	0.41	1.61
B19	0.69	2.21
B20	0.67	2.35

## Geoid Model Statistics

Reference Factor : 0.07

Redundancy Number (r) : 0.99

## Weighting Strategies

### GPS Observations

User-defined Scalar Applied to All Observations

Scalar : 2.79

### Geoid Observations

Default Scalar Applied to All Observations

Scalar : 1.00

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## Adjusted Coordinates

Adjustment performed in **NAD 1983 (Conus)**

Number of Points : 9

Number of Constrained Points : 4

Horizontal Only : 2

Elevation Only : 2

## Adjusted Grid Coordinates

Errors are reported using 1.96  $\sigma$ .

Point Name	Northing	N error	Easting	E error	Elevation	e error	Fix
BU07-01	230607.236sft	0.015sft	1172558.055sft	0.015sft	447.447sft	0.000sft	e
B008-01	243906.716sft	0.012sft	1173498.376sft	0.012sft	445.123sft	0.814sft	
SOUTHBASE	240989.436sft	0.000sft	1185268.161sft	0.000sft	470.229sft	0.814sft	N E
GPS86-37	234960.700sft	0.016sft	1255897.533sft	0.011sft	662.476sft	0.814sft	
GPS86-34	245182.151sft	0.000sft	1277152.288sft	0.000sft	692.777sft	0.815sft	N E
AN40-01	296060.479sft	0.018sft	1271616.581sft	0.018sft	703.972sft	0.815sft	
GOSHEN RM1	333339.957sft	0.027sft	1263875.154sft	0.030sft	714.802sft	0.000sft	e
STA008-2001	272736.425sft	0.013sft	1243753.057sft	0.012sft	512.961sft	0.814sft	
GPS86-43	278083.400sft	0.017sft	1206849.462sft	0.017sft	460.496sft	0.814sft	

## Adjusted Geodetic Coordinates

Errors are reported using 1.96  $\sigma$ .

Point Name	Latitude	N error	Longitude	E error	Height	h error	Fix
BU07-01	38°07'18.88686"N	0.015sft	85°52'35.03710"W	0.015sft	338.774sft	0.471sft	e
B008-01	38°09'30.50530"N	0.012sft	85°52'26.20607"W	0.012sft	336.354sft	0.471sft	
SOUTHBASE	38°09'03.69569"N	0.000sft	85°49'58.24028"W	0.000sft	361.373sft	0.471sft	Lat Long
GPS86-37	38°08'15.17133"N	0.016sft	85°35'13.03466"W	0.011sft	553.181sft	0.472sft	
GPS86-34	38°09'59.17370"N	0.000sft	85°30'48.77782"W	0.000sft	583.336sft	0.472sft	Lat Long
AN40-01	38°18'21.33287"N	0.018sft	85°32'06.97643"W	0.018sft	594.551sft	0.472sft	
GOSHEN RM1	38°24'28.74233"N	0.027sft	85°33'50.76008"W	0.030sft	605.052sft	0.471sft	e
STA008-2001	38°14'26.79792"N	0.013sft	85°37'52.11474"W	0.012sft	403.636sft	0.472sft	

GPS86-43	38°15'13.92433"N	0.017sft	85°45'35.71471"W	0.017sft	351.189sft	0.472sft	
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## Coordinate Deltas

Point Name	$\Delta$ Northing	$\Delta$ Easting	$\Delta$ Elevation	$\Delta$ Height	$\Delta$ Geoid Separation
BU07-01	0.000sft	0.000sft	0.000sft	0.017sft	-0.017sft
B008-01	0.000sft	0.000sft	0.017sft	0.017sft	0.000sft
SOUTHBASE	0.000sft	0.000sft	0.017sft	0.017sft	0.000sft
GPS86-37	0.000sft	0.000sft	0.017sft	0.017sft	0.000sft
GPS86-34	0.000sft	0.000sft	0.017sft	0.017sft	0.000sft
AN40-01	0.000sft	0.000sft	0.017sft	0.017sft	0.000sft
GOSHEN RM1	0.000sft	0.000sft	0.000sft	0.017sft	-0.017sft
STA008-2001	0.000sft	0.000sft	0.017sft	0.017sft	0.000sft
GPS86-43	0.000sft	0.000sft	0.017sft	0.017sft	0.000sft

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## Control Coordinate Comparisons

Values shown are control coord minus adjusted coord.

