

LIMESTONE COUNTY

GPS SURVEY REPORT

MAY 2005



PREPARED BY:

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REPORT ON THE 2005 GPS SURVEY OF LIMESTONE COUNTY, ALABAMA

INTRODUCTION

The primary purpose of this project was to establish 3 dimensional (XYZ) coordinates on 73 new concrete survey monuments and back sites to 24 of the 73 monuments. The back site identification is an iron with cap, railroad spike or a cotton spindle. A white aerial photography panel shaped in a chevron fashion was placed on each of the 73 survey monuments, with the inside vertex of the panel aligned flush over the surveyed point of the monument. Back site points were not paneled. In addition to the 73 concrete monuments, there were 8 iron with cap points, 4 ALDOT concrete survey monuments and one NGS vertical benchmark paneled in order to complete the required ground control for the aerial photography. One Photo-id point was established at the west entrance to the Limestone County Courthouse.

Since the 4 ALDOT existing survey monuments were horizontal only, orthometric heights were determined for the points by GPS observations. In total, there were 86 paneled, one PID point and 24 back sites that required 3 dimensional coordinates for mapping and coordinating the 73 new survey monuments.

The methods and principles as outlined in the "Geometric Geodetic Standards and Specifications for Using GPS Relative Positioning Techniques," Version 5.0, August 1, 1989 and published by the Federal Geodetic Control Committee (FGCC), were used as the guide for all GPS Surveying.

The project progression encompassed 6 phases which will be discussed in the subsequent paragraphs.

I. PLANNING AND RESEARCH

Good quality office planning and research is necessary for any type of field survey and especially, GPS. This is a survey that requires several field personnel working in a coordinated fashion to obtain GPS observations from the orbiting GPS satellites. This means that all tools necessary to carry a project to a successful and expedient conclusion must be available to the GPS survey crew.

This phase of the project began with the acquisition of suitable maps of Limestone and

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surrounding counties, with special interest being placed on Limestone County roads, trails, rivers, creeks, etc. The GPS receiver operators must travel between pre-determined sessions of GPS observations in a direct, efficient manner. Each operator had a map showing where the 111 survey points in Limestone County are located.

A second endeavor of office planning consisted of locating data that would be not only used for recovery and identification of existing survey monumentation, but would also provide the known coordinates of the fixed stations. Some horizontal control points have latitude and longitude values only; vertical control points have elevation values only.

By observing from more known fixed control points than is required, the quality assurance of the GPS Survey can be realized. This data was acquired from three sources:

1. The Survey Monument Database of the *NATIONAL GEODETIC SURVEY*,
2. The Tennessee Valley Authority (TVA) Database in Chattanooga, Tennessee.
3. File evidence of a similar survey of Lawrence County, Alabama.

II. CONSTRUCTION OF CONCRETE SURVEY MONUMENTS AND AERIAL PHOTOGRAPHY PANELS

This phase of the field effort required careful reconnaissance of each concrete survey monument site prior to setting the proposed monumentation and panel. Considerations for accepting or refining the proposed sites were:

1. Proximity to points chosen by the County Project Manager and the Mapping Photogrammetrist.
2. Sufficiently open sky horizon to allow GPS observations and photographic visibility.
3. Flat area large enough to accommodate panel.
4. Panels should be placed on public property, if possible. When conditions warrant the setting of panels on private property, the landowner's permission should be obtained.
5. Vehicular access to each site should be available if possible.
6. Monument and panel should be located so as to not damage existing utilities nor interfere with the free flow of pedestrian or vehicular traffic.
7. Sites should be chosen so as to prevent safety hazards to work personnel and passersby.

The survey monument is "poured in place" concrete, 8 inches in diameter, 30 inches deep with an embedded rebar and a 3.25 inch brass disk stamped with the point name, survey type and the year 2005. There are 73 of these survey monuments. As mentioned in the introduction, there are 24 back sites to certain ones of the 73 concrete monuments (See point listing). The back sites, or better, the back azimuths are identified as 10 RR spikes, 10 Iron Pins with Caps and 2 Iron Pins (See point sketches).

As mentioned in the introduction, the panels set on this project were "chevron" shaped, with the survey monument at the inside vertex. All panels were constructed of white vinyl, with legs of 18 feet and a width of 18 inches.

All survey points were identified, monumented, paneled and descriptions made during the months of January and February of 2005.