Point Name	$\Delta$ Northing	$\Delta$ Easting	$\Delta$ Elevation	$\Delta$ Height
BU07-01	N/A	N/A	N/A	N/A
SOUTHBASE	N/A	N/A	-0.030sft	N/A
GPS86-34	N/A	N/A	N/A	N/A
GOSHEN RM1	N/A	N/A	N/A	N/A

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## Adjusted Observations

Adjustment performed in **NAD 1983 (Conus)**

# GPS Observations

GPS Transformation Group: <GPS Default>

**Azimuth Rotation** : 0°00'00.0291" (1.96σ) : 0°00'00.0440"

**Network Scale** : 0.99999989 (1.96σ) : 0.00000017

**Number of Observations** : 19

**Number of Outliers** : 0

**Observation Adjustment (Critical Tau = 3.16). Any outliers are in red.**

Obs. ID	From Pt.	To Pt.		Observation	A-posteriori Error (1.96σ)	Residual	Stand. Residual
B8	GPS86-43	B008-01	<b>Az.</b>	223°21'36.2811"	0°00'00.0772"	-0°00'00.0968"	-2.27
			<b>ΔHt.</b>	-14.836sft	0.048sft	0.015sft	0.38
			<b>Dist.</b>	47754.220sft	0.019sft	-0.009sft	-0.67
B1	BU07-01	B008-01	<b>Az.</b>	3°01'57.2451"	0°00'00.1697"	0°00'00.0121"	0.36
			<b>ΔHt.</b>	-2.420sft	0.028sft	0.003sft	0.58
			<b>Dist.</b>	13332.968sft	0.010sft	0.004sft	1.89
B7	SOUTHBASE	B008-01	<b>Az.</b>	282°56'10.1996"	0°00'00.1951"	-0°00'00.0625"	-1.00
			<b>ΔHt.</b>	-25.019sft	0.031sft	-0.011sft	-1.06
			<b>Dist.</b>	12126.217sft	0.012sft	0.007sft	1.79
B15	SOUTHBASE	BU07-01	<b>Az.</b>	229°46'18.2720"	0°00'00.1899"	0°00'00.1487"	1.01
			<b>ΔHt.</b>	-22.599sft	0.038sft	0.018sft	0.61
			<b>Dist.</b>	16411.834sft	0.014sft	-0.017sft	-1.64
B4	GPS86-34	AN40-01	<b>Az.</b>	353°00'15.9800"	0°00'00.0570"	-0°00'00.0613"	-1.41
			<b>ΔHt.</b>	11.215sft	0.039sft	-0.012sft	-0.40
			<b>Dist.</b>	51180.101sft	0.016sft	0.005sft	0.50
B3	GPS86-34	GPS86-37	<b>Az.</b>	243°31'51.0708"	0°00'00.1616"	-0°00'00.0381"	-0.42

			<b>ΔHt.</b>	-30.155sft	0.033sft	0.014sft	1.31
			<b>Dist.</b>	23585.334sft	0.012sft	0.006sft	1.23
B16	SOUTHBASE	STA008-2001	<b>Az.</b>	60°31'17.7903"	0°00'00.0431"	-0°00'00.0132"	-0.40
			<b>ΔHt.</b>	42.263sft	0.032sft	-0.029sft	-1.13
			<b>Dist.</b>	66547.649sft	0.012sft	0.009sft	1.27
B12	STA008-2001	GPS86-34	<b>Az.</b>	128°39'48.9028"	0°00'00.0665"	-0°00'00.0214"	-0.52
			<b>ΔHt.</b>	179.701sft	0.037sft	0.018sft	0.74
			<b>Dist.</b>	43299.523sft	0.015sft	0.010sft	1.23
B19	GPS86-43	AN40-01	<b>Az.</b>	73°32'53.7025"	0°00'00.0551"	-0°00'00.0043"	-0.09
			<b>ΔHt.</b>	243.362sft	0.050sft	0.019sft	0.30
			<b>Dist.</b>	67217.917sft	0.016sft	-0.015sft	-1.18
B6	SOUTHBASE	STA008-2001	<b>Az.</b>	60°31'17.7903"	0°00'00.0431"	0°00'00.0193"	0.53
			<b>ΔHt.</b>	42.263sft	0.032sft	0.030sft	1.04
			<b>Dist.</b>	66547.649sft	0.012sft	-0.009sft	-0.53
B2	SOUTHBASE	GPS86-37	<b>Az.</b>	93°53'40.9288"	0°00'00.0551"	-0°00'00.0312"	-0.79
			<b>ΔHt.</b>	191.809sft	0.041sft	-0.030sft	-0.94
			<b>Dist.</b>	70887.764sft	0.014sft	0.005sft	0.67
B20	SOUTHBASE	GPS86-43	<b>Az.</b>	29°12'23.0222"	0°00'00.0776"	0°00'00.0589"	0.64
			<b>ΔHt.</b>	-10.183sft	0.042sft	-0.018sft	-0.33
			<b>Dist.</b>	42916.365sft	0.017sft	-0.025sft	-0.91
B14	STA008-2001	GPS86-43	<b>Az.</b>	277°23'05.5828"	0°00'00.0954"	-0°00'00.1186"	-0.85
			<b>ΔHt.</b>	-52.446sft	0.040sft	-0.037sft	-0.83
			<b>Dist.</b>	37290.083sft	0.015sft	-0.005sft	-0.37
B13	GOSHEN RM1	GPS86-43	<b>Az.</b>	225°05'06.3144"	0°00'00.0536"	-0°00'00.0063"	-0.35
			<b>ΔHt.</b>	-253.863sft	0.074sft	-0.003sft	-0.11
			<b>Dist.</b>	79408.150sft	0.019sft	-0.006sft	-0.74
B5	GOSHEN RM1	AN40-01	<b>Az.</b>	167°27'04.6877"	0°00'00.1041"	0°00'00.0322"	0.74
			<b>ΔHt.</b>	-10.500sft	0.076sft	0.002sft	0.04
			<b>Dist.</b>	38076.149sft	0.022sft	0.001sft	0.05

B9	GPS86-43	GPS86-37	<b>Az.</b>	130°22'57.8267"	0°00'00.0567"	-0°00'00.0371"	-0.72
			<b>ΔHt.</b>	201.992sft	0.044sft	-0.013sft	-0.42
			<b>Dist.</b>	65310.845sft	0.020sft	-0.015sft	-0.73
B18	STA008-2001	AN40-01	<b>Az.</b>	49°12'31.9822"	0°00'00.0874"	-0°00'00.0144"	-0.32
			<b>ΔHt.</b>	190.916sft	0.041sft	0.006sft	0.28
			<b>Dist.</b>	36338.301sft	0.015sft	-0.005sft	-0.58
B10	STA008-2001	GPS86-37	<b>Az.</b>	161°19'08.0482"	0°00'00.0625"	0°00'00.0016"	0.04
			<b>ΔHt.</b>	149.546sft	0.036sft	-0.002sft	-0.08
			<b>Dist.</b>	39680.920sft	0.017sft	-0.001sft	-0.09