III. RECONNAISSANCE OF EXISTING SURVEY CONTROL AND QUALITY ASSURANCE MONUMENTATION

The existing known survey control monuments were recovered for the Limestone Project on 17 and 18 March 2005. Sufficient horizontal (Lat./Long.) points of the ALDOT GPS NETWORK were recovered. The recovery of existing vertical control monuments was a different situation. Limestone County is lacking in vertical control, especially in the northern and western party of the County.

Primary considerations for choosing points to be used for control were:

1. Sufficient open sky horizon to permit good observations by GPS receivers.
2. Even distribution of control throughout the project area.
3. Ease of access in terms of property ownership and topography.

A Level Line was run by NGS during 1982 and 1983 from South Pittsburgh, TN along US-72 to Huntsville, AL; then along Alternate US-72 from Huntsville through Decatur and Lawrence County, AL to US-43 in West Alabama. The portion of the level line on Alternate US-72 from Huntsville to I-65 was taken up by the construction of I-565, thereby destroying the benchmarks of elevation placed by NGS. More than adequate elevation points were found along Alternate US-72 from I-65 through Decatur and Lawrence County. Five elevation points along this line were transferred across the Tennessee River to aid in the vertical control of Limestone County. The transfer was accomplished using GPS and occupying points for more than 2 hours. Four vertical control points were found at wide intervals along the railroad from Decatur to Athens, AL. Two TVA vertical benchmarks were found along the Tennessee River (See listing of all points which shows all existing control used). Three USGS Traverse points were recovered along the Alabama and Tennessee line, but were void of elevation.

There were a total of 41 ALDOT horizontal control points recovered in Limestone and adjacent counties, of which 21 were used to control the new and paneled horizontal coordinates of the project. Three of the points also had elevations (See final points listing).

As discussed previously, elevations were scarce throughout the County; however, 10 points were located and used, in a manner described earlier, to place good Third Order vertical accuracies on all new points.

CORS (Continuously Operating Reference Station) station "GTAC" located at the U.S. Space and Rocket Center in Huntsville, AL served as a master quality control check station for the entire project. GPS data from "GTAC" was downloaded daily and used to confirm the accuracy of the coordinates derived from the conventional static GPS work effort.

The letter "A" following a station name (in project point list) indicates that the elevation of the survey point was derived by leveling from the "Bluebook" station (point found in NGS Database) to the survey point. Four points, because of different obstructions for GPS observations had their elevations established by this method.

IV. GPS OBSERVATIONS

Seven LEICA GPS units were used to record all GPS ground observations at each new and existing point within the Limestone County Network. The seven units were deployed so that multiple survey baselines would be available into each point and the points interconnected in a network. This method of field observations will provide many "trivial" and "non-trivial" baselines that will have to be dealt with in the "off-line" data processing. One hour minimum was planned for each session observation time. However, in reality, each station observation consisted of an average time of 1.25 hours. Because of point density over the entire county, no intermediate survey points were needed to cut down on excessive long baselines between points.

GPS observations commenced on March 19 (Day 078) and ended on March 25 (Day 084). During this time, there were 34 sessions and 238 different station occupations for GPS observations.

V. GPS DATA PROCESSING

Raw data gathered by field observations was processed using Version 2.5 of LEICA "SKI-PRO" software for both, baseline distances and the network adjustment. The project network starts to take form as the baselines (trivial and non-trivial) are processed using the first day's observations from each station occupied. The same routine of processing is used each day, baseline distances computed, then added to the network until all new stations and existing control points have been connected into a closed network. Not all baselines were added to the growing network; only those that displayed, for each distance between points, an ambiguity resolution and low standard deviations in all three (XYZ) coordinate parameters.

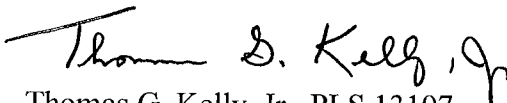
The network is then subjected to a minimally (one fixed control of position and ellipsoid height) constrained adjustment to determine the integrity of the trivial and non-trivial baselines when connected throughout the entire network. Baselines that do not meet the criteria for accuracy required are rejected and the network is re-computed.

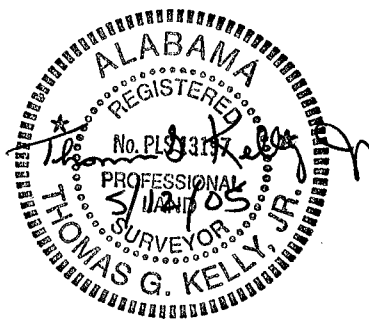
Once the rejected baselines have been eliminated, the network is then subjected to a constrained network adjustment (two or more fixed control points). The same process as used in the minimally constrained effort is used in the constrained adjustment to eliminate baselines that influence the overall accuracy of the network. As the existing fixed ground survey points are added as control for the network, the baselines have to move in X, Y and Z fashion to accommodate the fixed characteristics of the control added. If each existing control point in the network is not accurate, within a certain required accuracy limit, the network will become distorted and, thereby, give erroneous X, Y and Z coordinates of all new stations.

This situation is alleviated by using more existing control in the network than is required for fixing the coordinates of the new points. In other words, the additional extra existing points are used to quality control those points that control the network accuracy. All of the aforementioned methods of data processing and analysis were used in order to make the statement that the overall project accuracy meets and exceeds a First Order Survey in the Position category and a Third Order Survey in Vertical. Baseline accuracies exceeded 1:100,000.

VI. DATA REPORTING

All final network adjusted Horizontal Coordinates are on the North American Datum 1983 (NAD83) and the Alabama West, Zone 0102 State Plane Systems. Elevation values are on the North American Vertical Datum 1988 (NAVD88). The Reference Ellipsoid is GRS 1980. Geoid separations were computed using GEOID 03.


Thomas G. Kelly, Jr. PLS 13197
BWSC



PROJECT: LIMESTONE COUNTY, AL. MAPPING AND NEW CONCRETE
 SURVEY MONUMENT COORDINATES

HORIZONTAL DATUM: NAD 83 (1992 ADJUSTMENT)
 VERTICAL DATUM: NAVD 88
 STATE PLANE: ALABAMA WEST ZONE NAD83
 REFERENCE ELLIPSOID: GRS 1980
 STATE PLANE COORDINATES IN: U.S. SURVEY FEET
 ORTHOMETRIC HEIGHT IN: U.S. SURVEY FEET

POINT ID	EASTING	NORTHING	ORTHO. HGT
1	2182187.76037	1827376.95379	937.91961
2	2183371.62984	1811525.27296	874.61702
2 AZ	2183020.87436	1811545.26052	869.72555
3	2183256.68214	1788041.17058	806.67062
4	2183118.92264	1766140.53512	742.36389
5	2183038.82540	1744705.81143	705.10371
6	2182985.79124	1725666.74704	746.26507
6 AZ	2182974.16845	1725229.07682	733.03213
7	2182682.44350	1676123.85708	623.05018
7 AZ	2183737.33123	1675972.94416	593.67755
8	2185278.32465	1663575.54854	564.40823
9	2185410.75498	1656773.54878	563.31274
10	2171153.18458	1670706.75109	583.04634
11	2161060.38437	1667305.22325	577.53628
12	2165737.96080	1670524.09681	580.17196
13	2149379.57824	1676260.49457	562.83006
14	2156181.13665	1726664.15686	698.62666
15	2160476.53269	1733751.61256	689.56334
15 AZ	2160048.19533	1733809.42616	700.30919
16	2161364.40399	1742636.93672	722.12755
16 AZ	2160952.36483	1742629.43160	727.13425
17	2160935.38024	1755837.84737	754.44449
17 AZ	2160847.47710	1754567.19327	744.80615
18	2166396.54974	1763896.66790	791.53961
19	2169964.76214	1768303.81051	811.53366
20	2177763.60847	1779549.82789	867.42738
21	2172484.83211	1784951.71863	839.81062
21 AZ	2172490.84912	1785435.34911	845.26910
22	2167029.49122	1811499.39139	895.81227
23	2167091.05417	1817515.81799	909.48554
24	2160848.72579	1827943.54781	904.75834
25	2154068.74070	1828712.01006	643.07549
26	2161299.80903	1817991.11340	870.37926
26 AZ	2161559.80777	1817880.19236	869.43369
27	2161206.31577	1811406.01146	871.61092
28	2161609.41696	1795583.37509	851.17267
29	2161456.59666	1774321.26889	822.26654
30	2155723.87138	1763047.38182	728.02033
31	2150201.02307	1757975.36977	690.74347
32	2155556.35593	1753737.55060	754.88996
33	2150138.55119	1748072.56485	729.75934
34	2155454.59873	1743192.68659	712.72567
35	2150161.25421	1737863.82407	679.61008
36	2139548.26219	1734126.65269	731.76100