## Geoid Observations

Number of Observations : 9

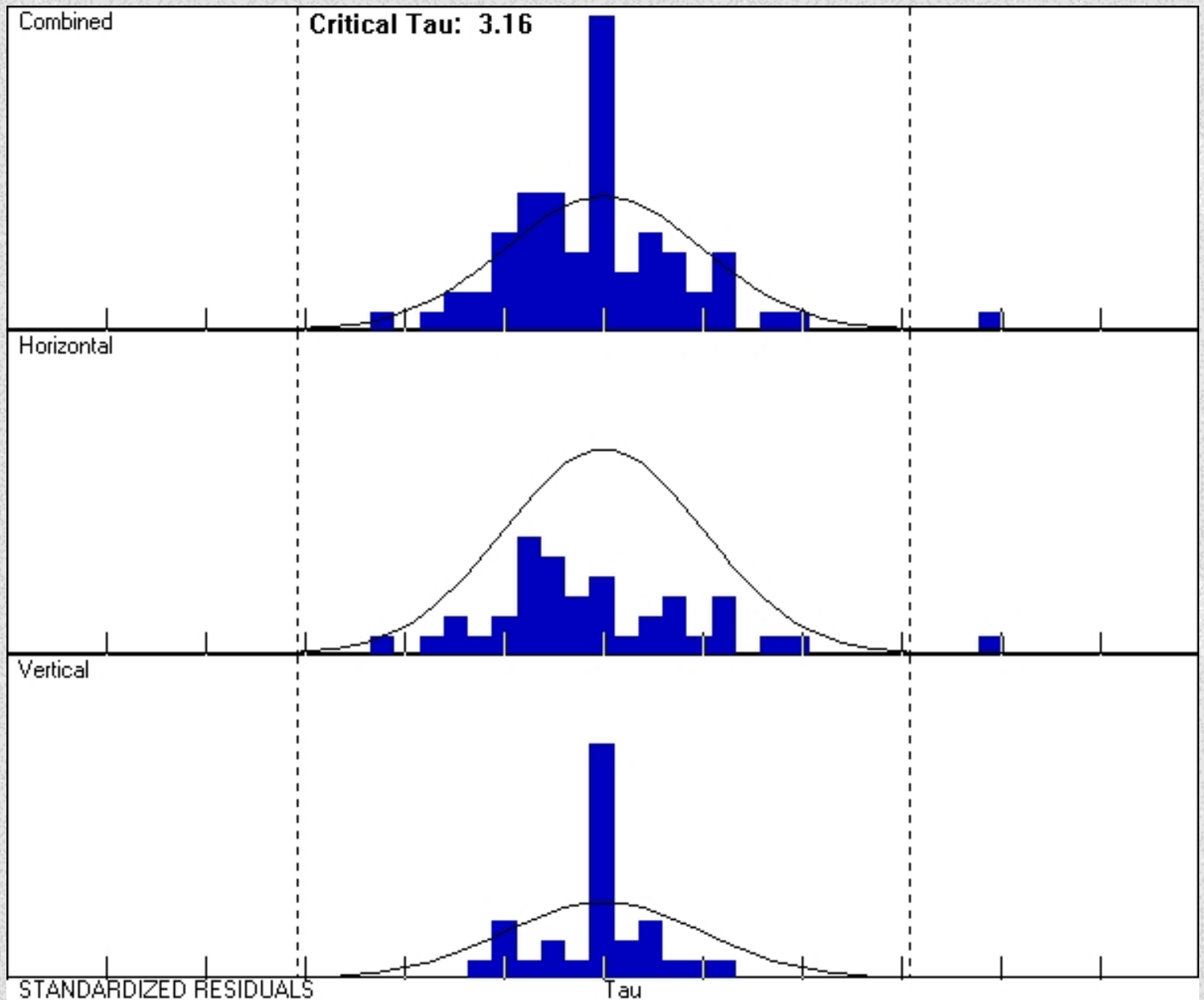
Number of Outliers : 0

Observation Adjustment (Critical Tau = 3.16). Any outliers are in **red**.

Observation ID	Point Name	Separation	A-posteriori Error (1.96σ)	Residual	Standardized Residual
G1	BU07-01	-108.673sft	0.471sft	-0.017sft	-0.07
G7	GOSHEN RM1	-109.750sft	0.471sft	0.017sft	0.07
G5	GPS86-34	-109.440sft	0.664sft	0.000sft	0.00
G2	B008-01	-108.770sft	0.664sft	0.000sft	0.00
G3	SOUTHBASE	-108.856sft	0.664sft	0.000sft	0.00
G4	GPS86-37	-109.295sft	0.664sft	0.000sft	0.00
G6	AN40-01	-109.421sft	0.664sft	0.000sft	0.00
G8	STA008-2001	-109.325sft	0.664sft	0.000sft	0.00
G9	GPS86-43	-109.307sft	0.664sft	0.000sft	0.00

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## Histograms of Standardized Residuals



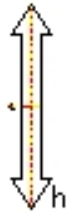
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## Point Error Ellipses