37	2149854.29426	1727090.51610	656.69289
37 AZ	2150226.98644	1726692.44126	658.29416
38	2144890.05322	1721408.78110	615.20256
39	2142172.15575	1717040.26546	603.50263
40	2118334.19027	1706049.55171	568.21149
41	2111445.55363	1700702.15760	564.71552
42	2101541.54130	1715249.33127	592.76040
43	2140158.76896	1774572.52188	789.59589
43 AZ	2140493.56556	1774577.04317	791.57303
44	2139823.57892	1794090.82829	851.19304
44 AZ	2139826.32652	1793214.65273	838.47671
45	2139794.54081	1823683.57604	697.31639
46	2121823.04427	1790817.34254	817.64495
47	2116384.13979	1793812.31195	800.74939
47 AZ	2117196.52826	1793749.66897	795.05376
48	2116801.68633	1786761.85523	770.44704
48 AZ	2116808.10439	1787270.33761	781.01776
49	2121688.73829	1785305.65653	672.95329
50	2097961.40981	1743434.25397	708.39338
50 AZ	2097463.63243	1743409.80490	705.92346
51	2086331.81305	1722628.73051	626.96822
52	2082373.51958	1717408.87697	586.00406
53	2072902.98575	1730237.40176	630.61135
53 AZ	2073327.54479	1730202.90151	635.96422
54	2075838.65401	1734926.91675	644.17077
54 AZ	2076361.77285	1734523.51867	641.03969
55	2098040.91045	1768694.98591	745.00656
55 AZ	2097260.88997	1768756.42635	733.42623
56	2097263.52343	1796436.51173	811.60129
56 AZ	2096198.89105	1797450.83208	808.78590
57	2100411.00542	1820035.45325	634.70633
58	2076969.96108	1821957.62039	856.70065
59	2076261.60048	1793221.61193	769.55579
60	2076034.83906	1763932.06823	697.41592
60 AZ	2076277.86770	1763891.53917	704.18634
61	2063807.77195	1743943.03548	680.89467
61 AZ	2063809.66598	1744286.36755	683.17174
62	2059892.17483	1736717.29305	603.47983
63	2050086.33792	1742242.05555	594.06849
63 AZ	2050063.48082	1743803.47907	596.34738
64	2054065.50935	1757054.08010	684.46533
65	2054282.49068	1768609.13904	719.60889
66	2054882.78522	1792511.61991	789.95323
66 AZ	2054896.97226	1793144.31895	789.44545
67	2055948.56994	1820260.55290	731.37649
68	2048116.60941	1822557.34842	812.90265
69	2044368.05334	1807242.71221	834.05392
69 AZ	2044403.93059	1807974.84392	848.10947
70	2043619.05811	1788929.92016	805.14694
71	2043591.20724	1764792.91166	697.78501
71 AZ	2043604.78046	1765268.82002	679.82183
72	2036610.83220	1743654.67603	632.35030
73	2038928.95983	1737940.57999	599.98061
130 (42 11)	2096993.46542	1707657.83588	566.93019
141 (42 21)	2171597.42725	1739577.88676	710.09143
144 (42 24)	2166510.95455	1771335.17269	815.84107
164	2154834.94850	1668957.55029	560.47352

170	2084394.60668	1710284.16809	593.54456
176 (A-53)	2121540.64038	1817260.74142	659.62825
180	2133658.38742	1684698.24212	573.96507
181	2125161.76799	1796250.74659	778.56599
182	2182840.05765	1703937.87889	691.01075
188 (42 34)	2144630.00519	1684110.02126	585.04174
195	2164682.61781	1697329.62230	611.68169
199 (K-53A) PID	2127013.81486	1747672.23271	718.77760
212	2127455.84311	1715819.35952	633.83074
220	2133842.41516	1691800.68217	576.12924