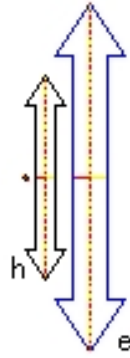
BU07-01

B008-01

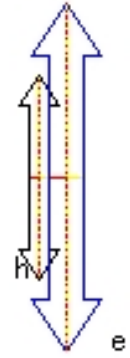
SOUTHBASE



-36°



-39°



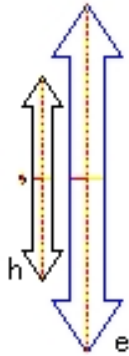
0°

Tick Size: 0.0100sft Horizontal Bivariate Scalar: 2.45  $\sigma$  Vertical Univariate Scalar: 1.96  $\sigma$

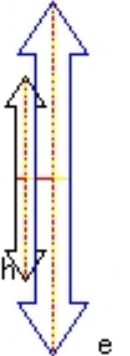
**GPS86-37**

**GPS86-34**

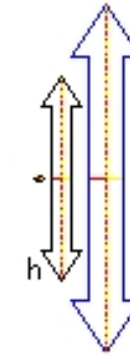
**AN40-01**



-74°



0°



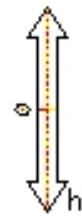
-36°

Tick Size: 0.0100sft Horizontal Bivariate Scalar: 2.45  $\sigma$  Vertical Univariate Scalar: 1.96  $\sigma$

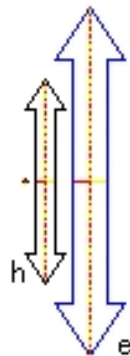
**GOSHEN RM1**

**STA008-2001**

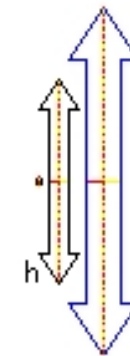
**GPS86-43**



-27°



-59°



82°

Tick Size: 0.0100sft Horizontal Bivariate Scalar: 2.45  $\sigma$  Vertical Univariate Scalar: 1.96  $\sigma$

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## Covariant Terms

Adjustment performed in **NAD 1983 (Conus)**

From Point	To Point		Components	A-posteriori Error (1.96 $\sigma$ )	Horiz. Precision (Ratio)	3D Precision (Ratio)
BU07-01	B008-01	<b>Az.</b>	3°01'57.2160"	0°00'00.1751"	1:1255202	1:1255202
		<b><math>\Delta</math>Ht.</b>	-2.420sft	0.028sft		
		<b><math>\Delta</math>Elev.</b>	-2.323sft	0.814sft		
		<b>Dist.</b>	13332.970sft	0.011sft		
BU07-01	SOUTHBASE	<b>Az.</b>	49°44'41.4151"	0°00'00.1974"	1:1157968	1:1157968
		<b><math>\Delta</math>Ht.</b>	22.599sft	0.038sft		
		<b><math>\Delta</math>Elev.</b>	22.783sft	0.814sft		
		<b>Dist.</b>	16411.836sft	0.014sft		
B008-01	SOUTHBASE	<b>Az.</b>	102°54'38.7590"	0°00'00.2041"	1:967566	1:967566
		<b><math>\Delta</math>Ht.</b>	25.019sft	0.031sft		
		<b><math>\Delta</math>Elev.</b>	25.106sft	1.151sft		
		<b>Dist.</b>	12126.218sft	0.013sft		
B008-01	GPS86-43	<b>Az.</b>	43°17'22.3658"	0°00'00.0800"	1:2579663	1:2579663
		<b><math>\Delta</math>Ht.</b>	14.836sft	0.048sft		
		<b><math>\Delta</math>Elev.</b>	15.373sft	1.151sft		
		<b>Dist.</b>	47754.225sft	0.019sft		
SOUTHBASE	GPS86-37	<b>Az.</b>	93°53'40.8997"	0°00'00.0473"	1:6060762	1:6060762
		<b><math>\Delta</math>Ht.</b>	191.809sft	0.041sft		
		<b><math>\Delta</math>Elev.</b>	192.247sft	1.152sft		
		<b>Dist.</b>	70887.772sft	0.012sft		
SOUTHBASE	STA008-2001	<b>Az.</b>	60°31'17.7612"	0°00'00.0391"	1:5383879	1:5383879
		<b><math>\Delta</math>Ht.</b>	42.263sft	0.032sft		
		<b><math>\Delta</math>Elev.</b>	42.732sft	1.151sft		
		<b>Dist.</b>	66547.656sft	0.012sft		
SOUTHBASE	GPS86-43	<b>Az.</b>	29°12'22.9931"	0°00'00.0808"	1:2473778	1:2473778
		<b><math>\Delta</math>Ht.</b>	-10.183sft	0.042sft		
		<b><math>\Delta</math>Elev.</b>	-9.733sft	1.151sft		
		<b>Dist.</b>	42916.370sft	0.017sft		

GPS86-37	GPS86-34	<b>Az.</b>	63°29'07.7971"	0°00'00.1458"	1:2129216	1:2129216
		<b>ΔHt.</b>	30.155sft	0.033sft		
		<b>ΔElev.</b>	30.301sft	1.152sft		
		<b>Dist.</b>	23585.337sft	0.011sft		
GPS86-37	STA008-2001	<b>Az.</b>	341°20'46.3719"	0°00'00.0743"	1:2155338	1:2155338
		<b>ΔHt.</b>	-149.546sft	0.036sft		
		<b>ΔElev.</b>	-149.515sft	1.152sft		
		<b>Dist.</b>	39680.924sft	0.018sft		
GPS86-37	GPS86-43	<b>Az.</b>	310°29'22.8319"	0°00'00.0676"	1:2978172	1:2978172
		<b>ΔHt.</b>	-201.992sft	0.044sft		
		<b>ΔElev.</b>	-201.980sft	1.152sft		
		<b>Dist.</b>	65310.852sft	0.022sft		
GPS86-34	AN40-01	<b>Az.</b>	353°00'15.9509"	0°00'00.0730"	1:2845935	1:2845935
		<b>ΔHt.</b>	11.215sft	0.039sft		
		<b>ΔElev.</b>	11.195sft	1.152sft		
		<b>Dist.</b>	51180.106sft	0.018sft		
GPS86-34	STA008-2001	<b>Az.</b>	308°44'10.6899"	0°00'00.0590"	1:3438908	1:3438908
		<b>ΔHt.</b>	-179.701sft	0.037sft		
		<b>ΔElev.</b>	-179.816sft	1.152sft		
		<b>Dist.</b>	43299.528sft	0.013sft		
AN40-01	GOSHEN RM1	<b>Az.</b>	347°28'09.0625"	0°00'00.1133"	1:1705333	1:1705333
		<b>ΔHt.</b>	10.501sft	0.076sft		
		<b>ΔElev.</b>	10.830sft	0.815sft		
		<b>Dist.</b>	38076.153sft	0.022sft		
AN40-01	STA008-2001	<b>Az.</b>	229°16'05.7366"	0°00'00.0907"	1:2500890	1:2500890
		<b>ΔHt.</b>	-190.916sft	0.041sft		
		<b>ΔElev.</b>	-191.011sft	1.152sft		
		<b>Dist.</b>	36338.305sft	0.015sft		
AN40-01	GPS86-43	<b>Az.</b>	253°41'14.6901"	0°00'00.0600"	1:3935871	1:3935871
		<b>ΔHt.</b>	-243.362sft	0.050sft		
		<b>ΔElev.</b>	-243.476sft	1.152sft		

		<b>Dist.</b>	67217.924sft	0.017sft		
GOSHEN RM1	GPS86-43	<b>Az.</b>	225°05'06.2853"	0°00'00.0667"	1:3577293	1:3577293
		<b>ΔHt.</b>	-253.863sft	0.074sft		
		<b>ΔElev.</b>	-254.306sft	0.814sft		
		<b>Dist.</b>	79408.158sft	0.022sft		
STA008-2001	GPS86-43	<b>Az.</b>	277°23'05.5537"	0°00'00.1010"	1:2284966	1:2284966
		<b>ΔHt.</b>	-52.447sft	0.040sft		
		<b>ΔElev.</b>	-52.465sft	1.151sft		
		<b>Dist.</b>	37290.087sft	0.016sft		

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