EXISTING HORIZONTAL USED TO ESTABLISH NEW
STATION HORIZONTAL COORDINATES

40 12	2010403.79945	1734302.49564	579.10839
40 34	2072122.98265	1701316.61707	626.65529
42 3	2091440.52056	1815447.15663	608.92051
42 6	2121779.02180	1817482.01390	658.29496
42 8	2070501.04019	1739476.59603	629.70177
42 9	2102311.12591	1735805.82257	692.63351
42 11	2096993.46542	1707657.83588	566.93019
42 15	2167679.91920	1676042.54768	572.76541
42 17	2165968.74571	1702471.84549	614.06559
42 20	2131427.99956	1736755.05396	685.06666
42 21	2171597.42725	1739577.88676	710.09143
42 24	2166510.95455	1771335.17269	815.84107
42 25	2167090.04377	1796534.94495	862.30989
42 27	2128702.58676	1778377.54160	795.16290
42 29	2067145.51940	1771589.35723	786.59705
42 31	2071279.34186	1799121.33936	588.11291
42 34	2144630.00519	1684110.02126	585.04174
45 1	2183130.29481	1673250.62104	601.31285

EXISTING HORIZONTAL AND VERTICAL USED
TO ESTABLISH NEW STATION COORDINATES

8900	2193824.93465	1806211.86495	895.67098
B-313	2189694.45750	1706674.60575	670.40652
S-313	2134677.84043	1691944.10862	577.16426

EXISTING VERTICAL USED TO ESTABLISH NEW
STATION ORTHOMETRIC HEIGHT

A-53	2121540.64038	1817260.74142	659.62825
A-477	2120327.45232	1681530.57312	566.95421
G-477	2087181.59201	1686393.94854	575.06551
K-53	2127092.19310	1747606.86254	720.04398
K-53A (PID) 199	2127013.81486	1747672.23271	718.77760
G-477	2087181.59201	1686393.94854	575.06551
L-53A	2127274.99166	1737634.87881	697.87855
WSR 31RA	2105029.16334	1708237.29565	562.80111
WSR-49RA	2166028.85856	1661893.73561	577.15926

PROJECT: LIMESTONE COUNTY, AL. MAPPING AND NEW CONCRETE
 SURVEY MONUMENT COORDINATES

HORIZONTAL DATUM: NAD 83
 VERTICAL DATUM: NAVD 88
 REFERENCE ELLIPSOID: GRS 1980
 GEODETIC COORDINATES IN: DD MM SS.SSSSS
 ORTHOMETRIC HEIGHTS IN: U.S.SURVEY FEET

POINT ID	LATITUDE	LONGITUDE	ORTHO.HGT
1	35 1 14.972611 N	86 47 10.677361 W	937.91961
2	34 58 38.105983 N	86 46 57.812348 W	874.61702
2 AZ	34 58 38.328550 N	86 47 2.025486 W	869.72555
3	34 54 45.840081 N	86 47 1.214592 W	806.67062
4	34 51 9.235081 N	86 47 4.746406 W	742.36389
5	34 47 37.232110 N	86 47 7.539151 W	705.10371
6	34 44 28.920686 N	86 47 9.797158 W	746.26507
6 AZ	34 44 24.592492 N	86 47 9.973664 W	733.03213
7	34 36 18.906066 N	86 47 17.627546 W	623.05018
7 AZ	34 36 17.339549 N	86 47 5.021060 W	593.67755
8	34 34 14.605142 N	86 46 47.644900 W	564.40823
9	34 33 7.315113 N	86 46 46.641498 W	563.31274
10	34 35 26.106527 N	86 49 35.981671 W	583.04634
11	34 34 53.110028 N	86 51 36.956865 W	577.53628
12	34 35 24.652426 N	86 50 40.765788 W	580.17196
13	34 36 22.401083 N	86 53 56.015597 W	562.83006
14	34 44 40.551411 N	86 52 30.907404 W	698.62666
15	34 45 50.387533 N	86 51 38.895836 W	689.56334
15 AZ	34 45 50.986297 N	86 51 44.025371 W	700.30919
16	34 47 18.217356 N	86 51 27.573046 W	722.12755
16 AZ	34 47 18.169164 N	86 51 32.513659 W	727.13425
17	34 49 28.815657 N	86 51 31.705674 W	754.44449
17 AZ	34 49 16.253112 N	86 51 32.857381 W	744.80615
18	34 50 48.175254 N	86 50 25.566189 W	791.53961
19	34 51 31.531787 N	86 49 42.401899 W	811.53366
20	34 53 22.237674 N	86 48 7.881209 W	867.42738
21	34 54 16.026114 N	86 49 10.806103 W	839.81062
21 AZ	34 54 20.809219 N	86 49 10.694407 W	845.26910
22	34 58 38.965907 N	86 50 14.191472 W	895.81227
23	34 59 38.468772 N	86 50 12.971942 W	909.48554
24	35 1 22.010106 N	86 51 27.193063 W	904.75834
25	35 1 30.034723 N	86 52 48.654129 W	643.07549
26	34 59 43.544434 N	86 51 22.540876 W	870.37926
26 AZ	34 59 42.430759 N	86 51 19.424462 W	869.43369
27	34 58 38.418620 N	86 51 24.174155 W	871.61092
28	34 56 1.894010 N	86 51 20.555249 W	851.17267
29	34 52 31.602173 N	86 51 24.031440 W	822.26654
30	34 50 40.450583 N	86 52 33.677297 W	728.02033
31	34 49 50.617758 N	86 53 40.304771 W	690.74347
32	34 49 8.376725 N	86 52 36.381014 W	754.88996
33	34 48 12.671611 N	86 53 41.770417 W	729.75934
34	34 47 24.082540 N	86 52 38.386001 W	712.72567
35	34 46 31.693869 N	86 53 42.235656 W	679.61008
36	34 45 55.342236 N	86 55 49.712969 W	731.76100
37	34 44 45.150991 N	86 53 46.691177 W	656.69289

37 AZ	34 44 41.191375 N	86 53 42.253843 W	658.29416
38	34 43 49.242171 N	86 54 46.576248 W	615.20256
39	34 43 6.187493 N	86 55 19.440095 W	603.50263
40	34 41 18.734665 N	87 0 5.656237 W	568.21149
41	34 40 26.170210 N	87 1 28.451090 W	564.71552
42	34 42 50.511233 N	87 3 26.266836 W	592.76040
43	34 52 35.365214 N	86 55 39.630157 W	789.59589
43 AZ	34 52 35.391001 N	86 55 35.611559 W	791.57303
44	34 55 48.440563 N	86 55 42.315916 W	851.19304
44 AZ	34 55 39.774154 N	86 55 42.343023 W	838.47671
45	35 0 41.142102 N	86 55 40.630780 W	697.31639
46	34 55 17.025766 N	86 59 18.704415 W	817.64495
47	34 55 46.919452 N	87 0 23.842104 W	800.74939
47 AZ	34 55 46.260114 N	87 0 14.088991 W	795.05376
48	34 54 37.162002 N	87 0 19.245822 W	770.44704
48 AZ	34 54 42.191167 N	87 0 19.138590 W	781.01776
49	34 54 22.515772 N	86 59 20.655098 W	672.95329
50	34 47 29.456181 N	87 4 7.704490 W	708.39338
50 AZ	34 47 29.235448 N	87 4 13.674151 W	705.92346
51	34 44 4.129444 N	87 6 28.118737 W	626.96822
52	34 43 12.646845 N	87 7 15.782417 W	586.00406
53	34 45 19.880021 N	87 9 8.707285 W	630.61135
53 AZ	34 45 19.524206 N	87 9 3.620370 W	635.96422
54	34 46 6.164872 N	87 8 33.323350 W	644.17077
54 AZ	34 46 2.156182 N	87 8 27.070079 W	641.03969
55	34 51 39.316342 N	87 4 5.447617 W	745.00656
55 AZ	34 51 39.957207 N	87 4 14.804842 W	733.42623
56	34 56 13.748174 N	87 4 13.348194 W	811.60129
56 AZ	34 56 23.826058 N	87 4 26.083894 W	808.78590
57	35 0 7.033202 N	87 3 34.294020 W	634.70633
58	35 0 26.977295 N	87 8 15.990148 W	856.70065
59	34 55 42.767970 N	87 8 25.748129 W	769.55579
60	34 50 53.062375 N	87 8 29.730197 W	697.41592
60 AZ	34 50 52.652883 N	87 8 26.815981 W	704.18634
61	34 47 35.748188 N	87 10 57.194793 W	680.89467
61 AZ	34 47 39.144219 N	87 10 57.159067 W	683.17174
62	34 46 24.394020 N	87 11 44.407409 W	603.47983
63	34 47 19.320974 N	87 13 41.777563 W	594.06849
63 AZ	34 47 34.766577 N	87 13 42.000969 W	596.34738
64	34 49 45.726025 N	87 12 53.563204 W	684.46533
65	34 51 40.016883 N	87 12 50.565077 W	719.60889
66	34 55 36.429538 N	87 12 42.535971 W	789.95323
66 AZ	34 55 42.687395 N	87 12 42.343699 W	789.44545
67	35 0 10.872244 N	87 12 28.762590 W	731.37649
68	35 0 33.806788 N	87 14 2.837769 W	812.90265
69	34 58 2.421488 N	87 14 48.369646 W	834.05392
69 AZ	34 58 9.662349 N	87 14 47.916254 W	848.10947
70	34 55 1.301392 N	87 14 57.920680 W	805.14694
71	34 51 2.551478 N	87 14 58.979261 W	697.78501
71 AZ	34 51 7.258604 N	87 14 58.802140 W	679.82183
72	34 47 33.625007 N	87 16 23.309751 W	632.35030
73	34 46 37.050496 N	87 15 55.674197 W	599.98061
130 (42 11)	34 41 35.613873 N	87 4 21.134120 W	566.93019
141 (42 21)	34 46 47.295553 N	86 49 25.134390 W	710.09143
144 (42 24)	34 52 1.741723 N	86 50 23.605930 W	815.84107
164	34 35 9.837934 N	86 52 51.288650 W	560.47352
170	34 42 2.095902 N	87 6 51.897133 W	593.54456

176(A-53)	34 59 38.593128 N	86 59 20.473034 W	659.62825
180	34 37 46.749785 N	86 57 3.541304 W	573.96507
181	34 56 10.597418 N	86 58 38.269465 W	778.56599
182	34 40 54.008921 N	86 47 13.388331 W	691.01075
188(42 34)	34 37 40.320823 N	86 54 52.290150 W	585.04174
195	34 39 49.862718 N	86 50 51.313848 W	611.68169
199(K-53A) PID	34 48 10.002779 N	86 58 19.098870 W	718.77760
212	34 42 54.911853 N	86 58 15.808708 W	633.83074
220	34 38 56.993727 N	86 57 0.875571 W	576.12924

EXISTING HORIZONTAL USED TO ESTABLISH NEW
STATION HORIZONTAL COORDINATES

40 12	34 46 1.588963 N	87 21 37.702680 W	579.10839
40 34	34 40 33.831943 N	87 9 19.243090 W	626.65529
42 3	34 59 22.027723 N	87 5 22.352540 W	608.92051
42 6	34 59 40.769663 N	86 59 17.594200 W	658.29496
42 8	34 46 51.351503 N	87 9 37.120300 W	629.70177
42 9	34 46 13.812173 N	87 3 15.956740 W	692.63351
42 11	34 41 35.613873 N	87 4 21.134120 W	566.93019
42 15	34 36 19.112133 N	86 50 17.105700 W	572.76541
42 17	34 40 40.643143 N	86 50 35.515850 W	614.06559
42 20	34 46 21.785033 N	86 57 26.873220 W	685.06666
42 21	34 46 47.295553 N	86 49 25.134390 W	710.09143
42 24	34 52 1.741723 N	86 50 23.605930 W	815.84107
42 25	34 56 10.951793 N	86 50 14.655390 W	862.30989
42 27	34 53 13.626853 N	86 57 56.886350 W	795.16290
42 29	34 52 9.105343 N	87 10 16.086740 W	786.59705
42 31	34 56 41.296933 N	87 9 25.342810 W	588.11291
42 34	34 37 40.320823 N	86 54 52.290150 W	585.04174
45 1	34 35 50.454853 N	86 47 12.513010 W	601.31285

EXISTING HORIZONTAL AND VERTICAL USED
TO ESTABLISH NEW STATION COORDINATES

8900	34 57 44.793273 N	86 44 52.681050 W	895.67098
B-313	34 41 20.590353 N	86 45 51.076830 W	670.40652
S-313	34 38 58.367233 N	86 56 50.866650 W	577.16426

EXISTING VERTICAL USED TO ESTABLISH NEW
STATION ORTHOMETRIC HEIGHT

A-53	34 59 38.593128 N	86 59 20.473034 W	659.62825
A-477	34 37 16.105530 N	86 59 43.257275 W	566.95421
G-477	34 38 5.674473 N	87 6 19.638090 W	575.06551
K-53	34 48 9.352105 N	86 58 18.163117 W	720.04398
K-53A(199) PID	34 48 10.002779 N	86 58 19.098870 W	718.77760
L-53A	34 46 30.706688 N	86 58 16.600689 W	697.87855
WSR-31RA	34 41 40.997544 N	87 2 44.868125 W	562.80111
WSR-49RA	34 33 59.267239 N	86 50 37.957355 W	577.15926